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A Review on Tidal Energy

Harshit Chaudhary[1], Parth Gupta[2], Dr. J.P. Kesari[3]

[1,2]*Student Dept. of Information Technology, Delhi Technological University, New Delhi, India*
[3]*Associate Professor, Dept. of Mechanical Engineering, Delhi Technological University, New Delhi, India*

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Abstract – *The rise and fall of sea levels which is caused by the combined effects of the gravitational forces exerted by the sun and the moon, and the rotation of the Earth are known as Tides. As we are progressing with technology the usage of electric and electronic devices is exponentially increasing and there is a need to produce extra power other than the existing power sources so as to meet the future demands.*
Tidal energy is considered as one of the best renewable sources of energy which exists presently. tidal energy is something that has a long-term perspective, and it can be forecasted more accurately as compared to other renewable sources of energy i.e., wind, thermal, solar energy, etc. Tidal energy is non-polluting and renewable. Because of these characteristics, it is unique and appropriate for future usage as a power generating source. Around the world, many types of tidal power plants exist, each with a different tidal elevation. In addition, the process of converting tidal energy into electrical energy varies by location. However, the technology used to harvest energy from tides is typically identical to that used in traditional hydroelectric power plants.

Key Words: *Tides, Tidal Energy, Power generation, electrical energy.*

1.INTRODUCTION

Tidal energy a.k.a Tidal power, is a form of hydropower that converts the energy of tides into electricity or other useful forms of power.
Although not often used today, tidal power has the potential to provide electricity in the future. Wind and solar energy are less predictable than tides. Tidal power has traditionally had a high cost and restricted availability of locations with sufficiently large tidal ranges or flow velocities, limiting its total availability among renewable energy sources. However, many recent technological advancements and improvements, both in design (e.g., dynamic tidal power, tidal lagoons) and turbine technology (e.g., new axial turbines, cross flow turbines), suggest that total tidal energy availability may be much higher than previously assumed, and that economic and environmental costs may be dragged down to realistic prices.

Tidal power is usually generated by building a dam across a tidal basin's entrance. The dam has a gate that opens to enable the tide to flow into the basin; the gate then closes, and typical hydropower technologies may be utilized to produce electricity from the raised water in the basin when the sea level decreases.

2. LITERATURE REVIEW

[1] For populations living near tidal bodies of water, tidal energy provides a clean, green, renewable, and efficient source of energy. Tidal energy is a promising, dependable, and environmentally friendly source of energy. There are several potential sites throughout the world that need to be investigated for the installation of tidal current turbines. India has a lot of promise when it comes to producing energy from renewable sources (RES).

[2] For power extraction from free or ultra-low head water flow, the tidal energy sector must create a new generation of efficient, low-cost, and ecologically friendly equipment. The negative environmental effects of tidal barrages are likely to be substantially lower than previously thought. those of other power sources, although they are not fully understood at the moment. It is essential to consider the impact of energy extraction when calculating available resources. Energy derived from a possible tidal energy location.

3. TIDAL ENERGY GENERATOR

Tidal energy is generated by the movement of our tides and seas, where the intensity of the water from tidal rise and fall is a type of kinetic energy. Tidal power is a subset of gravitational hydropower, which uses the flow of water to propel a turbine and create energy. The turbines are similar to wind turbines; however, they are located underwater.

Tidal energy can be obtained using three methods: tidal streams, barrages, tidal lagoons.

3.1 Tidal Streams

A tidal stream is a fast-flowing body of water caused by the tides. A turbine is a device that uses a fluid flow to draw out energy. This fluid might be either air (wind) or liquid (water). Tidal energy is more potent than wind energy because water is considerably denser than air. Tides, unlike wind, are predictable and steady. Tidal generators generate a consistent, dependable supply of energy wherever they are utilised.

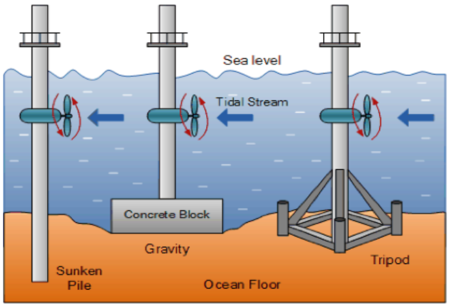

Fig-1: Design for Tidal Stream Generator

The installation of turbines in tidal streams is complicated since the devices are big and disturb the tide that they are attempting to capture. Depending on the size of the turbine and the location of the tidal stream, the environmental effect might be devastating. In shallow water, turbines are most efficient. This generates more energy and enables ships to navigate around the turbines. The turbine blades of a tidal generator also slowly turn which helps marine creatures from being entangled in the system.

3.2 Barrages

A large dam known as a barrage is used in another form of tidal energy generator. Because the dam is low, water can pour over the top or through turbines in the dam with a barrage. Barrages can be built over tidal rivers, bays, and estuaries (the wide part (mouth) of a river where it joins the sea).

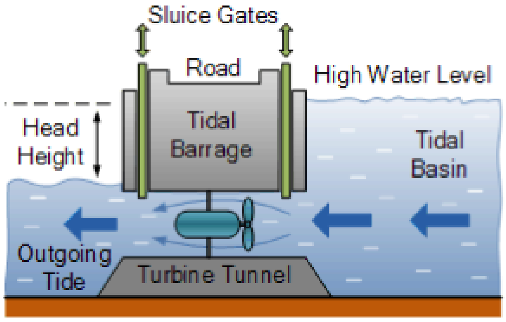

Fig-2: Tidal Barrage Flood Generation system

Turbines inside the barrage capture the force of the tides in the same manner as a river dam does. As the sea rises, the barrage gates open. The barrage gates close at high tide, producing a lake or tidal lagoon. The water is subsequently discharged through the barrage's turbines, which generate electricity at a rate that engineers can regulate.

A barrage system can have a major environmental impact. The tidal range's land has been entirely disturbed. Turbines in barrages move fast, and marine creatures can be trapped in the blades. Birds may migrate to new locations if their food supply is restricted.

A barrage is significantly more costly than a single turbine for generating tidal energy. Despite the lack of fuel expenses, barrages need more building and machinery. Barrages, unlike single turbines, require continual supervision in order to regulate power production.

3.3 Tidal Lagoon

A tidal lagoon is a body of ocean water partially surrounded by a natural or man-made barrier. Freshwater empties into tidal lagoons, which are also known as estuaries. A tidal energy producer that uses tidal lagoons would work similarly to a barrage. However, unlike barrages, tidal lagoons may be built along the natural coastline. Continuous energy might be generated by a tidal lagoon power plant. As the lagoon fills and empties, the turbines spin.

Fig-3: Tidal Lagoon in Swansea Bay

Tidal lagoons have a little environmental impact. Natural resources such as rock can be used to build the lagoons. At low tide, they would show as a low breakwater (sea wall), and at high tide, they would be submerged. Smaller creatures could swim inside the structure, and animals could swim around it. Large predators such as sharks would be unable to enter the lagoon, allowing smaller fish to thrive. Birds would most likely swarm the area. However, the energy production from tidal lagoon generators is likely to be low.

4. ENERGY CALCULATIONS

$$P = \frac{\varepsilon \rho A V^3}{2}$$

where,
ε=the turbine efficiency
P=the power generated (in watts)
ρ=the density of water
A=the sweep area of the turbine (in m^2)
V=the velocity of the flow

Since there are various types of turbine designs, hence each turbine has different efficiency. The above formula can help us formulate the power generated (in Watts) by these turbines if the following parameters are known to us.

5. SCOPE OF TIDAL ENERGY

5.1 Scope in India

India's tidal power potential is estimated to be approximately **12,455 MW**. The Gulf of Khambat, Gulf of Kutch, and southern Gujarat, Palk Bay- Mannar Channel in Tamil Nadu, and the Hoogly River, South Haldia, and Sunderbans in West Bengal are all possible places with low/medium tidal wave intensity. Tidal energy is still in the research and development (R&D) stage in India, and it has yet to be commercialised. Due to high capital costs ranging from Rs. 30 crores to Rs. 60 crore per MW, previous attempts to capture tidal power were unsuccessful.

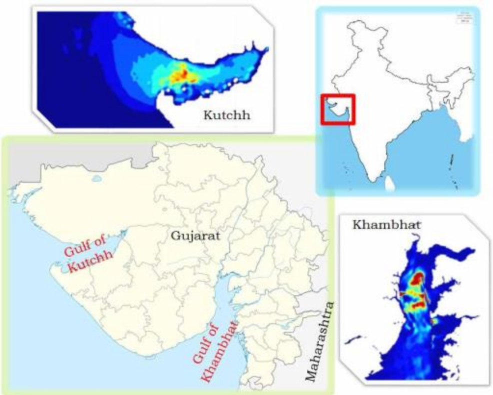

Fig-4: Image of India Gulfs

5.2 Around the World

5.2.1 Sihwa Lake Tidal Power Station, South Korea (254MW)

The world's largest tidal power plant, the Sihwa Lake tidal power station, is located on Lake Sihwa, roughly 4 kilometres from the city of Siheung in Gyeonggi Province, South Korea has an output capacity of 254MW.

Fig-5: Sihwa Lake Tidal Power Plant

The project, which is owned by Korea Water Resources Corporation, began operations in August 2011 and makes use of a 12.5-kilometer-long barrier built in 1994 for flood control and agricultural uses. Ten 25.4MW underwater bulb turbines generate electricity from tidal inputs into the 30km2 basin. The water discharge from the barrage is controlled by eight culvert-style sluice gates. This tidal power project was built between 2003-2010. The annual generation capacity of this facility is 552.7GWh.

5.2.2 La Rance Tidal Power Plant, France (240MW)

Fig-6: The La Rance Tidal barrage

The 240MW La Rance tidal power plant, located on the Rance River's estuary in Brittany, France, has been in operation since 1966. It is the world's oldest and second-largest tidal power plant. Électricité de France (EDF) presently operates the renewable power plant, which has an annual generating capacity of 540GWh.

5.2.3 Swansea Bay Tidal Lagoon, United Kingdom (Rejected by UK Govt.)

Fig-7: Visualization of a six-mile sea wall to generate Tidal Lagoon Power

The Swansea Bay Tidal Lagoon, United Kingdom, which was to be built at Swansea Bay, would have been the world's biggest tidal power project. The project was approved in march 2013 with a budget of £850m ($1.4bn).

The Secretary of State for Business, Energy and Industrial Strategy in June 2018 announced that the Government would not approve the plan, but other options to enable the proposal to go ahead are reportedly still being explored.

5.2.4 MeyGen Tidal Energy Project, Scotland (86MW)

This project is situated in the Inner Sound of the Pentland Firth off the north coast of Caithness, Scotland. It is currently the world's biggest underwater tidal turbine power project under development.

Fig-8: 6-MW MeyGen Array

The MyGen project began in 2006 by MeyGen, a joint venture between Atlantis Resources, a tidal technology firm, and Morgan Stanley. In December 2013, Atlantis Resources acquired full control of the tidal array project.

5.2.5 Annapolis Royal Generating Station, Canada (20MW)

The Annapolis tidal power producing station in Canada's Annapolis Basin, a sub-basin of the Bay of Fundy, has a capacity of 20MW, making it the world's third largest active tidal power plant. It generates enough electricity to power approximately 4,000 houses with 50 GWh per year.

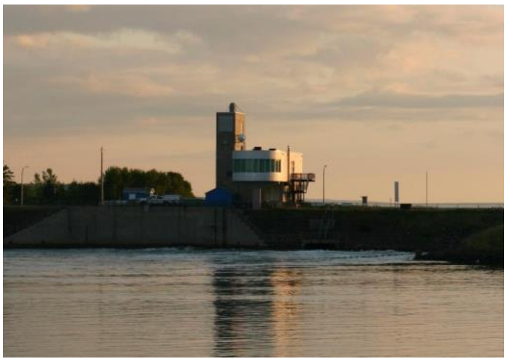

Fig-9: The Annapolis Tidal Station

A single four-blade turbine and sluice gates make up the power plant. When the approaching tides form a head pond in the lower sections of the Annapolis River upstream of the causeway, the gates are closed. When a head of 1.6m or more is established between the head pond and the sea side with the tide dropping, the gates are released and the water pouring into the sea powers the turbine to generate electricity.

6. ADVANTAGES & DISADVANTAGES OF TIDAL ENERGY.

6.1 Advantages

1. Being a renewable and sustainable energy source, tidal energy reduces the dependence on fossil fuels.
2. No liquid or solid pollutants are produced.
3. The energy from tides can be stored for future use.
4. In contrast to wind energy, tidal currents are both predictable and reliable.
5. Tidally driven coastal currents generate an energy density which is four times greater than air.

6.2 Disadvantages

1. The Tidal energy sources cannot be easily transported for long distances.
2. Energy generation can get disrupted by adverse weather conditions.
3. Tidal power can disrupt the habitats of aquatic life such as fishes, water mammals etc.
4. It is only appropriate for towns that are close to a tidal body of water.
5. The cost to set up the tidal power plants is exceedingly large.

7. CONCLUSION

For populations living near tidal bodies of water, tidal energy provides a clean, green, renewable, and efficient source of energy. Tidal energy is a promising, dependable, and environmentally friendly source of energy. There are several prospective sites throughout the world that need to be investigated for the installation of tidal current turbines. India has a lot of promise when it comes to producing energy from renewable sources (RES). Renewable energy now makes a minor contribution, but future advances may make RES technology more affordable, allowing it to supplant conventional energy sources.

The strategy for achieving these enhanced goals will rely heavily on the active participation of all stakeholders, including government agencies, non-governmental organisations (NGOs), manufacturers, research and development institutions, financial institutions, and developers, as well as a new breed of energy entrepreneurs.

8. REFERENCES

8.1 Content References

[1] Bharthi, D. Hemavathi and Shobha Rani "TIDAL ENERGY- A SOURCE OF CLEAN ENERGY" International Journal of Current Research.

[2] Vikas M, Subba Rao, Jaya Kumar Seelam "TIDAL ENERGY- A REVIEW"

[3] https://mnre.gov.in/new-technologies /ocean-energy

[4] https://www.power-technology.com/features/featuretidal-giants-the-world s-five-biggest-tidal-power-plants-42 11218/

8.2 Image References

[1] https://www.alternative-energy-tutorials.com/tidal-energy/tidal-stream.html

[2] https://www.carbonbrief.org/a-rough -guide-to-tidal-lagoons

[3] https://rnd.iitb.ac.in/research-glimps e/tidal-energy-assessment-resources- along-indian-gulfs

[4] https://en.wikipedia.org/wiki/Annapolis_Royal_Generating_Station

[5] https://www.powermag.com/meygen -array-sets-global-records-for-harnes sing-tidal-power/

[6] https://www.theguardian.com/environment/2019/feb/04/swansea-tidal-lag oon-plan-government

[7] https://tethys.pnnl.gov/project-sites/l a-rance-tidal-barrage

[8] https://www.bibalex.org/SCIplanet/en/Article/Details?id=76