A Review on Tidal Power in India

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Abstract—Tidal power, also called tidal energy, is a form of hydropower that converts the energy of tides into useful forms of power mainly electricity. Tides are more predictable than wind energy and solar power[1]. Tidal power still accounts for only a fraction of a percent of the world's total electricity generation [8]. That is slowly changing though, with numerous tidal power plants being constructed or planned for coastlines around the world. India is the latest country to wade into the tidal power waters with the announcement of its first commercial scale tidal current power plant to be constructed in the Indian State of Gujarat [2].

Keywords—waves, tidal energy.

I. INTRODUCTION

Among sources of renewable energy, tidal power has traditionally suffered from relatively high cost and limited availability of sites with sufficiently high tidal ranges or flow velocities, thus constricting its total availability[1]. Tidal energy technologies harvest energy from the seas. The potential of tidal wave energy becomes higher in certain regions by local effects such as shelving, funnelling, reflection and resonance.Tides are generated through a combination of forces exerted by the gravitational pull of the sun and the moon and the rotation of the earth. The relative motion of the three bodies produces different tidal cycles which affect the range of the tides. Energy can be extracted from tides by creating a reservoir or basin behind a barrage and then passing tidal waters through turbines in the barrage to generate electricity[7].

Energy can be extracted from tides in several ways. In one method, a reservoir is created behind a barrage and then tidal waters pass through turbines in the barrage to generate electricity. This method requires mean tidal differences greater than 4 meters and also favorable topographical conditions to keep installation costs low[6]. Another tidal wave technology harvests energy from surface waves or from pressure fluctuations below the sea surface. The third approach to harvesting tidal energy consists of ocean thermal energy technology. This approach tries to harvest the solar energy trapped in ocean waters into usable energy.

Oceans have a thermal gradient, the surface being much warmer than deeper levels of ocean. This thermal gradient may be harvested using modified Rankine cycle. India's National Institute of Ocean Technology (NIOT) attempted this approach over the last 20 years, but without success. In 2003, with Saga University of Japan, NIOT attempted to build and deploy a 1 MW demonstration plant [5]. However, mechanical problems prevented success. After initial tests near Kerala, the unit was scheduled for redeployment and further development in the Lakshadweep Islands in 2005. The demonstration project's experiences have limited follow-on efforts with ocean thermal energy technology in India.Energy generation based on renewable resources already accounts for about one-fifth of the global power generation capacity. There is, therefore, a need to give policy directive to encourage these indigenous resources too, in line with neighbouring countries like India and China, where such resources are being rapidly harnessed economically[8].

II. TIDAL POWER IN INDIA

India is surrounded by sea on three sides; its potential to harness tidal energy is significant [4].

One report claims the most attractive locations in India, for the barrage technology, are the Gulf of Khambhat and the Gulf of Kutch on India's west coast where the maximum tidal range is 11 m and 8 m with average tidal range of 6.77 m and 5.23 m respectively. The Ganges Delta in the Sunderbans, West Bengal is another possibility, although with significantly less recoverable energy; the maximum tidal range in Sunderbans is approximately 5 m with an average tidal range of 2.97 m. The report claims, barrage technology could harvest about 8 GW from tidal energy in India, mostly in Gujarat. The barrage approach has several disadvantages, one being the effect of any badly engineered barrage on the migratory fishes, marine ecosystem and aquatic life. Integrated barrage technology plants can be expensive to build.

In December 2011, the Ministry of New & Renewable Energy, Government of India and the Renewable Energy Development Agency of Govt. of West Bengal jointly approved and agreed to implement India's first 3.75 MW Durgaduani mini tidal power project. Indian government believes that tidal energy may be an attractive solution to meet the local energy demands of this remote delta region[3].

A report from the Ocean Engineering Centre, Indian Institute of Technology, Chennai estimates the annual wave energy potential along the Indian coast is between 5 MW to 15 MW per metre, suggesting a theoretical maximum potential for electricity harvesting from India's 7500 kilometer coast line may be about 40 GW. However, the realistic economical potential, the report claims, is likely to be considerably less[4]. A significant barrier to surface energy harvesting is the interference of its equipment to fishing and other sea bound vessels, particularly in unsettled weather. India built its first seas surface energy harvesting technology demonstration plant in Vizhinjam, near Thiruruvananthpuram[4].

India has a full-fledged Ministry of New and Renewable Energy, and the country has made tremendous progress in the field in the last few years. As of June 2013, India's energy from new and renewable resources increased to 27,542MW; an over 12 per cent share in its total energy mix of 225,793MW. India now targets to have 55,000MW of cumulative installed capacity of power generation through renewable energy resources by 2017[8].

The possible operating tidal power plants in India are shown in the following table

Table2.1:

PLACE	MEAN TIDAL RANGE(MM)	AREA OF BASIN(KM^2)	MAXIMUM CAPACITY (MW)
Kutch	5.3	170	900
Cambay	6.8	1970	7000

Fig1. Location of the first Asian Tidal Power Plant in India

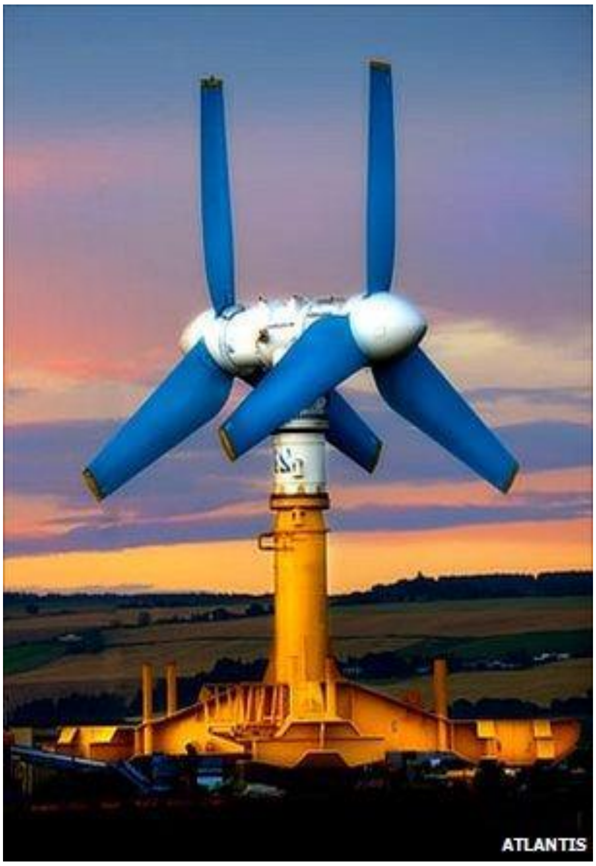

Fig2. Atlantis turbines to be installed at Gulf of Kutch

III. FEASIBILITY IN INDIA OF POWER GENERATION BY OTEC TEECHNOLOGY

Stressing the importance of earth-friendly natural energy, Indian government has been vigorously tackling on the ways to utilize tidal power. Ocean energy is their target resource for renewable energy. They put strong emphasis particularly on power generation by both OTEC technology and wave power technology. NIOT (National Institute of Ocean Technology, India), the central organization in charge of technical development of ocean energy, has long been pursuing roads for commercial application of the before-said two variations of ocean energy. OTEC generates most clean and renewable energy from seawater, which is available so abundant in the form of both quality and quantity. NIOT has predicted, as depicted in the drawing, some 1.5 x 106km2 of their coast lines should be technically good for total generation of 180,000 MW. They have decided to carry out experimental power generation off Indian coast and the specifications for the prototype experimental OTEC plant has been worked out. If things would turn positive as planned, 1,000 OTEC power plants can be constructed throughout Indian coast lines [10].

IV. CHALLENGES WITH TIDAL IN-STREAM TECHNOLOGY

There are several issues confronting the development of tidal current devices.Overall, survivability and reliability are the most significant technical challenges due to the costs related to their failures [9].

Other challenges include

- Predictability
- Affordability and Social acceptability
- Environmental issues
- Survivability and Reliability
- Manufacturability, Installability and Operability

V. ADVANTAGES AND DISADVANTAGES OF TIDAL POWER ENERGY

5.1 Advantages:

The advantages for using tidal and wave energy over different fossil fuels are plentiful, below there are several impressive benefits of using tidal and wave energy, including the factor of replacing a percentage of fossil fuel use [11].

• It reduces the dependence upon fossil fuels
• Tidal and wave energy is free, renewable, and clean source of energy
• It produces clean electricity, with no production of greenhouse gas or pollution.
•Tidal and wave energy generation and consumption creates no liquid or solid pollution
• Highly efficient resource (compared with coal and oil at 30%, tidal power efficiency is about 80%)
• Energy capturing and conversion mechanism may help protect the shoreline
• Energy capturing and conversion mechanism has little visual impact

• About 60 billion watts of energy from tides can be used for electricity generation
• Tides are active 24 hours a day, 365 days a year
• It produces energy for free, once the initial costs are recovered.

5.2 Disadvantages:

Apart from many advantages, the tidal energy generation suffers some disadvantages such as [11]

• It is not cost effective because fossil-fuel power stations do not pay for the cost of their carbon emissions to the planet. This will change as fossil fuel is valued at its real price.
• It leads to the displacement of wild life habitats.
• It can only be used where there is suitable tidal flow or wave motion. So it cannot be used inland.
• It only produces electricity during tidal surges.
• Barrage systems require salt resistant parts and lots of maintenance.
• The frames of the turbines can disrupt the movement of large marine animals and ships through the channels on which the barrage is built.
• Today, power produced from tidal fences is still a bit expensive than that using conventional plants using coal and natural gas (but it can be cheaper if improved technologies and large-scale generation is applied).
• The barrage systems have the disadvantages of disrupting fish migration and killing fish passing through the turbines, therefore, there is also the risk of destruction of ecosystem that rely on the coming and going of tides.
• The ecosystem is disrupted during the construction of building the tidal fence. This affects the fishes and also the fishermen who depends their life on it.
• Fossil fuels can be moved to just about any place to create energy on the spot. This is what allows a car to work while moving.
• Tidal energy can only be created on a coast with a good tidal differential. Worthless for a landlocked country, has to be converted to something else to be transported
• The main detriment is the cost of those plants, for constructing and running this facility with an annual output of 3423 GWh, is a cost about 1.2 billion, but this doesn't include operational and maintenance cost (coal and oil are cheaper).
• Construction of strong, cheap and efficient conversion devices may be problematic
• Technology isn't fully developed
• Problems exist with the transportation of hydroelectricity
• Ecological impacts relating to the alteration of tides and waves is not fully understood
• Appropriate waves and tides are highly location dependent
• Waves are a diffuse energy source, irregular in direction, durability and size
• Extreme weather can produce waves of great intensity.

VI. R&D ADVANCES IN TIDAL IN-STREAM TECHNOLOGY

Although India doesn't have much going on in terms of R&D and demonstration sites for tidal current energy, the government of the Indian state of Gujarat recently signed a memorandum of understanding with Atlantis Resources Corporation from England and Gujarat Power Corporation Ltd. to build a 50MW tidal farm on India's west coast. After running a global study of tidal power in 2008, Atlantis Resources Corporation identified the Gulf of Kutch in India as a site where the resource could match the capacity of the turbines. If the project follows as it is planned, the fifty Atlantis AK 1000 turbines would be installed in the Gulf with the construction starting sometime this year with the hope of being completed in 2013.28 Even though this is less about India and more about the UK in terms of technology, these types of projects, in which already-tested technology is being used in tidal farm developments all over the world, are likely to be seen more and more in the near future [9].

As those projects reflect, there is much happening in the tidal current energy industry. Innovation is moving quickly and developers are almost in a race to commercialization. However, the development of tidal energy technology is confronted with many challenges and there is still much uncertainty as to whether the timelines set for future projects can be met.

VII. CONCLUSION

The economic growth of any country depends only on the long term availability of energy from sources that are affordable, accessible and secured [13].

The assessment of tidal energy technologies confirms that the techniques have the potential to provide the nation with alternatives to meet the country's energy needs. To develop this potential, India would have to commit to the development and implementation of Tidal power plants technologies and energy conservation. The implementationof technologies would reducemany of the current environmental problems associated with conventional energy sources.

Tidal energy's scope for development will always be limited by geographical and environmental concerns. Nonetheless, the sheer size and reliability of energy produced means that, for those who have the option, tidal energy will remain a useful resource [12].

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