Implementation of Tidal Energy in Indian Coastline

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Abstract: - In this project we are going to take deep look on tidal energy in the coastal line of India, about how tidal energy is a solution for our currents situation in this world with this climate and how tidal energy works it's basically deep knowledge on tidal energy in the basis of civil engineering work. The development of renewable energy around the world has been given increased importance due to concerns regarding energy supply and climate change. Wave and tidal energy are very important components of the renewable energies that can be extracted from the oceans. Different locations around the India have good natural conditions for one of these forms of energy, with some locations even being suitable for both.

Key Words: —*Tidal Energy, Coastline, Climate change, Oceans.*

I. Introduction

Tidal energy is one of the oldest forms of energy harnessed by humans from the naturally occurring phenomena of rise and fall of the ocean's water level due to gravitational attraction between the sun, moon and the earth. A two-way pull from the earth exists between the earth and moon. The moon's pull on earth causes the ocean water facing the moon to be pulled towards it, producing the high tide. A similar high tide on the other side of the earth facing away from the moon occurs because the solid part of Earth is being pulled away by the moon as shown in the figure below. The two bulges are the high tides, the area between the bulges are the low tides. Each tidal location is approximately 6.25 hours apart.

Tidal energy is found to be concentrated in several regions of India. Although no formal study or pilot project has been reported. There is also a lack of strategic investment in this area in terms of research and development. The regions are identified, where tidal energy may be considered for development. Tidal stream conversion may be suitable for the deeper regions of Kutch and Khambat, while the shallower regions of these gulfs are suitable for barrage technology.

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Other regions of India including the Hooghly River / Sundarban areas may be considered for the development of medium to smaller tidal power plants.

Fig.1. Tidal Power Plant

II. Literature Survey

- India is the fourth biggest electricity consumer on the planet after the United States, china and Russia.
- Renewable energy is considered to be an important driver for low carbon growth and India's sustainable solution to issues related to electrification in remote locations. India has around 150 GW of known renewable energy potential.
- This potential is likely to be even greater than 150 GW, if all the sources including tidal, wave, geothermal with significant generation capacity will be mapped. Even with such a vast potential, only 22% of renewable energy potential (i.e. 33 GW 1) is developed in the country. The total installed capacity

in India is around 256 2 GW (as on October 2014) primarily dominated by thermal sources of energy.

- Thermal energy (comprising of oil, coal and natural gas) contributes around 69% 3 of total installed capacity followed by hydro, renewable and nuclear energy. Renewable energy forms 12.8% 4 of total installed capacity.
- This also shows that we are progressively moving towards the National Action Plan for Climate Change (NAPCC) target of renewable energy (i.e. 15% by 2020).
- India's energy strategy concentrates on securing energy sources to address the issue of its developing economy.
- Service of new and renewable energy has started an activity to track the advancing tidal administrative structure and build up an archive of data in a combined way.
- There are only three regions in India with largest concentration of tidal energies namely Khambat, Kutch and Sudarbans regions.
- The western coastline of India has higher tidal range. It has been learnt, when flow velocities are enhanced at the openings on the coastline, it is possible to realize reasonably good amount of energy in terms of kinetic energy.

III. OBJECTIVES

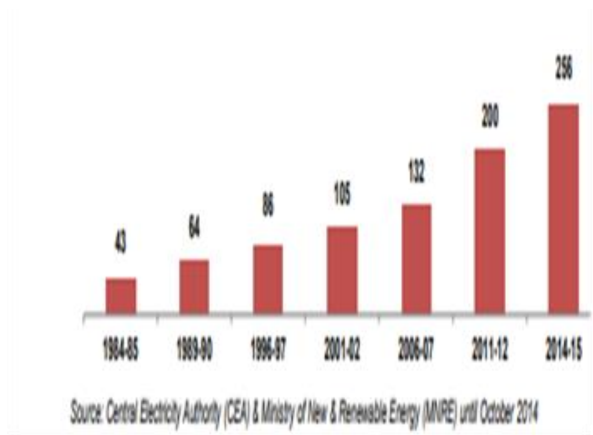
- To study tidal energy potential of India
- To make the energy need of rising population
- To overcome the environmental problem of the fossil fuel, security supply
- To provide temporary source of energy during flood in flood affected area
- To implement and to harness it for power generation
- To use the resources with other renewable energy sources such as hydro, solar, and ocean energy in the form as tidal, currents.

IV. INDIA'S CURRENT TIDAL ENERGY

The highest tidal currents usually occur in the Gulfs of Kutch and Khambat as well as Sundarbans regions. Usually, it is common to find currents exceeding 2m/s at most times of the day. This is generated by tidal gradients in the Kutch and Khambat regions. In the Sundarbans areas, even though the range of tide is lesser compared to that in the Kutch/Khambat regions, the fresh water flow and narrowing of channels in Hooghly can produce currents up to 3m/s most of the time. As far as tidal currents are concerned, these stretches could be categorized as Class-I-Tidal-Stream.

The currents generally exceed 2m/s in South of West Bengal and Khambat region. As tides enter the Bay of Bengal and the Arabian Sea, a general convergence is seen in the above regions which lead to good level of currents. These regions may be categorized as Class-II-Tidal-stream. Moderate currents exist in north of Tamilnadu and Kerala that are in the range of 1.5m/s to 2.0m/s. There are locations along the coast of Karnataka / Maharashtra (west coast) and along the Coromandal coast. These regions may be categorized as Class-III-Tidal-stream. The regions with currents less than 1m/s may be classified as Class-IV-Tidal-stream having weak tidal velocities.

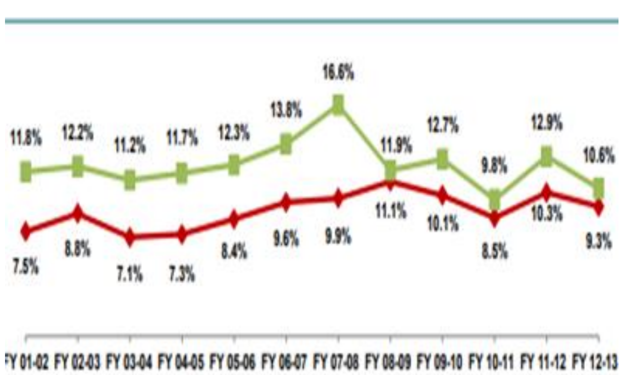
53 GW of ocean energy potential exists in India with a capacity utilization factor in the range of 15-20% for wave energy and 25%-30% for tidal energy. Most of the extractable potential exists on the western coastline of India. It includes the State of Gujarat, Maharashtra, Kerala, Karnataka, UT of Goa and Southern peninsula. Combination of off-shore wind with marine technologies helps in harnessing maximum renewable energy potential.



The continuous growth in installed capacity has not been able to catch up with the rising demand for electricity. As per the Central Electricity Authority (CEA), energy and peak demand shortage remained around 9% and 12.3% 8 respectively on an average years; and the trend is expected to continue in the near future.

Coastal Region	Tidal range	Typical tidal current	Stream classification
khambhat	5-11m	2.5m/s	Class-I-Tidal-stream
Kutch	4-9m	3.0m/s	Class-I-Tidal-stream
South Gujarat	2-4m	1.5-2.5m/s	Class-II-Tidal-stream
Karnataka/Kerala coast	1-1.5m	1.5-2.0m/s	Class-III-Tidal-stream.
Tamilnadu coast	1m	0.8m/s	Class-IV-Tidal-stream
Palk mannar bay	1.0m	0.6m/s	Class-IV-Tidal-stream
Andhra coast	1-2m	1m/s	Class-III-Tidal-stream.
Orissa coast	2-4m	1.5m/s	Class-II-Tidal-stream.

The graph below exhibits the movement of energy and peak demand shortages in the country.



The 12th Five-Year Plan (2012-13 to 2016-17) aims to add 30 GW of renewable capacity that will take the total tally of renewable energy based power plants to about 55 GW in 2016-17. Currently, the total renewable installed capacity stands at more than 32 GW.

A. Type of Tidal Energy

Tidal turbines:

Tidal turbines are very similar to wind turbines, except they are below the water's surface instead of above or on land. The water's current pushes the blades of the turbine, which is connected to a generator that creates electricity.

Tidal turbines are able to produce much more electricity than wind power plants, mainly because water is much denser than air. However, water's high density also means that tidal turbines need to be much stronger than wind turbines, making them more expensive to manufacture.

Tidal turbines are large, but they create relatively little disruption to the ecosystem around them. They could cause collision damage, like wind turbines, however, with marine life, but the blades tend to move slowly so it isn't that much of a concern. They also emit low level noise, which can impact marine mammals.

Tidal Barrages:

Tidal barrages are low-walled dams, usually installed at tidal inlets or estuaries.

Similar to traditional hydroelectric dams, sluice gates are used to create a reservoir on one side of the barrage. The barrage is secured to the sea floor, while the top of the barrage is just slightly above where the water level hits during the highest tide.

During an incoming high tide, water flows over the turbines as the water rises. Then, the water flows back through the turbines as it becomes low tide. The turbines are connected to a generator which produces the electricity.

Tidal turbines are located towards the bottom of the barrage, inside a tunnel, which allow water to flow through. Tidal barrages are the most efficient way to harness tidal energy, but they're also the most costly.

Tidal Fences:

A tidal fence is like a hybrid between tidal barrages and tidal turbines.

The vertical tidal fence turnstiles are installed together in a 'fence-like' structure, hence the name 'tidal fence'. Instead of spinning like a propeller, tidal fences spin like a turnstile.

To create electricity, the energy from tidal currents pushes the turnstile blades, which are connected to a generator.

Tidal fences have vertical blades that are pushed by moving water. These vertical turbines are installed together like a fence, but they don't require the large, concrete structure that tidal barrages do.

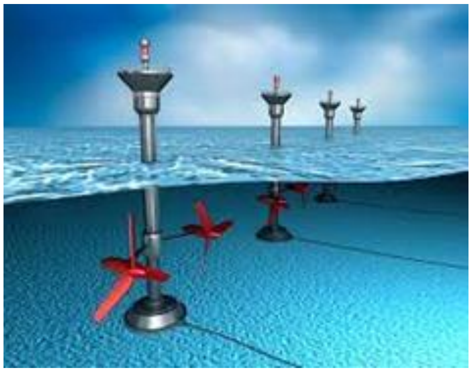


Fig.2. Tidal energy

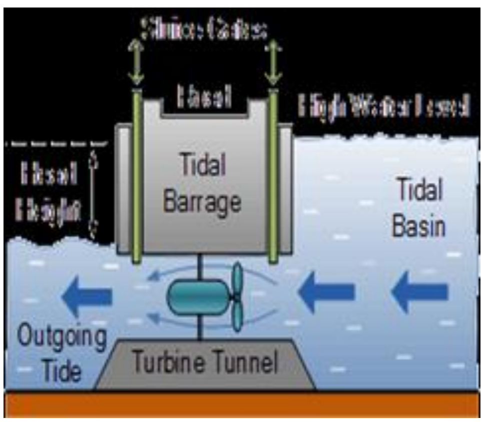


Fig.3. Tidal Barrage

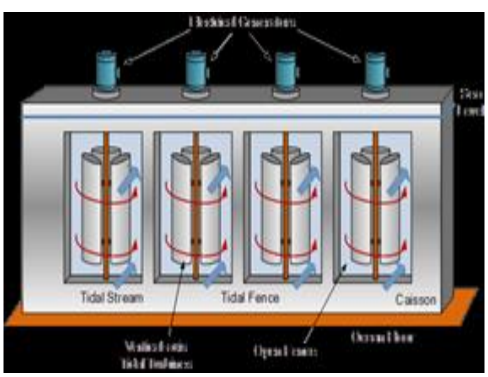


Fig.4. Tidal fences

V. India's Tidal Energy Policy

"The government has not planned harnessing tidal power due to high capital cost ranging from Rs. 30 crore to Rs. 60 crore per megawatt (MW)," Singh said in a written reply in Parliament.

India has a long coastline of 7,500 km with immense potential for ocean energy According to a study by IIT Chennai and CRISIL in December 2014, the tidal power potential of the country is estimated at about 12,455 megawatt (MW).

"The potential areas are in the Gulf of Khambhat, Gulf of Kutch and southern regions in Gujarat, Palk Bay-Mannar Channel in Tamil Nadu, and Hoogly River, South Haldia and Sunderbans in West Bengal," he added.

According to the study, the Gulf of Kambhat and Gulf of Kutch near Gujarat have an estimated potential of 7,000 MW and 1,200 MW, respectively, with Sunderbans having a potential of 100MW.

Tidal energy is a form of hydropower energy that exercises energy of the oceanic tides to generate electricity.

India had shown its inclination towards tidal energy in 2011 when the 50 MW tidal energy plant was conceptualized in Gujarat. Globally, tidal energy plants are limited with only 500 MW capacity in operation with South Korea leading the actual and planned investments.

VI. India's Future Potential In Tidal Energy

- Coal production remains key to energy mix.

- India is Fourth largest consumer of oil and petroleum in the world.
- India is relying on imports to meet growing demand for gas.
- Lack of electricity is hurting industrial output.
- Energy poverty and inequality spreads.
- GDP growth or sectoral value-added has historically not been a good indicator of electricity demand growth from irrigation pumping, which is based on both exogenous factors (for example, the monsoon quality) and policy choices.

Future Expectations and Demands of Indian Population

Future scenarios of the sectoral value-added and overall and per capita GDP, are used to determine service demands in certain sectors, which in turn determine the employment of various appliances and equipment to convert electricity into end-use services (such as water pumped, steel produced, lighting and air conditioning, etc.). The government over successive years has prioritised the manufacturing sector to draw surplus labour from primary activities and enhance growth, productivity and meaningful employment If this is achieved by 2030, then industry will need to grow at 1.5 percentage points higher than overall GDP, assuming services retains its current 60 percent share (Figure 2). This is illustrated in Table 1 at GDP growth rates of 6.5, 7 and 7.5 percent respectively, which have been chosen as the low, mid and high GDP scenarios for this study weak tidal velocities.

This has reflected in the National Manufacturing Policy (NMP) as well as the more recently launched Make in India (MII) campaign. Among key priorities has been increasing the share of manufacturing from 16-17 percent at present to 25 percent of GDP.

Table 1: Scenarios of GDP Growth (2016-30)

GDP Growth Scenarios (2016-2030)				
CAGR	GDP	6.5%	7.0%	7.5%
	Agriculture	2.2%	2.7%	3.2%
	Industry	8.0%	8.5%	9.0%
	Services	6.5%	7.0%	7.5%

Source: Author's calculations.

The Table shows the population and household characteristics (size and distribution) based on the urbanization levels in 2015 and 2030. This impacts the overall electricity and energy use from urban India based on demand for housing, urban infrastructure and related services. Over 100 million new households are expected to be added between 2016 and 2030, with three-fourths of these expected in urban areas owing to rising urbanization and shrinking household sizes.

Demographics	2012	2015	2030	CAGR {16-30}
Populaion (Million)	1262	1311	1528	1.0%
Urbanization {%}	31.4%	32.3%	40.0%	1.4%
HH Size Urban	4.52	4.36	3.54	-1.4%
HH Size Rural	5.06	4.96	4.45	-0.7%
HH Urban	88	97	173	3.9%
HH Rural	171	179	206	0.9%
HH Total	259	276	379	2.1%

A. *Drivers of Electricity Demand*

Sectors	Drivers
Agriculture	Net sown area, cropping intensity, surface and micro-irrigation coverage/ schemes, cropping pattern and water requirements, pump-set characteristics (size, head, discharge), solar, micro and canal irrigation policies, Ag-DSM
Buildings	Floor space area, urbanization and household sizes (rural and urban), affordable housing gap, service demand in low income households, appliance types, technologies and ownership, building shell design efficiency and electrical controls, ECBC, standards and labeling
Industry	National Manufacturing Policy, Make in India, Perform Achieve and Trade scheme (PAT), historical production and consumption patterns, infrastructure/development related demand, sub-sectoral policies and targets (e.g. Steel target, NG switching in fertilizer production), alternate fuels and raw material, waste/scrap recycling, thermal substitution).
Transport	Railway track growth, targets for rail route electrification, EV urban passenger demand (PKM demand, vehicle ownership and usage, EV sales targets, EV technologies, duty cycles and charging provisions)
Others	Historical rates of growth and urbanization, smart cites (smart metering)
Cross Sectoral Cross Sectoral	Demographics housing stock, rural-urban share, household sizes service demand per capita inorganic demand from new households

B. *Forecast Analysis for Future Potential of Tidal Energy*

The majority of tidal energy companies are developing horizontal axis turbines. In many ways these are analogous to both land-based and offshore wind turbines, and the general shape, mounting and fixing technology, and power take-off system designs are essentially the same. Size is by far the most important factor separating horizontal axis turbines operating in the water from horizontal axis turbines that harness wind power. Tidal turbines generating 1 MW of power can be up to one-third the size of a wind turbine with a similar generating capacity there are, however, several critical differences. Size is by far the most important factor separating horizontal axis turbines operating in the water from horizontal axis turbines that harness wind power

C. Resource Assessment and Forecasting

An important initial step towards market deployment of ocean energy is the characterization and mapping of ocean energy resources. The assessment of wave energy resources includes the identification of areas with high wave energy, the quantification of average energy resources (e.g. total annual wave energy) and the description of the resource by using parameters such as significant wave height, wave energy period and mean wave direction. Reducing uncertainties concerning the available resources will also increase the confidence of investors as it allows a better determination of the value of investments and minimizing risks. In the following sections, an overview of current state of wave and tidal current energy resource assessment and forecasting is presented Precise estimates and description of available wave energy resources at high spatial and temporal resolution are needed for proper planning and the optimization of the design of ocean energy converters, This will help to optimize device performance in terms of power produced. For example, the power output of a Oscillating Water Column device at a certain location has been studied .The current state of technology development will determine how much of the resource can be exploited with the main technical parameters to be improved being device efficiency and capacity .

VII. FUTURE RESEARCH

Accordingly "further R&D is needed in the field of resource assessment, both on the measurement side (…), and on the development and validation of suitable modeling systems."

Activities of IEC TC 114 include the definitions of resource assessment requirement which will help in achieving harmonization .Going beyond pure resource assessment, it is necessary to connect resource assessment with local limitations from other activities in the marine environmental such as fishing, shipping, and offshore wind.

However, in the recent years, modeling approaches have become more sophisticated and have been performed for many regions of the world. What is still missing is a harmonization of approaches. In Europe, the SI Ocean project aims developing a "harmonized and comprehensive pan-European wave and tidal power resource map". Current With the Ministry of New and Renewable Energy (MNRE) recently including all forms of ocean energy into the ambit of 'renewable energy' for satisfaction of renewable purchase obligations of the discoms, the immense potential of India's untapped 7,500 km coastline is up for taking. Official estimates of potential in tidal energy stand at 12,455 megawatt (MW) whereas other forms of energy such as wave energy provides for additional capacity. It is also notable that MNRE has not restricted the technologies that can be deployed for realizing the potential of ocean energy and all forms of ocean energy have been included. Given the pace of advent in technology this appears to be highly prudent step for an economy which is looking for more efficient solutions to the ever-growing energy needs

VIII. CONCLUSION

- Tidal energy is a kind of renewable energy with large potential, it has many advantages over solar and wind energy.
- The popularization of tidal energy can be expected worldwide with the development of innovative tidal turbine system and coastal infrastructure.
- And thus India should continue to build tidal energy stations along its coastal line.
- Tidal energy can be one of the most economical and less maintaining once installed.
- It can enhance the tourism industry at the coastline region.
- It will provide a large number of employment throughout the business sector, service sector industrial sector, labour.
- It can be also an emergency source of energy in flood affected areas at the coastline.

REFERENCES

[1]. Swarbrick J. Encyclopedia of pharmaceutical technology. 3rd ed. NewYork-London: Informa Healthcare; 2007. Vol. 3. p. 1850-60.

[2]. Renewable 2017 Global Status Report International Renewable Energy Agency 2017.

[3]. Study on tidal and wave energy in India survey on the potential and preposition of road map.

[4]. Andre H 1978 10 years of experience at the 'La Rance' tidal power plant Ocean Management 165-178.
[5]. https://www.iea.org/reports/india-2020.