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# UTILIZATION OF ENERGY FROM SEA WAVES IN INDIA- WAVE ENERGY TECHNOLOGY

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**ABSTRACT**

***Current Energy resources are having limitations on their use. These continuously reducing resources have increased importance of sustainable energy resources. Generating electricity from sea waves is one of the alternatives available and significant studies have been carried out on various technologies for the same. Ocean Wave Energy as the future of energy generation in India as it could result in most economic green process with minimal carbon emission review of technologies which are used to utilize the tremendous amount of energy available in sea waves as well as equipment's which are used in wave energy utilization plant. Wave energy techniques have been discussed briefly, which focuses on potential scope research and development in the future. This is going to be an alternative to meet increasing power demand and also for remote islands. This paper represents a basic review of the technology used in wave energy conversion and discusses its magnitudes in India.***

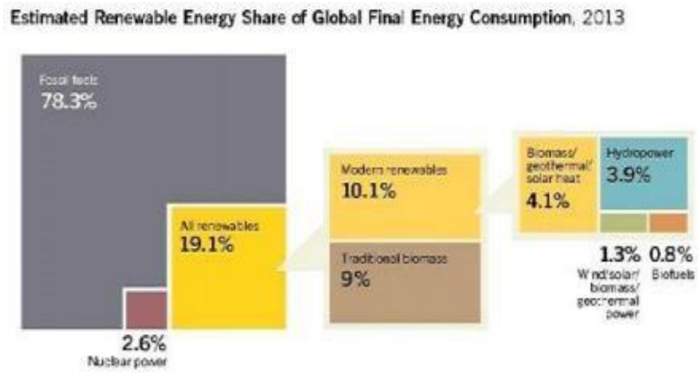
***Keywords:*** ***Renewable energy, wave energy, wave energy generation, equipment's, Power, Wave Energy Converters, Power Generation, Wave Energy Plants.***

## 1. INTRODUCTION

Among different types of ocean waves, wind generated waves have the highest energy concentration. Wind waves are derived from the winds as they blow across the oceans. This energy transfer provides a natural storage of wind energy in the water near the free surface. Once created, wind waves can travel thousands of kilometers with little energy losses, unless they encounter head winds. Nearer the coastline the wave energy intensity decreases due to interaction with the sea bed. A number of devices have been built over the last 30 years for converting wave energy into electricity. The devices built have been located on the shore line, near the shore or off-shore India has around 150 GW or greater than 150 GW, if all the sources like tidal, wave, geothermal, solar included. Even with such a vast potential, only around 22% of renewable energy potential is developed in the country Energy dissipation near shore can be compensated by natural phenomena as refraction or reflection, leading to energy concentration ("hot spots"). The power in a wave is proportional to the square of theamplitude and to the period of the motion. Long period (~7-10 s), large amplitude (~2 m) waves have energy fluxes commonly exceeding 40-50 kW per meter width of oncoming wave. The Indian Government has shifted focus towards development of renewable energy sources. This step will help India in achieving energy security, reducing adverse environmental impact, lowering carbon foot print.

### 1.1 Wave energy

Wave energy or wave power is essentially power drawn from waves. When wind blows across the sea surface, it transfers the energy to the waves. They are powerful source of energy. The energy output is measured by wave speed, wave height, and wavelength and water density. The more strong the waves, the more capable it is to produce power. The captured energy can then be used for electricity generation, powering plants or pumping of water. It is not easy to harness power from wave generator plants and this is the reason that they are very few wave generator plants around the world. When you look out at a beach and see waves crashing against the shore, you are witnessing wave energy. It's not being harnessed or used for the benefit of anyone in that state, but it is there producing power. And some enterprising individuals would say it is just waiting to be used to make our lives better and our energy consumption cleaner and cheaper. Wave energy is often mixed with tidal power, which is quite different.




### 1.2 Wave Energy Seasons

As most forms of renewable, wave energy is unevenly distributed over the globe. Increased wave activity is found between the latitudes of ~30° and ~60° on both hemispheres, induced by the prevailing western winds (Westerlies)blowing in these regions.

Power in wave is expressed as

$P=0.55 * H_s{}^2 * T_z$ KW per metre of crest length

Where, $H_s$=Significant wave height in metres,

$T_z$=Zero crossing period in seconds

## 2. WAVE ENERGY TECHNOLOGY

Wave energy technologies consist of a number of components: 1) the structure and prime mover that captures the energy of the wave, 2) foundation or mooring keeping the structure and prime mover in place, 3) the power take-off (PTO) system by which mechanical energy is converted into electrical energy, and 4) the control systems to safeguard and optimize performance in operating conditions. With the substantial resource potential, a wide variety of methods for extracting wave energy have been developed. The different devices and systems not only employ different techniques for "capturing" the wave energy, but also employ a large variety of different methods for converting it to electricity (i.e., the "power take-off" system). Some previous studies have classified wave energy devices according to their capture method (shape and method of front-end converter movement). While useful, this classification is subject to limitations due to the large diversity of wave energy device designs, some of which involve unique shapes and mechanisms that do not fall into established categories. These factors tend to blur the boundaries between categories when a large number of systems are considered

Wave technology is accompanied by wave data collection which is collected along all coast line. In India it is collected by ship observation and wave rider buoy Wave technologies have been designed to be installed in, far offshore, near shore and offshore locations. Near shore devices are deployed at moderate water depths (~20-25), at distances up to ~500 m from the shore. They have nearly the same advantages as shoreline devices, being at the same time exposed to higher power levels. Several point absorber systems are near shore devices.

Offshore devices exploit the more powerful wave regimes available in deep water (> 25 m depth). Far offshore devices are located much farther.

The following are the wave energy technology types based on location:

1. OWC (Oscillating Water Column) Systems
    a) OWC – Onshore
    b) OWC – Near-shore
    c) OWC – Floating
2. Absorber Systems
    a) Absorber – Point
    b) Absorber – Multi Point
    c) Absorber – DirectionalFloat

3. Inverted Pendulum Devices
4. Overtopping Devices

In this technology brief, we use a very broad categorization for oscillating water columns (OWCs), oscillating body converters and overtopping converters, as shown in figure.

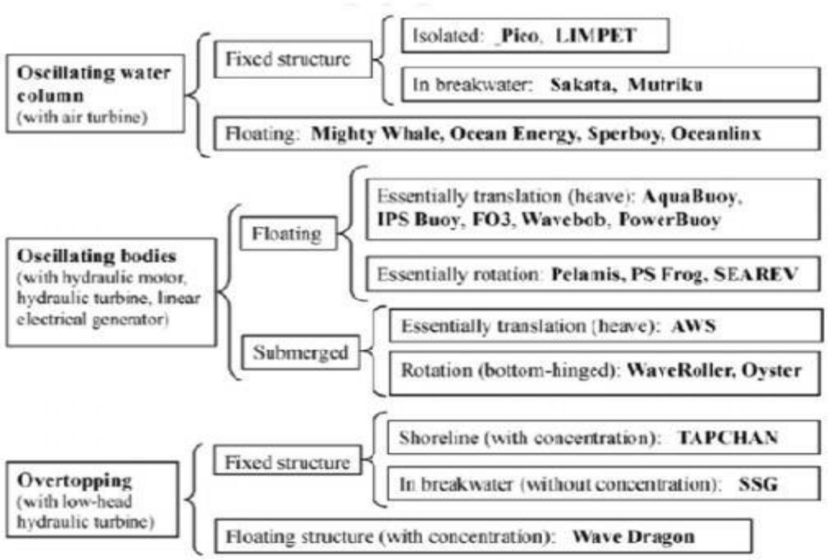



Fig.1- Wave Energy Technology

Oscillating Water Columns are conversion devices with a semi-submerged chamber, keeping a trapped air pocket above a column of water. Waves cause the column to act like a piston, moving up and down and thereby forcing the air out of the chamber and back into it. This continuous movement generates a reversing stream of high-velocity air, which is channeled through rotor blades driving an air turbine generator group to produce electricity.

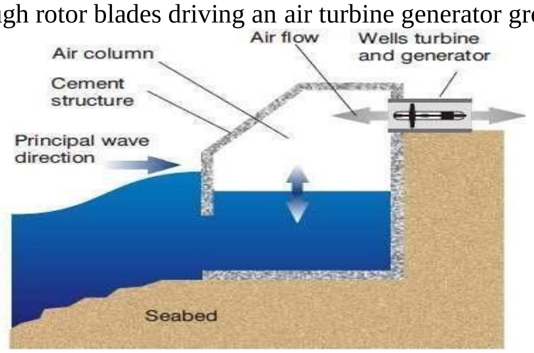



Fig.2- Working of OWC

The oscillating water column (OWC) device comprises a partly submerged concrete or steel structure, open below the water surface, inside which air is trapped above the water free surface. The oscillating motion of the internal free surface produced by the incident waves makes the air to flow through a turbine that drives an electrical generator.

Oscillating Body Converters are either floating (usually) or submerged (sometimes fixed to the bottom). They exploit the more powerful wave regimes that normally occur in deep waters where the depth is greater than 40 meters (m). In general, they are more complex than OWCs, particularly with regards to their PTO systems. In fact, the many different concepts and ways to transform the oscillating movement into electricity have given rise to various PTO systems, e.g., hydraulic generators with linear hydraulic actuators, linear electric generators, piston pumps, etc.

Overtopping converters (or terminators) consist of a floating or bottom fixed water reservoir structure, and also usually reflecting arms, which ensure that as waves arrive, they spill over the top of a ramp structure and are restrained in the reservoir of the device. The potential energy, due to the height of collected water above the sea surface, is transformed into electricity using conventional low head hydro turbines.

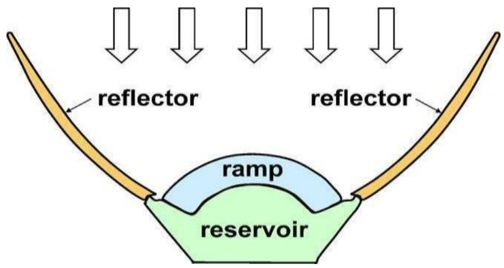


Fig.3- Plan of Wave Dragon Equipments

### 2.1 Next Generation

The next step for wave energy is to move from full scale testing of individual technologies to the deployment of array and cost reduction measures. Furthermore, the next generation of WECs is expected to go further offshore, reaching larger depths and higher waves — test facilities with 100 m water depth and 15 km offshore are planned, as yet no devices have been installed further than 6 km from shore or in deeper waters than 50 m — (JRC, 2013). To ensure cost reductions of the existing technologies and the development of next generation WECs, improvement of basic subcomponents is a pre-requisite.

## 3. BENEFITS

The best thing about wave energy is that it will never run out. There will always be waves crashing upon the shores of nations, near the populated coastal regions. The waves flow back from the shore, but they always return. Unlike fossil fuels, which are running out, in some places in the world, just as quickly as people can discover them, also unlike fossil fuels, creating power from waves creates no harmful by-products such as gas, waste, and pollution. The energy from waves can be taken directly into electricity-producing machinery and used to power generators and power plants nearby. In today's energy-powered world, a source of clean energy is hard to come by. Another benefit to using this energy is its nearness to places that can use it. Lots of big cities and harbors are next to the ocean and can harness the power of the waves for their use. Coastal cities tend to be well-populated, so lots of people can get use from wave energy plants.

A final benefit is that there are a variety of ways to gather it. Current gathering methods range from installed power plant with hydro turbines to seafaring vessels equipped with massive structures that are laid into the sea to gather the wave energy. Dependence on foreign companies for fossil fuels can be reduced if energy from wave power can be extracted up to its maximum. Not only it will help to curb air pollution but can also provide green jobs to millions of people. Unlike fossil fuels which cause massive damage to land as they can leave large holes while extracting energy from them, wave power does not cause any damage to earth. It is safe, clean and one of the preferred method to extract energy from ocean.

## 4. UTILIZATION OF ENERGY FROM SEA WAVES IN INDIA

Energy Generation & Requirement Electricity, a major ingredient for the growth of any economy, is a concern in a country like India. India being the second largest population and abode of around 15% people of the world has a large appetite of energy. Since its transformation into a production hub, a major part of world manufacturing has shifted here which has considerably escalated the consumption within recent years.

### 4.1 Status of Electricity Consumption

The total percentage of Indian domestic energy consumption has grown from 18.9% to 22% due to urbanization and rise in service sector. Demand for electricity in India far outstripped availability when the base load requirement was 961,591MU against availability of 888,355MU, 7.5% deficit. During peak, the demand was 152GW against availability of 140GW, a 9.9% shortfall. The main cause for this prorogation is the increasing quality of urban life as well as the industrial growth. Besides, there is a constant problem of transmission and distribution losses. In 2014 itself the TND losses were reported to be 30% of the total generation.

### 4.2 Status of Energy Generation

Indian power generation capacity hit the mark of 186654.62MW in 2011, 65% of which was based on fossil fuel, maximum contribution being played by coal based thermal (about 53%), and natural gas (about 11%). Apart from carbon emission due to these depleting resources, a large import requirement also affected the economy (18% of the total coal was imported in 2010).

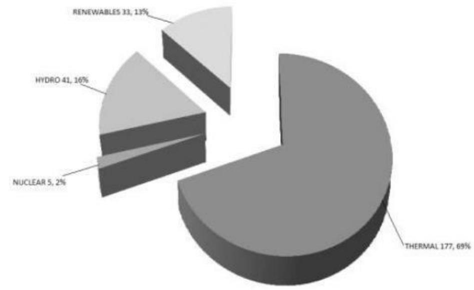



Fig.4- Status of Energy Generation

Vision for augmentation of nuclear power from present 4.2% to 9% in 25 years faced severe civil agitation in many parts of the country due to major risks involved. Hydroelectric power generation was 21.76% of total but has minute prospects of future development. The focus diverts to the fact that negligible research in any wave energy conversion techniques has been done in India to increase the share of renewable power

**4.3 Wave Energy Plants and Potential**

India is estimated to have a potential of 40-60 GW of Wave Energy around it cost with the current state of technology. The wave energy potential is estimated to be 5-15 MW per metre of coastline. Note there are no big wave energy plants in India except the pilot plant at Vizinjham Fisheries Harbour near Trivandrum in Kerala.


Fig.5- Wave Energy Plant,Vizhinjam

Maharashtra government has built project would generate 15 to 20 kilowatt of electricity located at Borya and Budhal villages in coastal Ratnagiri district. Similar pilot projects exploiting the tidal waves are being undertaken in 15 coastal villages. Agar Shakthi is a 1 MW OTEC plant built off the Tuticorn coast which utilizes the temperature different wave energy device. Fig.4 Wave Energy Plant 3.4 Wave power potential for Indian coastline In India the research and development activity for exploring wave energy started in 1982. Primary estimates indicate that the annual wave energy potential along the Indian coast is between 5 MW to 15 MW per meter. Hence theoretical potential for a coast line of nearly 6000 Km works out to 60000 MW approximately. However, the realistic and economical potential is likely to be considerably less and 47 kW/m is available off Bombay during Southwest monsoon period. Based on the wave statistics for the southern tip of India, a mean monthly wave power of 4 - 25 kW/m is estimated. The average wave potential along the Indian coast is around 5-10 kW/m. India has a coastline of approximately 6500 km. Even 10% utilization would mean a resource of 3750 –7500 MW. Fig. 5 Wave Power Potential for Indian Coastline.

## 5. CONCLUSIONS

WEC technology and potential along the coastlines of India. The ocean is a huge source of energy and harnessing the energy of ocean waves represents an important step towards coinciding renewable energy targets.

The technologies available for producing energy from sea important energy sources which must be utilized. Though there are some factors which limit thedevelopment of these wave energyplants such as higher construction costand difficulties in construction and testing of these energy converters. The need of electricity or energy in the future would be much greater if present conditions are considered; wave energy can fulfill this growing need of energy. Presently, traditional fossil fuels are employed for energy generation but there are various problems associated with fossil fuels. There is significant room for innovation and engineering development in harvesting and conversion devices of wave energy.

India is having vast coast line and number of wave energy plants installed will help meet the increasing power requirementwith ecofriendly approach. And most important this source is never going to cease. A sound effort will give a bestalternative to depleting conventional sources. From India's point of view still not much progress made in wave power technology and large capacity plants haven't been installed. Oscillating column converters are suitable for Indian environment and there is tremendous scope for development and power generation.

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