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Research Article

Indian Scenario of Wave Energy Technology

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Abstract

Ocean Wave Energy is the future of energy generation in India as it could result in most economic green process with minimal carbon emission. The power consumption and power generation of India lagging behind share of renewable energy because of increasing power requirement. Further few wave energy techniques have been discussed briefly, which focuses on potential scope research and development in the future. The wave energy technology is not so popular if current status of energy generation in India is taken in account. In case of India, there is tremendous scope for the energy from the ocean as India has a vast coastline and numerous islands in Bay of Bengal and Arabian Sea. This paper represents a basic review of the technology used in wave energy conversion and discusses its magnitudes in India.

Keywords: *Energy, Power, Wave Energy Converters, Power Generation, Wave Energy Plants.*

1. Introduction

Wave Energy is available at the ocean surface because of the interaction of the wind with the water surface. 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 (S P Sukhatme, 2014). 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. Total installed capacity in India is around 256 GW (as on October 2014) from all thermal source of energy like Oil, Coal and Natural Gas. India's commitment to reduce carbon emissions and fuel related concerns in conventional sectors has increased in recent years. 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 (Ruud Kempner, 2014).

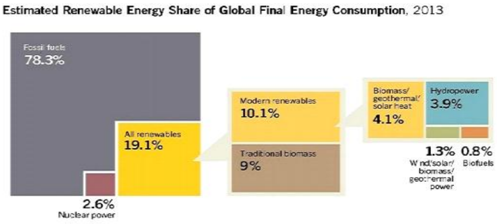

Fig.1 Energy Consumption of Various Traditional Ways of Energy Generation

1.2 Wave Energy Technologies

Wave energy technologies consist of a number of components: 1) the structure and prime mover that

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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. There are different ways in which wave energy technologies can be categorized, 1 e.g., by the way the wave energy is converted into mechanical energy or by the technology used. 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.

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. 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.

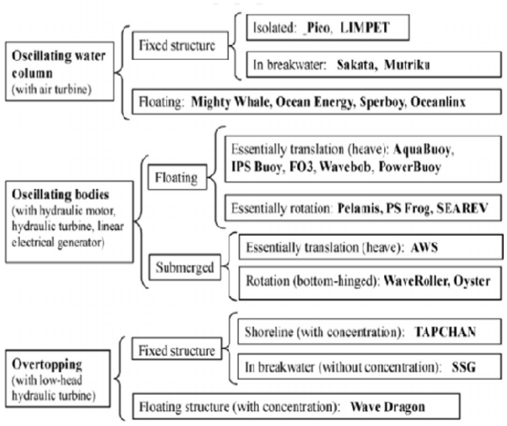

Fig. 2 Wave Energy Technologies

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.

1.3 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.

2. 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.

3. Indian Scenario for 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.

3.1 Electricity Consumption Status

The total percentage of Indian domestic energy consumption has grown from 16.9% to 24% due to urbanization and rise in service sector. Demand for electricity in India far outstripped availability even in 2011 when the base load requirement was 861,591MU against availability of 788,355MU, 8.5% deficit. During peak loads, the demand was 122GW against availability of 110GW, a 9.8% shortfall. The estimated demand in the power sector in the near years 2016–17 is expected to be at least 1392 Terra Watt Hours, with a peak electric demand of 218 GW. 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 2011 itself the TND losses were reported to be 24% of the total generation.

3.2 Energy Generation Status

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). 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 (D S Raghuvanshi, 2012).

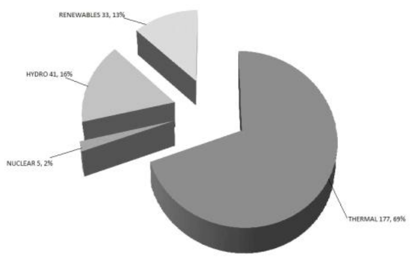

Fig.3 Electricity Generation Status of India

3.3 Wave Energy Plants and Potential in India

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. 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.

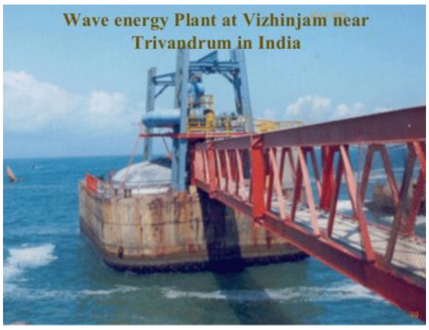

Fig.4 Wave Energy Plant

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.

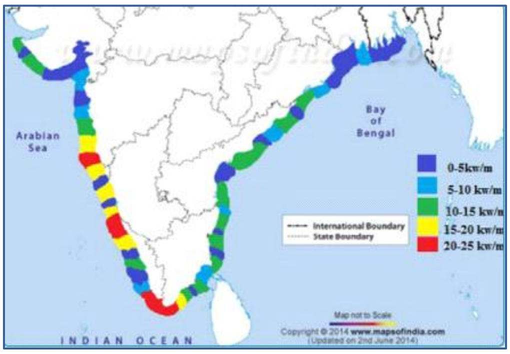

Fig. 5 Wave Power Potential for Indian Coastline

Conclusions

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.

This paper addresses the current status of 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.

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