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Ocean Energy and Development

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Abstract:

An incredible store of energy is given by the ocean which covers more than two-third part of our earth. The waves of the oceans and seas give huge quantities of clean energy. Ocean energy is also known as marine energy is the energy which is carried out by the waves of ocean, tides, salinity and different temperatures difference. Ocean energy plays a significant role in the system of future energy. As India has a long seashore, therefore, ocean energy has attracted increasing interest. For many years, technologies harnessing energy from the ocean have been discussed. To ensure the technology of ocean energy many numbers of mechanism and initiatives have been put which in short-term become cost- competitive, in order to exploit the benefits. This paper gives an overview of the various technologies used for the extraction of ocean energy and the current state of research in the field of ocean energy with their impacts on the environment. This paper also discussed or highlights the area of research gaps exists and the efforts for future implementation on ocean energy.

Keywords: *Ocean Energy, Impacts, Technologies, Marine Energies*

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Introduction

In the world full of competition, every nation wants to be in the league of developed countries by rapid growth. The ecological disequilibrium and malicious effect caused by fast industrialization and increasing population can't be ignored. For the developing countries like India which stand 6th in the world in terms of energy consumption, the dependence on a single technology or resource to fulfill all the energy needs is undoable and unreasonable. (Dhingra, Rijul, et al. 2014)

Oceans have an incredible amount of energy and the main form are tidal energy, thermal energy, ocean current and wave energy. To provide a renewable energy around the world, ocean energy has the potential. Generally, ocean energy can be divided into 6 different origin and characteristics: ocean wave, ocean current, ocean thermal energy, tidal range, tidal current and salinity gradient. India being a tropical country a constant difference in temperature is available between surface water and the deep ocean. This gradient can be used to generate fresh water and power simultaneously. To generate electricity to powerhouse, industries and transport the energy can be created from the movement of water in the ocean which creates a vast store of kinetic energy, or energy in motion. Coastal areas can receive electricity at low cost because the production of energy is from the ocean. The term marine energy covers both wave power – tidal power and power from surface waves, obtained from the kinetic energy of large bodies in moving water.
If we included all the sources like solar, tidal, geothermal and wave India has around 150GW or more than 150GW. Only about 22% of renewable energy potential is developed in the country like India which has such a vast potential. From all the thermal energy sources like coal, oil and natural gases the total capacity installed in India is around 300GW. The commitment of reduction of carbon emission and the concern related to fuel has increased in recent years. The focus of Indian government is shifted toward the development and protection of renewable energy sources, which will help the country in achieving the security of energy, lowering carbon footprint and reducing the most adverse environmental impacts. (Reji Shaji, 2014)

Tidal Energy

Tidal energy sometimes also refers to tidal power. It is the power which is achieved by the energy, captured during the moving water in tides and Open Ocean current. Tidal energy is divided into two techniques:

- Tidal barrage technique
- Tidal current technique

Tidal Barrage Technique:-

A large dam-like structure is built across the mouth of estuary or bay in a large tidal range, which consists of tidal barrages. With the tides, the level of water changes and a difference in height grows through the barrage. The flow of water is permitted through the barrage via turbines. Turbines can provide power during the receding tide, flood tide or during both tides. The most mature and oldest technology is represented by the tidal barrages. In the world, there are several commercial plants up to 240 MW in size. Many new studies and developments for this type of plant are also proceeding in many parts of the world. The considerable capital cost related to the construction and concerns over adverse environmental impact make the technology somewhat unpleasant in divergence to tidal current technologies.

Tidal Current Technique:-

In the tidal current technique, devices are placed directly "in stream" and energy is generated with the help of flow of water. It represents a different approach to extracting energy from tides. In this dam like structure is not used. A large number of technologies are available for extracting the energy from marine currents, including horizontal and vertical-axis turbines. Others also include ventures and oscillating foils.

For fixing the tidal current devices there is a variety of method in place, including seabed affixing via gravity base or driven loads, as flow as well as floating platforms fixed in place.

The combination of forces applied by the gravitation pull of the moon and the sun and rotation of the earth, tides are generally generated. Different tidal energy is produced by the relative motion of these three bodies which will affect the range of tides. By some local effects like funneling, reflection, resonance and shelving the substantially of tidal range can be increased. By creating a reservoir and basins behind the barrage and transient tidal waters through turbines in the barrage, energy can be extracted.

The three sides of India is surrounded by sea, its perspective to harness tidal energy has been acknowledged by the Government of India.to extract the energy two types of energy system are used:

a. Kinetic energy: this energy is from the moving water of tides, rivers and open ocean currents.
b. Potential energy: this energy is from the difference in height between the high and low tides.

The method of kinetic energy is becoming more popular to generate energy from tidal currents. Because it is said that it does not harm any environment condition as much as barrage or dams. (yadav, 2015)

Advantages of Tidal Power:-

- The system is easy to operate and maintain
- It does not create any type of pollution
- Low term operation lifetime of a plant
- The vulnerable coastline is also protected from floods and strong waves.
- The energy supply by this system is nonpolluting and supply of energy is exhaustible.
- It does not emit greenhouse gases.

Ocean Wave Energy:

Ocean currents are unidirectional, slower but continuous as compare to tidal current. Ocean currents are driven by the latitudinal distributions of winds and ocean circulation of thermohaline. In this, the current operation is strongly close to the surface. From the surface of waves or from the pressure fluctuation below the surface, ocean energy is taken. The conversion of motion of wave into usable mechanical energy is used to generate electricity. Wave energy has the potential to be a much larger resource than tidal power. Wave energy works best in a small number of highly favorable sites. (Sharma and Sharma, 2013)

To convert the energy of wave into the form of useful energy many technologies are adopted. Some technology is very costly and many variables are needed to converse ocean energy into useful work or electricity. In these variables, the methods include the interaction of waves with water depth (intermediate, shallow, and deep) as well as respective motion (surging, heaving, and pitching) and distance from the shore (offshore, shoreline, near shore). A well-ordered process of floating devices needs large motions which further can be achieved by resonance or by latching, that is, withhold/release of moving parts until potential energy has accumulated. For extracting energy from wave various variety of methods have been developed. The different system does not only employee different techniques for capturing the energy but various methods are also diploid to for converting it into electricity.

The types of wave energy conversion systems may be categorized in different ways.

- Oscillating water column (OWC)
- Absorber system
- Overtopping devices
- Inverted pendulum devices

Oscillating Water Column (OWC):

For converting fluid power into rotatory mechanical power, air turbines are almost exclusively by the Oscillating water column (OWC) type wave energy device. OWC is a closed chamber in which the chamber is open at the bottom and with the help of one more air turbine, it is open to the air. As the waves are influenced on the OWC device the level of water inside the chamber changes it rises and falls, expanding and compressing the air and then it will drive through the air turbine. Then at a time when the direction of air reverses halfway by each wave, the method for rectifying the airflow is required and the system which has multiple numbers of turbines should be used with one-way valves. The most favorite method which is currently used involves the use of self-rectifying turbines which will spin in a single direction irrespective of the direction of airflow. The design which is most popular is known as Wells Turbine, which involves airfoils with symmetrically shaped mounted at the 90˚ to the air flow. The flywheel motion of the turbine also provide some energy storage and the overall output of an air turbine is highly variable.

Absorber Systems

Point Absorber: A floating buoy whose mass and buoyancy should be selected contains the basic design of a point absorber. When the wave came in contact it will cause buoy to undergo relative movement against a reference which is fixed; this can be fixed the link to the seabed, flat damper plate which remains stable or with another buoy with different frequency of resonance. For harvesting this energy the linear generator is the straightest method, it simply converts the linear motion between the buoy and orientation directly into electricity.

A piston holding set of permanent magnets and stator consisting of coils arranged in tube-shaped form around the piston is the basic form of linear generators. In this one part of the point absorber, oscillating or the damped portion should be connected to the piston and another will be the stator, which will bring the complexity of the power

take-off system down to a minimum. The main disadvantages of this design are the cost of the permanent magnet is quite high and there is no any type of provision for the storage of energy to smooth the output. In the linear generator, the output of energy varies significantly over time so there is always a need for rectifier- inverter.

Directional Absorber: The floats of the directional absorber are similar to point absorbers, but directional absorber has their best efficiency for only one direction and convert wave power from other directions.

In point absorber buoys and in other energy converter designs mechanical and many other systems which take-off the power are used. The mechanical system of power take-off have many methods in which for converting vertical motion into rotation worm gears or rack-and-pinion type systems are used and for conversion of oscillating rotation into unidirectional rotation clutch-flywheel or rectifying systems are used.

By definition, mechanical systems require a reasonable number of moving parts, which can offer the high efficiency of conversion or allow for simpler generators (rotational instead of linear) to be used. On the design of the system, the storage capabilities of the system depend.

Pressurized hydraulics is one of the most popular methods of power take-off for a great number of wave energy devices.in this 30 surveyed system is used either in open-loop configuration or in a closed-loop system. The devices that are based on horizontal movements or pitching this method of power take-off is the best suited not only for point absorber buoys but also for the variability of other devices.

Overtopping Devices

To store the seawater in a wager that contains the warhead reflectors arms are generally used in overtopping devices. Therefore to generate electric power and to run water turbines the static head is used. In many different types of water turbines, the most common choice is low head “Kaplan” type turbines. In this energy storage are provided by the reservoir and the head and flow rate of the turbines will change with the reservoir drain and fills for making smooth power output more difficult. In the technology of the turbine, the advantage of their own overtopping devices has already in use in the hydropower industry for a long time.

Inverted Pendulum Devices

An inverted pendulum is a device that uses a lever arm or buoyant float, which is usually attached to the seabed. When the wave is passing over an inverted pendulum device, cause it to pitch back and out, which will further activate the power take-off system like hydraulic pumps.

Impacts of Marine Energy:

Environmental Impacts – In the activities of manufacturing, maintenance, decommission and operation of ocean energy devices shows various effects on the environment. Before the deployment of the ocean, energy government needs to vigorous understanding the effects on the environment. The decision of environmental implications is taken according to the Environmental Impact Assessments (EIA) in which the Life Cycle Assessments (LCA), are used to quantify and identify the impact of industrial products on the environment.

Due to alteration in flow patterns sediment dynamics, wave structures in ocean wave and tidal current technology, direct impact contain benthic community, entanglement of marine mammals, fishes, turtles, and seabirds. In the area of environmental impacts, future research needs to be focused on localized environmental impacts including sedimentation, electromagnetic field effects, flow alteration and change in the habitat of the generation device.

- **Tidal current –** Due to change of water flows, sediment dynamics, and composition of the substrate, the tidal current affects the benthic habitats. A study shows that the installment of the tidal array, benthic ecosystems and impacting on bed morphology is observed during the change in sediment dynamics. Which will also impact on the faunal and floral species of marine animals. In this fishes will experience discomfort and distress. But in the review of Fried et al. it is concluded that there is very less literature which shows that the underwater operations of tidal energy stream devices will cause raised the levels of morality to pelagic creatures like marine mammals and fish. Another critical issue related to tidal energy is noise disruption in turbulent water which will affect the particularly marine mammals.
- **Ocean Wave –** It is proved that the installation of a wave energy converter range can knowingly change in the inter-array and surrounding wave field. The impact of ocean energy converter also includes noise and vibration, space competition, disruption to biota

and habitat, pollution, change in water quality. A lower collision risk to offshore wind devices should be represented by the wind devices which could result in the risk of underwater collisions for diving birds. (Http://Www.energybc.ca)

Socio-economic Impacts

Socioeconomic impact addresses the impact of development on society and the local population of the country. Many issues like well-being, quality of life to employment, economic and income power, etc. should be addressed. Due to visual impacts and reduction of access to space-specific topics gave negative effects for the other user of the marine environment. Therefore both the positive and negative impacts of ocean energy need to be studied to support evidence-based plan production.

Social Impacts is the study of the social impact of ocean current, the main impact which is usually addressed is job creation. On global and national level the future potential for employment in this sector is estimated. Other social impacts include the reduction of carbon dioxide gas, which generally gives positive as well as negative impacts on local communities and marine users. It is also seen that the impacts of ocean current are difficult to quantify, including improvements to existing infrastructure, increased knowledge as a result of research and development in Wave and tidal, energy security improvements, health, and quality of life. (Uihlein and magagna, 2015)

Future Development

In order to meet our objective for energy security, polluting fossil fuels, reducing dependence on finite and to combat climate change, there is a need to exploit as many as natural resources which is available and sustainable resources within our planet as possible. One of the most deployed technologies is tidal and wave technologies which also gathered the most commercial interest. For the future development, the interest in the technology is increasing over time and many tidal projects are coming in upcoming years.

From the Indian Ocean Rim Association member state countries no large deployments can be seen but India the member of IORA announces a development of two wave energy plants in Andaman and Nicobar islands, an OCET (20 MW) and wave energy plant which is of 30 MW. According to global data United Kingdom (Scotland) is leading in the deployments of the tidal energy technologies. With a total capacity of projects 2700 MW tidal barrage project the IORA's dialogue partner, United Kingdom is leading for future deployments which would be operational by 2026. There is also a relation between technologies deployment rates and cost, the more deployments of ocean energy technologies, the more cost reduction which results in deploying much more ocean energy technologies
(https://Sustainabledevelopment.un.org).

Conclusion

In the power of the renewable source of energy ocean energy plays significantly. The demand for new renewable technologies noticeably shows a shift in preference towards the technologies like biomass, wind, ocean, geothermal hydropower, solar photovoltaic and many other as a source of energy. For the fast developing countries like India, the source of ocean energy is very important to fulfill the need for energy. In the ocean, the energy resources are vast which can light more than, current and projected India's demand for electricity. The technology of ocean offers CO2 emission-free power and permit energy independence. Another important area where research is needed to be focused is on the impacts of ocean energy on the economy and social environment. In the area of operation and maintenance, there is a need for lots of improvement. Ocean energy is becoming one of the most frequently emerging technology which has the potential to enhance the renewable energy technologies in India.

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