FEASIBILITY ANALYSIS OF WAVE ENERGY IN INDIA

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Abstract:

The paper mainly discusses about the wave feasibility along and near the coastline areas of India. Waves carry a lot of potential energy within the sea and oceans. As we all know that fossil fuels have become costly and reached to extinction stage, hence these days many organizations are showing interests in renewable power source usage in both small scale and large scale. We also discussed here, the geographical features along the coastline and compare the wave energy converters on various parameters like effectiveness, efficiency, cost, maintenance regarding the geographical conditions.

Keywords:* *Wave, Energy Converters, Coastal zones, Monochromatic waves

1. INTRODUCTION:

Energy is essential for developing. Coming to the energy generation ,the statistics say like about 63% of electricity is generated from fossil fuels (coal, natural gas, petroleum, and other gases). About 20% generated from nuclear energy, and about 17% from renewable energy sources**.[1].** Cheapest source of energy is coal. .With a complete combustion or fission, approx. 8 kWh of heat can be generated from 1 kg of coal.[2]. Most non renewable resources in this dataset will be depleted in the next 50 years if production continues at current rates. There is an estimated 1.1 trillion tonnes of proven coal reserves worldwide. So this is really a high time to bring the use of renewable resources to application.[3.],In 1991M.Ravindran discussed the importance of Energy from sea waves.

2. WAVE POWER:

We are surrounded with 75% of water on Earth. Waves which we commonly come across along the coast, contain a lot of potential which can be converted and even can be used. Wave power is the capture of energy of wind to do useful work. The disturbances take energy to create and propagate, in order to move the constitute particles or change the electric/magnetic fields.[4.] In1974 S.H.Saltet discussed about wave power in his article. The power of a wave is therefore energy transported per unit time by the oscillations of a particular wave.

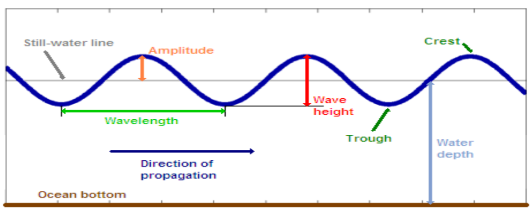

Fig 1 : Simple Monochromatic Waves

In order to understand the motion and behaviour of waves, one has to understand simple waves. Waves that can be described in simple mathematical terms. Sinusoidal or monochromatic waves are examples of simple waves, since their surface profile can be described by a single sine or cosine function. Simple waves like these are readily measured and analysed, since all of their basic characters remain the constant.**[5].**The useful potential energy in these waves are converted to electricity by using wave energy converter (WEC).[6.] In 2003 A.Fãlco discussed on wave energy convertors in 22nd International conference of off shore and Arctic engineering.

3. WAVE ENERGY CONVERTERS:

Waves contain energy but it cannot be used directly. The potential energy in waves is converted into kinetic energy and that will be used for electricity generation. For this process we need wave energy converters. Based on the principle used for conversion the wave energy converts are classified into many types.[7].Discussed by Jose Vazquez Taboada in Master Thesis , University of Stavnanger.

Some of them are attenuators, point absorbers, oscillating wave surge convertors, oscillating water columns, overtopping, submerged pressure differential, bulge wave, rotating mass. Many mid European countries started Research on efficient wave energy convertors. The tables mentioned below shows the details of the existing WEC.[8.]

Table 3.1: Six Basic Principles used to Convert Wave energy

	Onshore	North Sea	Atlantic
OWC	Suitable, Concepts exist	Concepts exist	Suitable, several concepts exist
Attenuator		Concepts exist	Suitable, concepts exist
Point Absorber		Suitable, Concepts exist	Suitable, Concepts exist
Submerged Pressure Differential			Possible, Concepts exist
Oscillating Surge Converter		Possible, concept exits	Suitable, Concepts exist
Overtopping Devices	Suitable, Concepts exist	Suitable, Concepts exist	Suitable

3.1 Classification of some wave energy converters:

Wave energy converters are classified based on the location, mechanism used for conversion. Basically on the location they are classified like onshore, offshore, near shore. They are classified based on the mechanism ,like point absorbers and, Oscillating Wave column. Point absorbers capture the energy by placing them in the path of the wave [9.]In 2014 Rudd Kemper discussed briefly about the technologies used. They are placed on the sea bed and left floating on the waves. Ocean Wave Converters are placed near shore and the water enters into partially submerged platform and let the water rise in the air column, which is compressed and drives the a turbine to generate electricity.[10].

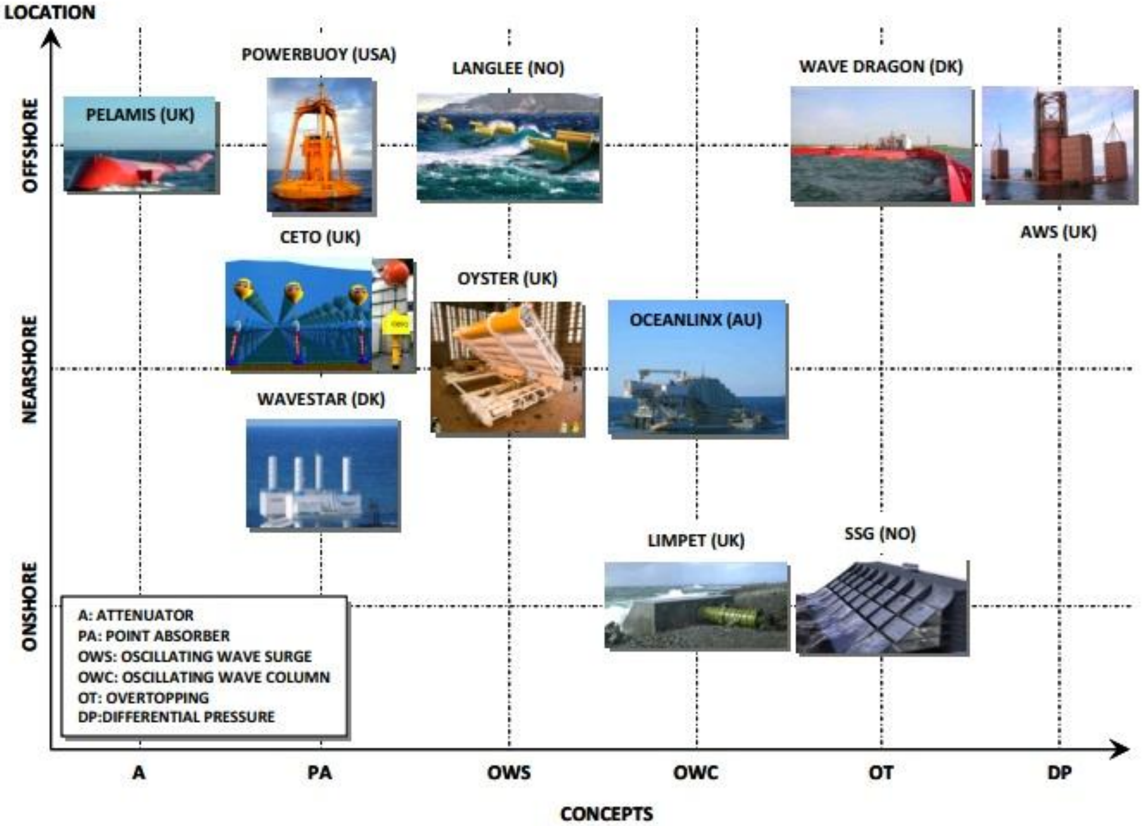

Fig. 2. Different types of Wave energy converters

Table 3.2. Different Wave Energy Converters around the world

Device	AquabuOY	Pelamis	Oceanlinx OWC	Oyster 800	Wave Dragon	CETO 5
Parent Company	Aqua Energy Development UK Ltd	Pelamis Wave Power Ltd	Oceanlinx	Aquamarine Power Limited	Wave Dragon	Carnegie Wave Energy Ltd
Rating (kW)	250	750	500-2000	800	4000	240
Site	Offshore	Offshore	Offshore	Nearshore	Nearshore	Nearshore
Status	demonstration	commercial	commercial demonstrator	prototype	demonstration /prototype	Design (CETO 3 commercial)
Type	wave activated bodies/point absorber	attenuator	OWC	terminator	overtopping	point absorber

For now the best wave generator technology in place in the United Kingdom is producing energy at an average project cost 7.5 cents kWh. In comparison, electricity generated by large scale coal burning power plants costs about 2.6 cents per kWh[11.] In 2017 Denny Nugroho Sugianto discussed his reviews on the generation of wave energy.

In the Coastline Of India, India measures 3214 km from north to south and 2933 km from east to west. It has a land frontier of 15200 km and a coastline of 7515 km. The coastal lines again divided into coastal zones. Each coastal zone have different main purposes like commercial, defence, domestic. The parameters which are considered before setting up a WEC are wave height, land type , and wave impact . [12].

Here some data regarding the coastal zone :

Table 3.3 : Zones

Geomorphological zones		Ecological classes	
Onshore areas	Beach	Muddy Sandy	Fringe tidal mangroves
Deltaic complex	Estuarine mouth	Inter-tidal mudflat	*Avicennia* pure (3 species) *Aegialitis* (only in Sunderbans & Mahanadi)
	Mid estuary (creeks and canals more)	Inter-tidal mudflat	*Rhizophora, Bruguiera, Ceriops, Sonneratia, Aegiceras, Xylocarpus*
	Inner estuary	Inter-tidal mudflat	*Rhizophora, Bruguiera, Heritiera, Carberra, Cynometra, Excoecaria, Phoenix, Xylocarpus*
	Outer estuary	High-tidal mudflat	*Dalbergia, Derris, Excoecaria, Acrostichum, Pongania* Marsh vegetation Saline blanks
Bay Complex	Mouth	Inter-tidal mudflats	*Rhizophora, Bruguiera, Ceriops, Sonneratia, Xylocarpus*
	Middle zone	High-tidal mudflats	*Avicennia, Phoenix, Lumnitzera littoralis, Heritiera littoralis, Nypa*
	Inner zone	High-tidal mudflats	*Avicennia, Nypa, Acrostichum, Thespesia, Derris* Marsh vegetation Saline banks
Gulf Complex	Seaward zone	Sub-tidal Mudflat	Algae
	Inner zone	Inter-tidal mudflat	*Rhizophora, Sonneratia, Avicennia, Ceriops, Bruguiera*
	Outer zone	High-tidal mudflat	*Avicennia,* Salt marsh vegetation Grass/ *Acanthus* Saline blanks
Offshore area	Continental shelf		Algae/ seaweeds
	Islands		Mangroves Sand vegetation
	Coral reefs		Algae/seaweeds/ seagrass

Table3. 4 Wave Power Generation

Wave power at selected sites along Maharashtra coast					
OFF SHORE Average Wave Power kW/m			COASTAL Average Wave Power kW/m		
Site	Annual	(Jun-August)	Site	Annual	(Jun-August)
Vengurla Rock	8.01	20.61	Girye	5.90	14.21
Square Rock	6.79	16.64	Vijaydurg	5.86	13.58
Redi	6.35	16.57	Ambolgarh	5.74	13.48
Malvan Rock	6.91	16.73	Kunkeshwar	5.64	13.35
Kura Inset	5.79	13.74	PawaPoint	5.36	13.10
			Wagapur	5.70	13.10

4. CONCLUSION:

India, thus has huge potential of wave energy. Realizing this potential, Government of India should actively make efforts to promote wave energy. Wave energy would positively affect the country's economy by providing three fold returns i.e. economic, social and environmental. However, high installation cost of generating energy from waves is a cause of concern but the working cost of this technology is zero. Hence, it is important to concentrate on development of new, technically advanced wave energy trappers which are cost effective and reduces per unit cost of wind power. It is vital for Indian government to increase investment in the R&D of wave energy generation.

References:

[1].]IRNEA reports 2017

[2].www.oceanenrgycouncil.com

[3].http://cdip.ucsd.edu

[4].Jose Vazquez Taboada in Master Thesis , University of Stavnanger.

[5].Hitesh J .Yadav, Recent developments of Ocean Energy in India- An Overview,IJRITCC,December-2015,ISSN:2321-8169.

[6].Hosna Titah-Benbouzid, Mohamed Benbouzid ,An Up-to-Date Technologies Review and Evaluation of Wave Energy Converters ,2015.,IREE, .

[7].S. Brusca,R. Lanzafame,Michele Messina,Design and performance of a straight-bladed darrieus wind turbine,International Journal of Applied Engineering Research, ISSN 0973-4562 ., 2015.,Vol. 10 No.5 .

[8].Kaveh Soleimani,M. J. Ketabdari,Feasibility study on tidal and wave energy conversion in Iranian seas,Sustainable Energy Technologies and Assessments · October 2015 ,http://dx.doi.org/10.1016/j.seta.2015.03.006

[9].Stephen Salter,Wave power,: https://www.researchgate.net/publication/232778016

[10].Ruud Kempener (IRENA), Frank Neumann (IMIEU),WAVE ENERGY TECHNOLOGY BRIEF,IRENA Ocean Energy Technology Brief 4 June 2014.

[11].Henk Polinder,Mattia Scuotto, Wave energy converters and their impact on power systems.,December,2015.,,IEEE A. Falcão, 'First generation wave power plants: current status and R&D requirements'. In Proceedings of OMAE2003, 22nd International Conference on Offshore and Arctic Engineering, Cancun, Mexico, 8-13 June 2003.

[12].Harshil Angre,Scope of Wave Energy in India, (IJEMS) ISSN-2348 –3733, October 2015.,Volume-2, Issue-10.

[13].M Ravindran, Paul Mario Koola, "Energy from Sea Waves - The Indian wave energy programme",25 June 1991.,Current Sciences, Vol. 60, No. 12.

[14].Denny Nugroho Sugianto,Wave energyIJMET) ., October 2017., Volume 8.,Issue 10., reviews in Indonesia.

[15].Subramaniam Neelamani,Venkat Reddy,Ocean energy technology development - The challenge of this millennium,International Journal of Earth Sciences and Engineering,ISSN 0974-5904, , December 2010.,Vol.03.