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Ocean energy technology development and demonstration activities by NIOT

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ABSTRACT

Today, the world faces several climate change-related issues due to pollution. The globe is seeing several alternate sources of renewable energy. Also, there is an acute energy crisis due to fast-depleting fossil fuel reserves on the earth, and there will be a time, when the known reserves will become extinct, or extraction from these reserves will become highly costly and technologically challenging, not forgetting the fact that this exploitation has led to adverse effects on the earth's climate. While solar, wind, biomass, and other forms are already being tapped globally, renewable energy resources that can be harnessed from the vast oceans, have now become a focus of the scientific community worldwide. The oceans offer huge spaces where new technologies can be tried and tested without affecting human settlement or the environment. Many countries have already started working towards this. In India, this development is led by the National Institute of Ocean Technology (NIOT). Extensive efforts are being made at this institute to develop technologies related to the energy extraction from ocean waves, based on the oscillating water column principle, from ocean currents using principles of hydrokinetics, and from ocean thermal gradient along the sea depth using a rankine cycle. The floating wave energy devices like backwards bent ducted buoy and wave-powered navigational buoy, cross flow hydro kinetic turbine and Open cycle ocean thermal energy conversion (OTEC), are a few of the technologies that have been developed and demonstrated. The development consists of numerical analyses, laboratory studies and open sea trials. This paper briefly discusses these developmental activities and the status of the development of ocean energy by NIOT. It also discusses all these indigenously developed ocean energy conversion systems, their performance during the testing phase, and their challenges and opportunities in India.

Keywords: Ocean energy, Wave energy, Oscillating Water Column (OWC), Hydro kinetic energy, Ocean Thermal Energy Conversion (OTEC), Renewable energy

INTRODUCTION

India has a very long coastline of about 7500 km (Dimri et al., 2023) and has very high tidal variation in specific sites (Raju and Ravindran, 1997). As a tropical country, India also possesses vast potential for OTEC resources. The ocean has approximately 8,000-80,000 TW/year of wave energy around the globe (Gunn and Stock-Williams, 2012). Locations with the most potential for wave power include the western seaboard of Europe, the northern coast of the UK, and the Pacific coastlines of North and South America, Southern Africa, Australia, and New Zealand. The north and south temperate zones have the best sites for capturing wave power (Folley and Whittaker, 2009). India is estimated to have a potential of 41GW of wave energy as per a study by the Indian Renewable Energy Development Agency Limited (IREDA) (Indian Renewable Energy, 2014). The average wave energy potential is estimated at 5-15 kW per meter of coastline. The Ministry of New and Renewable Energy (MNRE), assessed the potential of tidal energy in the country. The study indicated an estimated potential of about 8000 MW, with 7000 MW in the Gulf of Khambhat, 1200 MW in the Gulf of Kutch in Gujarat, and 100 MW in the Gangetic deltas in Sunder bans in West Bengal (Sannasiraj and Sundar, 2016). Based on the available literature, overall net power available from OTEC is around 9 to 10 TW (Ascari, 2012). A minimum temperature difference of 20^0C between the surface and deep-sea water is necessary for establishing an OTEC plant (Nihous, 2007). Water drawn from depths of 1000 m, will provide the above-mentioned temperature difference. Such conditions are more eminent in the country's Exclusive Economic Zone (EEZ). Theoretical estimates of the OTEC resource in India's EEZ, is around 180000 MW (Indian Renewable Energy, 2014). However, this is still under study and has to be asserted.

Further, wave-capturing devices can be installed near shore or offshore (Isaacs and Seymour, 1973; IEC, 2015) . Three fundamental methods for harnessing wave energy are, wave profile devices, oscillating water columns, and wave capture devices. Further, there are two main forms of practical tidal energy harvesting methodologies, tidal stream turbines and tidal barrages (Isaacs and Seymour, 1973). Currently, countries such as the United Kingdom, France, Canada, and China are leading in the development and deployment of tidal energy projects. The UK, in particular, has been a pioneer in this field, with the world's first tidal energy plant being established in 2016 in Scotland. With the growing interest in OTEC technology's potential to provide clean, reliable and sustainable energy, countries like Japan, India and United States are leading in OTEC research and development. OTEC works by harnessing the difference in temperature between warm surface waters and cold deep ocean waters to generate power through a heat engine (Jia et al., 2018). While OTEC is still in the early stages of development and faces challenges such as high capital costs, it has the potential to become a significant source of renewable energy for coastal communities around the world since it is a base-load source of power. With continued research and investment, we may see OTEC playing a vital role in our transition to a more sustainable future. There are three types of electricity conversion systems under OTEC: closed-cycle, open-cycle, and hybrid cycle.