

# Energy from sea waves—the Indian wave energy programme

*M. Ravindran and Paul Mario Koola*

*Ocean energy is one of the important forms of renewable energy. Wave energy has received considerable attention in the recent past. In India the Department of Ocean Development (DoD), Government of India, has sponsored wave-energy research at the Ocean Engineering Centre of the Indian Institute of Technology, Madras.*

Future energy-supply projections suggest that there will be problems in matching supply and demand early in the next century. Furthermore, since the cost of primary energy will almost certainly rise, alternative forms of energy conversion must obviously be investigated and developed as either supplementary or insurance technologies.

Power generation in India today is mainly from hydroelectric and thermal power plants. The present total installed capacity hardly meets the grid demand. Uncertainty of the monsoon and problems of coal transport put a strong limitation on expansion of present generation capacity. But the increase in standard of living and rapid industrial growth necessitate a high rate of growth of power supply. The price of oil continues to be high in India. The present contribution of power generation from nuclear plants is small, and the uncertainty in the protective measures against all environmental hazards of such plants indicates that development of renewable energy sources is important for India.

One important renewable source is ocean energy. Solar radiation, which sustains life on earth, is continuous and inexhaustible. It has been estimated that about  $10^{16}$  W of solar energy reaches the earth. The ocean, which covers nearly 71% of the earth's surface, acts as a natural collector of this energy. Thus the ocean has an enormous potential to supply energy in many different ways. The major advantages of ocean energy are that it is renewable and continuous throughout the year, is pollution-free, and has minimum health hazard. For remote islands, ocean energy will be the most important form of alternative energy since it comes from the immediate vicinity.

## Sea waves as source of energy

The incessant motion of the sea surface in the form of wind waves constitutes a source of continuous energy. About 1.5% of the incoming energy from the sun is converted to wind energy. Part of the energy from the winds is transferred to the sea surface, resulting in generation of waves. This energy is carried to coastlines throughout the world, where it is dissipated as the waves break. If this source can be tapped properly and used economically, it can generate a sizeable portion of world energy needs.

Extraction of energy from waves is more efficient than directly from wind, since wave energy is concentrated through interaction of the wind and the free ocean surface. The sea behaves like an immense energy collector whereby the wind energy, transferred to the large sea surface, is stored as mechanical energy in waves. The inertia of waves provides this short-time storage and partly smoothens the high variability of the wind over time and space.

Though the potential along the 6000 km of the Indian coast is quite substantial, estimated to be around 40,000 MW, the energy is less intensive compared to that in more northern and southern latitudes.

Ocean waves are random in nature. The power available in random sea is expressed as

$$P = 0.55 H_s^2 T_z \text{ kW per metre length of wave crest,}$$

where  $H_s$  is the significant wave height (defined as average of one-third of highest waves) in metres, and  $T_z$  the zero-crossing period in seconds. From this relation, for a significant wave height of 2 m and a zero-crossing period of 7 s, the available power is  $15 \text{ kW m}^{-1}$  of wave front.

Scientifically collected wave data along the Indian coast are scarce. A wave atlas published by the National Institute of Oceanography (NIO) in Goa based on swell data published in the Indian Daily Weather Reports (India Meteorological Department) gives the nation wide distribution of wave parameters. Scientific wave data, obtained using wave-rider buoys, are available for certain places along the Indian coast. These data give the precise information on wave heights and periods required to design the wave energy system. The average wave-power potential along the Indian coast is  $5 \text{ kW m}^{-1}$  to  $10 \text{ kW m}^{-1}$ . On the basis of scientifically collected data at Valliathura near Thiruvananthapuram on the Kerala coast<sup>1</sup>, the average wave-power potential works out to be  $13 \text{ kW m}^{-1}$  for the site.

## Research in India

Wave energy, which can make a significant contribution to the energy requirements of many countries with ocean coastlines, has received considerable attention. In India the Department of Ocean Development (DoD), Government of India, has sponsored wave-energy research at the Ocean Engineering Centre of the Indian Institute of Technology, Madras, from December 1982 onwards.

The first phase of the project was titled 'Scientific investigations on wave climate, wave regulation and wave power'. The main aim of this phase was to study the long-term wave climate along the Madras coast and to select a suitable wave-energy device. This study submitted its report<sup>2</sup> in February 1987, recommending a multipurpose energy-absorbing caisson breakwater as most suitable for the Indian coast. This was