Renewable and Sustainable Energy Reviews 15 (2011) 4876–4883

Contents lists available at SciVerse ScienceDirect

Renewable and Sustainable Energy Reviews

journal homepage: www.elsevier.com/locate/rser

Status and potentials of offshore wave energy resources in Chahbahar area (NW Omman Sea)

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ARTICLE INFO

Article history:
Received 18 February 2011
Accepted 24 June 2011
Available online 15 September 2011

Keywords:
Offshore wave energy
Chahbahar area
Statistical analysis
Electric power generation
Point absorber
Attenuator
Marine life
Tourism

ABSTRACT

Chahbahar area is located at the southern coasts of Iran in the Omman Sea. This paper examines possible examples of offshore wave power installations at Chahbahar area in the Omman Sea. The study aims at showing the physical possibilities of wave energy and electric power generation based upon point-absorbers and attenuator devices in the selected site. This site has been chosen to represent a range of offshore wave climates around Chahbahar area. Hindcasting data is used allowing estimations of wave energy generated and results show promising conditions in this area. Wave climate power density, or incident wave power per meter of WEC device reach a maximum value 24 kW/m with monthly maximum of 9.70 kW/m and annual average equals to 4.14 kW/m. We study power recoverable possibility for three different wave energy devices, based on their published power matrices; 750 kW Pelamis device, hypothetical modified 1500 kW Pelamis device and hypothetical 750 kW Single Point Absorber (SPA). Results show corresponding annual electric energy generation for this devices are 0.32 GWh, 4.9 GWh and 2 GWh respectively. Finally, we determine appropriate WEC device for selected site. Also, we propose a solution for some environmental problem.

Contents

1. Introduction

A warmer earth caused mostly by fossil fuels which bring about global warming may have consequences such as change in rainfall patterns, a rise in sea level, and various effects on plants, wildlife and human beings. Such effects have lead to serious concern among scientists and encouraged them to look to other resources for energy production.

Some of the energy resources which are available to mankind are called renewable energy. Their conversion has always played an important role in the lives of the inhabitants of the planet, and apart from a period of negligible length – relative to evolutionary and historical time scales – renewable energy sources have been the only ones accessible to mankind [1].

Wave energy is a renewable energy source with high power density, relatively high utilization factor, low visual impact and presumed low impact on environment compared to other renewable sources. Still, wave power has not yet been properly recognized partly due to lack of good technologies. Wave energy can bedivided into two potential extractable sources: open ocean swells

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doi:10.1016/j.rser.2011.06.015

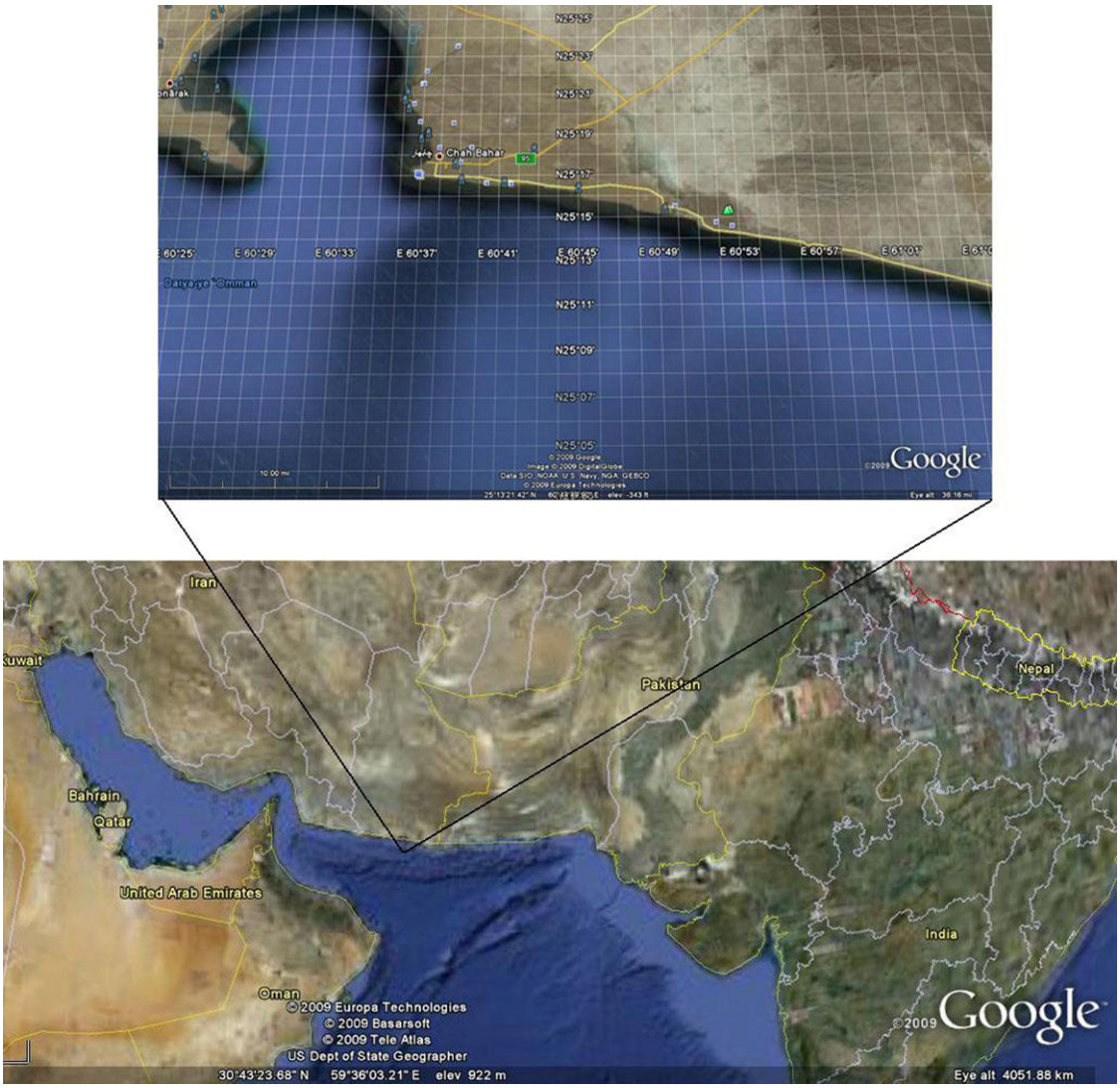

Fig. 1. Chahbahar area [2].

and breaking waves. Open ocean swells result from the aggregated effects of wind currents blowing across the surface of the ocean. Swells result from the constructive interference of waves resolving into larger waves with bigger amplitudes and longer wavelengths. Breaking waves result from the incidence of these ocean swells on the seabed, as waves approach the coast [6]. The two primary sources of wave energy in Chahbahar area built up by local trade winds, swell generated by storms in the Indian Ocean.

The selected site located at the southern coasts of Iran at the Omman sea (25°06′00″N., 60°30′E.) (Fig. 1). Analytical software – Minitab 15.1.1.0 and Microsoft Excel 2002 – has been used for the analysis of the wave data and the calculation of the electric power density based on the device capture width matrix and the site annual wave climate. The calculations and estimations in the article are based on the assumption that the wave energy devices are a small point absorber and two attenuator devices.

The present study therefore seeks to estimation of the offshore wave energy potential for one point at Chahbahar area in the Omman Sea with potential technologies without going to the next level of detail – to determine an economic value for a project proposed in this area.

2. Estimated wave power

To develop the wave energy scatter diagrams for this initial resource specification, seastate parameter records were read to extract the significant wave height (H_s in m), and the peak wave period (T_p in s), which is the inverse of the frequency at which the wave spectrum has its maximum value for the measured sea state record. Based on these two parameters, the incident wave power (J in kilowatts per meter of wave energy device width, or kW/m) associated with each sea state record was estimated by the following equation:

$$J = 0.42 H_s^2 T_p \quad (1)$$

The 0.42 multiplier in the above equation is exact for any seastate that is well represented by a two-parameter Bretschneider spectrum, but it could range from 0.3 to 0.5, depending on the relative amounts of energy in sea and swell components and the exact shape of the wave spectrum. Although such an estimate, based solely on the parameters (H_s) and (T_p) is not exact, it was supposed adequate appropriate for this initial specification [3,4].