Renewable and Sustainable Energy Reviews 59 (2016) 514–529

Contents lists available at ScienceDirect

Renewable and Sustainable Energy Reviews

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

Tidal range technologies and state of the art in review

Shaun Waters, George Aggidis *

Lancaster University Renewable Energy Group and Fluid Machinery Group, Engineering Department, Lancaster LA1 4YW, United Kingdom

ARTICLE INFO

Article history:
Received 23 March 2015
Received in revised form
7 November 2015
Accepted 29 December 2015

Keywords:
Archimedes screw
Bulb turbine
Renewable energy
Tidal energy
Tidal range
Tidal lagoon

ABSTRACT

Tidal range technology has seen much development and interest in recent years. The times when a barrage scheme would be rejected due to environmental and cost concerns is coming to an end. A large variety of new lower cost and less invasive methods have since emerged in the forms of tidal lagoons, reefs and fences. Since the construction of La Rance in 1967, advancements in turbine technologies and design has since resulted in a plethora of new, exciting turbine designs for tidal energy. A selection of new turbines with possible tidal range applications includes the modified bulb turbine with two sets of guide vanes, a counter-rotating turbine, Archimedes screw and a gyro device. However, the same design is continuously being chosen – the Kaplan bulb turbine. Through the use of a marking criterion covering key aspects that should be considered when choosing a turbine a variety of the new designs available are investigated. The key aspects researched include, environmental effects, the two-way efficiency, initial costs and maintenance costs/difficulty.

© 2016 Elsevier Ltd. All rights reserved.

Contents

* Corresponding author.
E-mail address: g.aggidis@lancaster.ac.uk (G. Aggidis).

http://dx.doi.org/10.1016/j.rser.2015.12.347
1364-0321/© 2016 Elsevier Ltd. All rights reserved.

1. Introduction

Oceans cover over two thirds of our planet's surface. Advancements in engineering through human civilisation have sought to take advantage of this huge abundance of water starting with the water wheel, first mentioned by Antipater of Thessalonica in a poem during Alexander the Great Hellenistic age [1].

Leaps in engineering have far outstripped these technologies; however the idea of extracting energy from water has remained. The methods of doing so can be broken down into three main categories: wave energy, tidal stream and tidal range. There is a worldwide potential for these forms of renewable energy of approximately 337 GW [2].

Each form of tidal energy has a distinct advantage over all other renewables – predictability. The ability to accurately quantify energy outputs at specific tidal times makes the idea attractive to potential investors and the national grid.

Tidal range power plants produce vast amounts of electricity, much more than any single form of renewable energy. Tidal range power is created using a head difference between two bodies of water. To create this difference a wall is used to separate the two areas and as the tide flows in or out, the wall blocks the flow of the tide and creates a head difference. When the head difference has reached an optimum level, the water passes through the barrage and creates energy due to the turbines placed within the holes in the wall. With two tidal cycles per day, this head difference is created 4 times each day (as the tide comes in and out).

This method has been utilised effectively in France, South Korea, Russia and China. Due to this, the UK among other countries is seriously considering various potential applications.

The aim of this paper is to assess the benefits of tidal range energy. As well as providing an update on existing/potential plants as well as the various new and innovative methods of generating power in this way. The paper also assesses both existing and potential turbine designs. Other papers that talk extensively on the subject of Tidal range technology are [3–5].

2. Existing projects

Although tidal range projects are currently few and far between, the leading countries in terms of operational output are France and South Korea.

2.1. La Rance, France

Located near to St. Malo, France the La Rance tidal barrage (Fig. 1) was the first tidal range project to be operational [3,6]. Cofferdams were used for the construction, which involved the creation circular dams and draining the water from within the basin [7]. Built between 1961–1967, it provides a yearly output of 480 GW h per year [8,3]. A 720 m long barrage links the two sides of the river, capturing a 22 km^2 area of water in the process [5]. It also doubles up as a road link across the river and a valuable tourist attraction, improving the local economy [9].

Download English Version:

https://daneshyari.com/en/article/8114079

Download Persian Version:

https://daneshyari.com/article/8114079

Daneshyari.com