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Identification, productivity, resources, and storage of renewable and clean energy at sea

Masumeh Adim*

Logistics and Maritime Transport Expert

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Abstract

Increasing use of fossil fuels has irreparable consequences such as global warming, the ozone layer gap, changes in the rainfall patterns, rising seawater, and destructive effects on the life of plants, animals and humans, hence reducing environmental impacts of these resources and the development of new energies are the main priorities in energy planning, and all these reasons encourage scientists to investigate renewable resources. Renewable energy includes diverse and difference sources of natural and accessible energy; for example, wind energy, tide and wave energy, solar energy, biomass, geothermal energy and the energy of moon gravity. The benefits of wave energy and tides are preventing of carbon dioxide pollution, joint commercial opportunities, preserving fuel resources, reducing the risk of fuel burning in the future, and increasing diversification of energy supplies. In this descriptive article, in addition to introducing renewable energy sources, the extent of the country's share of this energy, introducing the methods of productivity, strategies, and solutions in the country will be investigated.

Keywords: Renewable Energy; Tidal Energy; Fuel; Southern coast of Iran.

1. Introduction

Energy sources are the most important factors and elements of sustainable development. Having the suitable energy is the most important economic factor for industrial societies after human resources because energy is a fundamental requirement for the continuation of economic development, social welfare, the improvement of the life quality and the security of society.

1.1. Necessity of utilizing renewable energies

- Restrictions on energy sources: The consuming energy sources, especially fossil fuels are limited.

* Corresponding Author: m.adim4@yahoo.com

- Environmental pollution of energy resources: The global environmental problems that are posed by global and inevitable crises ultimately depend on energy.

One of the most important and applicable sources of renewable energy is the use of tidal energy from the seas and oceans. This energy comes from a tide caused by rising and falling sea levels. The energy of waves and tidal energy are among the most important marine energies that tidal power plants have made faster progression due to their similarity to hydroelectric plants and their technologies. Today, this energy source is one of the best ways to produce clean energy (Zeilik *et al.,* 1998).

Considering the favorable and suitable potential of renewable energy in the country, the rational development of these valuable and divine resources seems justified, because it can be achieved through the goals of sustainable development.

2. Materials and methods

Tidal power (tidal energy) is a form of aquatic energy that is derived from the conversion of tidal energy into useful energy forms, mainly electric power.

Currently, good operational work is being done in Qeshm, Khor Musa and Khark areas to provide more accurate information based on field observations. Considering the available potential in maritime and tidal energy section in the north and south of the country, the Renewable Energy Technology Development Committee in cooperation with the National Oceanographic Research Institute have started preparing the Atlas of waves and currents in the Caspian Sea, the Persian Gulf and the Oman Sea.

2.1. Methods of production and application of tidal energy

2.1.1 Tidal Stream Generator

Tidal stream generators (TSGs) use liquid-flow kinetic energy to move turbines, as wind turbines use wind force to move. Some tidal generators can be installed in existing bridges that have no aesthetic problems (Darwin, 1908).

2.1.2 Tidal barrage

Tidal barrage uses the potential energy of height difference (or head) between the top and bottom of waves. When a tidal barrage is used to generate electricity, the potential energy of a tide is saved by putting a special strategic dam. When the sea level rises and the tides appear, temporary tidal energy is driven into a large pond behind the dam and a large amount of potential energy is stored. By pulling back the tide, the energy of water is released and by moving large turbines, its energy is converted into mechanical energy and the electricity is generated by generators. These dams extend along the entire coast of the river mouth or the Gulf (Darwin, 1908).

2.1.3 Dynamical Tidal Power

Dynamic Tidal Power (DTP) is an untested, but promising technology that uses cross-interaction between potential and kinetic energy in tidal currents. The technology suggests very long dams (for example, 30 to 50 km) direct from the shore to the sea or the ocean without any area being included. The Tidal phase

differences created on both sides of the dam lead to a significant difference in the shallow coastal waters (Knauss and Garfield, 2016).

2.1.4 Method

Considering the objectives of this paper, the water places of Iran with the highest potential of tidal energy is investigated. Researchers of the National Oceanic and Atmospheric Research Institute of Iran have shown that two points in the Qeshm Strait and Khor Musa in the Persian Gulf have the highest tidal currents, hence high potential for clean and renewable energy generation are available. Recent research showed that the tidal power potential in these two regions estimated by hydrodynamic numerical models was exceeded of 300 W/m^2 in Khor Musa and 500 W/m^2 for Qeshm. The total tidal energy distributed on the Earth is about 3*10^6 MW.

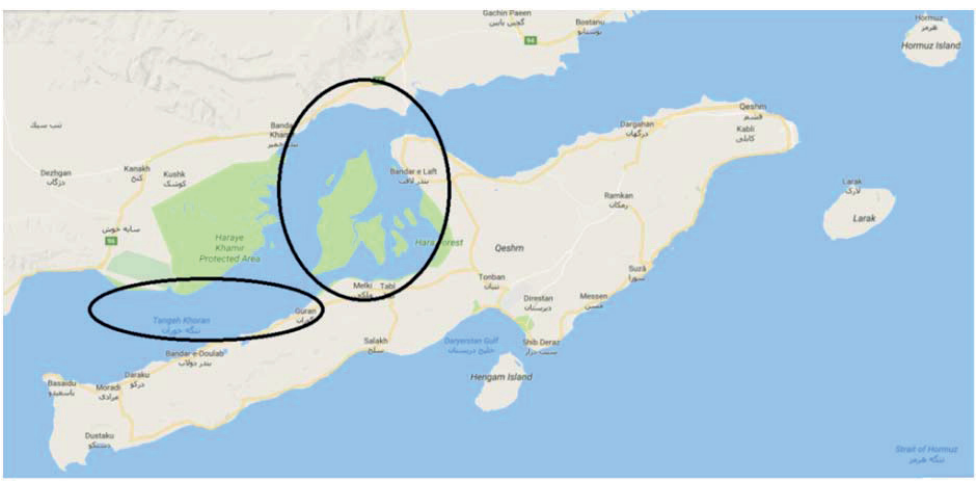

Figure 1. The enclosed area between the port of Laft and the Pohl and the Strait of Khuran

Figure 2. Areas with the highest tide impact and tide potential; with the 8m of minimum drainage area

2.1.5 Study area

As shown in Figures 1 and 2, two points of the Qeshm Island, the enclosed area between the ports of Laft and Pohl, as well as the Qeshm canal or Khuran Strait are studied where have the most tide impact and tide potential in the Qeshm area.

The most important factors in tidal energy estimation are tidal area elevation and tide height. The maximum energy that can be produced during the tide is calculated as follows (Fotouhi *et al.,* 2016):

$$E_{Max} = dgsh^2$$

which h is the tide height, s is the enclosed area, d is the water specific mass, and g is the gravity.

3. Results and Discussion

The Khuran Strait (Qeshm Channel) has 110 km length, and 22 km width in its eastern entrance which reduced about 2.5 km in westward direction, and then with about 10 km wide joins the Persian Gulf near the BaSaeed, where is one of the most important economic, commercial, strategic, environmental and military areas (Nazari and Sayebani, 2011).

The studied area is also between the Port of Pohl and the Laft Port with a surface profile of 6.5 km length, a width of 2 km, and a tidal difference of 4.3 m (Ranjbar *et al.,* 2011). Investigating the tidal cycle in the areas discussed in this paper over one year, which is twice a day, with an average of 13 hours, and also considering that the area has relatively high length, low width, and proper depth, and there is not much sea traffic, it is possible to build a power plant or dams to benefit from tidal energy.

It should be noted that the tidal energy is extracted in parts of the world where the minimum flow velocity is more than 1 m/s (Nazari and Sayebani, 2011); therefore, in the Strait of Khuran with flow velocity of 1.2 m/s, there is weak potential power available, therefore, it is proposed to build machines that can empower the velocity to increase the efficiency (ShafieFar *et al.,* 2000).

Also, regarding the situation of enclosed area between the Port of Pohl and the Laft Port, the water is displaced between two levels, with an energy rate of 14.11 W.h/m^2 in each tidal cycle and the high potential of 100 MW using Bi-directional turbines (Ranjbar *et al.,* 2011).

There are many studies and projects in different regions of Persian Gulf. For example, an estimation of energy from the tide, and the feasibility study about the construction of a power plant in the Chabahar area, the port of Mahshahr, Khor Musa, and Hengam Island.

Undoubtedly, the use of any kind of energy such as tidal energy and related equipment and technology has its own advantages and disadvantages. Hence, a brief overview of these advantages and disadvantages are summarized in following sections.

3.1. Advantages of tidal energy

Tide is known as one of renewable energy sources. It means that it does not depend on fossil fuels, and does not have CO_2 emissions and environmental pollution, and is constantly being renewed. Tides occur daily in different parts of the world, and their energy is convertible to useful mechanical and electrical energy. Tide is also known as a clean energy source, because it does not pollute the environment as green energy.

Tides are predictable. Not only the tide's level

rising and falling follow a given cycle, but its power is also specific. These two features make it possible to build power plants fit to the area capacity and to use of maximum available tidal power.

The production capacity of tidal power stations is constant throughout a day. Since the water is a dense fluid, it is possible that tidal power plants can produce power at low speed flows. Tidal power plants are more efficient than fossil power plants. The efficiency of these power plants is about 80%. Although tidal power plants have a high initial cost, their operating costs are very low, and these plants are capable of being completely automated. In addition, the tidal power plants have long durability, about 75 to 100 years (Fotouhi *et al.,* 2016).

3.2. Disadvantages of Tidal Energy

Like all forms of energy, tidal energy also has several disadvantages in comparison with its advantages as follows.

Contrary to the fact that the tides are predictable, the construction of power plants has certain limitations and cannot be built in any local area. Approximately 40 places in the world are known suitable for these power plants.

Since most of tidal power plants are distantly far from the distribution network, the transmission of energy to the power network is difficult.

Tidal power plants can produce the power only in 10 hours a day which is caused useful period of these energies to be 40% of a year. Furthermore, since the initial cost of building a power plant is a key parameter, it should be noted that the cost of these tidal power plants is very high.

Tidal power plants can affect on the aquatic environments. So, before the construction of these plants, their environmental impacts should be taken into account. Tidal dams interrupt accessing to open waters. Also, tidal power plants themselves, in some extent, eliminate the tidal energy. In addition, in tidal ponds, the water salinity increases.

Due to the direct contact of the plants with water, waves, tides, and water temperature changes, the converters are encountered with some problems, which are caused increasing the operating costs. Because the number of tidal power plants is very limited, economic estimation cannot be made for them. The construction of the tidal power plants changes the appearance of the region, which may disrupt the tourism industry (Fotouhi *et al.,* 2016)

Conclusion

Considering the descriptiveness of the article, it is possible to use the tidal energy in areas of Qeshm Island (the enclosed area between the Laft Port, the Pohl Port and the Strait of Khuran) using the tidal patterns of the area during a year, 2016. According to data from various sources, and taking into account the commercial, economic, strategic as well as the environmental and maritime traffic of these two regions, which have a high potential for the use of such renewable energy, as a proposed plan with the assistance of experts and researchers in this field, and the investment of public and private sectors, the production and employment of young people, it is hoped to have green and abandoned country.

Of course, given the proximity of the area between the Pohl port and Laft port to commercial and economic centers, such as Shahid Rajaee Harbor, refinery and etc, it is expected that less construction and investment

costs will be required than the Khuran Strait, but for the certainty, specific requirements for energy constraints as well as environmental limitations should be considered.

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