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Renewable energy potential in Malaysia: Hydrokinetic river/marine technology

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ABSTRACT

Utilization of electrical energy is the key to economic growth and improvement in people's living standards, especially in developing countries. The growing demand for electrical energy and the environmental effect of fossil fuel usage are the main topics driving us towards renewable technology. Hydropower, mainly hydrokinetic energy technology, is a well-known source of renewable energy. This study was carried out to present the potential of hydrokinetic energy in the world and Malaysia. Relevant research literature, based on developments, applications, design, operation, efficiency as well as different hydrokinetic technologies have been reviewed. This work critically considers the main characteristics of Malaysian current and water depth and the challenges associated with enhancing the efficiency of hydrokinetic turbines and providing electricity to remote areas with access to running water but little electricity. This paper will aid researchers to identify areas that need to be improved, as well as encourage public bodies to implement proper energy policies regarding hydrokinetic energy technology usage in rural areas with low-speed currents.

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1. Introduction

With the increase in awareness of the importance of a sustainable environment, it has been accepted that traditional dependence on fossil fuels has exacted a heavy cost on the environment and led to CO_2 emission, greenhouse problems and environmental pollution [1,2].

Keep in mind that world energy, especially in developing countries such as Malaysia [3] is still heavily dependent on fossil fuels, which are rapidly being depleted. At current production rates, global proven reserves of crude oil and natural gas are estimated to last for 41.8 and 60.3 years, respectively, [4,5], so the role of renewable energy as green and clean energy to supply sustainable power generation [6] is significant.

It is noteworthy that one-third of the world's population does not have access to electricity, but does have access to flowing water [7]. The majority of remote areas where they are located alongside flowing water are very poor, with low living conditions and limited access to media and information, and they have some limitations in extracting kinetic energy from water, especially in Malaysia.

It is known that utilization of electrical energy is the key to economic growth and improvement of people's living standards [8], so providing electricity to remote areas with less environmental impact is essential.

Different methods to provide electricity in remote areas, such as grid-extension and diesel generators can be listed. Grid-extension is uneconomic because electrification of inaccessible locations requires special tools, is time consuming and costly. This is an unsatisfactory supply option because most residents are poor and unable to finance electrical services [9].

Diesel-power generators are most popular among remote residents for electricity generation [10], but continuing this method is unsustainable for them because of increasing petroleum prices and the difficulty of transporting fuel to remote places.

Hence, renewable energies are being promoted as clean and reliable energy sources to provide cost-effective sources of electricity for remote areas that are poor in electricity but have access to flowing water, such as some places in Malaysia.

Biomass [11], wind [12], solar [13], hydro- and geothermal [14] are listed as renewable energy sources that are clean and reliable in reducing greenhouse gas emissions that lead to global warming, while saving money and creating jobs.

Among different renewable energy options, hydropower is the prime choice to contribute to the world's energy generation because it is continuously available, high density, powerful, predictable and independent of random weather conditions, as opposed to solar and wind options, and has less impact on environmental and human activity [15–21].

In addition, because of the geographical location of Malaysia, its equatorial climate, high rainfall, long coastline, numerous rivers and irrigation channels, hydropower as renewable energy is a viable choice to generate electricity, thereby reducing the high dependency on fossil fuels, for electrification of islands and remote areas using hydrokinetic devices.

Despite attempts to develop renewable energy, up to now it has not been used to its maximum potential in Malaysia because of restrictions on the head and current speeds [22–24].

Therefore, some modifications are required to allow turbines to harness maximum power, especially for remote areas alongside the ocean.

Depending on the alignment of the rotor axes with respect to flowing water, hydrokinetic turbines can be categorised into two main types, horizontal axis (axial-flow) and vertical axis, where the turbine blades would turn the generator by capturing the energy of the water flow to produce electricity [25–29].

Therefore, this paper attempts to review the potential of renewable hydro energy as an alternative source to supply renewable energy in the world and Malaysia. In addition, the status of water current turbines using hydrokinetic energy on a large or small scale to generate electricity that is clean and reliable to reduce greenhouse gas emissions while saving money is discussed.

It targets the promotion of hydrokinetic renewable energy to the public, industrial shareholders and local authorities. It is an important source of renewable energy and an industrial opportunity for a sustainable future.

2. The worldwide necessity for renewable energy

Electricity is the fastest-growing final form of energy. The International Energy Agency (IEA) estimated a 53% increase in global energy consumption is foreseen by 2030 [30]. According to the IEA, as shown in Fig. 1, around 68% of world electricity generation was mainly based on fossil fuels in 2012. These fossil fuels include 40.4% coal, 22.5% natural gas and 5.0% oil, the remainder consisting of 10.9%, 16.2% and 5.0% on nuclear power, hydroelectricity and other, respectively. World electricity generation from 1971 to 2012 in Fig. 2 shows the growing share of fossil sources, and this dependency will increase with each passing day, especially in developing countries (including Malaysia) because of increasing electricity demand.

Electricity generation using fossil fuels contributes negative impacts to the environment, namely CO_2 emission [1,31], greenhouse effect [32,33] and global warming [34–36] and human health leading to diseases such as skin cancer, respiratory diseases, etc. In addition, fossil fuels are less reliable in the long term because of limited reserves [37] and provide economic growth because of the high oil price [38–40].

In addition, population growth, which causes an increase in the energy demand, is the most important factor for increasing world energy consumption, as shown in Fig. 3 [3,41].

Hence, clean energy sources are vital to ensure a future electricity supply and protect the environment for future generations. The world renewable energy generation estimate is given in Fig. 4 and Table 1.

As Fig. 4 and Table 1 show, hydro sources will provide a significant portion of future electricity production.

Renewable energies are natural resources that can be recovered in a measurable time period. Therefore, renewable energy should be promoted for sustainable development. Hence, many countries attempt to use renewable energy as preferable and necessary sources to reduce the dependence on fossil fuels. According to IEA, the strong growth of renewables in many countries can raise their share in global power generation to one-third by 2040 [30].

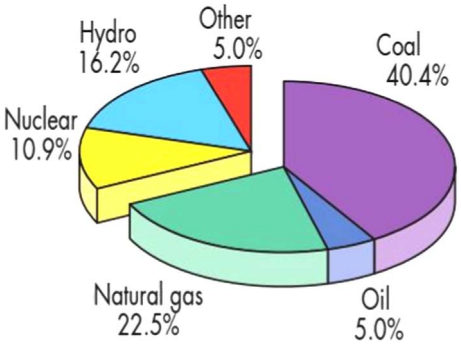

Fig. 1. World electricity generation from various energy sources [30].

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