THE FEASIBILITY STUDY OF ELECTRICITY GENERATION FROM OCEAN TIDAL ENERGY AT KUALA LAWAS

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Universiti Malaysia Sarawak
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This report submitted in partial fulfilment of the requirement for the degree of Bachelor of Engineering (Hons.) Mechanical Engineering and Manufacturing System from the Faculty of Engineering

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2002

Especially for my loving mother, my dearest family and

loving memory of my late father

BORANG PENYERAHAN TESIS

Judul : THE FEASIBILITY STUDY OF ELECTRICITY GENERATION FROM OCEAN TIDAL ENERGY AT KUALA LAWAS

SESI PENGAJIAN : 1999/2002

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This project report attached here, entitled " **The Feasibility Study of Electricity Generation From Ocean Tidal Energy at Kuala Lawas** ", prepared and submitted by Yusland bin Radin as a partial fulfilment of the requirement for the degree of Bachelor in Engineering with Honours in Mechanical and Manufacturing System is hereby read and approved by :

Date : 20 March 2002

NAZERI ABDUL RAHMAN
SUPERVISOR

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ABSTRACT

The ocean tide phenomenon has the potential to produce power for electrical generation. The gravitational force exerted by the moon and the sun towards the earth surface causes this phenomenon. Generally, there are two methods of harvesting the energy from an ocean tide phenomenon; water current turbine and tidal barrage system. This study is conducted to find out, whether the location of study, Kuala Lawas (Batang Lawas River), is suitable for the implementation of a tidal power plant. Other than that, this study is also conducted to discover, which method is suitable to be implemented in Kuala Lawas. The result from this study shows that the tidal barrage system could supply the required amount of electricity to the locals. On the other hand, the water current turbine could not produce sufficient electricity for the locals.

ABSTRAK

Fenomena pasang surut mempunyai potensi untuk menghasilkan tenaga yang diperlukan bagi menghasilkan tenaga elektrik. Kejadian air pasang surut adalah disebabkan oleh daya tarikan graviti bulan dan matahari kepada permukaan laut bumi dan bumi. Secara amnya, terdapat dua cara untuk menghasilkan tenaga elektrik daripada kejadian pasang surut; turbin arus dan sistem empangan. Projek ini bertujuan untuk mengkaji sama ada kawasan kajian, iaitu Kuala Lawas (Batang Lawas) mempunyai potensi untuk menghasilkan tenaga elektrik daripada keajadian pasang surut. Selain itu, kajian ini juga bertujuan untuk mengkaji kaedah yang paling sesuai dengan Batang Lawas bagi menghasilkan tenaga elektrik. Hasil daripada kajian ini menunjukkan bahawa, sistem empangan mampu menghasilkan tenaga elektrik yang secukunya untuk penduduk setempat dan didapati juga bahawas kaedah trubin arus adalah tidak sesuai.

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NOMENCLATURE

A = cross-sectional area of the river, m^2

d = river's depth, m

Eo = maximum potential energy, W

Ep = average potential energy, W/h

g = gravitational acceleration, ms^{-2}

g_c = conversion factor, 1.0 kg/(N.S^2)

h = head, m

m = mass flowing through turbine, kg

P = power available, W/day

R = tidal range = high tide level - low tide level, (m)

T = tidal period, h

W = work done by the water, J

w = river's width, m

ρ = density of water, kg/m^3 (assumed 1025kg/m^3 for sea water)

CHAPTER 1

INTRODUCTION

1.1 Energy Crisis of the World

Energy can be defined as "*the ability of matter or radiation to do work because of its motion, its mass or its electric charge, etc*" [Crowther J., 1995]. Energy is not creatable and it is indestructible. Energy can only be altered or converted to other form of energy. Nowadays, when energy is mentioned, people are more concern towards the usage of energy source to produce electricity than other purposes. This is because almost all the appliances in the world use electricity to operate. In this new century, the world is having a crisis on energy demand as demands are rising each year due to these factors:

1. Population growth
2. Energy per capita consumption
3. Economic growth
4. Energy Intensity

The source of energy nowadays mainly from the non-renewable or exhaustible energy. These sources, such as fossil fuels have been used and mined for decades and depletion problem is on its way. **Figure 1.1** shows the share of world energy useage in 1996.

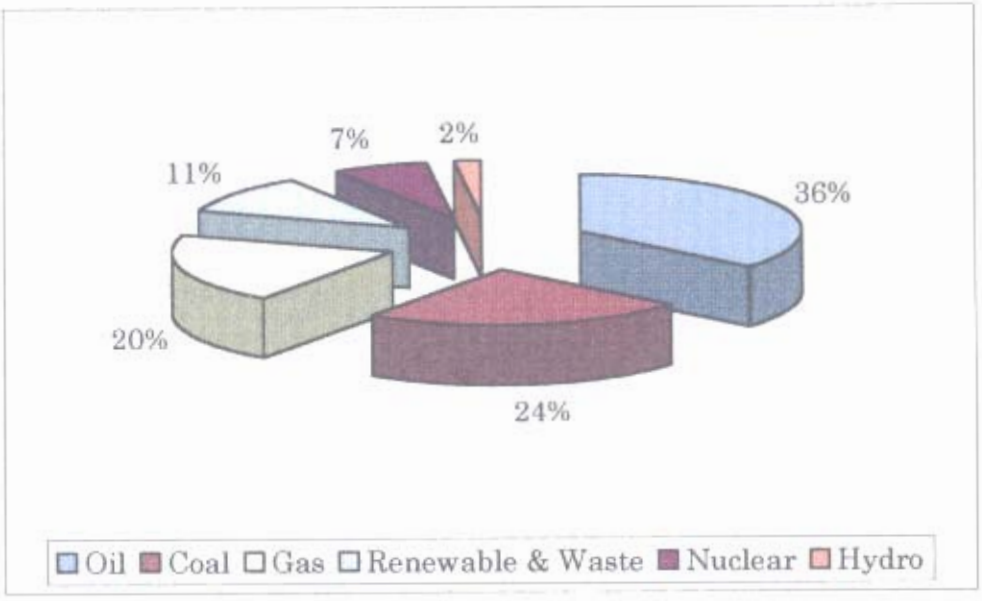

Figure 1.1 : Share of world Energy Use in 1996 [Australian Greenhouse Office, 2001].

According to the Australian Greenhouse Office [2001], about 80 percent of the world's energy source came from non-renewable energy source. In details, 24 percent of the world's energy source came from coal, 36 percent came from oil (fossil fuels) and 20 percent came from natural gas. All of these sources are exhaustible and facing a probability of exhaustions Other than that, these energy sources are burnt to produce electricity. The problem arises from this activity is the vast amount of carbon dioxide produced from the combustion of these energy sources. Carbon dioxide is the main greenhouse gas that contributes to global warming [Australian Greenhouse Office, 2001]. Thus, other clean energy sources, especially inexhaustible energies should replace the part of fossil fuels in generating electricity,

1.2 Types of Energy Sources for Electricity Generation

As the need of electricity supply increases, many methods have been created to convert energy sources to electrical energy. Different types of energy source require different steps or process to produce electricity. Basically, there are three types of energy sources in this world; exhaustible (non-renewable), inexhaustible and renewable.

1.2.1 Exhaustible (Non-renewable) Energy Sources

An exhaustible or non-renewable energy source is an energy source which cannot be replaced nor exist any more after being used. These types of energy are the ones, which are usually mined. These types of energy sources are finite and being depleted each day. According to Dr. Ralph C. Bohn [1986] and his colleagues in their book, "Energy, Power and Transportation Technology" there are basically two types of exhaustible energy sources; fossil fuels and uranium.

Fossil fuels are basically made of fossilized animals and plants aging millions of years old. These "fuels" are found underground and mined. The energy in these fuels actually came from the sun, which was stored by animals and plants millions of years ago [Bohn et al., 1986]. **Figure 1.2** shows the process of plants and animals decomposing for millions of years and fossilized, then finally became fossil fuels underground. Examples of fossil fuels are coal, petroleum, and natural gas. Fossil fuels release their energy in the form of heat and to extract this energy, they are simply burnt, thus producing heat energy. The heat energy from fossil fuels combustion are used to move vehicles such as cars, rains, ships and even planes. The heat energy from these fossil fuels is also used to produce electricity.

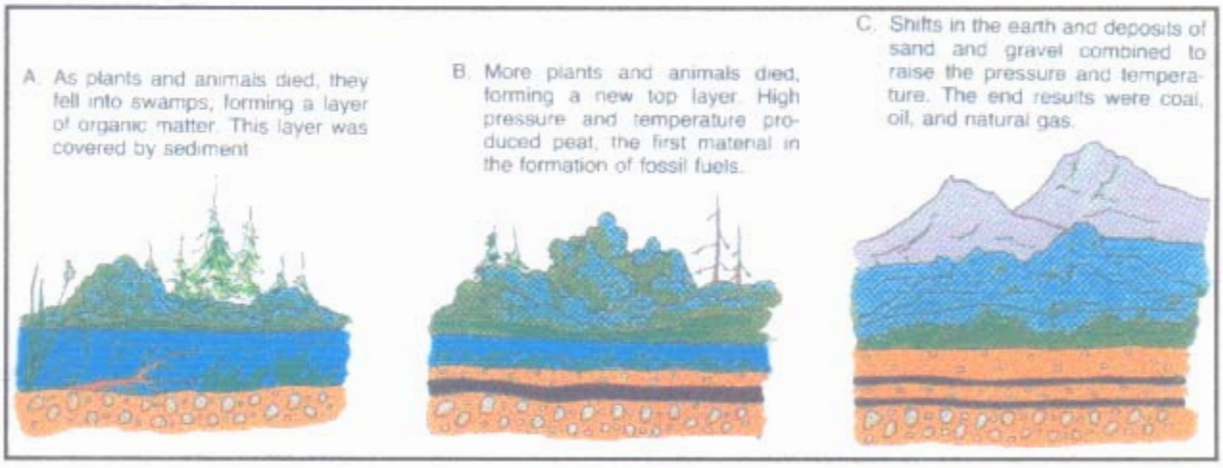

Figure 1.2: Fossil fuels are made of fossilized plants and animals, which were composed for millions of years [Bohn et al, 1992].

The main problem with this type of energy is that, during combustion they gave out carbon dioxide and other matters, which are contributing to air pollution and global warming effect. This problem cannot be resolved easily as the world's main energy sources came from this type of energy source.

Another type of non-renewable energy source is the nuclear energy. The most common nuclear "fuel" is uranium. Uranium is a heavy substance, which can be found in many metal ores. On Earth, there are two types or uranium, which are called isotopes. The first isotope is the uranium-238 (U-238), which is abundant, and the second isotope is uranium-235 (U-235) which is rare isotope. This rare isotope (U-235) is used as the fuel in nuclear plants. Uranium is obtained through the method of mining, thus making it as one of the exhaustible energy source.

1.2.2 Renewable Energy Sources

What are renewable energy sources? This type of energy sources is the ones, which can be used for an indefinite period only if they are managed and maintained properly. These include plants that grow on the earth and those that grow in the ocean. In other words, renewable energy sources are obtained from vegetation. These energy source can be exhausted if not properly managed, for example our timber supply may run-out if not properly managed, because forests take hundreds of years to produce mature & timbers prior for usage. There are four types of renewable energy sources ; wood, biofuels, gasohol and methanol.

A. Wood

Wood has been used to generate energy for centuries. Usually wood is used for cooking and heating. Nowadays, the role of wood has been replaced by coal and oil. Wood is usually to heat up homes around the world in fireplaces. Even though fossil fuels are used widely in generating electrical energy, there are still power plants that use wood for its "fuel". An example is a power company in Vermont uses wood chip to fuel two electrical power generation units. In the future, wood can be a major source of fuel for power generation and even for vehicles because it is renewable. However, its use as fuel will compete with its use in construction, including paper making and furniture industries.

B. Biofuels

Biofuels are actually fuels created from waste product to produce energy. These waste include vegetation waste, aquatic wastes, animals' wastes and municipal solid wastes. Projects are conducted to implement the usage of biomass or biofuels to generate energy. In fanning, agricultural waste products are used as fuels. In residential and business, garbage and solid waste products are used, and from sewerage, product of waste treatment plant are used as biofuels,

Basically, there are two types of biofuels ; biogas and biomass. Biogas is produced from plants and animals waste. The gas produced as biogas is methane. To produce methane, organic waste products are mixed with water, forming slurry. This slurry is the placed in a tank called digester. In the digester, bacteria will break down the waste products into gases and sludge. The methane produced in this process can be used for heat generation and electricity generation. With the vast improvement and development in technology, inventing automobiles using methane as its fuel is not an impossible task .This will help to reduce the usage of fossil fuels as main fuels for automobile which contributes to air pollution everywhere in this world.

Another type of biofuel is know as biomass, Solid waste products can be processed and burned to generate electricity. During waste processing, combustible substance is separated from other non-combustible substances such as, glass, metal and dirt. The combustible substance, which can be burned immediately like paper and wood, do not have to be processed. Other substance may need further processing to make them more burnable. These process may

include water removing and compressing, to produce fuel pellets to be used in power plants.

C. Methanol

Another name for methanol is methyl alcohol. This type of fuel is a clean burning liquid fuel. It can be produced from natural gas and even coal. On the other hand, these sources are not renewable. Luckily, one can produce renewable methanol. This renewable methanol is produced from wood, plants and other biomass materials from farm, homes and industries.

Methanol produces less energy than gasoline and burns more slowly [Bohn et al, 1992]. This means that more methanol is needed to produce the same amount of energy given out by gasoline. Nevertheless, methanol can still be used as fuel for automobiles, but with one condition. Slight modification has to be made to the engine to ensure that methanol can produce as much powers gasoline. In the future, methanol can be an important source of fuel.

D. Gasohol

Gasohol is a mixture of nine-tenth unleaded gasoline and one-tenth ethyl alcohol. The purpose of this mixture is to reduce the usage of gasoline from 100 percent to 90 percent, meaning that 10 percent of the oil needed to produce gasoline or petrol can be saved [Bohn et al., 1992].

The ethyl alcohol for this purpose is produced from sweet sorghums, sugar beets and grains. Distilleries process these materials into alcohol. This alcohol is then

mixed with gasoline to produce gasohol. The mashes from this process, which contain all the protein from the original product, are not wasted. Farmers use it as livestocks' food supplement.

1.2.3 Inexhaustible Energy Sources

According to Jonathan Crowther [1997] in Oxford: Advanced Learners Dictionary, inexhaustible carries the meaning "something that will always continue" or "never finished'. Thus, from this definition, inexhaustible energy sources can be defined as energy source, which will always be available and never be exhausted. These energy sources are never used up because they are renewed naturally by Mother Nature. Generally, there are four types of inexhaustible energy source ; solar, wind, geothermal, and oceans.

A. Solar Power

The sun is the main energy source in the world. All other energy sources are initially originated from the sun. The sun provides us with light and heat energy, these energy can be converted to electrical energy by using the right tools.

There are two ways to convert the energy from the sun to electrical energy. The first method is by using a mirror plant. A mirror plant is consist of collector mirrors called heliostat to reflect sunlight and concentrate it onto a boiler at the top a water tower. The heat supplied by the concentrated sunlight will provide the heat needed to heat up the water in the water tower to produce steam, which then will be used to operate a turbine to generate electricity. **Figure 1.4** shows