This report has been updated on the 18th of December 2018 to include a disclaimer and foreword.

Background

The following report was completed for the International Baccalaureate Middle Years Programme (IB MYP) Physics (Grade 11) at Fairview International School Subang, Malaysia on 18th November 2016.

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Alternatives to Fossil Fuels in Malaysia

We are constantly using electricity to power our world and everything around us. From the small and compact rechargeable devices with Lithium batteries to the DC-powered computers and the huge kitchen appliances powered by AC power, they all are powered by electricity. As of 2000, 3.8 million mW (Megawatts) of power has been used in total by the 7 billion people in the world. Electricity is used for all kinds of purposes such as industrial, commercial and residential purposes. The IEA (International Energy Agency) predicted that by the year 2020 the total power consumption will reach around 5.8 million mW (IEA, 2015) based on annual average power consumption graphs and population graphs. However, they also predicted that fossil fuels, the most common source of non-renewable energy used to generate electricity could only in total produce around 15 million mW of electricity and therefore it would probably run out by the year 2060. (World Energy Outlook, 2015) There are also concerns that fossil fuels, which have to be burned, produce a lot of toxic waste gasses that are harmful to the environment when burned.

Without electricity, all governments around the world would instantly fail to operate. Many governmental systems run by computer based systems to store their data and keep

control of their parliament and country. There would be handwritten or printed copies of these documents but most of the time they are stored in classified locations that are guarded by electric powered locks, which despite having backup power supply, would either take a long time to reach or be unreachable at all. This doesn't mean that countries would go into chaos yet, but the governments of countries would already have trouble because their economies would instantly crash due to the fact that all primary and secondary business sectors would stop production, tertiary business workers wouldn't have power to power their offices and consumers wouldn't be able to purchase anything. Added to this issue, most cars also run on fossil fuels and transportation would almost come to a halt. Cars that run on electric power wouldn't be able to recharge and those that run on hybrid power wouldn't be able to operate because their fossil fuels would run out. Cars that run on solar power wouldn't be cheap and therefore not many people would have them. Therefore almost the whole country would come to a halt in all sectors.

Fossil fuels are made of the remains of living organisms that decayed from millions of years ago, hence the name "fossil". Energy is harnessed from them by burning them, hence the part of the name "fuel". They can be manufactured into coal, oil or natural gas, which means that fossil fuels are able to come in any state of matter. Oil and natural gas are relatively more expensive to manufacture, but they are more environmentally friendly and require less fossils to manufacture. But still, with fossils running out, it is not the best idea to continue using any type of fossil fuels, and oil is used mainly for car engines as it would not be the best idea to build large power plants full of petrol or oil, since explosions could easily happen. Therefore, many countries use coal fossil fuels to generate their country's electricity.

As all living organisms are formed from one element, which is Carbon, when coal is burned, it releases Carbon Dioxide that is a toxic gas and is harmful to the environment.

To conserve fossil fuels, renewable energies such as solar, biomass, geothermal, hydroelectric, wind, wave, tidal and nuclear powers need to be used instead. Solar power uses solar panels constructed with man made materials like glass and special internal components that are rather costly. Biomass power uses all organic materials like old plants, old food and other organic matter that can no longer be consumed. Geothermal energy harnesses the power of the earth's heat to produce electricity. Hydroelectric power uses the water flow in rivers and lakes as well as dams to generate power. Wind power uses the power of the wind blowing against windmills or wind turbines to generate power. Wave powers harness the power of waves by the seaside or ocean to generate power. Finally, tidal power uses the rising and falling waves to produce power.

On average, 4 kW solars panels produce only around 0.048 mW of power per day, where the average Malaysian household uses up to 4 mW of power a day. Therefore, 8 of these solar panels will be required to power a whole house. Each of them cost around US$7000 on average. These solar panels are also extremely large in size, at average 30 square metres, where the average size of a house roof in Malaysia for a terraced house is only around 15 to 20 square metres. Solar panels around this size are rated at 2kWH and produce only 0.22 mW of power a day on average. Therefore, there would need to be 16 of them in order to produce enough power to power the whole house. Taking into consideration that the roofs of many older Malaysian houses are slanted, curved and sometimes even have exposed sections

of water tanks, solar panels are almost impossible to be installed on them and if possible, a lot of money would need to be spent on correcting the size or shape of the roof.

Biomass power requires organic waste like plants and dead animals, and many species of animals in Malaysia are protected or endangered. Deforestation is already very prevalent in Malaysia and due to the tropical weather and humid weather in Malaysia, most large plants survive for up to 50 to 100 years, and the small ones which die within 5 to 10 years, all combined are only able to power a handful of cities probably the size of Singapore, which is around 725 km^2, while Malaysia in total is over 330,805 km^2. Therefore, the power generated could only power 0.22% of Malaysia whereas around 70% of Malaysia comprise of areas that currently use non-renewable energy.

Geothermal energy can't be used in Malaysia, as geothermal energy would require drilling deep into the ground and most of Malaysia's underground and mainly composed of sandstone, a very weak material that could easily collapse and cave in if it is drilled into by strong drills and drilled with large holes, which are all required for the mechanisms to produce geothermal energy.

Wind energy can't be used in Malaysia, as the winds are not constant in Malaysia and average wind speeds in Malaysia is 1.8m/s and minimum average speeds of 6m/s are required to produce power suitable for daily use, and that would only be for a small town. Also, despite the fact that only one single turbine would be required to power the average Malaysian home, one single turbine would cost more than US$8000 and be very easily spoilt due to Malaysian weather conditions.

Wave and tidal energy can't be used since the tides in Malaysia come only during the monsoon season and waves are not present in all bodies of water, therefore only coastal cities have easy access to that power generated by waves. The waves in Malaysia are unlike those on islands like Hawaii and are most of the time merely waves that feel like they have been generated by the kicks of someone while they were swimming. Wave and tidal energy will use a propeller blade with half of it is submerged underwater, and it will spin according to the rate of movement of the speed

Nuclear power is not a good option for Malaysia, as the country has poor maintenance and enforcement culture. When cleanliness of public facilities such as public toilets and children's playgrounds cannot be maintained, it is certainly, in no way, feasible to maintain and regulate a nuclear reactor was requires round-the-clock maintenance and alertness. Also, the weather in Malaysia is very hot, and it would be very expensive to regulate the temperature of the nuclear reactor to prevent it from exploding due to excessive heat around it.

Hydroelectric energy would be the best type of renewable energy source to replace fossil fuels in Malaysia. Despite the fact that the weather is hot in Malaysia and solar power could have been used, as mentioned above, solar panels are expensive and most Malaysians, with a large middle-class income population would not be able to afford that many solar panels. The other methods are also all unsuitable for Malaysia as mentioned above. Hydroelectric power plants are also more efficient as they produce 40% more electricity than fossil fuels every hour (Alternative Energy, 2009). Hydroelectric power plants are very cost

effective compared to all other renewable energies listed above. Hydropower is only produced as US$0.85 per kWH, as opposed to the $1.70 per kWH for nuclear power, and US$2.20 per kWH for fossil fuels. This will benefit the economy tremendously. On average, hydroelectric power plants rated at standard power rating will cost around US$20 million (Jones, 2016) to build whereas coal power plants rated at standard power rating will cost around US$ 2 billion to build. (Semantic Scholar, 2016). On average, standard rated hydroelectric power plants produce over 2100 mW of electricity annually, as opposed to the conventional coal power plants which only produce 840 mW of power annually. 1 mW of power is enough to power over 700 homes, which means that 2100 mW of power can power around 1.47 million homes. Malaysia has over 6.5 million homes, and therefore we would only need to build five of these hydroelectric power plants. (Department of Statistics Malaysia, 2012) Currently, Malaysia does have five power stations that in total cost US$9.9 billion to build, while building these hydroelectric power plants would only cost around US$100 million to build, saving the government from economic stress. Due to the lower price of electricity, this prevents the people from getting economically stressed as well.

Hydroelectric electricity is generated in a hydroelectric plant. It has to be set up inside a dam as one part of the plant needs to have a higher water level than the other to create a drop of water. Inside the generator, there is a turbine, a windmill like device which will start turning because of the force of the downward flowing water's current. Inside the plant, there is a electrical generator that will convert the mechanical energy that the turbine produces into electric energy. Transmission lines are then hooked up to the generator and the power can be delivered to homes. The Bakun Dam, a hydroelectric power plant located in Sarawak, East Malaysia, generates about 2400 mW electricity annually which could power the whole of Sarawak, in addition to other cities in the state of Sabah and even some parts in West

Malaysia via a planned undersea cable project. Citizens of Sarawak have been actually paying 47% less for their electricity bill (Malay Mail Online, 2014) ever since the Bakun Dam has opened. Although the dam has benefitted the economy, and will cost less in the long term and prevent air pollution, the construction of the dam has caused the inundation of 700 square kilometres of forests and farmland around the dam site. As a consequence, over 10,000 residents have being displaced from their previous settlements to new village. As fish live in the river and fishing is a popular business in Sarawak, the construction of the dam has damaged the ecosystems and habitats of wildlife and made some citizens lose their jobs.

Therefore, in conclusion, hydroelectric power (or hydropower for short) is the best option of renewable energy replacing fossil fuels for Malaysia, but it does still come with disadvantages such as environmental issues like the ecosystem and the native's habitats being destroyed.

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