The Fifth Energy Option for Malaysia

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INTRODUCTION

Slightly more than thirty-two years ago the world was stunned with the First Oil Shock when the Arab members of OPEC decided to increase the price of crude oil from about USD3 per barrel to a hefty USD7 per barrel. Within a year the price rocketed to about USD12 per barrel. The spin-off from that shock was that suddenly consumers were designing and driving smaller cars with less petrol consumption. Marginal fields became more economically conscious, and investments were made on new sources of hydrocarbons and on new types of energy resources. Energy conservation, energy audits and more efficient systems became the buzz words of the day. Over the years the price steadily increased, steadied around the USD25 per barrel range for some time, steadily reduced down to a level of around USD12 per barrel, and steadily increased again to around USD30 per barrel. With about one price shock per decade we are seeing around the USD60 per barrel currently. The spin-offs of these shocks are still along similar lines. About twenty years ago the crystal-ball gazers were already talking about USD100 per barrel oil. We may still reach that level within this decade.

In 2003 the European Union agreed that by 2010, 21% of electricity consumed in Europe should be from renewable resources. Warnings have been sent to several countries which are seen not to keep to the schedule [1]. Just slightly over seven years ago the then Prime Minister of Malaysia, YAB Tun Dr Mahathir Mohamad said, "It is now timely to accelerate and make necessary preparations to bring these 'fringe' but unique domestic energy options into the mainstream." [2] He was referring to the 'four-fuel strategy' of oil, gas, hydro and coal to include renewable energy as the fifth option. Out of an estimated 29,000 MW of hydro-power potential only about 2,000 MW has been exploited There was a direct reference to solar as having a great potential as well, and that of biomass as another enormous source of renewable energy. Almost ten million tonnes of oil equivalent could be obtained from biomass coming from residues of the wood and agricultural sectors about 50% of which comes from oil palm industry waste.

In 2002 the energy supply mix was roughly 48.9 % oil, 41.4% gas, 4.8% biomass and waste, 4.1% coal and 0.9% hydro. It was also targeted that renewable energy contribution was to reach 5% by the year 2005. Energy fuel production for 2002 was 80 million tonnes oil equivalent (Mtoe) with exports of 28 Mtoe. For 2003 oil and gas production increased by nearly 7%. For 2003 there was a change of strategy resulting in natural gas going down from 68.5% to 65.3%, coal increasing from 14.1% to 24.6%, fuel oil down from 10.1% to 3.5% and hydro decreasing by about 1%. In 2004 crude production was 750,000 bbl/d with 80,000 bbl/d of natural gas liquids [3].

Fiscal incentives for renewable energy projects were given in the form of investment tax allowances and Small Renewable Energy Programme (SREP) which encourages the selling of power to the National Grid. Twenty-eight biomass projects totalling a potential of 194 MW production and four landfill-gas based projects producing a potential of 9 MW of power have been approved. There are eighteen mini-hydro projects producing a total of 70 MW which have also been approved. We will see the available so-called renewable energy resources and assess those that have the most potential for Malaysia.

SOLAR

Despite the abundance of solar energy resource in Malaysia, the utilisation of this renewable energy has only been limited to the installation of about 10,000 units of solar heaters, and photo-voltaic systems for rural electrification and minor applications involving telecommunication, street and garden lighting, and ticket dispensing machines. There have been a few solar-powered cars competitions organised. The advantages of solar energy systems are that the capital and the operating costs are fairly cheap; there are no pollution or the production of green-house gases and it could be modular. With the rapid expansion of the building construction industry the potential development in the application of the Building Integrated Photo-voltaic Technology is great. There is a great need in the research and development of such systems with commitment from the relevant authorities and organisations. The downside about solar energy is that it is only readily available during sunny days. And during the monsoon months the hours of sunshine could be much shorter especially on rainy and cloudy days. There could also be some negative visual impact, and the maintenance of such systems could be costly.

BIOMASS

Fifty percent of biomass in Malaysia comes from the oil palm industry, while the rest comes from wood and other agricultural waste like rice straw and husk. In the past most of these waste material has been either used for heating or simply burnt and the ash recycled into the system. Since open burning is no longer desirable, two possible approaches towards the utilisation of these wastes are their direct use as fuel and conversion to alcohol which is further used as fuel. This resource is cheaply available but it could be seasonal for some sources and collection and transport is a major problem. The palm oil industry utilises a fair amount of this waste for its own energy requirements. There is a power generation project with a capacity of 10 MW being implemented in Perlis utilising rice husk and straws as fuel. Looking at the alcohol route, we could see that the fermentation of cellulose to alcohol is not straight-forward and requires more research to make it viable.

BIOFUELS

Biofuels commonly come either from ethanol or the methyl ester. While Brazil

have for a long time pursued the alcohol approach from the fermentation of sugar, the US have concentrated on the fermentation of corn. Malaysia have for the last twenty years or so been looking at the methyl ester route to palm diesel. These fuels burn cleaner with less emission, and combustion temperature is lower giving longer lasting engines as compared to petroleum. The octane rating is higher which means that the knocking tendency is less; and the flash point is also higher meaning that it is safer to handle. Alcohol is more miscible with water than gasoline thus minimising separation problem in the storage tank; and less freezing problems. The challenge has for a long time been about the net amount of energy produced. Alcohol forms an azeotropic mixture with water meaning that there is a limit to the purity of alcohol you can get by simple distillation. Energy input into production was said to be high. There has been extensive debates [4,5] on the issue, and several recent work have focused on showing that there is in fact a definite net energy gain from the production. The other big challenge with both corn-based and palm-based biofuels is to change the perception of 'subsidised food burning'.

GEOTHERMAL

The temperature at the centre of the earth is about 6000°C. There is roughly an increase of 1°C for every 36 metres down into the earth. In volcanic areas molten rock could be close to the surface. By drilling a hole and pumping water onto the hot rock, steam could be produced, purified and utilised to drive turbines for electricity generation [6]. Facilities could be found in Italy, New Zealand, Iceland, Japan, Philippines, and the US. In countries like Philippines, a high percentage of the energy mix comes from this resource. The technology does not cause pollution, does not produce carbon dioxide, the system is compact, and requires minimal operating cost However, the sites are limited, the rock struture and properties for drilling through must be suitable, and sometimes the facilities could lose their heating capability after sometime. There could also be some negative visual impact from leaking steam, and poisonous gases could also be emitted.

TIDAL

Tidal energy is harnessed by using barrages much like a dam, only that it is very much bigger but have a much lesser height. Either the flow could be used to turn turbines or it could be used to push air which in turn turns the turbine [7,8]. The potential amount of power is enormous, but it is a big challenge to harness. It is renewable and predictable, have low operating cost, and have not much negative visual impact. The environmental impact could, however, be far-reaching where the mud-flats and the ecosystem of the beach could be changed. The system only works when the tide is coming in or going out so alternative supply needs to be provided in between. Furthermore there are only very limited suitable sites around the world where the system could be installed.

WAVES

The wave action pushes air in and out of a chamber turning turbines in the process [9]. It is renewable and the capital investment is reasonable and cheap to operate. There is no waste or pollution, it can generate a large amount of energy and there is no negative visual impact. Its application to-date is still not widespread. The challenge is to build and secure a structure sturdy enough to withstand the rough sea conditions and at the same time capable of generating enough power from small waves. It needs a sturdy civil structure and a suitable site with consistently strong waves. Corrosion and marine growth could add to maintenance costs. Noise is also another nuisance.

WIND

There are forty-three meteorological stations all over Malaysia recording weather conditions including wind histories. Wind have been utilised as a source of energy to propel ships and through windmills to do mechanical work. Wind power can also be used to turn wind vanes for electricity generation. We have seen remote applications like telecommunications, rural residences, and water pumping; and a 'wind farm' could also be a source of centralised power supply [10]. This resource is renewable; it could be left unattended for long periods of time with low operating cost. However, wind is a low density source of power, capital expenditure is high, it is unpredictable and not too reliable. The hybrid form is usually installed with additional generating system to achieve more flexibility and reliability. A fair amount of land is required and there is some negative visual impact.

MINI-HYDRO

Like in most other sources of energy, the principle is the use of kinetic energy of the medium to turn turbines which in turn generate electricity. In this case the medium is water. Hydro power is already included as one of the major energy options. The mini-hydros are those which are producing a few MWs only per unit. They serve the rural areas, and have low capital and operating costs.

CURRENTS

Ocean currents occur naturally through narrow channels as a result of tidal action or due to temperature gradient. It is still in an early stage of development but areas in UK [11], Ireland, Italy, Philippines, Japan, US, Canada and New Zealand [12] have been identified as suitable sites. This resource is renewable, have minimal environmental impact, have a high energy density as compared to wind which means more compact equipment, and the velocities are more predictable and less fluctuating giving rise to more accurate sizing of equipment [9]. Further more the land use is minimal, there is no negative visual impact. It can be sited near high population areas, can apply the modular concept and can avoid large civil engineering works. The challenges are in the technical areas of avoiding cavitation, minimising marine growth and ingress of debris into the system. Capital outlay could also be substantial and maintenance could also be high due to possible seawater corrosion of equipment and parts. More research needs to be conducted in this area.

NUCLEAR

Nuclear was once the Fifth Energy Option for Malaysia. It is now a forgotten option but it is one that still remains as the most important option. There is more energy potential in nuclear fuels than the combined total from oil, gas, coal and hydro. There are

scatterings of nuclear power plants in India, Eastern Europe and Korea, but the main concentration of these plants are in US, Western Europe and in Japan. There is a need for the technologists in Malaysia to be in a state of readiness to embark on this option any time the green light is given; and a state of readiness is more than twenty years of research reactor experience with production of isotopes for the health and NDT industries, and the ability of making some gas centrifuge components.

CONCLUSIONS

Malaysia does not have near-surface molten rock, so geothermal is not a viable option. Out of the three ocean-related sources of waves, tides and currents, the one with some potential is perhaps wave energy off-shore the east coast. We have plenty of sunshine and plenty of wood and other agricultural waste. Investments in the research and development of these resources are logical and essential. It may also be worthwhile spending some time on wind energy potential, and definitely the nuclear option should not be forgotten entirely. ■

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