

Energy Mix and Alternatives Energy for Sustainable Development in Malaysia

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ABSTRACT

Malaysia is currently adopting the Five-Fuel Diversification Strategy energy mix implemented in the year 1999. According to this strategy, the energy mix in Malaysia is contributed by five main sources, namely natural gas, coal, oil, hydro and renewable energy. Among the fossil fuel resources for energy generation, coal is offered the most attractive solution to the increasing fuel cost. The consumption of coal in Malaysia is growing at the rate of 9.7% per year since 2002. The total coal consumption for electricity generation in Malaysia is projected to increase from 12.4 million tons in 2005 to 36 million tons in 2020. With uncertain future supply and volatile fossil fuel prices, nuclear power could be viewed as a proven insurance base load power generation option to prevent runaway gas and coal prices. This paper outlines the possibilities of utilizing other sources of alternative energy such as nuclear and solar energy. This paper will also explain the photovoltaic energy for sustainable development.

Keywords: *Alternatives energy, renewable resource, photovoltaic, energy mix, sustainable development*

Introduction

According to the International Energy Outlook, 2008, the world's primary energy demand projected to increase by 45% from 2006 to 2030. From 1998 to 2006, the primary energy consumption in Malaysia has been increasing from 1.7 to 2.6 quadrillion Btu. Realizing the increase in energy consumption, the government needs to continuously review its energy policy to ensure long-term reliability and security of energy supply. Concerted efforts are continuously being undertaken to ensure the sustainability of energy resources, both non renewable and renewable. Basically, an effective and sustainable energy policy has two main considerations. The first consideration is to increase access to affordable, modern energy services, and secondly, to find the mix of energy resources and technologies (efficiencies) that will reduce the adverse environmental impacts and to maintain sustainable development.

97.8% of Malaysian has access to electricity. So, the crucial challenge facing the power sector in Malaysia currently is the issue of sustainability that is to ensure the security and reliability of energy supply and the diversification of the various energy resources. Therefore, the aim of this paper is to describe the role of both, non-renewable and renewable sources of energy in the current Five-Fuel Diversification Strategy energy mix for sustainable development. This paper will also describe nuclear power as an alternative energy and photovoltaic system as the most promising renewable energy in Malaysia.

Energy mix for sustainable development

On 11th May 2001, the Malaysian government launched the Small Renewable Energy Power Programme (SREP). The programme was among the steps being taken by the government to encourage and intensify the utilisation of renewable energy in power generation. This is in

line with the Government's decision to intensify the development of renewable energy as the fifth fuel resource under the country's Fuel Diversification Policy, as stipulated in the objectives of the Third Outline Perspective Plan for 2001-2010 (OPP3) and the Eight Malaysia Plan. The Four Fuel Strategy had been in operation since 1981.

Under the 8th Malaysia Plan (2001–2005), the government of Malaysia had changed the Four Fuel Policy to the Five Fuel Policy with the addition of renewable energy as the fifth source of fuel in 1999. In a long run, the aim of the policy was to generate 5% of the country's electricity from renewable sources by 2005. In this strategy, the energy mix in Malaysia is contributed by five main sources, namely natural gas, coal, oil, hydro and renewable energy.

Natural gas

With the discovery of natural gas in 1983, the volume of natural gas reserved increased from 2.39 trillion meter cubic in 2000 to 2.41 trillion meter cubic in 2005 and is expected to last for 33 years. The average natural gas production increased from 123.66 million m³ per day to 164.24 million m³ per day.

Currently, Malaysia had significant gas exploration and development in the Malaysia-Thailand Joint Development Area, located in the lower part of the Gulf of Thailand. The Malaysia – Thailand Joint Authority (MTJA) was established by the two governments for joint exploration of the once-disputed area. The delivery of natural gas into Malaysia started in the first quarter of 2005. Natural gas was also imported from West Natuna (Indonesia) beginning in 2002. These two sources are expected to supply about 20% of the total gas supply in Malaysia by 2010. In 2009, natural gas contributes about 75% of the energy mix in Malaysia as a source of fuel. The natural gas is supplied via a gas reticulation system installed by the national petroleum company, PETRONAS.

In 2008, Malaysia produced 64.5 billion cubic meters, exported 31.6 billion m³ and consumed 32.9 billion m³. The prove reserve is 2.35 trillion cubic meters. See Table 1

Table 1. Natural Gas Consumption in Malaysia

Year	Natural gas – consumption(m ³)	Rank	Percent Change
2004	31,250,000,000	18	
2005	31,250,000,000	18	0.00 %
2006	28,530,000,000	20	-8.70 %
2007	32,970,000,000	19	15.56 %
2008	32,900,000,000	23	-0.21 %

Source: CIA World Factbook (2008)

Coal

In 2003, coal contributed about 12% to the energy mix in Malaysia. However, countries like USA and China used approximately 14% and 68.7% of coal as the main source of fuel and energy. This is because coal was the cheapest and the most abundant available fossil fuel.

Total coal reserve in Malaysia in 2008 was about 1712 million tones of various coals ranging from lignite to anthracite of which consist of 275 million tones of proven reserve, 347 million tones of indicated reserve and 1090 million tones of inferred reserve. According to Thaddeus (2002), 69% of the coal reserve in Malaysia is in Sarawak, 29% is in Sabah while the remaining 2% is in Peninsular Malaysia. In general, the coal reserves in Malaysia have heat values ranging between 21,000 and 30,000 kJ /kg with low ash and sulfur levels. Even though Malaysia already has a sufficient coal reserve to meet its demand, 90% of the coal demands in the country are still imported, mainly from Australia, Indonesia, China and South Africa. This is due to the high extraction cost of locally sourced coal.

Currently, the government of Malaysia is promoting the utilization of locally sourced coal through the implementation of National Mineral Policy. According to Leo-Moggie, 2002, the steps taken such as the improvements in underground mining methods, the use of larger equipment in surface mining operation and computerization of the administrative and mine maintenance activities are the most promising expected outcomes.

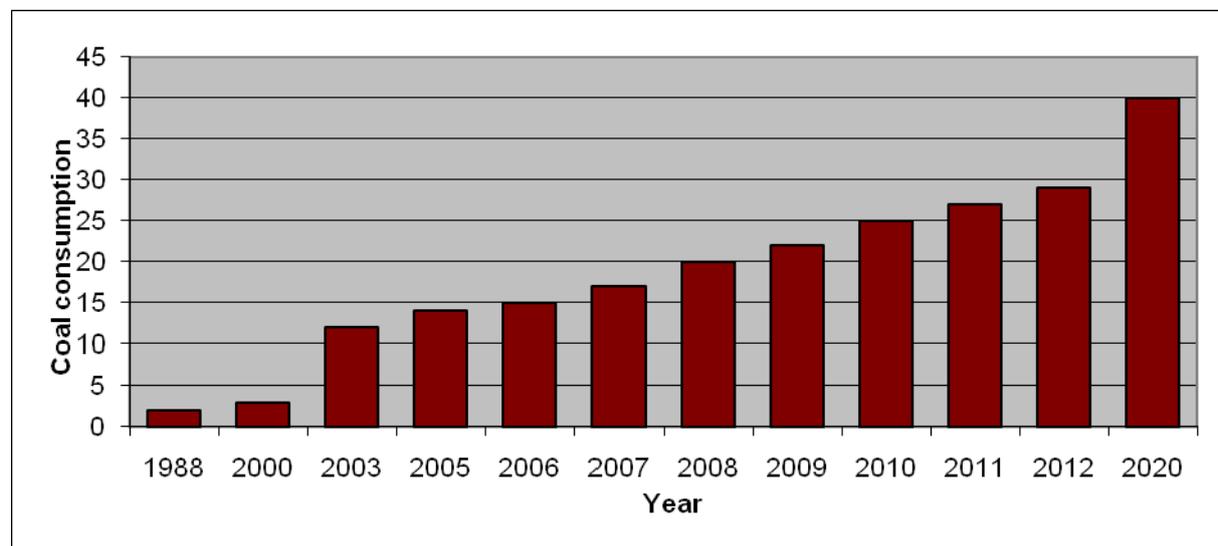


Figure 1. Coal consumption for electricity generation in Malaysia (million tons).

Source: Leo-Moggie, 2002

As shown in Figure 1, the demand for coal for electricity generation is projected to increase drastically, from an estimated 6.03 million tones in 2000 to between 19 and 20 million tones per annum by 2010. By 2020, the coal consumption for electricity demand will increase to 40 million tones. Thus, a sustainable energy mix for Malaysia in the longer term will see a greater contribution of coal to the energy mix of about 40–45%, while natural gas will contribute less than 50%. This is due to the commissioning of new coal-fired electricity generating plants, which will account for 60% of the increasing demand of energy in the future.

Even though the utilization of coal faces major challenges like the emissions of green house gasses and air pollutants such as sulfur dioxide (SO₂), oxides of nitrogen (NO_X) and carbon dioxide (CO₂), coal is still projected to play a far more important role in the energy mix. Fortunately, technological advances achieved in the recent years have made coal a much

cleaner fuel today. In particular, significant increases in thermal efficiency and reductions in sulfur and nitrogen oxides and particulate emissions have been achieved. Clean-coal technology, which includes electrostatic precipitators and flue gas desulfurization technology for air pollutants emission control, will be utilized in the new coal-fired power plants to ensure that environmental standards are met. In this context, Malaysia will remain committed to the goals of sustainable development and thus measures will be continuously improved to ensure that the production and utilization of coal will meet environmental standards.

Hydro

The hydropower project often involves socio-economic issues and required high capital investment. The development of a hydropower dam is overwhelmingly complex because the issues are not confined to the design, construction and operation of dams themselves but embrace the issues of social, environmental and political issues.

Hydropower dams can generate electricity that is clean and renewable. In long term, electricity from hydropower is relatively cheaper as compared to oil and natural gas and the cost will not be affected by the changing fuel prices, which are currently determined by international market. Apart from that, many hydropower projects had also brought socio-economic development such as flood control, irrigation, tourism, local employment and skills development, rural electrification and the expansion of physical and social infrastructure such as roads and schools or rather as a whole, the opening up of interior areas of the country to other economics.

Currently, the tallest concrete-faced rockfill dam in the world has been built in Malaysia. The Bakun Hydroelectric Project located in Sarawak is the largest dam in Asia outside China. It has the capacity to generate 2400MW of electricity. The Bakun hydroelectric project involved the construction of a 205m high rock filled concrete dam creating a reservoir of 695km². The Bakun project cost about RM 15 billion (US\$ 4 billion) including the 1650km of transmission system of which 650 km will be the undersea cable. Its construction generates much job opportunities as well as transfer of technology and know-how to the country. The implementation and completion of the project also bring much development to Sarawak especially to the interior areas and benefit the whole country and the people. This project was initially projected to be completed in the year 2003, but due to the Asian Financial crisis in 1997 and 2001 this project was halted and engineering work was resumed in October 2002. The project is expected to be completed by 2010.

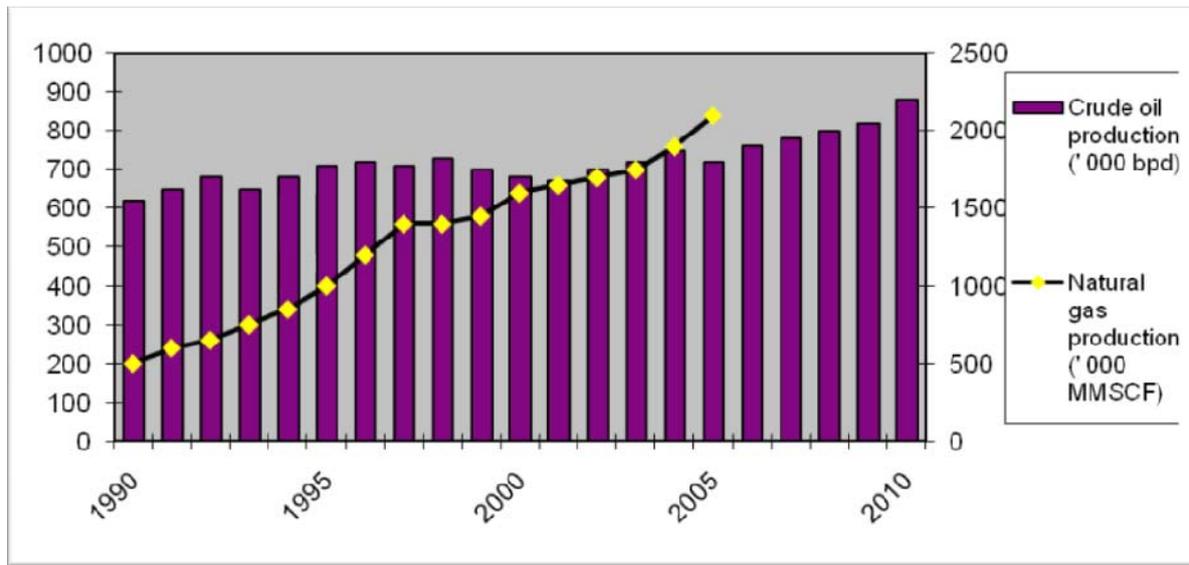
Oil

The depleting reserves and high price for oil had significant effect on the role of oil in the energy mix. The contribution of oil in the energy mix has declined sharply from a high 90% in 1980 to merely less than 10% in 2003 (Abdul-Rahman 2003; BioGen 2003.). Based on 2003, Malaysia contains proven oil reserves of 3.0 billion barrels, while the production has been relatively stable at around 700,000 barrels per day (EIA, 2003). Therefore, the contribution of oil in the energy mix is expected to further decline to less than 1% by 2010 (Thaddeus, 2002). Apart from using the oil for power generation, the remaining oil is exported either as crude oil or downstream petroleum products.

Estimated crude oil and condensate reserves increased from 4.5 billion barrels in 2000 to 5.3 billion barrels in 2005 (Figure 2). The average production of domestic crude oil and

condensate increased from 681,000 barrels per day (bpd) in 2000 to 727,000 bpd in 2005. Based on this production level, which is in line with the National Depletion Policy, the reserves are projected to last for 19 years. Although total refining capacity declined from 591,000 bpd to 546,000 bpd, it was sufficient to meet the demand for petroleum products. To ensure a sustainable supply of oil and gas, appraisal wells will continue to be drilled in small oil fields offshore as well as in deepwater areas. Over the period 2005 to 2010, crude oil production is expected to average 695,000 bpd.

Figure 2. Crude oil and condensate production, estimated and forecast, Malaysia 1990-2010



Note: MMCSF- Million Standard Cubic Feet, bpd-barrels per day

Sources of Data: 1) EPU Malaysia Five Year Plan (7th,8th and 9th)

2) Department of Statistic, Malaysia Economic Statistic-Time Series,2005

Renewable energy

As mentioned, in the 8th Malaysia Plan (2001–2005), the government has replaced the Four Fuel Diversification Policy with a Five Fuel Diversification Policy in 1999 by the addition of renewable energy as the fifth source of fuel. It was estimated that by utilizing only 5% of renewable energy in the energy mix, this could save the country RM 5 billion (US\$ 1.32 billion) over a period of 5 years (Mariyappan, 2000). Under this program, small power generating plants which utilizes renewable energy can apply to sell electricity to Tenaga Nasional Berhad (main utility company for energy generation in Malaysia). Each of this power generating plants will be given a license for a period of 21 years to provide up to a maximum of 10MW into the national distribution grid system. These power plants are only allowed to utilize all types of renewable sources such as biomass, solar, minihydro and wind as the source of fuel.

Among the various sources of renewable energy, biomass seems to be a very promising option for Malaysia. In line with the promotion of using biomass energy, a Biomass Power Generation & Cogeneration Project (BioGen) was commissioned in October 2002. The project was jointly funded by the Government of Malaysia, United Nations Development Program, Global Environment Facility and the Malaysian private sectors. The main objective of this project was to reduce the growth rate of green house gas emission from fossil fuel

fired combustion processes. Beside, the other main objectives of BioGen are to reduce the unused waste residue from palm oil and to catalyze wider adoption of grid-connected biomass-based power generation and cogeneration (PTM, 2004a). All these objectives can be achieved by utilizing biomass waste for power generating. Furthermore, it was reported that the productions of energy from agricultural wastes seems to be very attractive based on bio-resource sustainability, environmental quality and economic consideration (Tsai et al., 2004).

Although the use of renewable energy resources has a lot of benefits, it faces numerous challenges. Firstly, the development of technology. Secondly, the high cost of renewable energy. Thirdly, is the lack of reliable information on the potential supply of renewable energy at the national level. Beside, the low demand for energy from renewable resources is also hindering the utilization of renewable energy.

Possibility of utilizing nuclear energy

Malaysia's primary energy demand grows at an annual rate of 3.5% from 2002. Among the fossil fuels, coal usage grew at the fastest rate of 9.7% per year, followed by natural gas at 2.9% and oil at 2.7%. Coal demand will increase substantially to meet the rising electricity demand. The electricity demand in Malaysia will increase by 4.7% per year. The growth in electricity demand is heavily influenced by strong demand from the industrial sector, which increases at 5.4% annually. Electricity demand for the residential sector will also experience strong growth of 4.9% per year due to improved standards of living. Per capita electricity demand is projected to be more than double from 2002 to reach 7,571 kWh /person in 2030. One of the main usages of atoms is electricity generation. To produce 1000MW, 2,000,000 tonnes of coals needed. But, if we replace the coals with uranium, there are only 30 tonnes of uranium needed to produce the same amount of electricity which is 1000MW.

As indicated earlier, consumption of coal as energy sources for electricity generation have contributed to the emissions pattern in Malaysia. As a direct consequence of this policy, total CO₂ emissions from coal fired power plants are projected to grow at 4.1% per year, reaching 98 million tons of CO₂ in 2020, a two point sixty five-fold increase over 2005, as shown Figure.3. This CO₂ emissions will continuously increase with the construction of new coal fired power plant and the increase on the capacity of existing coal fired power plants.

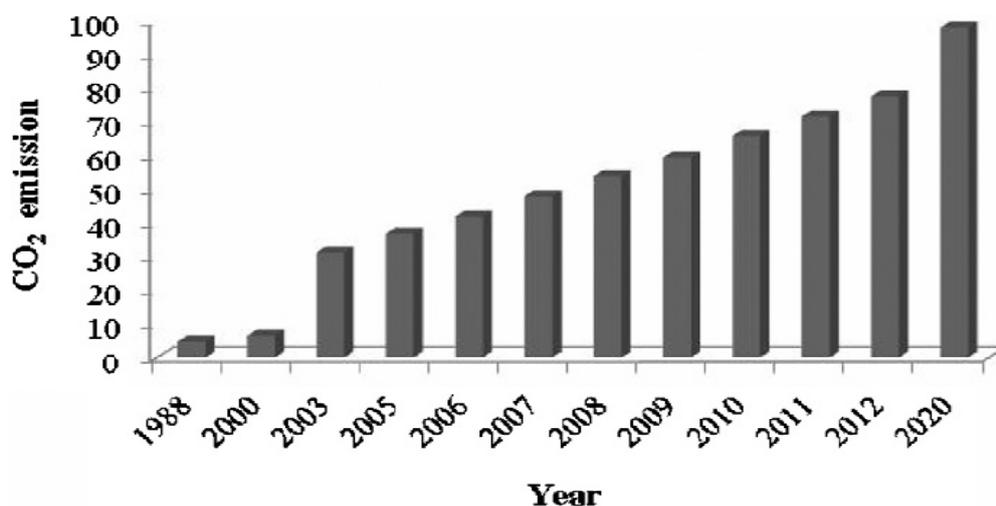


Figure 3. CO₂ emissions from coal fired plant in Malaysia (million tons).

In the energy sector, one focus has been on greenhouse gas emissions which could lead to global climate change. The nice thing about nuclear energy power is that it emits practically no carbon dioxide. A small quantity of carbon dioxide is emitted in 'fuel cycle' - the mining of uranium, refining, fuel enrichment and fabrication, transportation, decommissioning and waste disposal. But it's only a minor percentage of that emitted by burning fossil fuel such as coal, oil and gas, to obtain the same amount of energy. Nuclear power's future will undoubtedly have a potential role in reducing environmental impacts because it can certainly contribute to greenhouse gases mitigation.

Photovoltaic as the most promising renewable energy

Greenhouse gas emissions from combustion of fossil fuels for electricity generation have grown extensively over the past two decades. Such a rapid growth of emissions has caused the world to suffer, increasingly, the adverse effects of climate changes.

Under such a climatic condition, photovoltaic (PV) systems has become another favorable renewable energy source. In Malaysia, climatic conditions are favorable for the development of solar energy due to the abundance sunshine throughout the year. The solar radiation in Malaysia ranges from 6.5kwh/m² in the months of January and drops lower to 6.0 kwh/m² in the month of August (Mariyappan, 2000). However, at present, the prices of PV modules and related components are extremely high. The current market value of PV system is about RM 28.00/Wp (US\$ 8.40). The reason for such a high price is that, at present, Malaysia does not have any local PV manufacturer. All the PV modules and inverters are imported from foreign countries, such as Germany and Japan, hence causing the cost of PV systems to be very high. As a result, photovoltaic systems are not an attractive option to the public. In order to reduce the cost of PV system, the Malaysian Energy Centre has carried out a project named Malaysia Building Integrated Photovoltaic (MBIPV). This project is funded by the government, United Nations Development Programme (UNDP/GEF) and various private sectors.

The main idea of the MBIPV project is to incorporate PV grid-connected systems aesthetically into the building architecture and envelope. Activities undertaken in this project are aimed at creating the necessary conditions that will, in turn, lead to sustainable and widespread application of BIPV starting from 2006 onwards. The MBIPV project is expected to induce the growth of BIPV installations by 330% from the current status of 470 to about 2000 kW, with a unit cost reduction of about 20% by the year 2010. Since the commencement of the MBIPV project, a wide range of activities have been undertaken. For example, a PV market induction programme, known as SURIA 1000, was started from September 2006, although it was officially launched on 22nd June 2007. Under this programme, electricity customers can bid for price rebates on PV systems under the MBIPV project (Southeast Asia Renewable Energy Newsletter, 2007). The first round of bidding yielded 14 successful bids from 39 applicants. The successful applicants received discount of, on average, 53% of their PV systems. At the moment, the utilization of solar power or PV system in Malaysia is only limited to solar water heating systems in hotels, small food and beverage industries and upper middle class urban homes. It was estimated that there are more than 10,000 units of domestic hot water system using PV system at the moment in Malaysia (KTKM, 2004b). Although PV system has tremendous potential, especially for remote areas in Malaysia, the cost of PV panels and technology is still too expensive for mass power generation.

Conclusions

The Malaysian energy sector is still heavily dependent on non-renewable fuel such as fossil fuels and natural gas as a source of energy. These non-renewable fuels are finite and gradually depleting and also contribute to the emission of greenhouse gases. Thus, the government must be ready in substituting the non renewable energy to the renewable and other alternatives energy, source like nuclear energy and photovoltaic. This is an important step for Malaysia to conserve energy for sustainable development and utilize environmental friendly energy sources.

References:

- Abdul-Rahman, A., 2003. Issues and challenges of the development of RE in Malaysia. Available at: <http://www.ptm.org.my/biogen/PDF/Articles/DrAnuarISERE170903.pdf> (downloaded 9 September 2004).
- Abdul, R.M., Lee, K.T., 2005. Energy for sustainable development in Malaysia: energy policy and alternative energy. *Energy Policy* 34, 2388–2397.
- APERC (Asia Pacific Energy Research Centre), 2006. APEC energy demand and supply outlook 2006. Tokyo.
- Au Yeong How. Nuclear Malaysia serving the nation. *The Star*, Thursday July 23,2009
- BioGen, 2003. Biogen awareness and information session: renewable energy in Malaysia—potential and “the way forward”
- CIA World Factbook, 2008, (Central Intelligence Agency) Natural Gas
- Energy Information Administration, 2007. Petroleum Navigator Available at: <http://tonto.eia.doe.gov/dnav/pet/hist/wtotworldw.htmS>.
- Hitam, S., 1999. Sustainable energy policy and strategies: a prerequisite for the concerted development and promotion of the renewable energy in Malaysia. Available at: www.epu.jpm.my
- International Energy Outlook, 2008. World energy and economic outlook. Available at: <http://www.eia.doe.gov/oiaf/ieo/world.html>.
- Kam, S., 2004. Looking to the sun and biomass, *THE SUN WEEKEND*, 7–8 August
- K. Matsui / *Progress in Nuclear Energy* 50 (2008) 97e102
- Kataoka, S., 1992. Coal Burning Plant and Emission Control Technologies. Technical Note. World Bank, China Country Department, Washington, DC.
- KTKM (Ministry of Energy, Telecommunications and Multimedia), 2004a. Introduction to small renewable energy power programme (SREP). Available at: www.ktkm.gov.my/print_details.asp?Content_ID=277.. *Energy Policy* 32, 1935–1947.

KTKM (Ministry of Energy, Telecommunications and Multimedia), 2004b. Solar energy. Available at: www.ktkm.gov.my/print_details.asp?Content_ID=38

Leo-Moggie, A., 2001. Keynote address. Malaysia regional forum on energy policy for the new millennium, Kuala Lumpur, Malaysia.

Leo-Moggie, A., 2002. Keynote address. Eighth APEC coal flow seminar/ninth APEC clean fossil energy technical seminar/fourth APEC coal trade, investment, liberalization and facilitation workshop, Kuala Lumpur, Malaysia.

Mahlia, T.M.I., 2002. Emission from electricity generation in Malaysia. *Renewable Energy*, 293–300.

Mariyappan, K., 2000. Country report from Malaysia: status of renewable energy and energy efficiency in Malaysia. Available at: www.isep.or.jp/spena/2000/countryreports/malaysia.htm.

Mitchell, C., Connor, P., 2004. Renewable energy policy in the UK 1990–2003

Ninth Malaysian Plan, 2006. Sustainable Energy Development, pp. 395–411 (Chapter 19).

Nuclear Energy & the Environmental Debate: The Context of Choices by Evelyne Bertel (NEA/OECD) and Joop Van de Vate (IAEA)

PTM (Malaysia Energy Centre), 2004a. Biomass power generation & cogeneration project (BioGen). Available at: [http://www.ptm.org.- my/New_BioGen_Web_II](http://www.ptm.org.my/New_BioGen_Web_II)

PTM (Malaysia Energy Centre), 2004b. Biomass power generation & cogeneration project (BioGen). Available at: <http://www.ptm.org.my/biogen/BIOGEN1/html>.

PTM (Malaysia Energy Centre), 2004c, Photovoltaics (PV). Available at: <http://www.ptm.org.my/BIPV/bipv.htm>.

Southeast Asia Renewable Energy Newsletter, 2nd Quarter, 2007. UK Trade & Investment, Available at : <http://www.uktradeinvest.gov.ukS>.

Spalding-Fecher, R., Winkler, H., Mwakasonda, S., 2005. Energy and the world summit on sustainable development. *Energy Policy* 33, 99–112.

Thaddeus, J., 2002. Complementary roles of natural gas and coal in Malaysia. Eighth APEC coal flow seminar/ninth APEC Clean fossil energy technical seminar/fourth APEC coal trade, investment, liberalization and facilitation workshop, Kuala Lumpur, Malaysia.

Third Outline Perspective Plan for 2001-2010 (OPP3)

Tsai, W.T., Chou, Y.H., 2004. An overview of renewable energy utilization from municipal solid waste (MSW) incineration in Taiwan. *Renewable & Sustainable Energy Reviews* in press, available online 10 December 2004.

Tsai, W.T., Chou, Y.H., Chang, Y.M., 2004. Progress in energy utilization from agrowastes