Energy Policy for Sustainable Development in Malaysia

Abdul Rahman Mohamed* and Lee Keat Teong

School of Chemical Engineering, Universiti Sains Malaysia, Eng. Campus, Seri Ampangan, 14300 N. Tebal, Penang, Malaysia

Abstract: Energy is crucial to all aspects of development from powering manufacturing and modernization of agricultural sectors to providing electricity to run schools and health facilities, yet the impact of its production, distribution and use grows more severe with every decade. Although new alternative and renewable as well as cleaner and more efficient technologies are being developed and implemented every year, the strain caused by the rise in energy demand and global consumption outweigh the benefits brought by these improvements. The challenge lies in finding a way to reconcile the necessity and demand for energy supply with its impact on the natural energy resources in order to ensure a sustainable path for development. The aim of this paper is to describe the various energy policies adopted in Malaysia to ensure long term reliability and security of energy supply. The role of both, non-renewable and renewable sources of energy in the current Five-Fuel Diversification Strategy energy mix will also be discussed. Apart from that, the governments' implementation of energy efficiency program and also the role of Malaysia Energy Center in the implementation of the energy policies in Malaysia are also presented in this paper.

Keywords: Energy Efficiency, Energy Policy, Energy Resources, Renewable Energy, Sustainable Development.

1. INTRODUCTION

As the Malaysia economy sector is recovering from the financial and economic crisis, a resurgence in energy demand is expected. Within the last three years, the energy generating capacity (increases according to the energy demand) has increased almost 20%, from 13,000 MW in the year 2000 to 15,500 MW in the year 2003. The energy generating capacity is further expected to increase to 22,000 MW by the year 2010 [1]. In order to meet the increasing demand, energy supply infrastructure will need to be continuously developed and at the same time being very capital intensive. Consequently, this will impose tremendous pressure on the natural resources, particularly for developing countries like Malaysia. At the same time, it is clear that the current patterns of growth, resource use and environmental degradation cannot extend indefinitely into the future.

This concern has led to major challenge facing the power industry that is to have a sustainable energy policy and diversified source of energy. Apart from that, there is also a need to encourage the most efficient utilization of energy and its resources. The aim of this paper is to describe the various energy policies adopted in Malaysia to ensure long term reliability and security of energy supply. The role of both, non-renewable and renewable sources of energy in the current Five-Fuel Diversification Strategy energy mix will also be discussed. Apart from that, the governments' implementation of energy efficiency program and also the role of Malaysia Energy Center in the implementation of the energy policies in Malaysia are also presented in this paper.

2. ENERGY POLICIES

Throughout the years, the government of Malaysia has formulated some policies and programs on energy in order to ensure the long term reliability and security of energy supply for sustainable social-economic development in the country. The various energy policies included the National Energy Policy (1979), National Depletion Policy (1980) and Fuel Diversification Policy (1981 & 1999) while the various energy related programs are the renewable energy and energy efficiency program. The National Energy Policy has three primary objectives. The first primary objective is to ensure adequate, secure and cost-effective energy supply by developing energy resources (both non-renewable and renewable) using least cost options and diversify sources. The second objective is to promote the efficient utilization of energy and discourage wasteful and non-productive patterns of energy consumption and the final objective is to ensure that environmental protection is not neglected in the pursuit of the supply and utilization objectives. On the other hand, the National Depletion Policy is intended to conserve the country's energy resources, in particular oil and gas, as these resources are finite and non-renewable. In this respect, the production of crude oil is limited to an average 630,000 barrels per day (bpd) while the consumption of gas in Peninsular Malaysia is limited to about 32,000 million standard cubic feet per day [2].

The Fuel Diversification Policy in Malaysia was continuously reviewed to ensure that the country is not too dependent on a single source of energy. Table 1 shows the energy mix in the year 1980, 1995, 2001 and 2010 [2-4]. Since 1980, the Malaysian energy sector has been guided by the four-fuel diversification strategy. This strategy was formulated in the aftermath of the two international oil crisis and quantum leaps in prices in 1973 and 1979, in which during that time, the Malaysian energy sector had been highly dependent on a single source of energy, namely oil. Faced with the possibility of prolonged energy crisis, the government called for the diversification of energy resources away from oil, to develop more hydropower and to use more natural gas and coal. At that time, there were large untapped indigenous hydropower and natural gas reserves, while coal was considered an abundant worldwide resource with a very low and stable price. As a direct result of this strategy, Malaysia has drastically tipped the balance in the fuel mix in energy consumption from a high almost 90% dependence on oil in 1980 to less than 15% in 1995 as shown in Table 1.

Table 1 Energy mix in Malaysia.

Source	1980	1995	2001	2010 (estimated)
Oil	87.9%	13.3%	4.4%	2.0%
Natural gas	7.5%	62.7%	71.8%	45.5%
Hydro	4.1%	13.1%	10.1%	12.7%
Coal	2.2%	10.9%	12.0%	34.6%
Others (renewable energy)	-	-	1.7%	5.2%

The four-fuel policy was intended to avoid over

Corresponding author: chrahman@eng.usm.my

dependence of any one source of fuel. That said, gas is predominantly used and electricity suppliers are also turning to coal, a cheap and abundant energy source. Using conventional non-renewable energy such as fossil fuels (oil and coal) and natural gas has two major consequences. One, it depletes a finite depletable resource and two, it leads to the emission of greenhouse gasses, that raise the issue of climate change. Both of these are of major global concerns that will impact on the future of our generations to come. Considering the fact that energy demand in Malaysia in growing at a rate of about 5-6% annually, against finite conventional energy resources, the government realized the importance of further diversifying the energy mix into more sources of alternative energy [5].

In order to ensure sustainability of energy resources and to reduce the emission of greenhouse gases, the government under the 8th Malaysia Plan (2001 to 2005) 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[6]. In a long run, the aim of the program was to generate 5% of the country's electricity from renewable sources by 2005. A more sustainable energy mix for Malaysia in the longer term will see a greater percentage of coal utilization of between 30 to 35% while that of natural gas at not more than 50% [7]. This is due to the commissioning of new coal-fired electricity generating plants, which will account for the 60% of the increasing demand of energy in the future. At the same time, efforts will be intensified to encourage the utilization of renewable sources for the generation of energy.

3. ENERGY MIX FOR SUSTAINABLE DEVELOPMENT

As mentioned, Malaysia is currently adopting the Five-Fuel Diversification Strategy energy mix implemented in the year 1999. In this strategy, the energy mix in Malaysia is contributed by five main sources, namely natural gas, coal, oil, hydro and renewable energy. High prices of fuel need not be the only reasons for maintaining the Five-Fuel Diversification Strategy, but the security of supply through diversification is just as an important reasoning. With a balance energy mix, the economy and particularly the power sector is less vulnerable to shocks in the fuel supply.

3.1 Natural gas

With the discovery of natural gas in the year 1983, its contribution in the energy mix has grown increasing significant throughout the years. Malaysia natural gas reserves currently stands at 87 trillion cubic feet. Out of this, 58 trillion cubic feet is proven reserves. 36.6 trillion cubic feet of the total 87 trillion cubic feet are reserves found in the coast of West Malaysia while the rest are reserves found in the coast of East Malaysia (Sabah & Sarawak). Natural gas reserves in Malaysia is the largest in South East Asia and 12th largest in the world. Malaysia is also one of the main producer of natural gas in Asia with a production rate of 1,000 million cubic feet per day. Based on the natural gas reserves in Malaysia, it was predicted that natural gas could still contribute to the energy mix as a main source of energy for the next 80 years as compared to about 10 years for oil. At the moment, about 75% of the energy mix in Malaysia is contributed by natural gas as a source of fuel. The natural gas is supplied via a gas reticulation system installed by the national petroleum company, PETRONAS.

3.2 Coal

Malaysia has a coal mining history dating back as far as 1851. The coal resource in Malaysia currently stands at about 1,050 million tones of various coal ranging from lignite to anthracite, but bituminous to sub-bituminous coal forms the bulk of this amount. The resource of coal in Malaysia can be further divided into 231.8 million tones of proven reserve, 171.8 million tones of indicated reserve and 646.4 million tones of inferred reserve. 69% of the coal reserves in Malaysia are found in Sarawak while 29% are found in Sabah and the remaining 2% are found in Peninsular Malaysia. Generally, the coal reserves in Malaysia have heat values ranging between 21,000 to 30,000 kJ/kg with low ash and sulfur levels.

Although Malaysia has a large reserve of coal, most of the coal reserves are found in inland areas where there is poor infrastructure. Thus the production of coal in Malaysia is relatively small as compared to the demand. At the moment, the production of coal in Malaysia stands at about 383,000 tones, an significant increase from 65,000 tones in 1991. Most of the coal produced locally was utilized by a power station in Sarawak with a capacity of 100 MW. Since coal is expected to contribute significantly in the energy mix in the near future, coal demand for electricity generation is projected to increase sharply, from an estimated 6.03 million tones in 2000 to between 19 to 20 million tones per annum by 2010. Currently, about 90% of the economy's coal requirements are being met by imports, mainly from Australia, Indonesia, China and South Africa [7].

Due to the abundance and stable price of coal, it has been and will continue to be an essential component of long- term sustainable development, not only in Malaysia but also the world. Nevertheless, its utilization faces several major challenge. Locally, although Malaysia's coal resource is substantial and sufficient to meet its requirement, a major constraint is the high development cost as coal deposits are located in the interior areas without proper infrastructure. The development of infrastructure to transport coal is costly and most of the coal-fields require underground mining, which is more costly as compared to surface mining. In addition, the local coal industry faces stiff competition from other economies with bigger reserves and more establish coal industry.

With the implementation of the National Mineral Policy, the private sector will be encourage to play a key role in the development of coal resources in the economy, through greater involvement in exploration, development and production activities. They will be encouraged to take advantage of new technologies that would increase productivity. The most promising expected outcomes include improvements in underground mining methods, the use of larger equipment in surface mining operations and computerization of the administrative and mine maintenance activities.

Globally, the energy industry is undergoing a transformation driven by changes such as deregulation of electricity supply industry, more stringent environmental standards and regulations, climate change concerns and other market forces. All these developments present a variety of challenges and opportunities to the coal industry. The Kyoto Protocol implications on Climate Change will have profound impacts on the future of the coal industry and represents a major challenge facing the coal industry, in particular the energy sector. In 1997, it was reported that CO_2 emissions from the energy sector had exceeded the goal established at Kyoto by 16%. By about 2010, it was estimated that carbon emission could exceed the goal by more than 35%. There is a fear that technological development and market mechanism required to meet this challenge may not be fast enough [7].

For the region's economic growth and energy security, the coal industry must respond to the environment and greenhouse challenges. The environmental problems associated with coal must be closely examined to find new ways to address these problems. However, technological advances achieved in the recent years has 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. With the right technology, the process of coal extraction, movement and more efficient combustion system will help to reduce the environmental concerns associated with the use of coal for producing electricity.

Malaysia remains committed to the goals of sustainable development and measures have been and will continuously be improved to ensure that the production and utilization of coal will meet environmental standards. Clean-coal technology, which will include among others, electrostatic precipitators and flue gas desulfurization for emission control, will be utilized in the new coal-fired power plants to ensure environmental standards are met.

3.3 Hydro

Indigeneously, Malaysia has substantial hydroelectric resources. The hydropower potential is estimated at 29,000 MW, of which only 2,000 MW is currently utilized. Whilst developing hydroelectricity is capital intensive and often involve socio-economic issues, the advantages are nevertheless many. Hydro power is renewable and clean energy. In the longer term, electricity from hydro is cheap and the cost will not be affected by the changing fuel prices which is determined by international market forces in which we as a country has little to say. Many hydro projects had also brought socio-economic benefits, among others, flood control, irrigation, tourism and opening up of interior areas of the country to other economics. These are among some of the reasons why the government decided to implement the Bakun project having a capacity of 2,400 MW.

The Bakun hydroelectric project will involve the construction of a 205 meter high rock filled concrete dam creating a reservoir of 695 km^2. This reservoir is small compared with some of the hydroelectric power stations such as the 5,800 km^2 for the 2,400 MW Aswan Dam, 4,500 km^2 for the 1,500 MW Kariba Dam in Zambia and 8,500 km^2 for the 850 MW Akosomb Dam in Ghana [8].

The Bakun project is expected to cost about RM 15 billion including the 1,650 km of transmission system of which 650 km will be the undersea cable. Its construction will generate much job opportunities as well as transfer of technology and know-how to the country. The completion of the project will also bring much development to Sarawak especially to the interior areas. This project, if implemented smoothly will benefit the 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. However, engineering work was resumed in October 2002, but the completion date is still yet to be determined [9].

3.4 Oil

The depleting reserves and high price for oil had significant effect the role of oil in the energy mix. The contribution of oil in the energy mix has decline sharply from a high 90% in the year 1980 to merely less than 5% in the year 2000. Due to the further increases of oil in the near future, it is expected that the contribution of oil in the energy mix to further decline to less than 1% by the year 2010 [1].

3.5 Renewable energy

The development of renewable energy in Malaysia is still in the early stage, with few concrete policies for renewable energy. As mentioned, in the 8th Malaysia Plan (2001 to 2005), the government have replace the Four Fuel Diversification Policy with a Five Fuel Diversification Policy in 1999. It was estimated that by utilizing only 5% of renewable energy in the energy mix could save the country RM 5 billion over a period of 5 years [2]. Presently, renewable energy in Malaysia is yet to be commercialized in a large scale as its production is basically for individual or private utilization. However, concerted efforts is currently undertaken by the government to develop and promote the utilization of renewable energy resources due to a number of benefits.

Among one of the benefits of increased utilization of renewable energy resources is the sustainability of energy supply in the long term. The renewable nature of biomass, solar, wind and municipal waste will ensure that these resources are available in perpetuity. For biomass, there are 328 palm oil mills in 1998 which processed approximately 43.8 million tones of fresh fruit bunches (FFB) to produce 8.3 million tones of crude palm oil. In the process, huge amounts of biomass wastes namely, fibers, shells and empty fruit bunches (EFB) are generated in the mills. The EFB which is about 21% of the weight of FFB is a potential renewable energy resource. It is estimated that from the 8.5 million tones of EFB generated in 1998, the potential amount of energy which can be harnessed is about 2.0 million tones of oil equivalent (MTOE) or 6.5% of the total energy supply. Additional energy from biogas generated as a byproduct of the anaerobic treatment of palm oil effluent, is also a potential supplementary energy resource. Meanwhile, some palm oil mills have used oil palm residues for co-generation to generate electricity and usable energy [10].

In the case of solar, the energy available is about four times the world fossil fuel resources. In Malaysia, the climatic conditions are favorable for the development of solar energy due to the abundant sunshine. The average daily solar radiation in Malaysia of 5.5 kWh per square meter (equivalent to 15 MJ/square meter) is consider good for harnessing energy from the sun. Solar energy is currently used to generate electricity and heat in the country. In the electricity generation sector, solar energy is converted into electricity and used in the niche areas, i.e., villages, remote areas and isolated islands that have not been connected to the national grid. This is particularly so in Sabah and Sarawak where the electrification coverage rate is only about 70 and 75% respectively.

The next benefits of promoting the utilization of renewable energy, such as biomass and municipal waste, is it will also acts as a means of pollution control. In this respect, industrial waste, like wood residues, palm oil waste and agricultural waste, could be converted into usable forms of energy, such as for heat generation. The utilization of renewable energy will help to address the environmental concerns that emerged due to the emission of carbon dioxide (CO_2) oxides of nitrogen (NO_x), oxides of sulfur (SO_x) and particulate matters as a result of energy generation from crude oil and petroleum, natural gas and coal. Thus, the increase in the utilization of renewable energy will minimize the negative impacts of energy generation, transmission, conversion and consumption on the environment [10].

Although the use of renewable energy resources has a lot of benefits, it faces numerous challenges. Firstly, there is uncertainty in respect of the technological development to convert the renewable energy resources into usable forms. Although several research and studies have indicated the technical feasibility of generating energy from renewable resources, the commercialization of research findings has not

been fully undertaken on a large scale. Secondly, generation of energy from renewable resources is economically unattractive due to the availability of cheaper alternative energy and high cost of energy generation. The relatively high costs of energy generation from renewable resources, both in terms of investment costs and final energy costs, compared to conventional energy further restrain the efforts to promote the utilization of renewable energy. In this regard, the electricity costs from biomass, geothermal and solar sources are within the range of US 7-25 cents/kWh, compared to the conventional electricity costs of US 4-6 cents/kWh as shown in Table 2 [10].

Table 2 Investment costs and electricity costs of renewable energy

Sources	Investment costs (US $/kW)	Electricity costs (US cents/kWh)
Hydro (small scale)	900 – 1,000 (1,000)	1 – 12 (5 – 10)
Biomass	1,700 – 2,000	7 – 15
Solar thermal power	3,000	20 – 25
Geothermal	1,500	7 – 10
Wind	1,000	1 – 2
Conventional (oil & coal)	n.a.	4 – 6

Thirdly, there is a lack of reliable information on the potential supply of renewable energy at the national level. For instance, the availability of biomass is not easy to be computed, as the amount of waste materials, such as wood residues, palm oil waste and agricultural waste, is seldom captured by the waste generating entities as well as by the relevant government agencies. Fourthly, there seems to be little public demand for energy from the renewable resources. This is due to the weak public awareness on the positive attributes of renewable energy. Furthermore, the relatively high cost of renewable energy compared to conventional energy may discourage the public in utilizing renewable energy. These are among the practical issues that need to be address in detail in order to convince the public on the technical and commercial viability of renewable energy.

In line with the government's decision to intensify the development of renewable energy as the fifth source of fuel, a Small Renewable Energy Power (SREP) Program was launched in May 2001 [11]. Under this program, small power generating plants which utilizes renewable energy can apply to sell electricity to Tenaga Nasional Berhad (main utility of energy generation in Malaysia), each providing up to a maximum of 10 MW into the national distribution grid system. Each of this power generating plants will be given a license for a period of 21 years, which will be effective from the date of commissioning of the plant. These power plants are only allowed to utilize all types of renewable energy such as biomass, solar, mini-hydro and wind as the source of fuel. While it is recognized that the world, including Malaysia is not ready to displace non renewable energy with renewable fuels, the implementation of this program has increased the awareness of the important role of renewable energy in a sustainable global energy system. Up to date, 59 applicants have been approved with a total energy generating capacity of 352 MW.

4. ENERGY EFFICIENCY

Apart from promoting the use of renewable energy to ensure the sustainability of energy supply and consequently of the country's sustainable economic development, the government of Malaysia has also been implementing the energy efficiency program. Energy efficiency covers the efficiency of power generation, transmission and distribution of electricity and various end-uses of energy. In the 7th Malaysia Plan (1996-2000), energy efficiency and regulations requiring energy management of controlled installations, appointment and duties of energy efficiency officers, approval and labeling of certain energy consuming products and scheduled products were mentioned but these have yet to be finalized.

Implementation of energy efficiency activities in the industries is being actively practiced. It was found that 39.6% of the total final commercial energy consumption is attributed to the industrial sector in 1998 [2]. Initiatives were undertaken by the industrial sectors to use energy efficiently with the support of the government. Government is committing time and money in promoting and developing the energy efficiency activities and also with technical and financial assistance from foreign donors by carrying out energy audits in several companies or industries. Table 3 shows that a study based on 27 energy audits performed in all major industrial sectors concludes that with short-term measures, the energy costs could be reduced by around 3%. With the medium-term measures, another reduction of 6% could be obtained and improvement of processes would give 8% savings. Long term measures involving new technologies and processes seem the most promising and profitable effort with a more than 25% reduction in energy bill. Considering a annual electricity costs of RM 2,700 million, these potential savings are remarkable [2].

The latest and largest project in energy efficiency is the Malaysian Industrial Energy Efficiency Improvement Project (MIEEIP) which is co-funded by domestic sources, Global Environmental Facility (GEF) and United Nation Development program (UNDP). This 4-year project is implemented under the Ministry of Energy, Communications and Multimedia (MECM) with Malaysia Energy Center (PTM) as the main implementing agent. It was predicted that the nation could save as much as RM 76 million through this energy efficiency program.

Table 3 Energy savings potentials convert into financial savings potentials

	Investments (mil RM/year)	Savings (mil RM/year)
Short-term measures (no/low investments)	-	76
Medium-term measures	900	300
Long-term measure	4,200	685

5. MALAYSIA ENERGY CENTER

In order to coordinate the implementation of various energy policies and energy related programs in Malaysia, a not-for-profit company named Malaysia Energy Center (PTM) was launched on June 1999. The company was administrated by the Ministry of Energy, Communications and Multimedia. The vision of the company is to be a proactive and internationally recognized driving force in the promotion of sustainable energy solutions, in harmony with national

aspirations and the environment. The missions of the company is: (1) to establish and manage an energy information network and databank and their timely reporting and dissemination; (2) to support the formulation and implementation of energy policies and initiatives to sustain national strategic growth; (3) to promote renewable energy and energy efficiency in all economic sectors; (4) to coordinate and manage a dynamic and market driven R&D program in supporting national energy strategy and (5) to catalyze the development of the national energy technology and capabilities. Among two of the main projects implemented under the Malaysia Energy Center is the Malaysian Industrial Energy Efficiency Improvement Project (MIEEIP) and the Biomass Power generation and Cogeneration in Malaysia Palm Oil Industry (BioGen).

6. CONCLUSION

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 gas. In order to ensure the sustainability of energy supply and consequently of the country's sustainable economic development, the government has to further intensify the implementation of renewable energy and energy efficiency program. Thus, government and non-government agencies should take a more proactive steps to coordinate and promote energy generation based on renewable resources such as inventory of renewable sources, identification of suitable technologies, create incentives for appropriate practical application and a better national renewable energy policy to allow more participation from the government, non-government and public.

REFERENCES

[1] Thaddeus, J. (2002) Complementary roles of natural gas and coal in Malaysia, *Proceedings of the 8th APEC Coal Flow Seminar/9th APEC Clean Fossil Energy Technical Seminar/4th APEC Coal Trade, Investment, Liberalization and Facilitation Workshop*.

[2] Mariyappan, K. (2000) Status of Renewable Energy and Energy Efficiency in Malaysia, *Country Report from Malaysia*, pp 1-7.

[3] Abdul-Rahman, A. (2000) Issues and Challenges of the Development of RE in Malaysia, Keynote address.

[4] Abdul-Rahman, A. (2003) Renewable Energy in Malaysia – Potential and "the way forward", *Proceedings of the BioGen Awareness and Information Session*.

[5] Leo-Moggie, A. (1999) Keynote address, *Proceedings of the World Renewable Energy Congress 1999*.

[6] Leo-Moggie, A. (2001) Keynote address, *Proceedings of the Malaysia Regional Forum on Energy Policy for the New Millennium*.

[7] Leo-Moggie, A. (2002) Keynote address, *Proceedings of the of the 8th APEC Coal Flow Seminar/9th APEC Clean Fossil Energy Technical Seminar/4th APEC Coal Trade, Investment, Liberalization and Facilitation Workshop*.

[8] Leo-Moggie, A. (1995) Keynote address, Proceedings of the Energy Malaysia 1995 Conference: Powering into the 21st Century.

[9] Plant Engineering Business: Hydroelectric dam project, Bakum, Sarawak. (2004). http://yazmiz.blogs.com.gpsmcom/2004/01/hydroelectric_d.html (Date accessed: 11 August 2004)

[10] Hitam, S. (2000) Sustainable Energy Policy and Strategies: A Pre-Requisite for the Concerted Development and Promotion of the Renewable Energy in Malaysia.

[11] Ministry of Energy, Telecommunications and Multimedia (2004) Introduction to Small Renewable Energy Power Programme (SREP). http://www.ktkm.gov.my/print_details.asp?Content_ID=277(Date accessed: 11 August 2004).