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Alternative Energy in Malaysia Beyond 2020 – The Need for Nuclear Power

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Malaysia needs alternative energy sources to support power supplies demand beyond 2020. This paper scrutinizes through recent literatures and government's white papers on energy scenario to justify the need for nuclear power above other available sources in Malaysia. This study reveals the power demand forecast and the economics of power generation for all energy sources in Malaysian perspective. Considering the advantages and disadvantages between all available sources, it is hoped that this paper will contribute to the discussion of the choice of the most efficient alternative power source to support future power demand in Malaysia.

KEYWORDS: Alternative energy, power demand, economics, nuclear power

I. Introduction

Reliable energy plays an important role in achieving economic stability. Due to global industrial, technological, economic and population growth, energy demand is increasing every day and every country is struggling to meet up with this ever-growing demand for energy. Electricity is essential in modern life and the increasing energy demand results in increased efforts to diversify energy sources.

Diversification of energy source is not easily achieved, as it involves a lot of financial and political commitments and in the cases where new fuels are found, extraction processes are complicated and this leads to instability in fuel price[1)].

Post-independence records of rapid urbanization and industrialization require Malaysia to generate more electricity, in order to improve the living standard as well as being on the track of economic development. As the economy continues to grow, Malaysia's electricity demand is expected to have average increase of 3% per annum from 2010 to 2030[2)].

Malaysia generates electricity from 3 major sources – coal, natural gas and hydroelectric. The constituent of the Malaysian energy mix is 58% from gas, 37% from coal and 5% from hydro power[2)]. Coal and natural gas are fossil sources, which will be used up in the future. With energy demand rapidly increasing, the government has to find alternative means and consider diversification of the national grid to support current fossil sources.

This paper aims to scrutinize through literatures and government's energy white paper to give an insight on why Malaysia needs to add nuclear to its grid. This paper suggests that nuclear power is an efficient option that can fulfill the Malaysia energy needs beyond 2020.

II. Malaysia Energy Strategy

National energy strategy is needed to maintain competitiveness in the national energy sector. The strategy aims at ensuring energy security and independence from exterior factors that may affect or influence the energy production in Malaysia.

Energy security is an important aspect of ensuring stable electricity supply. At present, coal is fully imported and the gas reserve is fast depleting[1)]. The supply of coal is not controlled by Malaysia and the national oil and gas corporation, PETRONAS forecasted that Malaysia would have to start importing gas by 2015.

To ensure energy security, Malaysia must strive towards energy independence and take better control of national power supply. Efficient, reliable and low-prices energy sources that have less dependence on other countries need to be found, as energy independence will provide competitive and affordable electricity prices that can enhance the nation's economy[3)].

Malaysia is also committed to finding the solution to the global warming issues. Currently, Malaysia is adopting an indicator of a voluntary reduction of carbon emission to 40% by the year 2020 compared to 2005 levels[1)]. The Malaysia energy sector accounts for most of its CO_2 emission; serious consideration must be taken in the choice of future energy option in order to meet the above target.

III. Malaysia Energy Outlook and Resources

Figure 1 shows the scenario of energy demand in Malaysia[4)]. The figure shows the load demand for the past four years and the load demand for the first quarter of year 2010. The graph shows a significant rise in peak demand from 2007 to 2009. However, peak demand in 2010 increases drastically compared to the previous years. It shows that a much larger power supply is projected for the future. However, the national energy largest supplier, Tenaga National Berhad (TNB) stated that no new plant is scheduled for installation from now until 2015.

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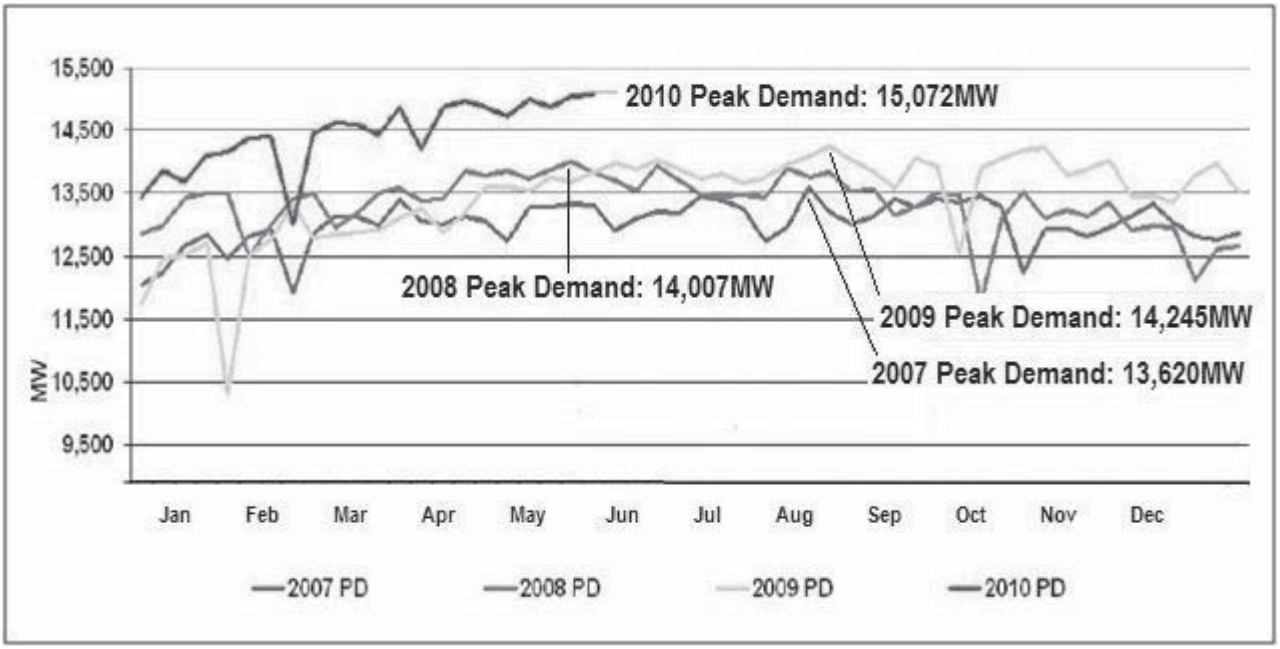

Fig. 1 Comparison of load demand (April 2010)[3].

PETRONAS reported that the natural gas reserve was depleting fast because of increasing demand and usage[1]. Natural gas is not only used for generating power, but also for other applications such as for transportation, chemical process and industrial production. Depending on gas reserve for as energy in the future is not practical anymore.

Coal is fully imported from neighboring Indonesia and Australia[5] and the increasing demand for coal results in instability of coal prices, which affects the electricity market. Coal power plants also emit most of the global carbon emission, which contradicts with Malaysia's commitment to reduce the carbon emission.

Hydropower is the only non-fossil source utilized for commercial electricity generation in Malaysia. Malaysia may increase the supply of electricity from hydroelectric, but hydropower alone is not enough to provide the desired amount of energy. Adding more hydro plants might not be a wise decision since there are limited potential sites for this project in the Peninsular Malaysia[5].

Malaysia has mean monthly wind speed at 5m s^{-1} [6]. Since minimum wind speed for commercial electricity generation 7m s^{-1}, it is obvious that wind is unsuitable for large scale electricity generation in Malaysia.

Utilizing solar may help in electricity production. However, solar has the intermittency problem that limits the electricity production. Backups must be provided to fill in the need during night and rainy season. Aside from intermittency, using solar source needs large area.

IV. Nuclear Power as New Energy Provider

Decision to go nuclear was made by Malaysian Government after careful consideration of energy forecast demand and current energy situation in Malaysia. Part of the preparation for a new nuclear power plant in the energy mix, was the creation of the Nuclear Power Development Steering Committee in June 2009. This committee is given the mandate to plan and coordinate the preparatory efforts towards deploying nuclear energy for electricity generation in the near future[1].

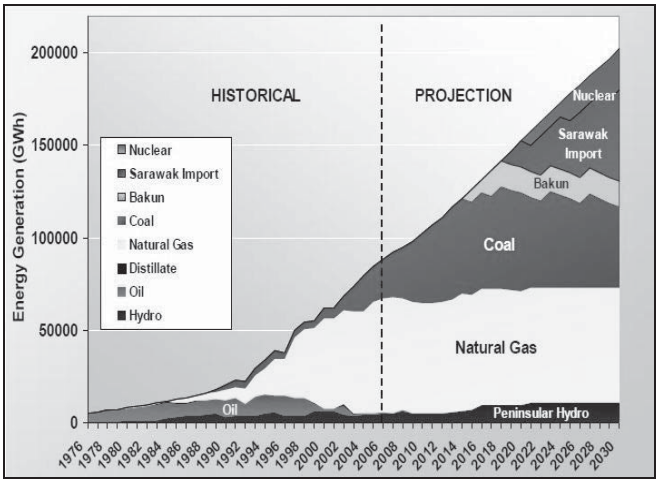

Fig. 2 Malaysia Generation Mix[4].

Figure 2 indicates the energy generation mix in the past and a forecast of the future scenario as well as the diversification needed to fulfill it. From the graph, natural gas and coal can provide enough energy only until 2016[4]. Importing hydropower from Sarawak is economically not viable due to technical difficulties in transferring it through South China Sea as this might be more expensive. Nuclear option is closely feasible to fulfill the National energy strategy.

The price of nuclear fuel is relatively stable compared to coal price and oil. Competition for nuclear fuel is not as high as coal since it can be reprocessed, resulting in slower use of uranium resources.

Economically, experience has shown that a nuclear power plant is a high intensity capital technology[7]. Capital costs vary depending on the location, country and where the plants are built. In general, the construction costs of nuclear power

plants are significantly higher than for coal or natural gas power plants because of the need to use special materials and to fulfill strict safety requirement for the plant operation. This includes the design of reactor, turbine building, waste disposal and processing and grid connection to the desired area around the location. The capital cost also includes the safety and emergency plans for the facility, public and environment.

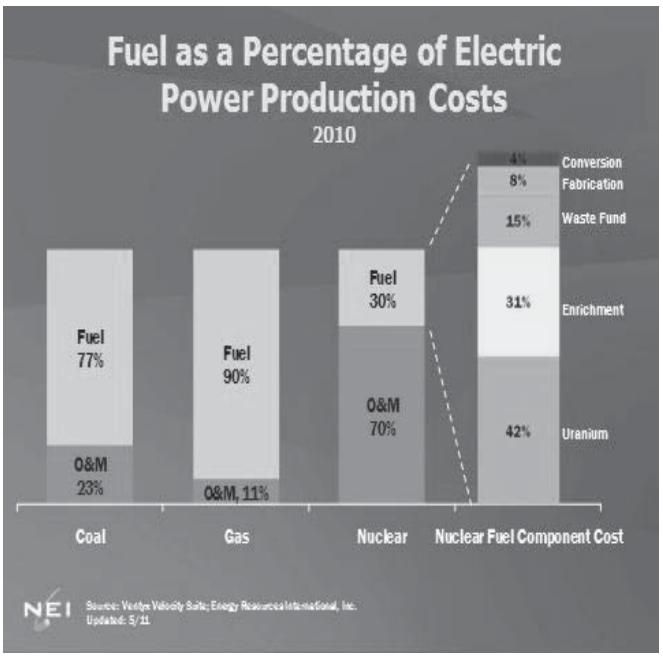

Fig. 3 Fuel Cost for Energy Sources.

Although the cost is high during construction and installation, nuclear power plant is more competitive compared to other sources due to its lower operating costs[7]. The production cost involves operation and maintenance (O&M) and the fuel cost (**Figure 3**). The nuclear fuel cost includes that for used fuel management and final waste disposal. Twenty six percent of the total production costs of nuclear power plant are from the fuel, which is lower than for coal, natural gas and oil (80%). A nuclear power plant needs to be refueled once in every 15 to 24 months while fossil sources have to be added continuously[5].

The other factor favoring nuclear power is the capacity factor. A 100% capacity factor means that the energy source produces at 100% power output every hour of every day of the year. Nuclear power plant is widely known for its higher capacity factor, and this increases with technology advancement. In the new generation of nuclear plants which are having capacity factors of more than 90%. High capacity factor enables the plant to produce an optimum amount of electricity during operation. Other than the high capacity factor, full utilization during operation and improved performance through better nuclear fuel design with the use of higher uranium enrichment levels gives more favorable characteristics for nuclear power plant.

The nuclear energy is also known as a green energy because of its lower carbon emission. Since the power generation process did not include burning, there are relatively no greenhouse gas emissions from nuclear power plant[5].The WNA[21] report on the comparison of life cycle emission of greenhouse gas by various electricity generation methods concludes that the greenhouse-gas emissions of nuclear power plants are among the lowest of any electricity generation method, and are on a life cycle basis comparable to that of the renewable energies.

Using nuclear will help Malaysia to achieve the goal to reduce carbon emission in order to meet its goal of 40% carbon reduction by 2020 compared to 2005.

Table 1 gives a simple comparison of energy options available for Malaysia to consider.

Table 1 Comparison of Alternative Energy Options.

	Nuclear	Solar	Wind
Capacity Factor	75 – 90 %	15%	33%
Power Dependence	Independent from weather, season and time	Depend on sun irradiation	Depend on wind speed
Maximum Power per plant	Up to 1GW or more	100 – 200 MW	1 – 5 MW per windmill
Plant Area Needed for 1GW	About 1km^2	100km^2	High wind speed areas
Life Time	40 – 60 years	20 – 25 years	20 years
Cost per kWh	RM 0.91 per kWh	RM 0.88 per kWh	RM 0.50 per kWh

* Data extracted from various sources – WNA[7], Mills[10], Unenergy[11] and other journals [12-15].

V. National Contribution by Nuclear Power

Considering nuclear option not only assures future energy security, but also helps Malaysia in various ways such as economy, production and social. The nuclear fuel cost is stable and the production cost is comparable to the present rate, so electricity will remain affordable for Malaysian citizens[3].

Steady, reliable, and cheaper nuclear energy will help to improve the various sectors[8]. For example, improved production and industrial sector from adequate electricity provides more job opportunity, upgrade product quality, and hence boosts the economy to a higher level.

Nuclear power also contributes in preserving environment and biodiversity since its land requirement smaller area compared to solar and wind energy. Thus, preserving land for future development and the valuable natural resources in the area are protected.

VI. Fear of Nuclear After Fukushima Incident

Level of risks for energy production can be gleaned from the fatalities occurred during energy production activity. For instance, from 1972 to 1992, worldwide energy production activity from oil and gas has caused 2259 and 1043 deaths

respectively[9]. During the same period, nuclear power caused only 31 deaths.

Despite low fatality record, nuclear accidents such as explosion and cooling failure cause severe effect to public and environment. Although a fuel meltdown might be expected once in 20,000 years of reactor operation, the consequences after an incident cannot be ignored[9].

The Fukushima event has triggered public curiosity and concern related to Malaysian competency to implement nuclear power. The level of accident was categorized at level 7 and was the second worst nuclear reactor accident in history after Chernobyl[19]. Although no fatalities occurred, radioactive materials were released after minor explosion and during critical time of cooling the reactor core.

Apart from safety issues, another issue of great importance is the security and safeguard of nuclear plant and nuclear material itself. Terrorism and the possibilities of attacks[20] is considered as topmost priorities in security plan for nuclear power plant.

The Fukushima incident proves the effectiveness of safety measures implemented at the nuclear power plant. The earthquakes and tsunami occurred in the area exceeded the safety limit for the nuclear plant safety design. The earthquake was 9.0 against the plant design of 8.2 Richter scale and tsunami wave was 14 m against the plants wave breaker which is 5.2 m. An earthquake of 9.0 Richter scale is the most damaging event in the history of times, and the tsunami was the cause of the failure of the diesel generator for the emergency cooling unit which leads to the incident[19].

Fukushima incident has provided exemplary lesson to Malaysia in safety and security plans for any new nuclear power plant. The incident should not in any way discourage Malaysia in it's pursue of future energy security by considering nuclear power development in the future. With close relationship with active nuclear nations and the IAEA, Malaysia should be confident to step into nuclear era by 2020.

VII. Conclusion

The need for alternative source energy in Malaysia is prudent. The fossil fuel reserves are fast depleting and this questions Malaysia's future energy security. Considering nuclear will be one of the best ways of curtailing any future challenges that might threaten the country's developing economy. Nuclear as a source of energy has its own advantages, so it should be judge with open minds not autocratically.

Energy analysis models such as Wavelet and LEAP should be used in analyzing the impact of adding nuclear energy to the Malaysian energy mix.

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References

1) JPM, *Economic Transformation Programme - A Roadmap For Malaysia*, Performance Management and Delivery Unit (PEMANDU), Kuala Lumpur, 167-205 (2010).
2) TNB, *Current capacity status*, Think Nuclear, Think Green p3, Tenaga Nasional Berhad, (2010).
3) M.H. Sabar, " Energy Options and Nuclear Imperatives," *Bengkel susulan Majlis Professor Negara*, April 2011 (2011).
4) N. Muslim, "Towards malaysia's first nuclear power plant commercial operation date by the year 2021," *Proc. in Tunisia AAEA Conference*, Tunisia, June 2010 (2010).
5) TNB, *Nuclear vs. Renewable Energy*, Think Nuclear, Think Green p7, Tenaga Nasional Berhad, (2010)
6) N. Rosly, *Current Situation of Wind Energy in Malaysia (2010)*, Malaysian Green Technology Corp., (2010).
7) WNA, *The New Economics of Nuclear Power*, WNA Report, World Nuclear Association, (2005).
8) A.T.Ramli, *Penggunaan Sinaran Keradioaktifan dan Tenaga Nuklear*, Dewan Bahasa dan Pustaka, Kuala Lumpur, 165-169 (1989).
9) S. Trigilio, *Applying the Principal of Risk Management to Nuclear Power Plant Safety*, International Foundation for Foundation Officers, 4-5 (2006).
10) D. Mills, *Comparison of solar, Nuclear, and Wind Options for Large Scale Implementation*, Solar Heat and Power Pty Ltd., (2006).
11) Unenergy, *Cost Comparison of Energy Supply Technologies*, UN Energy Report, May 2011 (2011).
12) S. K. Najid, et al., "Analyzing the East Coast Malaysia Wind Speed Data," *International Journal of Energy and Environment*, **3**[2], 53 (2009).
13) A. W. Azhari, et al., "A new approach for predicting solar radiation in tropical environment using satellite images – case study of Malaysia," *J. of WSEAS Transaction on Environment and Development,* **4**[4], 373 (2008).
14) A. M. Muzathik, et al., "Reference solar radiation year and some climatology aspects of east coast of west Malaysia," *American J. of Engineering and Applied Sciences*, **3**[2], 293 (2010).
15) K. Sopian and M. Y. Othman, "Estimates of monthly average daily global solar radiation in Malaysia," *J. of Renewable Energy*, 2[3], 319 (1992).
16) A.T.Ramli, *Biofizik Sinaran*, Dewan Bahasa dan Pustaka, Kuala Lumpur, 146-147 (1993).
17) Peter C. F. K, *Malaysia Considers Nuclear Energy to Meet With Increasing Energy Demands*, TenagaLink Publication, Vol. 1/10, (2011).
18) M. N. Shahruddin, "Carbon Reduction Policy, Strategy And Technology: Malaysia & TNB's Perspective," Proc. of The Conference of the Electric Power Supply Industry (CEPSI), Taiwan, 24-28 October 2010, (2010).
19) J. Buongiorno, R. Ballinger, Driscoll, M., "Technical lessons learned from Fukushima-Daichii accident and possible corrective actions for nuclear industry: an initial evaluation". MIT-NSP-TR-025 May 2011.
20) W.J.Nuttall., "Nuclear renaissance-technologies and policies for the future of nuclear power". Taylor & Francis, New York (2005).
21) World Nuclear Association.WNA Report, Comparison of Lifecycle Greenhouse Gas Emissions of various Electricity Generation Sources. London: WNA; 2011. Available at www.world-nuclear.org/. Accessed 20 December 2011.