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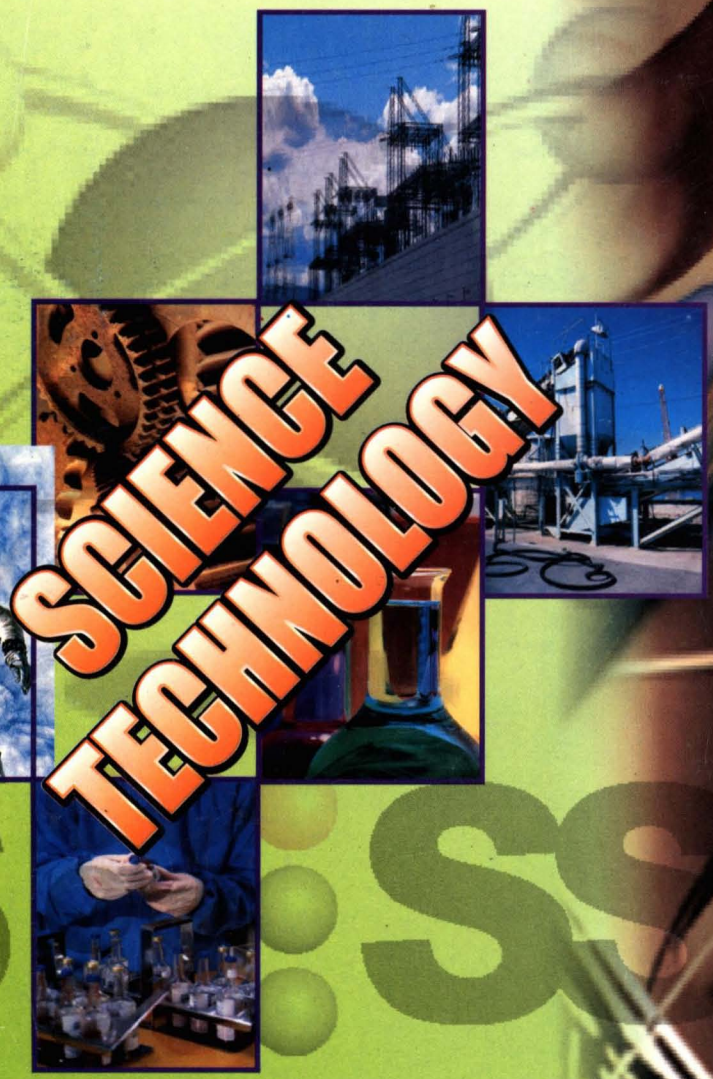

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The Current Energy Scenario and Prospects of Alternative, Renewable Energy Sources in Malaysia

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ABSTRACT

Malaysia is committed to become a developed nation by the year 2020. Energy is one of the important aspects to be considered in the development of a nation. Nowadays the crude oil price is increasing rapidly since past few years and it is not a good practice if Malaysia has been only depending on fossil fuel to generate electricity. To date, Malaysia has been generating energy using coal, natural gas, crude oil and hydro. A percentile amount of 47% of the energy generation uses crude oil. Total dependence on fossil fuel is not a healthy symptom on economic aspect. One of the ways to divert the dependence is to use the alternative and renewable energy resources. Since the 8th Malaysian Plan, Malaysian Government has been focusing to apply renewable energy as their fifth energy source. Agriculture is one of Malaysian economic resources that produce municipal waste during the process. This wastage along with the municipal garbage can be used and converted into electrical energy which is called biomass energy. Malaysia is geographically closer to the equator, and has a big potential in manipulating solar energy as one of potential source of electrical energy. Malaysia receives 8 hours of sunshine per day with a possible average amount of 4.5 KWh electricity conversions. As renewable energy sources like solar panels are approaching toward affordable range, Malaysia should start using this sort of alternative and renewable energy as one of their alternatives of energy. This paper will show the current energy scenario of the world together with some introduction on prospective renewable energy source such as Solar Cell activities to promote Solar Panels to be the best suited renewable for Malaysia.

Keywords: *Alternative Energy, Renewable Energy, Malaysian Energy Scenario, Malaysian Energy Prospect, MBiPV, Biomass*

Introduction

Most developed nations have started changing and using alternative and renewable energy as their sources of energy, for instance Japan, United States, Britain and Germany. Since the crude oil price are increasing in the few years time and depleting from time to time if we keep using uncontrolled.

What is alternatives and renewable energy? In this case alternative is defined as other resources than fossil fuel and renewable is defined as continues, long lasting and endless. So energy that long lasting and other than fossil fuel is the alternative and renewable energy. For example of alternative and renewable energy is hydroelectric, PV, wind, geothermal and biomass.

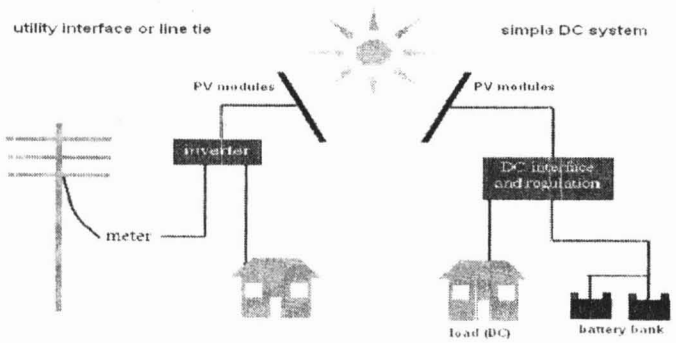

Fig.1: Choices of PV Systems at a Glance

Based on the geographical location and the manufacturing and daily life waste, Malaysia has a high potential of PV and biomass energy usage. The concept of Malaysia building integrated photovoltaic (BiPV) was caught in the late 1990's. In July 2005, the Malaysia BiPV project was launched by the Ministry of Energy, Water and Communications, as another step for PV application in Malaysia. Other than PV, the biomass program is also given a

scope under BioGen Project. All national renewable energy programs are mostly promoted by Pusat Tenaga Malaysia (PTM).

Solar cells are made from semi-conducting material that use in computer chip. It directly converts sunlight to electrical energy when the photons from the sunlight knock the electrons in the semi-conducting material free. The free electrons flow in the electrical circuit and produce electricity. Converting lights (photon) to electricity (voltage) is called photovoltaic effect. Combination of 40 solar cells will form solar module. 10 of the module mounted in PV array up to several meters. The array can be mounted to tracking device to follow the sun or at fix angle.

Although the solar modules are expensive, but if we focus on mass production, the price could decline eventually. Solar modules are modular that can be made out from mV to many of MV. Most of PV system does not have moving part. Some systems have tracking device to track the sun. Since most of it does not have moving parts, it does not have energy loss like heat. PV system is noiseless and pollution free. Once it is installed, the module life time guaranteed for thirty years with four times maintenance per year.

Materials and Methods

This review paper is a part of Solar Cell related research works at the current institute. Materials that have been referred in this study include field survey, research articles, journals and other working papers.

Discussion

World Energy Scenario

Production Sources and Price

Around 1973 to 1982, due to a major political upheaval that affected the oil producing countries caused a drastic increase in oil prices that has been continuing till to date. The recent price is more than $US 70 per barrel (Sept. 2005). The next 10 years after the oil crisis, new energy sources had been searched for as the reserved was depleting very fast. Recent survey by World Energy Council (WEC, 2004) has indicated that the oil reserves in the world will last only for another 40 years, 60 years for natural gas and 200 years for coal. Technology development is expected to produce renewable that will make up to 5% of the world energy by the year 2030. By the year 2020, renewable energy is expected to provide 30% of the world's energy needs.

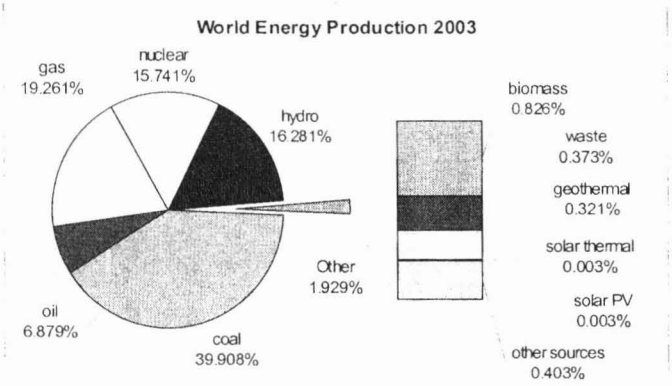

Fig. 2: World Energy Production in 2003

Until the year 2003, IEA has recorded that the world energy production has been mainly based on fossil fuel, coal and nuclear as shown in Figure 2. The alternative energy usage is only a small portion from the total production. As for the solar PV usage, it is even less than 1% of the total production. If the world keeps depending on fossil fuel and coal, the price of energy will continue to increase from time to time. From the crude oil price below shows that the crude oil price has been increasing in the last eight years. Increments of source price will also increase the energy price as a general concept.

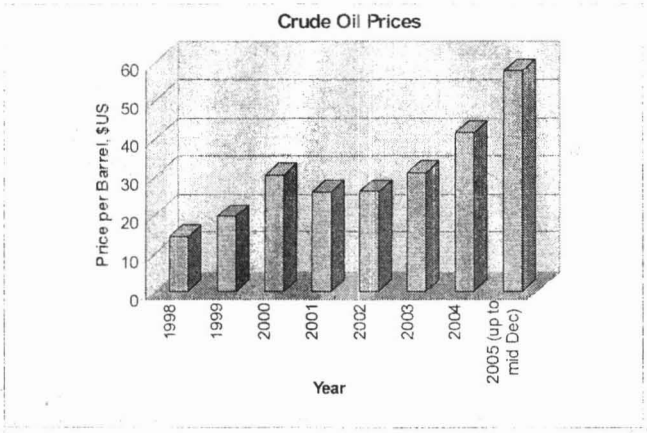

Fig. 3: Crude Oil Price Record (till Mid December 2005)

Taking PV panels as our alternative energy resource, we will show some facts here. For solar module price, different situations are going on. Since the year 2004, the module prices were declining due to the demand each year. The higher the usage, the higher the demand; when the demand is high the mass production is needed. This could reduce the cost of production and installation of PV solar system further.

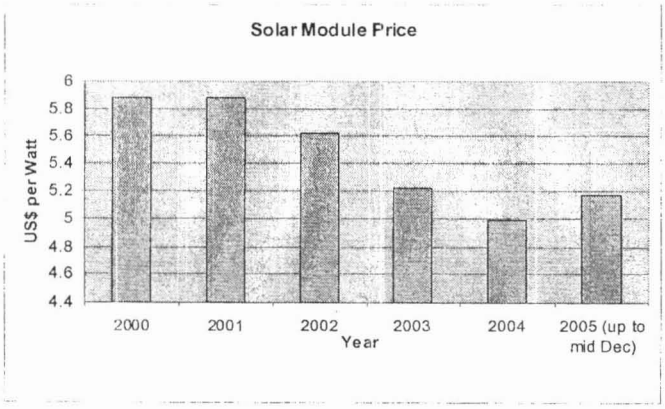

Fig. 4: Solar Module Price Trend

Photovoltaics (PV) Research and Growth

Since the past ten years photovoltaic (PV, the term well describes solar cells/panels) energy has been positioned among the fastest growing energy in the world. The annual average of global percentage growth of PV is about 28.5%. While the other conventional energy annual average growth is 1 – 3%. It shows that PV may continue growing and has better future than other conventional energy. To be more convincing, the PV module production is also increasing since early 90's. The production had been facing the sudden rise from the year 1997 till 2004; the world production had hit almost 1200 MW. Japan is the highest PV producer since they do not have natural resources like petroleum and gas to generate energy. PV is the excellent option to replace the conventional energy in countries like Japan.

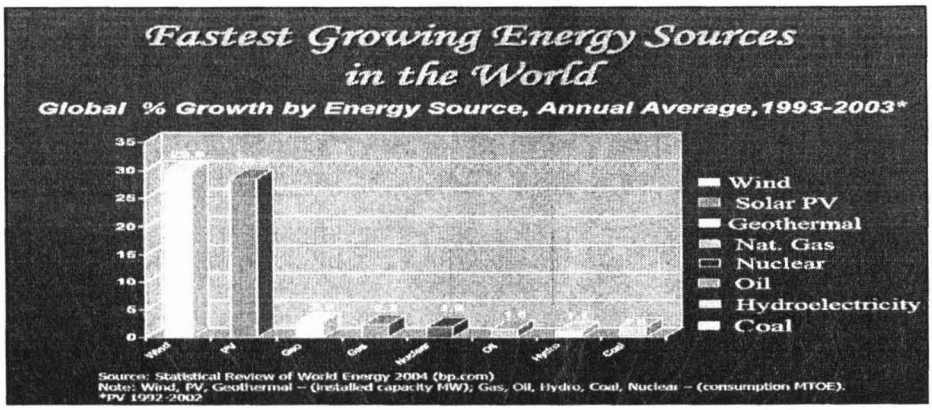

Fig. 5: Global Energy Growth *(source: Statistical Review of World Energy 2004)*

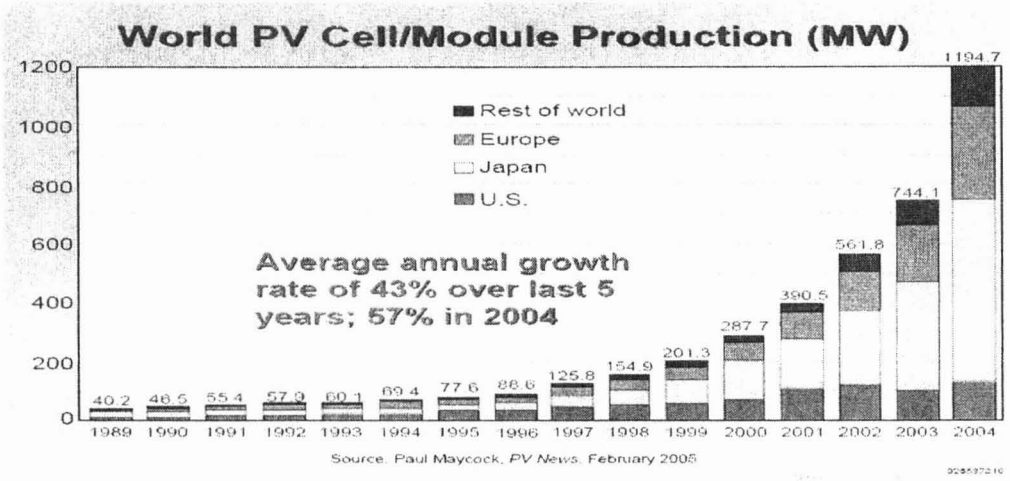

Fig. 6: World PV Cell/Module Production (source: Paul Maycock, PV News)

That is why most of the main PV module manufacturers are Japanese companies. The top 10 manufacturers are Kyocera, Sharp, Shell Solar, BP Solar, Sanyo, GE & Isofoton, Astro Power, Mitsubishi Electric and RWE Schott that give the total production of 745 MW. Half of it is produced by the top four companies, which are Kyocera, Sharp, Shell Solar and BP solar. The figure below gives the clear view of the total production.

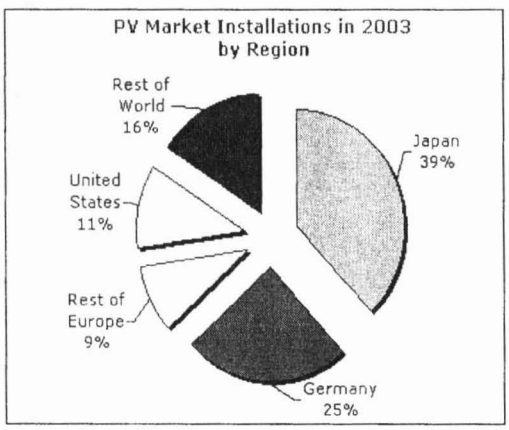

Fig. 7: PV Installation in 2003 (source: EERE)

The PV technology is also giving few options of module/cell. Currently the PV can be chosen from flat panel or solar concentrator. The solar concentrator is made by silicon or multi-junction. The concentrators manage to increase the efficiency by focusing more than a sun light by mirror or lenses. While the flat panel is the commonly used have several technology options. The flat panel can be made by crystalline Silicon, multi-crystalline Silicon, Gallium Arsenide (GaAs) crystalline or thin film, Copper Indium Gallium Selenide (CIGS), or Amorphous Silicon.

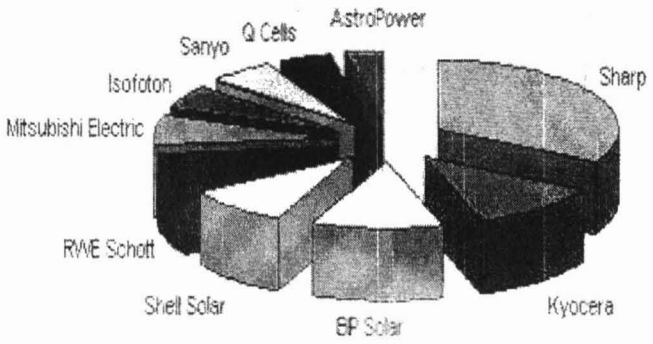

Fig. 8: Top 10 PV Module Manufacturer

The performance of solar cells is measured in its efficiencies of turning sunlight to electricity. Most commercial PV cells have efficiency of 15%. There are also commercial PV cells with as low as 8% as high as 20%. But in laboratory the efficiency are usually are higher that the commercial cells. In laboratory only few inches area of cell were made than larger area when it made for commercialization. In past 25 years there are lots group of people doing a research to have practical efficiencies as close as possible to the theoretical efficiencies. Some breakthroughs were made during this period. The figure below can be summarized by the Table 1.

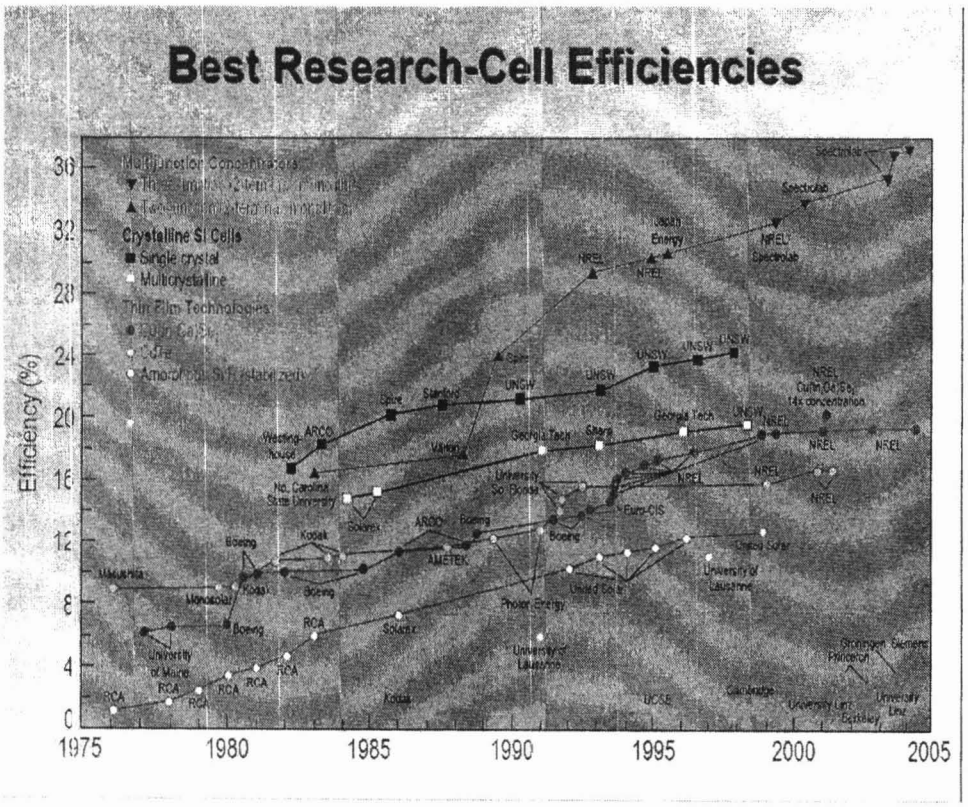

Fig. 9: Best Laboratory Cell Efficiencies *(source: NREL)*

Table 1: Solar cells Efficiency in Laboratory by types *(source: NREL)*

Type of Solar Cell	Conversion Efficiency (%)
Si (crystalline)	24.7
Si (multi-cryst.)	19.8
GaAs (crystalline)	25.1
GaAs (thin film)	23.3
CIGS (cell)	18.4
Amorphous-Si	12.7
GaInP/GaAs (multi)	30.3

Malaysian Energy Scenario

Past to Present

Malaysia is a maritime country that is close to the equator. As a maritime country, it is quite rare for Malaysia to have full day clear sky. Cloud will cut substantial amount of sunshine thus the solar radiation. Solar radiations are closely related to sunshine duration. On average, Malaysia receives about 6 hour of sunshine per day. Some of the places in Malaysia have seasonal and spatial variation on average. Alor Setar and Kota Bharu receive sunshine 7 hours per day on average. In the extreme month of January, Kuching receive sunshine 3.7 hours per day on average and Alor Setar receive 8 hours per day on average. Highest solar radiation recorded over most parts of Kedah, Perlis, Penang, North West of Perak and North of Kelantan. Lowest recorded solar radiation is over most parts of Johor, Southeast Pahang and north east Selangor. Annual solar radiation is between 1500 kWh/m² to 1600 kWh/m² with a daily average of 4.5 kWh (Malaysian Meteorological Department, 2005).

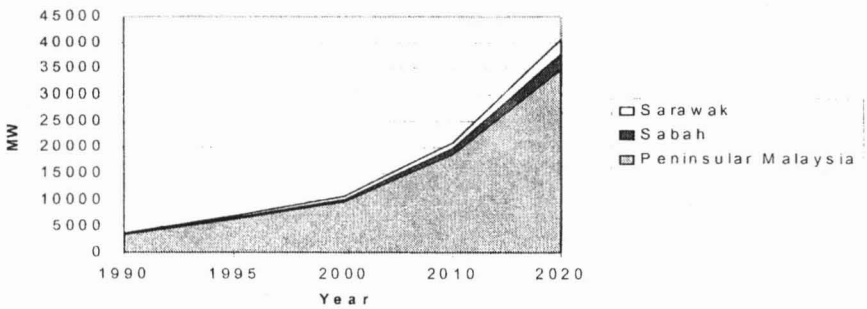

Fig. 10: Projected Energy Demand in Malaysia (MW)

In 1995, the installed capacity of electrical energy in Malaysia was about 7,000 MW. The demand over the next 20 years is expected to increase about 20,000 to 25,000 MW on average (Othman and Abdul Rahman, 2001). By the year 2020, the total energy demand for whole of Malaysia will exceed 40,000 MW as shown in the Figure 10.

Table 2: Final Energy Consumption per Capita

Country	kgoe
Singapore	6000
Taiwan	2400
South Korea	2000
Malaysia	1400
Philippines	600
China	500
Indonesia	400
Thailand	200
Myanmar	47
Cambodia	19

Malaysian government had introduced "The National Petroleum Policy 1975" to regulate downstream oil and gas industry via the "1974 Petroleum Regulations". In 1979, The National Energy Policy was introducing to ensure adequacy, security and cost-effectiveness of energy supply, promote efficient utilization of energy and to minimize negative impacts in energy supply. To prolong the lifespan of Malaysia's oil reserved for future security and stability of oil supply, the National Depletion Policies were introduced. The same year, the Four-fuel Diversification strategy was introduced to pursue the balance utilization of oil, gas, hydro and coal. Since the pressure and climate changes issues, in 1999 the Five-fuel Diversification Strategy was introduced to include renewable energy as the fifth fuel in the energy supply mix.

Supply and Demand in Malaysia

Energy is a very important necessity for survival and development of any nation. The final energy consumption per capita of population may be taken as an indicator to demonstrate the state of development. Table 2 shows the energy consumption in kgoe for several countries in South-East Asia. As can be seen the developed nation consumes more than 2000 kgoe per capita. As Malaysia becomes more developed each year, the energy supplies have to meet the demand.

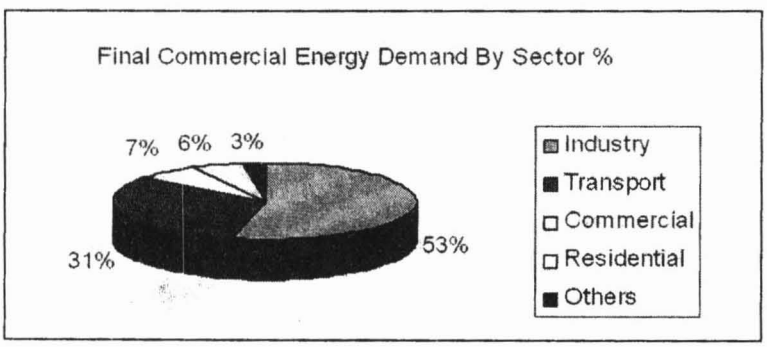

Fig. 11: Final Commercial Energy Demand

In 2002, the energy demand in Malaysia was divided into industrial, transportation, commercial, residential and others. About 53% was consumed by industrial sector. The energy supply for Malaysia divided to four sector – crude oil, natural gas, hydro and coal. An amount of 47% of the supply is from the crude oil, followed by the natural gas with 43%. The total from the fossil fuel is 90%. The energies from renewable, especially from bio-fuels have yet to reach a significant figure. The national policy is targeting for renewable sources to make up 5% of the total energy supply in Malaysia by 2005. The Figure 11 and 12 show the energy supply and demand in Malaysia in 2002.

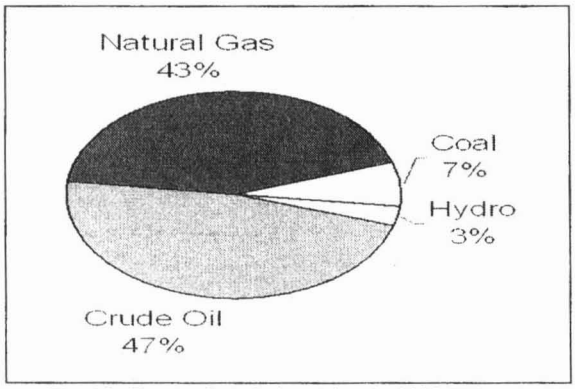

Fig. 12: Energy Supply in Malaysia 2002 (%)

The Energy Commission (EC) predicts that Malaysia can save more than RM11 billion from energy efficiency and demand-side management initiatives between now and 2015 – *Business Times Online, 2005*. Malaysia would save RM5.6 billion in investment to generate and supply electricity when the demand for energy drops and energy is used efficiently. While another RM6.2 billion savings comes from the cost of energy.

The recent EC study found that the average electricity consumption by commercial building in Malaysia is between 200 and 280 units per sq meters a year. Malaysia's energy efficiency is poor compared with the other developed nations and even against Singapore and Thailand.

Energy Production Scenario in Malaysia

The electricity sub-sector is dominated by three integrated utilities, i.e. Tenaga Nasional Berhad (TNB) serving Peninsula Malaysia, Sabah Electricity Sdn. Bhd. (SESB) and Sarawak Electricity Supply Corp. (SESCo) and complimented by various independent power producers (IPPs), dedicated power producers and co-generators.

TNB was established in September 1990 through a corporatisation and privatisation exercise by the Malaysian Government of the then National Electricity Board (NEB). TNB is the Malaysia's national electricity utility company. The main activities of TNB are in generation, transmission, and distribution of electricity. TNB group has the largest generation capacity of 11,137.5 MW. The TNB Group has a complete power system including the National Grid, Customer Service Centre, Call Management Centre and administration offices throughout Peninsular Malaysia and Sabah.

The electricity generation is run by their subsidiary companies like TNB Generation Sdn Bhd, TNB Hydro Sdn Bhd, and TNB Janamanjung Sdn Bhd. The source of generation is basically the four national fuels – coal, gas, oil and hydro. TNB is also buying energy from the other independent power production like Genting Sanyen Power Sdn Bhd.

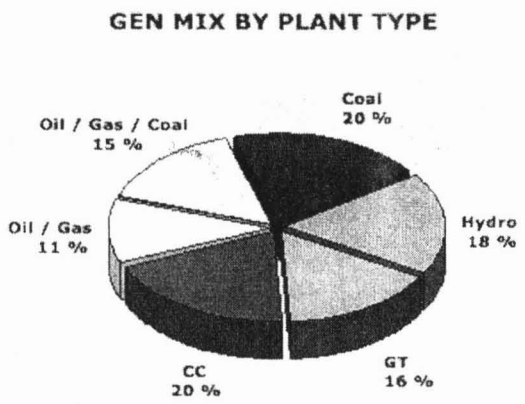

Fig. 13: TNB Generation Mix by Plant Type *(source: TNB)*

Sabah Electricity Sdn Bhd is the company that supplies electricity to the state of Sabah, whose 80% of subsidiary is owned by TNB and other 20% is owned by the State Government of Sabah. The total generation capacity is 785MW, whose 55% (1,742 GWh) of the total unit generated is purchased from the independent power producers.

The installed capacity of the West Coast Grid and Northern Coast Grid is 460 MW, where the maximum demand is 317 MW. While the East Coast Grid, 275/132 kV Transmission line has an installed capacity of 275 MW with the current demand of 172 MW.

SESB owns 57 power stations including 5 independent power producers. The electricity is also bought from the IPP like ARL Tenaga Sdn Bhd.

Sarawak Electricity Supply Corporation (SESCo) is responsible of supplying electricity to the state of Sarawak. Whose 51.6% is owned by the State Government of Sarawak, 45% is owned by Sarawak Enterprise Corporation Berhad (SECB) and 3.4% has been set aside for the employees of SESCo. The Corporation was established as a statutory body in 1963 to take over the assets and operations of the predecessor company, the Sarawak Electricity Supply Company Limited (SESCo). The company has 35 power stations with total capacity of 553 MW attributed by 64% from gas turbines, 18% by thermal generators and 18% by hydro turbines. Major towns are connected via a 275/132V State Transmission Grid. Generation are done by their subsidiaries and also bought from other independent power producer like Sejingkat Power Corporation Sdn Bhd. Currently SESCo has about 382,000 consumers with 8% growth over the last four years. SESCo has been privatized on 1st July 2005.

Table 3: TNB Generation Detail by Type *(source: TNB)*

Type of plant and capacity of installation MW - TNB Group(inclusive KEV)			
Gas Turbine	GT	1,653.00	16%
Combined Cycle	CC	2,050.00	20%
Conventional Thermal (Oil/Gas)	Oil/Gas	1,200.00	11%
Conventional Thermal (Oil/Gas/Coal)	Oil/Gas/Coal	1,600.00	15%
Conventional Thermal (Coal)	Coal	2,070.00	20%
Hydro	Hydro	1,909.90	18%
Total		10,482.9 MW	100%

Malakoff Berhad has grown into the nation's leading independent power producer. The generation assets are held through a number of subsidiary and associate companies. The Company holds a 75% equity interest in Segari Energy Ventures Sdn. Bhd. ("SEV"), owner of the 1,303 MW Lumut Power Plant in Segari, Perak. Ownership of the 640 MW GB3 Power Plant, also located in Segari, Perak, is through a 75% equity interest in GB3 Sdn. Bhd. Prai Power Plant, with a capacity of 350MW, is held through its wholly-owned subsidiary, Prai Power Sdn. Bhd. These three power plants are combined cycle gas turbine plants.

Malakoff interest in Port Dickson Power Plant, a 440 MW open cycle peaking power plant in Tanjong Gemok, Port Dickson, Negeri Sembilan, is through a 25% equity interest in Port Dickson Power Berhad, held through Malakoff's wholly-owned subsidiary, Hypergantic Sdn. Bhd. The acquisition of a 40% interest in the Kapar Power Station, a 2,420 MW coal, oil and gas-fired plant was completed.

Electricity distribution activities are carried out by Malakoff wholly-owned subsidiary Wirazone Sdn Bhd. which currently supplies centralised chilled water and distributes electricity to the landmark Kuala Lumpur Sentral development. Wirazone Sdn Bhd buys electricity from TNB in a bulk.

NUR is a dedicated power producer serving the Kulim High Technology Park in Kedah, a state which is located in the north of Peninsular Malaysia. It has two subsidiary Companies, NUR Generating involved in electricity generation and NUR Distribution which is involved in electricity distribution. The capacity of this dedicated power plant is 450 MW which is implemented in 2 phases. The first phase of 225 MW will be ready for commercial operation by August 2001. In generation, two blocks consist of two GE Frame 6E Gas Turbines each capable of producing 35MW in open cycle each. Waste heat from these Gas Turbines will be used to generate additional energy from conventional steam turbines. An additional capacity of 40 MV will be available from this arrangement on combined cycle operation. The blocks are capable of providing 110 MW to give a total capacity of 220 MW.

There are several independent power producers in Malaysia that generate electricity and sell to the major utility distributors such as TNB, SESB and SESCo. Some of the Independent Power Producers are Genting Sanyen Power Sdn Bhd, Port Dickson Power Sdn Bhd, Powertek Bhd, Segari Energy Ventures Sdn Bhd, YTL Power Generation Sdn Bhd, ARL Tenaga Sdn Bhd and Prai Power Sdn Bhd.

Octagon Consolidated Berhad is recycling the waste for producing and selling the renewable energy and investment holding. Operations are carried out in Malaysia, Indonesia, Hong Kong and the People's Republic of China. Currently the company has invested in two renewable projects, solid waste-to-energy plants in Malacca and waste tyre pyrolysis project. This company is waiting for the Cabinet approval to operate 40 MW power plants that will use municipal waste as fuel to produce electricity by waste-to-energy project in Malacca.

Government Initiative

In order to achieve the energy supply and demand, Malaysian Government had introduced many incentives. The Centre for Education and Training in Renewable Energy and Energy Efficiency (CETREEE) and Capacity Building in Integrated Resource Planning (IRP) Program were introduced in 2002. Recent initiatives include the introduction of the Electricity Efficiency Regulations, Energy ratings and labelling, a new policy on cogeneration and the building of the Low Energy Office as a showcase for Energy Efficiency in Buildings which has been officially launched in August 2005. In May 2001, Small Renewable Energy Power Program was launched to encourage and intensify the utilization of renewable energy in power generation.

Since the Country's Fuel Diversification Policies includes renewable energy as the fifth fuel SREP was formed. SREP is one of the Malaysian Government strategies to intensify the development of renewable energy as fifth fuel. So the Special Committee on Renewable Energy (SCORE) under Ministry of Energy, Communication and Multimedia was formed to supervise the program. Under this program, all renewable energy power generation company may apply to sell the electricity via the Distribution Grid System and they will be given licence for a period of 21 years. This program is applied to all types of renewable energies like wind, PV, biomass, biogas and mini-hydro.

Malaysian government expects palm oil fuel to be considered as an alternative to fossil fuel to help alleviate hardships faced by rural people, especially in the remote areas of Sarawak in the face of ever increasing price of petrol and diesel. Commercially manufactured bio fuel could be more cost effective to operate generators supply electricity in Malaysia's rural areas like Bario, Ba'kelalan and Kapit in the wake of the global fuel price hikes.

However the bio fuel usage and application must be governed by certain policy. Malaysia should have a clearer policy biodiesel policy to encourage more usage and production of palm oil biodiesel as an alternative energy. The clearer policy would enable the industry to determine its direction and create more local biodiesel producer. This is to ensure its success of the Government's effort in promoting the usage of biodiesel.

Malaysia Building-integrated Photovoltaic (MBiPV) was officially launched in July 2005. This project will promote the increase use of photovoltaic technology to tap solar energy and generate electricity for the building. It is also to promote the adaptation and adoption of the newer building-integrated photovoltaic technology. An amount of RM95 million has been allocated for this project. The Global Environment Facility (GEF) will provide RM18 million via United Nations Development Programme (UNDP), private sector and industry amounting to almost RM35 million and Government of Malaysia amounting about RM 42 million.

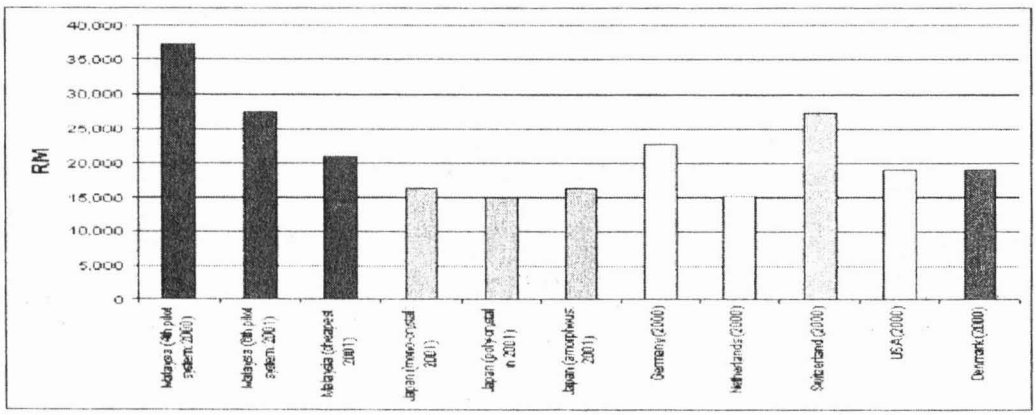

Fig. 14: BiPV Cost Comparison per kWp *(IEA-PVPS)*

Now, the study will show the potentialities of using solar power in the form of solar cells. Based on several simulation and field studies, Malaysia has been found to be capable of producing electricity about 1,200 kWhkWp^{-1} annually from sunlight to electricity conversion though PV panels. Approximately 2,500,000 households are suitable for BiPV for residential sector, whereas 20% are not suitable due to architectural constraints as well as about 5% of total residential consumers are flats or apartments that are not suitable for BiPV. Most commercial businesses are

located in urban areas and a potential for PV applications. 45,000 buildings could be considered for BiPV applications approximately. Only 10% are not suitable due to shading or obstacles on the roof. Shopping malls and business parks have high potential of BiPV applications. The industry sectors are usually bordering the urban centres. Hence the total available surface for BiPV is about 110,000,000 m².

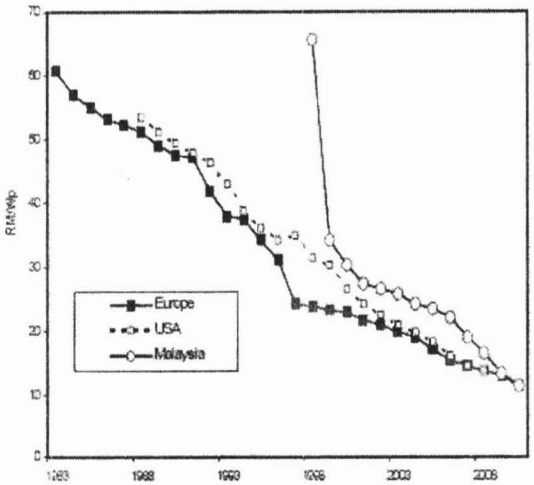

Fig. 15: Present and Predicted Cost Comparisons of BiPV in Malaysia, Europe and US

From the figure above, it clearly shows that the disparity is large. But the predicted cost comparisons of BiPV in Malaysia, Europe and United States can appreciate that the potential for improvement is large. A high proportion of the total cost is still associated with the lack of awareness and experience of photovoltaic in the building industry, limited planning guidance and metering arrangements. So Malaysia has a high potential of BiPV application offering several advantages.

Conclusion

Adopting alternative and renewable energy source as the option is the wisest idea for our prospective future. Concerning the current situation of the world crude oil price, we can foresee its ever-increasing trend as a threat to any developing country like Malaysia. Meanwhile, the Malaysian Government has to reject its national power producing company's proposal to increase the electricity tariff due to the price-hike of crude oil. This paper presented a number of facts of the recent situation of world energy and renewable energy resource like solar cells as well as stated the energy scenario of Malaysia to draw attention on its future planning. From various perspectives, solar energy is the most suitable choice as the alternative to implement in Malaysia. Even though it is not so much cost effective at present, solar energy usage by solar cells could save money more than the conventional energy in the long-term basis, as most of the solar energy panels are guaranteed for 30 years of life time. Malaysia, the maritime country received about 12 hours of daylight and about 6 to 7 hours of sunshine per day on average, it will be a total waste if the free sunlight is not effectively utilized in various forms like solar cells or others. Another alternative is biomass and bio diesel that use municipal waste and agricultural waste to generate electricity. Totally depending on conventional way to generate energy is unwise as the conventional sources are now depleting day by day. Usage of renewable energy could overcome this problem and we need to act fast from now on taking lessons from other countries adopting in Malaysian ways.

Acknowledgement

A deep gratitude to everyone who are currently involved directly or indirectly in renewable energy related works in Malaysia as well as around the world. Heartfelt thanks to Faculty of Engineering of Multimedia University for supporting all the ongoing Renewable Energy (Solar Cells) related research works.

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