CHAPTER 3.0 RENEWABLE ENERGY POTENTIAL IN MALAYSIA

Malaysia is a country that has abundance renewable energy which is biogas, biomass, small hydro, solar, and wind but most of these renewable energy resources are not fully explored and exploited. Table 3.1 below presents the renewable energy resource potential in Malaysia identified by a recent research study.

Table 3.1: Renewable Energy Potential
(Source: Cardas Research Industry Report 2010)

Renewable Energy Resources	Energy Value in RM (Annual)
Forest residues	11,984
Palm oil biomass	6,379
Solar thermal	3,023
Mill residues	836
Hydro	506
Solar PV	378
Municipal waste	190
Rice husk	77
Landfill gas	4

3.1 Biomass Energy Potential

3.1.1 Biomass Energy Resources

Biomass has great potential for renewable energy in Malaysia, due to the high level of production of palm oil waste and wood waste. Currently, statistics show that the biomass fuel account approximately 16% of energy consumption in the country, 51% account of biomass and palm oil and 22% of wood waste [11]. Other resources are available from the sources of the agricultural sector and agro-food industry. Availability of biomass base can be summarized in Figure 3.1. Basically there are five main categories of biomass in Malaysia, which are produced in the following categories of oil palm, palm wood, rice, sugar cane, municipal waste.

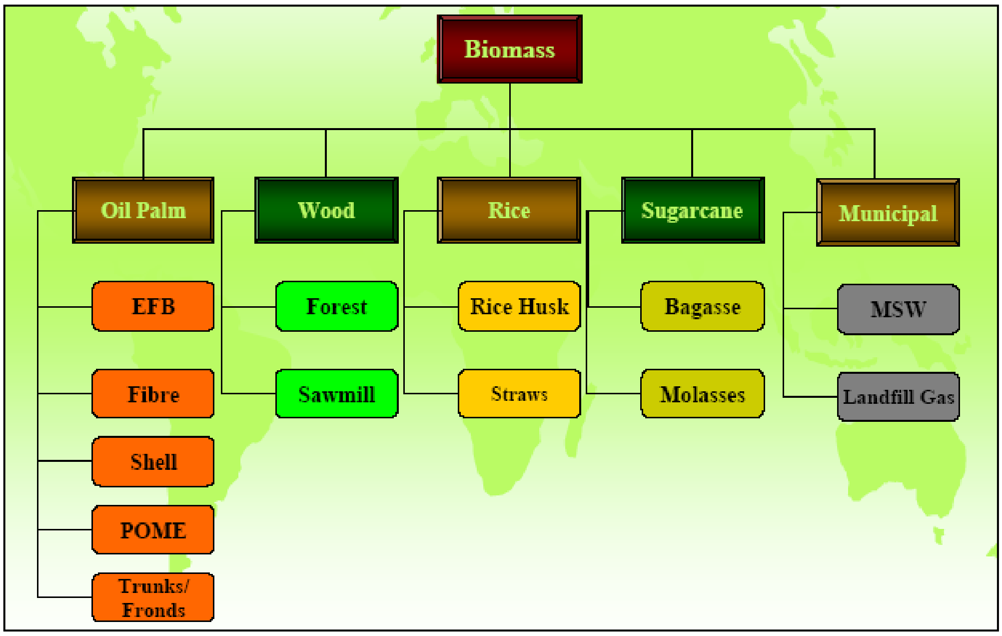

Figure 3.1: Sources of biomass in Malaysia

(Source: Biomass Resource Information System, PTM website)

As mentioned previously, Malaysia has plentiful biomass resources and most of them come from palm oil mill residues. Table 3.2 shows information about the quantity of wastes produced each year.

Table 3.2: Potential of biomass

(Source: Background Report, Malaysia RE and Energy Efficiency)

Sector	Quantity (kton/year)	Potential Annual Generation (GWh)	Potential Capacity (MW)
Rice Mills	424	263	30
Wood Industries	2,177	598	68
Palm Oil Mills	17,980	3,197	365
Baggase	300	218	25
POME	31,500	1,587	177
Total	**72,962**	**5863**	**665**

Palm oil mills offer the greatest potential capacity of 365 MW and 3,197 GWh of electricity per year. Palm oil mill effluent (POME) also gave a significant contribution to the potential production capacity of 177 MW. Bagasse, is the waste from sugar cane that crushed for juice, and rice mills also have a small production capacity of 25 MW and 30 MW respevtively.

3.1.1.1 Oil Palm Residues

Palm oil industry has grown on an average of 7.5% annually in 2006 and it can be said that more than 15.8 million tons of CPO were generated. In general, it is assume that all the statistics on the EFB, POME and the potential waste have been increased by 33% from 2002 to 2006. In 2007, the numbers of palm oil mills in Malaysia have taken up to 407. Table 3.3 shows the number of palm oil mills in the country, totaling with 10 MW of biomass in CFB class that can be produce.

Table 3.3: Palm oil mills based on FFB Process Amount
(Source: Final report of the Renewable Energy Policy and Action Plan)

State		Factory FFB process amount	
		More than 300,000 ton/year	More than 250,000 ton/year
Peninsular Malaysia	Kedah	1	2
	Pulau Pinang	0	0
	Perak	4	11
	Selangor	1	2
	Negeri Sembilan	0	1
	Melaka	0	2
	Johor	6	17
	Terengganu	0	0
	Kelantan	0	0
	Pahang	0	2
West Malaysia	Sabah	15	30
	Sarawak	2	9
Total		**29**	**76**

The table shows that 17 units are located in Sabah and Sarawak, while another 12 in Malaysia. Depending on the size of oil palm plantations in Malaysia, the largest annual biomass production is 26 million tonnes per year.

Palm oil industry in Malaysia has increased rapidly over the past 25 years towards the development of an economy based on agriculture, which is Malaysia's today is the largest exporter of palm oil products. Malaysia currently produces a vast range of biomass from palm oil, including palm trunks; empty fruit bunches (EFB), fibers and shells. The total waste of palm oil has been published in Table 3.4.

Table 3.4: Potential production of electricity from palm oil waste
(Source: Malaysian palm oil statistics 22nd edition, MPOB)

Type of Industry	Production (Thousand Tonne)	Residue	Residue Product Ratio (%)	Residue Generated (Thousand Tonne)	Potential Energy (PJ)	Potential Electricity Generation (MW)
Oil Palm	59,800	EFB at 65% MC	21.14	12,641.7	57	521
		Fiber	12.72	7,606.6	108	1032
		Shell	5.67	3,390.7	55	545
	Total Solid			**16,670.6**	**220**	**2098**
	POME			**38,870**		**320**

There are comparisons between the fibers, shells and empty fruit bunches (EFB). The total production capacity is expected to increase in the future due to the development of palm oil by 40% in 20 years [11].

Empty fruit bunches (EFB) from palm fiber mill is a material that is purely organic origin. It contains no chemical additives and minerals and generally without external components, such as gravel, nails, pieces of wood, waste, etc. The table clearly shows that the waste is nearly double the amount of fiber remaining and almost four times higher than that generated by the shell. Yet it has the lowest power at 521 MW. The reason is that the humidity. The moisture content of 65% is too high. For each kilogram of combustible material, 2 kg of water will be evaporated. The combustion process is an evaporation of water for cooling, therefore it is not possible to maintain good combustion quality unless the empty fruit bunches (EFB) is treated to reduce humidity by another process before it is used to power generation.

Shells in the palm oil sector are based on the fractions after his nut was removed in the crushing process. They are also fibrous materials that can easily handle in large quantities directly in the line of products for final use. The humidity is very low compared to other biomass waste, which is has a bit more potential to generate electricity than EFB, although much smaller. Fiber has the greatest potential for energy generation which is about 1032 MW.

3.1.1.2 Paddy Residues

Crop residues are increasingly produce all around the world and are far from adequately developed. One of the common agricultural wastes is rice husks. It may be advisable to remove and use part of crop residues for energy production to made large quantities of cheap materials. Figure 3.2 shows the potential of producing electricity from rice waste.

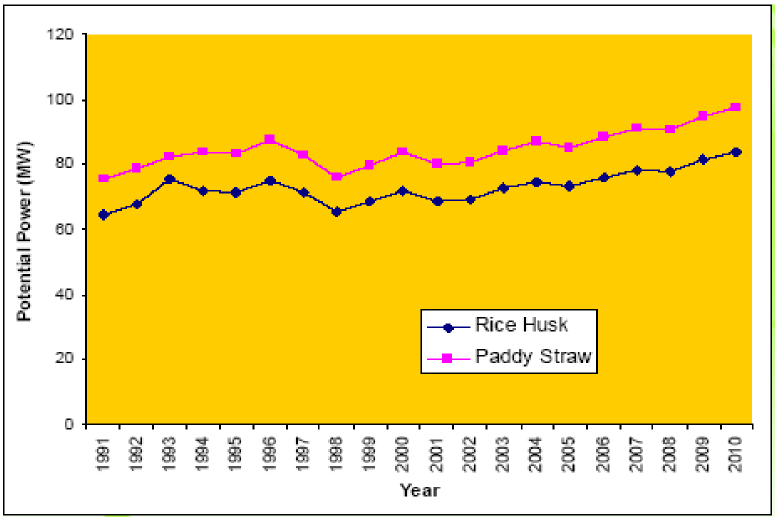

Figure 3.2: Production of potential energy from Paddy Waste

(Source: Biomass inventory report, Biogen project PTM)

Paddy straw and chaff of rice are the main crops from harvesting and milling generates. Even the potential is relatively high; consumption is still limited because of the problems in relations with the rice waste. Currently, only small amounts of rice husk use for power generation and other applications, such as silica production and compost. In general it can be assumed that only 2% of rice husk is used for the production of energy, such as the budget is deposited in landfills. The ratio of the products and the potential for generating energy from rice waste are shown in Table 3.5.

Table 3.5: Potential Power Generation from Paddy Residues
(Source: Biomass inventory report, Biogen project PTM)

Type of Industry	Production Year 2000 (Thousand Tonne)	Residue	Residue Product Ratio (%)	Residue Generated (Thousand Tonne)	Potential Energy (PJ)	Potential Power (MW)
Rice	2,140	Rice Husk	22	471	7.536	72.07
		Paddy Straw	40	856	8.769	83.86
TOTAL	**2,140**			**1,327**	**16.305**	**155.93**

Figure 3.2 and Table 3.5 show the potential energy that can be harnessed from paddy waste. Paddy waste is divided into two parts, rice husks and paddy straws. It can be seen that this graph is relatively flat with minor fluctuations from 1991 to 2007. It was a slight increase in the period 2007-2010, but it remains essentially the same amount of residue, as paddy production in Malaysia has reached its peak of production and land use. The only way out would be the production aspect of biotechnology. Due to the list of waste products, rice straw can produced little more power compared to rice husk. Total waste generated in the information for the year 2000 is 1,327,000 tons that is equal to about 156 MW of electricity.

3.1.1.3 Wood Residues

Wood is a major energy source in many part of world and has the potential in become significant renewable source of biomass energy. The wood can be burnt to generate steam or heat for cooking and also use in charcoal manufacture. There are three types of waste and the potential capacity figures for 2002 are shown in Figure 3.3.

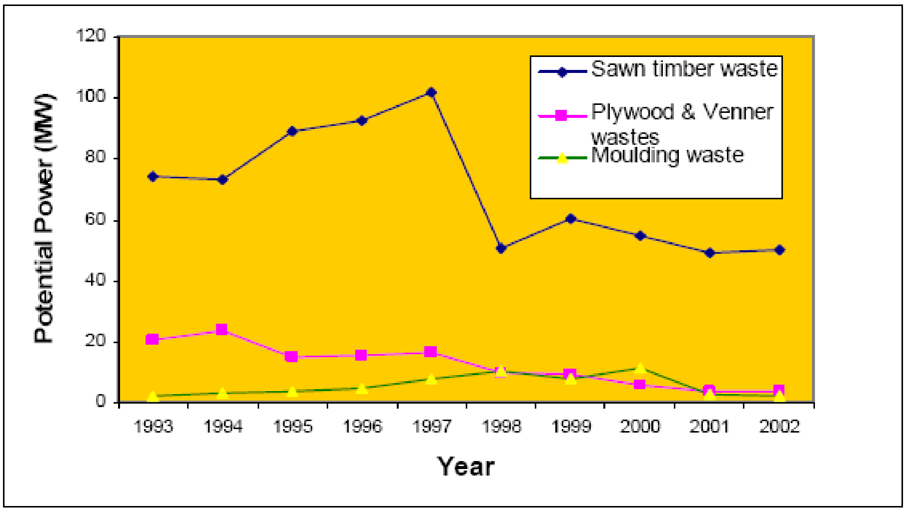

Figure 3.3: Potential of wood waste to produce energy

(Source: Biomass inventory report, Biogen project PTM)

As already mentioned, the wood residue plays a key role in energy production from biomass. Venner compensated forms of waste and has very small potential market. The possibility of significant stated that only timber waste can be used. Possible reduction of about 100 MW in 1997 to less than 50 MW in 1998 because of environmental problems, where the intensity fell trees in collaboration with the government that have the right to protect forests and reduce the complicated process.

3.1.1.4 Municipal Solid Waste (MSW)

Rubbish that comes from products of vegetable or animal is biomass. Food scraps, grass clippings and leaves are examples of biomass residues. The materials of glass, plastic and metals are not biomass because they are made of non-renewable resources. MSW is a source of energy by the combustion of municipal solid waste in power plants or capture of biogas. Incinerators, waste are burned to produce steam, which can be used for heating or electricity. Figure 3.4 shows the percentage of mixed waste in specific areas.

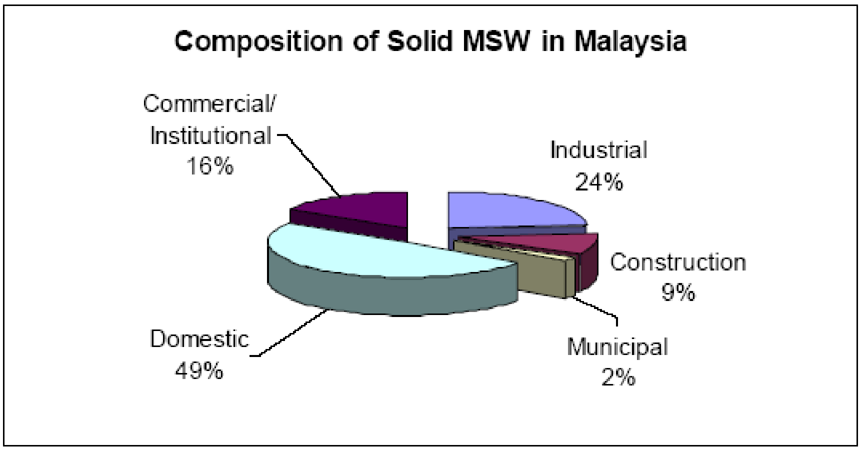

Figure 3.4: The composition of municipal solid waste in Malaysia
(Source: Biomass inventory report, Biogen project PTM)

Malaysia has experienced phenomenal growth over the past 10 years with the population growth has contributed to increase the amount of waste placed. A 2005 study estimated that the national average of waste amount about 0.5 to 0.8 kg/person/day, but rose to 1.7 kg/person/day in cities. Municipal Solid Waste (MSW), or better known as junk or scrap waste is also includes the majority of household waste, as part of the business. In Figure 3.5, it shows that domestic sector dominated sphere of municipal waste with almost 50%.

Durable goods, non-durable goods, containers and packaging, food wastes and yard trimmings, and miscellaneous inorganic wastes are the examples of municipal solid waste. [12]. These wastes are usually disposed of in landfills, but sometimes the causes of rapid accumulation of waste and the limited availability of landfill turn into a problem. To resolve this problem, solutions such as recycling need to be induced. In addition, another solution which also benefits in terms of potential combustion is incineration of municipal waste can produce energy, but the weight and volume of waste is reduced by 75% and 90% approximately [13].

Unfortunately, although preliminary studies conducted to evaluate the situation in many studies, there is still no conclusion have been published. The biggest problem in assessing this problem is difficulty to identify certain amount of waste produced in agriculture and industry because most of companies often unpublished the detail. They are also reluctant of openly communicate knowledge, as they can influence the future. Therefore, extensive researches need to be done to study the available of MSW in Malaysia. As a result, the right technology can be adopted in the future.

3.1.1.5 Biogas

Biogas typically refers to bio fuels or natural gas that contains mainly methane and carbon dioxide. They can be made from waste under anaerobic conditions. Malaysia is one of the areas used for the production of biogas and it can be produced in landfills. Landfill gas is produced from organic waste in landfills. The waste is covered and compressed mechanically. The anaerobic organic matter decomposes it and will produce gas in the landfill.

Figure 3.5: TNB Jana Landfill Project (2 MW)
(Source: Background Report, Malaysia RE and Energy Efficiency)

Figure 3.5 shows the landfill project of the first linked to grid-connected in Malaysia, which were taken in April 2004. It has 2 MW capacities with the production of biogas waste. Several possible locations were also identified with a planned capacity of 20 MW in the future.

3.1.2 Cogeneration

Cogeneration is often referred as a combine heat power (CHP) that is the combination products of electricity and heat, which is used in industrial and commercial processes. CHP offers an effective way to meet the energy in the form of heat that is normally wasted, to be captured and transformed into beneficial usage. Cogeneration offers numerous advantages in terms of power. Its major contribution was to support the main electrical equipment and certain statements in the network. To achieve this goal, the benefits will be relieved, so that the tension can be reduced in lines. This can lead to the reduced of investment and maintenance, which are distributed to the existing structure to improve service and reliability and also cost.

In accordance with the objective of utilizing biomass to the optimal performances, the government had proposed a project by the name of Biogen, which is kept for the production of biomass from cogeneration. Like MBIPV program this project is also jointly by the Global Environment Facility (GEF), the Malaysian government and private sector financing. The main objective is to reduce emissions of greenhouse gases and will be continue until the waste resulting from the use of palm oil is produced, and to increase in the energy production and cogeneration sectors.

Within the program of small renewable energy (SREP), 22 projects were approved for the waste of palm oil, and five of them had signed a contract with the utility to deliver electricity. TSH Resources Project, based in Kunak, Sabah had been commissioned already. It has a production capacity of 14 MW, with 10 MW of utility are to be sold.

The development division in Malaysia is the main consumer of electricity. Therefore, the potential for cogeneration exists in this area are for internal use and/or national networks. Electro-industries such as electronics, steel, and textiles as well as fuel consumption, such as ceramics and glass sub-sectors can be utilize to take advantage of this option.

A series of case studies was conducted on some sort of areas and fields to get to know the feasibility of CHP sub-production systems to determine the future implementation. Subsectors, which were analyzed, are as follows:

1. Electronic equipment
2. Dairies, food factories, oil and sugar

3. Non-metallic ceramic and glass industry
4. Cardboard, paper, Paper mills, and pulp
5. Rubber gloves and rubber products
6. Stainless steel base
7. Bleaching, dyeing, finishing , and textile

The choice of these areas is based on the total consumption of fuel, extent of energy usage and by using natural gas in industrialized procedure. Other sub-sectors such as palm oil, timber, and oil are not included in the list for the reason that they already receive part of the operation or management of the energy efficiency of cogeneration in various stages of work. Many cogeneration options are included in the study to allow the finding of the technically feasible options for each item. Several CHP that is analyzed are:

1. Cycle gas engine or steam turbine cogeneration at the start of production of electricity as a large industrial area and a couple as a byproduct.

2. Steam turbine for combined-cycle higher electricity as main product and process steam as a byproduct.

3. Steam turbine cycle to remove heat from the exhaust to produce electricity.

4. Engine or gas turbine CHP topping cycle power generation in major countries for use in exhaust gas directly for heating and drying of industrial and emerging economies.

3.1.3 Development and Commercialization of Biomass Energy

In Malaysia, the share of biomass is focused on oil palm residues. It is estimated that the national contribution amounts to 90 PJ of biomass energy ($90x10^{15}$ J). The share of waste palm oil was 80%, while the use of other wastes completely ineffective. However, the energy potential of biomass is about 130 PJ, or 5% of domestic energy requirement [24]. The petroleum oil is composed of 93% of the national energy supply, and only 0.3% is from fuel wood [25].

Currently, there is not much of government policy for the development and use of biomass for energy production and cogeneration (CHP). The most significant development has been designed with the Fifth Fuel Policy under 8th Malaysia Plan in fuel 1998. It promotes renewable energy as the fifth fuel in the context of this policy, which was particularly projected renewable energy to supply 5% of domestic electricity in 2005. In 2006, the use of biofuel was introduced which is a mixture of 5% palm oil and 95% of diesel fuel in some vehicles own by the ministry [26].

Despite the opportunities for the development of biomass energy, there are many obstacles to the commercialization and application in the industry. Capital projects and financial power of biomass make it difficult to obtain bank loans because there is no trace of the experience of trust. Loan officers have no experience of the bank to provide loans for projects supported by the evaluation of performance guarantees. This may be the cause of energy service companies (ESCOs) to be for companies to develop energy projects have been successful. IPP has built a large number of plants in the country, but there is no information on its activities in the biomass. The IPP is preferably focuses on the other technology, especially natural gas [27].

Nevertheless, it is still responsible for the main players of the energy market in Malaysia. Tenaga Nasional Berhad (TNB) is currently a monopoly of electricity market. The Company does not give rise to biomass as a fuel for power plants and there is no indication to do so. However, the process of restructuring the energy supply market and the Ministry of Energy, Communications and Media is responsible for ensuring equal opportunities for renewable energy, if necessary [24].

Total consumption of energy from biomass is still in its infancy in Malaysia although has shown great potential resources of the country as shown in Table 3.1. It is still in development efforts to commercialize the technology. Collaboration and stakeholder participation are needed in the process of realizing the use of biomass in order to obtain an additional source of energy at the national level.

These factors have led Visdamax Sdn. Bhd, a manufacturer of boilers and furnaces based in Kulim to take up the biomass project that proposed by the Malaysian Technology Development Center (MTDC) funds. Universiti Sains Malaysia was engaged in study on the development of the power system, with the hope that the efforts of the event and the results open the way for experimental investigation of energy from biomass resources.

3.1.4 Conversion Technology

Energy from waste biomass specifically can be obtained by direct combustion or by conversion of valuable and useful forms of energy. Typically, it is added as an update of solids, liquids or gases, or products with a higher value for the chemical industry. Methods are available had been developed to convert waste into more useful and usable energy sources.

Their processes are divided into two main groups, living and non-living processes. Biological or wet process leads to the production of methane or anaerobic digestion to produce ethanol. The non-biological or thermal processes are particularly dry. Over the past two decades, the thermal conversion technology has raised a lot of attention worldwide because of its potential to turn waste into energy on a large scale and economically.

There are three main processes in incineration of solid waste which are pyrolysis, gasification and combustion of energy. Each process has several product lines. Primary products of thermal conversion process can be gases, liquids or solids. These products can be used directly as a feedstock for fuel, or may be used for further processing and are subject to the processes of secondary products such as high quality fuels or chemicals for production.

Use of this residue is only useful in technological applications in the remote rural area. This is beneficial for the rural population due to social and technological education in rural areas. Priority should be used as fuel; agricultural residues can compete with other sources to use for traditional applications such as animal, food, fibers, fertilizers, chemicals, etc. The basic strategy for the use of crop residues must be cleaned and transformed into value-added property, where they were later posted.

Biomass is usually characterized with high humidity and low density, and thus a relatively low calorific value. The energy content of waste depends on moisture content and also the residual oil content. In most agricultural residues, the size of garbage that does not change significantly due to the nature of the shape of the plant, which makes it easier to use and consume less energy wastage. The case would be different for the coal or municipal waste, where the physical and chemical properties similarity, is not homogeneous. There was little sulfur and most of them contain low ash than coal. By reducing the cost of removal, collection and transportation of biomass is the best use of local energy production from biomass, which processes must be thoroughly cleaned of biomass for decentralized energy production.

Biomass combustion engines are divided into four phases. First, the warming and drying takes place in non-reactive solid phase. After the liquid has brought the environment with increasing temperature in pyrolysis process, degassing takes place. Chemical deposition from liquid air and the flame spread during combustion is oxidized. Nonvolatile biomass can provide a significant portion of the total heat released during combustion. If the volatiles are on fire, then the char combustion takes place where oxygen can reach the surface of the char. There are two mechanisms that the rate of oxidation of the carbon mass transfer of oxygen on the surface and kinetics of char on the surface. The reservoir is formed from the ashes on the transfer of the combustion chamber.

History shows that the large direct combustion is used in rural homes. Currently, direct combustion of biomass is used in major industries of electricity and heat making it the best way to recover energy from waste. There are several combustion technologies in the market, but it sustainability depends on the ability of biomass properties. In general, the efficiency of combustion of biomass Malaysia tilted bed of combustion unit. The combustion phasing is used to improve emission standards. Combustion of biomass is composed of volatile combustion and char combustion. Therefore, the residence time of both types of engines is different. As a result, the design of the combustion chamber will be different for different types of biomass. The heat of combustion can then be used for drying, milling processes and increase steam to produce electricity. Industry intermediate direct combustion of wood, brick and stone, ceramics, tobacco, and also tea treatment of gum is used to dry other crops of agriculture and fisheries.

3.1.4.1 Solid wood fuel combustor

This is an important application in the development of biomass systems in recent years, particularly body rubber wood as fuel. In Malaysia, there are basically only limited local companies that produce solid fuel for the local market. Guthrie Industries Malaysia Sdn. Bhd manufactures a wide range of water [14] combustion system under license. The system was introduced in 1985 for the use of wood for drying sheets of rubber and cocoa. The burner is a compact device with a controlled burn in the first chamber. The gas is then reacted in the secondary chamber. Combustion chamber is completely smoke-free through the third cycle gas burner patented achieved without stains and odors. For the drying of cocoa beans used in the exhaust gas is burned in the heat exchanger tubes. To dry the rubber in the boiler, the exhaust gas is directly fired in the boiler (FD-series). The torch was used by the largest water industry, rubber and cocoa in the country for five years. Recently a great interest in direct fire with solid fuel burner preheated model with sliding doors to collect and model the intercooler heat / heat from eight different sizes from 315 MJ/h to 10,500 MJ/h.

3.1.4.2 Pyrolisis

Knowing the different technologies available thermal pyrolysis seems to explore and develop the full potential for the production of pyrolysis oil as liquid oil. When the liquid fuel oil is in a high energy density then it can be easily transported and stored. The oil can be burned directly to produce steam, or burned into high quality fuels in gas turbines, or alternatively converted the refinery plant. Oil quality and higher calorific value of diesel fuel can be used in internal combustion engines and the heat of another technical system. Thus, pyrolysis can be used to produce liquid fuels and can be considered as an important way of recycling the solid wastes.

The conversion process of biomass is called pyrolysis, without complete combustion, which is defined as the absence of air or a very limited amount of oxidant. They are used depending on the nature of the process, there are three products, char (solid), pyrolysis oil (liquid) or gaseous fuels with low calorific value. The process takes place in a reactor in which heat is applied to solid waste and separates the volatile components of the char residue. Volatile gases and condensation exists. They are cooled below the dew point to obtain liquid, and the rest is in gas form.

The type and relative amount of pyrolysis products depends strongly on the pyrolysis method and process parameters. Recent studies have shown that the most important operating parameters are residential settings, temperature while operate, heating rate, feed rate, particle size, pressure and the presence of a catalyst.

Besides chemical composition and physical properties, moisture and ash content of biomass was also determined the quality of products. More research is dedicated to find the ideal conditions and higher productivity as a better quality of liquid petroleum products is intended.

3.1.4.3 Wood Gasification

Gasification of biomass has the potential to clean gaseous fuel for combustion in boilers and internal combustion engines to produce electricity and heat. The coal is generally used instead of wood gases whose production is relatively free of tar and water corrosion.

Downdraft gasifier is a popular project that specifically removes tar and diesel for the uses as gas engines. The moisture in the upper part was driven by dry pyrolysis. To use the gas engine, the gas is passing through cleaning system, which is usually transmitted by the cyclone, bag filter, and gas refrigerators.

Currently, the integrated gasification technology is the biomass gasification combined cycle, where the gasification of coal, which has been designed with the use of, pressurized fluidized bed. In Malaysia, the wood is converted into gaseous fuels for electricity generation and the system is promising especially in rural areas.

3.1.5 Current Gap / Constraint and Marker Barriers

The main challenges in the design of biomass energy are associated with the improvement of model to reflect the dynamics of forests and agricultural and in the integration and the development of individual factors and equations for estimating biomass, evaluation of competition between the energy conversion of biomass and other applications, and also the development of multi-objective optimization models. In addition, social and environmental aspects are considered in order to face such things for example the loss of biodiversity.

3.1.5.1 Electricity Sale Price

Electricity pricing vary extensively from state to state, and might differ significantly from place to place in the country. There are several reasons that report for this difference in charge. The price of electricity depends principally on the category and the market price adjustment of fuel, government subsidies, government and industry rules, and even the local weather conditions. In Malaysia, it had been 5 years since the last electricity charge hike by government in 2006. Lastly, the new electricity rate tariff hike of 7.12 % effective from 1st of June 2011. Below the new tariff, domestic customers with monthly bills lesser than RM 34.60/month (usage<200 kWh/month) are not exaggerated by the tariff hike because the rate has been maintained at a highly subsidized rate of 21.8 cent/kWh in the past tariff reviews since 1997.

The present electrical energy tariff system allows for a Standby Charge to be practice to electricity consumers who desire to own a standby support supply to the individual in-house production. In the case of Peninsular Malaysia, the price is at the charge of RM17.30 for every kW per month for Firm Standby and RM8.50 for every kW per month for Non-Firm Standby.

3.1.5.2 Renewable Energy Power Purchase Agreement (REPPA)

Apart from the consequence of the natural gas price agreement, the growth of Renewable Energy powered electricity generation is also troubled with the set of provisions called Renewable Energy Power Purchase Agreement (REPPA), where the buy tariff and other business-related and legal obligations militate in opposition to successful implementation of the "willing-buyer-willing-seller" conformity. TNB in Peninsular Malaysia is just eager to pay not as much than RM 0.17 / kWh for RE generated energy under the "willing-buyer-willing-seller" theory of tariff negotiation, whereas the SREP developers have been unenthusiastic to agree to this price. In Sabah, a little higher RE price has been decided.

TNB's charge for Renewable Energy is assessed on the "avoided cost" theory. Such an avoided cost is essentially a subsidised rate since it is based on the subsidised gas charge of RM 6.4 per gigajoules. With no financial support of gas price, TNB's 'avoided cost' will be greatly high and TNB will have to pay a superior charge to renewable energy based power generators.

The normal gas price financial support for power production has noticeably reduced TNB's production expenses, and the subsidy works in opposition to the encouragement of Renewable Energy generated electricity. The gas charge for power production (RM 6.4/gigajoules) is fewer than half of the gas charge for industrials utilization (RM 13.22/gigajoules). These tariffs were put on the basis of an oil charge of US$20 for every barrel. At time, crude oil charge is more than US$40 for every barrel; the concealed gas financial support to the power division is even well-built.

Other REPPA circumstances such as for assured supply, in terms of energy (MWh) and power capacity (MW) are also quite burdensome when compared to the similar situation for huge IPPs. Electricity production from renewable energy fuels ought to be seen as harvesting of fresh power reasonably than as small-scale IPPs.

It correspond to the other obstacle that the utility wishes each developer to go through the whole set of legal, engineering and design, negotiations independently for each scheme, irrespective of their dimension or position. The utilities could support the production of Renewable Energy power generation by budding ‘standard’ engineering solutions for a variety of dimension of RE plant respectively to their nearness to the grid and also the supply voltage, and could make easy of the growth of ‘localised’ plant where the biomass dissipate is enthusiastic at basis (palm oil mill).

The last obstacle associated to the Power Purchase Agreement (PPA) is that they are based on the basis that the power plants are coal-fired. Introducing biomass would need the commercial organization and other effective feature like presentation principles of the PPA be reviewed. The IPP and the financiers are not likely to be in good deed of this. In observation of the PPA matter, co-firing can merely be practiced in the average term in active coal-fired power plants owned by TNB or in new plants for which the characteristic of co-firing can be integrated.

3.1.5.3 Subsidy for Conventional Energy

The employment of fossil fuels in Malaysia’s power sector has been and still subsidised. Subsidies defuse the effect from rising global oil charge on the domestic charge for diesel, and gasoline for transportation. Referring to conformity, natural gas for power generation and manufacturing utilization is subsidized until the last part of 2005. This conformity translates into electricity tariffs lower than real costs of supply for all customer categories.

According to the universal economic philosophy, subsidies will cause over-stimulation of order and consequently hasten the requirement for capacity extension, it creates unlevelled playing field for option fuels and it discourages more well-organized employ of power as well as electricity.

Policy makers' reluctance so far to eliminate the gas subsidy is comprehensible as local manufacturing requirements to struggle in the regional market for goods and investment. Nevertheless, a sustained provision of generous subsidies is also disagreeable as it undermines the skill of local manufacturing to rise up and about to competition if it means defending and perpetuating unproductive practices. Besides, higher (unsubsidised) fuel and electricity expenditure are well-built motivators to drive hard work in the direction of the production of electrical energy and other forms of energy from unconventional and renewable resources and towards extra well-organized employment of energy, and frequently result in actually lowering the expenditure of energy used for manufacture of goods and provision of services.

The existing government policy has encouraged the utilization of ordinary gas in industries throughout a very complimentary price system. Natural gas pipeline networks are obtainable in mainly of the country's main industries area, taking natural gas a practical alternative for most industries. Possible markets for biomass employ in industries are in direct competition with low-priced natural gas. Except if the natural gas charge financial support is reduced, the prospective marketplace for biomass will be in the smallest amount.

A steady decrease of natural gas price subsidies will influence the promotion and proliferation of Renewable Energy/Energy Efficiency in two ways: Primarily, reduced subsidies will give confidence to the implementation of RE/EE by contributing to the formation a stage playing field for Renewable Energy and Energy Efficient. Many RE/EE options can be efficiently and practicable than their conservative alternatives, however they are not being implemented for the reason that the present subsidies on natural gas that also caused to subsidised electrical energy tariffs. Secondly, the decrease of subsidies will free up government finances, which can be used to embark on precise support programmes for encouragement of RE/EE in the energy division.

3.2 Solar Resource Potential

Solar energy is a source that has great potential for theoretical. The quantity of solar emission captured by the Earth is more than three orders of magnitude and higher than that yearly worldwide energy utilization but for a number of reasons the definite potential of solar energy is something lesser [15].

3.2.1 Identification of Solar Energy Potentials

Malaysia’s location is within the equatorial region and its exposure to ample and constant sunshine of up to eight hours a day with average radiation of 4,500 KWh make it an ideal environment for the research and development of suitable PV technologies.

Photovoltaics (PV) are the renewable energy which is clean and does not emit greenhouse gases. It depends entirely on solar energy, which does not lead to exhaustion of energy resources, land use and biomass crops.

Photovoltaic system in Malaysia would give the production of energy from 900 to 1,400 kWh per year, depending on the location. The Klang Valley is defined as the lowest radiation, whereas near Penang and Kota Kinabalu are the maximum values measured. However, a fitting in Kuala Lumpur would give about 1,000 to 1,200 kWh per year which receives 30% additional energy than an equal scheme in Germany.

Regardless of the plentiful source, applications of solar energy in Malaysia restricted to mostly stand alone PV scheme, particularly for rustic electrification, where the costs of technology are heavily subsidized. Others slight applications comprise street, garden lighting, telecommunications and solar water heaters.

3.2.1.1 Time Variation

The quantity of solar energy obtainable at some point is focus to daily and seasonal variation. This allows maximum flow of solar energy on the surface of about 1 kilowatt per square meter per year on average for a low point from 0.1 to 0.3 kW per square meter, depending on location. On the diffusion of solar energy, more than 10.5 percent of capacity for integrated isolation variability of electricity requires energy storage systems for backup or to obtain a reliable source of energy.

3.2.1.2 Geographic Variation

The availability of solar energy also depends on latitude. Areas near the equator have more sunlight than in the Polar Regions. But the geographic variation can be reduced by using solar collectors of following the position of the sun.

3.2.1.3 Weather Conditions

Weather is another factor that influenced the availability of solar energy. Sunlight is often very unclear, which is lower than the average power density. So the large-scale production of solar energy will require substantial land.

The wide availability of solar energy varies by region, location, typical weather conditions and availability of land. With an estimate of these factors, the potential of solar energy in Malaysia is shown in Figure 3.6.

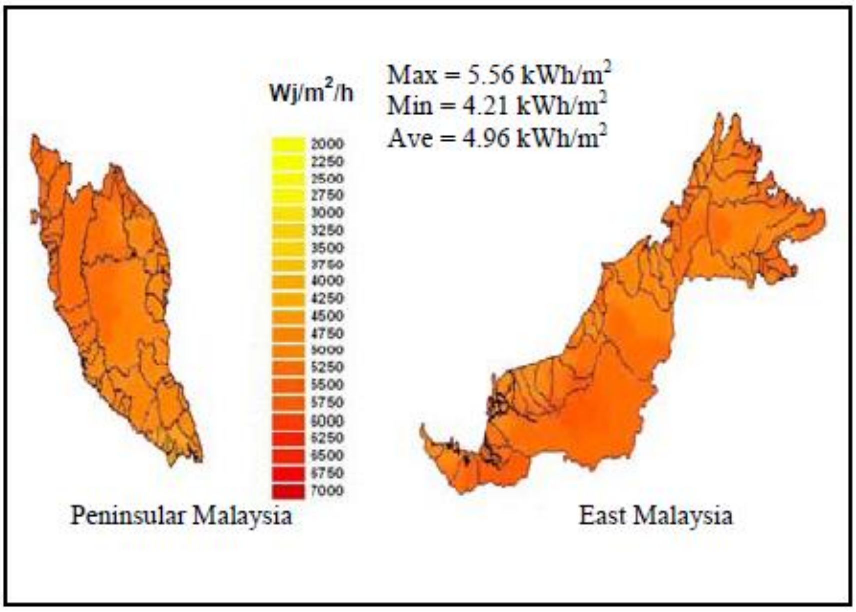

Figure 3.6: Annual average daily solar irradiation of Malaysia
(Source: Report on the national policy on renewable energy and action plan)

3.2.2 Development and Commercialization of Solar Energy

Malaysia is now moving forward in promoting solar energy to help the small group of homeowners to have photovoltaic systems installed in homes at lower costs. Below Suria 1000 as a part of the five-year Malaysian Building Integrated Photovoltaic (MBIPV) project, the owner can have bidding way to install photovoltaic systems in their homes. The auction has started at the quarter of the current cost of photovoltaic system at 4 KWp which is usually required for a house and installation now costs about RM 100,000.

General MBIPV Suria 1000 Programme aims residential and commercial area to have the ability to create new markets and BIPV give means of direct chances to the community and manufacturing to survive concerned in initiatives of renewable energy ecological defense. It is predictable that PV Company will lastly propose MBIPV scheme price corresponding to Europe and Japan. At the moment, the price of a 5kW is about RM25/W (less than USD7/W) including the turn-key roof-top system. Throughout this plan, it is projected than the MBIPV will reduce the cost at each subsequent year.

Table 3.6: Target MBPIV 'Suria 1000' program
(Source: Background Report, Malaysia RE and Energy Efficiency)

Years	Target BIPV Capacity	Min Target Cost Reduction	Reserve Bidding Price	Co-financiers (RM)
Year 1	100 kWp	5%	25%	Total Cost = RM27.5 Million
Year 2	300 kWp	5%	35%	• Min 40% by public
Year	300 kWp	5%	40%	• Max 50% by ST

3				
Year 4	300 kWp	5%	50%	• 10% by industry
TOTAL	**1,000 kWp**	**20%**		

3.2.3 Conversion Technology

The solar technology is widely used in residential and industrial. Forecast estimated of the market potential for solar energy in 2020 is shown in the table below.

Table 3.7: The estimated market for solar water heating in Malaysia in 2020 (Source: Renewable Energy in Malaysia (2003))

Type	Number of Establishment
Leisure Centre and Restaurants	553
Food	175
Hotels	250
Animal Food	43
Household (Medium & Upper)	500,000

As one of the world leader among the largest producers of computer chips, Malaysia has great potential for the production of photovoltaic wafers chip technology. In addition, photovoltaic inverters have been produced locally and it is cheap and easy to buy in the local market. It is therefore expected that the use of photovoltaic's to the grid may be a new business opportunities in Malaysia.

One of the most interesting technologies is the use of photovoltaic solar energy in buildings, or commonly known as Building Integrated Photovoltaic or BIPV. Thus, the structure of PV applications in the near future of the country will increase, in particular with the construction of building integrated photovoltaic or MBIPV project. This project that will be implemented by the Ministry of Energy, Water and Communications, is co-funded by UNDP and GEF. The main objective of the MBIPV project is climate and sustainable market for BIPV technology to create a farm operating costs and reduce driving.

3.2.4 Current Gap / Constraint and Marker Barriers

There are three main challenges of solar cells in Malaysia which are restricted consciousness, lack of capacity in restricted tune-up provider, and absence of political, fiscal and financial.

In the fifth fuel policy, it is a strong emphasis on energy efficiency (EE), with programs such as demand-side management (DSM), energy audits in government buildings (EAGB) and Malaysia industrial energy efficiency improvement project (MIEEIP). Solar energy is not really considered as one of the listed named as the fifth fuel. In May 2001, the government announced the launch of the SREP. Small hydro (less than 10 MW) which uses of renewable energy sources can be suitable in order to sell electricity to the utility grid system. Developers are forced to negotiate directly with the appropriate program in all aspects of the contract of electricity from renewable energy purchase, including sale price on an 'accepted and paid', 'willing-seller', and 'willing buyer' based.

Renewable energy producer license is granted for a period of 21 years from the date of launch of the plant. In this small program for renewable energy, the using of all types of renewable energy, including biomass, biogas, municipal waste, solar, hydroelectric and wind power are allowed. In order to coordinate the implementation of government policies to support development of renewable energy as the fifth fuel supply in the country, the Special Committee on Renewable Energy (SCORE), together with the Ministry of Energy, Water and Communications has been set up. SCORE is responsible for the assembly of small Renewable Energy Program (SREP).

RE was given the tax incentives in the form of tax exemptions and exemptions from import duties since the National budget 2000. The incentives are part of government efforts to implement renewable energy projects in the fifth fuel policy. Based on the state budget for 2002, solar energy is classified as a component of renewable energy, so it receives the same tax benefits as other fuels RE. Applicable tax incentives for photovoltaic are applicable until the year of 2005. Incentives for PV integrated in tax incentives for renewable energy in the following areas of allocation of capital taxes and duties and taxes waived. Tax relief is an effective tool to increase awareness among stakeholders to increase the utilization of RE.

It is important to determine for a good tax incentives for BIPV in order to raise public awareness and occupational structure. BIPV requires specially designed tax incentives that may be in the chain of implementation, particularly in the retail segment of the market. Unlike biomass, BIPV market segments are much smaller and has different market segment such as shopping centers and individual consumers. Therefore, the current tax rules and the budget are made in Malaysia, offering special incentives to promote and increase the share of BIPV. BIPV applications suggest that the segments of the commercial market and consumers can be more economical for BIPV and it is therefore necessary to develop incentives for both markets. Characteristics of tax incentives and financial mechanisms should be determined to encourage individual homeowners to consider PV treated as a part of the overall budget and the ability of small businesses to install an evaluation system.

3.3 Wind Energy Potential

The wind power is a rapid growing industry; referred as the new installation capital costs are projected to growth from $30.1 billion in 2007 to $83.4 billion in 2017. The wind continued to grow by 25-30% every year since 2000 and at least 93 GW in 2007 [16]. In 2007, the world had record of 20 000 MW of wind energy, which is corresponding to a total conventional power plants of 20 GW [17]. Wind energy converts kinetic energy of wind into mechanical or electrical energy then. Mechanical energy is used to replace the engines in rural and remote areas and is mainly used for pumping water. Wind turbines generate electricity for homes and businesses and to sell the media.

3.3.1 Market Potential

There are many projects lined up for the deployment of wind power generation. Pulau Perhentian was received two wind turbines of 100 kilowatts (kW) for installations in 2007. The project involves the installation and commissioning of two North Wind turbines from 100 kW photovoltaic systems which work in conjunction with the wind turbines to generate power. Solar and wind installation of the system will be integrated with isolated island of diesel engines in collaboration with the national public utilities. Support systems for controlling and monitoring wind data collection also are installed to create intelligent systems.

3.3.2 Wind Map of Malaysia

A brief study of previously obtained meteorological information indicates that the standard wind velocity in Peninsular Malaysia is fairly low and varies depending on the period. The locations with maximum wind velocity in Peninsular Malaysia are typically situated in the East Coast areas, such as Kota Bharu, Kuala Terengganu, and Mersing. The wind velocity information also indicates that Mersing is the most potential spot of wind resource.

The East coast is likely the most excellent wind location in Peninsular Malaysia as the tough North-east monsoon reached the coast area first. The North-east monsoon mutually with the South-east monsoon form leading winds in Peninsular Malaysia. Nevertheless, the wind is stronger for the north-east monsoon since the South Sea has no barriers to the wind before reach the east coast, and weaker monsoon winds in South-West of Sumatra as a result from the work as a barrier against the wind before reaching the west coast. Thus, the highest wind speed during the north-east monsoon is from November to April, while the wind speeds slower than the southwest monsoon from May to October. Both monsoons are landed in the coastal areas first before being admitted to the inner zone of the influence coastal area. Hard landing of the northeast monsoon on the east coast, so these areas can be predicted with a maximum wind speed.

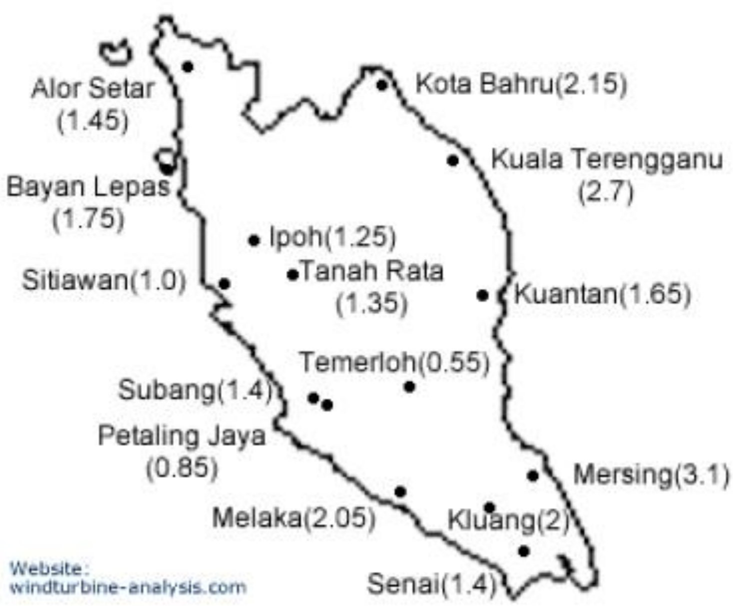

Figure 3.7: The annual wind speed of 18 meteorological stations in Malaysia (Source: website: windturbine-analysis.com)

Region of maximum wind speed is in Mersing for the Peninsular Malaysia and then in other regions of the east coast, such as Kuala Terengganu and Kota Bahru. These predictions are based on the statistics of wind speed from 18 weather stations based on 1984 and 1985. All information is collected for an hour, but the amount varies from place to place anemometers. However, no change of wind speed has the highest rate since the size is small, resulting in a large difference in speed. In addition, some of the anemometers' peak is not determined. The statistics of wind speed in the figure above shows that the three main beaches which the wind is in utmost speed were originated from east coast. These areas are Mersing, Kuala Terengganu and Kota Bahru with the wind speed of 3.1 m/s, 2.7 m/s and 2.15 m/s, respectively. The west coast and the interior made of low wind speeds, typically less than 2 m/s.

3.3.3 Development and Commercialization of Wind Energy

Currently, most wind speed turbines will drop under two main categories: horizontal axis wind turbines (HAWTs) and Vertical Axis Wind Turbines (VAWTs). HAWT systems are the earliest type of wind turbines developed; they include 12th century windmills used as mechanical motors for mills and also as water pumps in remote areas in the 19th century. Modern HAWT systems are more common in wind farms and are 3-balded with computer controlled motors. Today, HAWT have reached the design status where their major features (such as three-blade structures) have become standardized from supplier to supplier, due to a combination of factors such as aesthetics, dynamic stability and optimum cost versus power generation. HAWT systems have a number of advantages and disadvantages.

HAWT system advantages: Variable pitch of blade to give the turbine blades the best angle of hit and thus maximize power generation, tall tower bases to allow access in sites with significant changes in the wind and higher competency as the leaves/blades always perpendicular to the wind, thus the energy was provided by all transactions.

HAWT system disadvantages: Hard in the view of transportation due to the dimension of the blade and tower (transportation typically incurs 20% of the price of the HAWT system), massive support infrastructure for installation of towers, turbines and large gearboxes (cost also incurred from rental of specialized cranes and specialized crew), visually obtrusive and can interfere with radar systems and certain variants suffer from fatigue and high stress.

There is significant interest in the development of wind power in Malaysia. Malaysia is a tropical country with a relatively windy climate, making the deployment of wind speed turbines as a basis of power in Malaysia. However, certain factors such as the geography and economic constraints limit the number of wind turbines that can be deployed, and thus any deployment must be made after careful study of site-specific details. In Malaysia, the use of wind turbines has already been successfully demonstrated with the utilization of a 150 kW wind turbine in the Terumbu Layang Layang.

3.3.4 Conversion Technology

Due to R&D hard work throughout the precedent 30 years, wind energy translation has turn into a dependable and aggressive means for electric power production. The life span of current wind turbines is at present 20-25 years, similar to many other conservative electricity generation technologies. Standard accessibility of profitable wind turbines is at present approximately 98%. The rate of wind energy sustained toward turning down through technological development, amplified production level, and the utilization of larger turbines.

The major mechanism of a typical wind energy translation scheme includes control systems, generator, interconnection apparatus, and wind turbine. Today moment as well as for the close outlook, wind turbine generators will be induction generator, permanent magnet synchronous machines, and synchronous generator, as well as the wound rotor category and squirrel-cage category. For the windmills in the ability of small and medium-sized enterprises, squirrel-cage induction generator and also permanent magnet generators are commonly worn for the reason of their reliability and economy reward. Wound field Synchronous generators, permanent magnet synchronous generators and induction generators, currently in use with the different strong power wind turbines.

Wind Energy Conversion Systems (WECS) plays a role to change the energy in moving air (wind) to electricity. The basic idea is very simple and exists in the region for centuries: Wind offers a kind of a knife set that is mounted on the shaft to rotate freely. Fins characteristic of the blades that strike by winds will generate electricity, and this rotational kinetic energy can then be used for each of the different objectives (in the past, things such as pumping water, mills can move and rotate, etc). In the area of wind farms, power generator shaft converted the rotation kinetic energy into electrical energy.

3.3.5 Current Gap / Constraint and Marker Barriers

The main problem with wind energy is the lack of local knowledge, availability of spare parts, transportation and the management of energy efficiency.

3.4 Small Hydropower Potential

Hydropower was used in energy production since 1900. There was a record stated that the first dam was built on a river near Raub, Pahang in 1900. It was constructed by the mining companies from Australia. This plant was still in operation today. This source had been utilized by Tenaga National Berhad (TNB), which accounts for 20% from the total production capacity. At the end of 2001 there were 12 large dams (10 plants in Peninsular Malaysia, 1 in Sabah and the other is in Sarawak) and 50 small hydropower plants (36 of them is in peninsular, 5 in Sabah and 9 in Sarawak). Bakun project is an example of large hydro projects in Malaysia, with a total production capacity of 2.4 GW. The impact, however, had led to the social and environmental due to major floods areas.

Hydropower capacity in Malaysia is estimated at 25 GW, with a total production of 107 TWh/year. Currently there are 50 mini-hydro plants with an installed capacity of 200 kW to 2.2 MW with a total installed capacity of 38.85 MW. Most of the mini-hydroelectric plants in operation are funded by rural electrification program of Malaysia. These mini-hydro are extends to run the water systems of 500 kW to 1000 kW capacity. Currently 39 units are taken in a total capacity of 16,185 MW in operation in Peninsular Malaysia. Seven units with a total capacity of 2.35 MW were in Sarawak. In Sabah, it took five units with a total capacity of 5 MW. In Peninsular Malaysia, these units are owned by the energy utilities companies, Tenaga Nasional Berhad (TNB). The situation in the states of Sabah and Sarawak (northen Borneo), offers better opportunities for renewable energy, such as the level of electrification is relatively low.

It is estimated that Malaysia has 28,500 MW of hydropower (Asia-Pacific Development Centre, 1985). The mini-hydro power plant in Malaysia was built in the 80's as an element of government's rural electrification program. A total of 42 mini-hydro plants have been implemented and the range varies was from 50 kW to 2 MW with the total installed capacity of 17 MW. Progression of the country was redundant mini-hydro scheme as developer was provided electricity in rural areas through a network of national systems. The plants are neglected and in 1994, with only 9 out of 42 were in work operation.

Potential of small hydropower in the country are assessed and identified parties were alive. Some of these sites are run by public funds under the rural electrification program. They are based on run of the river systems and ranging from 500 kW to 1000 kW. Currently there are 39 units with a total capacity of 16,185 MW in Peninsular Malaysia, seven units with a total capacity of 2.35MW in Sabah and five units of 5 MW total powers in Sarawak.

3.4.1 Cost

Detailed costs for the micro-hydro power station ranges from 400-800 dollars per kW of establish power transmission, transportation and the construction one additional of 600-1200 dollars per kW. Costs are usually determined by the conditions of the area depends on the technology used, the specificity of transport and so on. At the international level, using the latest technology give the total cost of $1,500 to $2,500 per kilowatt of installed capacity, depending on system capacity and location.

3.4.2 Small Scale Hydro Power Turbine Technology

The Australian Michell or 'Banki' turbine is known as one of the easiest and well-organized types of turbines for small-scale. It is alike to the 'barrel' fan frequently seen in water vapor of air conditioning systems and also within a few small fan heaters for domestic use. Nevertheless this kind of turbines requires a high flow rate, high head, and high pressure to work. Other types of water turbine are Pelton wheel, worn in soaring stress scheme that include comparatively small surge rates however exceedingly high 'head'; Francis-category turbines for employ in upper flow rates and lesser 'heads'; and Tyson turbines that are mount on a raft to anchor in curving stream and worn at the very slow flow-rates. Down the skill scale are the water-wheels. These water-wheels are established and grown-up skill, even though at a straightforward design stage. They are capable to work in lower head and slow flow rate. Table 3.8 summarizes the criteria of the small scale hydro power turbine technology.

Table 3.8: Hydro Power Technology Design Specification

Type of water turbines	Pressure	Flow rate (liter/sec)	Head	Power
Michell or Banki turbine	High	High	High	<200 kW
Peltons wheel	High	Low	High	>10 kW
Francis turbine	High	Higher	Medium	>100 kW
Tyson turbine	Low	Very slow rate	Low	<3 kW
Water wheel	Low	Slow	Low	<5 kW

3.4.3 Current Gap / Constraint and Marker Barriers

Due to the position of dispersed and remote installations, logistics and communications were posed problems. The deteriorating condition of facilities and accessibility of the working was also in poor worse. A few constraints and market barriers are:

1. **Logistic and communication**

   The distance between headquarters and plants that range between 40 km-400 km will result in a significant loss of time in different categories of care. Distance from the station enables communication and is relatively conventional with mobile phones in some places that are virtually non-existent.

2. **Availability**

Access to most plants is to leave existing paths and logging, are harmful and dangerous to commuting in smaller vehicles. Landslides cause inadequate drainage which can give difficulties for them.

3. Deterioration of the plants

Mini-hydro plants are left alone on the line prior to a new direction. The main problems of the stations were associated with electromechanical equipment such as communications line failure, damaged wires and entrance blocked to the bay. The amount of waste in Malaysia's rivers make canals cooling clogged easily, and this will lead to overheating, transmission and hydraulic oil. Damage and lack of electromechanical devices and transmission lines were repaired and several changes to improve the generation are made.