ECONOMIC ANALYSIS OF THE POTENTIAL DEVELOPMENT OF SOLAR ENERGY IN MALAYSIA

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ABSTRACT
Nowadays, with the increasing of using renewable energy as an alternative sustainable energy sources in the many countries has put through an attention to Malaysia to seriously implementing this type of energy. Energy plays an important role for economic growth. The challenges facing in the conventional energy sectors such as uncertainty of energy cost, energy shortage, environmental pollution, energy supply in rural areas and green house effects have brought the solution to the usage of the renewable energy resources such as solar, wind and biomass energies. In this paper, the economic analysis of the potential renewable energy (RE) technology developed in Malaysia is presented. The economic analysis is presented by comparing the solar technology and conventional power generation. The case study shows the potential of RE can support power consumption and economical through reducing power generating cost.

KEY WORDS
Power economic analysis, renewable energy, solar technology, sustainable energy

1. Introduction

Today’s power industry faces big challenges from environment and economy. Energy issues and policies focused on increasing the supply of energy based on demands with minimal possible cost, safely and very less environmental impacts. Having a healthy supply and demand of energy is one of the main challenges. Energy plays an important role to the economy and society. Insufficient energy will create catastrophe to the country. In that case energy is the key in order to initiate the processes of economic development.

Energy demand is continuously rising due to the growing population and industrial activities. Today, world is facing a problem such as limitation of conventional energy resources. The utilization of fossil fuel energy resources has increased the impact on the global environmental issues such as CO₂ emissions that contribute to global warming and drastic climate changing. Besides that, the short age of the fossil fuel sources in near future made a hot discussion and warning alert in producing energy.

Sustainable energy can be regarded as all types of renewable energy (RE) resources. Malaysia as one of the developing country, which rich with RE resources is now tended to optimum the utilization of sustainable energy as part of energy producer. The failure to manage and use those energies will result in significant losses to the economy and energy sectors. The utilization of sustainable energy sources can solve the problem encountered with conventional power generation such as environmental issues, fossil fuel cost uncertainties and clean energy.

Figure 1: Diversity of energy in Malaysia to produce electricity

Figure 1 explains the diversity of energy use in Malaysia in year 2010. The graph shows that Malaysia almost depended on gas and coal to produce electricity until 2010, which 94% of energy in Malaysia supplies by conventional power plant (dispatchable generating sources). This fraction is not healthy in economy.
perspective point of view and gives a pressure to the economy. In 2013, Malaysia is targeting to use 45% of coal and 45% gas to generate electricity. Malaysia has sufficient reserve energy even though they are increasing demand on energy every year. Malaysia has 53.2% of reserve energy in 2009 but decrease to 44.8% in 2010 and it will continue decrease due to increasing of population and industrial activities [1]. Energy sustainability plays a big role in order to make sure there is no failure of production. Failure of production or major blackout gives negative impact to the economy.

Malaysia has a lot of potential renewable energy sources. These sources are free and friendly environmental. Malaysia has to unlock the potential of this energy and get benefit from it. Malaysia receives a lot of sun radiation and it’s very suitable for solar panel system. Malaysia also is one of the big players in palm oil industry; the waste from palm trees (bunch fruit) can be processes to energy, i.e., biomass energy. Due to free resources of these potential energies, it can give a high return investment in long term aims.

In this study, the potential of renewable energy source in Malaysia is discussed in terms of economic analysis perspective. This paper present show the usage of solar energy as a renewable energy source can increase the economy and decrease the depending at the conventional power plant.

2. Potential and obstacles of solar energy as renewable energy source in Malaysia

2.1 Potential of solar energy

Malaysia situated on equatorial region. The sunrise in Malaysia start on 7.00 am and sunset around 7.00 pm. Normally Malaysia receives effective sun irradiation around 6 hour per day and the sun irradiation average is 4.8 KWh/m²/day [2] as shown in Figure 2. The temperature range is between 23°C to 33°C, whereas, this range is suitable for photovoltaic to operate in optimum condition. To get optimum output the panel must be oriented to south with an inclination range between 5° to 15°.This inclination is allowed the rain to clean the panel photovoltaic. The solar energy technology can be determined as free operating cost power plant such almost no maintenance cost involved.

![Figure 2: Daily average solar radiation in Malaysia MJ/m²/day](image-url)[2]

In Figure 3, show that Malaysia receives average 1500kWh/m²/year to 1800kWh/m²/year of sun radiation. This data indicates that Malaysia has a big potential to optimum the solar energy technology. The detail of main cities received irradiation per day is illustrated in Figure 4.

![Figure 3: Average world solar radiation kWh/m²/year](image-url)[3]

![Figure 4: Solar Irradiation data in region in Malaysia facing true south kWh/m²/year](image-url)[4]
2.2 Obstacles of solar energy as renewable energy source

Renewable energy is a new chapter for energy sector in Malaysia. Thus, the development is not as quickly as other country but yet the incentive through this program is already begun. Solar technology has a great potential in Malaysia but the major problem is the unstable of weather. Weather plays a major role in solar power plant production. Another obstacle is the expensive of initial cost, and it takes 6 to 7 years to get back the return investments. Since the solar power plant can work when the sun rise, the availability is another issue in renewable energy. Solar power plant has availability maximum 30%, while a conventional power plant can give more than that. Furthermore, lack of skilled persons in this area and research has delayed the extensive development of this technology in Malaysia. On top of that, many Malaysian did not get good information of solar energy that made the development of this technology is still low. The depending with fossil fuel power energy make people stay in a comfort zone.

The solar panels need large space to install in the solar power plant, and it must be proper sizing and position angle in order to optimize the production. A solution or upgrading must be providing after the age of the system exceeds the life cycle of equipment. The selection place must be detailed considered in order to optimize the efficiency.

3. Economy analysis study case for RE power plant and Conventional power plant

3.1 8MW solar power plant at Pajam Negeri Sembilan

CyparkPajam solar power plant used 32000 of solar panels and 606 inverters, which had been spent the total cost of RM95 million with capacity of 8MW. It located at 26 hectare of land in Negeri Sembilan [5] that has considerably good solar irradiation per annum. It is estimated that most setup costing is in acquired PV solar as shown in Figure 5. The solar panels have a warranty up to 25 years and the systems are almost no maintenance required. In future, the possibility to generate 2100MW capacity of solar power plants is able to achieve by willingness to invest approximately RM 23.625 billion for initial setup cost, and will be taking about 6825 hectares of land. This is depicted in Table 1 for total estimated cost.

In Figure 6, the graft explains the return of investment for 8MW in 25 years at Pajam power plant. The fit in tariff (FIT) that has been introduced by government is 0.95/kW [6].The initial investment was high, but the systems generate income after 8 years and continue making profit with linear increasing profit. The average sun irradiation is 1500kWh/m² to 1700kWh/ m² at Pajam Negeri Sembilan. The power plant needs only RM38000/year for maintenance cost such as cleaning the PV panel, land cleaning and monitoring the systems. The maintenance cost is relatively low because the PV panel can be clean due to heavy rain in Malaysia. The power plant can generate more than RM 217.398 million for 25 years. The profit generated is by taking into account the panel output performance and the period of a life cycle of the components. The PV panels have a warranty for 25 years operated in 98% of output performance and 15 years for inverter [7]. The graph has shown a slightly deduction of profit at 15years (at 14 years = RM 78,872 million, at 15 years = RM 87,78million, at 16 years = RM 100,738million and at 17 years =RM 113,696million), taking into account an assuming of the cost for maintenances/upgrading the inverter. The total profit is equivalent to the factors as follows:

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1. This period of operating is taken due to the maximum possibility assured of the solar panel to produce an output power.
Total Profit = (∑ Esys × SI × FIT) – (CIN + CM)

Where:-

Esys = total power of system in kW
SI = average solar irradiation for one year
FIT = tariff of energy purchase
CIN = initial system cost
CM = cost maintenance

Since Malaysia has an extreme weather condition, the total profit result will vary through a year. Panel PV will operate with a minimum of 96% until 25 years of production and estimated to perform at 80% after 25 years. As a result, solar PV power plant can still be produced the energy even the life cycle of panel is over. However, it can be to reinstall the systems using new components/system since there is much profit has been generated during that period. An addition, with the technology is become advance, the cheaper system’s components can be produced in the future. The big advantages for the solar power plant are the system required very low maintenance and no CO₂ emissions.

3.2 JanaManjung coal fired power plant

Malaysia used conventional power plant since 20 years ago [1]. Malaysia chooses this type of technology because it’s cheaper at the initial cost and the most important is the availability and sustainable. Since the price of gas and coal increase rapidly each year (sometimes the price is uncertainty), the impact to economy can become unpleasant time to time. The generation of independent power producers (IPP) power plant in Malaysia was built in era 90’s and still working until present. The most problem in this power plant, it needs a lot of maintenance activities throughout a year to maintain the production.

The JanaManjung coal-fired power plant in Malaysia is now producing up to 2100MW at the initial cost of RM7.28 billion [8]. The JanaManjung power plant was built on 320 hectares of reclaimed on the island at Perak, where, it is estimated around 70%-75% of cost operation is come from the coal purchase [9] as shown in Figure 7.

Figure 7 shows the fraction of the cost involved for operating the JanaManjung coal fired power plant. To produce 2100MW, the JanaManjung power plant needs an average of 6 to 7 million tons of coal annually and most of the coal import from Indonesia and Africa regions. In early 2012, the market price for coal was $110 per ton therefore the source cost to generate the power plant is around RM2.2 billion per annum. The cost will be increased due to addition of power 1000MW unit to ensure energy reserve margin and it will finish in 2015. The cost given did not include the maintenance expenses that taken up to 20% until 25% of cost operation. The cost of coal is varied, and the price is very speculative.

3.3 Study case of operation cost for Solar Power Plant Vs Coal Fired Power Plant

Table 1: Table of cost comparisons for solar renewable energy with coal fired power plant.

<table>
<thead>
<tr>
<th>Item</th>
<th>Solar Power Plant</th>
<th>Coal Fired Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>power</td>
<td>2100MW</td>
<td>2100MW</td>
</tr>
<tr>
<td>Setup cost</td>
<td>RM23.625 billion</td>
<td>RM7.28 billion</td>
</tr>
<tr>
<td>Area</td>
<td>6825 hectare</td>
<td>320 hectare</td>
</tr>
<tr>
<td>Energy Source</td>
<td>Sun radiation</td>
<td>coal</td>
</tr>
<tr>
<td>Amount of source</td>
<td>1500kWh/m²-1700kWh/m²</td>
<td>6.7 million/year</td>
</tr>
<tr>
<td>Cost of source/year</td>
<td>RM 2.01 billion/year</td>
<td>RM 50.25 billion/25 years</td>
</tr>
<tr>
<td>Maintenance percent</td>
<td>0.3%-1%</td>
<td>20%-25%</td>
</tr>
<tr>
<td>Maintenance cost/year</td>
<td>RM 85.05 million/year</td>
<td>RM 547.284 million/year</td>
</tr>
<tr>
<td>Maintenance cost/25 years</td>
<td>RM3.02 billion/25 years</td>
<td>RM 14.3571 billion/25 years</td>
</tr>
<tr>
<td>Total cost of source+maintenanc e/ 25 years</td>
<td>RM 3.02 billion/25 years</td>
<td>RM 64.61 billion/25 years</td>
</tr>
<tr>
<td>Amount CO₂/year</td>
<td>-</td>
<td>24.5 billion lbs CO₂/sh ort ton</td>
</tr>
<tr>
<td>Amount CO₂/25 years</td>
<td>-</td>
<td>612.5 billion lbs CO₂/short ton</td>
</tr>
</tbody>
</table>

Table 1 explains the comparisons of the cost operation for two power plants. The fuel fossil price is the main burden for the conventional power plant. Approximately, about RM2.01 billion a year needs to spend to purchase the...
coal. This price was generating by average $100 per ton of coal, and the price can be higher due to market uncertainty prices. This cost increases reach up to RM50.25 billion or more for 25 years as compared to solar, i.e., zero. For the maintenance cost, more than RM14.3 billion need to be spent for 25 years for the coal fired power plant rather than RM3.02 billion for 25 years for solar power plant. The cost of maintenance will increases as the degradation of the equipment life in the power plant (such as electrical machines/motors, instrument meters, cabling, turbines, etc.). The total cost operation for conventional power plant is reached to RM 64.61 billion for 25 years. This analysis is omitted the labor cost.

4. Discussing on the Potential of Economy Growth through Renewable Energy Technology

![Graph showing RE potential](image)

Figure 10: The graph show illustration that how RE can generate economy and solve the energy issue

The potential in the development of solar power plants for energy supply in Malaysia can be highly concentrated since Malaysia has received a great amount of solar irradiation in a year. A high initial investment must be spent for this development and the return of investment will take some years for profit. This shows that the RE power plant is a long term profitable system.

However, factors of potential problems are also needed to take into account in appropriate view. Some concerns on season weather, unpredictability of cloud and nightly outages can be major contributed to the degrading the plant power output. In that situation, the technology on the energy storage and backup systems must be headway in regulate the power produce to the demand and grid. Another proposed system, the hybrid RE power plant can be introduced that taking the advantages for each RE involved in producing energy. However, the different economy analysis must be studied that take into account all possibility variables involved in each RE power plant. The problem on controlling the outputs into the grid system is also the concern to be detail concentrated. Figure 10 shows the illustration on renewable energy technology can relate to the economy by greatly reducing the depending on fossil fuel. The graft shows that billion of money can be saved if renewable energy is being implementing. The development of RE technology can solve the problem of energy sustainability. RE micro grid technology can supply and maintain to supply electricity to the local areas even though there is problem at major power supply. The main burden for fossil power plant is to make sure the availability of the main source to power up the power plant. 70%-75% of cost operation came from buying the sources; therefore billion of dollars are required in order to generate electricity. The price market of fossil fuel is not stable and speculative. The graph shows that, billion can be saved and economy able to growth due to decreasing the depending on fossil fuel. Imagine can be done, that one power plant need up to RM 2 billion per years to buy coal but renewable technology for example solar power plant, the sun radiation is free. The green graph is the result of the implementation of 3 factors which is energy sustainability, product efficiency and development of renewable energy. Product efficiency play an important role in energy efficiency for example LED lamp can produce batter bright of light with small ampere regarding the tube florescent lamp and many more appliances are being upgrade due to the research activity. Nowadays, there are a lot of product smart energy and friendly to the environment. This factor can solve the problem of energy sustainable. The smart grid system can monitor the supply and demand activity. This is very important to avoid major problem happen. The smart grid system will have a communication between RE micro grid and the major power plant as a result RE will play a major role to provide electricity and fossil power plant will be as a backup if there are insufficiencies energy occurred.

5. Conclusion

Malaysia spends a lot of money in order to make sure the electricity can be supply to the consumer. For JanaManjung, more than RM50.25 billion spends over 25 years to purchase coal. This cost not include another 30% cost operation that including the maintenances and labor cost. Solar farm need about RM24 billion in order to generate 2100MW and there is no cost to buy the sources; therefore billion of dollars are required in order to generate electricity. Malaysia had a great potential in reducing the depending on coal and gas by increasing the development of renewable technology. This so-called green technology can provide a good impact on the economy growth. Green technology makes sure the entire appliance work in smart condition as a result the efficiency energy will increase. Issue of sustainable energy will be solved and economy will growth because they no pressure to buy coal and gas. Malaysia can saving billion of money and yet still
produce healthy of energy. Conventional power plant still plays a major role since RE has a lot obstacle due to the intermittence and availability (in all day) factors. Solar also have problem with inverter efficiency and energy storage issue that need to be researched in order to optimum the production. Combination of RE and conventional power plant can make sure the efficiency and sustainability of power energy.

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