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Net Present Value and Payback Period for Building Integrated Photovoltaic Projects in Malaysia

Tze San Ong
Faculty of Economics and Management, University Putra Malaysia, Malaysia

Chun Hau Thum
Faculty of Economics and Management, University Putra Malaysia, Malaysia

Abstract

Photovoltaic systems (PV) offer a clean, alternative energy source that is very suitable in the Malaysian climate, and consistent with the peak production and high demand in power in Malaysia. However, the application of PV systems in Malaysia is still low. The objective of this research is to determine the total cost, price/kWp system, net present value (NPV), and payback period for PV project in Malaysia. All seven projects were selected and used for the analysis and named as Project 1 to 7. The findings from this research indicate that all seven projects show a negative NPV value and payback period is more than thirty eight years. Four projects even get payback period of more than fifty years. However, an interesting projection on the price reduction shows that a positive NPV is achievable if the price/kWp system reduced to RM11,000 and RM4,000 for government subsidized and non- subsidized projects respectively. The estimation on payback period is between four to eight years with the price reduction of 85% to 50% respectively from the current market price.

Global warming, climate change, environment pollution and demand for energy represent critically issues with a wide array of potential environmental disasters affecting people health and safety. These issues are opening up new opportunities for utilization of renewable energy resources like solar photovoltaic system (PV). PV system has been widely applied in many countries such as German, Spain, Japan, US, UK and Australia but interestingly the application is rather low in Malaysia. Al though Malaysia is a tropical country and located in the equator with sunlight all year round, the development of PV is still in small scale and at the beginning stage. This study is designed to find out the capital costs needed to install a PV system in Malaysia, and serve as a guideline for public when considering a PV system.

Keywords: photovoltaic project, net present value, payback period, Malaysia

Research Background

During the past decade, the world had realized that fossil fuels such as petroleum, natural gas, and coal, are causing tremendous damage to the earth. The emission of carbon dioxide and carbon monoxide by burning these fossil fuels will cause many environmental problems such as global warning, green house gases, and depletion of the ozone layer. One of the most severe environmental phenomenon is global warming that will caused melting of iceberg in north and south poles of the earth and resulted in increasing of sea level. With the increasing of sea level, the sea water will flood coastal cities and island countries. The United Nations-sponsored Intergovernmental Panel on Climate Change (IPCC) reported in 2001 that the average temperature is likely to increase by between 1.4°C and 5.8°C by the year 2100 (IPCC, 2001). An investigation on global warming in Malaysia carried out by Universiti Teknologi Malaysia (UTM) shows a similar result with the report of IPCC 2001. The mean annual temperature in Malaysia for the past fifty years (1951 – 2001) shows a significant increase, ranging from 0.99°C to 3.44°C which is fall into the range set by IPCC (Ng, Camerlengo, & Ahmad, 2005).

Figure 1 shows world population prospects from 1950 to 2050 done by United Nation Population Division in 2009. World population reached about 6.8 billion, up about 83 million from 2008. It is estimated the world population will reach 8 billion and 9.4 billion in 2025 and 2050 respectively (Nation, 2009). With this huge increase of world population, the demands for conventional fuels are also increase tremendously. Many Oil and Gas companies are exploiting conventional fuels rapidly to fulfill market demand. Some companies are force to go for deep sea exploration to search for fossil fuels but the cost of exploration is very high and the result is not guarantee. After spending high cost for drilling an oil rig, the amount of oil can be extracted is not guarantee and the cost of exploration may even higher than the revenue from selling this oil. With this rapid exploration, conventional fossil fuels are no longer enough to support human daily activities. Therefore, alternative fuel must be developed to replace or substitute conventional fuels before the fuels come to the end.

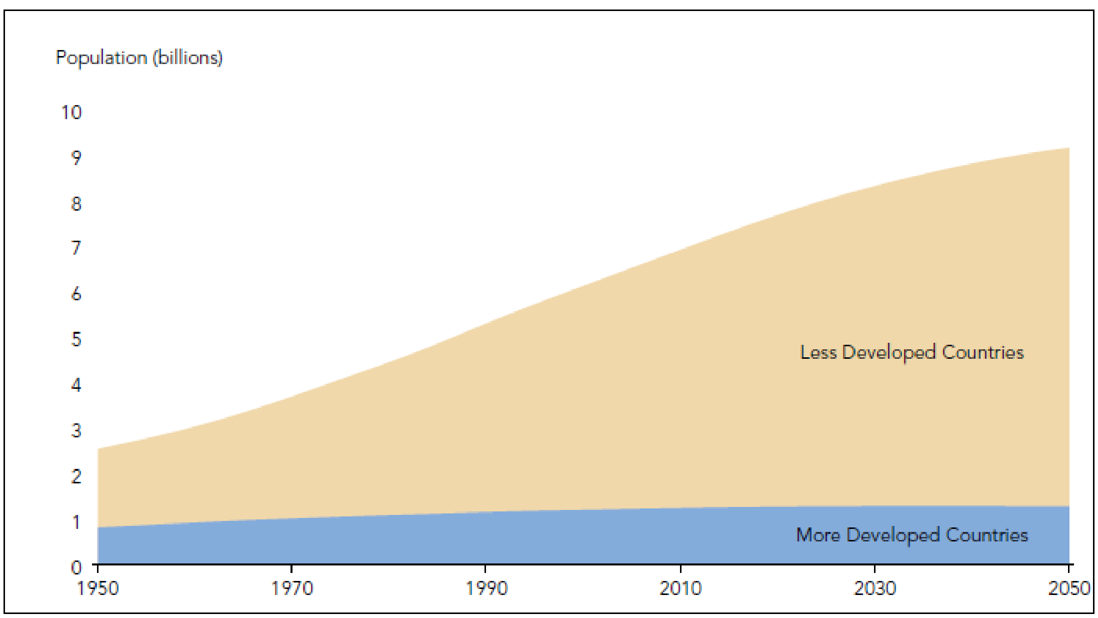

Figure 1: World Population Prospects from 1950 to 2050
(Source: United Nation Population Division, World Population Prospects, 2009)

These results proven that our country is no longer isolated from the consequences of global warming. Global warming is not only environmental phenomenon for developed countries but also a significant problem for developing countries. Proactive measures and long term planning must be taken to overcome this problem. One of the effective steps to reduce dependency on conventional fossil fuel will be using renewable energy, in particular photovoltaic (PV) technology. PV technology is one of the very effective solution to generate electricity available today (Maricar, et al., 2003) and this technology will not emit any green house gases while generating the electricity.

Malaysia as a tropical country has a steady solar radiation which is not seasonal in nature has a good potential for PV systems. However the applications of PV systems are still very low comparing to some developed countries like Germany, Spain, United States, and Japan. Table 1.1shows the cumulative of total renewable energy in Malaysia. For 2010, Malaysia is target for renewable energy of 350MW but Malaysia only able to achieve 53MW at the end of 2009 which is still far away from the targeted amount.

Table 1 and 2 show the cumulative total renewable energy and PV contribution to national energy mix in Malaysia. At 2010, PV only contributed 0.013% which is less than 1% to the national energy mix in Malaysia. Government of Malaysia is aiming for 1.5% for 2015 that will be contributed by PV generation. Figure 2 shows the PV market in the world in 2009. In 2009, total installed capacity for PV is 7.3GW in the world. European countries contributed the most with the amount of 77%, Germany, Italy and Czech Republic are the biggest contributors with 68%. Therefore, this study aims to investigate low popularization of the PV systems and identify the capital cost and maintenance costs for PV system. Then, payback period and net present value (NPV) will be determined for PV system in Malaysia by using the current feed in tariff proposed by MBIPV project group.

Table 1: Cumulative Total Renewable Energy in Malaysia

Year	**Cumulative Total Renewable Energy (MW)**	**Country Electricity Mix (%)**
2010 (target)	350	1.18
2009 (achieved)	53	0.18

(Source: The Start Online, Ang, 2010)

Table 2: PV Contribution to National Energy Mix in Malaysia

Year	**PV Contribution to National Energy Mix (%)**
2010 (achieved)	0.013
2015 (target)	1.500

(Source: Malaysia Photovoltaic Industry Association, 2009)

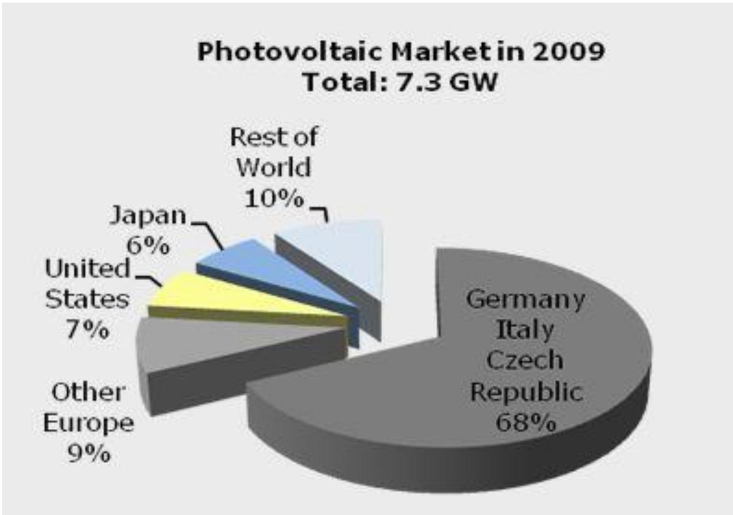

Figure 1: Photovoltaic Market for the World in 2009
(Source: Solarbuzz, 2010)

Research Objective

This study is motivated by the increasing of the electricity cost, depletion of the conventional fossil fuel, global warming caused by greenhouse gasses, and growing number of successful cases of implementation PV system in developed countries. Therefore, the research objectives below are designed for this study.

i. To identify the low popularization of PV system adoption in Malaysia.
ii. To evaluate all of the costs involved and price/kWp in implementing PV system in Malaysia.
iii. To examine the NPV and payback period for a PV system in Malaysia.

Scope of Study

The scope of this research is to focus on Malaysia which will involve building integrated photovoltaic system installed by residential and commercial users. This research will use quantitative where secondary data will be collected from Malaysia Building Integrated Photovoltaic (MBIPV) website to calculate all cost involved, NPV and payback period for implementing a PV project.

Definition of Photovoltaic

The term of photovoltaic is the combination word of photo and volt. "Photo" is derived from Greek word "phos," which means light while "volt" is commonly used as the unit of electricity. The used of "volt" definition is named after Alessandro Volta (1745-1827), a pioneer in the study of electricity and photo-voltaic is then translated as light-electricity (Maricar, et al, 2003).

PV panels are normally referred to solar cells or PV module which is used as converter. When solar cells are exposed to sunlight, it will convert the energy from sunlight into another form of energy which is electricity. The process of conversion will not involve any moving part, not require of conventional fuel, zero pollution, and able to last for decades with little maintenance and operational costs (Rahman, et al, 2008). PV systems are capable to produce electricity without any harmful effect to the environment.

Economic Analysis on PV System

There are several ways that can be used to determine the profitability of a project. The most common methods used to examine the profitability of a PV project are payback period, net present value, net cash flow (NCF), and internal rate of return (IRR). In this research, only NPV and payback period will be used.

Payback Period

Payback period is defined as the expected number of years required to recover the original investment. If all factors being held constant, project with shorter payback period is considering as better project because investor can recover the capital invested in a shorter period of time (Brigham & Ehrhardt, 2005). Besides, shorter payback period means greater project’s liquidity. Since cash flows expected in the distant future are generally riskier than near-term cash flows, the payback is often used as an indicator of a project’s riskiness.

However, there are some limitations by using payback period to measure the project’s effectiveness in an investment. The first limitation of payback period is it ignores any benefits that occur after the payback period and does not measure profitability. Payback period stresses on capital recovery rather than profitability. It does not take into account of the returns from the project after its payback period (Brigham & Ehrhardt, 2005). For instance, project A may have a payback period of 10 years whereas project B may have payback period of five years. According to payback period method, project B have shorter period and will be selected. However, it is quite possible that after seven years, project A gives return of 50% for another five years whereas project B stop giving returns after five years. Therefore, the payback period have its limitation when comparing two projects, one involving a long gestation period and the other yielding quick results but only for a short period.

Besides, payback period does not give any consideration to the time value of money. Cash flows occurring at all point of time are simply added and treated as equal value. It is contravention of the basic principle of financial analysis which promise compounding or discounting of cash flows when they arise at different points of time (Investopedia). Nevertheless, this research will still apply payback period method due to the ease of use and widely application despite recognized limitations.

Net Present Value (NPV)

Net present value (NPV) is applied in capital budgeting to analyze the profitability of an investment or project and this formula is sensitive to the reliability of future cash inflows that an investment or project will yield. NPV compares the value of money received today and the value of that same amount of money in the future by taking inflation and rate of return into account. NPV is based on discounted cash flow (DCF) techniques with three basic steps. The first step is to find the present value of each cash flow, including all inflows, outflows, and discounted at the project's cost of capital.

Secondly, sum up all of these cash flows, this amount is defined as the project's NPV. The last step is to determine which project to select. If the NPV is positive, the project should be accepted, while if the NPV is negative, it should be rejected. In some cases, two projects will show positive NPVs, so the one with higher NPV should be selected (Brigham & Ehrhardt, 2005).

Development of PV system in Malaysia

PV technology was introduced in Malaysia in the 1990s with consist of six showcase project with an average monthly consumption of 1500 kWh. The major hurdle to popularization of PV system is the huge initial capital cost and the absence of a feed in tariff which will ensure a reasonable payback period. In order to promote the use of PV technology in Malaysia, PTM started to launched Building Integrated Photovoltaic (BIPV) project to show grid- connected rooftop PV systems to the public. This grid- connected solar PV project continues to develop and to become a national BIPV program and named as SURIA 1000.

SURIA 1000 project is target to install 1000 roof-top, grid-connected PV systems with a total capacity of 790kWp. This project will provides financial capital incentives to both residential and commercial building owners to install BIPV systems in their premises. This program is based on bidding process which is opened to public every six months. The selection criteria of the recipients are based on lowest financial contribution (per kWp) requested by the bidders. Under this program, the maximum capital incentive reduces by 5% for each call starting from 75% for the first call to 40% for the final call once the quota has been taken up by investor.

This current price of PV system is about RM25,000/kWp and normally a double stories house will require 5kWp. Therefore, a complete PV system will require around RM125,000. For any investor who able to obtained 40% subsidy from government, investor still need to spend another RM75,000 for a 5 kWp roof-top PV system (Askar & Halim, 2009).

In Malaysia Budget 2010, Dato' Seri Najib Tun Abdul Razak, the Prime Minister of Malaysia announced the establishment of Green Technology Financing Scheme amounting RM1.5 billion as an effort to improve the supply and utilization of Green Technology. The scheme could benefit companies who are producers and users of green technology. For suppliers, the maximum financing is RM50 million and for consumer companies RM10 million. As a sign of commitment, the Government will bear 2% of the total interest rate. In addition, the Government will provide a guarantee of 60% on the financing amount via Credit Guarantee Corporation Malaysia Berhad (CGC), with the remaining 40% financing risk to be borne by participating financial institutions (PFIs). The Prime Minister also appointed National Green Technology Centre as the conduit for the Green Technology Financing Scheme (GTFS) application. The scheme is expected to provide benefits to 140 companies of which the application will commence from 1st January 2010 (Malaysia Budget 2010, 2009).

According to national renewable policy under 9th Malaysian Plan (2006-2010), government of Malaysia is planning to achieve generation of electricity by renewable sources by 300MW in Peninsular Malaysia and 50W in Sabah (Ninth Malaysia Plan :2006-2010, 2006). In 10th Malaysia Plan (2011-2015), government is planning to introduce Feed in tariff and setup renewable energy fund to encourage the implementation of renewable energy projects (Tenth Malaysia Plan: 2011-2015, 2010).

Malaysia's tropical climate has good potential for PV system. The annual average daily isolation for most parts of the country is between 4.55 and 5.41 kWh/m^2 as shown in the Table 3. The annual variation between maximum and minimum is about 25%.

Table 3: Monthly Average Isolation (kWh/m^2/day)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Average
Alor Setar	5.26	5.86	5.81	5.65	5.05	4.82	4.84	4.69	4.65	4.37	4.23	4.42	4.96
Georgetown	5.62	6.09	5.93	5.69	5.07	4.97	4.92	4.71	4.67	4.53	4.76	5.00	5.15
Kota Baru	5.14	5.95	6.23	6.28	5.54	5.33	5.35	5.30	5.42	4.76	3.98	4.24	5.28
Kuala Lumpur	4.79	5.37	5.42	5.27	5.11	4.98	4.92	4.87	4.88	4.76	4.36	4.17	4.90
Johor Baru	4.48	5.22	5.05	4.87	4.57	4.41	4.30	4.33	4.53	4.57	4.34	4.07	4.55
Kota Kinabalu	5.11	5.78	6.43	6.45	5.77	5.33	5.19	5.17	5.31	5.03	4.75	4.65	5.41
Kuching	3.96	4.36	4.69	4.99	4.87	4.93	4.84	4.87	4.68	4.59	4.48	4.16	4.62

(Source: Askar, Jagadeesh, & Halim, 2009)

Figure 3 shows the comparison of annual energy output between cities in Malaysia and other cities throughout the world. This finding gives a clear indication that cities in Malaysia have a very high energy output for rooftop PV installation. Among all the cities surveyed, Kota Kinabalu in Sabah has the highest PV energy output followed by Perth in Australia and Los Angeles in US. Other cities in Malaysia such as Penang, Kota Bahru, Kuching, Johor Bahru, Kuantan, Melaka, and Kuala Lumpur also have high potential for PV system which is more than 1000kWh/kWp.

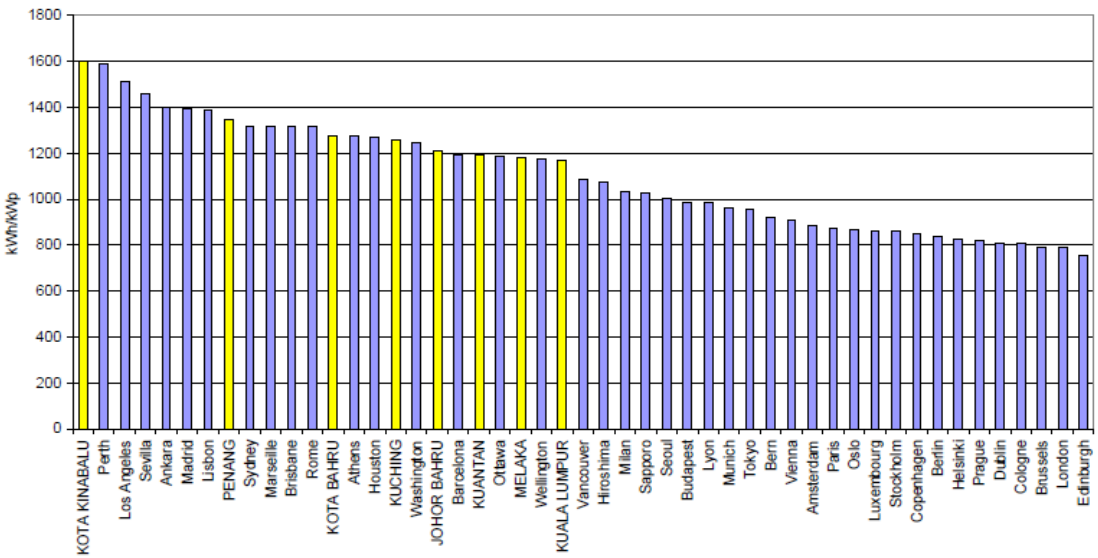

Figure 3:

Annual energy output of rooftop PV system
(Source: Askar, Jagadeesh, & Halim, 2009)

Figure 4 shows the average BIPV price/kWp from October 2005 to March 2010 in Malaysia. The prices are fluctuating between RM31,000 and RM19,000. The higest price/KWp was at October 2005 and lowest at RM19,120. In general, the price/kWp for BIPV is in the downard trend especially from 2008 to 2010. According to Kok (2010), the annual cost reduction for solar technology is 8%. Thus, the price of the PV module will continue to drop in future.

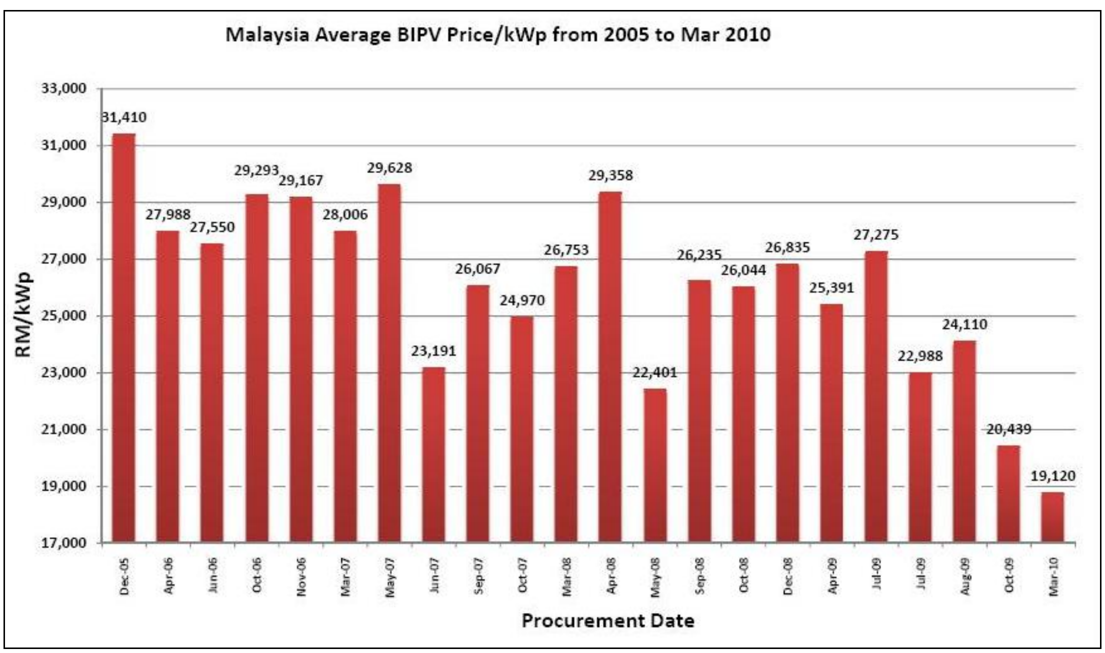

Figure 4: Malaysia Average BIPV Price/kWp from Oct 2005 to Mac 2010
(Source: MBIPV's Website)

Malaysia Building Integrated Photovoltaic (MBIPV) Project

In this research, majority of data are taken from MBIPV Project's website. MBIPV Project is a national building integrated photovoltaic project established under Pusat Tenaga Malaysia (PTM) or Malaysia Energy Centre with the objective to promote the application of BIPV and creating a sustainable BIPV market in Malaysia. This national project will specially focus on three major areas as below:

i. Policy and education
ii. Technical skill and market implementation
iii. Technology development support.

With this focus, MBIPV Project intended to induce long- term cost reduction of PV technology via integration of PV technology into building designs. However, starting from 13th January 2010, MBIPV Project was no longer associated with PTM and reports directly to the Ministry of Energy, Green Technology, and Water (KeTTHA) undersecretary of Sustainable Energy Division. With these changes, MBIPV Project has expanded from mainly focus on solar PV to all renewable energy including energy efficient policy. Now, MBIPV Project is acting as interim renewable energy team for KeTTHA that will provide consultation to the ministry on forming energy policy in Malaysia. Therefore, the data and information show in this website will be accurate and reliable for this research. The main report used in this research is the milestone report done by MBIPV Project group and the total number of reports used is seven, namely project 1 to 7 (Table 4). These projects are selected because they are building integrated photovoltaic projects in Malaysia with the purpose of demonstrating the concept of energy efficient by using PV technology to the public.

Table 4: Details of Seven Projects by MBIPV

No.	Name of Project	Date of Operation	Capacity (kWp)	Types of PV Modules
1	Energy Efficient Demonstration Bungalow, Bandar Tawik Kesuma Semenyih, Selangor	26th July 2006	5.25	Monocrystalline
2	Bungalow House at Taman Perkota, Bukit Sebukor, Melaka	27th June 2007	4.2	Monocrystalline
3	Bungalow House at Country Heights, Damansara, Petaling Jaya, Selangor	13th March 2007	4.0	Copper Indium Diselenide (CIS)

4	Damansara Utama Shoplots, Damansara Utama, Selangor	2nd February 2007	9.9	Monocrystalline
5	Putrajaya Perdana Bhd Head Wuarter, P16.	7th August 2007	11.88	Polycrystalline
6	Sri Aman Seceondery School, Petaling Jaya.	6th March 2008	4.4	Polycrystalline
7	Monash University, Sunway Campus.	12th June 2007	7.36	Amorphous Silicon

Total Cost of PV System

Total cost is the summation of all cost involved for an investment as show in below.

$$\mathbf{TC = C_{gen} + C_{inv} + C_{inst} - C_{sub}}$$

where

TC = Total cost of the PV system

C_{gen} = Cost of PV modules or solar cells

C_{inv} = Cost of inverter

C_{inst} = Cost of installation which included mounting structures, wiring, protective elements, electrical, mechanical and labour cost

C_{sub} = Amount of subsidy or incentive given by government

Net Cash Flow

The second equation will be NCF and defines as the net profit made in a particular year as a result of the investment. This net profit is the difference between the saving achieved in electricity bill and expenses incurred as a result of the investment. Below is the formula for profit made in year j.

$$\mathbf{NCF_j = (Cash\ input)_j - (Cash\ output)_j = P_{pv}E_{gen} - C_{O\&M} - C_{inv}}$$

where

NCF_j = Net cash flow in year j

P_{pv} = PV electricity tariff or feed in tariff

E_{gen} = Annual amount of PV generation

$C_{O\&M}$ = Cost of operation and maintenance

C_{inv} = Cost of inverter replacement for every five years

Lim et al. (2008) have applied the formula above under current Malaysia regulatory framework where PV generation is traded on a net metering basis. Net metering allows PV owner to connect the electricity generated from PV system and “store” on the TNB grid if they are not using at day when PV is generating electricity. Thus, it will reduce or offsetting part of the electricity that would have been purchased from the utility for the day. PV owner only need to pay the net amount of electricity bill after deducting on-site consumption and PV generation.

However, Malaysia main utility company, Tenaga Nasional Berhad (TNB) will not pay to PV owner if the PV generation is higher than on-site consumption. In other word, TNB will not buy back any surplus of the electricity generated by PV system. Any excess of PV generation in a particular month will be carried forward to the transaction of the following month. However, the expenses for PV system will be different over the years due to inflation

Net Present Value (NPV)

NPV is used to test the reliability of future cash inflows that an investment or project will yield. NPV compares the value of money received today and the value of that same amount of money in the future by taking interest rate and inflation into account. Ross(2010) defined NPV as the difference between an investment's market value and its cost. If the result of NPV is positive, a project should be acccepted. In contract, if the NPV is in negative, the project should be rejected. If NPV is equal to zero, there is no difference in taking or rejecting the project. Therefore, other capital budgeting techniwue will be used for analysis. Below is the formula of NPV.

$$\mathbf{NPV = -S + \sum_{j=1}^{N} \frac{Q_j}{(1+i)^j}}$$

$$NPV = -S + \frac{Q_1}{(1+i)} + \frac{Q_2}{(1+i)^2} + \cdots + \frac{Q_N}{(1+i)^N}$$

where
I = Discount rate = Interest rate + Inflation rate
N = Lifespan of PV system in year
J = Specific year for calculation

Payback Period

The fourth equation is payback period and it is defined as the amount of time required for an investment to generate cash flows sufficient to recover its initial cost. Based on the payback rule, an investment is acceptable if its calculated payback period is less than some pre-specified number of years (Ross, 2010). Below is the formula.

$$\textbf{Payback Period = Year before full recovery} + \frac{\textit{Unrecovered cost at start of year}}{\textit{Cash flow during year}}$$

ANALYSIS AND FINDINGS

NPV and Payback Period Analysis

Calculations of NPV are based on the energy yield from MBIPV milestone report and the electricity tariff from TNB's website. For domestic users like residential houses, the tariff used is type A. The tariffs are divided into two categories which are below 400kWh and above 400kWh as shown in Table 5. However, for low voltage commercial users like shop lot, office building, schools and university, the tariff are type B and it is also divided into two categories which are below 200kWh and above 200kWh as shown in Table 6. In addition, this study applied the estimation feed in tariff proposed by Ministry of Energy, Green Technology, and Water as shown in Table 7 but the final tariff will be enacted in Renewable Energy Law in 2011.

Table 5: Domestic Electricity Tariff for Malaysia (Type: Tariff A)

Monthly consumption	Consumption (kWh/month)	Tariff (RM/kWh)
Consumption < 400 kWh	1 – 200	0.218
	201 – 400	0.334
Consumption > 400 kWh	1 – 500	0.286
	501 – 600	0.378
	601 – 700	0.387
	701 – 800	0.397
	801 – 900	0.417
	901 onwards	0.446

(Source: TNB's Website)

Table 6: Commercial Electricity Tariff in Malaysia (Type: Tariff B- Low Voltage)

Monthly consumption	Tariff (RM/kWh)
Consumption < 200 kWh	0.37
Consumption > 200 kWh	0.397

(Source: TNB's Website)

Table 7: Feed in Tariff for Photovoltaic System in Malaysia

Feed in Tariff (PV)	RM/kWh
Installed capacity up to and including 4 kWp	1.23
Installed capacity up to and including 4 - 24 kWp	1.20

(Source: MBIPV's Website, Feed in Tariff FAQ)

Table 8 shows total cost used to calculate NPV and payback period. Annual maintenance cost for each project is estimated RM200 and assumed that the owner of the project will get a loan from bank to fund the installation of PV system. The average interest rate charged by bank is estimated 6% and under current Malaysia economy, the inflation rate is around 3%. The total discount rate is summation of interest rate with inflation rate and become 9%. Each PV system is assumed that it has a useful life of 21 years and replacement of inverter will be in every 5 years.

Table 8: Annual Maintenance Cost, Discount Rate, and Useful Life of PV Project

Item	Amount
Annual Maintenance Cost (RM)	200.00
Interest Rate (%)	6
Inflation Rate (%)	3
Discount Rate (%) = Interest rate + Inflation rate = 6% + 3%	9
PV System Useful Life (years)	21.00

Among these seven projects, five projects (Project 1 to 5) received incentive from MEWC to fund the installation of photovoltaic system and the remaining two projects didn't received incentive. After all the calculations, the results show that all seven projects get and negative NPV and the payback period is more than thirty eight. Four projects even get payback period with more than 50 years. The price/kWp system for PV project is fluctuating between RM24,969.55 to RM30,000 as shown in Table 9. Figure 5 and Figure 6 show the NPV and payback period in graphical form to provide better understanding to readers.

Table 9: Price (RM)/kWp System, NPV, and Payback Period (Actual)

Project No.	Price /kWp System	NPV	Payback Period (Years)	Incentive
1	26,466.71	-76,934.05	47.04	Yes
2	30,000.00	-71,756.38	48.08	
3	26,100.00	-54,372.90	38.90	
4	29,292.93	-175,521.98	>50	
5	29,627.88	-247,636.34	>50	
6	24,969.55	-92,380.67	>50	No
7	26,485.15	-172,068.50	>50	

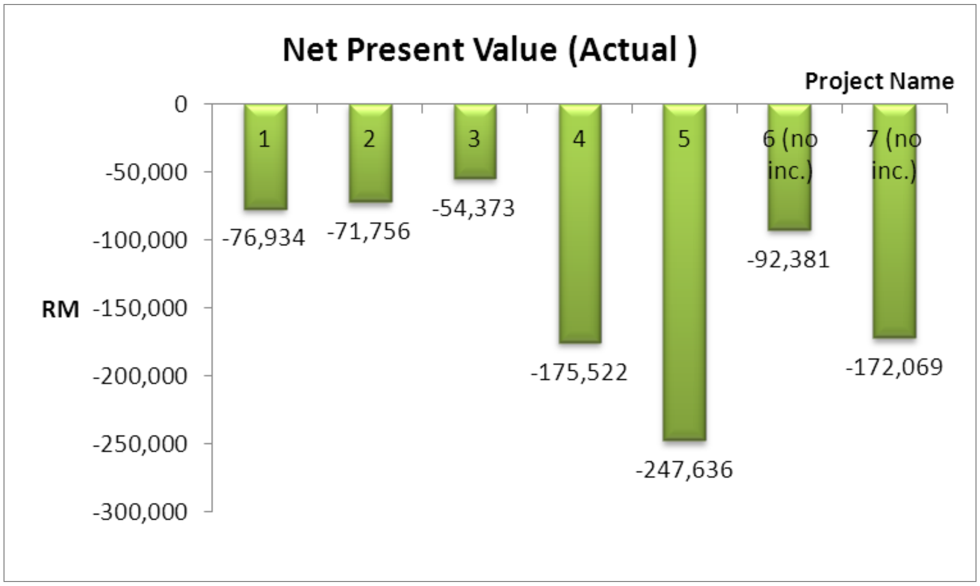

Figure 5: Net Present Value for PV Project (Actual)

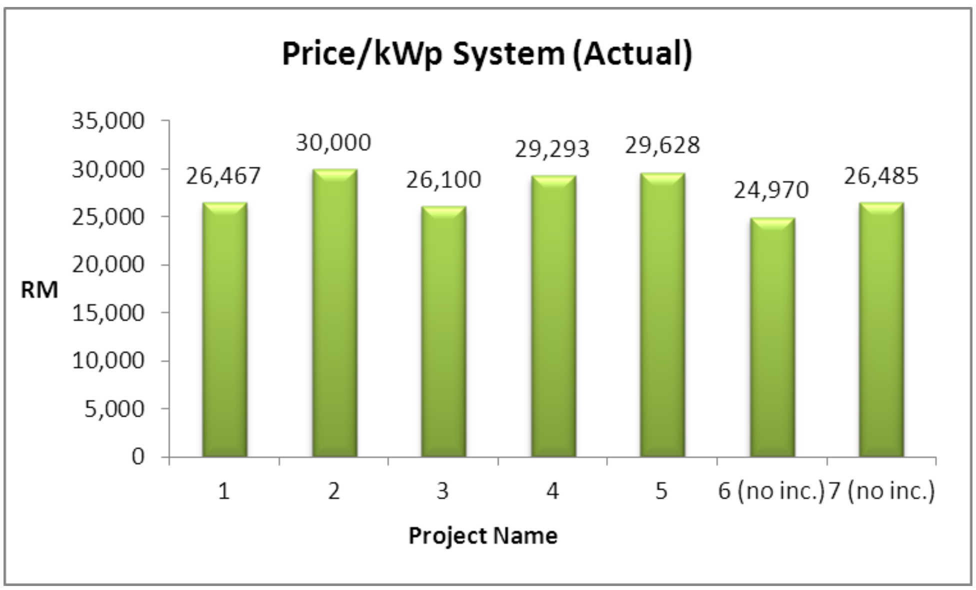

Figure 6: Price/kWp System for PV Project (Actual)

In order to get a positive NPV, a regression analysis is done for every project by reducing starting from 10% from the original price until it achieved positive NPV. For Project 7, 5% reduction from the original price is done to get more accurate price/kWp system. The summary of results is tabulated in Table 10. For Project 1 to 5 with the incentive from MEWC, the price/kWp system must reduced to at least RM11,717.17 or 60% from the actual price to get a positive NPV. For Project 6 and 7 with no incentive form MEWC, price/kWp system will be much lower which is at least RM3,972.77 or 85% from the actual price to get a positive NPV.

Table 10: Price (RM)/kWp System, NPV, and Payback Period (Estimation)

Project No.	Price/kWp Drop (%)	Price /kWp System	NPV	Payback Period (Years)	Incentive
1	50	13,233.36	2,659.78	7.98	Yes
2	50	15,000.00	395.49	8.44	
3	50	13,050.00	6,140.05	6.96	
4	60	**11,717.17**	24,725.58	5.75	
5	60	11,851.15	8,578.37	7.25	
6	80	4,993.91	9,477.88	6.45	No
7	85	**3,972.77**	4,203.01	4.46	

Figure 7 shows the minimum estimated price/kWp system for each project to get a positive NPV for PV project. Figure 8 shows the payback period when the NPV value is positive. This estimation of payback period in years is depends on the price/kWp system for each project. Larger price drop will get a shorter payback period while smaller price drop will get longer payback period. As for Project 7, the price/kWp drop should be at least 85% to around RM3,973/kWp for achieving positive NPV with payback period of more than four years. Since the price is dropped by 85%, the payback period will definitely be very short as compared to some project that only dropped by 50% and the payback period must at least eight years. Therefore, this estimation of payback period is between four to eight years with the price reduction of 85% to 50% respectively from the current market price. Figure 9 shows the contribution of PV module price to the total system price. Among these seven projects, PV module price contributed between 50% to 60% from the total cost.

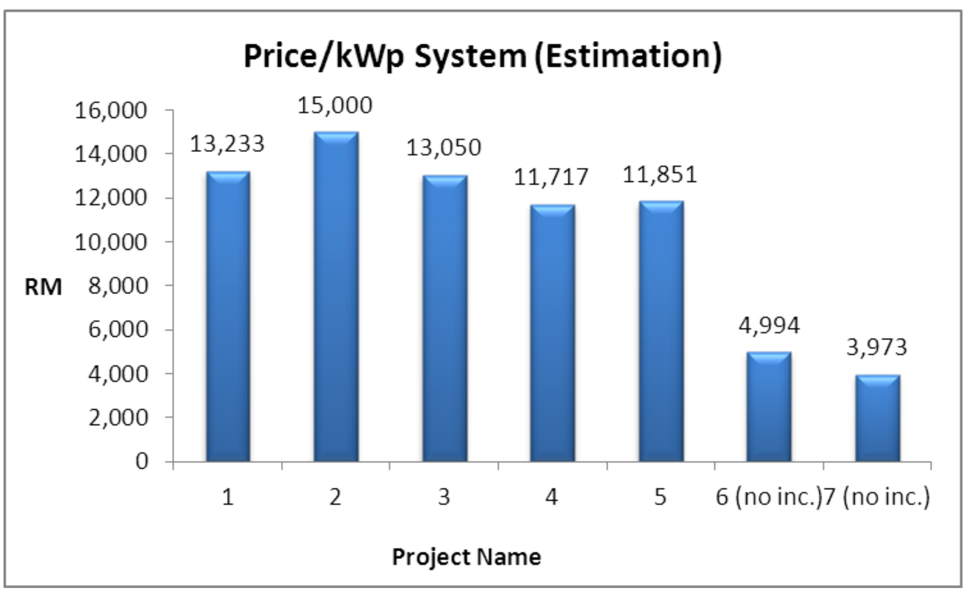

Figure 7: Price/kWp System for PV Project (Estimation)

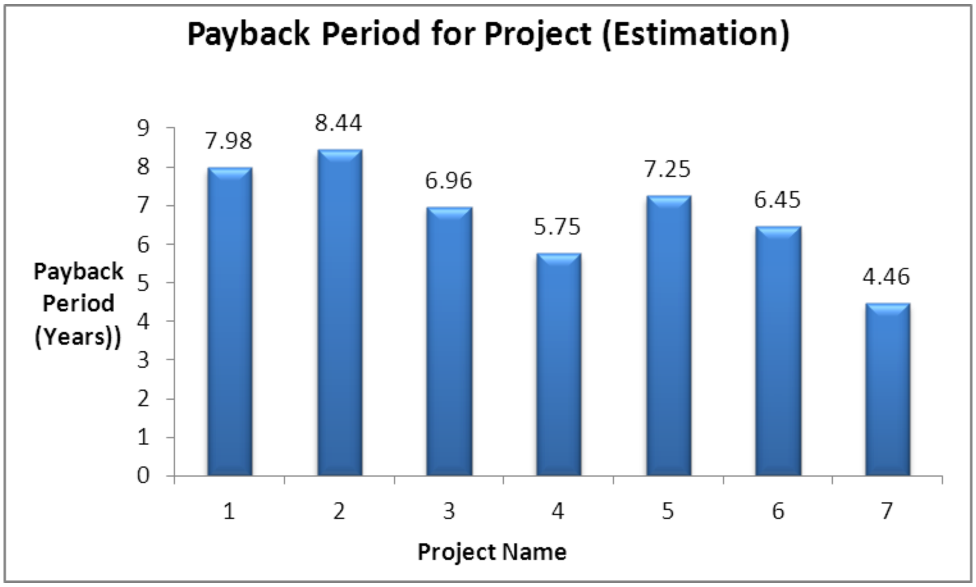

Figure 8: Payback Period for PV Project (Estimation)

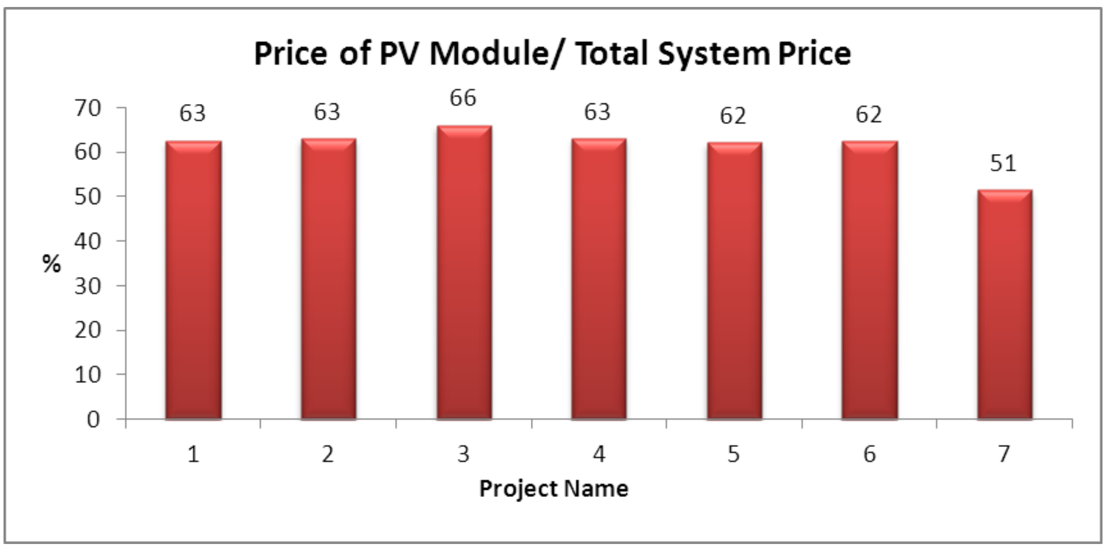

Figure 9: Contribution of PV Module Price to Total System Price in Percentage

Conclusion

This research shows that the price of PV project is highly dependent on the price of PV modules which contributed between 50% to 60% to the total cost for a PV project as shown in Figure 9. With the current price of RM24,000/kWp to RM30,000/kWp and feed in tariff between RM1.20/kWh to RM1.23/kWh, the owner of a PV system will not get a good return from the installation of PV system as all NPV show negative value. In addition, the payback period for the PV projects will be very long which more than thirty eight years. Therefore, if the owner of PV system is thinking of earning extra income from the installation of the PV system, this will not be a good investment at this moment.

However, if the price/kWp system is decreasing at the current rate as shown in Figure 2.2, the price of less than RM11,000/kWp and a positive NPV is achievable in future for government subsidized PV project. In contract, for PV project that didn't receive financial support, price/kWp must below RM4,000 and this will take longer time to achieve this rate. Furthermore, if the final enactment of Renewable Energy Law for feed in tariff increases to higher rate, a shorter payback period will be a reality. The higher feed in tariff will provides higher monthly income when the electricity generated from PV is sold to the utility company.

NPV for seven projects shows negative value and the payback period is more than thirty eight years. Four projects in this study even show the payback period of more than fifty years. As a result, if investors are thinking of making an extra income from installing PV system in either residential or commercial building, this is not the right timing yet. In contract, if an investor is thinking of helping the motherland to reduce emission of carbon dioxide and reduce global warming effect, renewable energy like PV system is a viable alternative and worth to pursue in Malaysia.

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Energy Efficient Demonstration Bungalow, Semenyih
(Source: MBIPV Milestone Report, Energy Efficient Demonstration Bungalow,Bandar Tasik Kesuma Semenyih, Selangor)