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Solar Electricity Market in Malaysia: A Review of Feed-in Tariff Policy

B. Bakhtyar,[a] O. Saadatian,[b] M.A. Alghoul,[b] Y. Ibrahim,[a] and K. Sopian[b]

[a]School of Economic, Finance and Banking, Business College, University Utara Malaysia, Kedah, Malaysia; bakhtyar11@gmail.com (for correspondence)

[b]Solar Energy Research Institute National University Malaysia, Selangor, Malaysia

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Malaysia's renewable energy (RE) feed-in tariff (FIT) (REFIT) is a new incentive for energy producers, the effects of which are unclear for investors. This study utilizes archival research method on existing Malaysian policies, plans, strategies, and action plans to present a comprehensive view of the solar aspect of the Malaysian FIT policy. This paper discusses Malaysia's REFIT scheme and the benefits of implementing the FIT policy in the solar sector. The Malaysian solar energy sector can preserve the country's oil and gas reserves, thus reducing carbon production and hindering environmental degradation. This paper examines the advantages and disadvantages of the Malaysian FIT model, and it concludes with an analysis of this design, with a focus on its implications for investors and for society. © 2014 American Institute of Chemical Engineers Environ Prog, 00: 000–000, 2014

Keywords: feed-in tariff, renewable energy, solar energy

INTRODUCTION

Malaysia is a tropical country that experiences a hot climate throughout the year. The average solar sunshine is approximately 12 h in most areas of this country [1]. The solar irradiance is between 1400 and 1900 kWh/m^2 per annum [2]. Thus, certain local parameters must be considered in the installation of solar systems in this country to harvest the maximum possible energy. In addition, Malaysia has a remarkable capacity for electricity generation from solar energy [3]. In 2012, the estimated amount of electricity production was 1 MW; however, its actual capacity can reach 6500 MW [4]. Expansion in the usage of renewable energy (RE) was suggested in the Eighth Malaysian Plan 2001 to 2005 for the first time [5]. Five RE sources, namely solar, wind, hydro, biomass, and biogas, were highlighted in the Malaysian FIT programme. In this Plan, 5% of the total energy production in Malaysia was supposed to be supplied by renewable energy [6].

During the development of the Ninth Malaysian Plan, i.e., 2006–2010, identified goals for renewable energy were maintained (300 MW for Peninsular Malaysia and 50 MW for Sabah) [7]. Meanwhile, the proportion of the five energy sources were delineated as follows: 56% for natural gas, 36% for coal, 6% for hydro, 0.2% for oil, and 1.8% for renewable energy [8]. Moreover, the Ninth Malaysian Plan stated that the amount of carbon dioxide emission must be reduced by 40% by 2020 (compared with the level of emission in 2005) [9].

In 2012, the efficiency of solar energy harvested from the sun has reached 40% in Malaysia [10]. Nevertheless, its production cost has decreased significantly [11]. By 2050, the price of energy generated from solar cells is projected to be less than that of the energy generated from fossil fuel or hydroelectric. That is, solar energy would cost less than $0.12 per kWh [12].

MALAYSIA'S REFIT SCHEME

In the 10th Malaysian Plan, the Malaysian government introduced new RE regulations, which included feed-in tariff (FIT) [13]. FIT aims is to reward investors whenever they generate electricity. If investors are found eligible of producing renewable energy, they would be allowed to sell electricity to the national security grid. This new regulation encourages people to generate energy in their houses through the use of renewable sources such as solar panels [14]. The 10th Malaysian Plan targets to generate 5.5% of the total energy by the end of 2015 [15]. REFIT is a new mechanism in Malaysia that is legislated under the RE Act, whose main purpose is to accelerate the production of RE [16]. This scheme guarantees the production of local RE for a given period [15]. FIT is a government strategy that accelerates the investment in RE in Malaysia [17]. The FIT law has a distinctive feature for four main renewable energy sources; namely, solar photovoltaic (PV), biomass, biogas, and mini-hydro. In fact, the FIT law is an incentive strategy that encourages the participation of investors in this sector to boost the country's economy [6]. Accordingly, the Malaysian government would pay the investors a certain amount per kWh of generated electricity. The amount earned by investors depends on the type of technology and the size of the system that they use for generating electricity. FIT guarantees a fixed amount of payment for a certain period from 15 to 21 yrs [15].

ENERGY TREND AND THE SOLAR ENERGY ROLE

In recent decades, energy consumption has increased rapidly in Malaysia. The curve for electricity consumption has shown an uphill trend during these years. Figure 1 shows the accelerated trend of electricity demand, particularly after 1992. In this period, electricity consumption is less than 30 billion kWh. However, from 2002 to 2010, this value ranged between 70 billion and 100 billion kWh (Figure 1).

However, the trend also shows that electricity cost has been increasing during these years, reaching up to

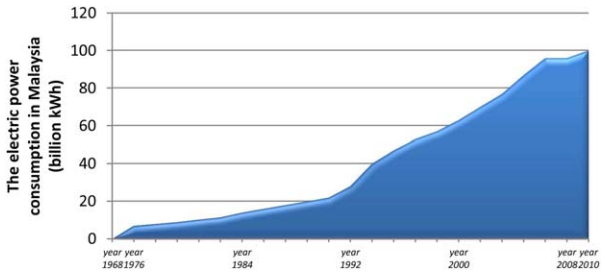

Figure 1. Electric power consumption in Malaysia from 1970 to 2009 [18]. [Color figure can be viewed in the online issue, which is available at **wileyonlinelibrary.com**.]

Table 1. Projected annual shares of the solar PV after FIT implementation [2].

Years	Solar PV	Total per annum (MW)
2011	9	219
2012	11	146
2013	13	178
2014	15	210
2015	17	232
2016	19	224
2017	21	231
2018	24	224
2019	28	218
2020	33	198
2030	280	282
2040	850	852
2050	1,350	1352

approximately US$ 0.70 per kWh from less than US$ 0.30 per kWh in the 1970s [19]. Nevertheless, the trend of energy use per dollar as a result of increased electricity consumption has slowly risen under oscillating conditions. The energy use in 1980 (kilogram of oil equivalent) per $1,000.00 gross domestic production (constant 2005 Purchasing Power Parity) was 180, which increased to 210 in 1998 and then decreased to 191 in 2010 [20]. Table 1 shows the annual share of solar PV in Malaysia after FIT was implemented in 2011 [21]. The share of PV in the total RE of Malaysia in 2011 was very small; however, by 2030, it is projected to cover nearly all of its RE supplies.

Enjoying more than a four-unit level of radiation (sunshine), Malaysia has a strong base for implementing solar energy [16]. Solar energy can be utilized in this country throughout the entire year. Figure 2 shows the formation and growth of solar PV among the renewable energy sources in Malaysia during 1999–2006, which shows the increasing trend of both RE and PV during the same time.

In the 10th Malaysian Plan (2011–2015), the government gave particular attention to solar energy. This attention, as well as the financial incentives (which support the solar industries), is the reason for expanding the use of solar energy throughout the country [14]. Malaysia's solar industry is expected to take an aggressive step toward significantly increasing the number of solar energy users, especially after the FIT policy is implemented. Figure 3 shows the plans of the Malaysian government for expanding the use of solar energy compared with that for other renewable energy sources during the period 2011–2050.

Malaysia's demand for electricity has significantly increased because of industrialization and increasing population. Highly fluctuating oil price and CO_2 emissions contrib-

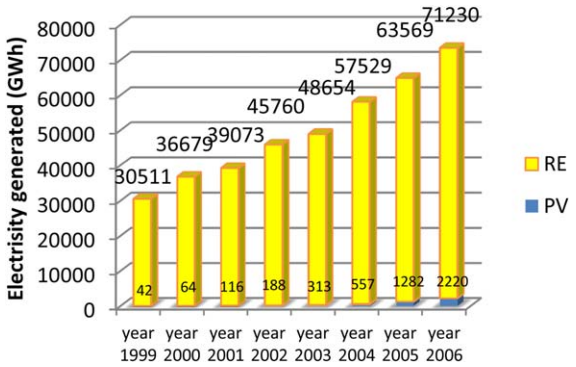

Figure 2. Growth of solar PV among the renewable energy sources during 1999–2006 in Malaysia [22]. [Color figure can be viewed in the online issue, which is available at **wileyonlinelibrary.com**.]

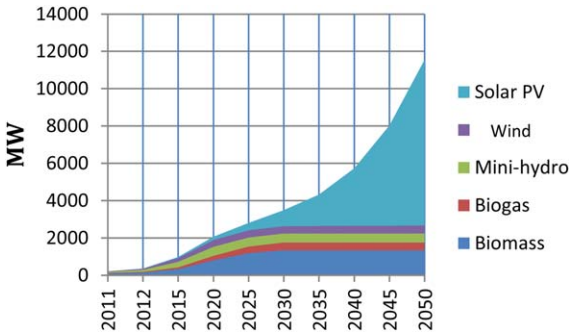

Figure 3. Malaysian trend in generating solar energy among the renewal energy sources in 2011–2050 [23]. [Color figure can be viewed in the online issue, which is available at **wileyonlinelibrary.com**.]

ute to the government's drive to use more renewable energy sources. The high potential of solar energy motivates the policymakers to use solar energy to meet the country's electricity demands. FIT is the main government policy for extending solar panels throughout Malaysia.

FLOOR PRICE ELEMENT IN MALAYSIA

Under the Malaysian National RE Policy and Action Plan, the FIT rate for biomass and biogas since 2001 has been pegged at RM0.17/kW h (US$ 0.052/kW h). This rate was revised to RM0.19/kW h (US$ 0.058/kW h) in 2006 and to RM0.21/kW h (US$ 0.064/kW h) in 2007. The FIT rates for solar PV are shown in Table 2.

Solar PV is one of the renewable energy sources that benefit from FIT; it has the highest tariff amounting to RM1.78 or US$0.95 [23]. This tariff is fixed for 21 yrs, whose degression is 8% per year (Table 3). This policy means the tariff rate for new registrants, through a mechanism called degression, would be reduced by 8% annually; however, the registered capacity would remain fixed for 21 yrs. Policymakers believe that such a degression rate creates a balance between current investment and cheaper renewable technologies in the future [23]; it will also annually decrease the cost of renewable electricity.

Despite the legislated FIT rate and related articles, only the solar PV FIT is being implemented in the country [6]. Many discussions has arisen on the rate of solar FIT, payback period, and required down payment for installing solar panels.

Table 2. FIT rates for solar PV [15].

Capacity of RE installation	FIT rate (RM per kW h)	Effective period (years)	Degression rate (%)
Installed capacity up to and including 4 kWp	1.23	21	8
Installed capacity above 4 kWp up to and including 24 kWp	1.20	21	8
Installed capacity above 24 kWp up to and including 72 kWp	1.18	21	8
Installed capacity above 72 kWp up to and including 1 MWp	1.14	21	8
Installed capacity above 1 MWp up to and including 10 MWp	0.95	21	8
Installed capacity above 10 MWp up to and including 30 MWp	0.85	21	8
Additional for installation in buildings or building structures	0.26	21	8
Additional for use as building materials	0.25	21	8
Additional for use of locally manufactured or assembled solar PV modules	0.03	21	8
Additional for use of locally manufactured or assembled solar inverters	0.01	21	8

Table 3. Proposed full FIT rate [23].

RE	Duration year	Tariff RM/kW h (US$/kW h)*	Annual degression (%)	Displaced electricity cost RM/kW·h (US$/kW h)**
Wind	21	0.23–0.35 (0.07–0.11)	1	0.22 (0.07)
Solar PV	21	1.25–1.75 (0.39–0.54)	8	0.35 (0.11)
Solid waste and sewage gas	21	0.30–0.46 (0.09–0.14)	1.5	0.22 (0.07)
Biomass	16	0.24–0.35 (0.07–0.11)	0.2	0.22 (0.07)
Biogas	16	0.28–0.35 (0.09–0.11)	0.2	0.22 (0.07)
Geothermal	21	0.28–0.46 (0.09–0.14)	1	0.22 (0.07)
Mini-hydro	21	0.23–0.24 (_0.07)	0	0.22 (0.07)

*Subject to final confirmation upon enactment of the RE law.
**Subject to tariff increment.

ECONOMIC BENEFITS OF FIT IN MALAYSIA

The effects of FIT on the Malaysian economy can be observed in the following five general sectors:

Creating Green Jobs

The Sustainable Energy Development Authority (SEDA) of Malaysia believes that by 2020, the country can generate at least 50,000 jobs from the construction, operation and maintenance of RE plants. SEDA confirms that FIT has an important role in RE booming in Malaysia [24]. This number of jobs is calculated with an assumption of 15–30 careers per MW in power plants [15]. A study shows that most of the new jobs require professionals with high capabilities to engage in the design, supervision, and personal service sectors [24]. According to the International Monetary Fund (2011), the unemployment rate in Malaysia is below 4%, which is regarded as quite logical and a natural rate for any country [25]; thus, FIT does not eliminate unemployment in Malaysia, but can direct unsustainable employments toward sustainable ones and toward green jobs [26].

Establishing FDI

According to the report by the United Nations Conference on Trade and Development, the cycle of foreign direct investment (FDI) in Malaysia coincides with the restructuring of the global trade in 2010. This figure has reached nearly US$ 10 billion in 2011 [27]. The majority of foreign investments in Malaysia are absorbed by the industrial sector and factories, and they represent approximately 54.9% of the total foreign investment in 2010. The service sectors absorb 34.1% of this amount [28]. In 2009, Malaysia was reported as the fourth (after China, Germany, and Japan) largest producer of solar PVs. This high production needed a large foreign investment. The huge investment enabled Malaysia to surpass Japan in 2011 and become the world's third largest producer of solar PVs [29]. One of the largest FDI figures in Malaysia is dedicated to oil and gas [30], which belongs to the energy sector. The last 5 yrs has been a successful period for Malaysia in attracting FDI, during which many branded solar PV and thin-film companies established their factories in Malaysia (Table 4).

Investors in the solar industry became attracted to Malaysia because of its different technology parks with new infrastructures and 15-yr tax exemptions. In addition to these incentives, solar companies are provided with a helpful banking and debt venture system, so that they can establish their factories or solar farms in Malaysia [32]. For instance, the RM2.3 billion project of SunPower, an American-based company, in Alor Gajah was financed by a RM1 billion loan from the Malaysian government [33].

Establishing a Safe Atmosphere Against Fluctuation in Fuel Prices

Energy prices have fluctuated significantly over the past decades, with those of the natural gas and electricity fluctuating the most [34], as shown in Figure 4. Although current crude oil price has decreased compared with that in June and July 2008, the intense fluctuation in oil prices threatens the economy of the industry.

Table 4. First group of foreign investors in the solar sector in Malaysia [31].

Company name	Original country	Location	Product	Total investment
First Solar	USA	Kulim Hi-Tech Park	Solar panel (thin-film)	RM2 billion
Q-Cells	Germany	Selangor Science Park II	Solar cells	RM5 billion
SunPower	USA	Rembia, Melaka	Solar panel	RM1.8 billion
Tokuyama Corp	Japan	Bintulu, Sarawak	Polycrystalline silicon	RM1.8 billion
Twin Creeks Technology Inc.	USA	Perak Hi-Tech Park	PV cells	RM1 billion
EQ Solar	China	Senai High Tech Park	Solar module & cells	RM1.7 billion
STX Corp	South Korea	Senai High Tech Park	Solar cells	RM1.5 billion
Bosch Solar Energy AG	Germany	Batu Kawan, Penang	Solar panel	RM2.2 billion
Solexel Inc.	USA	Senai High Tech Park	PV cells	RM2.8 billion

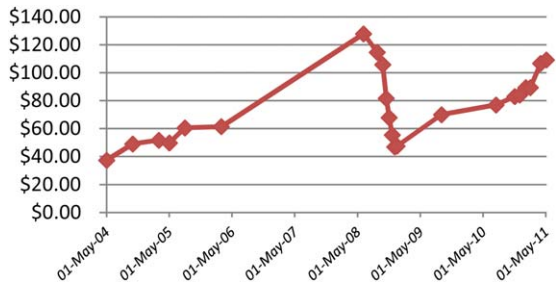

Figure 4. Malaysian crude oil price 2004–2011 [35]. [Color figure can be viewed in the online issue, which is available at **wileyonlinelibrary.com**.]

Figure 4 shows that Malaysian investors suffered from three severe price shocks in June 2008, September 2009, and April 2011. Expanding the solar PV industry in Malaysia and sharing the country's energy supply can provide a safer atmosphere against fluctuation in fuel prices and protect energy investors against oil price shocks.

Establishing a Safe Atmosphere for Investors of the Renewable Energy Sector

Energy investors search for four main factors: first, opportunities from all over the world; second, optimum strategy for developing national energy resources and reaping benefits; third, ensuring a secure and safe area for supplying energy; and fourth, reduced investment risk by enhanced geopolitical stability [36]. Every safe investment in the domain of renewable energy involves three phases: selection, control, and transformation phases [37].

By guaranteeing a fixed interest, FIT reduces investment risks in the Malaysian energy sector. The secured investment assists the stability of Malaysia's future economy. FIT specifies a roadmap (Figure 5) for continuing the development in the field of renewable energy, especially at the control phase. If the government ensures stability, the investors would achieve their main goals and would be assured of a reasonable investment return. Thus, FIT assures an atmosphere of return of investment as well as supply of energy in the country.

The Malaysian solar PV roadmap attempts to convince investors to use an optimum strategy to develop a national energy resource and consequently reap the benefits thereof. In addition, this scheme tries to ensure a secure and safe area for energy supply in Malaysia as a result of the government's determination to support the solar industry. However, this roadmap is dependent on geopolitical stability.

Conducting Economic Development

In the United States, FIT is considered one of the main principles in the policy making for renewable energies, which control economic development [38]. Manipulated oil prices and sanctions against oil producers have made the government aware that alternative materials or products should be considered to continue the economic development policies [39]. In this regard, Malaysia is not an exception [40]. With regard to the role of energy in Malaysia's development and the status of renewable energy, FIT can maintain some parts of the industry, including solar PV and its related industries. Since its establishment in 1974, Petronas has been the biggest petroleum company in Malaysia and has paid over RM403 billion taxes to the Malaysian government [41]. In 2008 alone, this figure reached RM67.6 billion, which accounted for 44% of the government's total revenue [42]. The total amount of taxes paid by Petronas in 1 yr is more than the total gross domestic product of six Malaysian states, namely Labuan (RM million 2,272), Perlis (RM million 2,890), Kelantan (RM million 9,273), Melaka (RM million 14,385), Terengganu (RM million 14,715), and Kedah (RM million 18,153) in 2008 [43].

Further, the oil and gas sectors produce 30% of Malaysia's total income, which is roughly equal to 8% of the annual gross domestic production [44]. Therefore, any disaster in the oil and gas industry would have adverse effects on economic development. The gradual transition of the oil and gas industries' shares, which are extremely vulnerable to political and external fluctuations, to renewable energies, particularly solar energy, would make Malaysia's economic development sustainable, efficient, and manageable in the long run.

MAIN DISCUSSIONS ON FIT

Given the infrastructures built in Malaysia, FIT's success in the solar sector mainly depends on the following factors:

Increasing Production Costs

Although the government should focus on investments in electricity generation, it should not stop from making investments in the other sectors, such as training human resources as well as improving solar panel manufacturing technologies and equipment. A shortage or deficiency in any basic factor could lead to a decline in quality and an increase in electricity costs, which ultimately leads to failure in the predicted success.

Loss of Sense of Confidence by Investors

The main objective of the FIT program is to attract and protect investments as well as guarantee profits. Therefore, any action or change in the laws that would harm the investor's confidence contradicts the goal of FIT. The amount of production and the percentage of degression play essential roles in determining the income rate. Any change in the laws would damage the investor's confidence and hinder development.

Loss of Sense of Competition

FIT considered the degression rate so that the investor can benefit from the nearest rates and quickly enter the

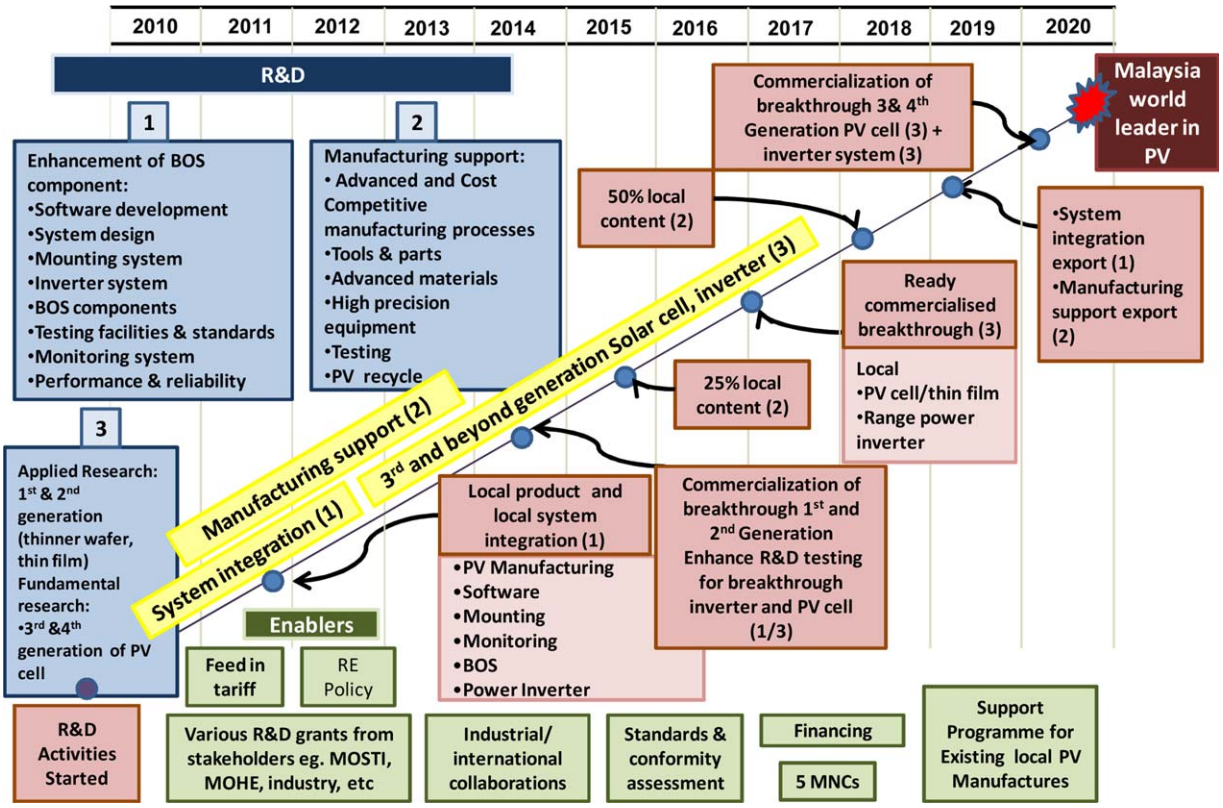

Figure 5. Malaysian roadmap for solar PV in 2010–2020 [10]. [Color figure can be viewed in the online issue, which is available at **wileyonlinelibrary.com**.]

Table 5. Renewable tariff adjustment for inflation [45].

Ontario SOC	20%
France	60–70%
Spain	75% to 2012; 50% after 2012
Greece	25%
Ireland	100%

competitive market. Any change in the rates should be applied in such a way that it does not lead to investors' failure to expand.

High Degression Rate

The main objective of the FIT program is to attract small and big investors until 2050, and the 8% degression rate contradicts this target. Annually deducting 8% from the FIT fixed rate would decrease the program's effectiveness, consequently discouraging investors. Although the price of the panel has decreased in recent years, the smaller FIT rate results in longer payback periods for investors, which is no longer an incentive.

Ignoring Inflation Annual Rate

According to the Central Bank of Malaysia, the country has experienced an inflation of 3–4% in recent years, thus raising the critical question as to "why legislators did not incorporate inflation rate in the FIT calculation." At 4% inflation, the real value of the total FIT amount for a family in the first year is not the same as that in the 5th or 10th year; this situation is analogous to the loss of confidence on the part of the investors. To protect the FIT, a number of countries apply an adjustment tariff for inflation, as shown in Table 5.

This adjustment rate protects the investors. However, such an adjustment rate must be introduced in advance to promote competition among investors. In the current Malaysian FIT situation, with respect to the 8% annual degression and normal inflation, the FIT practically does not provide any further incentive to new investors after 4 yrs.

Malaysia FIT Does Not Cover Poor Households

Although the FIT program targets both small and large investments, preparing approximately RM50,000 for 3600 kW·h per annum [46] is impossible for the low- and middle-income Malaysian households. Thus, only rich families or those with higher income can benefit from FIT. According to the 2012 FIT price, the income of a family from their panels is approximately RM5300 per year for 21 yrs. Thus, the payback period for each family without considering the loan interest is nearly 10 yrs. After 10 yrs, with an average 3% inflation, the value of RM5300 will be less than today's RM3700. Adding loan interest to investment cost results in an even smaller benefit for families.

Long-Term Investment Payback

The investment payback for Malaysia's FIT is 10 yrs at a fixed price. According to the 2012 FIT rate, the nominal price payback is at least 14 yrs. With the decreasing FIT rate after deducting the annual 8% degression for new investors, investment payback time would increase, and the motivation of investors would be significantly reduced.

CONCLUSIONS

Having 12 h of sunshine daily, Malaysia has approximately 4.5 kWh/(m^2·day) potential for solar radiation,

prompting the government to use PV to generate 5.5% of the total electrical energy by 2015. FIT accelerates the investment and increases electricity generation using PV. FIT provides benefits for both government and private investors. Implementing FIT in Malaysia will create 50,000 new green jobs, especially for professionals and experts. Malaysian investors had suffered from three severe crude oil price shocks in June 2008, September 2009, and April 2011. FIT creates a safe platform against fluctuations of crude oil and fuel prices. Moreover, FIT reduces investment risks in the Malaysian energy sector, which will result in a secure atmosphere for the energy supply in the country in the future. In parallel with the FIT advantages for Malaysia, some stress points also exist in implementing FIT. Implementing FIT increases electricity costs. Any changes in the FIT rate could destroy the entire sector as a result of creating a loss of confidence or loss of competition among investors. Some special points of view exists with regard to Malaysia's FIT. The investment payback time for FIT is quite long. Malaysia's FIT program does not have any mechanism for the low- and medium-income people. The rate of inflation has not been included in the FIT rate, and the 8% degression rate per annum discourages investors after a short period. We hope that the Malaysian government can devise a practical remedy to take advantage of the FIT benefits and eliminate the negative points of the FIT program. A modified FIT might support the country in achieving its energy roadmap target.

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