Solar Photovoltaic – Plug into the Sun

This article is published with the generous permission from the writer, Ms Chen Wei-Nee, Technical Adviser (Strategic Communications) of MBIPV Project.

This is an article answering many questions regarding information on solar photovoltaic focuses on photovoltaic technologies and the different applications. one needs to know and how to go about installing solar photovoltaic for the end-users in Malaysia.

Background

Solar photovoltaic is a technology which generates electricity from sunlight. Unlike solar thermal system which works with the heat component of the sun, solar photovoltaic works only with certain spectrum of the white light component of the sun. In Malaysia, the abundance of sunlight makes solar photovoltaic a very viable form of generating electricity. Since the sun is the fuel source of photovoltaic electricity, this form of electricity generation is said to be renewable. Solar photovoltaic (PV) is not only renewable; since there is no CO_2 emission in the process of electricity generation, solar photovoltaic is also considered a clean form of electricity generation. Other forms of renewable energies are mini hydro, biomass, biogas, municipal solid waste, geothermal, wave power and wind. Key reasons why renewable energies have emerged in recent years are due to their abilities to ensure energy security, mitigate climate change and to provide energy autonomy to countries.

Source: Kota Damansara, 3.15 kWp, Selangor, Malaysia.

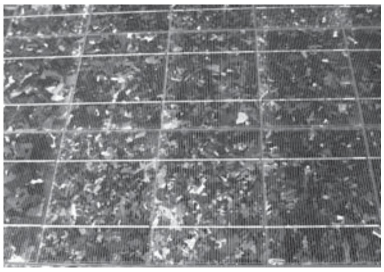
Energy Autonomy

According to Dr Hermann Scheer, the German Parliamentarian who was instrumental in implementing the Feed-in Tariff in Germany and the author of the Energy Autonomy, economies of countries are strongly pegged to cost of fuel for power generation and transportation. If a country has energy autonomy, the country's economy is resilient to fluctuating dominant fuel price. Malaysia is blessed in that the country is pretty much insulated against global fuel price fluctuation that occurred in the recent years. However, with depleting fossil fuel, the choice of fuel for the next generation has to be made wisely. For this reason, countries are moving towards renewable energies as their main resort to achieve energy autonomy. While nuclear plant has been a hot debate in many countries, unless a country has abundant naturally occurring uranium and plutonium, the warning from Dr Scheer is that future cartel of nuclear fuel source will hold ransom the economies of those countries which rely on others to supply uranium and plutonium.

Minister YB Dato Sri Peter Chin having a discussion with Dr Hermann Scheer on energy policies.

Applications for Solar Photovoltaic

Solar photovoltaic is a highly scalable technology and the applications are very versatile; we have solar powered watches, calculators, car park meters, standalone PV systems for rural or remote sites, grid-connected PV systems for urban applications and large solar PV power plants, and PV to power non-terrestrial applications such as satellites. In standalone PV applications, the heart of the PV system is the battery and charge controller. The standalone PV applications sometimes come with generator set (genset) and this is called a PV hybrid system. The genset is to provide parallel or backup power to the PV supply for both ac and dc load. For places where access to the electricity grid is easily available, grid-connected PV system is applicable. The heart of the grid-connected PV system is the inverter which converts direct current (dc) to alternating current (ac) before connecting to the main supply. The battery and charge controller are not required for grid-connect applications as the grid acts as a "battery" in which PV electricity is fed into. The BIPV system can be connected to the electricity supply network in a "Direct Feed" or an "Indirect Feed" configuration. In direct feed the PV meter, which records the generation from the PV system is installed beside the TNB supply meter at the customer's incoming supply point. The PV generated electricity feeds into the TNB distribution grid before the utility meter through wiring connection. Direct feed is the recommended option where it is physically possible as it allows a ready infrastructure for Feed-in Tariff mechanism, a mechanism I shall explain in greater detail later on. For indirect feed, the PV generated electricity is first used by the consumer and only excess electricity generated is fed into the grid network. Because of the versatility and aesthetic value, PV is one of the few renewable energy technologies that are highly suitable for urban applications. The demand for electricity is highest in urban areas and electricity generation from PV peaks between 11 am to 3 pm and this coincides with the daily peak demand of electricity in cities. Hence, PV is said to save conventional electricity by its ability to "shave" peak electricity demand and save the nation from operating too many peaking plants which are costly to run.



Architects incorporate PV as part of building materials due to its naturally-occurring aesthetic features.

PV Market Condition

PV market in Malaysia lies predominantly in the off-grid or rural applications. Off-grid PV applications started as early as in 1980s and today, the total off-grid PV capacity is around 10 megawatt peak (MWp). Off-grid PV market is nearly 100% supported by the Malaysian Government and as such, the market is not sustainable as it relies on Government to fund the PV projects. Globally, grid-connected PV applications dominate 84% of the total PV installed capacity with the highest capacity in Germany (5,340 MWp), Spain (3,354 MWp), Japan (2,144 MWp) and USA (1,168 MWp) (Source: IEA PVPS Trends 2008). Countries achieve such high grid-connected PV capacities with the implementation of policy mechanism which encourages public participation in the deployment of PV for their own use. However, renewable energies are not without challenges. In most countries including Malaysia, the major challenges faced are:

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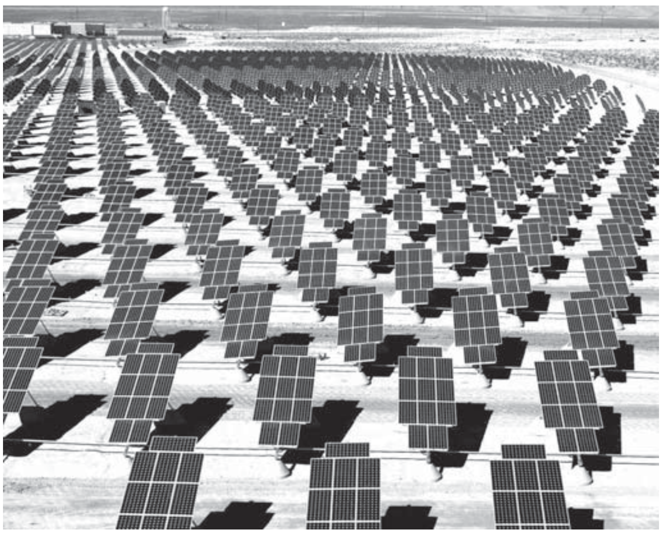
1. The need for electricity utility to have a greater acceptance of renewable energies as part of their energy portfolio and to show greater support for distributed renewable energy generation. Renewable energy operators need the support of Government and national electricity utility to overcome a host of administrative barriers.
2. The initial capital investment for renewable energies requires an equal playing field with conventional fuel. Financial incentives and technical support are required to encourage the public and commercial entities to install renewable energies either for own use or for sale to electricity utility. Until grid parity is attained, incentives must be sufficient for financial justification of the renewable energy projects. Grid parity occurs when the cost of generating electricity by renewable energy sources is on par with cost of electricity generated by conventional fuel.
3. While the global cost for renewable energy technologies is on a downward trend, in Malaysia, the cost of renewable energy (RE) projects are priced exorbitantly. This is due to the lack of transparent mechanism for pricing of RE projects which gave a negative perception to many on the inflated capital investment required for such projects.
4. Until a regulatory framework on RE is established, it will be challenging to expect RE to grow in a sustainable manner. In order for RE industry to sustain, business risk is reduced if there is a commitment from Government on RE in the forms of regulatory framework.
5. Lack of effective and efficient information dissemination and the need for continuous awareness programme for RE.
6. Renewable energy requires a long term strategy and a stop-and-go is one of the main hindrances to the development of stable and sustainable RE market.

In Malaysia, the initiative to create a grid-connected PV market began in the 9th Malaysia Plan with the inception of the Malaysia Building Integrated Photovoltaic (MBIPV) Project. The project receives funding support from Malaysian Government and Global Environment Facility through United Nations Development Programme. The MBIPV Project spans the entire 9th Malaysia Plan (2005-2010) and in that period of time, the main objective is to increase the grid-connected PV market and to reduce the cost of PV systems. As at end of December 2009, the total installed grid-connected PV capacity is approximately 1,000 kWp. MBIPV Project has several categories of financial incentives offered to the public; the most well known is the SURIA 1000 which concluded the final call in December 2009. Besides the financial incentives from MBIPV Project, the Government is also offering fiscal incentives for companies to install PV in their premises. Budget 2009 announcement has extended import duty and sales tax exemption on PV systems to PV system importers and PV service providers approved by Suruhanjaya Tenaga, for products they import for supply to their clients. Commercial applications can continue to claim Investment Tax Allowance (ITA) in addition to the normal Capital Allowance (CA) on investment in as was approved under Budget 2008. As funding from MBIPV Project comes to an end, the Government is aware of the need to avoid a stop-and-go political decision towards RE.

Feed-in Tariff

In June 2010, the Prime Minister YAB Dato Sri Najib Tun Razak has announced that that the Feed-in Tariff (FiT) would be implemented under the 10th Malaysia Plan. The feed-in tariff is a mechanism that allows electricity that is produced from renewable energy sources to be sold to power utilities at a fixed price for specific term. Under the Feed-in Tariff, different tariff structure will be set for different RE technologies. For the feed-in tariff to be implemented, the country needs to have a Renewable Energy Act which will provide a long term committed framework for the feed-in tariff to operate in. The RE Act is currently being drafted by the Ministry of Energy, Green Technology and Water with technical support from the MBIPV Project; the RE Act is expected to be tabled in the Parliament upon the approval of the Cabinet at the end of 2010. Should the RE Act is passed in Parliament, the feed-in tariff can start and shall be implemented by mid-2011.

So how does funding for FiT work? In countries where FiT have been implemented, the source of fund is derived from a cost sharing via retail electricity tariff. The cost sharing is typically between 3% to 8% of the total electricity bill (eg Germany, Switzerland, Italy, Taiwan). In Malaysia, it is proposed that a modest cost sharing of only 1% is included in the electricity bill and the cost sharing is only valid for consumption above (say) 100 kWh per month usage of electricity. According to Ir Ahmad Hadri Haris, National Project Leader of MBIPV Project, the FiT is structured based on “polluters pay concept” which means those high on electricity consumption will contribute more to cover their carbon footprints and those families with lower income shall be relieved of contributing. In return, Malaysians would have the opportunity to their part in mitigating climate change and global warming, as well as to generate revenue by operating renewable energy systems at their homes. The FiT is perhaps the only RE policy mechanism that is self destructive, said Ir Hadri. By this, Ir Hadri explained that the tariff for FiT is degressive in nature and each year the tariff will decline until such time as grid-parity is reached. Within each FiT contract with the electricity utility, the tariff is secured for a fixed period of time (say 21 years) and those who signed the contract earlier will be able to enjoy a higher tariff. The contract and tariff is activated only when the RE system is commissioned. “Grid parity is attained when the displaced cost of electricity by utility (at the point of interconnectivity) matches with the FiT”, said Ir Hadri. Once grid parity for a specific RE technology is attained, the FiT rate is replaced with the rate for displaced electricity cost from the utility and this is to avoid any financial loss by RE systems owner. In countries like Germany where FiT is first pioneered, the FiT became a popular programme especially among farmers and pensioners who receive steady income for 20 years for electricity generating from their rooftops. In countries like Spain, large PV power plants run by individual or consortium of companies have been developed to leverage on the country’s lucrative FiT. In Malaysia, the concept of FiT is not meant for excessive profiteering but to reduce long term cost barriers for public to work alongside with the Government to achieve energy security, mitigate climate change and energy autonomy, while spurring a new economic activity, concluded Ir Hadri.



Source: Ground-mounted Solar Photovoltaic Power Plant, 14 MWp, Nellis Airforce Base, Nevada, USA.

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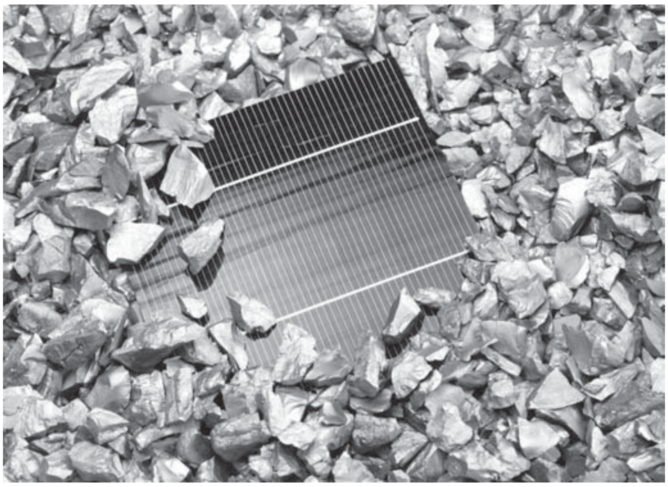


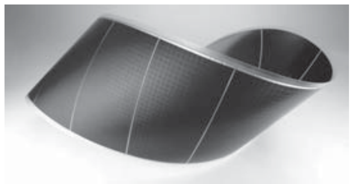
Source: Polycrystalline Solar Cell are made up of many monocrystalline silicon, Schott AG.

Photovoltaic Technologies

Photovoltaic is a technology which depends on sunlight to generate electricity. Photovoltaic is a semiconductor (typically silicon-based) and when the semiconductor is exposed to sunlight, electrons in the semiconductor which receives sufficient photon energy will break free from their valence bond and this flow of free electrons give rise to electricity. At this juncture, the photovoltaic (PV) market is dominated by 2 generations of PV technologies: crystalline silicon and thin film. There are 2 types of solar cells from crystalline silicon: monocrystalline and polycrystalline. Monocrystalline solar cells are made up of a single and very pure silicon crystal. Because of the single cell structure, the efficiency of the monocrystalline solar cell is the highest. The operating efficiency is typically between 14 % - 18 %. The cost of monocrystalline solar cell is reflected in the efficiency of the cell. Polycrystalline solar cells are made up of many monocrystalline silicon and the increase in the number of crystalline cells meant the electrons have to overcome the barriers of crossing between the 'walls' of the crystalline cells and this reduces the efficiency of the polycrystalline solar cells. The operating efficiency of polycrystalline solar cell is typically between 11 % - 15 % and the price of polycrystalline solar cells is lower than the monocrystalline. Crystalline solar cells constitute 86% of the total PV market of which polycrystalline solar cells have nearly double the market share of monocrystalline.

The second generation of PV technology is the thin film which holds a much lower market share due to its new presence in the market. Thin film can also be made from crystalline (amorphous) or other chemical deposition such as Cadmium Telluride (as used by First Solar Inc) and Copper Indium Diselenide (CIS). Thin film is highly versatile in its application as chemical deposition can be applied on any shapes of surfaces making curvilinear structure possible for PV. The efficiency of thin film is lower than the first generation; typical operating efficiency is around 7 %. However, cost of manufacturing thin film is also lower than first generation and to date, results have indicated that thin film technology produces much higher energy yield making the return based on cost per kWh a much more viable investment. The conditions which crystalline silicon and thin film technologies thrive in are different. Crystalline technologies prefer direct sunlight and are more sensitive to changing temperatures. The efficiency of crystalline solar cells drops by roughly 0.5 % for one degree Celsius increase in temperature. Thin film has a higher tolerance of temperature change; the efficiency loss is roughly 0.1 % for each degree Celsius increase in temperature. Unlike crystalline solar cells which require direct sunlight, thin film thrives well under diffused sunlight (ie cloudy condition).

PV modules usually come with aluminium frames although there are some PV modules which come in the form of laminates (ie no frames). The aluminium frames provide support to the PV modules and if the owner or architect of the building prefer to use laminates, then care must be given to install the laminates as laminates are vulnerable to breakages and the mounting structure that holds the laminates needs to withstand the wind load. The capacity of PV modules differs for different brands and models. PV capacity is expressed in Wp (watt peak) and the figures (eg voltage, current) provided in the datasheet are for standard testing condition (STC). Some manufacturers may provide additional information such as performance of PV module under Nominal Operating Cell Temperature (NOCT). It is important that these PV modules comply with internationally renowned quality standards. In Malaysia, the MS 1837:2005 on Installation of Grid Connected Photovoltaic (PV) System requires crystalline silicon PV module to comply with the IEC 61215 and thin film with IEC 61646.



Source: Flexible thin film, Dupont Photovoltaic Solutions.

PV modules have no mechanical parts which will result in accelerated wear and tear. Theoretically, these modules can have a very long life span. However, manufacturers have limited their liabilities to offer warranties for PV modules typically from 20 – 25 years. Some manufacturers provide linear performance guarantee for their PV modules. Basically, the linear guarantee includes a first year of operation guarantee of at least (say) 97% of the nominal power output, with the second year of operation declining by no more than (say) 0.7% of the nominal output. In the final year of the warranty (say 25th year), the module would have an actual performance of at least 80.2% of the nominal output. This slow declining rate of performance is to cater for aging factor of PV modules.

In the world today, there are four generations of PV technologies. The third and fourth generations are still in R&D and some are close to commercialisation. The fundamental philosophies in these later generations are driving towards lower manufacturing cost and increasing efficiency eg by making use of multiple spectrum of white light from the sun. Today, China (eg Suntech, Trina, Yingli, Canadian Solar Inc) is the leading country in PV manufacturers while Germany (Q-Cells AG), Japan (Sharp Corporation) and USA (First Solar Inc, SunPower Corporation) pioneered in many PV technologies as these countries have been in the PV market for much longer period of time. First Solar Inc (Kulim), Q-Cells AG (Selangor), SunPower Corporation (Melaka) and Tokuyama Corporation (Sarawak) have established their manufacturing presence in Malaysia, this helps to elevate the status of Malaysia as a significant producer of solar PV.

Aside from the PV modules, the other key component of a grid-connected PV system is the inverter. The function of the inverter is to convert dc generated by the PV modules to ac to feed to the ac load or public grid. There are different sizes of inverters in the market today to cater for different PV capacities. For PV capacity of less than 10 kWp, string inverters are used. These inverters typically range from 700 W to 8,000 W. String inverters can be single or multi-string depending on how the PV array is designed. Multi-string configuration is desired if the PV modules on rooftop face different directions. For PV capacities between 10 – 20 kWp, multiple string inverters can be used as the PV array can be divided into sub-arrays. For PV systems greater than 20 kWp, central inverters are required. Central inverters typically range from 20 – 1,000 kWp. Warranties for inverter

Source: String inverter, Fronius.

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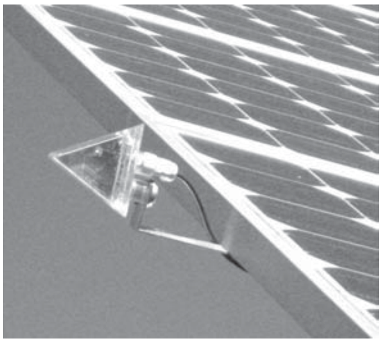
range from 5 – 10 years with some manufacturers offering the option to extend their warranties for another 10 years. In Malaysia, the MS1837:2005 on inverters require compliance to the MS IEC 61000-3-2, MS IEC 61000-6 and BS EN 50178. In the event of power failure from the public grid, the inverters will shut down automatically. This is to prevent islanding effect. In Malaysia, Universiti Teknologi Malaysia in Skudai, Johor Darul Takzim has been appointed by MBIPV Project to be the inverter quality control centre (IQCC). While inverters have been extensively tested by manufacturers before launching into the market, the role of IQCC is to test these imported inverters under local conditions. In addition, the IQCC will also test locally manufactured inverters to ensure product quality and reliability.
For more information on IQCC, please visit http://www.mbipv.net.my/content.asp?higherID=20&zoneid=5&categoryid=21.

Further information on PV industry is readily available from http://www.pv-tech.org/, http://www.solarbuzz.com/ and http://www.photon-magazine.com/registry/registry.aspx.

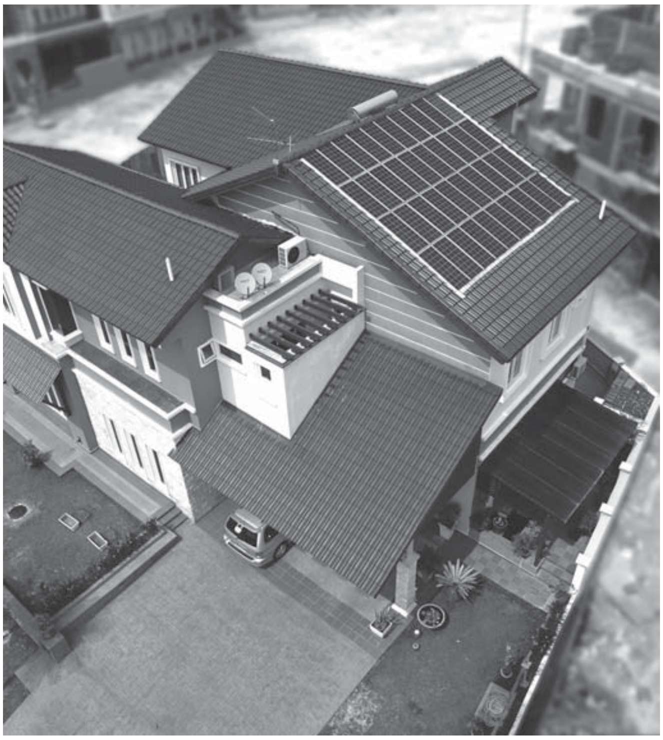
PV Applications

Now that we've gained some insight about the key PV components, let's move towards understanding the various applications of grid-connected PV systems. Grid-connected PV systems require easy access to the public electricity grid. There are two types of grid-connected PV systems: (i) directly connected to public grid and (ii) connected to public grid via house (or building) grid. Solar PV power plants are examples of direct connection to the public grid. The PV modules are mounted on either stationary mounting structure or tracking mounting frame. Tracking mounting frames are able to move (either single or dual axial movements) and tracking can be either in active or passive mode. In passive tracking, mechanical movement is achieved without the use of motor usually based on achieving balance within the tracker by means of differential heating of the refrigerant liquid within the tracker structure by the sun (Sulaiman et al 2009). Active tracking requires typically microprocessor to power the movement. Large PV power plants are ideal for land which has little agriculture or development use (eg desert, brown land).



Optical sensor for active tracking mounting structure.

The second type of grid-connected PV systems connects to the public grid via house (or building) grid and is configuration is highly suitable for urban applications. PV modules can be either integrated into the building (hence the name "building integrated") or retrofitted on existing buildings. In building applications, PV serves the dual roles of generating electricity as well as a building material. In a building integrated application, when the PV modules are mounted on the roofs, roof tiles are no longer required as the PV modules act as roofing materials. Similarly, PV modules can be the building's facade; glass-glass PV modules serve as natural day-lighting for atrium and PV modules can also serve as window awning and pergola for the garden. Some companies have installed PV modules as part of their corporate responsibility to consciously reduce their carbon footprints. In most cases, these companies will have a display at their main reception area to show the amount of CO2 avoidance as a result of generating clean electricity from their PV system. Some of these companies have also opted for PV facade application to increase their visibility in commitment towards conserving the environment. In Malaysia where the country lies within the equatorial sun belt, PV is best located on rooftops of inclination not more than 15 degree facing south. The energy yield from PV facade application in Malaysia will result in nearly 50 % drop compared to rooftop applications. Therefore customers who wish to have PV facade applications must be alerted of the drop in energy output. While building integrated PV applications can be much more aesthetic than retrofitted ones, care must be given to ensure sufficient ventilation behind the PV modules. As a rule of thumb, a 15 cm gap will ensure negligible loss in efficiency, a 5 cm gap will have approximately 5 % drop in efficiency and if there is no gap for ventilation, the PV module will suffer approximately 10 % drop in efficiency (Ruoss 2007). Hence, a retrofitted PV system will typically have less system losses compared to integrated ones. Today, nearly 90% of total global urban PV applications are retrofitted mainly because the buildings exist before the owners decide on the PV installation. In countries like Japan, the Government-funded PV systems must be retrofitted even on new buildings. In Malaysia, the local grid-connected PV installations can be viewed from http://www.mbipv.net.my/products.asp?higherID=14&zoneid=4&categoryid=15 . While in Malaysia, the focus is developing building integrated photovoltaic (BiPV) market, elsewhere, the trend is moving from BIPV to developing a city integrated photovoltaic (CiPV) market.



Source: BIPV application, Shah Alam, 4.8 kWp, Selangor, Malaysia.

Source: Ohta City Land Development Corporation.

Source: Bukit Damansara, 4.2 kWp, Kuala Lumpur, Malaysia.

Out of curiosity, an informal survey was carried out in Malaysia to find out the reasons why building owners install solar PV systems in their house/office buildings. The survey showed that these owners do so for the following several reasons:

i) Leverage on existing government incentives for solar PV;

ii) For retirees, having a BIPV house will help to hedge against future electricity price increase;

iii) Environmental conscious;

iv) For home buyers, having a BIPV house will help create a point of differentiation by being a clean micro IPP (independent power producer);

v) For commercial entities, the installation of PV systems in the buildings helps create an image of corporate responsibility.

How much does it cost?

One of the frequent questions raised is the cost of installing grid-connected building integrated photovoltaic (BiPV) systems. Globally, the prices of PV modules have seen a decline over the past 2 years. This is largely due to economic crisis which forces some key markets to revise their policy mechanism to accommodate their national budget. In Malaysia, we have recorded a steady decline of BiPV pricin (see http://www.mbipv.net.my/content.asp?zoneid=4&categoryid =12). As of December 2009, the average cost of a grid-connected PV system (based on standard PV module) is RM 20,000 per kWp ± 10 %. 65 % - 70 % of the total cost is on PV modules, inverter accounts for 10 % - 15 % of the total cost and the remaining cost is for the balance of system (BoS), design & installation fees and typically one year warranty on worksmanship from PV service provider. Balance of system covers cabling (ac and dc), junction boxes, switches (ac and dc), fuses, surge protection devices and mounting structure. This price is expected to vary with the types of modules (standard or customised), the size of PV system (larger system can achieve economies of scale), complexity in installation and local condition (eg windy, proximity and ease to delivery).

Approved Photovoltaic Service Provider

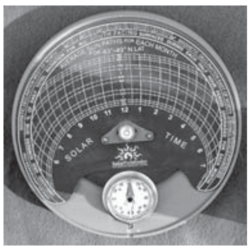
If you are interested in installing a PV system for your home or commercial building, it is strongly recommended that you contact an Approved PV Service Provider (APVSP). Companies listed with MBIPV Project as APVSPs have complied with requirements to reduce the risk of potential PV buyers. This includes the requirement for companies to have at least an employee who has passed the rigorous exam for grid-connected PV training (ISP). This is to ensure companies have theoretically competent designers and installers for grid-connected PV systems. The list of APVSP with their ratings can be found in http://www.mbipv.net.my/rating.asp?zoneid=10&categoryid=61. When you contact an APVSP, a good APVSP should:

- Respond to your enquiry within 48 hours;
- Explain how a PV system works, the concept of net metering for direct and indirect feed, expected energy output and the Ringgit Malaysia equivalent based on existing tariff;
- Advise you on any possible shadowing affecting the performance of PV system (eg growing trees, new construction site);
- Advise you on the fire and theft insurance to cover your PV system;
- Conduct at least one site visit before producing a quotation. Once the quotation is presented to the customer, the APVSP will explain about the quotation, what can be expected during pre-installation, installation and post-installation of the PV system, the warranties of equipment and workmanship, the operation and maintenance (O&M) of the PV system;
- Not criticise the workmanship or system design of another APVSP.

What should the quotation for a solar PV system include?

The quotation from the APVSP should minimally include the following:

- Full specifications of the system offered (quantity, manufacturer, model number of the solar modules & inverter including the IEC or related standards complied with);
- Warranty information for each item;
- Minimum 1 year warranty on installation workmanship of the system;
- A firm quotation which includes all equipment and installation charges and services during the warranty period;
- PV module and inverter authorisation for channel distributor or resellership.
- An estimate quotation for call-out services after the first 12 months warranty period on workmanship has expired,
- Validity period of quotation; and
- Importantly, the quotation should be accompanied by an estimate of the yearly energy output of the system. If the output from the installed PV system should fall consistently below the estimated output, the client should request the APVSP to investigate and account for the lower than expected energy output.



Solar Path Finder : Check shading of proposed PV site.

PV Service Provider should advise customers of any potential shading which will affect the performance of PV system.

Guidelines for sales contract for solar PV system

Each sale of solar PV system should result in a formal contract between the customer and APVSP. This will save some headache during implementation especially when contract and work schedule or plan are completely missing. The contract should be signed once the customer has decided to purchase the PV system. The contract should include supply, installation and commissioning of the solar PV system. A copy of the contract should be retained by the customer and the other by the APVSP. The contract should include PV product manufacturers' names, product ratings & model serial numbers, international manufacturing standards, materials delivery schedule. Installation work plan which should correspond to progress payment schedule. The APVSP should include an estimate price for call-out services once the initial 12 months warranty period on workmanship has expired. The contract should include terms specifying: the customer's and the APVSP's rights, changes to specifications, agreed penalty charges (if any) for clauses pertaining to early termination of contract, delayed delivery, damaging of owner's properties and injury resulting from lack of safety measures taken during installation.

During the installation of the PV system

A good APVSP should update the customer on regular basis the progress of the installation. The APVSP should ensure safe working environment for customer as well as workers, examples of safety issues include scaffolding and roof covering. The APVPS should ensure that their workers who are responsible for the roof and structural installation work possess current CIDB Green Cards (as applicable). The company should only engage electricians having valid wireman certificates to do the electrical installation. The APVSP must not tamper with TNB installation and the company should follow all the requirements of MS 1837: 2005 on Installation of Grid Connected Photovoltaic (PV) System during the installation of the PV system. After the installation is over, the APVSP should test to ensure there is no roof leakage and to leave the premise in a tidy order. If there is any damage to the property as a result of the installation of the PV system and the customer is able to prove that there is an element of negligence in the APVSP, then the APVSP shall repair any damages to the property.

Safetyness for both the installers and customers are important during installation period.

Testing and commissioning (T&C) of the system

Once the PV system has been installed, the system is ready to go 'live'. Before the PV system is commissioned, projects which are co-funded by MBIPV Project will require the APVSP to submit 3 types of forms: one for MBIPV Project, power utility (TNB) and Suruhanjaya Tenaga (Energy Commission) at least 3 weeks before the proposed T&C is scheduled. The PV System owner or representative, APVSP, power utility, Mounting Structure Quality Control Centre (MSQCC represented by IKRAM) and PV Monitoring Centre (represented by UiTM) must be present during the T&C. The APVSP shall explain to the customer the equipment installed including interpreting the PV meter.

After the PV system has been commissioned

For projects co-funded by MBIPV Project, the APVSP is required to submit the T&C report to MBIPV Project within 3 weeks of T&C. The APVSP should follow up with the customer to verify satisfactory performance of the system installed and its performance against the declared performance for at least the first 12 months. The APVSP should respond to after sales service calls within 24 hours and provide support to the customer when a product fails under warranty. This support will include liaising with the manufacturer or equipment agent on behalf of the customer. The APVSP should attempt to solve all complaints in a professional manner and directly with the customer to avoid the complaint being formerly lodged to the Quality Assurance Scheme (QAS) Secretariat (MBIPV Project). MBIPV Project will randomly audit BIPV sites (which received financial incentives under the Project) and will inform the APVSP with a copy of the report to the customer on any corrective measures to the PV system. PV Systems receiving funding from SURIA 1000 will be monitored on monthly basis for three years. The PV Monitoring Centre will contact the customer to arrange for a method most suitable for the PV meter recording (telephone call, SMS or email). The performance of your PV system can be viewed at http://pvmc.uitm.edu.my/pvmc/ between one to two months after T&C. The website will also be able to show how well your PV system is performing. On six-monthly or annual basis, arrange with your PV Service Provider for a scheduled system inspection (electrical connections, any rust on racking system, fuses, condition of conduit, clippings). The cost of inspection for the first 12 months should be part of the sales contract. Customer is advised to keep a log book to record each PV Service Provider's visit and if your surroundings are dusty (eg located next to construction site), follow the instruction from the manufacturer to remove dirt from the PV modules.

If you suspect your PV System is faulty

If the failure occurs in the 12 month installation workmanship warranty period then the customer should attempt to diagnose the problem with guidance over the phone by the APVSP. If the diagnosis is not successful, then the APVSP is obliged to inspect the PV system to determine the fault and then rectifying the fault as soon as possible. If it is a fault in installation workmanship then it is the APVSP's responsibility to rectify the problem. If it is a fault in the equipment then the APVSP should liaise with the equipment manufacturer to fix the product as soon as possible. The cost for the APVSP in providing this service (ie cost incurred in removing, returning and then re-installing the product) should either be paid for by the manufacturer or by the APVSP. If the failure is after the 12 month warranty period, then the customer should attempt to diagnose the problem with guidance over the phone by the APVSP. If the diagnosis is not successful, then the APVSP is obliged to inspect the PV system to determine the fault and then rectifying the fault as soon as possible. A fair price should be quoted to the customer for the call-out as per agreed in advance. If it is a fault in installation workmanship then the APVSP should provide the customer a quotation for repairs. If it is a fault in the equipment then the APVSP should liaise with the equipment manufacturer to fix the product as soon as possible. The cost in providing the repairs shall be quoted to the customer. If equipment is still under warranty the cost should just be for the time spent travelling to/from site and onsite when undertaking the replacement (or repairs) of equipment unless this will be paid by the manufacturer.

I hope this article has been enlightening to you. The materials and references for this article can be found at www.mbipv.net.my. For comments, please email to weinee@mbipv.net.my. Ms Chen Wei-Nee is the Technical Adviser (Strategic Communications) of MBIPV Project.