IEA INTERNATIONAL ENERGY AGENCY

National Survey Report of PV Power Applications in MALAYSIA 2014

PVPS

PHOTOVOLTAIC POWER SYSTEMS PROGRAMME

Prepared by

Sustainable Energy Development Authority Malaysia

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Foreword

The International Energy Agency (IEA), founded in November 1974, is an autonomous body within the framework of the Organisation for Economic Co-operation and Development (OECD) which carries out a comprehensive programme of energy co-operation among its member countries

The IEA Photovoltaic Power Systems Programme (IEA-PVPS) is one of the collaborative R & D agreements established within the IEA and, since 1993, its participants have been conducting a variety of joint projects in the applications of photovoltaic conversion of solar energy into electricity.

The participating countries and organisations can be found on the www.iea-pvps.org website.

The overall programme is headed by an Executive Committee composed of one representative from each participating country or organization, while the management of individual Tasks (research projects / activity areas) is the responsibility of Operating Agents. Information about the active and completed tasks can be found on the IEA-PVPS website www.iea-pvps.org

Front cover image: 10,25 MW Solar Power Plant located in Gemas, Negeri Sembilan, Malaysia, project owner Amcorp Power Sdn Bhd, also the winner of 2015 Malaysia Solar Systems Company of the Year by Frost & Sullivan Malaysia Best Practices Award.

Introduction

The objective of Task 1 of the IEA Photovoltaic Power Systems Programme is to promote and facilitate the exchange and dissemination of information on the technical, economic, environmental and social aspects of PV power systems. Task 1 activities support the broader PVPS objectives: to contribute to cost reduction of PV power applications, to increase awareness of the potential and value of PV power systems, to foster the removal of both technical and non-technical barriers and to enhance technology co-operation. An important deliverable of Task 1 is the annual "*Trends in photovoltaic applications*" report. In parallel, National Survey Reports are produced annually by each Task 1 participant. This document is the country National Survey Report for the year 2014. Information from this document will be used as input to the annual Trends in photovoltaic applications report.

The PVPS website www.iea-pvps.org also plays an important role in disseminating information arising from the programme, including national information.

1 INSTALLATION DATA

The PV power system market is defined as the market of all nationally installed (terrestrial) PV applications with a PV capacity of 40 W or more. A PV system consists of modules, inverters, batteries and all installation and control components for modules, inverters and batteries. Other applications such as small mobile devices are not considered in this report.

For the purposes of this report, **PV installations are included in the 2014 statistics if the PV modules were installed and connected to the grid between 1 January and 31 December 2014, although commissioning may have taken place at a later date**.

1.1 Applications for Photovoltaics

Prior to 2006, most PV installations were off-grid and funded by Government for rural electrifications. From 2006 - 2010, the Ministry of Energy, Green Technology and Water of Malaysia (MEGTW) together with financial support from the Global Environment Facility (GEF) channelled via United Nations Development Programme (UNDP) established the Malaysian Building Integrated Photovoltaic (MBIPV) Project. The project's objectives were to promote grid-connected PV systems on buildings and by the end of the project, to establish a PV policy to grow the local PV market. At the end of the Project, approximately 2 MW of grid-connected PV systems were installed on buildings (residentials and commercial). Importantly, the project was instrumental in the establishment of the National Renewable Energy Policy and Action Plan (NREPAP) together with MEGTW.

The NREPAP was approved by the Cabinet in April 2010; the NREPAP mandated the feed-in tariff (FiT) to be the key policy driver for stimulating local PV market. The FiT would be underpinned by a legal framework and the NREPAP cited the establishment of an agency to spearhead the FiT implementation. On 27th April 2011, the Parliament approved the Renewable Energy Bill 2010 and the following day, the Sustainable Energy Development Authority Bill 2010 was also approved. On 1st September 2011, the Sustainable Energy Development Authority (SEDA) Malaysia was established under the SEDA Act 2011 [Act 726]. The FiT, which is administered and monitored by SEDA, is finally implemented on 1st December 2011. The renewable resources under the FiT portfolio include biomass, biogas, small hydro and PV. Against this backdrop, grid-connected PV systems continue to grow under the FiT, the installed capacity of grid-connect PV systems began surpassing off-grid PV capacity.

1.2 Total photovoltaic power installed

Data collected is based on PV systems under the FiT mechanism which is administered and monitored by SEDA. Applications for the FiT are handled electronically by the e-FiT online system. Off-grid PV data are obtained from electricity utilities located in the states of Sarawak (Sarawak Electricity Berhad, SEB) and Sabah (Sabah Electricity Sdn Bhd, SESB). In both of these states, electrification is only 92 % (as at end of 2014) whereas in Peninsular Malaysia, electrification rate is close to 100 %. Any PV systems

installed outside of the FiT and the jurisdiction of SEB and SESB, will not be reflected in this report. All PV capacities reported are DC-rated.

Table 1: PV power installed during calendar year 2014

Type of Connection	Category	MW_{dc} installed in 2014
Grid-connected	Individuals	13,46
	Non-individuals	73,27
Off-grid	Residential	0,15
	Hybrid system	1,587
Total		**88,467**

Table 2: Data collection process

If data are reported in AC, please mention a conversion coefficient to estimate DC installations.	Data reported in DC
Is the collection process done by an official body or a private company/Association?	Data collection was done by SEDA
Link to official statistics (if this exists)	SEDA's official website is www.seda.gov.my.
	Off-grid data was contributed by SESB and SEB.

Table 3: PV power and the broader national energy market. (Grid-connect data only)

MW for capacities and GWh for energy	**2014 numbers**	**2013 numbers**
Total power generation capacities (fossil fuel, large hydro & RE)	Data not available	29 748 MW
Total renewable power generation capacities (excluding large hydro)	243,36 MW	147,93 MW
Total electricity demand (= consumption)	Data not available	123 076 GWh 19 219 MW (maximum demand)
New generation capacities installed during the year (excluding RE including large hydro)	Data not available	600 MW
New renewable generation capacities installed during the year (excluding large hydro)	95,43 MW	49,4 MW
Total PV electricity production	119,1 GWh	53,4 GWh
Total PV electricity production as a % of total electricity consumption	Data not available	0,04 %

(Source: Non-RE Data from the Energy Commission, Malaysia)

Table 4: Other information

	2014 Numbers	Cumulative total
Number of PV systems in operation in your country (a split per market segment is interesting)	1 447 Individuals 109 Non-individuals	2 773 Individuals 195 Non-individuals
Capacity of decommissioned PV systems during the year in MW	Nil	Nil
Total capacity connected to the low voltage distribution grid in MW	Data not available	Data not available
Total capacity connected to the medium voltage distribution grid in MW	Data not available	Data not available
Total capacity connected to the high voltage transmission grid in MW	Nil	Nil

Table 5: The cumulative installed PV power in 4 sub-markets

Sub-market	Off-grid Domestic (MW)	Off-grid Hybrid (MW)	Grid-connected distributed (MW)	Grid-connected centralized (MW)
Prior 2014	0,13	4,113	25,02	nil
			48,28	Nil
2014	0,15	1,587	86,73	Nil
TOTAL (MW)	0,28	5,70	160,03	nil

2 2. COMPETITIVENESS OF PV ELECTRICITY

2.1 Module prices

Table 6: Typical module prices for a number of years

Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Standard module price(s): Typical (MYR per W)	21,39	17,25	16,00	14,57	9,81	8,06	5,8	6,00	6,00	3,00
Best price										2,00
PV module price for concentration (if relevant)	NA									

2.2 System prices

Table 7: Turnkey Prices of Typical Applications – local currency

Category/Size	Typical applications and brief details	Average price per W (MYR per W)
Grid-connected Rooftop up to 12 kW	This cost includes cabling, interconnection and substation.	8,5
Grid-connected PV systems up to 425 kW (non-individuals)	This cost includes cabling, interconnection and substation.	8,0
Grid-connected PV systems above 425 kW and up to 1 MW (non-individuals)	This cost includes cabling, interconnection and substation.	7,5
Grid-connected PV systems above 1 MW and up to 5 MW (non-individuals)	This cost includes cabling, interconnection and substation.	6,0

Table 8: National trends in system prices (current) for different applications

Price (MYR) /Wp	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Residential PV systems (< 12 kW)	31,41	27,55	23,19	22,41	20,44	19,12	11,00	9,00	7,50	8,5
Commercial and industrial	Not available									8,0
Ground-mounted (up to 1 MW)	Not available									7,5

2.3 Cost breakdown of PV installations (optional)

2.3.1 Residential PV System < 12 kW

Table 9: Cost breakdown for a residential PV system – local currency

Cost category	Average (local currency/W)	Low (local currency/W)	High (local currency/W)
Hardware			
Module	3,0	Not available	
Inverter	1,2		
Other (racking, wiring…)	1,4		
Soft costs			
Installation	0,70		
Customer Acquisition	0,25		
Profit	1,45		
Other (permitting, contracting, financing…)	0,5		
Subtotal Hardware	5,6		
Subtotal Soft costs	2,9		
Total	8,5		

2.3.2 Utility-scale PV systems up to 1 MW

Table 10: Cost breakdown for an utility-scale PV system – local currency

Cost Category	Average (local currency/W)	Low (local currency/W)	High (local currency/W)
Hardware			
Module	2,6	Not available	
Inverter	0,8		
Other (racking, wiring, etc.)	1,5		
Soft cost			
Installation Labor	0,6		
Customer acquisition	0,2		
Profit	1,2		
Other (contracting, permitting, financing etc.)	0,6		
Subtotal Hardware	4,9		
Subtotal - Soft cost	2,6		
Total Installed Cost	7,5		

2.4 Financial Parameters and programs (leasing)

Table 11: PV financing scheme

Average Cost of capital per market segment	Between 7 - 8 % p.a.
Description of a specific PV financing scheme (leasing, renting…)	Largely debt financing based on 75 - 85% financing for tenure of between 10 - 15 years (depending on various risks of project and company financial status) via establishment of a special purpose vehicle (SPV).

2.5 Additional Country information

Table 12: Country information

Retail Electricity Prices for an household (range)	Peninsular Malaysia, average electricity tariff (2014) was MYR 0,3166/kWh, full domestic electricity tariff can be found @ http://www.tnb.com.my/residential/pricing-and-tariff/tariff-rates.html.
Retail Electricity Prices for a commercial company (range)	Peninsular Malaysia, average electricity tariff (2014) was MYR 0,4792/kWh, full commercial electricity tariff can be found @ http://www.tnb.com.my/business/for-commercial/pricing-tariff.html.
Retail Electricity Prices for an industrial company (range)	Peninsular Malaysia, average electricity tariff (2014) was MYR 0,3615/kWh, full industrial electricity tariff can be found @ http://www.tnb.com.my/business/for-industrial/pricing-tariff.html.
Population	30 452 473 (source: http://www.statistics.gov.my/, accessed 8th May 2015)
Country size (km^2)	329 847 square kilometres (127 350 sq mi)
Average PV yield (according to the current PV development in the country) in kWh/kWp	1.200 kWh per kWp
Name and market share of major electric utilities.	There are 3 major electricity utilities in the country split by region: • Peninsular Malaysia (Tenaga Nasional Berhad, Gov't linked company, www.tnb.com.my), • Sarawak (Sarawak Electricity Berhad, 100% owned by state of Sarawak, www.sarawakenergy.com.my) • Sabah (Sabah Electricity Sdn Bhd, 80% owned by TNB & 20% owned by state of Sabah, www.sesb.com.my). More info on these utilities can be found under section 7.1 Structure of the Electricity System

3 POLICY FRAMEWORK

This chapter describes the support policies aiming directly or indirectly to drive the development of PV. Direct support policies have a direct influence on PV development by incentivizing or simplifying or defining adequate policies. Indirect support policies change the regulatory environment in a way that can push PV development.

3.1 Direct support policies

Table 13: PV support measures (summary)

<table>
<tr><th></th><th>On-going measures</th><th>Measures that commenced during 2014</th></tr>
<tr><td>Feed-in tariff (gross)</td><td>Implemented since 1st December 2011</td><td rowspan="14">None</td></tr>
<tr><td>Capital subsidies for equipment or total cost</td><td rowspan="6">nil</td></tr>
<tr><td>Green electricity schemes</td></tr>
<tr><td>PV-specific green electricity schemes</td></tr>
<tr><td>Renewable portfolio standards (RPS)</td></tr>
<tr><td>PV requirement in RPS</td></tr>
<tr><td>Investment funds for PV</td></tr>
<tr><td>Income tax reduction</td><td>Investment tax allowance for PV (up to end of 2015)</td></tr>
<tr><td>Prosumers' incentives (self-consumption, net-metering, net-billing…)</td><td>Nil</td></tr>
<tr><td>Commercial bank activities e.g. green mortgages promoting PV</td><td>Green Technology Financing Scheme</td></tr>
<tr><td>Activities of electricity utility businesses</td><td>Gov't owned electricity utilities (e.g. TNB, SEB, SESB) largely monopolized generation, transmission and distribution in the country. There are several IPPs selling electricity directly to these main Gov't owned electricity utilities.</td></tr>
<tr><td>Sustainable building requirements</td><td>Green Building Index rating tool</td></tr>
</table>

3.2 Direct Support measures

3.2.1 Support measures exiting in 2014

There were no support measures exiting in 2014.

3.2.1.1 Description of support measures excluding prosumers, BIPV, and rural electrification

In Malaysia, the primary support measure promoting the growth of renewable energy market is the feed-in tariff (FiT). The FiT has been covered in section 1.1 Applications for Photovoltaic.

3.2.1.2 Prosumers' development measures

There are no prosumers' measures implemented in the country. Net metering framework is still being developed between the Ministry of Energy, Green Technology and Water of Malaysia, the Sustainable Energy Development Authority Malaysia, the Energy Commission, electricity utilities and PV industry stakeholders. Net metering is expected to be implemented under the 11th Malaysia Plan (2016 – 2020).

3.2.1.3 BIPV development measures

The requirement of PV on buildings form part of the Green Building Index rating tool although such requirement is not mandatory (http://www.greenbuildingindex.org/).

3.2.1.4 Rural electrification measures

Rural electrification using PV (hybrid or standalone) is under the jurisdiction of the Ministry of Rural and Regional Development. Rural electrification is mostly concentrated in the states of Sarawak and Sabah whereby their electrification rate is only 92 % compared to nearly 100 % in Peninsular Malaysia.

3.2.1.5 Other measures including decentralized storage and demand response measures

Market on decentralized storage is largely for rural electrification, there is no financial incentive for grid-connected decentralized storage. Demand response measures are carried out by Government in some government buildings (Government Lead by Example Programme), however there is no legal framework governing demand response programme nor this such measure mandated by the Government. However, the Government has announced that under the 11th Malaysia Plan (2016-2020), demand side management may be incorporated as part of the green growth strategy (source: http://www.pressreader.com/malaysia/the-malaysian-reserve/20150508/281934541513471/TextView, 8th May 2015).

3.2.2 Support measures phased out in 2014

There were no support measures exiting in 2014.

3.2.3 New support measures implemented in 2014
There were no new support measures being implemented in 2014.

3.2.4 Measures currently discussed but not implemented yet
Besides net metering, the Sustainable Energy Development Authority Malaysia has initiated the development of framework for PV systems of utility scale; the stakeholders involved in this exercise included the Ministry of Energy, Green Technology and Water of Malaysia, the Energy Commission, electricity utilities and PV industry stakeholders.

3.2.5 Financing and cost of support measures
The FiT is financially supported by electricity consumers who contributed 1,6 % on top of their electricity bills to the renewable energy (RE) fund. Domestic electricity consumers, with not more than 300 kWh of electricity consumed per month, are exempted from such contribution. On annual basis, the 1,6 % collection translated to approximately MYR 625 million.

The Green Technology Financing (GTFS) Scheme started in 2010 as part of the programmes under the National Green Technology Policy to accelerate the expansion of green investments by providing easier access to financing from the private and commercial financial institutions. The Scheme offers a 60 % guarantee of the financing amount and a rebate of 2 % on the interest/profit rate charged by the financial institutions. The GTFS is available until 31 December 2015 or upon reaching a total financing approval amount of MYR 3,5 billion whichever is earlier. To date, the approved GT Value for financing is MYR 2 156 142 245, the balance of GT Value for financing is MYR 1 343 857 755 (https://www.gtfs.my/).

3.3 Indirect policy issues

3.3.1 International policies affecting the use of PV Power Systems
Commitment at the COP 15 by the Prime Minister of Malaysia to achieve a voluntary reduction of up to 40 % in terms of emissions intensity of GDP (gross domestic product) by the year 2020 compared to 2005 levels. The cut was conditional on receiving the transfer of technology and adequate financing from the developed world. As at the end of 2014, Malaysia has achieved more than 33 % out of the 40 % carbon emission intensity reduction (source: http://www.therakyatpost.com/business/2014/12/02/malaysias-carbon-emissions-cut-33/).

3.3.2 The introduction of any favourable environmental regulations
Nil.

3.3.3 Policies relating to externalities of conventional energy
Nil.

3.3.4 Taxes on pollution (e.g. carbon tax)
Nil.

3.3.5 National policies and programmes to promote the use of PV in foreign non-IEA countries

NA

4 HIGHLIGHTS OF R&D

4.1 Highlights of R&D

R&D activities in PV are largely under the purview of the Ministry of Science, Technology and Innovation. Table 14 shows the list of universities and research institute and their research area involvement in solar PV.

Table 14: Solar PV Researches by Local Universities and Research Institute

Research Institute	Areas of R&D
1. Universiti Teknologi MARA	Performance of Selected Stand-Alone PV Systems under the AAIBE-funding
	Impact of Ambient Parameters on PV Systems Output in Equatorial Climate
	Stabilisation Period and Assessment of Design Techniques for Thin-Film PV modules under Malaysian Weather
	Sizing of Stand-Alone PV systems using ANN
	Development of SCADA for Application on PV Systems
	http://www.uitm.edu.my/index.php/en/
2. University of Malaya Power Energy Dedicated Advanced Centre	Design of Grid-connected PV inverter 3-10kW
	Inverter - performance testing
	PV integration and monitoring
	Photocells testing
	http://www.umpedac.um.edu.my/
3. Solar Energy Research Institute, Universiti Kebangsaan Malaysia	Advanced Solar Cell (Thin Film Silicon, CdTe, CIGS and organic solar cell including dye-sensitized solar cell)
	Solar Hydrogen Production System
	Grid Connected Photovoltaic
	Solar PV Hybrid Systems
	Solar Power Regenerative Electrolyzer/Fuel Cell System
	Charge controllers
	Inverters
	Power Quality
	Impact study on PV technology to the grid
	http://www.ukm.my/seri/?lang=en
4. TNB Research	PV system performance - impact from local weather (cloud effect)
	Solar PV resource assessment and forecasting
	PV performance and reliability
	http://www.tnbr.com.my/tnbr/
5. Universiti Teknologi PETRONAS	CPV
	PV performance

Research Institute	Areas of R&D
	http://www.utp.edu.my/
6. Universiti Teknologi Malaysia	Study of partial shading problem for PV in tropical countries
	Development of MPPT for PV inverters using soft computing methods
	Design and construction of PV charging station for Electric Vehicle.
	Monitoring of performance of various PV technologies under tropical environment
	Development of new "inverter efficiency index" for PV inverters for tropical regions.
	Partial shading solution based on hardware energy harvesting.
	http://www.utm.my/
7. UNITEN Power Engineering Centre	Grid connection issues of PV plants
	http://www.uniten.edu.my/research/pec/Pages/Introduction.aspx
8. Universiti Tunku Abdul Rahman	CPV
	http://www.utar.edu.my/main.jsp
9. Universiti Malaysia Perlis	PV application performance
	http://www.unimap.edu.my/
10. Universiti Malaysia Trengganu	organic solar cells
	solar thermal collector
	http://www.umt.edu.my/index.php?go=
11. Universiti Sains Malaysia	PV cells
	http://www.usm.my/index.php/en/

4.2 Public budgets for market stimulation, demonstration / field test programmes and R&D

Table 15: Public budgets for R&D, demonstration/field test programmes and market incentives.

	R & D	Demo/Field test
National/federal	Not available	
State/regional		
Total		

5 INDUSTRY

5.1 Production of feedstocks, ingots and wafers (crystalline silicon industry)

Table 16: Production information for the year for silicon feedstock, ingot and wafer producers

Manufacturers (or total national production)	Process & technology	Nameplate Capacity	Product destination (if known)	Price (if known)
Elpion Silicon	Metallurgical Grade Silicon	33,4 tonnes	Export to parent company, OCI in South Korea	Not available
Tokuyama	Polycrystalline silicon	20 tonnes	-	
SunEdison (formerly MEMC)	mc-Si & sc-Si wafers	1000 MW	Wafer exported to Taiwan	

(Source: Malaysian Industry-Government Group for High Technology)

5.2 Production of photovoltaic cells and modules (including TF and CPV)

Module manufacturing is defined as the industry where the process of the production of PV modules (the encapsulation) is done. A company may also be involved in the production of ingots, wafers or the processing of cells, in addition to fabricating the modules with frames, junction boxes etc. The manufacturing of modules may only be counted to a country if the encapsulation takes place in that country.

Total PV cell and module manufacture together with production capacity information is summarised in the table below.

Table 17: Production and production capacity information for 2014

Cell/Module manufacturer (or total national production)	**Technology** (sc-Si, mc-Si, a-Si, CdTe)	**Total Production (MW)**		**Maximum production capacity (MW/yr)**	
		Cell	Module	Cell	Module
Wafer-based PV manufactures					
1. AUO-Sunpower	mc-Si	Data not available		700	
2. Panasonic	HiT			300	300
3. Hanwha Q-Cells	sc-Si			1 000	
4. TS Solartech	sc-Si			400	
5. Flextronics	sc-Si				577
6. Malaysian Solar Resource	mc-Si & sc-Si				200
7. SolarTIF	sc-Si				5
8. PV Hi-Tech Solar	sc-Si				5
Total				2 400	1 087
Thin film manufacturers					
1. First Solar	CdTe	Data not available			1 690
TOTALS				**2 400**	**2 777**

(Source: Malaysian Industry-Government Group for High Technology)

5.3 Manufacturers and suppliers of other components

Malaysia has a large PV manufacturing base, subsequently, supporting industry is gaining importance. The table below lists some of the companies in the PV supporting industry.

Table 18: List of Companies in PV Supporting Industry

Type of Supporting Industry	Company
Chemical & Raw Material	1. SPCI 2. May Chemical 3. Titan Chemicals 4. KLH Chemicals 5. Classic Advantage 6. Vital Technical 7. Dou Yee 8. Nagase 9. STR 10. Luvata
Equipment/Machineries	1. ATS Automation 2. Invenpro 3. Ulvac 4. Frontken 5. S&J Barcode 6. UMS 7. Siemens 8. Oryx 9. RedRing Solder
Industrial Gas	1. Linde EOX 2. Air Products
Production Supply	1. Ire-tex 2. Master-Pack 3. Super Starnix 4. Prostat 5. HexaChase 6. Proguard 7. Namhwa Paper Industries 8. Standard Box Industry
BoS	1. ETI Tech (M) 2. Huber+Suhner (M) 3. ABB Malaysia 4. Schneider Electric (M) 5. Innotech Synergy 6. Superpan 7. Barysol (M)
Inverter	1. Tamura Electronics (M) (Leonics inverter)

(Source: Malaysian Industry-Government Group for High Technology)

6 PV IN THE ECONOMY

6.1 Labour places

Table 19: Estimated PV-related labour places in 2014

Research and development (not including companies)	66
Manufacturing of products throughout the PV value chain from feedstock to systems, including company R&D	
Distributors of PV products	
System and installation companies	11 204
Electricity utility businesses and government	200
Other	30
Total	11 500

6.2 Business value

Table 20: Value of PV business

Sub-market	**Capacity installed *in 2014* (MW)**	**Price per W** *(from table 7)*	**Value**	**Totals**
Off-grid domestic	*Pricing Data not available*			
Off-grid non-domestic				
Grid-connected distributed	86,73	MYR 8,00	*MYR 693 840*	*MYR 693 840*
Grid-connected centralized	*NA*			
				MYR 693 840
Export of PV products				*Data not available*
Change in stocks held				*Data not available*
Import of PV products				*Data not available*
Value of PV business				*Data not available*

7 INTEREST FROM ELECTRICITY STAKEHOLDERS

7.1 Structure of the electricity system

Short description of the electricity industry landscape	Peninsular Malaysia: Electricity market (generation, transmission & distribution) is monopolised by Tenaga Nasional Berhad (TNB), which is a Gov't linked company. IPPs exist, and they largely sell their electricity to TNB. The list of IPPs in Peninsular Malaysia can be found in http://www.st.gov.my/index.php/industry/ipps-directories/list-of-independent-power-producers-ipps/peninsular-malaysia.html. In 2014, the Government successfully segregated the accounts of generation, transmission and distribution sectors to increase transparency. Generation mix is 53,8 % gas, 35,3 % coal, 10.3 % hydro, 0,6 % distillates and 0,04 % medium fuel oil (MFO). Sarawak is the only state whereby they have their own autonomy over electricity generation. The electricity market (generation, transmission & distribution) in Sarawak is monopolised by Sarawak Energy Bhd, which is 100 % owned by the state. Generation mix in Sarawak is 60 % hydro, 20 % coal and 20 % gas. The ratio for hydro will continue to increase in Sarawak; the state has in excess of 20 GW of hydro potential. Sabah: The electricity market (generation, transmission & distribution) in Sabah is monopolised by Sabah Electricity Sdn Bhd, which is 80 % owned by TNB and 20 % owned by the state. The list of IPPs in Sabah can be found in http://www.st.gov.my/index.php/industry/ipps-directories/list-of-independent-power-producers-ipps/list-of-independent-power-producers-at-sabah-ipps.html. Generation mix in Sabah is 67 % gas, 21 % MFO & Diesel, 8 % hydro and 4 % biomass. Energy Commission of Malaysia, created under the Energy Commission Act 2001, (www.st.gov.my) regulates electricity industry in Peninsular Malaysia and Sabah. In Sarawak, the regulatory role is vested with the electrical Inspectorate Unit under the Ministry of Public Utilities Sarawak (http://www.mpu.sarawak.gov.my/) .

7.2 Interest from electricity utility businesses

- In Peninsular Malaysia, by 2019, another 7.500 MW of coal and gas plants will be included in the generation mix, increasing the total generating capacity to close to 29 GW. By 2020, coal will increase from 43 % to 53 % whereas gas will drop from 40 % to 29 % (11th Malaysia Plan, Chapter 7). Hydrocarbon in the generation mix will still continue to dominate up to 2020.
- Concern on stranded asset cost recovery: As a result of the commitment to the 7.500 MW of new coal and gas plants, from utility's viewpoint in Malaysia, the need to prevent the situation of not being able to recover from stranded assets costs is crucial. For this reason, revenue stream from sales of electricity remains very important and any measures (e.g. net metering/self-consumption) are still being discussed with the utilities and government ministry and relevant authorities to ensure any losses to sales revenue are reduced as much as possible.
- Government is looking into investment in nuclear power plants as dispatchable generation (11th Malaysia Plan, Chapter 7)
- PV power plants are seen by utilities as unreliable power supply because they are not dispatchable generations like conventional, fossil-fuel based plants.
- PV power plants are keen as consuming too much usable land; Malaysia is a small country and such use of land space for PV power plants is seen as being wasteful.
- Highly subsidized natural gas in the production of electricity has kept the electricity tariff low. There are plans in place to address subsidy rationalization albeit there were some delays in the implementation. Based on current situation, grid parity for PV is still far ahead.
- Unlike Germany and some European countries which are on the way to democratize their electricity markets, Malaysia's electricity market is still highly regulated with limited flexibility/alternatives for the consumers.

In conclusion, Malaysia is still progressing towards achieving widespread local PV market. However, taking the cues from the recent boom in internet and mobile phone technologies, it is envisaged that the need to democratize electricity market is only a question of time. As the country moves towards a developed status (target 2020), people will want greater empowerment to decide where their electricity source should come from, how much they wish to pay for electricity and eventually, if they should defect from the grid. The internet and mobile phone technologies have seen a move from a centralized and rigid control to a distributed and flexible management of technologies by end-users. Electricity will be that next wave of disruptive technology once regional and international geopolitical decision on interoperability among grid protocol and electricity pricing (distortions) are resolved.

7.3 Interest from municipalities and local governments

At the federal level, the government has initiated a project to install PV systems on 25 selected government buildings with total capacity of 670 kW. The project which began in 2014 is expected to finish by mid-2015. Electricity generated by PV system on these buildings will be for self-consumption purpose. The 670 kW PV systems are expected to generate about 804 MWh per annum with CO2 emission avoidance of 596 tonnes per year.

At state level, various states have their own PV aspirations e.g. the state of Melaka has aspired to be "Melaka World Solar Valley", having AUO-SunPower as the key PV manufacturer and several moderate size PV power plants.

8 STANDARDS AND CODES

Under the RE Act 2011 [Act 725], there is a subsidiary legislation on the Technical and Operations (T&O) Requirements Rules to be complied with by distribution licensees and feed-in approval holders.

In addition to the subsidiary legislation, SEDA together with key stakeholders such as the distribution licensees, Energy Commission have developed several procedures with regards to PV systems:

1. Guidelines and Determinations of SEDA – which provides guidelines pursuant to the T&O rules 2011;
2. Procedure for the Testing and Commissioning of Grid-Connected Photovoltaic Systems in Malaysia – this procedure is only relevant for PV installations greater than 12 kW and carried out by owner's qualified person;
3. TNB Technical Guidebook on Grid-interconnection of Photovoltaic Power Generation – all PV installations to be connected to low and medium networks are required to comply with TNB's PV interconnection guide;
4. Power systems study (PSS) or Connection Confirmation Check (CCC): before applying for any FiT application, the eligible producer is required to conduct a PSS (for installations greater than 425 kW and above) or CCC (for installations greater than 12 kW and up to 425 kW) with Distribution Licensee to assess the potential impact of the distributed generation on the planning and operation of the Distribution Licensee's distribution system;
5. Malaysian Grid Code – published by the Energy Commission of Malaysia is a regulatory instrument in which power generators are required to comply with to ensure electricity supply in Peninsular Malaysia remains reliable. The Malaysian Grid code and Sabah and Labuan Grid Code can be downloaded from http://www.st.gov.my/index.php/industry/grid-system-operation.html.
6. There are two standards on PV have been established by SIRIM (formerly known as the Standards & Industrial Institute of Malaysia); the standards can be purchased online via http://www.msonline.gov.my/default.php and they are:
    a. MS 1837: 2010 *Installation of Grid-connected PV Systems* (First Revision), and
    b. MS2440: 2012 *Design, Installation, Maintenance and Inspection of PV Mounting System*.

9 HIGHLIGHTS AND PROSPECTS

Market drivers for PV:

Beyond the FiT (which may end by 2017), *net metering* and *solar utility scales* (USS) are aspired to be the next policy instruments to enable local PV market to grow. However, this is operating within the current constraints as outlined in section 7.2.

Industry drivers for PV:

- The on-going *anti-dumping and countervailing duties* imposed on Chinese and Taiwanese PV products by US and EU have made Malaysia an attractive circumvention strategy to bypass such punitive measures. The Government (via Ministry of International Trade and Industry, MITI, together with Malaysia Investment Development Authority, MIDA) has taken prudent measures to prevent Malaysia being a target country for such circumvention activities.
- New PV foreign direct investments commencing operation in 2015 include:
    - As at end of 2014, *Comtec Solar* (from China) is constructing their monocrystalline wafer plant in the state of Sarawak, the expected nameplate capacity of the plant is 1 000 MW.
    - As at end of 2014, *TetraSun First Solar* is in the progress of constructing their 100 MW high efficiency monocrystalline wafer plant in the state of Kedah, Malaysia. The target market is Japan.
    - *Jingko Solar* is also constructing their manufacturing facility in Penang a 500 MW solar cells fabrication and 450 MW for PV module assembly.
- PV manufacturing expansion plans in 2015 include:
    - *SunEdison* is expected to expand their wafer plant capacity from 1 000 MW to 1200 MW.
    - *First Solar* in Malaysia will expand their annual production capacity to 2 000 MW (from 1 690 MW).

Definitions, Symbols and Abbreviations

For the purposes of this and all IEA PVPS National Survey Reports, the following definitions apply:

PV power system market: The market for all nationally installed (terrestrial) PV applications with a PV power capacity of 40 W or more.

Installed PV power: Power delivered by a PV module or a PV array under standard test conditions (STC) – irradiance of 1 000 W/m^2, cell junction temperature of 25^oC, AM 1,5 solar spectrum – (also see 'Rated power').

Rated power: Amount of power produced by a PV module or array under STC, written as W.

PV system: Set of interconnected elements such as PV modules, inverters that convert d.c. current of the modules into a.c. current, storage batteries and all installation and control components with a PV power capacity of 40 W or more.

CPV: Concentrating PV

Hybrid system: A system combining PV generation with another generation source, such as diesel, hydro, wind.

Module manufacturer: An organisation carrying out the encapsulation in the process of the production of PV modules.

Off-grid domestic PV power system: System installed to provide power mainly to a household or village not connected to the (main) utility grid(s). Often a means to store electricity is used (most commonly lead-acid batteries). Also referred to as 'stand-alone PV power system'. Can also provide power to domestic and community users (plus some other applications) via a 'mini-grid', often as a hybrid with another source of power.

Off-grid non-domestic PV power system: System used for a variety of industrial and agricultural applications such as water pumping, remote communications, telecommunication relays, safety and protection devices, etc. that are not connected to the utility grid. Usually a means to store electricity is used. Also referred to as 'stand-alone PV power system'.

Grid-connected distributed PV power system: System installed to provide power to a grid-connected customer or directly to the electricity grid (specifically where that part of the electricity grid is configured to supply power to a number of customers rather than to provide a bulk transport function). Such systems may be on or integrated into the customer's premises often on the demand side of the electricity meter, on public and commercial buildings, or simply in the built environment on motorway sound barriers etc. They may be specifically designed for support of the utility distribution grid. Size is not a determining feature – while a 1 MW PV system on a rooftop may be large by PV standards, this is not the case for other forms of distributed generation.

Grid-connected centralized PV power system: Power production system performing the function of a centralized power station. The power supplied by such a system is not

associated with a particular electricity customer, and the system is not located to specifically perform functions on the electricity grid other than the supply of bulk power. Typically ground mounted and functioning independently of any nearby development.

Turnkey price: Price of an installed PV system excluding VAT/TVA/sales taxes, operation and maintenance costs but including installation costs. For an off-grid PV system, the prices associated with storage battery maintenance/replacement are excluded. If additional costs are incurred for reasons not directly related to the PV system, these should be excluded. (E.g. If extra costs are incurred fitting PV modules to a factory roof because special precautions are required to avoid disrupting production, these extra costs should not be included. Equally the additional transport costs of installing a telecommunication system in a remote area are excluded).

Field Test Programme: A programme to test the performance of PV systems/components in real conditions.

Demonstration Programme: A programme to demonstrate the operation of PV systems and their application to potential users/owners.

Market deployment initiative: Initiatives to encourage the market deployment of PV through the use of market instruments such as green pricing, rate based incentives etc. These may be implemented by government, the finance industry, electricity utility businesses etc.

Final annual yield: Total PV energy delivered to the load during the year per kW of power installed.

Performance ratio: Ratio of the final annual (monthly, daily) yield to the reference annual (monthly, daily) yield, where the reference annual (monthly, daily) yield is the theoretical annual (monthly, daily) available energy per kW of installed PV power.

Currency: The currency unit used throughout this report is MYR (Malaysian Ringgit). Exchange rate of MYR 1 – EUR 0,2352 (http://www.bnm.gov.my, accessed on 31st December 2014).

PV support measures:

Feed-in tariff	an explicit monetary reward is provided for producing PV electricity; paid (usually by the electricity utility business) at a rate per kWh that may be higher or lower than the retail electricity rates being paid by the customer
Capital subsidies	direct financial subsidies aimed at tackling the up-front cost barrier, either for specific equipment or total installed PV system cost
Green electricity schemes	allows customers to purchase green electricity based on renewable energy from the electricity utility business, usually at a premium price

PV-specific green electricity schemes	allows customers to purchase green electricity based on PV electricity from the electricity utility business, usually at a premium price
Renewable portfolio standards (RPS)	a mandated requirement that the electricity utility business (often the electricity retailer) source a portion of their electricity supplies from renewable energies
PV requirement in RPS	a mandated requirement that a portion of the RPS be met by PV electricity supplies (often called a set-aside)
Investment funds for PV	share offerings in private PV investment funds plus other schemes that focus on wealth creation and business success using PV as a vehicle to achieve these ends
Income tax credits	allows some or all expenses associated with PV installation to be deducted from taxable income streams
Compensation schemes (self-consumption, net-metering, net-billing…)	These schemes allow consumers to reduce their electricity bill thanks to PV production valuation. The schemes must be detailed in order to better understand if we are facing self-consumption schemes (electricity consumed in real-time is not accounted and not invoiced) or net-billing schemes (the electricity taken from the grid and the electricity fed into the grid are tracked separately, and the electricity account is reconciled over a billing cycle). The compensation for both the electricity self-consumed and injected into the grid should be detailed. Net-metering schemes are specific since they allows PV customers to incur a zero charge when their electricity consumption is exactly balanced by their PV generation, while being charged the applicable retail tariff when their consumption exceeds generation and receiving some remuneration for excess electricity exported to the grid
Commercial bank activities	includes activities such as preferential home mortgage terms for houses including PV systems and preferential green loans for the installation of PV systems
Activities of electricity utility businesses	includes ‘green power’ schemes allowing customers to purchase green electricity, operation of large-scale (utility-scale) PV plants, various PV ownership and financing options with select customers and PV electricity power purchase models
Sustainable building requirements	includes requirements on new building developments (residential and commercial) and also in some cases on properties for sale, where the PV may be included as one option for reducing the building’s energy foot print or may be specifically mandated as an inclusion in the building development