IEA INTERNATIONAL ENERGY AGENCY

National Survey Report of PV Power Applications in MALAYSIA
2015

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 Technology Collaboration 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

Cover picture: 5 MW PV farm on single-axis tracker, Fortune 11 Solar Farm Dengkil, Malaysia

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 2015. 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 2015 statistics if the PV modules were installed and connected to the grid between 1 January and 31 December 2015, although commissioning may have taken place at a later date**.

1.1 Applications for Photovoltaics

Prior to 2011, grid-connected photovoltaic (PV) applications were driven by a project under the joint effort between the Government of Malaysia and UNDP-GEF. The project was the Malaysia Building Integrated Photovoltaic (MBIPV)[1] which spanned from 2006 to 2010. The project together with the Ministry of Energy, Green Technology and Water (executing agency) culminated in the formulation of the National Renewable Energy Policy and Action Plan which was approved by the Cabinet on 20th April 2010. Within the next 12 month, the Renewable Energy Act 2011 [Act 725] and Sustainable Energy Development Authority Act 2011 [Act 726] were passed in Malaysia. Sustainable Energy Development Authority (SEDA) Malaysia was established on 1st September 2011 and the feed-in tariff (FiT) scheme was implemented on 1st December 2011[2]. Under the FiT portfolio, there are five renewable resources: biomass, biogas, small hydro, geothermal and PV. Today, PV market in Malaysia is dominated by grid-connected PV applications largely residential rooftop applications; however, the installed capacity is dominated by non-individuals.

1.2 Total photovoltaic power installed

The data on PV reported is limited to projects approved under the FiT and does not include any PV projects that are off-grid or PV installed for the purpose of self-consumption. The data reported has high accuracy as SEDA is the authority administrating the FiT applications. All PV capacities reported are DC-rated.

[1] www.mbipv.net.my

[2] The FiT has jurisdiction covering the entire country with the exception of the state of Sarawak which has its own electricity ordinance governing its own electricity supply.

Table 1: PV power installed during calendar year 2015

AC			MW installed in 2015 (mandatory)	DC
Grid-connected	BAPV	Residential	18,7516	DC
		Commercial		
		Industrial		
	BIPV (if a specific legislation exists)	Residential	6,0753	DC
		Commercial		
		Industrial		
	Ground-mounted	cSi and TF	2,000	DC
Off-grid		Residential	Nil	
		Other		
		Hybrid systems		
		Total	**26,8269**	

Table 2: Data collection process:

If data are reported in AC, please mention a conversion coefficient to estimate DC installations.	All PV installed capacity data reported are DC-rated
Is the collection process done by an official body or a private company/Association?	SEDA
Link to official statistics (if this exists)	www.seda.gov.my

Table 3: PV power and the broader national energy market.

MW-GW for capacities and GWh-TWh for energy	**2015 numbers**	**2014 numbers**
Total power generation capacities (all technologies)	Not available	29.974 MW
Peak Demand		19.845 MW
Total power generation capacities (renewables including hydropower)		5677,7 MW
Total electricity demand (= consumption)		128.330 GWh
New power generation capacities installed during the year (all technologies)		Not available
New power generation capacities installed during the year (renewables including hydropower)	89,4 MW	Not available

MW-GW for capacities and GWh-TWh for energy	**2015 numbers**	**2014 numbers**
Total PV electricity production in GWh-TWh	Not available	159.968 MWh
Total PV electricity production as a % of total electricity consumption		0,12%

Table 4: Other informations

	2015 Numbers
Number of PV systems in operation in your country (a split per market segment is interesting)	Individuals: 1.752 systems (14,091 MW) Non-individuals: 37 systems (12,026 MW) Community: 45 systems (0,709 MW) Total (2015): 1.834 systems (26,826 MW)
Capacity of decommissioned PV systems during the year in MW	1 system (0,1766 MW)
Total capacity connected to the low voltage distribution grid in MW	1.825 systems (19,322 MW)
Total capacity connected to the medium voltage distribution grid in MW	9 systems (7,504 MW)
Total capacity connected to the high voltage transmission grid in MW	None

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

Sub-market	Stand-alone domestic	Stand-alone non-domestic	Grid-connected distributed	Grid-connected centralized
Prior 2013	No data		31,58	**Nil**
2013			107,01	
2014			65,06	
2015			26,83	
TOTAL (MW)			230,48	

2 COMPETITIVENESS OF PV ELECTRICITY

2.1 Module prices

The prices below are including of Goods & Services Tax (GST). In Malaysia, the GST came into effect on 1st April 2015, the standard GST rate is 6 %.

Table 6: Typical module prices for a number of years

Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015[3]
Standard module crystalline silicon 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	3,07
Lowest prices	No data available									2,00	2,13
Highest prices	No data available										4,80

2.2 System prices

The prices below are including of Goods & Services Tax (GST).

Table 7: **Turnkey Prices of Typical Applications – local currency**

Category/Size	Typical applications and brief details	Current prices per W
Grid-connected Rooftop up to 12 kW	This cost includes cabling, interconnection and substation.	MYR 7,79
Grid-connected PV systems up to 425 kW (non-individuals)	This cost includes cabling, interconnection and substation.	MYR 6,83
Grid-connected PV systems above 425 kW and up to 1 MW (non-individuals)	This cost includes cabling, interconnection and substation.	MYR 6,92

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

Price (MYR) /Wp	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
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	7,79
Commercial and industrial (up to 425kW)	Not available									8,0	6,83
Ground-mounted (up to 1 MW)										7,5	6,92

[3] Based on residential up to 12 kW

2.2 Cost breakdown of PV installations

The prices below are including of Goods & Services Tax (GST).

2.2.1 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	3,07	2,13	4,80
Inverter	1,00	0,46	1,48
Other (racking, wiring…)	0,94	0,34	1,81
Soft costs			
Installation	1,36	0,57	2,73
Customer Acquisition	0,02	0,16	0,25
Other (permitting, contracting, financing…)	0,11	0,02	0,39
Profit	1,29	0,12	3,06
Subtotal Hardware	**5,01**	**Not applicable***	
Subtotal Soft costs	**2,78**		
Total	**7,79**		

*Caveat: the above pricings for highest/lowest category do not reflect a single system pricing but the component of pricing that is highest/lowest. Subsequently, it is not applicable to include a subtotal for hardware/software and total.

2.2.2 Utility-scale PV systems ≤ 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	2,45	2,13	2,70
Inverter	0,67	0,48	0,87
Other (racking, wiring, etc.)	1,23	0,60	1,99
Soft cost			
Installation Labor	1,49	0,50	2,35
Customer acquisition	0,02	0,0002	0,06

Cost Category	Average (local currency/W)	Low (local currency/W)	High (local currency/W)
Other (contracting, permitting, financing etc.)	0,67	0,02	1,97
Profit	0,39	0,14	0,73
Subtotal Hardware	**4,35**	**Not applicable****	
Subtotal - Soft cost	**2,57**		
Total Installed Cost	**6,92**		

**Caveat: the above pricings for highest/lowest category do not reflect a single system pricing but the component of pricing that is highest/lowest. Subsequently, it is not applicable to include a subtotal for hardware/software and total.

2.3 Financial Parameters and specific financing programs

Table 11: PV financing scheme

Average rate of loans – residential installations	Not available
Average rate of loans – commercial installations	Between 7 - 8 % p.a.
Average cost of capital – industrial and ground-mounted installations	Between 7 - 8 % p.a. or BLR[4] + 0,5%

2.4 Specific investments programs

Table 12: Investment Programs

Third Party Ownership (no investment)	None
Renting	
Leasing	
Financing through utilities	
Investment in PV plants against free electricity	
Crowdfunding (investment in PV plants)	
Other (please specify)	CSR activity

[4] Prevailing base lending rate (BLR) is between 6,60% to 6,85% (http://www.bnm.gov.my/documents/2016/base_rates/BR%20&%20ELR_160805.pdf, accessed 4th August 2016).

2.5 Additional Country information

Table 13: Country information

Retail Electricity Prices for an household (range)	Peninsular Malaysia, range of electricity tariff (2015) was from MYR 0,2180/kWh to MYR 0,5710/kWh (source: http://www.tnb.com.my/residential/pricing-and-tariff/tariff-rates.html).
Retail Electricity Prices for a commercial company (range)	Peninsular Malaysia, range of electricity tariff (2015) was from MYR 0,435 to MYR 0,509/kWh (LV), MYR 0,365/kWh (MV), maximum demand charges applied (MV) @ (source: https://www.tnb.com.my/commercial-industrial/pricing-tariffs1/).
Retail Electricity Prices for an industrial company (range)	Peninsular Malaysia, range of electricity tariff (2015) was from MYR 0,38 to MYR 0,441/kWh (LV), MYR 0,296 to MYR 0,337/kWh (MV maximum demand charges applied (MV) @ (source: https://www.tnb.com.my/commercial-industrial/pricing-tariffs1/).
Population at the end of 2015 (or latest known)	31 329 503 (source: http://www.statistics.gov.my/, accessed 30th April 2016)
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

3.1 Direct support policies for residential installations

Table 14: PV support measures (summary table)

	On-going measures residential	Measures that commenced during 2015 - residential	On-going measures Commercial + industrial	Measures that commenced during 2015 – commercial + industrial	On-going measures Ground-mounted	Measures that commenced during 2015 – ground mounted
Feed-in tariffs[5]	yes		yes		yes	
Feed-in premium (above market price)						
Capital subsidies						
Green certificates						
Renewable portfolio standards (RPS) with/without PV requirements						
Income tax reduction			Green Technology Incentive in the form of Investment Tax Allowance for owners of PV projects			
	Green Technology Incentive in the form of Income Tax Exemption for PV service providers [6]					
Self-consumption	On-going					
Net-metering						
Net-billing						
Commercial bank activities e.g. green mortgages promoting PV[7]	yes		yes		yes	
Activities of electricity utility businesses[8]			Test-Pilot Floating PV system			
Sustainable building requirements	Not mandated although standards and assessment tools are available[9]					
BIPV incentives	BIPV incentives under the FiT have always been available since 2011 in the form of bonus tariff but in 2015, the requirements of BIPV[10] are under continuous refined					
Other (specify)						

[5] The FiT has jurisdiction covering the entire country with the exception of the state of Sarawak which has its own electricity ordinance governing its own electricity supply.

[6] http://www.mida.gov.my/home/tax-incentives-for-green-industry/posts/

[7] Green Technology Financing Scheme, https://www.gtfs.my/.

[8] https://www.tnb.com.my/assets/accolades/6a64f235e772a4c68046f641e7eb72c1.pdf

[9] http://new.greenbuildingindex.org/, http://www.msonline.gov.my/download_file.php?file=14239&source=production , http://www.cidb.gov.my/cidbv4/images/pdf/announcement/MyCrest/myCrest.pdf.

[10] https://efit.seda.gov.my/?omaneg=00010100000001010101000100001000000001010000010001l0&id=1810.

Direct Support measures

3.1.1 Support measures exiting in 2015

There are no support measures exiting in 2015.

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

None.

3.1.1.2 Prosumers' development measures

Self-consumption is permitted in Malaysia under the condition that there is no injection of excess electricity to the grid and to achieve this, the prosumer is required to install a reverse power relay.

3.1.1.3 BIPV development measures

Under the Green Building Index (GBI) certification[11], building features with PV will contribute to the green building assessment.

3.1.1.4 Rural electrification measures

None.

3.1.1.5 Other measures including decentralized storage and demand response measures

By 1st January 2016, TNB will implement the enhanced Time-of-Use (ETOU) electricity tariff scheme for Commercial consumers at medium voltage and industrial consumers at both medium and high voltages. These rates will be determined for peak, mid-peak and off-peak times of the day on energy charge (kWh) and peak and mid-peak for demand charge (kW). The rates will be off-peak for the entire weekend and any public holidays[12].

3.1.2 Support measures phased out in 2015

None.

3.1.3 New support measures implemented in 2015

Green Technology Incentive [13] provides investment tax allowance for PV developers/owners of projects an income tax exemption for PV service providers. However, PV projects approved under the FiT mechanism are not eligible for this incentive.

[11] http://new.greenbuildingindex.org/

[12] https://www.tnb.com.my/faq/etou/

[13] http://www.mida.gov.my/home/tax-incentives-for-green-industry/posts/

3.1.4 Measures currently discussed but not implemented yet

Net energy metering (NEM) which will be implemented by SEDA in 2016/2017 and competitive bidding for the large scale solar (LSS) power plants by the Energy Commission.

3.1.5 Financing and cost of support measures

The FiT is supported by the Renewable Energy (RE) fund contributed by electricity consumers of TNB, SESB and NUR Distribution Sdn Bhd. Electricity consumers with more than 300 kWh usage per month are obliged to contribute 1,6% of their electricity bill to the RE fund. The rest of the fiscal and monetary support draw from the Government's consolidated fund.

Other financing support by the Government includes the Green Technology Financing Scheme (GTFS) as highlighted in Table 14 under 3.1. The purpose of the Scheme that offers a 60% guarantee of the financing amount and a rebate of 2% on the interest/profit rate charged by the financial institutions is to accelerate the expansion of green investments by providing easier access to financing from the private and commercial financial institutions.

3.2 Indirect policy issues

Several policy enablers that may positively influence the PV market to grow in Malaysia: (i) Fully rationalizing of subsidy on electricity tariff (ii) liberalizing of electricity supply industry (iii) reduce the planting up of new coal/gas power plants that may potentially crowd out PV in the electricity mix, and (iv) energy transition roadmap .

3.2.1 International policies affecting the use of PV Power Systems

Paris Agreement:

At the COP21 held in Paris at the end of 2015, Malaysia has pledged our INDC whereby Malaysia intends to reduce its GHG emissions intensity of GDP by 45 % by 2030 relative to the emissions intensity of GDP in 2005. This consists of 35 % on an unconditional basis and a further 10 % is condition upon receipt of climate finance, technology transfer and capacity building from developed countries.

APAEC Commitment

ASEAN Plan of Action for Energy Cooperation (APAEC) 2016-2025 and agreed to reach a target of 23 % of RE in the total primary energy supply by 2025 and 20 % of energy intensity reduction by 2020 from 2005[14]

3.2.2 The introduction of any favourable environmental regulations

None

[14] http://www.aseanenergy.org/articles/strengthening-nre-and-eec-cooperation-with-china-japan-and-south-korea/

3.2.3 Policies relating to externalities of conventional energy

None

3.2.4 Taxes on pollution (e.g. carbon tax)

None

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

Malaysia is the Chair for the Renewable Energy Sub-sector Network (RE-SSN) under the ASEAN Centre of Energy (ACE) and participated in Asia-Pacific Economic Cooperation (APEC) meetings and workshops. Malaysia also sits as part of the ACE Governing Council represented by the Secretary-General of the Ministry of Energy, Green Technology and Water and the Deputy Secretary-General as Alternate Senior Officials on Energy (SOE) Leaders.[15]

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. The tables below show the list of universities and research institute and their research area involvement in solar PV.

Table 15: List of Universities and Research Institutes involved in R&D of Solar PV

National University of Malaysia (UKM)

PV Cell	PV Module	BOS	PV System	Others
• Bifacial C-Si Cell • Junction formation optimization of C-Si Cell • Surface texturisation of C-Si Cell • CdS/CdTe Cell • CdCl2 Treatment • Indoline-based dye for DSSC	• Bifacial module • PV-thermal panels with bifacial solar cell • Thermal analysis of semi-transparent PV	• Optimization of inverter • Optimization of MPPT controller	• Hybrid PV systems design • Performance study of PV/T collector	• Solar radiation monitoring • Solar radiation, solar energy, meteorological variables prediction

University of Malaya (UM)

PV Cell	BOS
• Nanostructured TiO2-Ge thin film • Multilayer Si/Ge thin-film	• SEPIC converter for MPPT • 6-phase induction motor drive • Active power filter for harmonic compensation • Transformerless inverter/converter • Multilever inverter/converter • Temperature sensor for PV inverter

[15] http://www.aseanenergy.org/about-ace/ace-governing-council/

University of Science, Malaysia (USM)

PV Cell
• Highly doped N-type porous Si • Nano-texturing of C-Si Cell • CdS/CIGS cell on PET substrate • ITO/ZnO and other thin film on PET substrate • Flexible substrate for electronic devices at low temperature of 70°C and atmospheric temperature

Universiti Teknologi Malaysia (UTM)

BoS	PV System
• Selective harmonics elimination with PWM for inverter • Bidirectional inverter/converter	• PV system simulator/MPPT/ Energy recovery scheme during partial shading condition

Universiti Putra Malaysia (UPM)

PV Cell	BOS	Others
• CIS thin film • SnSe thin film	Cascade voltage doubler for voltage multiplication	Solar radiation prediction

Universiti Teknologi MARA (UiTM)

PV System
• Grid-connected/stand-alone PV system sizing optimization • GCPV system output prediction

Technical University of Malaysia (UTEM)

• PV System
Energy recovery scheme during partial shading condition

Universiti Malaysia Perlis (UNIMAP)

PV Cell
Natural anthocyanins compound as photovoltaic sensitizer

Multimedia University (MMU)

PV System
Performance analysis of PV/T system

Universiti Tunku Abdul Rahman (UTAR)

PV Cell	BOS
• Non-imaging concentrator • Non-imaging focusing technology • Synthesis of TiO2 for DSSC	• Sun tracking system • Polymer electrolyte for lithium rechargeable battery

Universiti Malaysia Pahang (UMP)

PV Cell	PV System
• TiO2 nanostructure • Electrospinning of TiO2 and SnO2 nanoflowers/nanowires	Estimation of solar radiation

• Perovskite solar cells	

Universiti Teknologi PETRONAS (UTP)

PV Cell	PV System
• Optimization/Synthesis of TiO2 aggregates • Flexible DSC	• Estimation of solar radiation

SIRIM Berhad

Others
Fabrication of solar simulator

MIMOS Berhad

PV Cell	BOS
PV Device	Solar tracking apparatus

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

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

Table 16: 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)

On the PV manufacturing front, Malaysia remains a significant PV producer (after China and Taiwan). In 2015, the total metallurgical grade silicon (MGS) and polysilicon manufacturing nameplate capacity remained at 53,4 kilo tonnes with employment of 840. For wafer and ingot manufacturing, the total estimated nameplate capacity was 1.205 MW with employment of 970. Since the local PV market for Malaysia is miniscule, most of the production is for export to major PV markets such as Europe, Japan, and USA.

Table 17: Production information for the year for silicon feedstock, ingot and wafer producers

Manufacturers (or total national production)	Process & technology	~~Total Production~~ Nameplate Capacity	Product destination (if known)	Price (if known)
Elpion Si	Metallurgical Silicon feedstock	33,4 kilo tonnes	Not available	
Tokuyama	Poly-Si feedstock	20,0 kilo tonnes		
Sun Edison	P-type mc-Si wafer	1.000		
Comtec	N-type mc-Si ingot	205		

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

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

Total PV cell and module manufacture together with production capacity information is summarised in Table 9 below.

Table 18: Production and production capacity information for 2015

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
Thin film manufacturers					
First Solar	CdTe	Not available			2.400
Solar Cells & PV Modules					
1. AUO-SunPower	N-type mc-Si	Not available		750	
2. Hanwha Q-Cells	P-type Poly-Si			1.700	1.600
3. TS Solartech	Poly-Si			210	
4. First Solar Tetrasun	N-type mc-Si			100	
5. Jinko Solar	Poly-Si solar			500	450
6. Flextronics	OEM for Si				1.100
7. Panasonic	HIT N-type Mc-Si				300
8. MSR	Mc-Si & Poly-Si				85
9. Solartif (Multi-Si)	Poly-Si				10
10. PV HiTech (Multi-Si)	Poly-Si				5
11. Endau XT	Mc-Si & Poly-Si				75
12. Promelight	Mc-Si & Poly-Si				40
TOTALS				**3.260**	**6.065**

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

In 2015, JA Solar announced that it will be establishing a multicrystalline silicon solar cell fabrication plan in the city of Bayan Lepas, Malaysia. The plan has nameplate capacity of 400 MW with employment of 700 people and initial investment of MYR 300 million. As of end of 2015, there was no record of production [16].

[16] http://www.pv-magazine.com/news/details/beitrag/ja-solar-completes-70m-malaysian-fab_100021631/#axzz47MSVBcCF .

5.3 Manufacturers and suppliers of other components

Table 19: Supporting Industry of Solar PV

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

Although PV market is small in Malaysia, PV manufacturing industry is significant in the country. Most of the PV manufacturing companies are foreign direct investments (FDIs) from countries such as Japan, USA, South Korea, and China. The growth of FDIs is largely due to the efforts of the Malaysian Investment Development Authority (MIDA). According to MIDA, Malaysia is now the world's 3rd largest manufacturer of PV cell and module, contributing significantly to its economic growth and job creations. Based on a study conducted by GTM Research in 2015, Malaysia was ranked 4th in terms of global PV manufacturing attractiveness index behind China, Singapore and Taiwan[17].

6.1 Labour places

Table 20: Estimated PV-related labour places in 2015

Research and development (not including companies)	NA
Manufacturing of products throughout the PV value chain from feedstock to systems, including company R&D	13.985
Distributors of PV products	
System and installation companies	1.770
Electricity utility businesses and government	200
Other (PV Project Owners)	5.762
Total	21.717

6.2 Business value

Table 21: Value of PV business

Sub-market	**Capacity installed *in 2015* (MW)**	**Price per W *(from table 7)***	**Value**	**Total (MYR)**
Grid-connected distributed, up to 12 kW	**43,9878**	MYR 7,79		*342,22 million*
Grid-connected distributed, up to 425 kW	**2,3908**	MYR 6,83		*16,33 million*
Grid-connected distributed, up to 5 MW	**184,1005**	MYR 6,92		*1.274 million*
Grid-connected centralized	None			
Export of PV products				*Data not available*
Change in stocks held				
Import of PV products				
Value of PV business				

[17] http://www.mida.gov.my/home/3052/news/pvcelltech-2016-reaffirms-malaysia%E2%80%99s-position-as-leader-for-new-cell-fabrications-in-asean/

7 INTEREST FROM ELECTRICITY STAKEHOLDERS

7.1 Structure of the electricity system

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. Generation mix is 51,8 % gas, 42,3 % coal, 3,6 % hydro, 1,8 % distillates and medium fuel oil (MFO), and 0.5% co-gen[18].

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 48,2 % hydro, 25,4 % coal, 25,2 % gas and 1,3% diesel. 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 75,7 % gas, 14,9 % MFO & Diesel, 5,7 % hydro and 3,6 % renewable energy.

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 the Peninsular Malaysia Electricity Supply Outlook 2016[19] released by the Energy Commission of Malaysia, it was reported that renewable energy is "anticipated to play complementary role to fossil fuels due to factors such as output intermittency, location and system constraints, technology development and potential limitation". In addition, coal in the electricity generation mix will continue to dominate and peak at 66% in 2023 whereas renewable energy (exclude large hydro) will peak at 4% by 2017.

[18] All electricity mix data for Peninsular Malaysia, Sabah and Sarawak are from http://www.eri.chula.ac.th/eri-main/wp-content/uploads/2015/11/S1-3_Ketta_v2_new.0.pdf.

[19] http://www.st.gov.my/index.php/en/download-page/category/106-outlook.html?download=495:peninsular-malaysia-electricity-supply-industry-outlook-2014

8 HIGHLIGHTS AND PROSPECTS

Way Forward for PV Beyond 2015

PV under the FiT is expected to finish issuing quota post 2017. As mentioned in section 3.1.4, NEM of up to 500MW will allow consumers to self-generate most of their electricity requirement. In 2016, the Government will initiate a plan to introduce NEM to complement the on-going FiT system and subsequently replacing it by 2018. The main objective of NEM is to promote Renewable Energy (RE) in current energy generation mix, hence decreasing the dependency on fossil fuel according to the Renewable Energy Act 2011. Starting from 2016, a 100MW quota per year will be available for bidding. The quota is divided into three sections - Domestic, Commercial and Industrial which make up 10 %, 45 % and 45 % respectively of the total capacity. In addition to NEM, the introduction of Large-scale Solar of 200MW every year from 2017 to 2020 will provide a platform for potential solar-based power producers to compete on their own merit, while doing away with the need of continuous assistance from the Government (source: Peninsular Malaysia Electricity Supply Outlook 2016).

Also as mentioned in section 3.1.4, the Energy Commission will initiate a competitive bidding for LSS power plants by 2016. [20] The Government has decided that a quota of installed capacity of 250 MW will be allocated each year commencing 2017 to 2020, implying a total installed capacity of 1.000 MW by 2020. This competitive bidding is for LSS power plants to be located in Peninsular Malaysia and the state of Sabah. The quota split will be 200 MW for Peninsular Malaysia and 50 MW for Sabah per annum.

[20] http://www.st.gov.my/index.php/industry/competitive-bidding-for-combined-cycle-power-plant/large-scale-solar-photovoltaic-plant.html.

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°C, 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 0,2131 (http://www.bnm.gov.my, accessed on 31st December 2015).

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

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