IEA INTERNATIONAL ENERGY AGENCY

National Survey Report of PV Power Applications in MALAYSIA 2016

PHOTOVOLTAIC POWER SYSTEMS PROGRAMME

PVPS

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

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.

Cover picture: Solar farm – Fortune 11 located in Sepang, using a single axis tracker with an installed capacity of 5MW

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 2016 statistics if the PV modules were installed and connected to the grid between 1 January and 31 December 2016, although commissioning may have taken place at a later date**.

1.1 Applications for Photovoltaics

Since 2011, the grid-connected photovoltaic (PV) market in Malaysia is largely driven by the implementation of the feed-in tariff (FiT) mechanism by Sustainable Energy Development Authority Malaysia ("the Authority"). The FiT is framed by the Renewable Energy (RE) Act 2011 [Act 725] whilst the establishment of the Authority is under the SEDA Act 2011 [Act 726]. PV allocation under the FiT falls under three categories: individuals, communities and non-individuals. Nevertheless, PV under the FiT will be come to an end post 2017 due to limitation of the Renewable Energy (RE) Fund. 2016 marked the dawn of new programmes beyond the FiT with the implementation of Large Scale Solar (LSS) and Net Energy Metering (NEM) programmes by the Energy Commission (EC) of Malaysia and the Authority respectively. The main actors involved in the FiT, LSS and NEM are the Ministry of Energy, Green Technology and Water, the Authority, the EC, the distribution licensees, RE developers, and the PV service providers.

1.2 Total photovoltaic power installed

In 2016 alone, a total of 3 794 applications for PV under the FiT were approved with a total capacity of 101,60 MW. The breakdown of approved applications is as follows: individuals (3 449 applications 32,13 MW), community (126 applications 3,39 MW), and non-individuals (219 applications 66,08 MW). As at 31 December 2016, a **cumulative installed capacity of 335,7703** MW of PV projects were operational. The **installed PV capacity in 2016 alone was 71,8059 MW**; 14,3275 MW from individuals, 1,4526 MW from communities, and 56,0258 MW from non-individuals. More information on PV quota, FiT rates and operational capacity can be viewed at www.seda.gov.my.

Table 1: PV power installed during calendar year 2016

AC			MW installed in 2016 (mandatory)	MW installed in 2016 (optional but HIGHLY NEEDED)	AC or DC
Grid-connected	BAPV	Residential	30,9102		DC
		Commercial			DC
		Industrial			DC
	BIPV (if a specific legislation exists)	Residential	33,1257		DC
		Commercial			DC
		Industrial			DC
	Ground-mounted	cSi and TF	7,50		DC
		CPV			DC
	Floating Solar	cSi	0,27		
Off-grid		Residential			
		Other			
		Hybrid systems			
		Total	**71,8059**		

Table 2: Data collection process:

If data are reported in AC, please mention a conversion coefficient to estimate DC installations.	All PV capacities reported in this report are DC-rated
Is the collection process done by an official body or a private company/Association?	Sustainable Energy Development Authority Malaysia
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	2016 numbers	2015 numbers
Total power generation capacities (all technologies)	29 333 MW	Not available
Total power generation capacities (renewables including hydropower)	9 199 MW	
Total electricity demand (= consumption)	PM: 17 788 MW (108 858 GWh) Sabah: 944 MW (5 141 GWh) Sarawak: 3 432 MW	PM: 16 822 MW (104 653 GWh) Sabah: 914 MW (4 980 GWh) Sarawak: 3,339 MW
New power generation capacities installed during the year (all technologies)	Not available	Not available
New power generation capacities installed during the year (renewables including hydropower)		
Total PV electricity production in GWh-TWh		
Total PV electricity production as a % of total electricity consumption		

Table 4: Other informations

	2016 Numbers
Number of PV systems in operation in your country (a split per market segment is interesting)	Individuals: 1586 systems (14,3275 MW) Non-individuals: 114 systems (56,0258 MW) Community: 62 systems (1,4526 MW) Total (2016): 1762 systems (71,8059 MW)
Capacity of decommissioned PV systems during the year in MW	None
Total capacity connected to the low voltage distribution grid in MW	1725 systems (31,4949 MW)
Total capacity connected to the medium voltage distribution grid in MW	37 systems (40,311 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	**2015**	**2016**
Stand-alone domestic	N/A	N/A
Stand-alone non-domestic	N/A	N/A
Grid-connected distributed	263,9644 MW	335,7703 MW
Grid-connected centralized	N/A	N/A
TOTAL (MW)	**263,9644**	**335,7703 MW**

*The 2015 figures have been updated according to data extracted from e-FiT on 4 July 2017.

Table 5B: Annual installed PV power in 4 sub-markets.

<table>
<tr><th>Sub-market</th><td>Stand-alone domestic</td><td>Stand-alone non-domestic</td><td>Grid-connected distributed</td><td>Grid-connected centralized</td></tr>
<tr><td>Prior 2013</td><td colspan="2" rowspan="5">No data</td><td>31,5787</td><td rowspan="6">Nil</td></tr>
<tr><td>2013</td><td>107,0118</td></tr>
<tr><td>2014</td><td>65,1217</td></tr>
<tr><td>2015</td><td>60,2522</td></tr>
<tr><td>2016</td><td>71.8059</td></tr>
<tr><td colspan="3">TOTAL (MW)</td><td>335,7703</td></tr>
</table>

*Figures shown above are based on data extracted from e-FiT on 4 July 2017, and thus they may not necessarily reflect the figures reported in the NSR from previous years.

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[1]	2016
Standard module crystalline silicon price(s): Typical (MYR per W)[2]	21,39	17,25	16,00	14,57	9,81	8,06	5,8	6,00	6,00	3,00	3,07	2,56
Lowest prices	No data available									2,00	2,13	2,47
Highest prices	No data available										4,80	2,67

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
OFF-GRID Up to 1 kW	No info	
OFF-GRID >1 kW	No info	
Grid-connected Rooftop: 12 kW (residential)	This cost includes cabling, interconnection and substation.	MYR 7,83
Grid-connected PV systems: 425 kW (non-individuals)	This cost includes cabling, interconnection and substation.	MYR 7,10
Grid-connected PV systems: 1 MW (non-individuals)	This cost includes cabling, interconnection and substation.	MYR 6,94

[1] Based on residential up to 12 kW

[2] The currency unit used throughout this report is MYR (Malaysian Ringgit). Exchange rate of MYR 1 – EUR 0,2117; MYR 1 – USD 0,2229 (http://www.bnm.gov.my, accessed on 31st December 2016).

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	2016
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	7,83
Commercial and industrial (425kW)	Not available									8,0	6,83	7,10
Commercial and industrial (1 MW)										7,5	6,92	6,94

**increase in 2016 prices due to weakening of RM against USD in the same year.*

2.3 Cost breakdown of PV installations

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

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	3,85	2,08	6,67
Inverter	1,30	0,67	2,50
Balance of System	1,34	0,25	3,81
Soft costs			
Installation	0,62	0,11	3,01
Design Cost	0,24	0,04	0,78
Preliminary Cost	0,21	0,01	0,71
Interconnection Cost	0,27	0,02	0,80
Subtotal Hardware	**6,49**	***Not applicable**	
Subtotal Soft costs	**1,34**		
Total	**7,83**		

2.3.2 Utility-scale PV systems at 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	2,85	2,33	3,62
Inverter	0,62	0,49	0,82
Balance of System	1,18	0,26	4,00
Soft costs			
Installation	0,68	0,25	1,85
Design Cost	0,27	0,05	0,67
Preliminary Cost	0,60	0,03	2,24
Interconnection Cost	0,74	0,41	1,38
Subtotal Hardware	**4,65**	***Not applicable**	
Subtotal Soft costs	**2,29**		
Total	**6,94**		

2.4 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[1] + 0,5%

2.5 Specific investments 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

[1] Prevailing base lending rate (BLR) is between 6,60% to 7,00% (http://www.bnm.gov.my/index.php?ch=8&pg=29&ac=19&bb=file, accessed 24th June 2017).

2.6 Additional Country information

Table 12: Country information

Retail Electricity Prices for an household (range)	Peninsular Malaysia, range of electricity tariff (2016) 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 (2016) 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 (2016) was from MYR 0,38 to MYR 0,441/kWh (LV), MYR MYR 0,337/kWh (E1 category: MV General Industrial Tariff maximum demand charges applied (MV), MYR 0,2190-MYR0,3550/kWh (E2 category – MV Peak/Off Peak Industrial Tariff with maximum demand charges applied) and MYR0,2020 – MYR0,3370/kWh (E3 category – HV Peak/Off Peark Industrial Tariff with maximum demand charges applied) @ (source: https://www.tnb.com.my/commercial-industrial/pricing-tariffs1/).
Population at the end of 2016 (or latest known)	32 148 751 (source: http:// https://www.dosm.gov.my/v1/, accessed 24th June 2017)
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 for PV installations

3.1.1 New, existing or phased out measures in 2016

3.1.1.1 Description of support measures excluding BIPV, and rural electrification

As mentioned in section 1.1, in 2016, the Government introduced both the Large Scale Solar (LSS) as well as the Net Energy Metering (NEM) scheme. The following para provides update on both schemes.

LSS Update: The total quota allocated for the LSS from 2017 to 2020 is 1 250 MW^2_{ac}. 250 MW_{ac} was granted direct awarded under fast track programme and these projects will achieve commercial operation in 2017. The remaining 1 000 MW_{ac} will be under bidding mechanism. At the end of 2016, the EC announced the winners of its LSS bidders who participated in the March 2016 call for tender for Peninsular Malaysia and Sabah. The capacity will reach commercial operation between 2017 and 2018. For Peninsular Malaysia, the capacity was divided into three categories – P1 (1 to 5 MW_{ac}), P2 (6 to 29 MW_{ac}) and P3 (30 to 50 MW_{ac}). For Sabah region, there were two packages – 1 to 5 MW_{ac} (S1) and 6 to 10 MW_{ac} (S2). A total of 450,896 MW_{ac} was awarded to 19 bidders, the result can be viewed at http://www.st.gov.my/images/highlight/2016/Announcement_RFP_Results.pdf.

NEM Update: On the 1st November 2016, the Authority opened the NEM application for domestic, commercial and industrial sectors. The NEM permits an eligible electricity consumer to install a PV system primarily for own use and the excess energy to be exported to the grid. The credit on the excess energy is based on prevailing Displaced Cost and credit can be rolled over for a maximum of 24 months. A total of 100 MW per year has been allocated from 2016-2010 making a total of 500 MW. As the NEM only started towards the end of 2016, only 27,4 kW of applications were approved and none have achieved operational in 2016. The digital dashboard on quota availability and allocation of the NEM can be viewed at https://services.seda.gov.my/nem/auth/login.

3.1.1.2 BIPV development measures

3.1.1.3 Rural electrification measures

On 9th June 2016, the Sarawak State Government supported by Sarawak Energy Berhad launched the Sarawak Alternative Rural Electrification Scheme (SARES) to provide electricity supply to remote communities where it is not viable for the electricity grid to reach these remote areas. The SARES target to provide electricity to 300 remote villates over the five

[2] *Unless specified, all PV capacities in this report are dc-rated.*

years in which under the first phase, 50 villages will be electrified by early 2017. The funding allocated for the scheme is MYR 500 million from both the State and Federal Government. The electricity source will be either solar PV hybrid with energy storage or micro hydro. For more information on SARES, please visit http://www.sarawakenergy.com.my/index.php/about-us/what-we-do/alternative-energy-for-sarawak

3.1.1.4 Support for electricity storage and demand response measures

There is no market for decentralised energy storage with PV systems yet although the Authority is considering initiating a programme on this.

With regards to demand response measures, the Government has initiated several programme such as offering incentives for energy audit conditional grant for energy intensive buildings and industry sectors. The Authority is currently implementing a 5-year United Nations Development Programme under the Global Environment Fund (UNDP-GEF) a project on Green Technology Applications for Low Carbon Cities (GTALCC). The Authority is also actively working with Local Authorities to promote reduce carbon footprint of buildings via energy audit, retrofitting energy efficiency measures and energy management.

On 1st January 2016, Tenaga Nasional Berhad (TNB), the main power utility in Peninsular Malaysia, has implemented 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 are 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[3].

Table 13: PV support measures (summary table) [FiT/RET]

	On-going measures residential	Measures that commenced during 2015 - residential	On-going measures Commercial + industrial	Measures that commenced during 2016 – commercial + industrial	On-going measures Ground-mounted	Measures that commenced during 2016 – ground mounted
Feed-in tariffs[4]	yes		yes		yes	
Feed-in premium (above market price)						
Capital subsidies						
Green certificates						
Renewable portfolio standards (RPS) with/without PV						

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

[4] 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.

	On-going measures residential	Measures that commenced during 2015 - residential	On-going measures Commercial + industrial	Measures that commenced during 2016 – commercial + industrial	On-going measures Ground-mounted	Measures that commenced during 2016 – ground mounted
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 [5]					
Self-consumption	On-going					
Net-metering				Yes		
Net-billing						
Commercial bank activities e.g. green mortgages promoting PV[6]	yes		yes		yes	
Activities of electricity utility businesses[7]			Test-Pilot Floating PV system			
Sustainable building requirements	Not mandated although standards and assessment tools are available[8]					
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[9] are under continuous refined					
Other (specify)						

3.2 Self-consumption measures

In Malaysia, there is the self-consumption scheme as well as the net energy metering (NEM) scheme. Under the self-consumption, excess PV electricity is not permitted to inject to the grid and power systems study is required for PV capacity greater than 425 kW and the system size is limited to 75 % of the maximum demand of the building. The NEM scheme is as described in the table below, for more information on NEM, please download the FAQ[10].

[5] http://www.mida.gov.my/home/tax-incentives-for-green-industry/posts/
[6] Green Technology Financing Scheme, https://www.gtfs.my/.
[7] https://www.tnb.com.my/assets/accolades/6a64f235e772a4c68046f641e7eb72c1.pdf
[8] 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.

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

[10] https://efit.seda.gov.my/?omaneg=00010100000001010101000100001000000001010000010001l0&id=2880

PV self-consumption	1	Right to self-consume	Yes
	2	Revenues from self-consumed PV	No PV electricity allowed to be injected to the grid, the prosumer is required to install a reverse power relay.
	3	Charges to finance Transmission & Distribution grids	None
Net Energy Metering (Excess PV electricity)	4	Revenues from excess PV electricity injected into the grid	Excess PV electricity injected to the grid is priced at prevailing displaced cost[11] as prescribed by the Energy Commission; the credit is allowed to be rolled over for a period of not more than 24 months.
	5	Maximum timeframe for compensation of fluxes	NA
	6	Geographical compensation	NA
Other characteristics	7	Regulatory scheme duration	2017-2020
	8	Third party ownership accepted	No
	9	Grid codes and/or additional taxes/fees impacting the revenues of the prosumer	An assessment study by the Distribution Licensee is required for PV capacity > 12 kW. An application fee of MYR10/kW (non-refundable) for all PV capacities.
	10	Regulations on enablers of self-consumption (storage, DSM…)	Regulated by the Energy Commission under the Electricity Supply Act 1990
	11	PV system size limitations	For domestic or residential consumers, the maximum capacity of the PV system installed is ≤ 12 kWp for single phase or 72 kWp for 3 phase systems For commercial and industrial consumers, the maximum capacity of the PV system installed shall be 1 MWp or 75% of maximum demand or 60% of fuse rating or 60% of current transformer (whichever is lower)
	12	Electricity system limitations	As above.
	13	Additional features	

11 http://www.seda.gov.my/?omaneg=000101000000010101010001000010000000000000000000000&s=7

3.3 Collective self-consumption, community solar and similar measures

The electricity market in Malaysia is still highly regulated and as such, there is no such scheme to accommodate virtual net energy metering.

3.4 Tenders, auctions & similar schemes

As mentioned in Sections 1.1 and 3.1.1.1, Malaysia has implemented the LSS under competitive bidding. The competitive bidding is administered by the Energy Commission of Malaysia and PPA is between the Distribution Licensee and the awarded bids. The electricity is paid via a pass-through mechanism allocated in the electricity tariff.

3.5 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). 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.

3.6 Indirect policy issues

Several policy enablers that may positively influence the PV market to grow in Malaysia: (i) Fully rationalizing of natural gas subsidy on electricity tariff (ii) liberalizing the 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) developing an energy transition roadmap to increase the contribution of renewable energy in the electricity mix.

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.

Local University and Research Institutions	3rd Gen Cell/Wafer		4th Gen	Module	BOS			PV system	Radiation Monitoring	Review on Technology /Policy	Social/ Technology /Economy /Environment Analysis & Evaluation	PV application
	CPV	Organic PV, Dye Sensitized Solar Cell			Mounting Structure, racking, tracking system	(inverters, cables, charge controller	Energy Storage (battery)					
Universiti Kebangsaan Malaysia		P		P		P	P	P	P	P	P	P
University Malaya					P	P	P	P		P	P	
Universiti Sains Malaysia	P		P									
Universiti Teknologi Malaysia				P		P		P	P	P		
Universiti Putra Malaysia	P				P	P		P	P	P	P	
Universiti Teknologi MARA						Patent		P				
Universiti Teknikal Malaysia Melaka								P			P	

Local University	3rd Gen Cell/Wafer		4th Gen	Module	BOS			PV system	Radiation Monitoring	Review on Technology	Social/ Technology	PV application
Universiti Tenaga Nasional											P	
Universiti Malaysia Perlis		P							P			
Universiti Malaysia Pahang		P						P				
Local University and Research Institutions	**3rd Gen Cell/Wafer**		**4th Gen**	**Module**	**BOS**			**PV system**	**Radiation Monitoring**	**Review on Technology /Policy**	**Social/ Technology /Economy /Environment Analysis & Evaluation**	**PV application**
Multimedia University				P				P		P		
Universiti Tunku Abdul Rahman	P	P			P		P					
Universiti Malaysia Trengganu				P					P			
Universiti Teknologi PETRONAS		P						P	P			P

Local University	3rd Gen Cell/Wafer		4th Gen	Module	BOS			PV system	Radiation Monitoring	Review on Technology	Social/ Technology	PV application
Universiti Malaysia Sabah									P			
SIRM Berhad									P			Patent
MIMOS Berhad					Patent							Patent

P: Journal publications

Table 13a: Main Solar PV Researches by Local Universities and Research Institute

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

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

Information was not available at the time of publication.

Table 14: 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). According to the Malaysia Investment Development Authority (MIDA), in 2016, export and local sourcing activities undertaken by the top solar companies in Malaysia was valued at US$2,5 billion and US$320 million respectively. It was estimated that over 80% of the PV products were exported to Europe, US and Asia. MIDA also reported that in 2016, Malaysia has attracted seven more solar manufacturing projects in the solar industry worth US$400 million. In 2016, the total metallurgical grade silicon (MGS) and polysilicon manufacturing nameplate capacity remained at **53,4** kilotonnes with employment of 840.

Table 15: 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 Si	Metal Si	33,4 tonnes	Not available	
Tokuyama [12]	Poly-Si	20 tonnes		
COMTEC[13]	mc-Si ingots	124 MW		

[12] Sold to South Korea's OCI Co Ltd in 2017

[13] In early 2017, LONGI agreed to buy over COMTEC Malaysia.

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.

Malaysia is ranked third largest producer of PV cells and modules in the world and over 80% of the PV product are exported to Europe, US and Asia. Malaysia has also completed a Solar PV Roadmap 2030 which will be launched in 2017 to drive the country's solar PV industry forward.[14]

Total PV cell and module manufacture together with production capacity information is summarised in Table 16 below.

Table 16: Production and production capacity information for 2016

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. Sunpower[15]	mono-Si	Not Available		685	
2 Hanwha Q-Cells	mc-Si			260	1 319
3 TS Solartech	Mono & mc-Si			500	
4. Jinko Solar	mc-Si			1 300	450
5. JA Solar	mc-Si			500	
6. Flextronics	c-Si				1 100
7. Panasonic	HiT mono-Si				425
8. MSR	Mono & mc-Si				85
9. Solartif	mc-Si				10
10. PV HiTech	mc-Si				5
11. Promelight	Mono & mc-Si				150
Total				3 245	3 544
Thin film manufacturers					
1 First Solar	CdTe	Not Available			2 400
2 Nanopac					12

[14] http://www.thestar.com.my/business/business-news/2017/03/15/mida-malaysia-to-benefit-from-growing-solar-power-industry/

[15] SunPower took over its joint venture (JV) solar cell manufacturing operations in Malaysia from Taiwan-based partner AUO, a subsidiary of AU Optronics Corporation at a cost of US$170 million in 2016

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
Total					2 412
Cells for concentration					
1. None		g		h	
TOTALS				**3 245**	**5 956**

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

5.3 Manufacturers and suppliers of other components

Table 16 b: 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. Huber+Suhner (M) 2. ABB Malaysia 3. Schneider Electric (M) 4. Innotech Synergy

Type of Supporting Industry	Company
	5. Superpan 6. 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 has an ecosystem comprising 250 companies involved in upstream activities such as poly silicon, wafer, cell and module production and downstream activities such as inverters, and system integrators.

6.1 Labour places

Table 17: Estimated PV-related labour places in 2016

Research and development (not including companies)	NA
Manufacturing of products throughout the PV value chain from feedstock to systems, including company R&D	16 390
Distributors of PV products	
System and installation companies (based on 106 PV service providers in 2016)	1 590
Electricity utility businesses and government	200
Other	
Total	18 180

6.2 Business value

Table 18: Value of PV business

Sub-market	Capacity installed *in 2016* (MW)	Price per W *(from table 7)*	Value	Totals
Off-grid domestic				*Not available*
Off-grid non-domestic				
Grid-connected distributed	**71,8059**	**MYR 7,29**		*MYR 523.5m*
Grid-connected centralized				*Not Available*
Export of PV products				*Not Available*
Change in stocks held				
Import of PV products				
Value of PV business				***MYR 523.5m***

If possible, please provide some brief comment on the industry value chain in your country or provide references to articles, reports dealing with this topic.

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/en/industry2/78-list-of-independent-power-producers-ipps. Generation mix is 34 % gas, 58 % coal, 5 % hydro, and 3%% renewables[16].

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 74 % hydro, and the balance from a mixture of coal, gas and diesel. Thermal power is targeted to rise to 40% by 2025[17]; the state has in excess of 20 GW of hydro potential.

[16] http://www.st.gov.my/index.php/en/all-publications/item/758-energy-malaysia-volume-11-2017.

[17] http://www.sarawakenergy.com/index.php/hydroelectric-projects/11-about-us

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/en/industry2/561-list-of-independent-power-producers-at-sabah-ipps . A of July 2015, generation mix in Sabah is 76 % gas, 15 % MFO & Diesel, 6 % hydro and 3 % biomass[18].

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

Information was not available at the time of publication.

7.3 Interest from municipalities and local governments

Information was not available at the time of publication.

8 HIGHLIGHTS AND PROSPECTS

By 2020, total grid-connected PV installed capacity is estimated to be 2 200 MW. Malaysia has a huge solar PV technical potential being along the Sun-Belt. Under the Green Technology Masterplan, the total renewable energy is estimated to be 25% of electricity mix by 2030. In 2016, the key highlight for the PV market is the introduction of the NEM as well as LSS programme.

[18] http://www.st.gov.my/index.php/en/component/k2/item/660-sabah-electricity-supply-industry-outlook-2015.html