Technology Collaboration Programme
by iea

International Energy Agency
Photovoltaic Power Systems Programme

Task 1 Strategic PV Analysis and Outreach

PVPS

National Survey Report of PV Power Applications in Malaysia

2019

Sustainable Energy Development Authority
seda
MALAYSIA

What is IEA PVPS TCP?

The International Energy Agency (IEA), founded in 1974, is an autonomous body within the framework of the Organization for Economic Cooperation and Development (OECD). The Technology Collaboration Programme (TCP) was created with a belief that the future of energy security and sustainability starts with global collaboration. The programme is made up of 6.000 experts across government, academia, and industry dedicated to advancing common research and the application of specific energy technologies.

The IEA Photovoltaic Power Systems Programme (IEA PVPS) is one of the TCP's within the IEA and was established in 1993. The mission of the programme is to "enhance the international collaborative efforts which facilitate the role of photovoltaic solar energy as a cornerstone in the transition to sustainable energy systems." In order to achieve this, the Programme's participants have undertaken a variety of joint research projects in PV power systems applications. The overall programme is headed by an Executive Committee, comprised of one delegate from each country or organisation member, which designates distinct 'Tasks,' that may be research projects or activity areas.

The IEA PVPS participating countries are Australia, Austria, Belgium, Canada, Chile, China, Denmark, Finland, France, Germany, Israel, Italy, Japan, Korea, Malaysia, Mexico, Morocco, the Netherlands, Norway, Portugal, South Africa, Spain, Sweden, Switzerland, Thailand, Turkey, and the United States of America. The European Commission, Solar Power Europe, the Smart Electric Power Alliance (SEPA), the Solar Energy Industries Association and the Cop- per Alliance are also members.

Visit us at: www.iea-pvps.org

What is IEA PVPS Task 1?

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 2019. Information from this document will be used as input to the annual Trends in photovoltaic applications report.

Authors

- **Main Content:** Ir. Dr. Sanjayan Velautham, Dr. Wei-nee Chen, Tan Weng Han
- **Data:** Sustainable Energy Development Authority (SEDA) Malaysia, Suruhanjaya Tenaga
- **Analysis:** Nor Azaliza Damiri, Nur Haziqah Binti Mohd Zaki, Koh Keng Sen, Ts. Azah Ahmad, Mohd Idham bin Mohammad, Steve Anthony Lojuntin

COVER PICTURE

2.5MWp, largest NEM application connected to the grid in 2019 by Goodyear Malaysia Berhad in Selangor

TABLE OF CONTENTS

ACKNOWLEDGEMENTS

This paper received valuable contributions from key stakeholders in Malaysia; our gratitude goes to the Ministry of Energy and Natural Resources (KeTSA), the Energy Commission of Malaysia (ST), Ministry of Utilities of Sarawak (MoU), key utilities such as Tenaga Nasional Bhd (TNB), Sarawak Energy Bhd (SEB), and Sabah Electricity Bhd (SESB) and domestic PV industries (e.g. MPIA).

1 INSTALLATION DATA

The PV power systems 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 2019 statistics if the PV modules were installed and connected to the grid between 1 January and 31 December 2019, although commissioning may have taken place at a later date.

1.1 Applications for Photovoltaics

In 2019, the total new PV capacity added was 390,51MWac. 5,89MWac came under off-grid capacity; decentralized PV installation was 66,00MWac with contribution by self-consumption (SELCO) and net energy metering (NEM), lastly, the centralized capacity comprised of the feed-in tariff (FiT) and large scale solar (LSS) schemes and they amounted to 318,62MWac. The cumulative PV capacity by end of 2019 is 1 128,25MWac of which ground-mounted and floating PV are 715,59 MWac, followed by rooftop PV applications of 371,12 MWac and off-grid PV at 41,53MWac.

1.2 Total photovoltaic power installed

The dataset presented here was provided by both the Sustainable Energy Development Authority (SEDA) Malaysia on FiT, NEM, and SELCO schemes, and the Energy Commission (EC) on off-grid, LSS, and SELCO schemes. Analysis was done by SEDA .

Table 1: Annual PV power installed during calendar year 2019

		Installed PV capacity in 2019 [MW]	AC or DC
PV capacity	Off-grid	5,89	AC
	Decentralized	66,00	AC
	Centralized	318,62	AC
	Total	390,51	AC

Table 2: PV power installed during calendar year 2019

			Installed PV capacity [MW]	Installed PV capacity [MW]	AC or DC
Grid-connected	BAPV	Residential	66,67	3,25	AC
		Commercial		25,60	AC
		Industrial		37,81	AC
	BIPV	Residential	N/A	N/A	N/A
		Commercial		N/A	N/A
		Industrial		N/A	N/A
	Utility-scale	Ground-mounted	317,95	317,87	AC
		Floating		0,08	AC
		Agricultural		N/A	N/A
Off-grid		Residential	5,89	N/A	AC
		Other		N/A	AC
		Hybrid systems		N/A	AC
Total			390,51		AC

Table 3: Data collection process

If data are reported in AC, please mention a conversion coefficient to estimate DC installations.	AC Value x 120% (Decentralized) AC Value x 130% (Centralized)
Is the collection process done by an official body or a private company/Association?	Sustainable Energy Development Authority (SEDA) Malaysia
Link to official statistics (if this exists)	N/A

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

Year	Off-grid [MW] (including large hybrids)	Grid-connected distributed [MW] (BAPV, BIPV)	Grid-connected centralized [MW] (Ground, floating, agricultural…)	Total [MW]
2012	1,00	10,46	15,83	27,29
2013	1,00	56,47	59,00	116,47
2014	1,00	90,75	79,00	170,75
2015	1,00	139,36	80,67	221,03
2016	1,00	197,98	86,92	285,90
2017	8,90	230,19	88,92	328,01
2018	35,64	302,68	399,42	737,74
2019	41,53	371,12	715,59	1 128,25

Table 5: Other PV market information

	Sector	2019 [MW]	2019 [MW]
Number of PV systems in operation in your country	Residential	1 094 Systems[1] (390,51 MW)	434 systems (9,14 MW)
	Commercial		374 Systems (25,60 MW)
	Industrial		286 Systems (355,76 MW)
Decommissioned PV systems during the year [MW]	Residential	7 systems (0,16 MW)	5 Systems (0,03 MW)
	Commercial		2 Systems (0,13 MW)
	Industrial		N/A
Repowered PV systems during the year [MW]	Residential	N/A	N/A
	Commercial		N/A
	Industrial		N/A
Total capacity connected to the low voltage distribution grid [MW]	Residential	673 systems (21,67 MW)[2]	432 Systems (3,08 MW)
	Commercial		185 Systems (8,23 MW)
	Industrial		56 Systems (10,36 MW)
Total capacity connected to the medium voltage distribution grid [MW]	Residential	14 systems (74,60 MW)[2]	N/A
	Commercial		1 Systems (1,41 MW)
	Industrial		13 Systems (73,19 MW)
Total capacity connected to the high voltage transmission grid [MW]	Residential	5 systems (250 MW)[2]	N/A
	Commercial		N/A
	Industrial		5 Systems (250 MW)

1 – Exclude off-grid

2 – Exclude SELCO & off grid

Table 6: PV power and the broader national energy market

	2018*	2019*
Total power generation capacities [GW]	33,53	36,43
Total renewable power generation capacities (including hydropower) [GW]	7,16	7,79
Total electricity demand [TWh]	148,85	N/A
Total energy demand [TWh]	N/A	N/A
New power generation capacities installed [GW]	N/A	N/A
New renewable power generation capacities (including hydropower) [GW]	0,63	N/A
Estimated total PV electricity production (including self-consumed PV electricity) in [GWh]	538,32	821,31
Total PV electricity production as a % of total electricity consumption	0,004	N/A

* Estimated figures

1.3 Key enablers of PV development

Table 7: Information on key enablers

	Description	Annual Volume	Total Volume	Source
Decentralized storage systems	N/A	N/A	N/A	N/A
Residential Heat Pumps [#]	N/A	N/A	N/A	N/A
Electric cars [#]	N/A	N/A	5403 (March 2019)	https://www.thesundaily.my/local/50-road-tax-reduction-for-electric-hybrid-cars-EG811666
Electric buses and trucks [#]	N/A	N/A	N/A	N/A
Other	N/A	N/A	N/A	N/A

2 COMPETITIVENESS OF PV ELECTRICITY

2.1 Module prices

The dataset reported in the table below was based on licenses issued under the NEM scheme in 2019 managed by SEDA. The prices were based on average price declared by consumers, while the capacity was through quota allocated. The minimum price that was reported in 2019 was $0,21/Wp and was both imported/locally manufactured.

Table 8: Typical module prices for a number of years

Year	Lowest price of a standard module crystalline silicon [USD/Wp]	Highest price of a standard module crystalline silicon [USD/Wp]	Typical price of a standard module crystalline silicon [USD/Wp]
2015	N/A	N/A	0,5
2016			0,4
2017			0,35
2018			0,29
2019	0,21	0,25	0,23

System prices

The distributed dataset reported in the table below was based on licenses issued under the NEM scheme in 2019 managed by SEDA. The prices were based on average price declared by consumers, while the capacity was through quota allocated. The ground-mounted projects are managed by the EC, supported under the LSS scheme awarded through competitive tender exercise

Table 9: Turnkey PV system prices of different typical PV systems

Category/Size	Typical applications and brief details	Current prices [MYR/Wp]
Residential BAPV 5-10 kW	Grid-connected, roof-mounted, distributed PV systems installed to produce electricity to grid-connected households. Typically roof-mounted systems on villas and single-family homes.	5,58
Small commercial BAPV 10-100 kW	Grid-connected, roof-mounted, distributed PV systems installed to produce electricity to grid-connected commercial buildings, such as public buildings, multi-family houses, agriculture barns, grocery stores etc.	4,43
Large commercial BAPV 100-250 kW	Grid-connected, roof-mounted, distributed PV systems installed to produce electricity to grid-connected large commercial buildings, such as public buildings, multi-family houses, agriculture barns, grocery stores etc.	3,83
Industrial BAPV >250 kW	Grid-connected, roof-mounted, distributed PV systems installed to produce electricity to grid-connected industrial buildings, warehouses, etc.	3,38
Small centralized PV 1-20 MW	Grid-connected, ground-mounted, centralized PV systems that work as central power station. The electricity generated in this type of facility is not tied to a specific customer and the purpose is to produce electricity for sale.	2,86

Table 10: National trends in system prices for different applications

Year	Residential BAPV Grid-connected, roof-mounted, distributed PV system 5-10 kW **[MYR/kW]**	Small commercial BAPV Grid-connected, roof-mounted, distributed PV systems 10-100 kW **[MYR/kW]**	Large commercial BAPV Grid-connected, roof-mounted, distributed PV systems 100-250 kW **[MYR/kW]**	Small centralized PV Grid-connected, ground-mounted, centralized PV systems 10-20 MW **[MYR/kW]**
2015	8,70	8,11	N/A	N/A
2016	7,83	7,61		
2017	7,98	6,40		
2018	6,00	5,50	4,00	2,95
2019*	5,58	4,43	3,83	2,91

* 2019 prices in MYR / kWp

2.2 Cost breakdown of PV installations

The cost breakdown of a typical 5-10 kW roof-mounted, grid-connect, distributed PV system on a residential single-family house and a typical >10 MW Grid-connected, ground-mounted, centralized PV systems at the end of 2019 is presented in Tables 11 and 12, respectively.

The cost structure presented is from the customer's point of view. I.e. it does not reflect the installer companies' overall costs and revenues. The “average” category in Tables 11 and 12 represents the average cost for each cost category and is the average of the typical cost structure. The average cost is taking the whole system into account and summarizes the average end price to customer. The “low” and “high” categories are the lowest and highest cost that has been reported within each segment. These costs are individual posts, i.e. summarizing these costs do not give an accurate system price.

The dataset reported in the table below was based on licenses issued under the NEM scheme in 2019 managed by SEDA. The prices were based on average price declared by consumers, while the capacity was through quota allocated.

Table 11: Cost breakdown for a grid-connected roof-mounted, distributed residential PV system of 5-10 kW

Cost category	Average [MYR/Wp]	Low [MYR/Wp]	High [MYR/Wp]
Hardware			
Module	2,58	0,91	4,20
Inverter	1,00	0,28	10,40
Mounting material			
Other electronics (cables, etc.) Total Balance of System	0,91	0,11	4,84
Subtotal Hardware			
Soft costs			
Planning			
Installation work	1,09	0,18	6,88
Shipping and travel expenses to customer			
Permits and commissioning (i.e. cost for electrician, etc.)			
Project margin			
Subtotal Soft costs			
Total (excluding VAT)			
Average VAT Sales & Services Tax (SST)	6%		
Total (including VAT)			

Table 12: Cost breakdown for a grid-connected, ground-mounted, centralized PV systems of >10 MW

Cost category	Average [MYR/Wp]	Low [MYR/Wp]	High [MYR/Wp]
Hardware			
Module	1,65	1,65	1,65
Inverter	0,33	0,33	0,33
Mounting material			
Other electronics (cables, etc.) Total Balance of System	0,72	0,72	0,72
Subtotal Hardware			
Soft costs			
Planning			
Installation work	2,91	2,91	2,91
Shipping and travel expenses to customer			
Permits and commissioning (i.e. cost for electrician, etc.)			
Project margin			
Subtotal Soft costs			
Total (excluding VAT) Sales & Services Tax	**6%**		
Average VAT			
Total (including VAT)			

2.3 Financial Parameters and specific financing programs

Green Technology Financing Scheme (GTFS) is a financing scheme offered up to year 2020 to investors which is supported by the government offering a 2% p.a. interest/profit rate subsidy for the first seven years and 60% government guarantee of green component cost to financial institutions (https://www.gtfs.my/).

Others financing scheme initiated by private financial institutions include the following:

i) UOB Bank: An array of financial solution to support the solar PV value chain [https://www.nst.com.my/business/2019/10/532316/uob-launches-u-solar-promote-re-adoption]

ii) Hong Leong Bank: RM500 million

[https://www.hlb.com.my/en/personal-banking/news-updates/hlb-rm500-million-in-renewable-energy-financing.html]

iii) CIMB Bank Berhad: RM 100 million
[https://www.nst.com.my/business/2019/10/526179/cimb-allocates-rm100-million-renewable-energy-financing-smes]

iv) Alliance Bank

Table 13: PV financing information in 2019

Different market segments	Loan rate [%]
Average rate of loans – residential installations	3.8-5%
Average rate of loans – commercial installations	7-9%
Average cost of capital – industrial and ground-mounted installations	7-9%

2.4 Specific investments programs

Table 14: Summary of existing investment schemes

Investment Schemes	Introduced in Malaysia	Description
Third party ownership (no investment)	N/A	N/A
Renting	N/A	N/A
Leasing	2018	Leasing under the NEM scheme
Financing through utilities	N/A	N/A
Investment in PV plants against free electricity	N/A	N/A
Crowd funding (investment in PV plants)	N/A	N/A
Community solar	N/A	N/A
International organization financing	N/A	N/A
Green Sukuk (Green Islamic Bond)	2017	Sustainable & Responsible Investment (SRI) Sukuk collaboration between Securities Commission Malaysia, Bank Negara Malaysia and the World Bank Group

2.5 Additional Country information

Table 15: Country information

Retail electricity prices for a household [MYR/W]	Peninsular Malaysia: https://www.tnb.com.my/residential/pricing-tariffs Sabah: https://www.sesb.com.my/?q=content/domestic-tariff Sarawak: https://www.sarawakenergy.com/customers/tariffs			
Retail electricity prices for a commercial company [MYR/W]	Peninsular Malaysia: https://www.tnb.com.my/commercial-industrial/pricingtariffs1/ Sabah: https://www.sesb.com.my/?q=content/medium-voltage-general-commercial-tariff Sarawak: https://www.sarawakenergy.com/customers/tariffs			
Retail electricity prices for an industrial company [MYR/W]	Peninsular Malaysia: https://www.tnb.com.my/commercial-industrial/pricingtariffs1/ Sabah: https://www.sesb.com.my/?q=content/medium-voltage-general-industrial-tariff Sarawak: https://www.sarawakenergy.com/customers/tariffs			
Population at the end of 2019	32,68 mill (estimates)			
Country size [km^2]	330 621			
Average PV yield in [kWh/kW]	1 314 kWh (15%)			
Name and market share of major electric utilities		Electricity production [%]	Share of grid Subscribers [%]	Number of retail customers [%]
	Tenaga Nasional Berhad	79% / 123 170,39 GWh	N/A	88% / 9 039 197

	Sabah Electricity Sdn Bhd	4% / 5 979,99 GWh	N/A	6% / 609 124
	Sarawak Electricity Berhad	17% / 26 583,57 GWh	N/A	6% / 659 189

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.

Table 16: Summary of PV support measures

Category	Residential		Commercial + Industrial		Centralized	
Measures in 2019	**On-going**	**New**	**On-going**	**New**	**On-going**	**New**
Feed-in tariffs	-	-	-	-	-	-
Feed-in premium (above market price)	-	-	-	-	-	-
Capital subsidies	-	-	-	-	-	-
Green certificates	-	-	-	-	-	yes
Renewable portfolio standards with/without PV requirements	-	-	-	-	-	-
Income tax credits	-	-	-	-	-	-
Self-consumption	yes	-	yes	-	yes	-
Net-metering	yes	-	yes	-	yes	-
Net-billing	-	-	-	-	-	-
Collective self-consumption and virtual net-metering	-	-	-	-	-	-
Commercial bank activities e.g. green mortgages promoting PV	-	-	-	-	-	-
Activities of electricity utility businesses	-	-	-	-	-	-
Sustainable building requirements	-	-	yes	-	-	-
BIPV incentives	-	-	-	-	-	-
Other (specify)	-	-	-	-	-	-

3.1 National targets for PV

The Government of Malaysia in 2019 has committed to reach a 20% RE target (excluding large hydro >100MW) in our national capacity mix by 2025 and the strategic deployment of solar PV is very pivotal to the goal. The preliminary Renewable Energy Transition Roadmap (RETR 2035) developed by SEDA has projected that by 2025, more than half (56%) of the 20% RE target's capacity will be contributed by solar PV. This could be attributed to two major factors - reasonably high average solar irradiation throughout Malaysia and the constant declining price trend of the solar PV technology. Consistently by 2035, solar PV is projected to be the most adopted RE technology in our national capacity mix and could displace some thermal power plants. This sectoral decarbanisation could ensure that Malaysia is on par in reducing the GHG emissions intensity as pledged in our NDC target.

3.2 Direct support policies for PV installations

3.2.1 Feed-in Tariff (FiT)

Grid connected PV schemes remained the same in Malaysia from 2018 to 2019 which are the Large Scale Solar (LSS) and Feed-in Tariff (FiT). FiT for solar PV was introduced at the end of 2011 and by 2017, FiT does not offer new allocation of quota for solar PV anymore. The FiT scheme currently services the monthly payments of solar PV which was released for quota from 2011 to 2017. Under the FiT scheme, the PPA tenure is 21 years. The programme was very successful in mooting an early PV market and an ecosystem to support the market.

3.2.2 Large Scale Solar (LSS)

The LSS application is of the utility scale awarded through regulated competitive bidding/tendering process. As at the end of last year, Malaysia has awarded third tranche of LSS (500MW) through regulated tendering.

3.2.3 BIPV development measures

Malaysia has nine low carbon sustainable building tools. None of the tools mandate the incorporation of solar PV, however, they encourage measures to reduce their carbon footprint of which solar PV is one of the options to do so.

1. GreenMARK (BCA – Singapore)
2. Green Building Index (GBI)
3. LEED (USGBC – US)
4. GreenRE (REHDA)
5. Melaka Green Seal
6. CIS 20:2012 – GreenPASS (CIDB & SEDA) - based on 100% CO_2 reduction assessment
7. Green Rating Tool - Penarafan Hijau (PH-JKR)
8. MyCREST (CIDB-JKR) - based on 100% CO_2 reduction assessment
9. CASBEE Iskandar (IRDA-Japan

Red indicates Government tools | Underlined indicates tools developed in Malaysia

3.3 Self-consumption measures

Table 17: Summary of self-consumption regulations for small private PV systems in 2019

PV self-consumption	1	Right to self-consume	Yes
	2	Revenues from self-consumed PV	Yes
	3	Charges to finance Transmission, Distribution grids & Renewable Levies	No
Excess PV electricity	4	Revenues from excess PV electricity injected into the grid	Yes
	5	Maximum timeframe for compensation of fluxes	Yes (saving can be carried forward up to 24 months)
	6	Geographical compensation (virtual self-consumption or metering)	No
Other characteristics	7	Regulatory scheme duration	N/A
	8	Third party ownership accepted	Yes (NEM leasing)
	9	Grid codes and/or additional taxes/fees impacting the revenues of the prosumer	N/A
	10	Regulations on enablers of self-consumption (storage, DSM…)	Yes (NEM/SELCO guidelines)
	11	PV system size limitations	Yes
	12	Electricity system limitations	Yes
	13	Additional features	N/A

3.3.1 Net Energy Metering (NEM)

The Net Energy Metering (NEM) scheme was improved in year 2019 making it a one-to-one energy offset mechanism instead of the previous net billing mechanism implemented from 2016 - 2018. The NEM scheme also allows prosumers to sell the excess electricity back to the utility which will further reduce their utility bills. Under the previous net billing, the excess solar electricity is compensated at a lower rate than the regulated electricity retail tariff. This improved mechanism was well supported by the public, in 2019 alone, the approved NEM take-up rate by the Authority has tripled as compared to 2016 - 2018 combined. The NEM scheme of 500MWac quota is open for consumers of domestic, commercial, industrial, and agricultural bands. Property developers who are keen to reserve NEM quota can do so and quota is reserved up to 30 months from project commencement date.

3.3.2 New PV leasing or PPA business models

In 2019, the Authority established a directory for the Registered PV investors (RPVI). These are the companies who provide solar leasing/PPA options for customers. As of end of 2019, the Authority approved 62 companies that successfully registered themselves via the online RPVI directory. Globally, the world is moving towards owning a solar PV system without the high upfront cost via solar leasing or solar PPA method. Malaysia is also moving towards the same direction by introducing both new purchase options in 2019 via the RPVI. It was recorded that ~3.5% of total NEM capacity was awarded under the leasing and PPA options. The Authority foresees a rising trend for both leasing and PPA methods to own a solar PV system in the future especially among the commercial and industrial tariff consumers.

3.3.3 Self-Consumption (SELCO)

The SELCO scheme was implemented in 2017 as an alternative to NEM scheme. The total installed PV capacity under this scheme is projected to stay relatively constant in the future due to economic reason. Unlike the NEM scheme, excess electricity under this scheme is not allowed to sell back to the utility. System size that is over 72kW is required to obtain a private generating licence as mandated by the Energy Supply Act.

3.4 Collective self-consumption, community solar and similar measures

3.4.1 In the Pipeline…

The electricity market in Malaysia is still being regulated and the process of electricity industry and market reform is still underway led by special agency, MyPower. Part of the reform includes the opening of third-party access (TPA) to the national electricity grid which will enable Corporate PPAs. As part of the effort, a peer-to-peer energy trading pilot study was launched by the Minister in October and the official commencement is scheduled in early 2020 which also leverages on front-of-meter PV trading.

3.5 Tenders, auctions & similar schemes

3.5.1 Large Scale Solar (LSS)

In 2019, 500MWac quota was announced by the government for LSS 3 competitive bidding. The scheme uses a reverse auction system to award bidders based on the lowest bid for offtake prices. The offtake bids witnessed a 50% reduction as compared to offtake bids received in LSS 2. The implementing agency - Energy Commission (EC) has received a total of 112 bids, out of the total bids, 4 bids received were lower than average gas generation cost of 23,22 MYR cent/kWh. This indicated that the LCOE of solar is gradually reaching grid parity. Foreign shareholding is allowed but capped at 49%. The common financing methods are via debt financing. There is only a single off-taker, which is Tenaga Nasional Berhad and this cost is directly passed to the electricity consumers.

3.6 Other utility-scale measures including floating and agricultural PV

The floating PV is getting more traction in recent years. In the state of Sarawak, the utility will be tendering out a 50MW floating PV system in Batang Ai hydropower dam which expects to commission by 2021. As of 2019, there were two floating PV projects in operation (270kWp and 108kWp) and 2 more floating PV projects underway (30MWac each under the LSS scheme). In Malaysia, it is found that the suitable water area for PV installation is about 2 944km2, this translates to a technical potential of 16,5GW.

Sources:

https://dayakdaily.com/sarawak-to-build-floating-solar-system-on-batang-ai-hydrodam/

http://www2.sesco.com.my/noticeDoc/SBP-190011(SY01)%20-%20Tender%20Particulars.pdf

3.7 Social Policies

N/A

3.8 Retrospective measures applied to PV

N/A

3.9 Indirect policy issues

3.9.1 Rural electrification measures

The current electrification rate in Malaysia is close to 100% and is projected to fully electrified by 2025. Rural electrification is still a priority of the government which is done together with utilities as a form of public-private partnership. The main ministries which are championing the effort are the Ministry of Rural and Regional Development and the Ministry of Education in Peninsular Malaysia and Sabah. In Sarawak, it is championed by the state government together with utility Sarawak Energy Berhad. The Sarawak Alternative Rural Electrification Scheme (SARES) has electrified almost 5 000 households in 192 villages in remote Sarawak since its launch in 2016 and has received regional recognition in 2019. The solar PV and hybrid systems are often used, in Sarawak, microhydro technologies are used as well.

Sources:

https://www.sarawakenergy.com/media-info/media-releases/2019/sares-lights-up-125-households-in-tatau-with-renewable-solar

https://www.sarawakenergy.com/media-info/media-releases/2019/regional-recognition-for-sares

3.9.2 Support for electricity storage and demand response measures

Currently there is no supporting policy in place for electricity storage and demand response. Prosumers who are keen to include an energy storage system to their solar PV system need to invest on their own. As the price trend for energy storage continues to decline, the role of

energy storage will be getting more importance as it is projected to provide energy balancing solution to address the intermittency of solar energy, helping the nation to decarbonise the sector further.

3.9.3 Support for electric vehicles (and VIPV)

The use of EV is being championed by the government agency - Malaysian Green Tech Corporation (MGTC). It is reported in 2019 that by the end of 2018, there were 250 public EV chargers installed at shopping malls, hotels, Petronas petrol stations and other selected public places. It has also recorded a 50% increase of consumption compared to 2017, a total of 254 802 kWh was used which is equivalent to 1 698 682 km driven. MGTC continued to work with Tenaga Nasional Berhad (TNB) to install 100 EV chargers in major cities - Kuala Lumpur, Johor Bahru, and Penang in Peninsular Malaysia by end of 2019. Meanwhile in Sarawak, three-in-one fuel stations were being set up catering for vehicles powered by fossil fuels, electricity, and hydrogen fuel cells.

Sources:

https://www.greentechmalaysia.my/the-era-of-electric-vehicles/

https://www.malaymail.com/news/drive/2019/10/10/tnb-mgtc-to-install-100-electric-vehicle-charging-stations-by-year-end/1799010

https://www.thestar.com.my/news/nation/2019/05/27/three-in-one-fuel-stations-in-sarawak-to-offer-fossil-fuels-electricity-and-hydrogen

3.9.4 Curtailment policies

N/A

3.9.5 Other support measures

N/A

3.10 Financing and cost of support measures

The FiT scheme is supported by the Renewable Energy (RE) fund contributed by electricity consumers of TNB, SESB and NUR Distribution Sdn Bhd. Consumers with electricity consumption of more than 300 kWh per month are obliged to contribute additional charge of 1,6% of their electricity bill to the RE fund. The RE fund is managed by the Authority to support the renewable energy developers who invest in PV, small hydro, biomass, and biogas resources to generate electricity. The NEM and LSS schemes are supported by a passthrough mechanism to the consumer tariffs.

4 INDUSTRY

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

Table 18: Silicon feedstock, ingot and wafer producer's production information for 2019

Manufacturers	Process & technology	Total Production	Product destination	Price
OCIM Sdn. Bhd. (Poly Si)	Silicon feedstock [Tonnes]	27 kilo tonnes	N/A	
LONGi (Kuching) Sdn. Bhd. (Ingot & Wafer)	Mono-Crystalline ingot & wafer [MW]	500 MW		
Sun Everywhere Sdn. Bhd. (Wafer)	Silicon Wafer [MW]	49,8 MW		

4.2 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 Table 19.

Table 19: PV cell and module production and production capacity information for 2019

Cell/Module manufacturer (or total national production)	Technology (sc-Si, mc-Si, a-Si, CdTe, CIGS)	Total Production [MW]		Maximum production capacity [MW/yr]	
		Cell	Module	Cell	Module
Wafer-based PV manufactures					
Hanwha Q CELLS	mc-Si	2 000	2 000	N/A	
LONGi (Kuching) Sdn. Bhd.	sc-Si	880	900		
LONGi Technology (Kuching) Sdn. Bhd.	sc-Si	1 250	N/A		
Jinko Solar Technology Sdn Bhd	mc-Si	3 450	2 480		
Sun Everywhere Sdn. Bhd.	sc-Si	229,5	318,2		
SunPower Malaysia Manufacturing Sdn Bhd	sc-Si	773	N/A		
Thin film manufacturers					
First Solar	CdTe	N/A	3 200	N/A	
Totals	N/A	**8 582,5**	**8 898,2**	**N/A**	

4.3 Manufacturers and suppliers of other components

N/A

5 PV IN THE ECONOMY

This chapter aims to provide information on the benefits of PV for the economy.

5.1 Labour places

Table 20: Estimated PV-related full-time labour places in 2019

Market category	Number of full-time labour places
Research and development (not including companies)	50
Manufacturing of products throughout the PV value chain from feedstock to systems, including company R&D	17 731
Distributors of PV products	8 312
System and installation companies	
Electricity utility businesses and government	140
Other	N/A
Total	26 233

5.2 Business value

Table 21: Rough estimation of the value of the PV business in 2019 (VAT is excluded)

Sub-market	Capacity installed [MW]	Average price [MYR/W]	Value [MYR]	Sub-market [MYR]
Off-grid	5,89	N/A		
Grid-connected distributed	90,86	6,6	599 696 535,90	599 696 535,90
Grid-connected centralized	319,19	3,9	1 244 828 000,00	1 244 828 000,00
Value of PV business in 2019				1 844 524 535,90

6 INTEREST FROM ELECTRICITY STAKEHOLDERS

6.1 Structure of the electricity system

In Malaysia, the electricity market is split into three main regions:

Peninsular Malaysia:

- Vertically integrated with the majority share taken by Tenaga Nasional Berhad (TNB).
- Liberalised generation - largely due to the FiT and LSS programmes and the resulting Power Purchase Agreements (PPAs) signed.
- Retail and transmission under TNB control, with the committed exploration into opening up of the retail segment.
- Regulated by the Energy Commission of Malaysia (EC).

Sarawak:

- Sarawak Energy Berhad was delisted in 2011 and is now under 100% control by the Sarawak State Government. This was decided so that SEB could better be aligned to state goals and aspirations in terms of expansion support from foreign direct investment (FDI) for the energy industry.
- Retail users / consumers enjoy the same rates, however the cost of operating the network differs significantly due to the size of Sarawak. (Sarawak is almost the size of Peninsula Malaysia and its population spread out).
- Presently there are no plans to liberalise generation, transmission, or retail of SEB.

Sabah:

- Sabah Energy Sdn. Bhd. (SESB) was formed in 1998 and is a wholly owned subsidiary of TNB (80%) with the remainder (20%) owned by Sabah State Government.
- As of 2019, the due diligence of the full acquisition of SESB by the Sabah State Government was almost complete.
- SESB is vertically integrated (generation, transmission, and distribution) servicing the state of Sabah and the Federal Territory of Labuan.
- Regulated by the Energy Commission of Malaysia (EC)
- As of 2019, a Bill is being prepared to set up the autonomous Sabah state Energy Commission

6.2 Interest from electricity utility businesses

Supply Agreement for Renewable Energy (SARE):

Behind-the-meter (BTM) PV businesses is getting traction since 2018 and projected to become more robust in the future. This option enables PV investors to provide leasing or PPA services to customers who do not wish to go for an outright purchase option. Under the leasing or PPA model, counterparty risks exist when customers do not pay to the PV investors. The national utility, Tenaga Nasional Berhad (TNB) came up with an innovative package to provide billing, collection, and remittance services to PV investors by including the billing of the PV investors in the prosumers' monthly electricity bills. In doing so, counterparty risks due to customers not paying to the PV investors are reduced. Additionally, SARE provides deed of assignments to allow the payment collected from customers to be channelled to financial institutions that financed the PV investors' projects. In return, TNB charges a small fee for the services provided under the SARE. Under the SARE, TNB, the PV investor and the customer entered into a tripartite agreement and with TNB on board, the project is attractive to the financial institutions as the PPA is bankable and this is helpful for the small medium enterprises/industries (SMEs and SMIs).

6.3 Interest from municipalities and local governments

The Petaling Jaya City Council (MBPJ) is still offering a tax rebate scheme worth RM500 to its local residents who practise green living. The tax rebate covers five green aspects – energy (maximum rebate of 40%), water (40%), waste (40%), transportation (30%) and biodiversity (30%). This scheme was introduced in 2011, and since then 1 240 households have benefitted from the scheme worth a cumulative sum of RM414 380,48. As of May 2019, the MBPJ is the only local council in Asia that provides such assessment rebates. In 2019, this green assessment rebate project was also chosen by the ministry as a pilot project for the implementation of the Green Technology Application for Low Carbon Cities (GTALCC).

Source: https://www.thestar.com.my/metro/metro-news/2019/05/29/mbpj-offers-waivers-for-green-households

7 HIGHLIGHTS AND PROSPECTS

7.1 Highlights

- In 2019, the Malaysian government has committed to having 20% RE share in the national installed capacity by 2025 (excluding large hydro > 100MW). The detailed study will be outlined in the Renewable Energy Transition Roadmap (RETR) 2035 which is set to publish in year 2020.

- In the same year, the NEM scheme has been improved from the previous net billing mechanism, allowing true energy offset. This has led to 3 times increase in quota approved by the Authority in 2019 alone compared to the previous mechanism.

- Under the Malaysian Electricity Supply Industry (MESI) 2.0, an electricity industry and market reform were underway to liberalise the market
  (Source: https://www.mestecc.gov.my/web/wp-content/uploads/2019/11/MESI_2.0_IGEM19-web.pdf).

- As part of the strategies to scale up solar PV rooftop market, a Peer-to-Peer energy trading pilot study is tested under a regulatory sandbox in 2019 and should complete by 2020
  (Source: https://www.seda.gov.my/2019/10/malaysias-1st-pilot-run-of-peer-to-peer-p2p-energy-trading/).

- The LCOE of solar PV which is gradually reaching grid parity in Malaysia, as reflected in 4 of the LSS 3's bids which are lower than average gas generation cost of 23,22 MYR cent / kWh

7.2 Prospects

N/A