



Task 1 Strategic PV Analysis and Outreach

National Survey Report of PV Power Applications in Thailand

PVPS
2018

Prepared by:

Thailand PV Status Report Committee 2018 and

Department of Alternative Energy Development and Efficiency

PHOTOVOLTAIC POWER SYSTEMS
TECHNOLOGY COLLABORATION PROGRAMME



Cover picture:

The 75 kWp Solar PV rooftop system installed over the Department of Alternative Energy Development and Efficiency, Bangkok, Thailand



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 IEA carries out a comprehensive programme of energy cooperation among its 30 member countries and with the participation of the European Commission. The IEA Photovoltaic Power Systems Programme (IEA PVPS) is one of the collaborative research and development agreements (technology collaboration programmes) 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. This report has been prepared under Task 1, which deals with market and industry analysis, strategic research and facilitates the exchange and dissemination of information arising from the overall IEA PVPS Programme.

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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 2018. Information from this document will be used as input to the annual Trends in photovoltaic applications report.

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Data for non-IEA PVPS countries are provided by official contacts or experts in the relevant countries.

Data are valid at the date of publication and should be considered as estimates in several countries due to the publication date.



TABLE OF CONTENTS

TABLE OF CONTENTS.....	2
1	INSTALLATION DATA 4
1.1	Applications for Photovoltaics 4
1.2	Total photovoltaic power installed 4
2	COMPETITIVENESS OF PV ELECTRICITY 7
2.1	Module prices..... 7
2.2	System prices..... 8
2.3	Financial Parameters and specific financing programs..... 9
2.4	Specific investments programs 9
2.5	Additional Country information 9
3	POLICY FRAMEWORK 12
3.1	National targets for PV 12
3.2	Direct support policies for PV installations 13
3.2.1	The Solar Incentive Program for Government Building and Agricultural Cooperatives (Phase 2) 13
3.2.2	The Household Solar PV Rooftop Program 13
3.3	Self-consumption measures..... 13
3.4	Collective self-consumption, community solar and similar measures..... 14
3.5	Tenders, auctions & similar schemes..... 14
3.6	Other utility-scale measures including floating and agricultural PV 14
3.7	Social Policies 14
3.8	Retrospective measures applied to PV 14
3.9	Indirect policy issues 14
3.9.1	Rural electrification measures..... 14
3.9.2	Support for electricity storage and demand response measures 14
3.9.3	Support for electric vehicles (and VIPV)..... 14
3.9.4	Curtailment policies..... 15
3.9.5	Other support measures 15
3.10	Financing and cost of support measures 15
4	INDUSTRY 16
4.1	Production of feedstocks, ingots and wafers (crystalline silicon industry)..... 16
4.2	Production of photovoltaic cells and modules (including TF and CPV)..... 16
4.3	Manufacturers and suppliers of other components 17
5	PV IN THE ECONOMY 18
5.1	Labour places 18
5.2	Business value 18



6	INTEREST FROM ELECTRICITY STAKEHOLDERS	19
6.1	Structure of the electricity system.....	19
6.2	Interest from electricity utility businesses.....	19
7	HIGHLIGHTS AND PROSPECTS.....	20
7.1	Highlights.....	20



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 2018 statistics if the PV modules were installed and connected to the grid between 1 January and 31 December 2018, although commissioning may have taken place at a later date.

1.1 Applications for Photovoltaics

Thailand has the Alternative Energy Development Plan 2015 or AEDP 2015 to stimulate the PV system installation during 2017 – 2036. At the end of 2018, the cumulative installation of PV systems reached 3,437.34 MWp. It was increased 396.35 MWp. The systems can be divided into PV rooftop systems, ground-mounted PV power plants as well as floating PV systems.

~~[At the end of 2018, the cumulative installation of PV systems reached 2,962 MWp of installation capacity in 2018. It was increased 265.18 MWp. There were PV rooftop systems and ground-mounted PV power plants.]~~

The main market segment was the commercial PV rooftop system that it was double increased in the ground-mounted PV installation. In the same way floating PV system was double increased in the capacity of 2017.

1.2 Total photovoltaic power installed

Data collection for the photovoltaic power installation in Thailand National Survey Report was conducted via the body of regulatory processes of the official agency. PV systems installation has the licensing database of the Energy Regulatory Commission (ERC) for PV power plants and the other voluntary database of PV rooftop systems. The PV systems installation data were reported by the utilities e.g. the Electricity Generating Authority of Thailand (EGAT), Provincial Electricity Authority (PEA) and Metropolitan Electricity Authority (MEA) which were regulated by the Energy Regulatory Commission (ERC). Meanwhile the off-grid PV system data was the survey data from the owners' off-grid systems.

Table 1: Annual PV power installed during calendar year 2018.

		Installed PV capacity in 2018 [MW]	AC or DC
PV capacity	Off-grid	11.43	DC
	Decentralized	598.86	DC
	Centralized	2827.05	DC
	Total	3,437.34	DC

Table 2: Data collection process.

If data are reported in AC, please mention a conversion coefficient to estimate DC installations.	PV installation data in this report is in DC.
Is the collection process done by an official body or a private company/Association?	The collection process done by an official body.
Link to official statistics (if this exists)	http://www.dede.go.th and http://www.erc.or.th

Table 3: 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]
2005	22.11	-	1.77	23.88
2006	28.66	-	1.86	30.52
2007	28.90	-	3.61	32.51
2008	29.34	-	4.05	33.39
2009	29.49	-	13.68	43.17
2010	29.65	-	19.57	49.22
2011	29.88	-	212.28	242.68
2012	30.19	-	357.38	387.57
2013	29.73	-	793.73	823.46
2014	29.15	-	1,268.78	1,298.51
2015	30.03	-	1,389.55	1,419.58
2016	33.80	129.68	2,282.64	2,446.12
2017	34.14	359.79	2,663.12	3,057.05
2018	11.43	598.86	2,827.05	3,437.34

Remark: Off-grid systems data in 2018 has removed the un-functional systems.

Table 4: Other PV market information.

	2018 Numbers
Number of PV systems in operation in your country	PV systems of ground-mounted applications was 2,822.25 MWp. PV rooftop systems was 598.86 MWp.
Capacity of decommissioned PV systems during the year [MW]	n/a
Capacity of repowered PV systems during the year [MW]	n/a

Total capacity connected to the low voltage distribution grid [MW]	There are 49.33 MWp of PV rooftop system where a system has a capacity less than 10 kWp.
Total capacity connected to the medium voltage distribution grid [MW]	There are 2,777.67 MWp where a system has a capacity less than 10 MWp (2,233.78 MWp) and a system has a capacity more than 10 kWp but not excess than 1500 kWp (543.89 MWp).
Total capacity connected to the high voltage transmission grid [MW]	There are 588.47 MWp of PV power plants where each power plant has a capacity more than 10 MWp but not exceeding 90 MWp.

Table 5: PV power and the broader national energy market.

	2017 numbers	2018 numbers
Total power generation capacities [GW]	51.79	53.86
Total renewable power generation capacities (including hydropower) [GW]	10.24	11.37
Total electricity demand [TWh]	185.12	187.83
Total energy demand [TWh]	188.20	189.31
New power generation capacities installed in 2018 [GW]	1.68	2.07
New renewable power generation capacities installed in 2018 (including hydropower) [GW]	0.80	1.13
Estimated total PV electricity production (including self-consumed PV electricity) in [TWh]	4.38	5.23
Total PV electricity production as a % of total electricity consumption	2.37%	2.78%

2 COMPETITIVENESS OF PV ELECTRICITY

2.1 Module prices

Table 6 shows the crystalline silicon module prices during 2012 – 2018. The lowest price of a standard module refer to the prices of PV panel in PV power plants. The highest prices of standard module refer to the prices of PV rooftop systems. The standard price is an average value of all known prices. The currency unit is in THB.

Table 6: Typical module prices for a number of years.

Year	Lowest price of a standard module crystalline silicon (THB)	Highest price of a standard module crystalline silicon (THB)	Typical price of a standard module crystalline silicon (THB)
2012	50	80	75
2013	35	60	55
2014	20	50	43
2015	20	40	33
2016	15	22	19
2017	15	20	18
2018	14	20	18

2.2 System prices

The PV systems prices of the different ranges of capacity is shown in Table 7. All prices are excluded VAT/sales tax. The currency unit is in THB. The standard price is an average value of all known prices. National trends of the PV rooftop systems and ground-mounted grid connected systems in system prices for different applications is shown in Table 8.

Table 7: Turnkey PV system prices of different typical PV systems.

Category/Size	Typical applications and brief details	Current prices [THB/W]
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.	52
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.	47
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.	45
Industrial BAPV >250 kW	Grid-connected, roof-mounted, distributed PV systems installed to produce electricity to grid-connected industrial buildings, warehouses, etc.	32
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.	30
Large centralized PV >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.	28

Table 8: National trends in system prices for different applications

Year	Residential BAPV Grid-connected, roof-mounted, distributed PV system 5-10 kW [THB/W]	Small commercial BAPV Grid-connected, roof-mounted, distributed PV systems 10-100 kW [THB/W]	Large commercial BAPV Grid-connected, roof-mounted, distributed PV systems 100-250 kW [THB/W]	Small centralized PV Grid-connected, ground-mounted, centralized PV systems 10-20 MW [THB/W]
2013	120	100	90	80
2014	83	80	63	50
2015	80	67	53	40
2016	63	58	51	43
2017	58	55	50	-
2018	52	48	40	-

Remark: 10-20 MW of ground-mounted grid-connected centralized PV systems are not available in 2017-2018.

2.3 Financial Parameters and specific financing programs

PV system applications in Thailand are consisted of off-grid PV systems for rural area and the grid-connected PV systems that including ground-mounted and PV rooftop systems. In 2018 the national program of the energy conservation include the PV rooftop systems. Moreover the Department of Alternative Energy Development and Efficiency (DEDE), Ministry of Energy has implemented the revolving money for energy conservation by financial institute project for the purpose to improve the energy efficiency of Thailand. The project started from 2015 to 2018 with interest rate not exceeding 3.5 percent per year, instalment period not exceeding 5 years and credit line not exceeding 50 million THB.

Table 9: PV financing information in 2018.

Different market segments	Loan rate [%]
Average rate of loans – residential installations	3.5 % per year
Average rate of loans – commercial installations	
Average cost of capital – industrial and ground-mounted installations	< 40 million THB

2.4 Specific investments programs

The Solar Incentive Program for Government Building and Agricultural Cooperatives (Phase 2) was one of the FiT incentive program implemented by the government. In this program, the agricultural cooperative own the land use and the private sector was the investor of the PV systems. The other type of investments programs was renting the roof for PV rooftop system to self-consumption.

Table 10: Summary of existing investment schemes.

Investment Schemes	Introduced in Thailand
Third party ownership (no investment)	Yes
Renting	Yes
Leasing	No
Financing through utilities	No
Investment in PV plants against free electricity	No
Crowd funding (investment in PV plants)	No
Community solar	No
International organization financing	No

2.5 Additional Country information

The country information and additional parameters linked to its electricity system show in Table 11.

Table11: Country information.

Retail electricity prices for a household (The energy consumption for three consecutive months through a single Watt-hour meter are more than 50 kWh per month.) [THB/W]	<u>Energy consumption ≤150 kWh/month</u> Energy charge: 2.3488-4.4217 THB/kWh, (progressive rate) Monthly service fee: 8.19 THB/month <u>Energy consumption >150 kWh/month</u> Energy charge: 3.2484-4.4217 THB/kWh, (progressive rate) Monthly service fee: 38.22 THB/month
Retail electricity prices for a commercial company : <u>Small General Service:</u> (A maximum of 15-minute integrated demand of less than 30 kW through a single Watt-hour meter)	<u>Normal Rate of Small General Service:</u> Voltage Level 1: Energy charge: 3.2484-4.4217 THB/kWh, (progressive rate) Monthly service fee: 46.16 THB/month Voltage Level 2: Energy charge: 3.9086 THB/kWh, (progressive rate) Monthly service fee: 312.24 THB/month



<p>Voltage Level: 1 refer to < 12 kV of MEA and < 22 kV of PEA. 2 refer to 12-24 kV of MEA and 22-33 kV of PEA. [THB/W]</p> <p><u>Medium General Service:</u> (A maximum of 15-minute integrated demand from 30 to 999 kW and the energy consumption for three consecutive months through a single Watt-hour meter are not exceeding 250,000 kWh per month)</p> <p>Voltage Level: 1 refer to < 12 kV of MEA and < 22 kV of PEA. 2 refer to 12-24 kV of MEA and 22-33 kV of PEA. 3 refer to > 69 kV of both MEA and PEA. [THB/W]</p>	<p><u>Time of Use Tariff of Small General Service:</u> Voltage Level 1: Energy charge: 2.6369 (off Peak) - 5.7982 (on Peak) THB/kWh, Monthly service fee: 46.16 THB/month Voltage Level 2: Energy charge: 2.6037 (off Peak) - 5.1135 (on Peak) THB/kWh, Monthly service fee: 312.24 THB/month</p> <p><u>Normal Rate of Medium General Service:</u> Voltage Level 1: Demand charge: 221.50 THB/kWh, Energy charge: 3.2009 THB/kWh, Voltage Level 2: Demand charge: 196.26 THB/kWh, Energy charge: 3.1729 THB/kWh, Voltage Level 3: Demand charge: 175.70 THB/kWh, Energy charge: 3.1355 THB/kWh, *Monthly service fee of all voltage level: 312.24 THB/month</p> <p><u>Time of Use Tariff of Medium General Service:</u> Voltage Level 1: Demand charge: 210.00 THB/kWh, Energy charge: 2.6627 (off Peak) - 4.3555 (on Peak) THB/kWh, Voltage Level 2: Demand charge: 132.93 THB/kWh, Energy charge: 2.6295 (off Peak) - 4.2097 (on Peak) THB/kWh, Voltage Level 3: Demand charge: 74.14 THB/kWh, Energy charge: 2.6107 (off Peak) - 4.1283 (on Peak) THB/kWh, *Monthly service fee of all voltage level: 312.24 THB/month</p>
<p>Retail electricity prices for an industrial company: (A maximum of 15-minute integrated demand exceeds 1,000 kW, or the energy consumption for three consecutive months through a single Watt-hour meter exceeds 250,000 kWh per month)</p> <p>Voltage Level: 1 refer to < 12 kV of MEA and < 22 kV of PEA. 2 refer to 12-24 kV of MEA and 22-33 kV of PEA. 3 refer to > 69 kV of both MEA and PEA. [THB/W]</p>	<p><u>Time of Day Tariff:</u> Voltage Level 1: Demand charge: 332.71 THB/kWh, Energy charge: 3.2009 (off Peak) - 68.22 (on Peak) THB/kWh, Voltage Level 2: Demand charge: 285.05 THB/kWh, Energy charge: 3.1729 (off Peak) - 58.88 (on Peak) THB/kWh, Voltage Level 3: Demand charge: 224.30 THB/kWh, Energy charge: 3.1355 (off Peak) - 29.91 (on Peak) THB/kWh, *Monthly service fee of all voltage level: 312.24 THB/month</p> <p><u>Time of Use Tariff:</u> the same as Medium General Service</p>
<p>Population at the end of 2018</p>	<p>66,413,979</p>
<p>Country size [km²]</p>	<p>513,115</p>



Average PV yield in [kWh/kW]	1,531 kWh/kW excluding self-consumption PV system			
		Electricity production [%]	Share of grid Subscribers [%]	Number of retail customers [%]
Name and market share of major electric utilities	1. Electricity Generating Authority of Thailand (EGAT)	76	n/a	2
	2. Provincial Electricity Authority (PEA)	24	n/a	68
	3. Metropolitan Electricity Authority (MEA)		n/a	30

3 POLICY FRAMEWORK

Table 2: Summary of PV support measures.

	On-going measures in 2018 – Residential	Measures introduced in 2018 – Residential	On-going measures in 2018 – Commercial + Industrial	Measures introduced in 2018 – Commercial + Industrial	On-going measures in 2018 – Centralized	Measures introduced in 2018 – Centralized
Feed-in tariffs	Yes	-	-	-	Yes	Yes
Feed-in premium (above market price)	-	-	-	-	Yes	-
Capital subsidies	-	-	-	-	-	-
Green certificates	-	-	-	-	-	-
Renewable portfolio standards (RPS) with/without PV requirements	-	-	-	-	-	-
Income tax credits	-	-	-	-	-	-
Self-consumption	Yes	Yes	Yes	Yes	-	-
Net-metering	-	-	-	-	-	-
Net-billing	-	-	-	-	-	-
Collective self-consumption and virtual net-metering	-	-	-	-	-	-
Commercial bank activities e.g. green mortgages promoting PV	-	-	Yes	Yes	-	-
Activities of electricity utility businesses	-	-	-	-	-	-
Sustainable building requirements	-	-	-	-	-	-
BIPV incentives	-	-	-	-	-	-
Other (specify)	-	-	Yes (Tax exemption from BOI)	-	Yes (Tax exemption from BOI)	-

3.1 National targets for PV

According to Alternative Energy Development Plan 2015, Thailand set the target to achieve 30% of renewable energy consumption in final energy consumption by 2036, with the target of installation of solar PV at 6,000 MWp. In 2018, the total installed capacity for the solar PV platforms was around 3,437 MWp. However, Thailand is under the consideration of major revision of all energy master plans. These plans are consisted of the Power Development Plan (PDP), the Alternative Energy Development Plan (AEDP), the Energy Efficiency Plan (EEP), the Gas Plan and the Oil Plan. The result would readjust the goal of each renewable energy technologies.

The newly proposed draft of PDP 2018 had set the target of installing 10,000 MWp from solar PV and 2,725 MW_{AC} from solar floating. Next year, Thailand will introduce the new household solar PV rooftop program that aim to promote the installation of 100 MWp per year for the 10 years duration.

3.2 Direct support policies for PV installations

Thailand had long promoted the power production from PV since 1993 where we began to give full support for the installation of off-grid solar PV in the remote area. The adder program was implemented in 2007 where private solar PV investment was introduced at the rate of 8 THB/kWh and subsequently at 6.5 THB/kWh when the price of PV platform began to decrease. The Feed-in-Tariff (FiT) program was introduced in 2013 when the National Energy Policy Committee approved the FiT program at 5.66 – 6.85 THB/kWh depend on the size of the system.

Thailand paradigm in solar PV had recently shifted towards utilizing power produced from the system for self-consumption according to the 2018 Country Reformation Plan (under the Renewable Energy Promotion Reformation to Promote Competitive Economy and Create Value Added Products section).

The upcoming revision of PDP may incorporated large amount of power production from solar PV from household rooftops that emphasize on self-consumption. The excess amount of power can be then sold back to the utility grid at the certain fixed rate.

3.2.1 *The Solar Incentive Program for Government Building and Agricultural Cooperatives (Phase 2)*

The ongoing and continuous Solar Incentive Program for Government Building and Agricultural Cooperatives (phase 2) was implemented where the Energy Regulatory Committee set the target of incorporating 219 MW (100 MW for government building and 119 MW for agricultural cooperatives) into the grid with the scheduled COD at 31st June 2018.

The FiT for the program was 4.12 THB/kWh with the 25 years project duration.

3.2.2 *The Household Solar PV Rooftop Program*

Ministry of Energy plan to introduce the new solar rooftop program in 2019 to promote more growth of solar PV system and initiate the nationwide power production from the residential sector. Small households of Thailand will now have chance to become prosumers whereby the power production from the rooftop PV would be primarily used for self-consumption first where the excess electricity can be sold back to the utility (either Metropolitan Electricity Authority or Provincial Electricity Authority). Each household may hold up to 10kWp size with the buying rate at 1.68 THB/kWh for 10 years.

3.3 Self-consumption measures

Table 3: Summary of self-consumption regulations for small private PV systems in 2018.

PV self-consumption	1	Right to self-consume	Yes
	2	Revenues from self-consumed PV	-
	3	Charges to finance Transmission, Distribution grids & Renewable Levies	-
Excess PV electricity	4	Revenues from excess PV electricity injected into the grid	-
	5	Maximum timeframe for compensation of fluxes	-
	6	Geographical compensation (virtual self-consumption or metering)	-



Other characteristics	7	Regulatory scheme duration	Yes
	8	Third party ownership accepted	-
	9	Grid codes and/or additional taxes/fees impacting the revenues of the prosumer	Yes
	10	Regulations on enablers of self-consumption (storage, DSM...)	-
	11	PV system size limitations	Yes
	12	Electricity system limitations	Yes
	13	Additional features	-

3.4 Collective self-consumption, community solar and similar measures

none

3.5 Tenders, auctions & similar schemes

none

3.6 Other utility-scale measures including floating and agricultural PV

In 2019, EGAT (Energy Generation Authority of Thailand), which is the state-owned power utility and the largest power producer of Thailand, plan to introduce the first Hydro Floating Solar Hybrid plant on one of its dam (Sirindhorn Dam, Ubonratchathani Province) with the size of 45MW. The project would be considered as the world largest Hydro Floating Solar Hybrid and is expected to be online by December 2020. The project is expected to depend on double-glasses PV technology to maximize the efficiency and performance on water.

Thailand also promoted solar pumping for agricultural purposes for quite a long time but only in small scale through various support projects and Royal Initiatives.

3.7 Social Policies

none

3.8 Retrospective measures applied to PV

none

3.9 Indirect policy issues

3.9.1 Rural electrification measures

Thailand had implemented a number of solar PV off-grid projects in the Royal Initiatives area, local community learning center, remote school, local hospitals, protected forest area, and border school to enable the access to electricity where grid access was not applicable. The total combined power production from solar PV off-grid from the Ministry of Energy during 1993 to 2017 was reported around 5,022 kW.

3.9.2 Support for electricity storage and demand response measures

Under intensive study

3.9.3 Support for electric vehicles (and VIPV)

none



3.9.4 Curtailment policies

none

3.9.5 Other support measures

The Board of Investment (BOI) ongoing campaign on Investment Promotion Measures to Increase Production Efficiency had extended from 2017 to 2020. This measure allowed the Industry and SMEs to install solar rooftop on their area to increase their performance. The benefits from this measure included a) tax exemption for imported machineries (10% import tax and 7% VAT) and b) 3 years income tax exemption with the amount equal to 50% of investment costs.

3.10 Financing and cost of support measures

none

4 INDUSTRY

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

Thailand has no production of feedstocks, ingots and wafers for crystalline silicon industry.

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

There are total 15 companies that produce PV modules in Thailand in 2018. Half of them are capable of produce both cells and modules with 3,850 MW of production capacity and only fabricating the modules was 475 MW of production capacity.

The name of manufacturers, the total PV cell and module production, and their production capacity information is summarised in Table 14 below.

Table 14: PV cell and module production and production capacity information for 2018.

Cell/Module manufacturer	Technology	Total Production [MW]		Maximum production capacity [MW/yr]	
		Cell	Module	Cell	Module
Wafer-based PV manufactures					
1. Canadian Solar (Thailand)	sc-Si, mc-Si	n/a	n/a	1,000	800
2. Ekarat Solar	sc-Si, mc-Si	-	4	-	50
3. Fullsolar	sc-Si, mc-Si	-	8	-	50
4. G.K. assembly	sc-Si, mc-Si	-	80	-	84
5. Gintech (Thailand)	sc-Si, mc-Si	n/a	650	n/a	1,000
6. Irradiance Solar	mc-Si	-	6	-	6
7. Jetion Solar (Thailand)	mc-Si	140	250	140	250
8. Pornjaroen Tempered Safety Glass	mc-Si	-	30	-	30
9. Schutten Solar (Thailand)	sc-Si, mc-Si	-	12	-	30
10. Solar Power Technology	sc-Si, mc-Si	-	3	-	25
11. Solar PPM	sc-Si, mc-Si	-	n/a	-	200
12. Solartron	sc-Si, mc-Si	n/a	180	180	200
13. TaleSun Technology (Thailand)	sc-Si, mc-Si	850	800	850	800
14. Trina Solar (Thailand)	sc-Si, mc-Si	n/a	n/a	700	500
15. Yingli Solar (Thailand)	sc-Si, mc-Si	n/a	n/a	n/a	300
Totals		n/a	n/a	n/a	4,325



4.3 Manufacturers and suppliers of other components

PV system value chain can be separated into 3 main groups; the manufacturers of the components such as modules, inverter, battery, the engineering procurement construction (EPC) and the information technologies. In 2018 the PV rooftop systems installation became more prominent as the government promote the direction of such systems. There are 80 PV inverter suppliers for both grid-connected PV system and the retail shops. There are 20 companies in storage batteries and 70 companies dealing with the EPC for both PV power plant and PV rooftop system.

5 PV IN THE ECONOMY

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

5.1 Labour places

Activity involve the PV system come with the renewable energy development. Official agency and private sector work together to drive the output to reach the target of AEDP2015 Plan. Table 15 show the estimated PV-related full-time labour places in 2018. There are 6 groups of market category and totalling 18,710 labour places related to PV.

Table 15: Estimated PV-related full-time labour places in 2018

Market category	Number of full-time labour places
Research and development (not including companies)	70
Manufacturing of products throughout the PV value chain from feedstock to systems, including company R&D	3,000
Distributors of PV products	200
System and installation companies	1,400
Electricity utility businesses and government	40
PV power plant operation	14,000
Total	18,710

5.2 Business value

PV business in Thailand of grid-connected systems grow continuously in 2018, particularly in private sector. Table 16 show rough estimation of the value of the PV business in 2018. This year there is no new installation for off-grid systems while there are growth in grid-connected systems that has the accumulated value of more than 18.4 billion THB.

Table 4: Rough estimation of the value of the PV business in 2018 (VAT is excluded).

Sub-market	Capacity installed in 2018 [MW]	Average price [THB/W]	Value	Sub-market
Off-grid	None	n/a	None	None
Grid-connected distributed	240	50	12,000,000,000	12,000,000,000
Grid-connected centralized	160	40	6,400,000,000	6,400,000,000
Value of PV business in 2018				18,400,000,000



6 INTEREST FROM ELECTRICITY STAKEHOLDERS

6.1 Structure of the electricity system

The structure of electric utilities system Thailand is consisted of 3 sections; the generation, transmission and distribution. The power generation consists of the independent power producers, the small power producers (SPPs), the very small power producers (VSPPs), as well as the electricity generating authority of Thailand (EGAT). The different type of power producers depend on the power purchasing agreement with EGAT. Moreover EGAT own the transmission sector of the national grid that include those connected from the solar power plants and solar PV rooftop system to be a channel to sell the electricity.

The distribution sectors are included the Metropolitan Electricity Authority (MEA) and the Provincial Energy Authority (PEA). MEA is responsible for 3 provinces which is Bangkok and two adjacent provinces (Nonthaburi and Samut Prakan). PEA is responsible for the whole country area apart from MEA.

PV rooftop systems generation is categorized in the very small power producers (VSPPs) so they are regulated under MEA and PEA, depend on the area.

The national energy policy of Thailand is conducted by the National Energy Policy Committee (NEPC) and Energy Regulatory Commission (ERC).

6.2 Interest from electricity utility businesses

The new PDP 2018 plan promote the incoming of more electricity utility businesses and players in PV system during 2018 to 2037. The PDP2018 had incorporated the target of 10,000 MWp of power production from solar PV and target of floating PV at 2,725 MW_{AC} which will be carried out by EGAT.



7 HIGHLIGHTS AND PROSPECTS

7.1 Highlights

In 2018 Thailand had shifted its interest in solar PV market towards self-consumption. The ground-mounted system of VSPP was implemented under The Solar Incentive Program for Government Building and Agricultural Cooperatives (Phase 2). Each power plant has no more than 5 MWp of capacity. However the PV rooftop systems for residential household (<10 kWp of capacity) will be more strongly supported by government under the new National Reformation Plan. The initial target of the program is to introduce 100 MWp power into the system per year for 10-year duration.

The non-firm of renewable energy will be shifted to the firm power production under government support for initiative phase by the purchase of electricity from SPP hybrid firm year 2017 project.

The top activity of 2018 is the PDP 2018 during 2018 to 2037 (PDP 2018) that proposed the target of floating PV of 2,725 MW_{AC} to be carried out by EGAT.

Finally, the energy production activity in Thailand for the next 20 years are driven according to the National Country Reformation Plan of Thailand. The Household Solar PV Rooftop Program was carried out in accordance with the National Country Reform plan to support the green community and city by using residential PV rooftop systems and to support the private electricity production and distribution. This help stimulate more employment in the PV industry and business and to help reduce the greenhouse gas emissions as Thailand had pledged in COP21.

