Thailand
PV Status
Report 2012–2013

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MINISTRY OF ENERGY

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THAILAND

PV STATUS REPORT

2012-2013

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DEFINITIONS

Adder

An additional energy purchasing price on top of the normal prices that power producers (under the VSPP and SPP scheme) will receive when selling electricity to the Power Utilities.

FiT, Feed-in-Tariff

A fixed-rate of energy purchasing price that power producers (under the VSPP and SPP scheme) will receive when selling electricity to the Power Utilities.

Grid-connected centralized PV system

PV power production system performing the function of a centralized power station. The power supplied by such a system is not associated with a particular electricity consumer. The system is not located to perform specific functions on the electricity grid other than the supply of bulk power, typically large scale ground mounted system, i.e. solar farm.

Grid-connected distributed PV system

PV system installed on or integrated into consumers' premises usually on demand side of electricity meter, on public and commercial buildings to provide power to a grid-connected consumer or directly to the electricity grid.

Off-grid domestic PV system

PV system installed to provide power mainly to a household or village, not connected to the utility grid.

Off-grid non-domestic PV system

PV system used for a variety of industrial and agricultural applications such as water pumping, remote communications, telecommunication relays, safety and protection devices, etc. that are not connected to the utility grid.

SPP, Small Power Producer

Small Power Producer supplying electricity to the grid by using non-conventional energy including renewable energy but excluding natural gas, oil, coal and nuclear energy, waste energy, energy based on the cogeneration principle as a primary energy source with generating capacity more than 10 MW but not exceeding 90 MW.

VSPP, Very Small Power Producer

Very Small Power Producer supplying electricity to the grid by using renewable energy source such as wind, photovoltaic, mini-hydroelectricity, micro-hydroelectricity, geothermal energy, biogas, and agricultural waste and municipal waste, biomass energy with back-up supply < 25%, waste energy as a primary energy source with generating capacity not exceeding 10 MW.

ABBREVIATIONS

AEDP	Alternative Energy Development Plan
BOS	Balance of System
CDM	Clean Development Mechanism
CIGS	Copper Indium Gallium Selenide
COD	Commercial Operation Date
EPC	Engineering Procurement and Construction
FiT	Feed-in-Tariff
GWh	Gigawatt-hour
kW	Kilowatt
kWh	Kilowatt-hour
MOR	Minimum Overdraft Rate
MLR	Minimum Loan Rate
MSW	Municipal Solid Waste
PPA	Power Purchasing Agreement
PV	Photovoltaic
RE	Renewable Energy
REDP	Renewable Energy Development Plan
SHS	Solar Home Systems
RPS	Renewable Energy Portfolio Standard
SME	Small and Medium Enterprises
SPP	Small Power Producer
TCO	Transparent Conductive Oxide
VSPP	Very Small Power Producer

ACRONYMS

BOI	Board of Investment
BSE	Bangchak Solar Energy Co. Ltd.
BSP	Bangkok Solar Power Co., Ltd.
CAT	Communication Authority of Thailand
CSSC	CES Solar Cells Testing Center
CU	Chulalongkorn University
DEDE	Department of Alternative Energy Development and Efficiency
EEI	Electrical and Electronics Institute
EGAT	Electricity Generating Authority of Thailand
EPPO	Energy Policy and Planning Office
ERC	Energy Regulatory Commission
ESCO	Energy Service Company
KKU	Khon Kaen University
KMITL	King Mongkut's Institute of Technology Ladkrabang
KMUTNB	King Mongkut's University of Technology North Bangkok
KMUTT	King Mongkut's University of Technology Thonburi
MEA	Metropolitan Electricity Authority
NED	Natural Energy Development Co., Ltd.
NEPC	National Energy Policy Committee
NSTDA	National Science and Technology Development Agency
NU	Naresuan University
PEA	Provincial Electricity Authority
PSU	Prince of Songkla University
PTEC	Electrical and Electronic Products Testing Center
PTT	The Petroleum Authority of Thailand
RMUTL	Ratjamangala University of Technology Lanna
SMA	SMA Solar Technology AG
TISI	Thai Industrial Standards Institute
TPVA	Thai Photovoltaic Industries Association
UBU	Ubonratchathani University
UEE	Universal Energy Engineering Co., Ltd.

INTRODUCTION

This report highlights the achievements in Thailand with the dissemination of photovoltaic technology and the contribution this has made towards addressing the imbalance between fossil fuels and renewable forms of energy in this country. With an ambitious target of 25% renewable energy sources set for the current plan the climate is right for solar cells to play a major role in reducing the country's dependence on oil.

From very small beginnings of government sponsored demonstration projects, through a phase of research and development, testing and standards, we have now reached the point where the private sector is leading the way in implementing solar energy projects. This is as it should be and has been the intention of both government policy and research institutes from those very early days.

While Thailand cannot compete in the world market for manufacturing solar cells, we at least have the technical capability and can be confident in having built up sufficient knowledge of system performance, long-term monitoring in the field and expertise in ancillary equipment.

Solar companies listed on the Stock Exchange of Thailand are enjoying unprecedented popularity and the country is now on the threshold of building major energy projects that will help achieve our targets for renewable energy.

This report highlights some of the steps and achievements on that road.

(Krissanapong Kirtikara)
Chairman

1 Executive SUMMARY

Widespread PV applications in Thailand started over two decades ago as PV stand-alone systems for rural areas, and funded by government budgets. Import tariffs were lowered for PV and BOS manufacturers in 1990s, but considered not attractive enough for PV industry to take off.

The situation has changed dramatically with incentives on Feed-in-Tariffs (FiT) in the new millennium for electricity generation by renewable energy, bringing about substantial private investments in grid connected PV power plants and commercial rooftop systems, in line with global trends.

At the end of December 2013, the figure is 436 MW for annual grid connected PV systems capacity. A dynamic of renewable energy policy, in early 2010, there was adder 6.50 THB/kWh (US$ 0.22 /kWh) with support duration of 10 years for PV power plants, decreasing from 8.0 THB/kWh.

In September 2013 a new scheme to further support 200 MW PV commercial and domestic rooftops was launched with a FiT scheme of 6.16 to 6.96 THB/kWh and 25-year support duration.

1.1 Installed PV power

PV installation is 823 MW of cumulative capacity in 2013, with 794 MW of grid connected PV systems and 29 MW of PV stand-alone systems. The amounts of annual installation of PV power plants are 145 MW in 2012 and 436 MW in 2013.

1.2 Cost and prices

In 2011 and 2012, most of PV power plants were built with imported PV component, the average p-Si module price is 50 – 80 THB/Wp and the average system price is 60 – 100 THB/Wp. The range of prices is established on a case by case based on the applications.

1.3 Cell and module production and component

Most of PV module and grid-connected inverter are imported for the PV power plant. There are 6 local manufactures of cell and module production and only one of local inverter manufacture. The price competition is not available in a global market.

1.4 Research Development Activity

The research development and demonstration projects are active in limited area due to their own target. The research of private sector is for increasing the productivity. While the institute of government and universities aim for the comprehensives study of PV technology. Research on PV system monitoring is at a high level in Thailand.

1.5 Business value

The manufacture of cell and module production is conducted in parallel business with the Engineering Procurement and Construction service. PV industry value chain has a small amount of productivity for upstream, while the larger amount is for PV installation and service.

2 IMPLEMENTATION of PV Systems

2.1 Applications of PV

Thailand has a long record of PV applications since the 1980s. Initially PV modules provided electricity for telecommunication equipment of mobile medical clinics and to electrify rural school appliances. In the first half of the 1990s, PV water pumping units and PV battery charging stations were introduced into rural areas, at no cost to rural people. PV units were subsidized by two government agencies supporting rural area development, i.e. the Department of Energy Development and Promotion and the Public Works Department. The evolution of PV applications in Thailand is illustrated in Fig. 2.1.

The Telephone Organization of Thailand began using PV modules to supply electricity for telecommunication repeaters in remote areas and for village-based rural telephones. In the mid 1990s a government project called the Green Esarn Project also installed water pumping systems in north-east Thailand. Unfortunately these PV water pumping units and PV battery charging stations failed within 5-10 years, as owners could not take care the systems by themselves. Due to rapid rural electrification, PV based telecommunication repeaters and rural telephone units quickly fell into disuse, in the late 1990s.

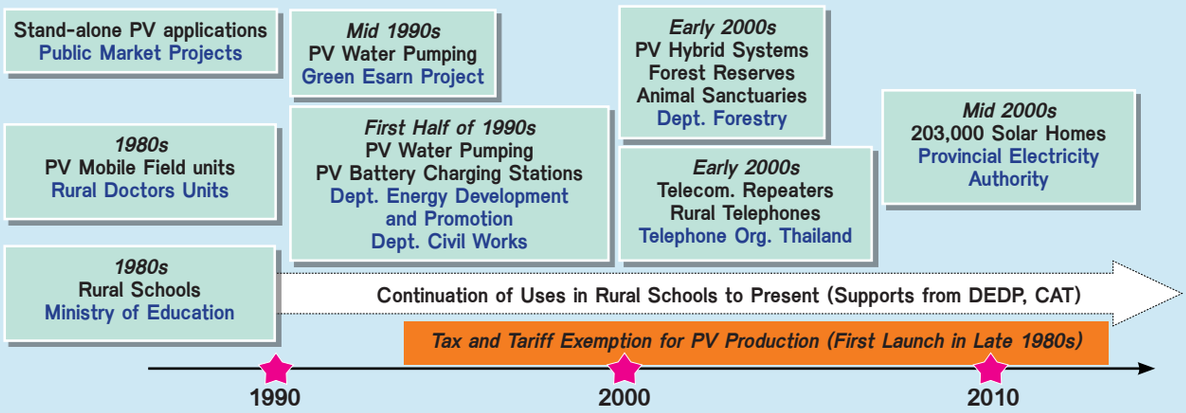


Fig.2.1 Evolution of PV applications

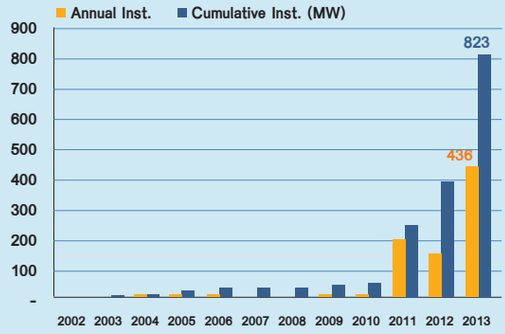
At the turn of the millennium, three new applications were introduced, i.e. PV hybrid systems, solar home systems (SHS) and PV units for rural schools. The Department of Forestry brought in PV-wind-diesel generator hybrid systems for their operation in national forests and parks, and wild life sanctuaries. At present, with adequate maintenance, these hybrid systems are still functioning after over a decade of operation. They have demonstrated reliability for remote area operation and requirements of the Department of Forestry.

In the mid-2000s, about 203,000 PV stand-alone solar home systems (SHS) were introduced by the Provincial Electricity Authority (PEA) free of charge to rural villagers. These SHSs broke down in a few years due to inverters and battery life, and fell into disuse.

Applications of PV for electricity supply to rural schools were funded by the Ministry of Education, the Department of Alternative Energy Development and Efficiency (DEDE) and the Communication Authority of Thailand (CAT). A few hundred schools in areas that are not electrified are still using these PV modules. Lessons learned from early PV applications are that PV units that were provided free of charge and did not fit real needs would quickly become derelict.

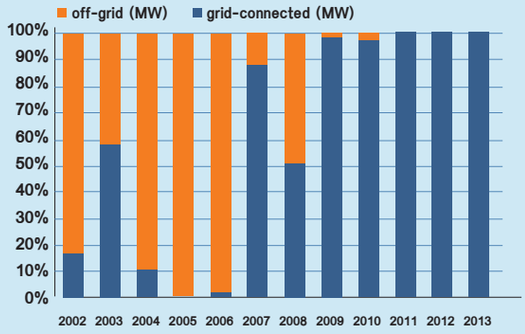
The 15 Year Renewable Energy Development Plan (REDP) commenced in 2009 with the ADDER programs as incentive for PV investors. In the next three years the Alternative Energy Development Plan (AEDP) launched in 2012, has greatly stimulated PV growth, mostly PV power plants. In the two decades (1990 and 2010) before Feed-in-Tariff (FiT) incentives, PV cumulative installation was close to 50 MW, 29.6 MW from stand-alone systems and 20 MW from grid-connected systems.

2.2 Capacity of Photovoltaic Systems



Remark :This data was provided by DEDE, EGAT, PEA and ERC.

Fig.2.2 Cumulative PV systems installation in Thailand as of December 2013



Remark :This data was provided by DEDE, EGAT, PEA and ERC.

Fig.2.3 Cumulative Grid Connected and Off-grid systems as of December 2013

Since the introduction of ADDER, in 2009 the PV situation has changed dramatically. In 2011 and 2012 the cumulative capacity was 242 MW and 387 MW, respectively. Solar power plant or solar farm has become the main PV installation in Thailand.

At the end of December 2013, the installed capacity of PV power plants was 794 MW and the cumulative capacity both PV grid and off-grid was 823 MW. In addition, about 400 MW is being installed and not yet connected to the grid. This data was provided by DEDE, EGAT, PEA and ERC.

Table 2.1 Development of PV applications between 2002 and 2013 (MW/year)

	Cumulative Installation			Annual Installation		
Year	On-grid	Off-grid	Total	On-grid	Off-grid	Total
2002	0.32	2.57	2.89	0.19	0.93	1.12
2003	1.10	3.13	4.22	0.78	0.56	1.33
2004	1.76	9.07	10.83	0.67	5.94	6.61
2005	1.77	22.11	23.88	0.01	13.04	13.05
2006	1.86	28.66	30.52	0.09	6.55	6.64
2007	3.61	28.90	32.51	1.74	0.24	1.98
2008	4.06	29.34	33.39	0.45	0.44	0.89
2009	13.67	29.49	43.17	9.62	0.16	9.77
2010	19.57	29.65	49.22	5.89	0.16	6.05
2011	212.80	29.88	242.68	193.23	0.23	193.46
2012	357.38	30.19	387.57	144.89	0.15	145.04
2013	794.07	29.73	823.80	436.69	-0.45	436.24

Remark :This data was provided by DEDE, EGAT, PEA and ERC.

2.3 Electricity Generated from Grid-Connected Photovoltaic Systems

In 2011 and 2012, the annual electricity consumption of Thailand was 153,332 and 164,276 GWh, respectively. Meanwhile, the annual electricity generation was 162,343 and 176,973 GWh, respectively. PV electricity generation from SPP started since December 2011. In 2012, the electricity generation from SPP was 120.37 GWh and in 2013 the electricity energy was 161.37 GWh. Meanwhile in 2012 and 2013, the electricity generation from VSPP was 319.48 GWh and 781.60 GWh, respectively. Total of the electricity generation of PV power plant in 2012 and 2013 were 439.85 GWh and 942.97 GWh, respectively.

Table 2.2 PV electricity generation between 2012 and 2013

Year	SPP	VSPP	Total
2012	120.37	319.48	439.85
2013	161.37	781.60	942.97

Remark: SPP electricity generation from EGAT and VSPP electricity generation from PEA.

2.4 PV Projects of SPP

The section covers PV power plant which is more than 10 MW of capacity but not larger than 90 MW of capacity as called "PV SPP". There are three PV SPP projects in Thailand which are under operation, 55 MW of the Natural Energy Development (NED), 30 MW of the Bangchak Solar and 90 MW of Energy Absolute (EA). The total of COD Plants is 175 MW. However, there are three PV mega projects with the Power Purchasing Agreement (PPA) signed, but not yet with a Commercial Operating Date (COD), total installed capacity is 220 MW as table 2.3 shows the detail of PV SPP project. The data in this section was provided by ERC and EGAT.

Table 2.3 PV SPP Power Plant in Thailand (MW)

No.	Company	Location	Capacity* (MW)	COD date
1	NED	Lopburi	55 + 8	Dec 2011
2	BSE	Ayutthaya	30 + 8	Jul 2012
3	EA Solar	NakhonSawan	90	Dec 2013
4	EA	Lumpang	90	Waiting for COD
5	EA	Phitsanulok	90	Waiting for COD
6	SarmSarnPalungNgaun	Lopburi	40	Waiting for COD

*Remark: * PV capacity from Agree to Purchase Contract, this data was provided by ERC and EGAT.*

Table 2.4 shows the annual electricity productions from NED in 2012 and 2013 were 97.71 and 108.43 GWh, respectively. Meanwhile the annual electricity productions from BSE were 22.66 (for 6 months) and 52.93 GWh, respectively. This data was provided by EGAT.

Table 2.4 Electricity production of PV SPP Power Plant in Thailand (GWh)

No.	Company	Location	2012	2013
1	NED	Lopburi	97.71	108.42
2	BSE	Ayutthaya	22.66	52.93

Remark: This data was provided by EGAT.

2.5 PV Projects of VSPP

This section covers the PV VSPP projects which are the PV power plants with a generating capacity not exceeding 10 MW each. Most of operating PV VSPP projects are located in the Central and North-East of Thailand due to high solar irradiation. In 2013 the total capacity of PV VSPP is 619 MW (169 projects), there are 54% in the Central area and 40% in the North-East of Thailand. Table 2.5 shows the companies which are the PV power plant owner in the Top 10 as of December 2013 and this data was provided by ERC and PEA.

Table 2.5 Top 10 of PV VSPP Power Plant in Thailand (MW) in December 2013

	Company	Capacity* (MW)	Projects
1	Solar Power Co., Ltd. (SPC)	129.48	23
2	Siam Solar Energy Co., Ltd.	40	5
3	Solarta Co., Ltd.	35	8
4	Bangchak Solar Energy Co., Ltd.	32	4
5	Gunkul Powergen Co., Ltd.	30.90	6
6	Electricity Generating Public Co., Ltd.	30	4
7	Bangkok Solar Power Co., Ltd.	27.25	12
8	G-Power Gorge	26	4
9	Siam Solar Generation Co., Ltd.	22.50	9
10	Infinite Green Co., Ltd.	15	3
	Total	**388.13**	**78**

*Remark: * PV capacity from Agree to Purchase Contract, this data was provided by ERC and PEA.*

2.6 PV rooftop systems

The Government launched a PV rooftop program with FiT in September 2013. Of the 200 MW rooftop systems, 120 MW would be under the jurisdiction of the Provincial Electricity Authority (PEA) for rural areas, whereas 80 MW comes under the Metropolitan Electricity Authority (MEA) for Bangkok and two other adjacent provinces (Nonthaburi and Samut Prakan). Table 2.6 shows the acceptance of rooftop applications of PEA and MEA are 2,628 projects (79.06 MW) and 1,120 projects (53.96 MW) respectively, as of January 2014. This data was provided by PEA and MEA.

Table 2.6 PV rooftop in the 200 MW rooftop program on January 2014

Electricity Authority	Capacity*(MW)	Projects
PEA	79.06	2,628
MEA	53.96	1,120
Total	133.02	3,748

Remark: PV capacity from the acceptance of rooftop applications of PEA and MEA, this data was provided by PEA and MEA.*

3 Industry and GROWTH

3.1 Development of PV Cell and Module Production

In the 1990s there was little PV module production in Thailand, most of PV systems using imported crystalline silicon cells from Japan and Germany. With the Solar Home System Project in 2005, plant manufacturing of both crystalline and amorphous silicon modules were established. After ADDER incentives in 2007 – 2012, more modules imported from China have come into operation. However, survival of module production in Thailand is uncertain depending on global players and renewable energy policy. Table 3.1 provides the latest available information of Cell and Module Production.

Table 3.1 Cell and Module Production

Company	Silicon	Cell	Module	Capacity MW/yr
Bangkok Solar	-	-	Crystalline amorphous	60-65
Ekarat Solar			Crystalline	25
Fullsolar	-	-	Crystalline	30-45
Sharp Thai			Thin film	7
Solartron	-	Crystalline	Crystalline	70
Solar Power Technology	-	-	Crystalline	n/a
G.S.Energy	Metallurgical grade	-	-	45,000 tonne/yr
Siga New Materials	Metallurgical grade	-	-	30,000 tonne/yr

Remark: The information provides by local manufactures and company annual report.

3.2 Module Price and System Price

Thailand has mostly imported modules and inverters for the PV power plants. There are modules of amorphous, monocrystalline, polycrystalline, amorphous/microcrystalline or tandem, copper indium gallium selenide (CIS) and cadmium telluride (CdTe). The majority are silicon type modules, 51% amorphous and 30% polycrystalline, respectively (Fig 3.1).

In 2011 and 2012, most PV systems in Thailand were PV power plants, the average p-Si module price was 50 – 80 THB/W and the average system price was 60 – 100 THB/W. The prices are established on a case by case based on the applications.

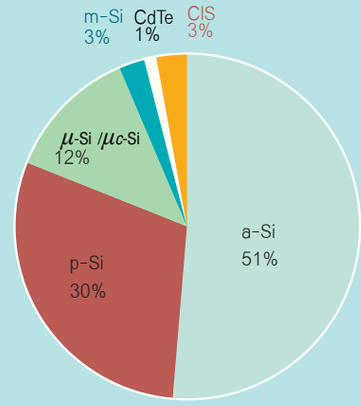


Fig. 3.1 Share of PV module of the CDM registered PV power plants in Thailand as of December 2012 (source: http://cdm.unfccc.int/)

3.3 PV Industry Value Chain

PV industry value chain consists of equipment manufacturers and consumers who supply the equipment. Thailand has the production of cell and module and inverter as local manufacture. There are 10 projects based on BOI registration and 172 MW of total capacity of cell and module production with BOI certification. However, the local module price is not competitive with global prices.

Thailand CDM registered PV power plants in 2012, the imported modules are mainly from Taiwan (45%), Japan (27%) and China (13%). Amorphous local modules have 5% of total PV system installation. The imported PV modules are illustrated in Table 3.2.

The mainly imported inverters of PV power plants are from United States (53%), Germany (26%) and Japan (10%). The local inverter company has 8% of total PV system installation. The associated services for PV systems and power sales include engineering procurement and construction (EPC) services, maintenance and monitoring PV systems, to evaluation of electricity production etc. However, 20 – 25 local companies (roughly 50% of total companies) producing both PV and inverters, provide services in both the local market and neighbouring countries such as Malaysia and Indonesia.

Table 3.2 Percentage of imported PV modules in PV power plant in 2012

Unit: percentage (%)

Country	a-Si	p-Si	m-Si	CIS	CdTe	a-Si/ μc-Si	Total
CN	**2**	**10**				**1**	**13**
DE		**4**					**4**
JP		**12**		**3**		**12**	**27**
KR		**1**					**1**
TH	**5**						**5**
TW	**44**	**2**					**45**
UK and NO			**3**				**3**
USA					**1**		**1**
Total	**51**	**30**	**3**	**3**	**1**	**12**	**100**

Remark: The information provides only the Thailand CDM registered PV power plants in 2012, a-Si: amorphous silicon, p-Si: polycrystalline silicon, m-Si: monocrystalline silicon, CIS: copper indium selenide, CdTe: cadmium telluride, a-Si/µc-Si: amorphous and microcrystalline silicon.

3.4 Research Development and Demonstration Activities

In the early 1980s research on solar cell fabrication using locally developed technology met with success by the Semiconductor Device Research Laboratory (SDRL) of Chulalongkorn University (CU) and King Mongkut's Institute of Technology Ladkrabang (KMITL). Research activities on solar cell application in photovoltaic systems were conducted in parallel to several PV demonstration projects in Thailand by CU, King Mongkut's University of Technology Thonburi (KMUTT), Naresuan University (NU) and the National Science and Technology Development Agency (NSTDA).

In the late of 1980s the research activities on cell and module production were carried out by the private sector to improve their module productivity, whilst the research activities of universities and government research institutes worked towards building a knowledge base.

The R&D activities are divided into 3 groups (Table 3.3) such as solar cells and related materials, PV components and PV applications. Solar cells and related materials consists of the topics of silicon ingot (UEE), TCO glass (NSTDA), thin film Si (NSTDA, BSC), CIGS (CU), organic and dye sensitized (NSTDA, CU, KKU, UBU, PSU, KMUTNB). Inverters in grid and stand-alone hybrid systems are one PV component provided by Leonics. PV applications consist of system evaluation and techno socio-economic management of PV systems in rural areas (CU, KMUTT, NU, RMUTL). System evaluation topic is summarized in Table 3.4.

Currently, hundreds of PV power plants and many types of technology of PV modules drive the research direction. The top topics are long term monitoring and system evaluation, PV penetration to the grid and acceleration testing for tropical climates.

Collaboration between the private sector and universities and research institutes is working towards long term monitoring of PV systems such as NED-KMUTT, SMA-KMUTT and PTT-NSTDA. In addition the Energy Research Institute (ERI) of CU conducts policy research to continually improve the Thailand renewable energy policy as well as Thailand PV roadmap.

Table 3.3 PV research activities

Research topics	Company/Agency
Solar cells and related materials	
- Silicon	UEE
- TCO glass	NSTDA
- Thin film Si	NSTDA, BSC
- CIGS	CU
- Organic and dye sensitized	NSTDA, CU, KKU, UBU, PSU, KMUTNB
PV components	
- Inverters in grid and stand-alone hybrid systems	Leonics
PV applications	
- PV systems demonstration and assessment	CU, KMUTT, NU, RMUTL

Table 3.4 PV systems evaluation in Thailand

Organization	Descriptions
NU	Mini grid, Tracking system
	Environmental effects
KMUTT	Impact of PV penetration
	Long term monitoring
	Smart mini grid for rural area
EGAT	PV tracking by water weighted
	PV floating plant
NSTDA	Long term monitoring
	Environmental effects
	Loss analysis
DEDE	Evaluation of off grid system production
	PV installation for remote areas
	PV systems mornitoring
	Voluntary register for PV installer

4 Framework for DEPLOYMENT

4.1 Policies and Incentives

Renewable energy growth in Thailand is primarily driven by the energy policy of the government, similar to other countries. In the first half of the 2000s there were policies and incentives for small power producers (SPP) and very small power producers (VSPP) and renewable energy portfolio standards (RPS).

This had brought about the launching of PV rooftop promotion. The initial project was undertaken by the Electricity Generating Authority of Thailand (EGAT) with a 50% cost subsidy, resulting in 60 PV rooftop units. Coupled with these, there was a tax and tariff exemption for manufacturers of PV modules and BOS.

The REDP was the first issue of renewable energy plan with 15 year plan (2007–2022) and the next 5 years it was replaced by the AEDP, an improved renewable energy plan with 10 year plan from 2012 – 2021, targets for renewable energy, as well as the incentives under FiT have completely transformed the scene.

This happened concurrently with the rapid decrease in prices of PV modules and BOS owing to the emergence of China as the biggest PV module manufacturer. Initially, the adder for PV of 8.00 THB/kWh (about $US 0.23/kWh) together with a base electricity price of 3 THB/kWh resulted in a FiT of 11.00 THB/kWh ($US 0.33 /kWh).

With this level of FiT for 10 years, investors and financial institutions have quickly capitalized on the opportunity in the last few years and invested substantially in PV power plants.

As adders are shouldered by all electricity consumers, the National Energy Policy Committee (NEPC) became concerned about the increasing burden. The original adder of 8 THB/kWh was reduced to 6.50 THB/kWh while keeping the support duration at 10 years. Recently, the NEPC has recommended an alternative of a flat FiT for PV rooftops. Evolution of renewable energy targets is shown in Table 4.1.

Table 4.1 Renewable Energy Target Evolution between 2007 and 2013

RE Technology	15 Year REDP 2007 – 2022	10 YEAR AEDP 2012 – 2021	
Biomass	Target	Target	New Target*
	3,700	3,630	4,800
Biogas	120	600	3,600
Solar	500	2,000	3,000
Wind	800	1,200	1,800
Waste (MSW)	160	160	400
Small/Microhydro	324	1,608	324
New Energy	3.5	3	3

*Remark: * by mid – 2013, this information was provided by EPPO and DEDE.*

Between 2011 and 2012 there were no new PV stimulus schemes. In September 2013 a new scheme to further support PV was launched with FiT incentives. The targets are 800 MW for ground mounted units for community and 200 MW for rooftop units.

Of the 200 MW rooftops, 120 MW would be under the jurisdiction of the Provincial Electricity Authority (PEA) for rural areas, whereas 80 MW comes under the Metropolitan Electricity Authority (MEA) for Bangkok and two other adjacent provinces (Nonthaburi and Samut Prakan). The FiT scheme of 6.16 to 6.96 THB/kWh and 25-year support duration is available. The 200 MW PV rooftops are set to be operational by 2013.

No details are yet available for the 800 MW ground mounted units. Adders and FiTs of various RE Incentive Support Programs are shown in Table 4.2.

Table 4.2 Adders and FiTs of Various RE Incentive Support Programs

Technology	REDP		AEDP	Descriptions
Biomass				Adder program of 7 years
: Capacity ≤ 1 MW	0.30	0.50	0.50	
: Capacity > 1 MW	0.30	0.30	0.30	
Biogas				Adder program of 7 years
: Capacity ≤ 1 MW	0.30	0.50	0.50	
: Capacity > 1 MW	0.30	0.50	0.50	
Waste				MSW and Industrial waste, excluding hazardous waste and organic waste Adder program of 7 years
: Landfill or Digestion Process	2.50	2.50	2.50	
: Thermal Process	2.50	3.50	3.50	
Wind				Adder program of 10 years
: Capacity ≤ 50 MW	3.50	4.50	4.50	
: Capacity > 50 MW	3.50	3.50	3.50	
Small/Microhydro				Adder program of 7 years
: Capacity < 50 kW	0.80	1.50	1.50	
: Capacity 50 to≤ 200 kW	0.40	0.80	0.80	
Solar Electricity				*Adder program of 10 years
PV power plant	8.00	6.50	6.50	
PV rooftop	8.00	6.50	-	
PV rooftop (2013)				**FIT program of 25 years
: Capacity ≤ 10 kW	-	-	6.96	
: Capacity > 10 to 250 kW	-	-	6.55	
: Capacity > 250 kW to 1 MW	-	-	6.16	

Remark : additional 1.00 THB/kWh of Special Adder for diesel replacement and Special Adder for Three Southern most provinces, excepting Wind energy and solar energy are 1.50 THB/kWh.

** The consideration for selling electricity of PV systems in the Adder program was quitted in June 2010, by the National Energy Policy Committee.*

*** It was announced in September 2013.*

In 2012 and 2013 electricity generation from renewable energy revealed that the installation of PV systems is the second major contributor to RE technology. The first is biomass technology and the third is biogas technology due to Thailand having predominantly agriculture-based industry.

To conclude the section on renewable energy and incentive programs, a summary of PV applications and promotion mechanisms is shown in Table 4.3.

Table 4.3 PV Applications and Supporting Measures

Year	Promotion Mechanisms	Supporting Measure
1985 - 2006	PV installations in rural area by various national projects (mostly stand-alone applications : water pumping, battery charging, telecommunication, solar home systems) - Introduction of policy on Small Power Producers - SPP and Very Small Power Producers –VSPP by Private Sector and demonstration of PV Rooftop	- 100% budget and implementation by government - Renewable Portfolio Standard – RPS sets an 8% target for RE in 2011
2007 - 2011	15 Year Renewable Energy Development Plan – REDP sets a renewable energy target of 20% of final energy consumption in 2022 (500 MW from PV)	- Adder (Feed in Premium) on top of the normal electricity tariff, 8 THB/kWh of both solar PV and solar thermal energy of 10 years - VSPP undertaken by distributed generators authority (PEA, MEA) - SPP undertaken by generator and transmitter authority (EGAT)
2012 - 2013	10 Year Alternative Energy Development Plan – AEDP sets a renewable energy target of 25% of final energy consumption in 2021 (set new target of PV from 2,000 to 3,000 MW) - Promotion of solar PV rooftop for domestic, SME enterprises and factories of 200 MW by 2013 (total plan for 800 MW) - Promotion of solar PV rooftop for government building of 25 MW by 2014, the electricity production is for self-consumption (no FiT) - Promotion of solar PV generation by community of 800 MW by 2014	- Feed in Tariff – FiT for VSPP not more than 1 MW, 6.16 to 6.96 THB/kWh of 25 years - Voluntary register registration of solar rooftop installation and consultants by Ministry of Energy to support the PV rooftop program - Feed in Tariff – FiT of 25 years for PV generation by community not more than 1 MW, 9.75 THB/kWh of 1 – 3 years, 6.50 THB/kWh of 4 – 10 years, 4.50 THB/kWh of 11 – 25 years

Incentives from BOI have promoted the manufacture of solar cells and fabrication of modules and related equipment (BOS, battery) and solar power plant. The advantages offered by these investment projects for sustainable development in all provinces except Bangkok and >1 million THB of investment cost excluding land and revolving costs are:

- waiver of the import duty on machinery and 8 year corporate income tax with no cap for solar power plant and manufacture of solar cells
- waiver of the corporate income tax for fabrication of modules and related equipment: 5 years for zone 1, 6 years for zone 2 and outer industry zones, 7 years for zone 2 and inner industry zones, 8 years for zone 3 by the income tax rate based on the investment cost
- 50% reduction of income tax for 5 years from year 9 to year 13
- 25% reduction of infrastructure construction costs for 10 years of investment
- double reduction of public utility costs of operation.

Note:
Zone 1: Bangkok and 5 provinces (Samut Prakan, Samut Sakhon, Nakhon Pathom, Nonthaburi and Pathumthani)
Zone 2: 12 provinces, Angthong, Ayutthaya, Chacheongsao, Chonburi, Kanchanaburi, Nakhon Nayok, Phuket, Ratchaburi, Rayong, Samut Songkhram, Saraburi and Suphanburi
Zone 3: Remaining 58 provinces

Table 4.4 BOI Investment support for solar cell and related equipment and solar power plant

Year	Project	Capacity (MW)	Capital cost (million THB)
Solar power plant			
to 2011	107	573.2	63,742
2012	86	639	57,073
2013	35	176.9	18,561
Total	***228***	***1,389.1***	***139,376***
Manufacture of solar cells and fabrication of modules and related equipment			
2004	2	30	500
2005	2	25	100
2006	2	40	2,400
2007	2	39	2,000
2008	1	30	1,800
2012	1	8	10
Total	***10***	***172***	***6,810***

Remark: This information was provided by the Board of Investment of Thailand (BOI).

In addition the PV projects have support from financial institutes. The Energy Conservation Promotion Fund (ENCON Fund) provides the Energy Service Company (ESCO) Fund and E for E has been appointed the ESCO Fund Manager to manage the project implementation in Phase 2 (October 2010 - September 2012), with an allocated management budget of 300 million Baht.

Banks are the main sector providing financial support for PV projects. During the early stages of REDP the PV projects lacked financial support until a few projects started to show success. There are three pioneers of RE financial support from Thai banks such as Kasikorn Bank, Bangkok Bank and Siam Commercial Bank. The PV investors have to prove the return of project and trustworthiness of the company. Foreign consultant companies have an advantage due to their greater experience with RE technology.

Thailand energy policy in 2012 and 2013 follows the AEDP with the growth of PV power plant projects and a new scheme of PV rooftop. Currently, the new schemes of financial support from banks are a long term soft loan with differing conditions. The typical soft loan program of SME, energy conservation and RE projects are shown in Table 4.5. The maximum loan has both 50 million THB per project and unlimited term loan.

Table 4.5 Long term loan of energy saving and renewable energy of Thai bank

	program	Interest rate (%/year)	Period
Bangkok Bank			
	Bualuang Green	Interest rate and credit term are subject to the bank's consideration	
	Bualuang Energy Saving	Subject to the Bank's rules and regulations	3-7
Kasikorn Bank			
	K-Energy Saving	4	7
	K-Energy Saving Guarantee program	Subject to the Bank's rules and regulations	Long term
Krung Thai Bank			
	KTB-Energy Saving	Term Loan: MLR-1.0% of 1st year to 2nd year and MLR from 3rd year	10
		Working Capital: MOR	n/a
	KTB Green Loan	MLR	7
Thai Military Bank			
	Facilities for Energy Conservation & Renewable Energy project	4	5

4.2 Standards, Codes and Testing Services

Certification is important to investors as it ensures performance and reliability of PV systems that have attracted their investment. The minimum certification requirements are IEC61215 for crystalline silicon modules and IEC61646 for thin film modules.

In 2011 the Thai Industrial Standards Institute (TISI) announced in the Government Gazette the TIS1843-2553 being the Thai version of IEC61215:2005 for crystalline silicon modules. In early 2013 TIS 2210-2555, the Thai version of IEC61646:2008, for thin film modules was announced.

PV module safety standard was announced in the Government Gazette. There are requirements for construction and requirements for testing, according to IEC standards IEC61730-1 and IEC61730-2, respectively.

BOS standard in Thailand concerns the safety for distribution lines and networks of the utility, the applied BOS standards are IEC61727 and IEC62116.

In addition, inverters for 200 MW of PV rooftop have to comply with the regulatory measures for grid connected inverters that was announced by the two Thai electricity distributing utilities, i.e. the Provincial Electricity Authority – PEA for rural areas and the Metropolitan Electricity Authority – MEA for Bangkok.

There are three facilities providing standard testing services for specifications and compliance tests requested in procurement terms of reference.

The CES Solar Cells Testing Center (CSSC) of KMUTT is an accredited laboratory, complying with ISO/IEC17025. It provides lab-based testing services for PV modules, batteries and inverters and on-site testing for system commissioning.

The Electrical and Electronic Products Testing Center (PTEC) set up by the National Electronics and Computer Technology Center (NECTEC) which also provides PV module, batteries and inverters standard testing according to IEC standards and PV on- site testing for maintenance services.

The Electrical and Electronics Institute (EEI) under the Ministry of Industry provides testing services for BOS.

5 Highlights and PROSPECTS

5.1 Highlight 2013

PV power plant installation has become dominant between 2009 and 2013 due to the renewable energy policy both the 15 Year REDP and the 10 Year AEDP. This 10 Year AEDP has a target to share the renewable energy with 25% of the final energy consumption. The latest target of solar energy installation capacity is 3,000 MW of AEDP.

Up to March 2014, status of PV power plant development and commercial operation show that the central and northeast regions of Thailand (Table 5.1) have the largest numbers of PV power plants in operation (State 4) and under construction (State 3). This is due to high solar irradiation, compared to the other regions, and availability of flat terrain.

In March 2014, most of the large power plants under construction and operation (SPP) are taking place in the central region. Moreover, the capacity of COD plants is 844 MW, mostly VSPP size. Those under PPA state are 469 MW, 53% of VSPP and 47% of SPP. This shows that these PPA projects should reach the COD stage at the end of 2014. There is no information on the status of the 182 projects, totaling 1,029 MW, under consideration.

The 200 MW of PV rooftop project was announced in September 2013 and operation schedule at the end of 2013. Additional FiT program was launched with different rates based on the installation capacity and fixed rate though 25 years.

5.2 Future trends

The new PV project of renewable energy of community and PV rooftop will be announced in the near future. The system capacity is not larger than 1 MW per community under the Provincial Electricity Authority (PEA). The FiT program will be applied with dynamic rate based on the year of system operation.

Several of the PV systems as the distribution generator, both the PV power plant and PV rooftop affect the grid distribution systems. It is critical to give precedence to impressment of the infrastructure of grid distribution and grid regulation, as well as the grid codes.

Table 5.1 States of PV power plant development and under operation (as of March 2014).

		VSPP		SPP	
		Number of plants (Project)	Capacity (MW)	Number of plants (Project)	Capacity (MW)
North		16	25.41	1	90.00
	state 1	2	7.70		
	state 2				
	state 3	2	1.92	1	90.00
	state 4	12	15.79		
North-East		140	624.26		
	state 1	40	246.62		
	state 2	1	1.25		
	state 3	29	117.25		
	state 4	70	263.14		
Central		170	793.25	6	346.00
	state 1	79	409.48	1	41.00
	state 2				
	state 3	8	56.99	2	130.00
	state 4	83	326.78	3	175.00
East		51	221.64		
	state 1	31	157.42		
	state 2				
	state 3	9	40.62		
	state 4	11	23.60		
West		24	97.76		
	state 1	4	25.90		
	state 2				
	state 3	5	32.01		
	state 4	15	39.85		
South		34	141.99		
	state 1	25	141.45		
	state 2				
	state 3	6	0.52		
	state 4	3	0.02		

(i) State 4 : Plants (or projects) already supplying electricity to the grid , and are designated by projects with COD – Commercial Operation Date : 844.19 MW

(ii) State 3 : Projects that have Power Purchasing Agreement (PPA) signed but not yet COD : 469.32 MW

(iii) State 2 : Projects that have purchasing agreed, but PPA not yet signed : 1.25 MW

(iv) State 1 : Projects that have been submitted for consideration : 1,029.57 MW

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