

Output analysis and experiences of PV Projects

By

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Thailand Electricity Structure

Renewable Energy Development Plan 15 Years (2008-2022)

**Alternative Energy Development Plan
(AEDP: 2012-2021)**

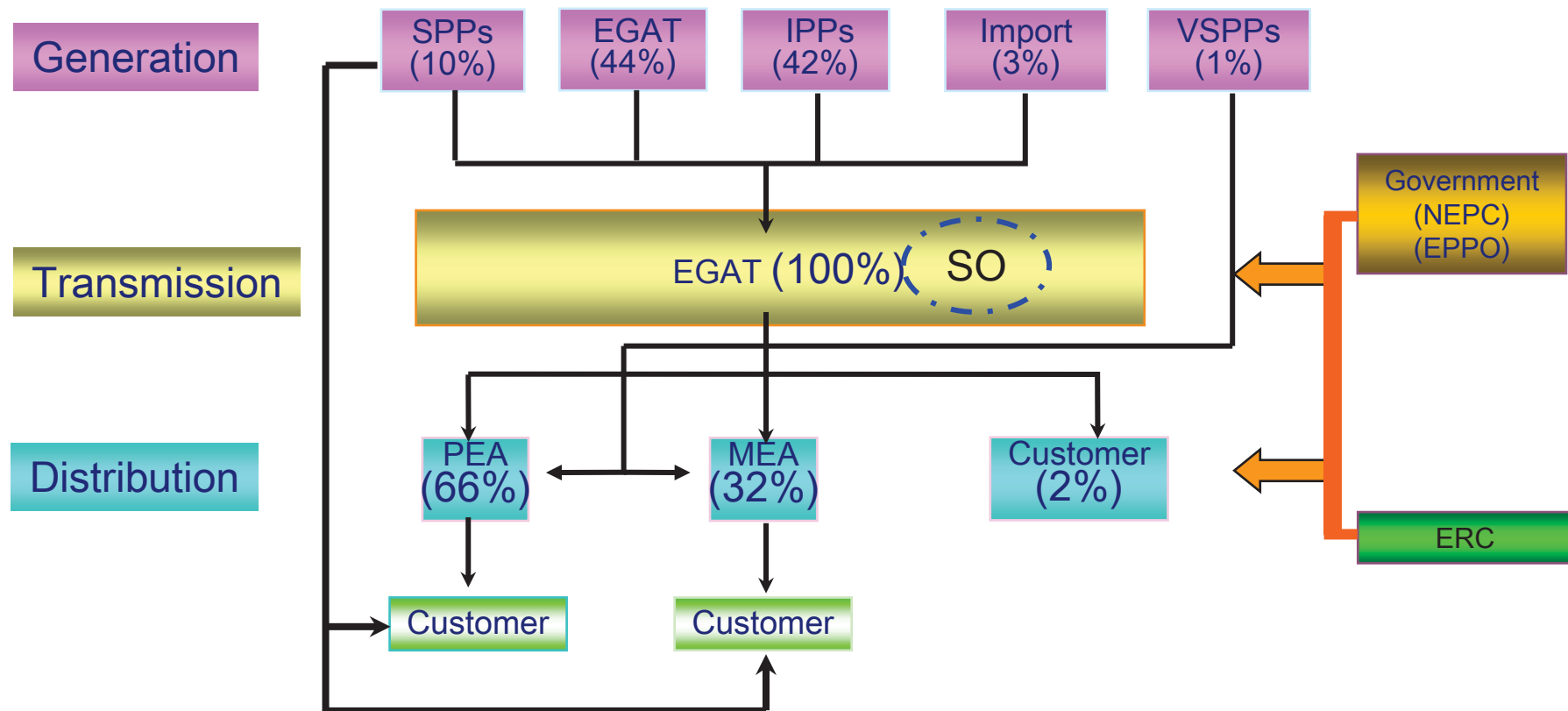
Status of PEA VSPP Project

Today's VSPP Solar situation

Solar Power Plant Performance in Thailand



Thailand Electricity Structure





Alternative Energy Development Plan (AEDP)

Committed to the Development of
Low-Carbon Society

Government Funding on
R&D Activities

Alternative Energy Development Plan
(AEDP: 2012-2021)

Encouraging
Private-Led
Investment

Target 25% of RE in Total Energy Consumption
by 2021

New Energies		Solar	Wind	Hydro-electric			Bio-energy			Biofuels		
Tidal	Geothermal			Micro	Mini	Pump Storage	Biomass	Biogas	MSW	Ethanol	Biodiesel	New Fuel Replacing Diesel
2 MW	1 MW	2,000 MW	1,200 MW	324 MW		1,284 MW	3,630 MW	600 MW	160 MW	9 Mill It/d	5.97 Mill It/d	25 Mill It/d
3 MW		3,200 MW		1,608 MW			4,390 MW			Oil Replacing 44%		

แผนพัฒนาพลังงานทดแทนและพลังงานทางเลือก 25% ใน 10 ปี (พ.ศ.2555-2564)
(Alternative Energy Development Plan: AEDP 2012-2021)

ประเภท (Type)	หน่วย (Unit)	ปัจจุบัน (Current)	เป้าหมายเดิม (Previous Target)	เป้าหมายใหม่ (New Target)	
ไฟฟ้า (Electricity)		MW	KTOE (MW)	KTOE (MW)	ล้านหน่วย (Million Units)
พลังงานลม (Wind Power)		7.3	89 (800)	134 (1200)	1,283
พลังงานแสงอาทิตย์ (Solar Power)		75.5	56 (500)	224 (2000)	2,484
ไฟฟ้าพลังน้ำ (Hydro Power)		86.4	85 (324)	756 (1608)	5,604
พลังงานชีวมวล (Biomass)		1751.9	1,933 (3700)	1,896 (3630)	14,008
ก๊าซชีวภาพ (Biogas)		138	54 (120)	270 (600)	1,050
พลังงานจากขยะ (Waste to Energy)		13.5	72 (160)	72 (160)	518
พลังงานรูปแบบใหม่ (Others)		-	ไฮโดรเจน/ hydrogen (2)	0.86 (2)	10
รวม (Sub-total)			2,290 (5,606)	3,352.86 (9,200)	24,956
สัดส่วนทดแทนไฟฟ้า (Electricity Substitution Ratio)	%		6%	10.1%	
ความร้อน (Heating)					
พลังงานแสงอาทิตย์ (Solar Power)	KTOE		38	100	
พลังงานชีวมวล (Biomass)	KTOE		6,760	8,200	
ก๊าซชีวภาพ (Biogas)	KTOE		600	1,000	
ก๊าซชีวภาพ (Biogas) CBG (5% ของ NGV)				797	
				203	
พลังงานจากขยะ	KTOE		35	35	
รวม (Sub-total)	KTOE		7,433	9,335	
เชื้อเพลิงชีวภาพ (Biofuel)					
เอทานอล (Ethanol)	ลล/วัน (mL/day)		9.0	9.0	
ไบโอดีเซล (Biodiesel)	ลล/วัน (mL/day)		4.5	5.97	
เชื้อเพลิงใหม่ทดแทนดีเซล (Diesel Substitute Fuel)	ลล/วัน (mL/day)		-	25.0	
รวม (Sub-total)	ลล/วัน (mL/day)		13.5	39.97	
สัดส่วนทดแทนน้ำมัน (Fossil Fuel Substitute Ratio)	%		14%	44%	
สัดส่วนพลังงานทดแทนต่อการบริโภคพลังงานขั้นสุดท้ายของประเทศ (Percentage of Renewable Energy to Total Energy Consumption)			12% (ไม่รวม NGV/ exclude NGV)	25%	

Fixed Adder Rates for VSPPs

Type of Fuels	Adder (Baht/kWh)	Extra Adder (Baht/kWh)	Special Adder for VSPPs in 3 southern most provinces * (Baht/kWh)	Period (Year)
1. Biomass				
- Installed Capacity ≤ 1 MW	0.50	1.00	1.50	7
- Installed Capacity >1 MW	0.30	1.00	1.30	7
2. Biogas				
- Installed Capacity ≤ 1 MW	0.50	1.00	1.50	7
- Installed Capacity >1 MW	0.30	1.00	1.30	7
3. MSW				
- Landfill Gas	2.50	1.00	3.50	7
- Thermal Process	3.50	1.00	4.50	7
4. Wind				
- Installed Capacity ≤ 50 kW	4.50	1.50	6.00	10
- Installed Capacity > 50 kW	3.50	1.50	5.00	10
5. Mini Hydro				
- Installed Capacity 50 kW - <200 kW	0.80	1.00	1.80	7
- Installed Capacity <50 kW	1.50	1.00	2.50	7
6. Solar				
	6.50	1.50	9.50	10

Remark : * 3 southern most provinces: Yala, Pattanee, Narathiwad

Status of PEA VSPP

Project

Fuel Type	Submitted		Approved		Contracted		COD		Total	
	Amount	Capacity (MW)	Amount	Capacity (MW)	Amount	Capacity (MW)	Amount	Capacity (MW)	Amount	Capacity (MW)
Biomass	54	276.17	36	156.42	184	1328.41	69	391.32	343	2152.31
Biogas	23	41.71	29	48.87	48	80.92	70	102.73	170	274.23
Solar	171	931.66	28	80.19	400	1777.88	74	162.12	677	2976.33
- PV	171	931.66	21	37.94	174	655.61	73	154.12	443	1803.81
- Stirling Engine					120	718.50			120	718.50
- Parabolic Trough			7	42.25	106	403.77	1	8.00	114	454.02
Waste	19	94.90	7	7.86	13	48.91	11	36.33	50	188.00
Wind	31	61.74	6	27.06	26	75.33	3	0.38	66	164.52
Hydro	7	15.40	2	0.13	5	6.20	3	0.28	17	22.00
Cogen.					9	37.80	6	15.50	15	53.30
Total	305	1421.58	108	320.53	685	3355.45	236	708.66	1338	5830.69



Today's VSPP Solar situation

Today's VSPP Solar Situation

There are two type of Solar Energy Technology: Photovoltaic System (PV) and Thermal System

Photovoltaic System (PV)

Total Grid connected is 73 Project, 154.12 MW as following;

Type	No.of project	MW
PV (Total)	73	154.12
- Amorphous	13	17.746
- Crystalline	40	127.523
- Rooftop	17	0.451
- Cadmium Telluride	2	6.9
-Amorphous+Cystalline	1	1.5



Thermal System

Total Grid connected is 1 Project, 8 MW (Thai solar Energy)



Type	No.of project	MW
Solar Thermal (Total)	1	8
- Parabolic Trough	1	8
- Stirling Engine	0	0



- Crystalline : 40 Projects

NO.	Company/Personal	kW	Size of Inverter (kW)
1	Siam Energy Trade Co.,Ltd	2	1.2
2	Mr.Pree Malakul Na Ayutthaya	2	1.2
3	Plan Creation Co.,Ltd	10	10
4	Grenzone (Thailand) Co.,Ltd	10	10
5	Ekarat Engineering Co.,Ltd	18	10
6	Phetchabun Innovation Co.,Ltd	20	10
7	Green Energy Technology Co.,Ltd	25	10
8	Standard Unique Supply Co.,Ltd	28	10
9	Chaipakpan Co.,Ltd	42	10
10	Ekarat Engineering Co.,Ltd	42	10
11	J Y K Power Co.,Ltd	48	10
12	UdonSunergy Co.,Ltd	996	100
13	Green Energy Inn Co.,Ltd	480	100
14	Ekarat Engineering Co.,Ltd	627	630
15	Gunha Solar Power Co.,Ltd (Project 1)	998	100
16	Gunha Solar Power Co.,Ltd (Project 2)	998	100
17	Sun Sweet Co.,Ltd	1000	100
18	EnerQ Co.,Ltd	1250	100
19	Gunkul PowerGen Co.,Ltd	3000	500
20	Indorama Holding Co.,Ltd	2000	15

NO.	Company/Personal	kW	Size of Inverter (kW)
21	Gunkul PowerGen Co.,Ltd (Project 2)	4400	500
22	Loei Solar Supply Co.,Ltd	1000	250
23	Solar Power (Sakonkhon 1) Co.,Ltd	5880	11
24	Solar Power (Nakhonphanom 1) Co.,Ltd	5880	11
25	Solar Power (Loei1) Co.,Ltd	5880	11
26	SPP Four Co.,Ltd	6000	500
27	Solar Power (Korat 1) Co.,Ltd	5880	11
28	Solar Power (Korat 2) Co.,Ltd	5880	11
29	Rootsun Co.,Ltd (Project 1)	1000	17
30	Rootsun Co.,Ltd (Project 2)	1000	17
31	Infinite Green Co.,Ltd	5000	500
32	Solata Co.,Ltd	3000	11
33	Bangchak Petroleum Co.,Ltd	8000	630
34	L-Solar 1 Co.,Ltd	8000	250
35	Sea on top Co.,Ltd	8000	880
36	East Energy Co.,Ltd	2000	300
37	G-Power Source Co.,Ltd (Takeed Project)	6500	500
38	G-Power Source Co.,Ltd (Tasung Project)	6500	500
39	G-Power Source Co.,Ltd (Dongkorn Project)	6500	500
40	Pro Solar Co.,Ltd	4000	100



- Amorphous : 13 Projects

NO.	Company/Personal	kW	Size of Inverter (kW)
1	UdonSunergy Co.,Ltd	996	100
2	Best Solar Energy Co.,Ltd	980	100
3	Bangkok Solar Power Co.,Ltd (Banphot Phisai)	530	62.5
4	Bangkok Solar Power Co.,Ltd (Phatthana Nikhom)	2000	500
5	Bangkok Solar Power Co.,Ltd (Phatthana Nikhom)	4000	250
6	Bangkok Solar Power Co.,Ltd (Nakha)	240	62.5
7	Bangkok Solar Power Co.,Ltd (Phen)	1500	62.5
8	Bangkok Solar Power Co.,Ltd (Bua Yai)	1125	1000
9	Bangkok Solar Power Co.,Ltd (Ang Thong)	1200	62.5
10	Bangkok Solar Power Co.,Ltd	1300	62.5
11	Bangkok Solar Power Co.,Ltd (Cha-am)	2125	62.5
12	Bangkok Solar Power Co.,Ltd (Hua-Hin)	1750	62.5
13	Bangkok Solar Power Co.,Ltd (Sirintorn)	4500	500

- Cadmium Telluride : 2 Projects

NO.	Company/Personal	kW	Size of Inverter (kW)
1	Nakhonratchasima Co.,Ltd	6000	500
2	Siam Solar Co.,Ltd	900	100

- Rooftop : 17 Projects

NO.	Company/Personal	kW
1	Prabathuitom Royal Project	3
2	Mrs.Fungruk Ruamcharoen	3
3	Dr.Praneat Sagantrakul	3
4	Gen.Pang Malakul Na Ayutthaya	3
5	Prof.Dr.Sunthorn Bunyathikarn	3
6	Mr.Boonserm Wanwongsorn	56
7	Mr.Sarot Sornnoi	30
8	Mr.Korn Renault	2
9	Miss.Marisa Sorat	56
10	Mr.Somchai Wimuktanon	15
11	Miss.Nongporn Kingsuwan	3
12	Mr.Pree Malakul Na Ayutthaya	3
13	Mr.Suwat Sutuntirat	3
14	Mrs.Thunyada Lerdwichai	180
15	Mrs.Putcharin Sangtien	35
16	ChangHuaMan Royal Project	50
17	Mr.Torboon Bunyamarn	3

- Crystalline & Thinfilm : 1 Projects

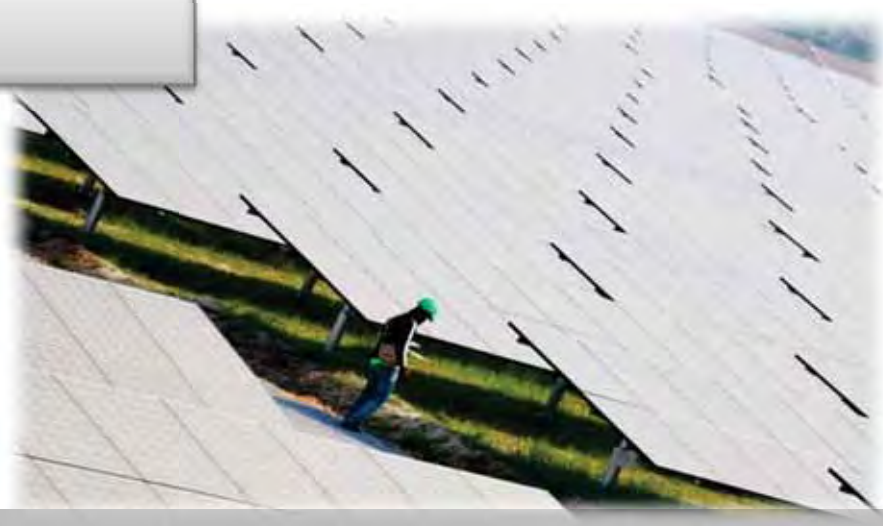
NO.	Company/Personal	kW	Size of Inverter (kW)
1	Solar Park Co.,Ltd	1500	100



Solar Power Company Group



5.88 MW/PPA
Nakornratchasima
Sakonnakorn
Nakornpanom





Bangkok Solar Power



1.2 MW Ang Thong

Bangkok Solar Power COD 11 Projects

Ban Pho Chachoengsao	1.3 MW
Mueang Udon Thani	0.24 MW
Phen Udon Thani	1.5 MW
Cha um Phetchaburi	2.125 MW
Phatthana Nikhom Lopburi	2.0 MW
Banphot Phisai Nakhon Sawan	0.53 MW
Mueang Ang Thong	1.2 MW
Bua Yai Nakhon Ratchasima	1.125 MW
Hua-Hin Prachuap Khiri Khan	1.75 MW
Sirintorn	4.5 MW
Phatthana Nikhom Lopburi	4.0 MW



1.5 MW Phetchaburi



Thai Solar Energy



Solar Thermal Parabolic Trough



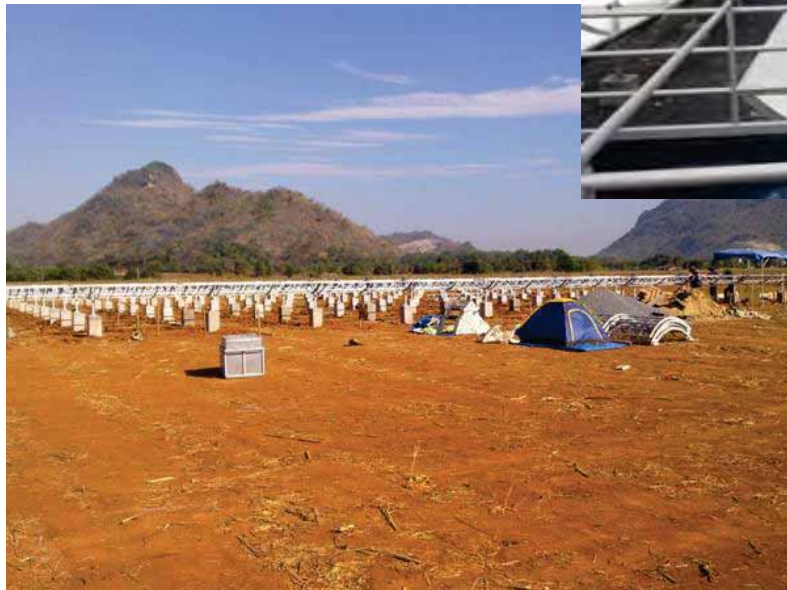
Solar Thermal Parabolic Plant Kanchannaburi 5 MW

PPA 8 MW

COD 5 MW Kanchannaburi



Sport online (Saraburi)





Suthiti (Nakornratchasima)



Company/Personal	Capacity (kW)	Type	Average 4 months
Prabathuikom Royal Project	3	Rooftop	0.1206
Mrs.Fungruk Ruamcharoen	3	Rooftop	0.0249
Dr.Praneat Sagantrakul	3	Rooftop	-
Gen.Pang Malakul Na Ayutthaya	3	Rooftop	0.0780
Prof.Dr.Sunthorn Bunyathikarn	3	Rooftop	0.0487
Mr.Boonserm Wanwongsorn	56	Rooftop	0.1445
Mr.Sarot Soranoi	30	Rooftop	0.0904
Mr.Korn Renault	2	Rooftop	0.0764
Miss.Marisa Sorat	56	Rooftop	-
Mr.Somchai Wimuktanon	15	Rooftop	0.1525
Miss.Nongporn Kingsuwan	3	Rooftop	0.0428
Mr.Pree Malakul Na Ayutthaya	3	Rooftop	0.0029
Mr.Suwat Sutuntirat	3	Rooftop	-
Mrs.Thunyada Lerdwichai	180	Rooftop	-
Mrs.Putcharin Sangtien	35	Rooftop	0.0154
ChangHuaMan Royal Project	50	Rooftop	0.1406
Mr.Torboon Bunyamarn	3	Rooftop	0.0584
UdonSunergy Co.,Ltd	996	Amorphous	0.2109
Best Solar Energy Co.,Ltd	980	Amorphous	0.1905
Bangkok Solar Power Co.,Ltd (Banphot Phisai)	530	Amorphous	0.1489
Bangkok Solar Power Co.,Ltd (Phatthana Nikhom)	2000	Amorphous	0.1859
Bangkok Solar Power Co.,Ltd (Phatthana Nikhom)	4000	Amorphous	0.1856
Bangkok Solar Power Co.,Ltd (Nakha)	240	Amorphous	0.1725
Bangkok Solar Power Co.,Ltd (Phen)	1500	Amorphous	0.1637
Bangkok Solar Power Co.,Ltd (Bua Yai)	1125	Amorphous	0.1680
Bangkok Solar Power Co.,Ltd (Ang Thong)	1200	Amorphous	0.1476
Bangkok Solar Power Co.,Ltd	1300	Amorphous	0.1581
Bangkok Solar Power Co.,Ltd (Cha-am)	2125	Amorphous	0.1581
Bangkok Solar Power Co.,Ltd (Hua-Hin)	1750	Amorphous	0.1940
Bangkok Solar Power Co.,Ltd (Sirintorn)	4500	Amorphous	0.2198
Siam Energy Trade Co.,Ltd	2	Crystalline	0.0673
Mr.Pree Malakul Na Ayutthaya	2	Crystalline	0.0043
Plan Creation Co.,Ltd	10	Crystalline	0.0587
Grenzone (Thailand) Co.,Ltd	10	Crystalline	0.0844
Ekarat Engineering Co.,Ltd	18	Crystalline	0.1676
Phetchabun Innovation Co.,Ltd	20	Crystalline	0.1207
Green Energy Technology Co.,Ltd	25	Crystalline	0.0470
Standard Unique Supply Co.,Ltd	28	Crystalline	0.1675
Chaipakpan Co.,Ltd	42	Crystalline	0.1410
Ekarat Engineering Co.,Ltd	42	Crystalline	0.1495
J Y K Power Co.,Ltd	48	Crystalline	0.2027
UdonSunergy Co.,Ltd	996	Crystalline	0.2073
Green Energy Inn Co.,Ltd	480	Crystalline	0.0748
Ekarat Engineering Co.,Ltd	627	Crystalline	0.1893
Gunha Solar Power Co.,Ltd (Project 1)	998	Crystalline	0.1770
Gunha Solar Power Co.,Ltd (Project 2)	998	Crystalline	0.1753
Sun Sweet Co.,Ltd	1000	Crystalline	0.0195
EnerQ Co.,Ltd	1250	Crystalline	0.1942
Gunkul PowerGen Co.,Ltd	3000	Crystalline	0.2300
Indorama Holding Co.,Ltd	2000	Crystalline	-
Gunkul PowerGen Co.,Ltd (Project 2)	4400	Crystalline	0.1873
Loei Solar Supply Co.,Ltd	1000	Crystalline	0.1914
Solar Power (Sakonkakhon 1) Co.,Ltd	5880	Crystalline	0.1775
Solar Power (Nakhonphanom 1) Co.,Ltd	5880	Crystalline	0.1823
Solar Power (Loei1) Co.,Ltd	5880	Crystalline	0.1720
SPP Four Co.,Ltd	6000	Crystalline	0.1982
Solar Power (Korat 1) Co.,Ltd	5880	Crystalline	0.1864
Solar Power (Korat 2) Co.,Ltd	5880	Crystalline	0.1863
Rootsun Co.,Ltd (Project 1)	1000	Crystalline	0.1883
Rootsun Co.,Ltd (Project 2)	1000	Crystalline	0.1905
Infinite Green Co.,Ltd	5000	Crystalline	0.1885
Solata Co.,Ltd	3000	Crystalline	0.1834
Bangchak Petroleum Co.,Ltd	8000	Crystalline	0.2090
L-Solar 1 Co.,Ltd	8000	Crystalline	0.1980
Sea on top Co.,Ltd	8000	Crystalline	0.1443
East Energy Co.,Ltd	2000	Crystalline	0.2058
G-Power Source Co.,Ltd (Takeung Project)	6500	Crystalline	0.1976
G-Power Source Co.,Ltd (Tasung Project)	6500	Crystalline	0.2034
G-Power Source Co.,Ltd (Dongkorn Project)	6500	Crystalline	0.0555
Pro Solar Co.,Ltd	4000	Crystalline	0.1843
Solar Park Co.,Ltd	1500	พลังงานแสงอาทิตย์	0.1863
Nakhonratchasima Co.,Ltd	6000	พลังงานแสงอาทิตย์	0.2309
Siam Solar Co.,Ltd	900	พลังงานแสงอาทิตย์	0.1406
Thai Solar Energy Co.,Ltd	8000	Parabolic Trough	0.0477

Roadmap Overview

Planning and Pilot Project

Large Scale Expansion

Power quality and service efficiency improvement

Smart Energy

- Electricity networks in 4 cities automated system.
- Network supports of DG
- Micro-grids
- Energy Storage
- The integration of Enterprise System
- Mobile Workforce in 4 cities
- Renewable energy development in communities

- Optimal Asset management
- Complete of MWM
- Completion of unmanned substation
- Expand fully automated network covering major cities across the country
- The penetration of renewable energy sources and energy storage in communities

- Automated electricity networks nationwide/self-healing features enabled
- Smart community network integrated with a large renewable energy resources
- Perfect cyber security system
- The balanced and forecast system production corresponds to energy utilization
- Virtual power plants created

Smart Life

- Network supports of DG
- Advanced Metering Infrastructure (AMI) completion in central region and 10 other large cities
- Smart & Green PEA completion in 216 offices
- Demand response management

- AMI development completion
- Energy management completion in all large/medium cities
- The system provides power usage information via the internet
- Domestic consumers can produce their own electricity; surpluses can be sold to utility
- Home/building energy management automation reduces electricity bills

- Power consumers can buy or sell electricity in real time
- Users can choose to buy electricity from different supplies
- Optimal Energy management

Smart Community

- Public charging station
- Energy savings for public street and community lighting

- The extensive use of electric transportation
- The penetration of intelligent public street and community lighting in communities
- Bundled services with other utilities (common billing etc.)

- Intelligent electric vehicle charging to reduce peak demand
- Two ways power supply of electric vehicles (vehicle to grid -V2G)

Start

2012

2017

2022

2026

Stage 1 :

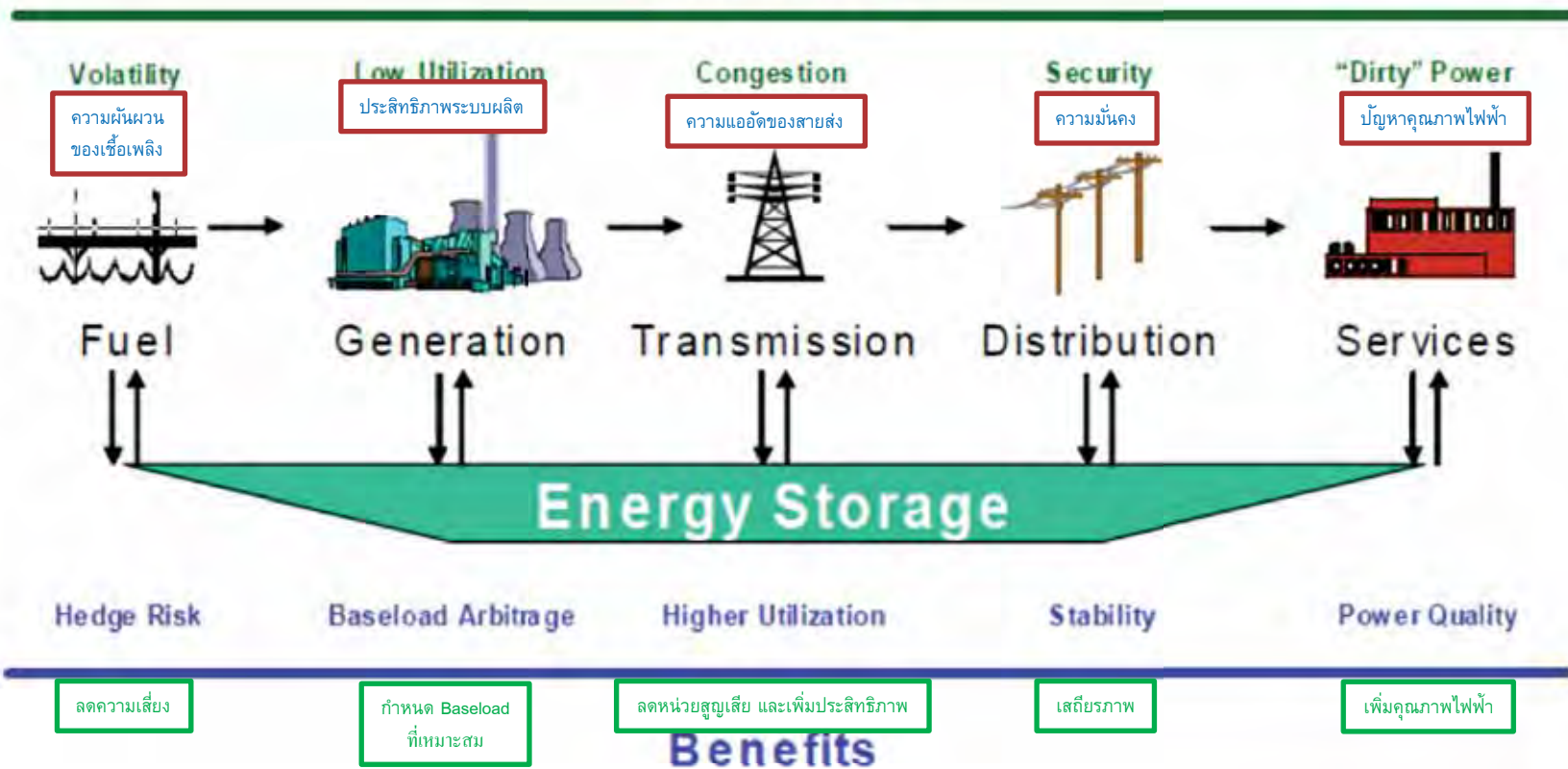
Stage 2 :

Stage 3 :

Energy Storage

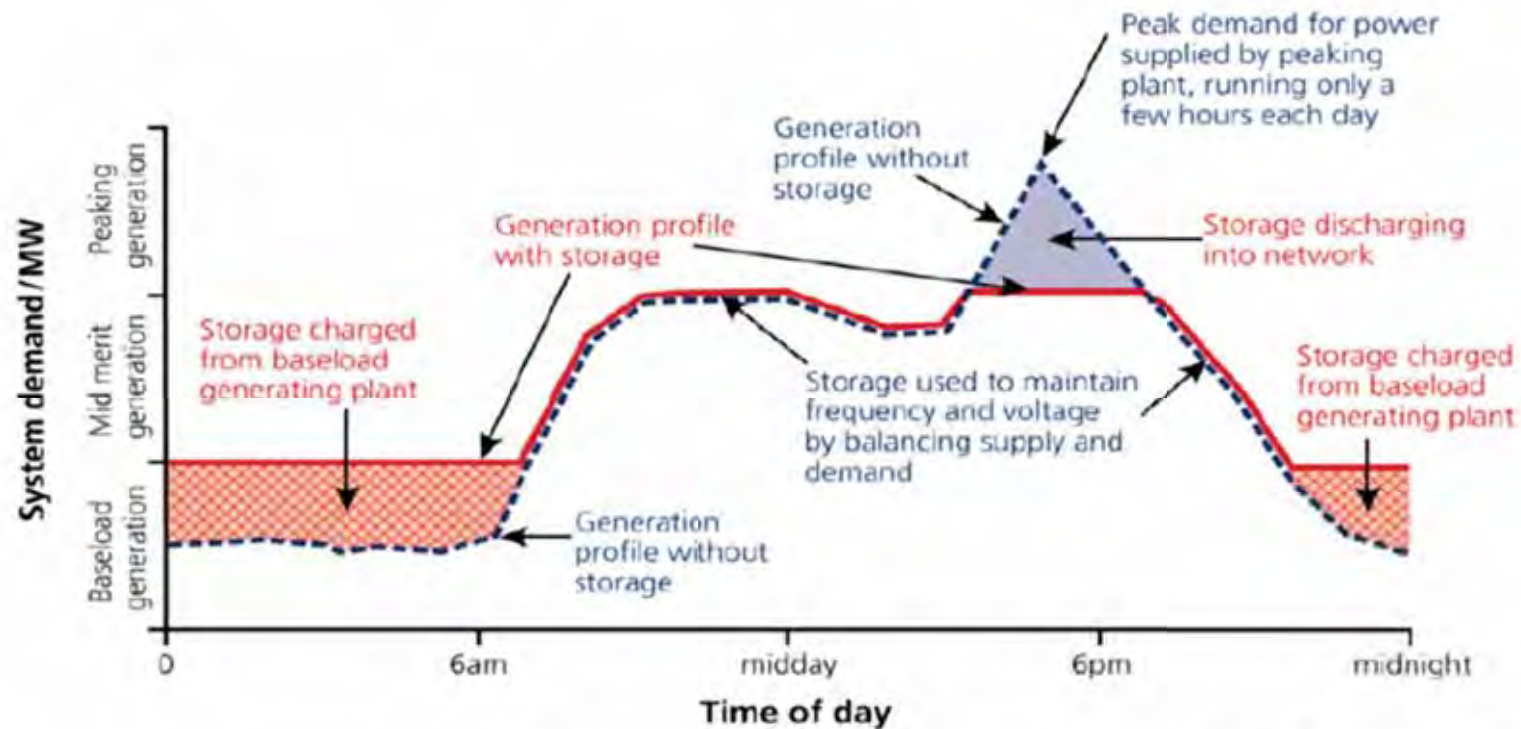
Benefits of Energy Storage Along the Electricity Value Chain

Challenges

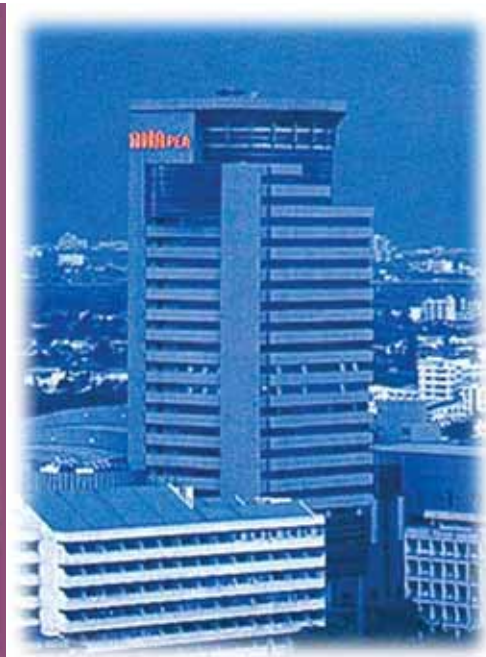


Energy Storage

Load Profile of a Large-Scale Energy Storage Facility



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Thank you for your attention
Q&A