



National Survey Report of Photovoltaic Applications in CHINA 2017



PVPS

PHOTOVOLTAIC
POWER SYSTEMS
PROGRAMME

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Foreword

The International Energy Agency (IEA), founded in November 1974, is an autonomous body within the framework of the Organisation for Economic Co-operation and Development (OECD) which carries out a comprehensive programme of energy co-operation among its member countries

The IEA Photovoltaic Power Systems Technology Collaboration Programme (IEA-PVPS) is one of the collaborative R & D agreements established within the IEA and, since 1993, its participants have been conducting a variety of joint projects in the applications of photovoltaic conversion of solar energy into electricity.

The participating countries and organisations can be found on the www.iea-pvps.org website.

The overall programme is headed by an Executive Committee composed of one representative from each participating country or organization, while the management of individual Tasks (research projects / activity areas) is the responsibility of Operating Agents. Information about the active and completed tasks can be found on the IEA-PVPS website www.iea-pvps.org

Introduction

The objective of Task 1 of the IEA Photovoltaic Power Systems Programme is to promote and facilitate the exchange and dissemination of information on the technical, economic, environmental and social aspects of PV power systems. Task 1 activities support the broader PVPS objectives: to contribute to cost reduction of PV power applications, to increase awareness of the potential and value of PV power systems, to foster the removal of both technical and non-technical barriers and to enhance technology co-operation. An important deliverable of Task 1 is the annual “*Trends in photovoltaic applications*” report. In parallel, National Survey Reports are produced annually by each Task 1 participant. This document is the country National Survey Report for the year 2017. Information from this document will be used as input to the annual Trends in photovoltaic applications report.

The PVPS website www.iea-pvps.org also plays an important role in disseminating information arising from the programme, including national information.

Cover

Photo provided by SUNGROW: 48MW floating PV power station of Panji District, Huainan, Anhui Province.

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 2017 statistics if the PV modules were installed and connected to the grid between 1 January and 31 December 2017, although commissioning may have taken place at a later date.**

1.1 Applications for Photovoltaics

2017 witnessed a fast growth of PV power market scale, with a newly added installation capacity of 53.6 GW, of which PV station 33.62 million KW, an increase of 11%, and distributed PV 19.44 GW (include distributed PV power plants), an increase of 3.7 times on a year-on-year growth. By the end of Dec., the national PV installation reached 130 GW, shared by 100.59 GW PV station and 29.66 GW distributed PV power. In 2017, the nation's distributed PV experienced an explosive development. In terms of accumulated PV installation, the proportion of distributed power increased to 23%. Household PV became a hotspot. Initial statistics show that the installation of household PV reached 2GW, with 100 thousand accumulated household in 2017, and the total household PV reached 500 thousand. The total PV power output in 2017 reached 118.2 billion KWh, a 78.6% year-on-year increase.

1.2 Total photovoltaic power installed

Table 1: PV power installed during calendar year 2017

AC			MW installed in 2017 (mandatory)	MW installed in 2017 (split optional but HIGHLY NEEDED)	AC or DC
Grid-connected	BAPV	Residential	14440MW	2440MW	DC
		Commercial & Industrial		12000MW	DC
	BIPV (if a specific legislation exists)	Residential	0		
		Commercial			
		Industrial			
	Utility-scale	Ground-mounted	38620MW	33620MW	DC
		Floating & Agricultural		5000MW	DC
	Off-grid	Residential (SHS)	Very Few		
		Other	0		
		Hybrid systems			
		Total	53060MW		

Table 2: Data collection process:

If data are reported in AC, please mention a conversion coefficient to estimate DC installations.	N/A
Is the collection process done by an official body or a private company/Association?	Data on annual and accumulated PV grid-connected installation capacity in 2017 were published by National Energy Administration. Off-grid installation accounts for a very small scale in China so the data was estimated by PV experts.
Link to official statistics (if this exists)	http://www.nea.gov.cn/2018-01/24/c_136921015.htm
	Additional comments on market and data collection, especially the estimated accuracy of data.

Table 3: PV power and the broader national energy market.

<i>MW-GW for capacities and GWh-TWh for energy</i>	2017 numbers	2016 numbers
Total power generation capacities (all technologies)	1777.03GW	1645.75GW
Total power generation capacities (renewables including hydropower)	670.93GW	558.17GW
Total electricity demand (= consumption)	6307.7TWh	5919.8TWh
Total energy demand (= final consumption) ²³	4.49 Billion Tce	4.36 Billion Tce
New power generation capacities installed during the year (all technologies)	133.72GW	120.61GW
New power generation capacities installed during the year (renewables including hydropower)	79.83GW (hyd. 9GW, wind 15.03GW, PV 53.06GW, Bio. 2.74GW)	64.81GW (hyd. 12.59GW, wind 17.43GW, PV 34.79GW)
Total PV electricity production in TWh	118.2TWh	66.2TWh
Total PV electricity production as a % of total electricity consumption	1.87%	1.1%

Source: National Energy Administration

Table 4: Other informations

	2017 Numbers
Number of PV systems in operation in your country (a split per market segment is interesting)	Total installed 53GW except for Distributed PV 20GW (37.73%) ; Ground Mounted LS-PV 33GW (62.27%)
Capacity of decommissioned PV systems during the year in MW	N/A

Total capacity connected to the low voltage distribution grid in MW	14440 MW (220V, 380V)
Total capacity connected to the medium voltage distribution grid in MW	5000 MW (10kV, 35kV)
Total capacity connected to the high voltage transmission grid in MW	33620 MW (110kV, 220kV)

Table 5: The cumulative installed PV power in 4 sub-markets (MWp).

Sub-market	Stand-alone domestic	Grid-connected distributed	Grid-connected centralized	Annual Total	Cumulative
2001	4.50	0.01	0.00	4.51	23.50
2002	18.50	0.01	0.00	18.51	42.01
2003	10.00	0.07	0.00	10.07	52.08
2004	8.80	1.20	0.00	10.00	62.08
2005	6.40	1.30	0.20	7.90	69.98
2006	9.00	1.00	0.02	10.02	80.00
2007	17.80	2.00	0.20	20.00	100
2008	29.50	10.00	0.50	40.00	140
2009	17.80	34.20	108.00	160.00	300
2010	27.00	190.00	283.00	500	800
2011	20.00	680.00	2000.00	2700	3500
2012	40.00	890.00	2630.00	3560	7060
2013	80.00	800	9800	10680	17740
2014	40.00	2050.00	8550.00	10640	28380
2015	20.00	1390.00	13740.00	15150	43530
2016	10.00	4230.00	30310.00	34550	78080
2017	8.00	19440.00	33620.00	53060	131140
TOTAL (MW)	368	29730	101042		131140

Source: National Energy Administration, Prof. Wang Sicheng

1.3 Key enablers of PV development

Table 6: information on key enablers

	Description	Annual Volume (Units)	Total Volume (Units)	Source
Decentralized storage systems				
Residential Heat Pumps				
Electric cars (and light weight)		639.17GW		CPIA,2018,4
Electric buses/trucks				
Other				

Source: PV Industry Annual Report of China, 2018.5

2 COMPETITIVENESS OF PV ELECTRICITY

2.1 Module prices

Table 7: Typical module prices for a number of years (Units: RMB Yuan)

Year	2010	2011	2012	2013	2014	2015	2016	2017
Standard module crystalline silicon price(s): Typical	13.0	9.0	4.5	4	3.8	3.5	3.2	3.0
Lowest prices	-	-	-	-	-	-	-	-
Highest prices	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Source: Prof. Wang Sicheng & Estimation based on findings of a survey to main PV enterprises

2.2 System prices

Table 8: Turnkey Prices of Typical Applications – local currency

Category/Size	Typical applications and brief details	Current prices per W
OFF-GRID Up to 1 kW (SHS)	Solar lighting systems, solar home systems, Flashlight, calculator, street lamp and other PV products	N/A
OFF-GRID > MW scale	Rural stand-alone PV system	N/A
Grid-connected Rooftop up to 5-10 kW (residential BAPV)	Distributed PV system built on residential rooftop	5.5-6.0
Grid-connected Rooftop from 10 to 250 kW (commercial BAPV)	Distributed PV system built on commercial rooftop like malls	
Grid-connected Rooftop above 250kW (industrial BAPV)	Distributed PV system built on industrial rooftop	
Grid-connected Ground-mounted above 10 MW	Large-scale ground-mounted PV power plant	5.0-5.5
Other category (hybrid diesel-PV, hybrid with battery...)	-	

Floating PV		
Agricultural PV		
Residential BIPV (tiles, or complete roof).		N/A
Industrial BIPV		N/A

Source: Estimation based on findings of a survey to main PV enterprises

Table 9: National trends in system prices (current) for different applications – local currency

Price/Wp(RMB Yuan/W)	2009	2010	2011	2012	2013	2014	2015	2016	2017
Residential PV systems < 5-10 KW	-	-	-	-	-	13	6-7	6.0-6.5	5.5-6.0
Commercial and industrial BAPV	-	-	18	14	12	8	6-7	6.0-6.5	5.5-6.0
Ground-mounted > 10 MW	30	20	15	12	10	8	7-8	5.5-6.0	5.0-5.5

Source: Estimation based on findings of a survey to main PV enterprises

2.3 Cost breakdown of PV installations

2.3.1 Residential PV System < 5-10 kW

Table 10: Cost breakdown for a residential PV system – local currency

Cost category	Average (local currency/W)	Low (local currency/W)	High (local currency/W)
Hardware			
Module	2.6		
Inverter	0.7		
Other (racking, wiring...)	0.8		
Soft costs			
Installation	0.6		
Customer Acquisition			
Profit	0.5		
Other (permitting, contracting, financing...)	0.5		
Subtotal Hardware	4.1		
Subtotal Soft costs	1.6		
Total	5.7		

Source: Estimation based on findings of a survey to main PV enterprises

2.3.2 Utility-scale PV systems > 10 MW

Table 11: Cost breakdown for an utility-scale PV system – local currency

Cost Category	Average (local currency/W)	Low (local currency/W)	High (local currency/W)
Hardware			
Module	2.4		
Inverter	0.2		
Other (racking, wiring, etc.)	1.8		
Soft cost			
Installation Labor	0.6		
Customer acquisition			
Profit	0.2		
Other (contracting, permitting, financing etc.)	0.3		
Subtotal Hardware	4.4		
Subtotal - Soft cost	1.1		
Total Installed Cost	5.5		

Source: Estimation based on findings of a survey to main PV enterprises

2.4 Financial Parameters and specific financing programs

Table 12: PV financing scheme

Average rate of loans – residential installations	4.9%(float within the prescribed scope of 15%)
Average rate of loans – commercial installations	4.9%(float within the prescribed scope of 15%)
Average cost of capital – industrial and ground-mounted installations	5.5-6.0 Yuan/W

2.5 Specific investments programs

In 2017, the continued active development of the whole PV market industrial chain brought about innovation of corresponding financing and financial services. In terms of downstream PV application market, bank loan and financial leasing services for newly-added ground PV station and distributed power became a booming business. Targeted to household PV system, financial institutes developed multiple “PV loan” products for individual customers. For stock grid-connected PV station assets, the institutes also started to attempt new financial methods of asset securitization to increase asset liquidity of PV stations.

Table 13: Specific investment programs

Third Party Ownership (no investment)	N/A
Renting	N/A

Leasing	N/A
Financing through utilities	N/A
Investment in PV plants against free electricity	N/A
Crowdfunding (investment in PV plants)	N/A
Community solar	N/A
Other (please specify)	N/A

2.6 Additional Country information

Table 14: Country information

Retail Electricity Prices for an household (range)	0.54804 RMB Yuan/kWh
Retail Electricity Prices for a commercial company (range)	0.82514 RMB Yuan/kWh
Retail Electricity Prices for an industrial company (range)	0.64397 RMB Yuan/kWh
Population at the end of 2017 (or latest known)	1 390 080 000
Country size (km ²)	9 634 057
Average PV yield (according to the current PV development in the country) in kWh/kWp	Zone 1: > 1500 Zone 2: 1200-1500 Zone 3: < 1200
Name and market share of major electric utilities.	N/A

3 POLICY FRAMEWORK

This chapter describes the support policies aiming directly or indirectly to drive the development of PV. Direct support policies have a direct influence on PV development by incentivizing or simplifying or defining adequate policies. Indirect support policies change the regulatory environment in a way that can push PV development.

3.1 Direct support policies for PV installations

3.1.1 New, existing or phased out measures in 2017

3.1.1.1 Climate change Commitments

With the formal effective of the “Paris Agreement”, the development of new energy and clean energy has become the general trend of the world. The International Renewable Energy Agency (IRENA) predicted in its 2050 global energy transformation roadmap published in Apr. 2018 that by 2050, all countries will greatly increase their respective proportion of renewable energy in their total energy consumption. Meanwhile, IRENA predicted that in China, the proportion of renewable energy will increase from 7% in 2015 to 67% in 2050.

In terms of state macro policy, there’s a favourable environment for the development of PV industry. The party’s 19th congress listed sustainable development of energy under the great framework of ecological civilization construction strategy and system reform and put forward the establishment of an economic system with green, low carbon and renewable development. The energy sector was allocated to the green development system to promote such industries as energy saving and environment protection, clean production, and clean energy production.

3.1.1.2 Description of support measures (excluding BIPV, VIPV and rural electrification)

In Jul, 2017, the National Energy Administration issued the “Guidance opinion on the implementation of renewable energy development during the ‘Thirteenth Five-year Plan’ period”. The document put forward a number of guidance opinions and targeted measures to promote the implementation of renewable energy during the period, including strengthening target guidance and monitoring and examination, enhancing the leading role of planning, stressing the implementation of conditions for grid connection and market consumption, innovating development method to promote technological progress and reduction of cost, perfecting construction scale management mechanism, and strengthening policy guarantee measures, etc.

The guidance opinion set the target of annual PV station scale for 2017-2020, proposed the newly-added PV station construction scale, and the scale of the “leading runner” bases for each of 21 province, municipality and region. According to the document, the ‘Thirteenth Five-year Plan’ period, the newly-added PV power market scale is expected to be over 170 million KW on the basis of distributed PV projects, village level poverty relief PV station, cross province and region power transmission auxiliary PV station, and self-managed PV station in 7 provinces and municipalities, all with unlimited construction scale, as clearly defined in the document. By 2020, the accumulated installation is expected to at least double the PV power output target of 105 million KW defined in the “Renewable energy ‘Thirteenth Five-year’ period planning”. On the basis of market consumption condition and continued decrease of PV power cost, the state provided greater market development space for the PV industry through the implementation of the planning.

3.1.1.3 BIPV development measures

There is no incentive policies to support near-zero or positive-energy buildings. Current FIT can only make BAPV projects in reasonable benefits and there is few BIPV projects due to higher cost and difficult in construction.

3.1.1.4 Utility-scale measures including floating and agricultural PV

Large-scale ground mounted PV (connected to 110kV and 220kV utility grid) enjoy FIT based on solar resources zones (see Table 17). PV+ Agricultural, PV+ Forest or Floating PV are generally connected to 35kV or 10kV grid, we define such projects as “distributed PV power plants” and generated electricity usually consumed locally. Distributed PV plants enjoy the same incentive of FIT.

3.1.1.5 Rural electrification and other off-grid application measures

By the end of 2015, China already announced that whole China has been electrified and there is no un-electrified people at all. So, there is no government supported projects for off-grid rural electrification any more since 2016.

PV industry applications, like communication, signal system for navigation, railways, highways, remote weather stations, remote satellite TV, etc., are sponsored by industry units and there is no special policy for such sector. The market is about several MW annually.

PV commercial products, like solar street lights, lawn lights, moveable solar chargers, solar watches, solar fans, etc., are all directly selling on market without any government subsidy. The market size is about few MW each year.

3.1.1.6 Support for electricity storage and demand response measures

In 2017, the National Development and Reform Commission published the “Guidance opinion on promotion of energy storage technological and industrial development”. The document called for development of power storage to promote pilot renewable energy application level; support direct grid connection of power storage system; establishment and perfection of mechanism for participation of power storage in auxiliary service market; gradual optimization according to market development; formation of a market mechanism of “payment according to performance and payment by beneficiary” on the basis of the principle of voluntary trading; and encouragement of establishment of distributed energy storage system on user’s side.

Table 15: PV support measures (summary table)

	On-going measures residential	Measures that commenced during 2017 - residential	On-going measures Commercial + industrial	Measures that commenced during 2017 - commercial + industrial	On-going measures Ground-mounted, including floating	Measures that commenced during 2017 - ground mounted, including floating
Feed-in tariffs	Yes Feed-in tariffs or desulfurized coal-fire power benchmark price+ 0.42 yuan/kWh (include tax)	No	Yes Feed-in tariffs or desulfurized coal-fire power benchmark price+ 0.42 yuan/kWh (include tax)	No	Feed-in tariff : on the basis of resource regions, 0.65 , 0.75,0.85 yuan/kwh respectively	Feed-in tariff, on the basis of three catalogue regions, decreased 0.15,0.13,0.13 yuan/kwh respectively
Feed-in premium (above						

market price)						
Capital subsidies	Golden Sun Demonstration during 2009-2013, not yet now.					
Green certificates	<p>Yes</p> <p>Development and Reform Commission, Ministry of Finance and National Energy Administration jointly issued the "Notice on trial implementation of renewable energy green power certificate approve and issuance and voluntary subscription and trading system (Fagainengyuan[2017]#132", and initiated green certificate voluntary subscription and trading on Jul. 1st, 2017, and will launch power quota assessment and mandatory green certificate trading in 2018 at a proper time.</p>					
Renewable portfolio standards (RPS) with/without PV requirements						
Income tax credits						
Self-consumption	Yes		Yes		NA	
Net-metering	No	No	No	No	No	No
Net-billing	No	No	No	No	No	No
Collective self-consumption and virtual net-metering	No	No	No	No	No	No
Commercial bank activities e.g. green mortgages promoting PV	Yes		Yes		Yes	
Activities of electricity utility businesses	Yes		Yes		Yes	
Sustainable building requirements						
BIPV incentives	Yes		Yes		Yes	

Other (specify)						
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3.2 Self-consumption measures

Table 16: Self-Consumption Schemes

PV self-consumption	1	Right to self-consume	Yes
	2	Revenues from self-consumed PV	Yes
	3	Charges to finance Transmission & Distribution grids	No
Excess PV electricity	4	Revenues from excess PV electricity injected into the grid	Yes
	5	Maximum timeframe for compensation of fluxes	Savings on the electricity plus a self-consumption bonus (0.42Yuan/kWh).
	6	Geographical compensation	None
Other characteristics	7	Regulatory scheme duration	Market price plus a bonus(0.42Yuan/kWh). 20 years
	8	Third party ownership accepted	Real-time
	9	Grid codes and/or additional taxes/fees impacting the revenues of the prosumer	On site only
	10	Regulations on enablers of self-consumption (storage, DSM...)	20 years
	11	PV system size limitations	6 MW
	12	Electricity system limitations	None
	13	Additional features	NA

3.3 Collective self-consumption, community solar and similar measures

Implementation of pilot distributed power market trading program to provide basic conditions for promotion of new business model. In Oct. 2017, the National Development and Reform Commission and National Energy Administration issued the “Notice on initiation of distributed power market trading program (Fagainengyuan [2017] #1901)”, and published the supplementary notice in Dec. to formally launch distributed power market trading pilot program. According the notice, the local government units were expected to complete pilot program compilation and delivery by the end of Mar. 2018, and launch the trading in Jul. the same year.

This policy document put forward two types of innovative mechanism of direct trading and grid companies commissioned to sale power. There’re three kinds of operation and benefit models for distributed power for single or multiple selection: 1. Direct trading model: a distributed power project conducts direct trading with end users, makes “grid transmission” payment to a grid company. The scope of the trading is principally limited to the scope of power supply of the upper level transformer; 2. A grid company commissioned to sale power: a distributed power project entrusts a grid company to sale power, and the commissioned grid company sales power on the basis of an overall power price, after deducting “power transfer fee” (including grid power loss), the grid company returns the rest power sale income to the distributed project; and 3. Grid company purchase: a grid company

purchases the power at the benchmark price, but the state subsidy will deduct the amount of transfer price corresponding to the expected highest price level clients. Under such model, the grid company suffers the loss of benefit directly, thus encouraged to adopt the first and second business model.

3.4 Tenders, auctions & similar schemes

Since 2016, China started to explore competitive method to decide renewable energy project developers and power price, and implemented bidding for PV “leading runner” technology bases and regular PV power station projects. The deployed competitive projects represented by PV “leading runner” bases facilitated the speeding up of the process for PV power grid parity. In Mar. 2018, China completed the bidding for 7 PV “leading runner” bases in the third batch projects.

3.5 Financing and cost of support measures

There has been a significant drop cost of PV investment, the decrease rate of benchmark power price reached 12-15%. Since the second half year of 2017, the drop of price for main PV power component, along with the rapid expansion of market scale, especially driven by PV “leading runner” bases, a number of new technologies and processing have been applied to improve cell module and system efficiency, leading to further decrease of the cost of PV power initial investment and power output. On the basis of such situation, in Dec. 2017, the National Development and Reform Commission issued the “Notice on 2018 PV power project price policy (Faguaijiagegui [2017] #2196)”, which lowered PV power benchmark price to 0.10 yuan/KWh in three types of electric price regions to the levels of 0.55yuan/KWh,0.65 yuan/KWh and 0.75yuan/KWh respectively. Meanwhile, for the first time, the subsidy level for distributed PV power per KW was lowered from 0.42 yuan/KWh to 0.37 yuan/KWh, while subsidy to benchmark power price per KW for village level poverty relief PV station (0.5 MW and below) and subsidy to per KW household distributed poverty relief power remained unchanged.

Table 17: New FITs of 2018

Solar Resources	FIT for PV Plants (Yuan/kWh)
I	0.55
II	0.65
III	0.75
Subsidy for Self-Consumption(Yuan/kWh)	
Self-consumed	Excess PV electricity Feed-Back to Grid
Grid Retail Price +0.37	Wholesale Coal-Fire Tariff + 0.37

Source: NDRC

NDRC also announced in the Tariff Document, the FIT of PV will be regulated every year and for the projects the FIT are set by bidding, the tariff level should be never higher than the published level. For self-consumed PV projects, the subsidy level is kept the same as before.

The subsidy money is come from surcharge. The surcharge level is 1.9 cents/kWh. By this surcharge, about 60 billion Yuan (about 10 billion USD) can be collected every year to subsidy PV, wind and biomass power.

3.6 Indirect policy issues

The preferential policy of 50% immediate levy and refund of value added tax for PV power still has an expiring date. In Aug. 2017, the National Energy Administration issued a notice asking for opinions on the topic of alleviation of the taxation burden of renewable energy enterprises. The notice mentioned that the preferential policy of 50% immediate levy and refund of value added tax for PV power could be extended to the end of 2020.

4 INDUSTRY

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

4.1.1 Polycrystalline silicon material

China's polycrystalline silicon production remained continued increase in 2017 to reach 242,000 tons output, accounting 54.8% of global total output, and a 6.3 percentage point increase on year-on-year basis, and compared with 2016's 19400 tons, an increase of 24.7%. The apparent consumption of polycrystalline silicon in 2017 was 400,000 tons (polycrystalline silicon output + polycrystalline silicon import – polycrystalline export), so there's still certain amount of gap in demand/supply and need to import the material.

Table 18: Production information for the year for silicon feedstock, ingot and wafer producers

Manufacturers (or total national production)	Process technology &	Total Production	Product destination (if known)	Price (if known)
Jiangsu Zhongneng Polysilicon Technology Development Co. Ltd	mc-Si	74818		
Xinte Energy Co., Ltd	mc-Si	29400		
DAQO New Energy Corp.	mc-Si	20200		
China Silicon Corporation LTD.	mc-Si	18212		
Sichuan Yongxiang Co. Ltd.	mc-Si	16000		
Asia Silicon Co., Ltd	mc-Si	14250		
Jiangxi LDK Solar Hi-Tech Co. Ltd	mc-Si	10272		
DunAn Holding Group Co., Ltd	mc-Si	8277		
Yichang CSG Polysilicon.Co.,Ltd	mc-Si	8100		
Kunming Yeyan New Material Co., Ltd.	mc-Si	6080		
Jingyang Energy Co., Ltd	mc-Si	5717		
Inner Mongolia Shenzhou Silicon Industry Limited Liability Company	mc-Si	5088		
Sichuan ReneSola Silicone Materials Co., Ltd.	mc-Si	4388		
East Hope Co. Ltd	mc-Si	4300		

Jiangsu Combo PV Co. Ltd	mc-Si	4250		
Rest	mc-Si	13048		
Total	mc-Si	242400		

Source: CPIA,2018.4

Describe briefly the overseas activities of any key companies also operating in other countries.

4.1.2 Silicon wafer

There's a significant increase of production capacity of silicon wafer in China, as a result of expanded production from new project and improved production capacity brought about by technological advancement. In 2017, the total production capacity of China was 105GW, an increase of 28.2% on a year-on-year basis, accounting for 85.9% of global production capacity, an increase of 4 percentage point on a year-on-year basis. The output of silicon wafer the same year in China was 91.7GW, a year-on-year growth of 41.5%, and 87.2% of global silicon wafer production.

Table 19: Production information for the year for silicon wafer producers

Manufacturers (or total national production)	Process & technology	Total Production(GW)	Product destination (if known)	Price (if known)
GCL-Poly Energy Holdings Limited	Silicon wafers	23.902		
Xi'an LONGI Silicon Materials Corp	Silicon wafers	10.492		
Jinko Solar Holding Co., Ltd	Silicon wafers	6.824		
Inner Mongolia Zhonghuan Solar Material Co., Ltd.	Silicon wafers	6.117		
Sornid	Silicon wafers	3.633		
Huantai Group	Silicon wafers	3.225		
JA Solar Holdings Co., Ltd	Silicon wafers	2.797		
Trina Solar Co., Ltd	Silicon wafers	2.742		
Rietech	Silicon wafers	2.739		
Yingli green energy holding Co., Ltd	Silicon wafers	2.642		
Rensola Ltd	Silicon wafers	2.498		
Dahai Group	Silicon wafers	2.098		
Canadian Solar Inc.	Silicon wafers	1.858		
Yichang CSG Polysilicon.Co.,Ltd	Silicon wafers	1.666		

BYD Company Limited	Silicon wafers	1.453		
Jiangxi LDK Solar Hi-Tech Co. Ltd	Silicon wafers	1.403		
Jinzhou Yangguang Energy Co., Ltd.	Silicon wafers	0.882		
Eging PV	Silicon wafers	0.791		
Xian Fenghuo Photovoltaic Technology Co., Ltd.	Silicon wafers	0.754		
Zhejiang Xi-sheng Electronic Co., Ltd.	Silicon wafers	0.568		
Total	Silicon wafers	79.084		

Source :CPIA, 2018.4

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.

4.2.1 Solar cell

By the end of 2017, the total production capacity of China's solar cell was about 82.8GW, and the output was 72GW, a 41.2% year-on-year increase, and accounting 69% of global production.

The export of solar cell increased steadily in 2017. Statistics from the custom showed that China exported about 4.8GW solar cell to 128 countries and regions, with an export value of 990 million US\$, an increase of 22.8% on a year-on-year basis, accounting for 6.8% of total PV product export value.

4.2.2 PV module

In 2017, the general production capacity of PV module was about 105.4GW, and the output was 75GW, a year-on-year growth of 39.7%, accounting about 71.1% of global production, an increase of 2.1 percentage point on a year-on-year basis. In terms of product type, almost all products were crystalline silicon PV module, the output of thin film PV module was less than 200MW.

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

Table 20: Production and production capacity information for 2017

Cell/Module manufacturer (or total national production)	Technology (sc-Si, mc-Si, a-Si, CdTe)	Total Production (MW)		Maximum production capacity (MW/yr)	
		Cell	Module	Cell	Module
<i>Wafer-based PV manufactures</i>					
Jinko Solar Holding Co., Ltd.		3400	6000	3600	6500
Canadian Solar		4000	5910	4100	6500

JA Solar Holdings Co., Ltd.		5300	5730	5800	7000
Trina Solar Co., Ltd.		2010	4800	2000	5700
GCL System Integration			4610		5400
Lerri Solar		3200	4381	4200	6200
Yingli green energy holding Co., Ltd.		3100	3026	3600	4300
Risen Energy Co.,Ltd.		2000	2885	2200	6300
Hanwha Solar		1380	2390	1500	2500
Suntech solar power electric power Co., Ltd.		3000	1812	3400	2200
Hanwha Q CELLS			1739		2500
Talesun Solar Co., Ltd.		1100	1570	1200	2000
Eging PV			1551		2000
Jinzhou Yangguang Energy Co., Ltd.			1252		1200
Jiangsu Seraphim			1209		1500
ReneSolar SOL			1127		1200
BYD Company Limited			1100		1200
Tangshan Haitai New Energy Technology Co., Ltd.			937		1200
Jinergy Group		1300	920	1400	1400
HT-SAAE			849		900
Total		29790	53798	86798	67700
<i>Thin film manufacturers</i>					
Hanergy Group	CIGS				2700
Triumph Group	CIGS				300
Sunharmonics	CIGS				50
China National Building Materials Group Corporation	CdTe				85
Advanced SolTech Renewable Energy Hangzhou Co., Ltd.	CdTe				40
Rest					
Total					3175
<i>Cells for concentration</i>					
TOTALS		29790	54798	86798	70875

Source:CPIA,2018,4

4.3 Manufacturers and suppliers of other components

Balance of system component manufacture and supply is an important part of the PV system value chain. Please briefly comment on the nature of this industry in your country, paying particular attention to recent trends and industry outlook, under the headings of:

- PV inverters (for grid-connection and stand-alone systems) and their typical prices

China's PV market experienced again a leap forward progress in 2017, with newly added installation scale of 53GW, about half of world market. China's inverter enterprises actively deployed their overseas market and strengthened their business development in foreign market. In 2017, the export scale of China's inverter products increased to 12GW. Benefited from a heated PV market domestically and breakthrough of export business, the total shipment of Chinese inverter enterprises reached 67GW, 9 of the enterprises exported over 2GW of products.

- Storage batteries
- Battery charge controllers
- DC switchgear
- Supporting structures

The PV supporting structure industry in China has very low market threshold and no industry barrier. With the rapid development of the country's PV installation market, the number of companies engaging in supporting structure increase dramatically. There's fierce market competition, but product quality varies greatly, and overall profit margin of this industry is at a low level.

The characteristics of the supporting structure industry in China include: industrial concentration further increased, industrial distribution concentrated, production chain extended to downstream, and low average rate of profit.

5 PV IN THE ECONOMY

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

5.1 Labour places

Provide an estimate of labour places in the following (where these are mainly involved with PV):

- Public research and development (not including private companies);
- Manufacturing of products throughout the PV value chain from feedstock to systems, including company R&D;
- All other, including within electricity companies, installation companies etc.

Table 21: Estimated PV-related labour places in 2017

Research and development (not including companies)	few thousands
Manufacturing of products throughout the PV value chain from feedstock to systems, including company R&D	2.5 Million
Distributors of PV products	
System and installation companies	
Electricity utility businesses and government	few hundreds
Other	few hundreds
Total	Near 3.0 million

5.2 Business value

Table 22: Value of PV business

Sub-market	Capacity installed in 2017 (MW)	Price per W (from table 8)	Value	Totals
Off-grid domestic	0			
Off-grid non-domestic			<i>b</i>	
Grid-connected distributed	19440	5.7	110 808 000 000	
Grid-connected centralized	33620	5.5	184 910 000 000	
				295 718 000 000
Export of PV products				N/A
Change in stocks held				N/A
Import of PV products				N/A
Value of PV business				N/A

If possible, please provide some brief comment on the industry value chain in your country or provide references to articles, reports dealing with this topic. PV Industry Annual Report of China (2017-2018), edited and published by China PV Industry Association (CPIA) in May of 2018.

6 INTEREST FROM ELECTRICITY STAKEHOLDERS

6.1 Structure of the electricity system

<p>Short description of the electricity industry landscape</p> <ul style="list-style-type: none"> - structure – vertically integrated or separate generation, transmission, distribution; - retailers and network businesses – integrated or separate; - ownership – private – public (state owned or municipal) - Electricity industry regulator? 	<ul style="list-style-type: none"> - <i>Transmission and distribution are vertically integrated, and the generation is separated.</i> - -Integrated; - Public (state owned) <p>Yes</p>
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6.2 Interest from electricity utility businesses

Please briefly report on the key drivers and barriers for PV activity by electricity utility businesses in your country (you may also wish to list references for relevant studies that have been published in your country).

Please outline key PV business models that have been implemented or are being considered **by electricity utility businesses** in your country (eg PV plant development / ownership, PV power purchase arrangements, customer PV support initiatives and so on, self-consumption policies, storage policies, electric vehicles...).

6.2.1 13th Five-Year PV Plan (2016-2020)

July 19th, 2017, National Energy Administration (NEA) issued “Implementation Guideline for 13th Five-year Plan of Renewable Energy” (NEA [2017]No. 31) and issued the PV quota of 2017 – 2020:

2017-2020 total PV quota is 86.5GW, including 32GW of Top Runner Program (8 GW per year);

There is no quota control for distributed PV, include: PV on buildings, self-consumed PV, home PV systems, etc.. 60 GW distributed PV is estimated by the year 2020;

For Beijing, Tianjin, Shanghai, Chongqing, Tibet, Hainan and Fujian, there is no quota control for PV installation. At least 10 GW for the 7 Cities and Provinces;

15GW for PV Poverty Alleviation before 2020.

131GW of PV already installed by the end of 2017. If 30GW of PV will be installed in next 3 years, total cumulative PV installation will be above 220GW by 2020.

6.2.2 PV Poverty Alleviation Plan

By the end of 2016, there are 20 million families with 70.17 million people lived under poverty level (annual income is less than 2300 Yuan per person, about \$1 USD per day per person) in China. 3 million of poor families, will be funded by government to build 5kW PV for each family and the family will get at least 3000 Yuan each year by selling PV electricity to grid. By this way, the poor families will get money and PV market will be expanded. 15GW of PV will be installed before 2020 for poverty alleviation.

6.2.3 Subsidy Money Shortage and Curtailment Problems

In China, PV and wind power market is growing fast, annual installation is number one in the world and huge subsidy money is required. Every Year, the subsidy money for wind and PV generation is about 100 billion Yuan, but only 60 billion Yuan can be collected from surcharge (1.9 cents/kWh). By the end of 2017, total shortage of subsidy money reaches to 100 billion Yuan (recently announced by NEA). To solve the problem, Renewables Portfolio Standards (RPS) and “Green Certificate” system will be implemented to expand RE market and to collect enough money from selling “Green Certificate” to support green electricity and to fulfill the gap of subsidy money.

For PV curtailment problem in western China, Chinese government announced on Nov. 8th (NEA [2017] No.1942) : curtailment of PV in Xinjiang and Gansu will be controlled within 20% by 2020, and in other western provinces the PV curtailment will be controlled within 10% and less than 5% for whole China.

6.3 Interest from municipalities and local governments

Local economic support policies for PV power generation are mainly based on electricity price subsidy policies, and investment subsidies are adopted in a small number of regions. Compared with the national electricity price subsidy policy, the local electricity price subsidy policy generally has a short application time, such as support for a single project in 3-5 years. Uncomplete statistics listed the areas where local economic support policies are still implemented, include Beijing, Shanxi (Jincheng), Jiangsu (Zhenjiang), Shanghai, some cities in Zhejiang, Anhui (Hefei, Wuzhou, Maanshan), Hunan, and parts of Jiangxi. Guangdong (Dongguan, Foshan), etc. In addition, some provinces have formulated local economic support policies for PV poverty-alleviation projects.

7 HIGHLIGHTS AND PROSPECTS

7.1.1 Development goals

In July, 2017, the National Energy Administration issued "Guiding Opinions on the Implementation of the 13th Five-Year Plan for Renewable Energy Development", which proposed the new construction scale of PV power plants in 21 provinces and municipalities annually from 2017 to 2020, 14.40GW ,3.90GW, 13.10GW, 13.10GW respectively, totalled 54.50GW in 4 years. In addition, the scale of the PV leading runner bases is 8GW per year, and a total of 32GW in 4 years.

7.1.2 Policies

In December, 2017, the National Development and Reform Commission published the "Notice on Price Policy of PV Power Generation Projects in 2018 " (Fagaijiagegui [2017] No. 2196), and the price of PV power generation benchmarks in the three types of electricity price zones decreased 0.10 yuan/KWh, and the lowered electricity price levels were 0.55 yuan/KWh, 0.65 yuan/KWh, and 0.75 yuan/KWh, respectively. In addition, the subsidy level of distributed PV power generation has been reduced from 0.42 yuan/KWh to 0.37 yuan/KW for the first time, the benchmark electricity price of village-level poverty alleviation power stations (0.5MW and below) and the subsidy standard for household distributed PV poverty alleviation remained unchanged.

7.1.3 Market

In 2017, PV market in China was booming, total installation reaches 53.06GW! Worthwhile to indicate that the distributed PV was growing very fast in 2017, especially the home PV systems, 500,000 sets were installed.

Table 23: PV Installation by Sectors 2017

Market Sec.	Annual	Cumulative	Share
	(MWp)	(MWp)	(%)
Off-Grid		360	0.28
Distributed	20000	30290	23.11
Power Plant	33000	100430	76.62
Total	53000	131080	100.00

Source: CPIA

During last decade, the cost of PV in China has been reduced sharply. It is estimated that PV price will reach grid-parity at user-side by the year of 2020 and reach to grid-parity at generating side at most by the year 2025.

7.1.4 Industry

China has been the largest producer of PV modules in the world since 2007. In 2017, China is also the top country in PV production in the world.

Table 24: Production of PV Chain (2015-2017)

Year	2015	2016	2017
Poly-Silicon (10 ³ Ton)	165.00	194.00	242.00
Silicon Wafer (GW)	48.00	64.80	87.60
PV Cells(GW)	41.00	51.00	68.00
PV Modules (GW)	43.90	53.00	76.00

Source: CPIA

7.1.5 R&D

1) Top Runner Plan

The “PV Top Runner Plan” started in 2015, total installed PV capacity for the 1st and 2nd phases is 6.5GW. The 3rd phase Top Runner Plan was approved on Sep.22, 2017 and the total capacity is 6.5GW (5GW for Top-Runner and 1.5GW for Super Top-Runner). The specification requirements are listed below:

Table 25: Specification Requirements of Top Runner Plan

Type	Multi-Si	Mono-Si
Size of Cells (mm)	156*156	156*156
Cell Number in Module	60	60
Market Entry Specifications		
Module Efficiency (%)	16.0	16.8
Module Power (Wp)	265	275
Top-Runner Specifications		
Module Efficiency (%)	17.0	17.8
Module Power (Wp)	280	295
Super Top Runner Specifications		
Module Efficiency (%)	20.0	21.50
Module Power (Wp)	295	310

Source: NEA

Stimulated by “Top Runner Plan”, PV technologies get big progress and the module efficiency at industry level is increased a lot. Mass production has been achieved for high-efficiency, even super-high-efficiency technologies:

Table 26: Manufacture Capacity for High-Efficiency PV

Technology	Manufacture Capacity (MW)
P-PERC	20000.0
N-PERT	2000.0
HJT	500.0
IBC	100.0
MWT	1000.0
Bifacial Modules	10000.0

Source: CPVS

2) Highest Cell & Module Efficiencies

The following tables show the best efficiencies in China for various types of PV cells and modules. Some of these have been manufactured in mass production.

Table 27: The best cell efficiency

No.	Type/Materials	Efficiency (%)	Area (cm ²)
1	P-PERC (mono-Si)	22.71	244.32
2	P-PERC (multi-Si)	22.04	245.83
3	N-PERT (mono-Si)	22.3±0.5	156.26
4	IBC (mono-Si)	25.04	243.2
5	HJT (mono-Si)	23.2	242.70
6	GaAs (1-Junction)	28.8±0.9	1.00
7	GaAs (2-Junction)	31.6±1.9	1.00
8	GaAs (3-Junction)	34.5±4	1.002
9	CIGS	21.0	1.00
10	CdTe	17.8	-
1. Longi ;2.Jinko; 3. Trina ; 4. Trina; 5. SIMIT; 6. Hanergy; 7. Hanergy; 8. Derong Tech; 9. Hanergy;10. CNBM			

Source: CPVS

Table 28: The best module efficiency

No.	Type	Cell structure	Efficiency. (%)
1	P-Multi-Si	PERC	19.86
2	P-Mono-Si	PERC	20.41
3	N-Mono-Si	PERT	20.4
4	N-Mono-Si	HJT	19.45
5	GaAs		25.1
6	CdTe		14.50
7	CIGS (Glass)		18.7
8	CIGS (flexible)		17.88
9	Perovskite		16.0
1. Trina; 2. Longi; 3.Yingli; 4. Jinneng;5. Hanergy; 6. CNBM ; 7. Hanergy ; 8. Hanergy; 9. Microquanta			

Source: CPVS

7.1.6 Development trend of 2017

In July 2017, the National Energy Administration issued the “Guiding Opinions on the Implementation of the 13th Five-Year Plan for Renewable Energy Development”. The document proposed to strengthen the guidance and monitoring of renewable energy target, and strengthen the leading role of renewable energy development planning. The scale management mechanism for wind power and PV generation were required, and the new construction scale plan for PV power plants year by year from 2017 to 2020 was provided. Considering the scale of PV power plants that have been completed in 2016 and the development goal of 60 million kilowatts of distributed PV in 2020, according to this

document, the installed capacity of PV power generation in China will exceed 210 million kilowatts in 2020, far exceeding the original “13th Five-Year Plan” of 105 million Kilowatts development goal. According to the scale of PV power plants built in 2017 and the new targets for the next three years proposed in this document, the scale of PV power will reach 250 million kilowatts in 2020. The installed capacity will reach 160-170 million kilowatts in 2018.

