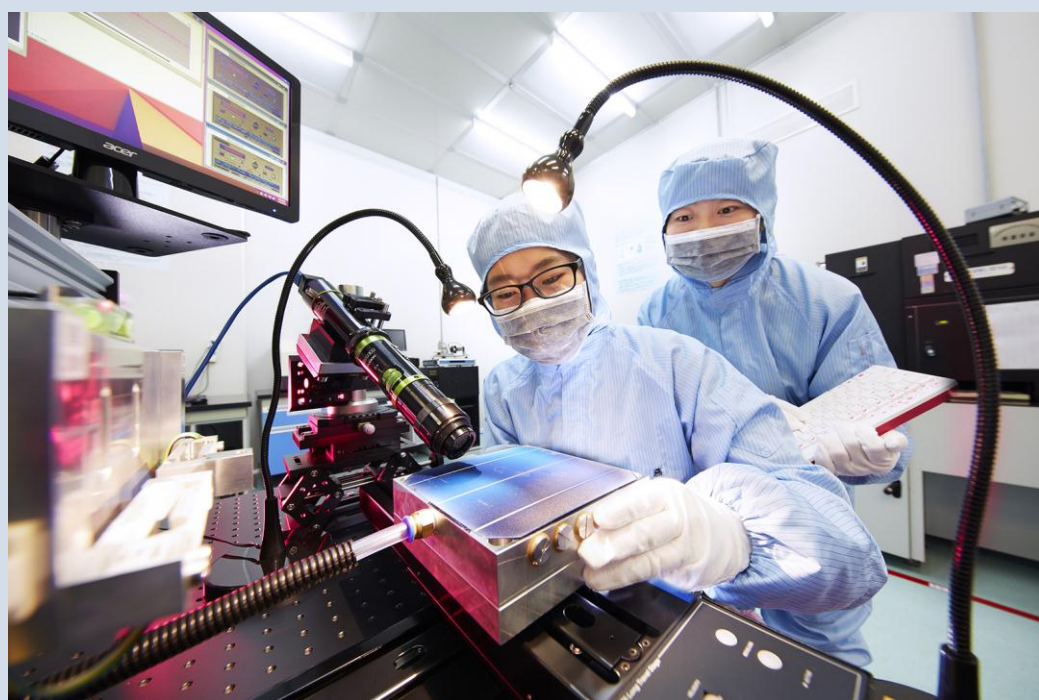


National Survey Report of PV Power Applications in CHINA 2015



PHOTOVOLTAIC POWER SYSTEMS PROGRAMME

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Cover story

Trina Solar in China broke 13 world-records since 2011

Trina's SKL PVST made a series of breakthroughs since 2011, creating 13 world-records in solar cell conversion efficiency and module power output, for example, the IBC cell efficiency at 23.5% in this April. Trina's multi-crystalline silicon cell efficiency world record was recorded twice in the world's highest efficiency figure which published by NREL. Meanwhile the module efficiency in mass production is at the leading global level: mono-crystalline silicon PERC cell efficiency at 21.1%, multi-crystalline silicon PERC cell efficiency at 20.16% and multi-crystalline silicon DP cell efficiency at 18.7%.

Photo by: Trina Solar

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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 2015. 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.

1 INSTALLATION DATA

1.1 Applications for Photovoltaics

By the end of 2015, China's accumulated PV installation reached 43.18 GW to become the largest country in the world in terms of PV installation. Of which, PV power station accounted for 37.12 GW, distributed 6.06 GW, with a total power output of 39.2 billion kWh. The newly added grid connected PV installation was 15.13 GW (exclude off grid installation) to realize the annual target of 15 GW, accounting for over a quarter of world newly added PV installation and one-thirds of China's annual output of PV module which provided effective market support to China's PV manufacturing industry.

The development of the PV industry demonstrated a pattern of simultaneous development of the east, middle and west regions. In the middle and east regions, there were 6 provinces that installed over 1000 MW PV power, including Jiangsu (4220 MW), Hebei (2390 MW), Zhejiang (1640 MW), Shandong (1330 MW), Anhui (1210 MW), and Shanxi (1130 MW). The top three of the province and regions with newly added installation included Xinjiang (including construction corps), Inner Mongolia and Jiangsu, with 2100MW, 1870 MW, and 1650 MW installation respectively. Provinces on the top three list with more distributed PV installation were Zhejiang (1210 MW), Jiangsu (1190 MW), and Guangdong (570 MW).

1.2 Total photovoltaic power installed

Table 1 PV power installed during calendar year 2015

AC			MW installed in 2015(mandatory)	MW installed in 2015(optional but HIGHLY NEEDED)	AC or DC	
Grid-connected	BAPV	Residential	1390MW		DC	
		Commercial				
		Industrial				
	BIPV (if a specific legislation exists)	Residential				
		Commercial				
		Industrial				
	Ground-mounted	cSi and TF		13740MW		DC
		CPV				
	Off-grid			Residential	10MW	
		Comm.& Indus.	5MW		DC	
		PV Products	5MW		DC	
		Total	15150MW		DC	

Table 2 Data collection process

If data are reported in AC, please mention a conversion coefficient to estimate DC installations.	DC
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 2015 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)	www.nea.gov.cn/2016-02/05/c_135076636.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>	2015 numbers	2014 numbers
Total power generation capacities (all technologies)	1506.73GW	1360.19GW
Total power generation capacities (renewables including hydropower)	518.6GW	424.16GW
Total electricity demand (= consumption)	5550TWh	5523.3TWh
New power generation capacities installed during the year (all technologies)	N/A	103.50GW
New power generation capacities installed during the year (renewables including hydropower)	N/A	N/A
Total PV electricity production in GWh-TWh	39.2TWh	25TWh
Total PV electricity production as a % of total electricity consumption	0.71%	0.45%

Source: National Energy Administration

Table 4 Other informations

	2015 Numbers
Number of PV systems in operation in your country (a split per market segment is interesting)	43.53GW including Rural Electrification 180MW (0.41%) ; Comm.& Indus. 85MW (0.20%) ; PV Products 85MW (0.20%) ; Building PV6060MW (13.92%) ; Ground Mounted LS-PV37120MW (85.27%)
Capacity of decommissioned PV systems during the year in MW	N/A

Total capacity connected to the low voltage distribution grid in MW	N/A
Total capacity connected to the medium voltage distribution grid in MW	N/A
Total capacity connected to the high voltage transmission grid in MW	N/A

Source: National Energy Administration

Wang Sicheng

Table 5 The cumulative installed PV power in 4 sub-markets(MW)

Sub-market	Stand-alone domestic	Stand-alone non-domestic	Grid-connected distributed	Grid-connected centralized
2000	3.00		0.00	0.00
2001	4.50		0.01	0.00
2002	18.50		0.01	0.00
2003	10.00		0.07	0.00
2004	8.80		1.20	0.00
2005	6.40		1.30	0.20
2006	9.00		1.00	0.00
2007	17.80		2.00	0.20
2008	29.50		10.00	0.50
2009	17.80		34.20	108.00
2010	27.00		190.00	283.00
2011	20.00		680.00	2000.00
2012	40.00		1360.00	1800.00
2013	40.00		10950 ¹	
2014	40.00		2050.00	8550.00
2015	20.00		1390.00	13740.00
TOTAL (MW)	350.00		6060.00	37120.00

Source: National Energy Administration

Wang Sicheng

¹PV grid-connected installation capacity in 2013 was modified to 10950MW by National Energy Administration in 2014.

2 COMPETITIVENESS OF PV ELECTRICITY

2.1 Module prices

The rapid expansion of PV market led to further expansion of PV module production scale, continued improvement of module transfer efficiency and reduction of module cost. In 2015, the sale price of PV module in China was 3.6 yuan RMB/w, a reduction 81% of the price in 2009.

Table 6 Typical module prices for a number of years(RMB Yuan)

Year	2009	2010	2011	2012	2013	2014	2015
Standard module crystalline silicon price(s): Typical	19	13.0	9.0	4.5	4	3.8	3.6
Lowest prices		-	-	-	-	-	-
Highest prices		N/A	N/A	N/A	N/A	N/A	N/A

Source: Wang Sicheng

2.2 System prices

Table 7 Turnkey Prices of Typical Applications – local currency

Category/Size	Typical applications and brief details	Current prices(RMB Yuan) per W
OFF-GRID Up to 1 kW	Flashlight, calculator, street lamp and other PV products	
OFF-GRID >1 kW	Rural stand-alone PV system	
Grid-connected Rooftop up to 10 kW (residential)	Distributed PV system built on residential rooftop	6-7
Grid-connected Rooftop from 10 to 250 kW (commercial)	Distributed PV system built on commercial rooftop like malls	6-7
Grid-connected Rooftop above 250kW (industrial)	Distributed PV system built on industrial rooftop	
Grid-connected Ground-mounted above 1 MW	Large-scale ground-mounted PV power plant	7-8
Other category (hybrid diesel-PV, hybrid with battery...)		-

Table 8 National trends in system prices (current) for different applications – local currency

Price (RMB Yuan)/Wp	2008	2009	2010	2011	2012	2013	2014	2015
Residential PV systems < 10 KW	-	-	-	-	-	-	13	6-7
Commercial and industrial	-	-	-	18	14	12	8	6-7
Ground-mounted	50	30	20	15	12	10	8	7-8

2.3 Cost breakdown of PV installations

2.3.1 Residential PV System < 10 kW-

Table 9 Cost breakdown for a residential PV system – local currency

Cost category	Average (local currency: RMB Yuan /W)	Low (local currency: RMB Yuan /W)	High (local currency: RMB Yuan /W)
Hardware			
Module	3.9	3.5	4.1
Inverter	0.6	0.4	0.8
Other (racking, wiring...)	0.8	0.6	1.15
Soft costs			
Installation	1.25	1	1.42
Customer Acquisition			
Profit	0.13		
Other (permitting, contracting, financing...)	0.60	0.53	0.8
Subtotal Hardware	5.3		
Subtotal Soft costs	1.98		
Total	7.28		

Source: Consulting company

2.3.2 Utility-scale PV systems > 1 MW

Table 10 Cost breakdown for a utility-scale PV system – local currency

Cost Category	Average (local currency: RMB Yuan /W)	Low (local currency: RMB Yuan/W)	High (local currency: RMB Yuan/W)
Hardware			
Module	3.9	3.5	4.1
Inverter	0.35	0.25	0.45
Other (racking, wiring, etc.)	1	0.99	1.2
Soft cost			
Installation Labor	1.45	1.34	1.6
Customer acquisition			
Profit	0.18		
Other(contracting, permitting, financing etc.)	1.05	0.93	1.13

<i>Subtotal Hardware</i>	5.25		
<i>Subtotal - Soft cost</i>	2.68		
Total Installed Cost	7.93		

Source: Consulting company

2.4 Financial Parameters and specific financing programs

Table 11 PV financing scheme

Average rate of loans– residential installations	4.9%
Average rate of loans – commercial installations	4.9%
Average cost of capital – industrial and ground-mounted installations	4.9%

2.5 Specific investments programs

Third Party Ownership (no investment)	
Renting	
Leasing	
Financing through utilities	
Investment in PV plants against free electricity	
Crowdfunding (investment in PV plants)	
Other (please specify)	

2.6 Additional Country information

Table 12 Country information

Retail Electricity Prices for an household (range)	0.45-0.65 RMB Yuan/kWh
Retail Electricity Prices for a commercial company (range)	0.77-1.17 RMB Yuan/kWh
Retail Electricity Prices for anlarge-scale industrial company (range)	0.6-0.8 RMB Yuan/kWh
Population at the end of 2014 (or latest known)	1374620000
Country size (km ²)	9600000
Average PV yield (according to the current PV development in the country) in kWh/kWp	N/A
Name and market share of major electric utilities.	N/A

3 POLICY FRAMEWORK

3.1 Direct support policies for PV installations

3.1.1 New, existing or phased out measures in 2015

3.1.1.1 Description of support measures excluding BIPV, and rural electrification

(1) Development plan and target

In Dec. 2015, the National Energy Administration (“NEA”) set the targets of 150GW PV installation and 170 billion kWh PV power output by the year 2020 in the “Solar Power Application Plan during the Thirteenth Five-year Plan (draft for comments)”, of which concentrated PV power station accounts for 80GW and distributed PV 70GW. Meanwhile, the draft also set the target to increase the proportion of PV installation in total power installation and newly added power installation to about 7% and 15% respectively, and about 2.5% in power output, compared with 2015 proportion of 2.9% in power installation and 0.7% in power output.

On Jun. 5, 2016, the NEA put forward the target of 18.10 GW of newly added PV power station construction in 2016, of which traditional PV stations will account for 12.60 GW, while PV pacemaker program bases 5.50 GW.

(2) Scale index and project management

In 2015, the PV project management system was transferred from state examination and approval to local filing and the new method was gradually implemented. Large scale concentrated PV stations adopted local approval management, while distributed PV power only needed to file locally. Meanwhile, the annual construction index management continued to be effective.

The policy guidance on PV power feed-in competitive bidding has been published. There is also indication of a new trend to adopt competitive method in PV development project management model, as described in the NEA’s draft on PV development during the Thirteenth Five-year Plan.

(3) Power price and subsidy policy

Increase PV power output, the pricing mechanism shall be carried out according to the principle of gradual price reduction along with expanded PV development scale to decrease PV power benchmark.

In Dec. 2015, the National Development and Reform Commission issued the “Notice on Perfection of Onshore Wind Power and PV Power Feed-in benchmark Price Policy”. The notice decreased prices of the 1, 2, 3 catalogue regions 0.1, 0.07, 0.02 yuan RMB/kWh respectively to 0.80, 0.88, 0.98 yuan RMB/kWh respectively. In terms of pricing mechanism, the notice added the principle of “gradual decrease feed-in benchmark price along with expanded PV development scale”.

In the above-mentioned notice, the price policy for distributed PV was changed from to choose either the model of “self-generation self-consumption, surplus feed into grid” or the model of “entire power feed into grid” and may make one adjustment during the operation term to the only change for once from “self-generation self-consumption, surplus feed into grid” to “entire power feed into grid”. Meanwhile, in 2015, the benchmark price of coal power and tariff for industry and commerce and large scale industry had all witnessed certain degrees of reduction.

Increase the level of added price of renewable energy, please refer to 3.5.

(4) Land use policy

In Nov. 2015, the State Forestry Bureau issued the “Notice on Issues of Using Forest Land to Construct PV Stations” which set the threshold of using forest land to develop PV power project from the perspective of forestry.

In Sep. 2015, six ministries including the Ministry of Land and Resources issued the “Opinions on Providing Support to Land Use for Emerging industries and New Businesses to Promote

Popular Entrepreneurship and Innovation”, which provided differentiated land use policy for PV projects.

In Dec. 2015, the Ministry of Land and Resources issued the “Land Use Control Index for PV Project”, providing standard and basis for PV project design, feasibility, land use pre-review, examination and approval, land supply and subsequent supervision, etc.

(5) Industrial upgrading the standard

In Jun. 2015, the NEA, the Ministry of Industry and Information Technology (“MIIT”) and China Certification and Accreditation Administration (“CNCA”) jointly issued the “Opinions on Promotion of Application of PV Products with Advanced Technologies and Industrial Upgrading”. The opinions proposed to adopt differentiated market entrance standard for PV technologies and products at different development stages to provide support to market expansion of products with advanced technologies and facilitate accelerated elimination of products with backward technologies.

(6) Grid connection and consumption

In Mar. 2016, the NEA issued a document that clearly established a target guide mechanism for renewable energy development and application to ensure future development space for renewable energy including PV power.

Also in Mar. 2016, the NEA issued the “Management method of indemnificatory purchase of full amount of renewable energy” to establish and implement the mechanism of indemnificatory full purchase of renewable energy.

(7) Government special PV projects

a) “Pacemaker Program”

The future policies will incline to become more favorable to innovative products with leading technologies and advanced technologies that may facilitate realization of high ratio renewable energies.

On Jan. 29, 2015, the NEA issued the “Opinion on market oriented measures to promote PV technological progress and industrial upgrading (draft for comments)” (Guoxinzongxinneng (2015) No. 51), proposing the concept of the “pacemaker program”. Subsequently, on Jun. 1, 2015, the NEA, jointly with MIIT and CNCA, issued the “Opinions on promoting application of products with advanced technologies and industrial upgrading” (Guonengxinneng (2015) No. 194), providing basic PV market entrance requirements and technical indexes of the “pacemaker program”.

In Aug. 2015, the NEA approved the establishment of the “State advanced technology PV pilot base in deep sinking coal mine areas” in Datong city of Shanxi province, providing an additional 1GW PV quota and stipulating that only products meeting requirements of the pacemaker program were eligible to be applied in the pilot base so as to promote application demonstration of advanced PV technology.

b) Micro grid pilot project

On Jul. 13, 2015, the NEA issued the “Guiding opinions on construction of new energy micro grid pilot project” (Guonengxinneng (2015) No. 265), planning to establish 30-50 micro grid demonstration project in the next 3 to 5 years across the country (including independent and grid connected micro grids).

c) PV poverty alleviation program

On Mar. 9, 2015, the NEA issued the “Compilation outline of PV poverty alleviation implementation program” (draft for comments). On Dec. 24, 2015, the NEA published the “Implementation opinions on acceleration of energy development and construction in poverty-stricken areas to promote poverty alleviation efforts” (Guonengguihua [2015] No. 452). The

formal document clearly expanded the scope of PV poverty alleviation on the basis of existing pilot projects.

On Mar. 23, 2016, the National Development and Reform Commission, NEA, the Poverty Relieve Office of the State Council, China Development Bank and China Agricultural Development Bank (three ministries and two banks) jointly published the “Opinions on implementation of PV poverty alleviation work” (Fagainengyuan [2016] No. 621), which further defined issues on construction scale, scope of benefit, capital collection, project management and policy guarantee of PV poverty alleviation project.

3.1.1.2 BIPV development measures

The draft of the NEA document for comments indicated that in 2016, distributed PV power will be comprehensively promoted and by 2020, the accumulated distributed PV power installation will reach 70GW.

3.1.1.3 Rural electrification measures

See 3.1.1.1-7) -c.

3.1.1.4 Support for electricity storage and demand response measures

Table 13 PV support measures (summary table)

	On-going measures residential	Measures that commenced during 2015 - residential	On-going measures Commercial + industrial	Measures that commenced during 2015 – commercial + industrial	On-going measures Ground-mounted	Measures that commenced during 2015 – ground mounted
Feed-in tariffs	Feed-in tariff : desulfurized coal benchmark price+ 0.42 yuan/kWh (include tax);		Feed-in tariff : desulfurized coal benchmark price+ 0.42 yuan/kWh (include tax);		Feed-in tariff : on the basis of resource regions, 0.8, 0.88,0.98 yuan/kwh respectively	Published 2016 PV feed-in tariff, on the basis of three catalogue regions, decreased 0.1,0.07,0.02 yuan/kwh respectively
Feed-in premium (above market price)						
Capital subsidies						
Green certificates						
Renewable portfolio standards (RPS) with/without PV requirements						
Income tax credits						
Self-consumption						
Net-metering						
Net-billing						
Commercial bank activities e.g. green mortgages promoting PV					People’s Bank of China and China Banking Regulatory	

					Commission is guiding financing institution to strengthen credit support and financing service and to support key enterprises to grow stronger.	
Activities of electricity utility businesses	State Grid Corporation Of China and China Southern Power Grid have established one-stop service system with free grid-connected service to distributed PV project.					
Sustainable building requirements						
BIPV incentives						
Other (specify)						

3.2 Self-consumption measures

Mandatory

PV self-consumption	1	Right to self-consume	Yes
	2	Revenues from self-consumed PV	Savings on the electricity and a self-consumption bonus (4.2Yuan/kWh).
	3	Charges to finance Transmission & Distribution grids	None
Excess PV electricity	4	Revenues from excess PV electricity injected into the grid	Market price and a bonus (4.2Yuan/kWh).
	5	Maximum timeframe for compensation of fluxes	Real-time
	6	Geographical compensation	On site only
Other characteristics	7	Regulatory scheme duration	20 years
	8	Third party ownership accepted	None
	9	Grid codes and/or additional taxes/fees impacting the revenues of the prosumer	None

	10	Regulations on enablers of self-consumption (storage, DSM...)	None
	11	PV system size limitations	None
	12	Electricity system limitations	No, PV electricity will account for 2.5% of the total electricity by 2020.
	13	Additional features	None

3.3 Tenders, auctions & similar schemes

3.4 Financing and cost of support measures

The Renewable Law published in 2009 defined that “Renewable Energy Development Fund” includes dedicated funds allocated by annual finance of the state and added tariff for renewable energy collected according to law.

The added tariff for renewable energy is specifically used on subsidy to power price of renewable energy and fees for grid connectivity, allocated through grid companies. Since 2006, the state started to collect added tariff from revenue of electricity sales from users excluding power for residents and agriculture. In Dec. 2015, the National Development and Reform Commission for the fifth time increased the standard of such added tariff collection, from 0.015 yuan/kWh to 0.019 yuan/kWh.

The dedicated renewable energy fund is directly controlled by the Ministry of Finance. The fund is used on construction of renewable energy projects in remote areas without electricity and renewable energy pilot projects. On Apr. 2, 2015, the Ministry of Finance issued the notice on “Interim management method of dedicated development fund for renewable energy” (Caijian [2015] No. 87), which clearly defines that the dedicated development fund for renewable energy refers to the dedicated fund allocated by means of central financial budget arrangement and is used on supporting development and application of renewable energy and new energy.

3.5 Indirect policy issues

In Dec. 2015, the world’s 195 countries reached the “Paris Agreement” on the United Nations Climate Change Conference held in Paris, France. The agreement outlined the global system framework of tackling climate change after 2020, and proposed global targets including 1.5 degree temperature increase control and net zero emission in the next half century. The agreement serves as a new starting point post-Kyoto Protocol and milestone in handling climate change globally.

4 HIGHLIGHTS OF R&D

4.1 Highlights of R&D

4.1.1 Efficiency of crystalline silicon cell

Presently, the efficiency of regular polycrystalline silicon cell usually range from 19.6%-20.0%, and that of regular polycrystalline silicon cell is between 18.2%-18.6%. The efficiency of polycrystalline silicon cell is largely affected by the quality of silicon wafer, and presently the third generation high efficiency polycrystalline silicon wafer (M3) is applied, with efficiency between 18.3% and 18.5%. Increase of efficiency for regular cell mainly relies on improvements of wafer quality, positive surface silver paste, further optimization of emitter, and improvement of backside aluminium paste. In terms of high efficiency crystalline silicon cell, development of high efficiency and low cost crystalline silicon cell has become a trend, and there're products that have started large scale production. The efficiency of the high efficiency low cost cells developed by PV enterprises such as Yingli Group, Suntech Power, Trina Solar, JA Solar, Artix Power and CSUN has surpassed 20%. For IBC cell, the efficiency of the 6-inch large area IBC cell independently developed by the state key PV science and technology research laboratory in Trina Solar has reached 22.9% to reach the highest efficiency for 6-inch IBC cell. Meanwhile, backed by the state 863 Program, Trina Solar established a pilot scale production line. After 2015, researchers in Trina Solar adopted the latest processing to achieve the results of average 22% and maximum 23.4% (internal testing) efficiency on the pilot production line to reach the highest efficiency of industrial class 6-inch crystalline silicon cell (SunPower cells are all 5-inch). For PERC cell, in Dec. 2015, Changzhou Trina laboratory increased the efficiency of PERC cell to 22.13%, creating a world record of 6-inch PERC cell (tested by the third party German Fraunhofer ISE testing laboratory). The peak output of 60 slices of 156 mm cell standard module reached 335.2Wp.

4.1.2 Thin film cell efficiency

Noncrystalline silicon/microcrystalline silicon laminated solar cell has obtained 13.65% efficiency; glass basal CIGS thin film solar cell device achieved an efficiency of 20.18%; The efficiency of laboratory made small space CdTe solar cell reached 16.28%, and such efficiency on small sized cell is over 15% from industrialized production line.

4.1.3 New type and concentrator cell efficiency

Soft perovskite solar cell realized 15.07% efficiency, while that of rigid plane cell reached 19.4%.

Under the condition of 500 times concentrate light, efficiency of three junction GaInP/GaInAs/Ge concentrator cell is over 40%.

4.2 Public budgets for market stimulation, demonstration / field test programmes and R&D

Table 14 Public budgets for R&D, demonstration/field test programmes and market incentives

	R & D	Demo/Field test
National/federal	N/A	N/A
State/regional	N/A	N/A
Total	N/A	

5 INDUSTRY

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

5.1.1 Polycrystalline silicon material

China's polycrystalline silicon production remained continued increase in 2015 to reach 165,000 tons output, accounting 47.8% of global total output, and a 2 percentage point increase on year-on-year basis, and compared with 2014's 136,000 tons, an increase of 21.3%. The apparent consumption of polycrystalline silicon in 2015 was 260,000 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 15 Production information for the year for silicon feedstock 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	74000 tonnes		
Tbea Solar Co. Ltd	mc-Si	21000 tonnes		
China Silicon Corporation LTD.	mc-Si	12000 tonnes		
DAQO New Energy Corp.	mc-Si	9500 tonnes		
Asia Silicon Co., Ltd	mc-Si	7900 tonnes		
Sichuan Yongxiang Co. Ltd.	mc-Si	7500 tonnes		
Yichang CSG Polysilicon.Co.,Ltd	mc-Si	5600 tonnes		
LDK Jiangxi LDK Solar Hi-Tech Co. Ltd	mc-Si	5500 tonnes		
DunAn Holding Group Co., Ltd	mc-Si	5000 tonnes		
Sichuan ReneSola Silicone Materials Co., Ltd.	mc-Si	5000 tonnes		
Rest	mc-Si	12000 tonnes		
Total	mc-Si	165000 tonnes		

Source :CPIA,2016.5

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

5.1.2 Silicon wafer

In 2015, the total output capacity of silicon wafer in China was 64.3GW, the output was about 48GW, an increase of 26.3% on the year-on-year basis, accounting for 79.6% of world output.

The total production capacity of the top 10 silicon wafer manufactures is 41GW, 63.8% of total national capacity; their combined output is about 35.1GW, 73.1% of national total, with much higher product concentration than the concentration in the link of cell module.

Table 16 Production information for the year for silicon wafer producers

Manufacturers (or total national production)	Process & technology	Total Production	Product destination (if known)	Price (if known)
GCL-Poly Energy Holdings Limited	Silicon wafers	15000MW		
Xi'an LONGI Silicon Materials Corp	Silicon wafers	3200MW		
Jinko Solar Holding Co., Ltd	Silicon wafers	2800MW		
RENESOLA LTD	Silicon wafers	2300MW		
LDK Jiangxi LDK Solar Hi-Tech Co. Ltd	Silicon wafers	2200MW		
Yingli green energy holding Co., Ltd	Silicon wafers	2200MW		
Sornid	Silicon wafers	1980MW		
Rietech	Silicon wafers	1900MW		
Inner Mongolia Zhonghuan Solar Material Co., Ltd.	Silicon wafers	1860MW		
Trina Solar Co., Ltd	Silicon wafers	1700MW		
Rest	Silicon wafers	12860 MW		
Total	Silicon wafers	48000 MW		

Source :CPIA,2016.5

In 2015, China imported as many as 116,000 tons of polycrystalline silicon, a 13% increase on the year-on-year basis, mainly from USA, South Korea and Taiwan.

The export value of silicon wafer in 2015 was 2.16 billion US\$, mainly to Taiwan, South Korea, Malaysia, the Philippines and the USA, export value of these five countries/region was 2.028 billion US\$, and 93.8% of total export.

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

Module manufacturing is defined as the industry where the process of the production of PV modules (the encapsulation) is done. A company may also be involved in the production of ingots, wafers or the processing of cells, in addition to fabricating the modules with frames, junction boxes etc. The manufacturing of modules may only be counted to a country if the encapsulation takes place in that country.

Total PV cell and module manufacture together with production capacity information is summarised in Table 9 below.

5.2.1 Solar cell

By the end of 2015, the total production capacity of solar cell in China mainland was about 53GW, and the output was 41GW, a 24.2% increase on year-on-year basis, accounting 66% of world total, and listed No. one in the world.

The total output of the top 10 solar cell manufacturers in China is about 21.8GW, 53.1% of national total, and 27.1GW production capacity, 51% of national total, further industrial concentration is expected in the future.

5.2.2 PV module

In 2015, the total production capacity of China's PV module was about 71GW, with 45.8GW output; of which China's mainland produced about 43.9GW, a 23.3% increase on year-on-year basis and accounted 69.1% of world total. Of the total output, crystalline silicon cell accounted for about 45.4GW, 99.1% of total output, thin film cell was about 300MW, while concentrator module was about 60 MW.

Table 17 Production and production capacity information for 2015

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>					
JA Solar Holdings Co., Ltd		3600	3300	4400	
Trina Solar Co., Ltd		3300	4300	3500	
JinkoSolar Holding Co., Ltd		2500	3300	2500	
Yingli green energy holding Co., Ltd		2400	2500	4000	
Artix Power		2000	3800	2700	
Shunfeng Photovaltic International Limited		1900		3000	
Hanwha Solar		1700	1900	1750	2070
Tongwei Solar		1630		2300	
Hareon Solar		1500		1600	
Risen Energy Co. Ltd		1260	1360	1300	1800
BYD		1036	1000	1040	1500
Zhongli Talesun Solar Co. Ltd		1000	1100	1000	1500
Eging PV		983	1300	1000	1600
Fortune Energy		937		1080	
DMEGC		720		1500	
GCL System Integration			2100		3700
SunTeck			1200		2400
Zhengtai			1000		1200

ReneSolar SOL			820		1200
Lerri Solar			800		1500
HT SAAE			800		800
Rest		14534	15220	20330	30030
Total		41000	45800	53000	71000
<i>Thin film manufacturers</i>					
Hanergy Holding Group Ltd.	Si-based	x	x	2820	
Hanergy Holding Group Ltd.	CIGS			100	
Advanced Solar Power (Hangzhou) Inc.	CdTe	10 ²			
<i>Cells for concentration</i>					
Total					
TOTALS		41010	45800	55920	71000

Source :CPIA,2016.5

The export value of China's solar cell in 2015 was 724 million US\$. Affected by the audit of the main export market of Europe and change of enterprise strategies, the total value of solar cell export dropped 23.4% on year-on-year basis. China export solar cell to 71 countries or regions, South Korea is the largest one, with 174.59 million US\$ export value. In 2015, China had 170 enterprises that exported solar cell, JA Solar was the largest exporter, with 63.43US\$ export value.

In 2015, China exported 13.05 billion US\$ of PV module, a 2.3% increase on year-on-year basis, and the volume of the export was about 24GW. In 2014, the number of destination countries or regions for PV module export reached 192, the largest of which was Japan, with 3.685 billion US\$ export value and 28% of total. In 2015, the number of export enterprises was over 1500, the largest was Trina Solar, with 1.538 billion US\$ export value and over 2800 MW volume.

²10MW is the amount of shipment.

5.3 Manufacturers and suppliers of other components

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

Driven by strong growth of China's PV market, shipment of Chinese inverter enterprises reached more than 22 GW in 2015, increasing to 40% of world market share. Of the total shipment, domestic accounted for about 19GW while export was over 3GW.

Dramatic price drop and rapid decrease of the number of manufacturers. Price of centralization inverter fell from 0.8 Yuan/W in 2012, 0.4 Yuan/W in 2013 and 0.28 Yuan/W in the beginning of 2014 to 0.22 Yuan/W by the end of 2015. With fierce market competition, the number of inverter manufacturers reduced to less than 50.

Further inverter industrial concentration. In 2015, the total shipment of the top five domestic inverter manufactures, including Sungrow Power, Huawei Technologies, Sineng Power, and TBEA, accounted for over 75% of total domestic shipment.

A new force of stringing inverter market rose rapidly. With the gradual transformation of terminal application market from LS-PV plant to distributed PV, PV station owners are paying more attention on how to increase power output per watt for better investment return instead of initial investment cost. The application of stringing inverters followed suit of such transformations, and resulted in expanded market.

Inverter enterprises transform from product to service. According to operational characteristics of stringing inverters, Huawei has provided extended services including monitoring, data collection and analysis on operation and maintenance, introduced cloud monitoring and cloud management services, and put forward the concept of intelligent power plant. The company has changed from a component supplier to a professional supplier of integrated power plant solution and services. Sungrow Power Supply also launched its power station operation and maintenance platform in Apr. 2015. The innovation of such service mode has subverted operation concept of traditional manufacturer, improved operation and maintenance efficiency and reduced cost in the process.

- Supporting structures

In 2015, China had become the largest PV mount production base in the world, producing over 50% of PV mount in the world. With low market entry threshold and fierce market competition, the overall profit rate has been remained at a low level. In order to avoid the awkward low profit situation caused by homogeneous competition, main PV mount enterprises have started to develop downstream applications in recent years. For example, in 2015, PV power stations owned by AKcome Industrial Group achieved over 1GW of accumulated grid connection.

6 PV IN THE ECONOMY

6.1 Labour places

Table 18 Estimated PV-related labour places in 2015

Research and development (not including companies)	N/A
Manufacturing of products throughout the PV value chain from feedstock to systems, including company R&D	
Distributors of PV products	
System and installation companies	
Electricity utility businesses and government	N/A
Other	N/A
Total	

6.2 Business value

Table 19 Value of PV business

Sub-market	Capacity installed in 2015(MW)	Price per W(RMB Yuan) (from table 7)	Value(RMB Yuan)	Totals(RMB Yuan)
Off-grid domestic	20	14	280 000 000	
Off-grid non-domestic				
Grid-connected distributed	1390	6.5	9035 000 000	
Grid-connected centralized	13740	7.5	103050 000 000	
				112365 000 000
Export of PV products				N/A
Change in stocks held				N/A
Import of PV products				N/A
Value of PV business				

7 INTEREST FROM ELECTRICITY STAKEHOLDERS

7.1 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"> - Vertically integrated - -Integrated; - Public (state owned) - Yes
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7.2 Interest from electricity utility businesses

In Mar. 2015, the State Council published Zhongfa No. 9 document “Opinions on further deepening electricity system reform” to forcefully drive a new round of electricity system reform, of which power sale side reform was the focus point. In Dec. 2015, the State Council published “Implementation opinions on promoting power sale side reform” to further promote power sale side reform and open up power sale business in an orderly way. In 2016, the National Development and Reform Commission, NEA and related government departments started to study and compile implementation details of the reform, and two such implementation detail documents, “Power sale company entrance and exit management method” and “Management method of opening up power distribution network business in an orderly way” have been drafted for public comment.

To meet the requirements of rapid development of renewable energy and increase consumption capacity of renewable energy, the NEA is making efforts to strengthen regulating capability of electricity system, especially flexibility of thermal power operation. On Jan. 14, 2016, the NEA issued the “Reply letter on approval for the establishment of a collaboration platform to strengthen flexibility of thermal power plant” (Guonengdianli [2016] No. 11). The document approved Electrical Planning and Design Institute to take the lead to prepare the establishment of such a collaboration platform. On Jun. 14, on the basis of the requirements outlined in the document “Memorandum of understanding on the establishment of Sino-Denmark partnership on thermal power flexibility” and work arrangement of China’s thermal power flexibility collaboration platform, the NEA formally initiated the pilot project of flexibility transformation, the result is expected to increase 20% peak load regulation capacity over the rated capacity of thermal generator.

7.3 Interest from municipalities and local governments

In order to implement the State Council documents, near 30 provinces, municipalities and regions across the country compiled their respective local policies to provide support to the development of PV industry, 14 of them worked out their respective local economic support policies to provide certain tariff or investment subsidies for PV power projects.

Apart from economic policies, there have been diversified local policies to provide support to PV development. Some western provinces such as Shaanxi, Qinghai and Gansu have worked out land policies; Shandong province proposed special fund investment plan for regional promotion strategy of distributed PV power projects; and Shanghai initiated “sunshine loan” for distributed PV projects. These policies are all well targeted and are expected to play important roles in exploring financing and investment mechanism for distributed PV power projects and the establishment of related business models.

8 HIGHLIGHTS AND PROSPECTS

8.1 Highlight of 2015 development

8.1.1 Development goals

In Dec. 2015, the NEA in its draft for comment document put forward the target of 150 GW PV power installation and 170 billion KWh solar power output by 2020, of which concentrated PV station 80 GW and distributed PV 70 GW.

8.1.2 Special plans

In Jun. 2015, the NEA, MIIT and CNCA jointly issued the “Opinions on Promoting Application of PV Products with Advanced Technologies and Industrial Upgrading”, proposing the implementation of the “pacemaker program”, which included construction of PV power pilot bases with advanced technology and new technology pilot projects, requiring that all these projects apply products with advanced technologies.

8.1.3 Highlight of technologies

In 2015, state key PV science and technology research laboratory in Trina Solar successively created two world records of cell efficiency, one was 21.25% of polycrystalline silicon PERC cell and the other 22.13% of P-type monocrystalline silicon cell.

8.1.4 Highlight of policies

In Dec. 2015, the National Development and Reform Commission lowered PV feed-in benchmark price. For 1, 2, and 3 catalogue regions, the price dropped 0.1, 0.07 and 0.02 yuan RMB/kwh to the level of 0.80, 0.88, 0.98 yuan RMB/kwh respectively. Meanwhile, there were certain degrees of reduction of coal power benchmark price and tariff price for industry and commerce and large scale industries, which led to the reduction of 0.03-0.05 yuan RMB/kwh actual profit for distributed PV power project in 2015.

8.2 Development trend of 2016

On Jun. 5, 2016, the NEA put forward the 2016 target of 18.1GW newly added PV installation across the country, including 12.60 GW of regular PV station and 5.50 GW pacemaker PV bases. Due to the fact that subsidy to large-scale PV station would be lowered after Jun. 30, the first half year of 2016 witnessed large scale construction of PV plants with rapid increase of PV installation. According to statistics of the NEA, in the first quarters alone, the newly added PV capacity already reached 7.14GW, while in the second quarter, ground station capacity already increased 11.16GW. Taking into consideration of newly added distributed PV projects, it is expected that PV installation in the first half year may reach 20GW.

In the second half year of 2016, construction of large-scale PV station will enter a stable period, reform of domestic electricity system is in the full swing, and distributed PV power will have new outlets and adopt new business models. With further deepening of reform on power sale side and successive publication of supporting policies, some areas have started special pilot projects in power sale markets. By the end of May 1, 2016, the areas had established nearly 400 power sale companies, but apart from 9 power sale companies in Guangdong that started concentrated trade since Mar. this year, the rest are still under preparation.

In 2016, the Ministry of Science and Technology initiated the special research and development project for the Thirteenth Five-year Plan, in the special topics of renewable energy and hydrogen energy, the project put forward three technological directions for PV cell, PV system and comprehensive PV application, deciding the roadmap of PV technological research in the next five years.

