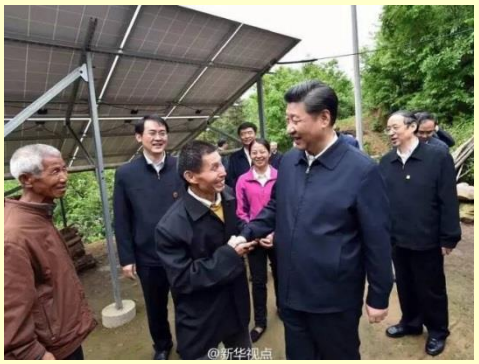
Current PV Status in China and Future Forecast





Wang Sicheng PV Committee of China

Dec. 5-7, 2017 Weihai，China

PV Industry in China

China is the Leading Country in PV Industry

(2016)

1. World Poly-Si Production is 400,000 Tons , China produced 194,000 Tons , shared 48.50% ;

2. World silicon wafers produced 74.8GW , China produced 64.8GW , shared 86.63% ;

3. PV cell production in the world is 75GW , China produced 51GW , shared 68.00% ;

4. PV module production in the world is 72GW , China produced 53GW , shared 74.7%。

Source: China PV Industry Association (CPIA)

Poly-Silicon Production in the World (2015, 2016)

Country	USA	Germany	Japan	Korea	China	Others	Total
2015 Capacity（Ton）	75000	58000	33000	92000	190000	22000	470000
2015 Production（Ton）	43000	56000	8800	63000	165000	9200	345000
2016 Capacity（Ton）	80000	60000	35000	100000	210000	5000	490000
2016 Production（Ton）	45700	56000	10000	85000	194000	9300	400000

China shared 48.5% of poly-silicon production in the world.

Imported Poly-Silicon from Abroad (2006-2016)

Year	2006	2007	2008	2009	2012	2013	2014	2015	2016
Production（Ton）	287	1093	4685	20071	71000	84000	136000	165000	194000
Capacity（Ton）	1500	5000	15000	40000	190000	160000	158000	190000	210000
Requirement(Ton)	4686	10597	20400	29250	150000	161000	215000	250000	330000
Imported(Ton)	4399	9504	15715	9170	79000	77000	79000	85000	136000
Share of Import(%)	93.88	89.69	77.03	31.35	52.67	47.83	58.09	51.52	41.21

Source: China PV Industry Association (CPIA)

Poly-Silicon Production in the World and China (2016)

No.	World Manufacturer	Location	2015 Production（Ton/y）	2016 Production（Ton/y）
1	GCL	China	74300	70000
2	Wacker	Germany	52000	56000
		USA	4000	10000
3	OCI	Korea	45000	52000
		Malaysia	0	8000
4	Hemlock	USA	25000	25000
5	TBEA Xinjiang	China	21000	22800
6	China Silicon, Luoyang	China	12000	15700
7	HK Silicon	Korea	9000	15000
8	Asia Silicon Co.	China	7900	13300
9	Da Quan New Energy	China	9500	13000
10	Yongxiang, Sichuan	China	7500	12300
Total			267200	313100
World Total			345000	400000

No.	China Manufacturer	2015 Production（Ton/y）	2016 Production（Ton/y）
1	GCL	74300	70000
2	TBEA Xinjiang	21000	22800
3	China Silicon, Luoyang	12000	15700
4	Asia Silicon Co.	7900	13300
5	Da Quan New Energy	9500	12800
6	Yongxiang, Sichuan	7500	12300
7	LDK	5500	10100
8	Dun An Group	5000	7000
9	Jingyang CGC	5100	5600
10	Ruineng Sichuan	5000	5100
11	China South Glass	5600	4700
12	Shenzhou Silicon	4300	4000
13	Kangbo Jiangsu	0	800
Total		162700	184200
Others		2300	9800
China Total		165000	194000

GCL is the largest poly-silicon producer in the world ；
48.5% of poly-silicon world production shared by China.

Source: China PV Industry Association (CPIA)

Top 16 Wafer Manufacturers in the World and China (2016)

Year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	%
World Capacity（GW）	6	10	16	33	56	60	50	68	84	100	100
World Production（GW）	5	8	10	23	36	36	45	50	60.3	74.8	100
China Capacity（GW）	1.8	4.5	6.8	23	40	50	35	50	64.3	81.9	81.9
China Production （GW）	0.8	2.4	4.4	11	24.5	26	28	38	48	64.8	86.63

World Top 16	Manufacturers	2016 Cap.（MW）	2016 Pro.（MW）
1	GCL	20000	17300
2	Longji Co	7500	7000
3	Jinko	5000	3900
4	JA Solar	4500	3700
5	Zhonghuan	3300	3100
6	LDK	3800	2900
7	Yingli Green Ene.	4300	2700
8	Rene Solar	3800	2600
9	Green Energy Taiwan	3000	2600
10	Sornid High-Tech	3000	2300
11	Huantai Group	3000	2100
12	Rongde Bew Ene.	3000	2000
13	Trina Solar	1800	1800
14	Dahai Group	2500	1700
15	Hanwha	1500	1300
16	China South Glass	1500	1100
Others		28500	16700
Total		100000	74800

In 2016，86.63% of wafer production in the world shared by China.

Source: China PV Industry Association (CPIA)

Top 20 PV Cell Manufacturers in the World and China (2016)

No	Cell Manuf.	2016 Capacity (MW)	2016 Prodiction (MW)
1	Trina Solar	5000	4700
2	JA Solar	5500	4600
3	Hanwha (KR)	5200	4000
4	JinKo	4000	3500
5	Motech (Taiwan)	3600	3200
6	Yingli Green Ene.	4200	3200
7	Shun Feng Int. (SunTech)	3400	3000
8	Tongwei Solar	3400	2200
9	Canadian Solar	2500	2100
10	New Sunshine (Taiwan)	2200	2000
11	Harein Solar	1800	1750
12	Zhongli Talesun	2000	1600
13	Gintech (Taiwan)	2200	1600
14	Zhanyu Jiangxi	1600	1500
15	Solar World	1500	1400
16	Risen Energy	1500	1380
17	Sunpower	1500	1370
18	AKCom	1400	1360
19	Kyocela	1250	1100
20	Fortune Energy	1300	1100
Others		39950	28340
Total		95000	75000

Source: China PV Industry Association (CPIA)

No.	Cell Manuf.	2016 Capacity (MW)	2016 Production (MW)
1	Trina Solar	5000	4700
2	JA Solar	5500	4600
3	JinKo	4000	3500
4	Yingli Green Ene.	4200	3200
5	Shun Feng Int. (SunTech)	3400	3000
6	Tongwei Solar	3400	2200
7	Hanwha China	2300	2100
8	Canadian Salar	2500	2100
9	Harein Solar	1800	1750
10	Zhongli Talesun	2000	1600
11	Zhanyu, Jiangxi	1600	1500
12	Risen Energy	1500	1380
13	AKCom	1400	1360
14	Fortune Energy	1300	1100
15	Yijing	1200	1050
	Sub-Total	41100	35140
	Others	21900	15860
	Total	63000	51000

68% global PV cell production shared by China Mainland.

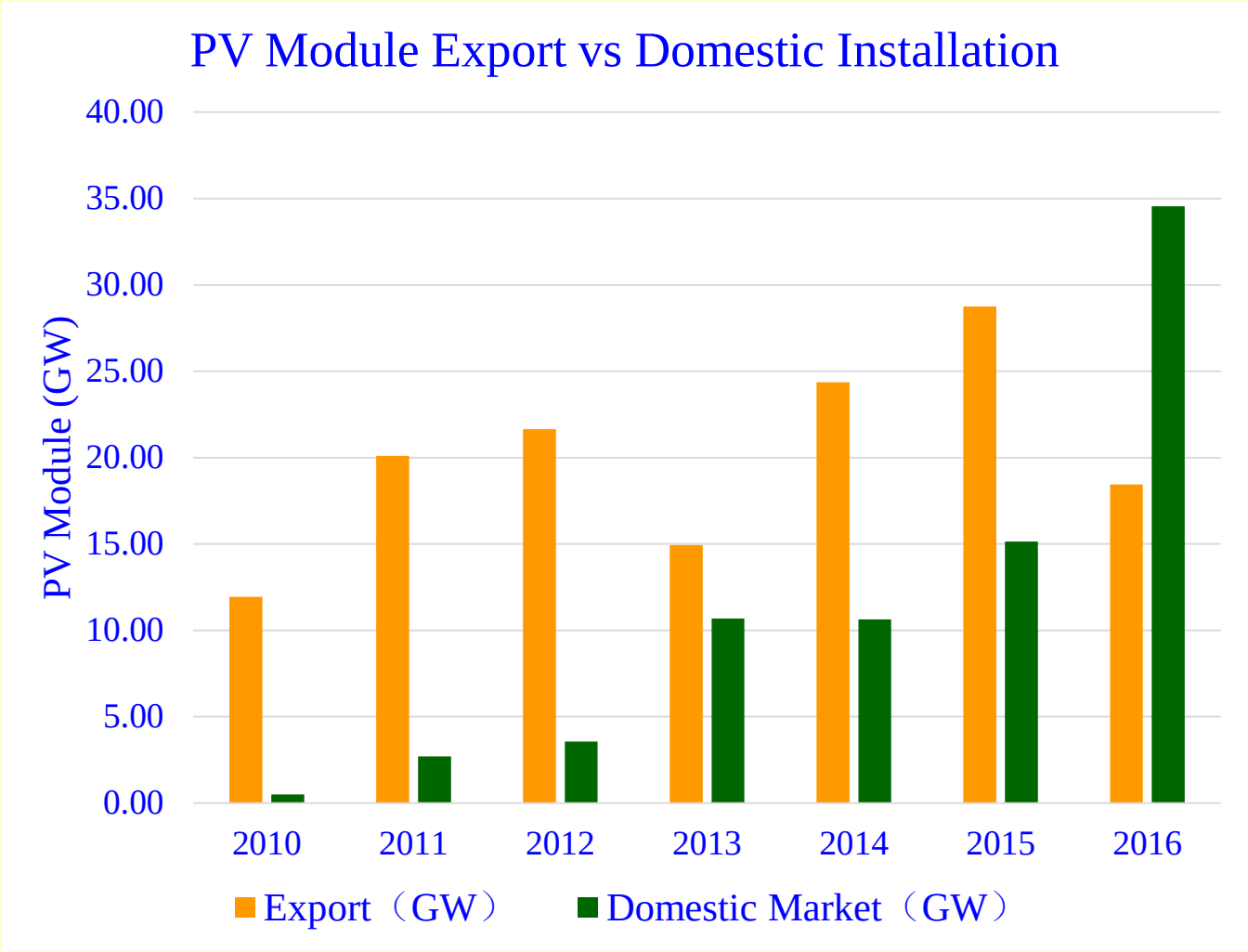
Top 20 PV Module Manufacturers in the World and China （2016）

No.	Manufacturer	2016 Capacity （MW）	2016 Production （MW）
1	JinKo	6500	6570
2	Trina Solar	6000	6000
3	Canadian Solar	5800	5200
4	Hanwha (KR)	5000	4800
5	JA Solar	5500	4800
6	GCL	5000	4000
7	First Solar (US)	3200	3100
8	Yingli Green Energy	4200	2800
9	Leye (Longgi)	4000	2400
10	Talesun Solar	2200	1600
11	Risen Energy Co.	2200	1500
12	Changzhou Yijing	2000	1500
13	SunTech	2200	1500
14	Solar World (DE)	1500	1400
15	Sunpower (US)	1500	1360
16	Kyocera (JP)	1400	1200
17	ReneSolar	1500	1200
18	REC (US)	1200	1100
19	Harein Solar	1500	950
20	Solar Frontier (JP)	1200	900
	Others	59400	24020
	World Total	123000	77900

No.	Manufacturer	2016 Capacity （MW）	2016 Production （MW）
1	JinKo	6500	6570
2	Trina Solar	6000	6000
3	Canadian Solar	5800	5200
4	JA Solar	5500	4800
5	GCL	5000	4000
6	Yingli Green Energy	4200	2800
7	Leye (Longgi)	4000	2400
8	Hanwha Jiangsu	2250	2100
9	Talesun Solar	2200	1600
10	Risen Energy Co.	2200	1500
11	Changzhou Yijing	2000	1500
12	SunTech	2200	1500
13	ReneSolar	1500	1200
14	Harein Solar	1500	950
15	ZN Shine Solar	1000	750
16	Jiangsu Seraphim	1000	710
17	Jinzhou Solar Power	750	710
18	JINNENG Clean Energy	750	680
19	Shenzhou New Energy	700	650
20	CECEP Solar	650	620
Others		23300	7460
China Total		79000	53700

China shared 74.7% of PV module production in the world.

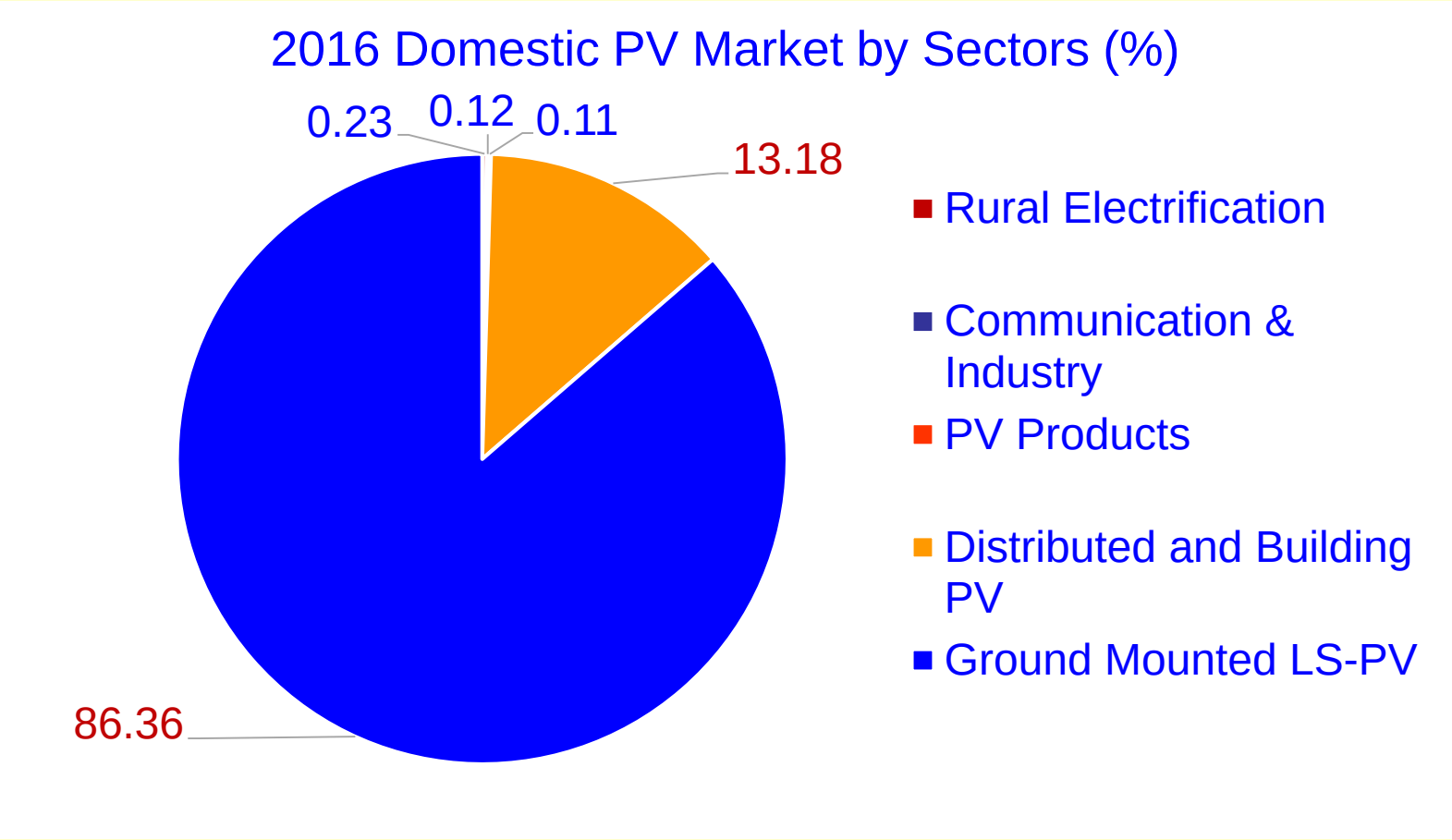
Source: China PV Industry Association (CPIA)



7 years before, 96% of PV modules exported to other countries, last year 65% of PV modules installed in China domesticly.

Year	2010	2011	2012	2013	2014	2015	2016
Module Production（GW）	12.44	22.80	25.21	25.61	35.00	43.90	53.00
Export（GW）	11.94	20.10	21.65	14.93	24.36	28.75	18.45
Domestic Market（GW）	0.50	2.70	3.56	10.68	10.64	15.15	34.55
Share of Export（%）	95.98	88.16	85.88	58.30	69.60	65.49	34.81

PV Market in China



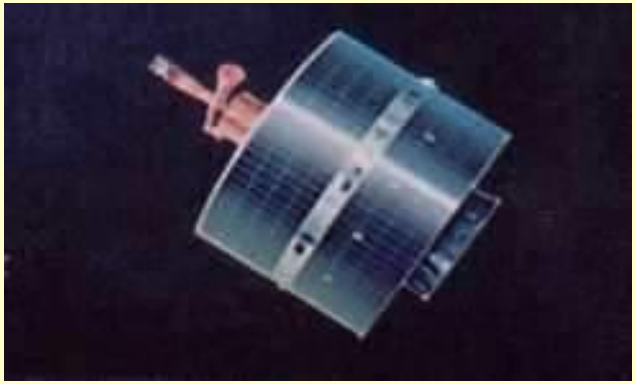
2016 Domestic PV Market by Sectors				
No.	Market Sector	Annu.Ins. (MWp)	Cum. Ins. (MWp)	Share (%)
1	Rural Electrification	2	182	0.23
2	Communication & Industry	5	90	0.12
3	PV Products	3	88	0.11
4	Distributed and Building PV	4230	10290	13.18
5	Ground Mounted LS-PV	30310	67430	86.36
	Total	34550	78080	100



Rural Electrification (0.23%)

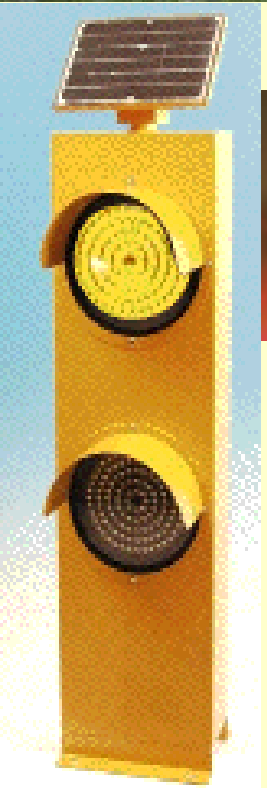




Communication & Industry Sector 0.12%

Solar Products 0.11%



PV Buildings

BIPV&BAPV

13.18%

LS-PV in Gobi – Desert (86.36%)

Largest PV Power Plant in the World

850MW PV Power Plant in Golmud, Qinghai，2015-12-20

(Invested by Yellow River Power Co.)

PV + is a remarkable market in China

PV + Agriculture

PV + vegetables or flowers

PV Greenhouses

Floating PV or Fish-pool

PV at hilly Area

PV Along High-way

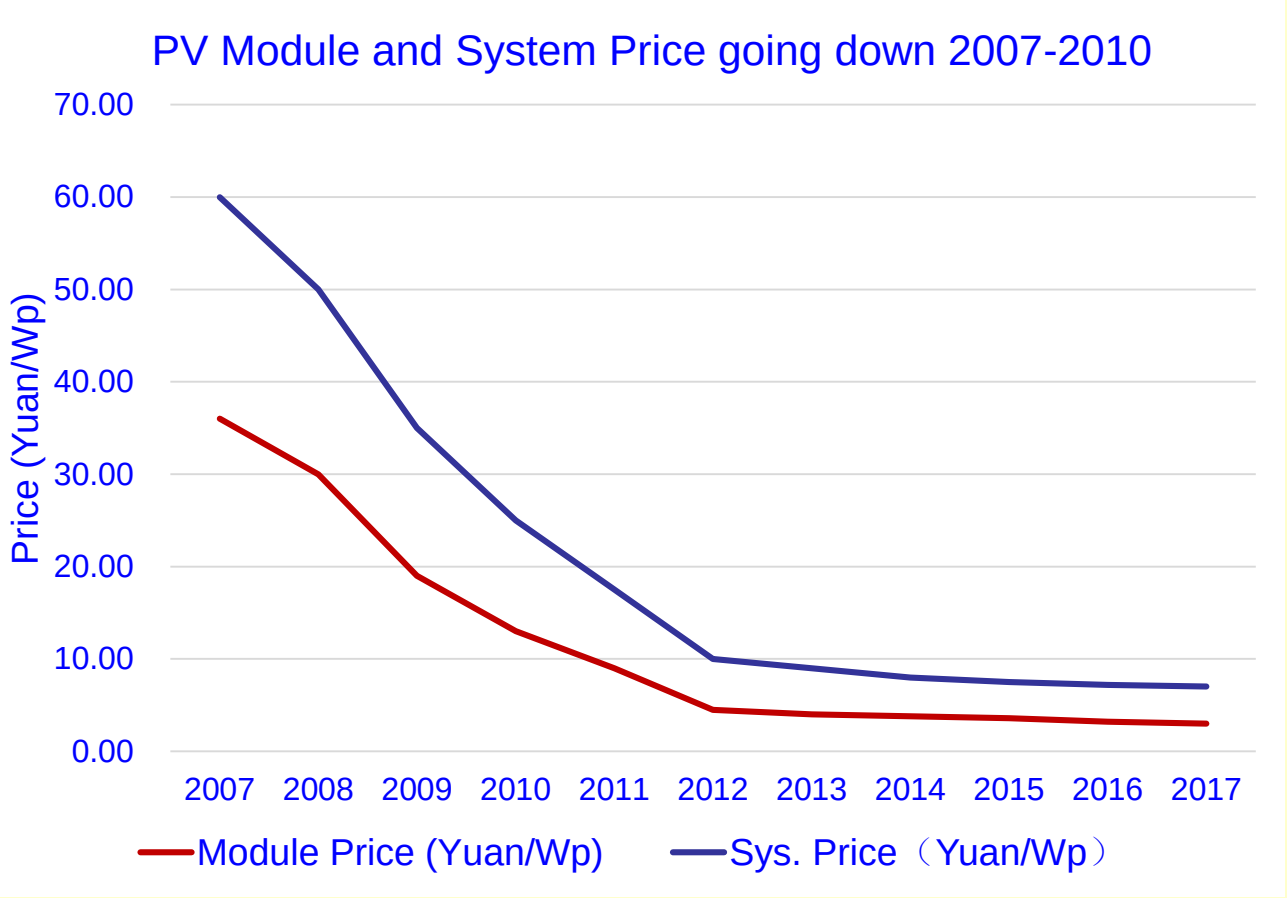
World PV Market Progress 2010-2016

Year	China	Japan	Germany	US	GB	India	Others	Annual Total（MW）
2010	520	893	7400	961	45	12	16700	16700
2011	2700	1404	7487	1855	700	172	27650	27650
2012	3560	2467	7603	3373	925	986	27979	27979
2013	10680	7042	3304	4840	1546	1004	38350	38350
2014	10640	9740	1900	6200	2200	883	41000	41000
2015	15150	10800	1463	7300	4100	2133	53000	53000
2016	**34550**	8600	1400	14762	1940	4500	73000	**73000**
Cumulative（MW）	78080	45400	40750	40362	11480	10300	76628	303000

Source：EPIA，IEA，CPIA

PV installation in China shared 47.3% of world PV market in 2016, and by the end of 2016，China cumulative PV installation shared 25.8% of the world total PV installation.

90% cost down in last 10 Years



During Last 10 Years：

- **Module price was reduced 91.6%;**
- **System price was reduced 88.3% ;**
- **Inverter price goes down 92.5% ;**
- **PV FIT goes down 81.3% ;**

Year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Cumul. Ins.（GWp）	0.10	0.14	0.30	0.80	3.50	7.06	17.74	28.38	43.53	78.08	115.00
Module Price (Yuan/Wp)	36.00	30.00	19.00	13.00	9.00	4.50	4.00	3.80	3.60	3.20	3.00
Sys. Price（Yuan/Wp）	60.00	50.00	35.00	25.00	17.50	10.00	9.00	8.00	7.50	7.20	7.00
Inverter Price（Yuan/W）	4.00	3.00	2.00	1.00	0.80	0.60	0.50	0.38	0.35	0.30	0.30
Module Lifetime（y）	20.00	20.00	25.00	25.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
PV FIT（Yuan/kWh）	4.00	Set by Bidding			1.15	1.00	1.00	0.9-1.0	0.9-1.0	0.8-0.98	0.65-0.85

Technology Innovation

Leading Runner Plan was start in 2015 to Up-grid PV Technology

Type	PV Cells	PV Modules	Market Entry		Leading Runner	
	Size of Cells (mm)	Cell Number in one Module	15.5% Efficiency（Wp）	16% Efficiency（Wp）	16.5% Efficiency（Wp）	17% Efficiency（Wp）
Multi-Si	156*156	60	255	/	270	/
	156*156	72	305	/	325	/
Mono-Si	156*156	60	/	260	/	275
	156*156	72	/	315	/	330
a-Si	All Thin-Film (TF)		Efficiency ≥ 8%		Efficiency ≥ 12%	
CIGS			Efficiency ≥ 11%		Efficiency ≥ 13%	
CdTe			Efficiency ≥ 11%		Efficiency ≥ 13%	
Other TF			Efficiency ≥ 10%		Efficiency ≥ 12%	
HCPV	500 concentrating times		Efficiency ≥ 28%		Efficiency ≥ 30%	
DC/AC Inverter	Grid-connected Inverters		Efficiency ≥ 96% with transformers;			
			Efficiency ≥ 98% without transformers.			

New Specification Requirements for Market Entry and Leading Runner 2017

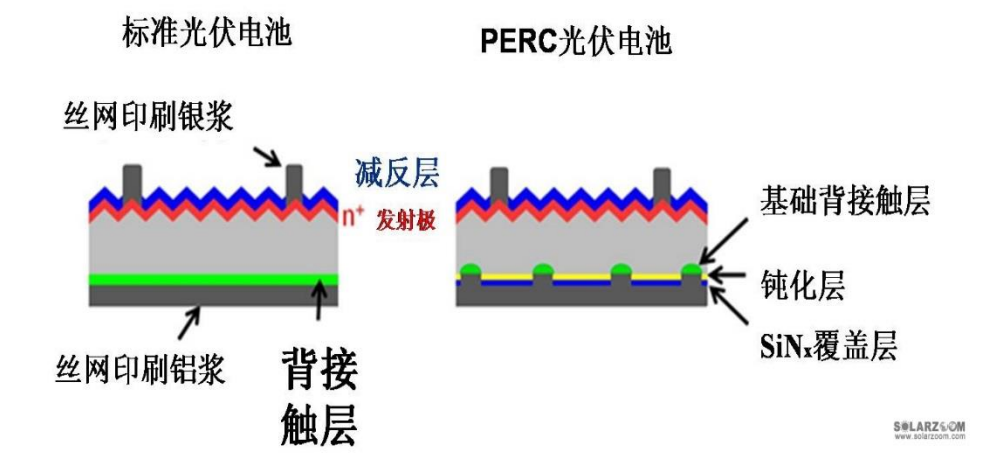
Government Announced the New Specification Requirements on July 18th,2017

Type	PV Cells	PV Modules	Market Entry		Leading Runner	
	Size of Cells (mm)	Cell Number in one Module	16.0% Efficiency（Wp）	16.8% Efficiency（Wp）	17.0% Efficiency（Wp）	17.8% Efficiency（Wp）
Multi-Si	156*156	60	265	/	280	/
Mono-Si	156*156	60	/	275	/	295
For Super-Leading Runner Plan						
Multi-Si PV Module (156x156, 60 cells) must be higher than 295 Wp; Mono-Si PV Module (156x156, 60 cells) must be higher than 310 Wp;						

PERC PV Modules are Manufactured by All First-Tier Chinese Manufacturers

P-Type Mono-PERC Module.

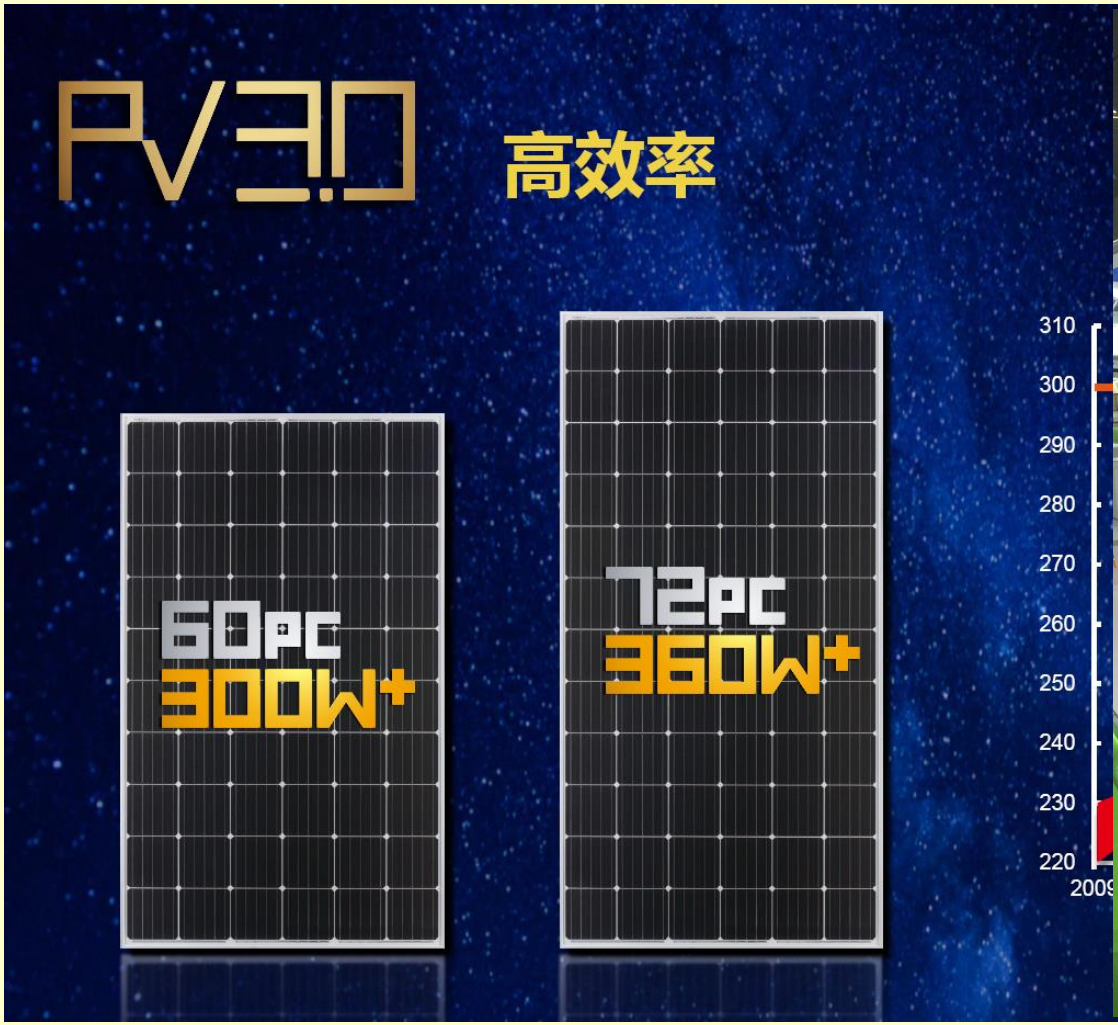
Cell efficiency 21%.



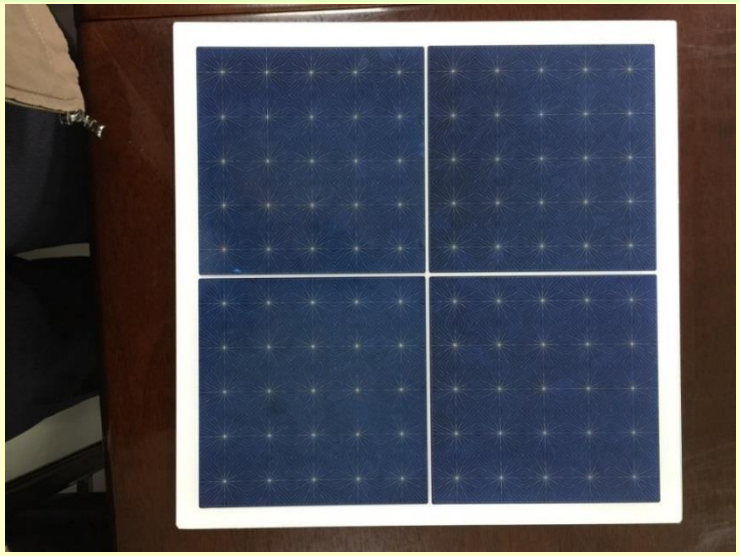
PERC is an high-efficiency and low-cost PV technology

1) The cell efficiency is higher than **21%**;
2) The module cost is now **$0.4USD/Wp**.
3) **20GW** production capacity has been reached in China.

Longji 60-Cell Mono-Si module: 325.6W ,
72-Cell Mono-Si module: 365.0W.
P-PERC-Bilateral Module > 300Wp



1GW Production Line was Built for MWT PV Module by Sunport Power



Nanjing Sunport Power developed high-efficiency MWT PV Modules：

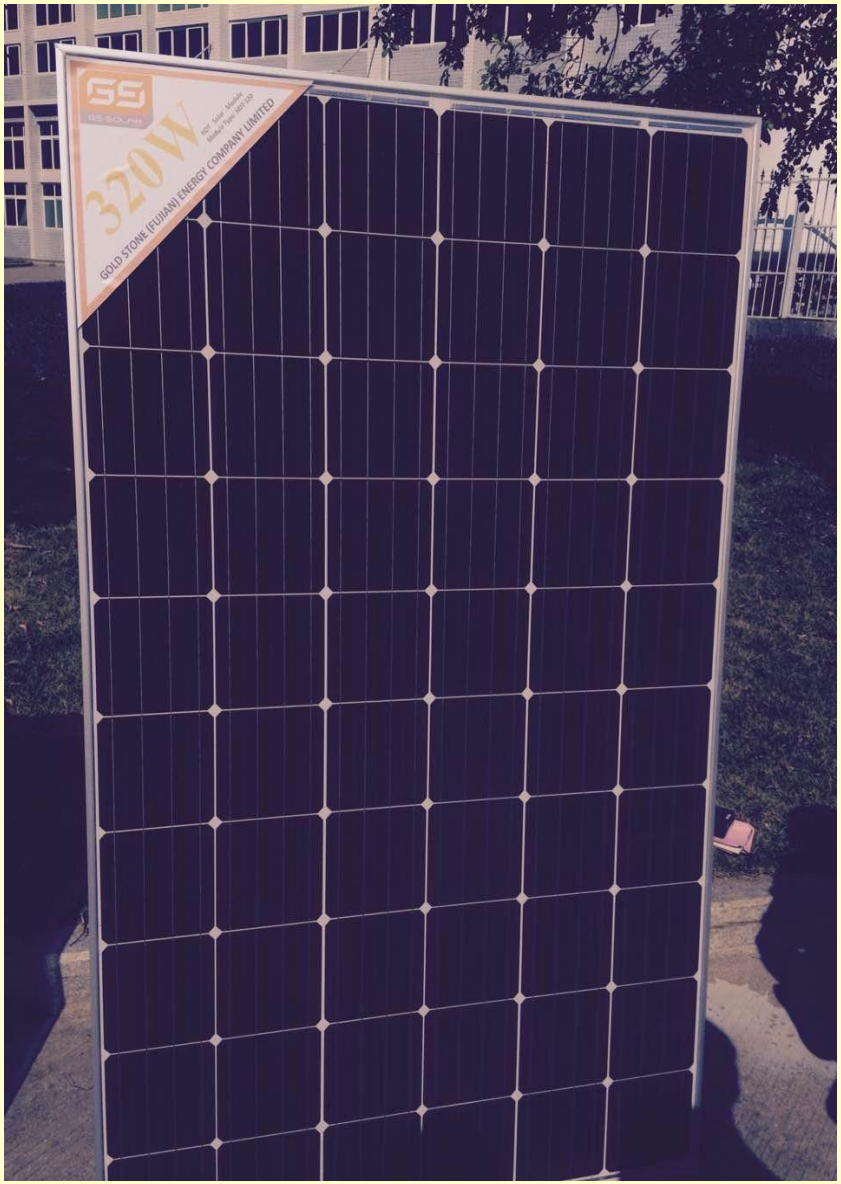
1) 20Wp higher than ordinary multi-Si PV module: for 60-156 PV module, 285Wp;
2) The cost is even lower than ordinary PV modules;
3) The thickness of the MWT cells is only 150 micro-meters.

Trina Solar IBC High-Efficiency PV Modules

Trina Solar N-type IBC PV module: Efficiency 22%

Get championship of Solar Vehicle Racing. Manufacturing capacity is now 30MW.

100MW capacity of HIT High-Efficiency PV Module Line At GS Solar, Fujian Province



GS Solar N-Type HIT Module-60 Cell-156-320 Wp ;

Efficiency＞22%

Production Line Capacity：100MW ;

Cost is = PERC Module

Innovation on System Technology to Lower LCOE

1、Increase PV-Inverter Ratio（ 10% more income and 10% lower of LCOE）；

2、Using Solar Trackers（20% - 30% more generation）；

3、Using Information technology to build intelligent monitoring and O & M System. 3%-5% more income by reducing maintenance cost and less trouble losses；

4、Increase the Performance Ratio（PR）, form 75% to 80%.

Conclusion: 40% more less of LCOE can be reached by system innovation. The grid-parity can be reached by the year 2020, PV FIT can be around 0.4 Yuan/kWh (6 US cents/kWh).

Various Type of Solar Trackers : 10%-35% More Generation

E-W Tracking

Tilted E-W Tracking

Pole-Axis Tracking

Dual-Axis Tracking

Solar-Azimuth Tracking

Manual Tracking

How can PV in China growing so fast?

Because the Incentive Policies

(The Most Important Issue)

PV Incentive Policies in China

1、”Renewable Energy Law” was issued in 2006;

2、According to “Renewable Energy Law”, the surcharge was collected since 2008 and the surcharge level from 0.2 cents/kWh, 0.4cents, 0.8 cents, 1.5 cents to today’s 1.9 cents/kWh. Now, 65 billion Yuan (10 billion USD) can be collected each year to support RE power ;

3、Since 2008, China start Feed-in Tariff policy;

4、Government sponsored market expansion and technology promotion demonstration projects: PV Buildings, Golden Sun Project, PV poverty alleviation project, Hybrids and Micro-grid demonstrations, Leading runner plan, etc.. ;

5、Supporting policies from Ministry of Finance, National Grid Company, Ministry of Land Resources, State Administration of Taxation, etc.. ;

6、Incentive policies are also issued by more than 20 provincial governments.

Feed-in Tariff and Fixed Subsidy Policies

Released by NDRC on Aug. 26, 2013：NDRC [2013] No.1638

Solar Resources	FIT for LS-PV	Self-Consumption for Distributed PV	
	FIT (Yuan/kWh)	For self-consumed PV (Yuan/kWh)	Excess PV Feed-Back to Grid (Yuan/kWh)
I	0.65 ($0.100)	Retail Price of Grid Electricity+0.42 Yuan (+ $0.068)	Whole-sell Coal-Fire Tariff + 0.42 Yuan (+$0.068)
II	0.75 ($0.115)		
III	0.85 ($0.131)		

Key Points：

（1）3 level of FIT for LS-PV based on local solar resources；

（2）For distributed PV，0.42 Yuan/kWh will be subsidized to PV electricity；

（4）Subsidy duration: 20 Years.

Why China doing so Hard to develop Solar PV?

We have to Finish the Energy Transition within next 20-30 years!

China Now is Facing Pressure in Energy Supply and GHG Emission

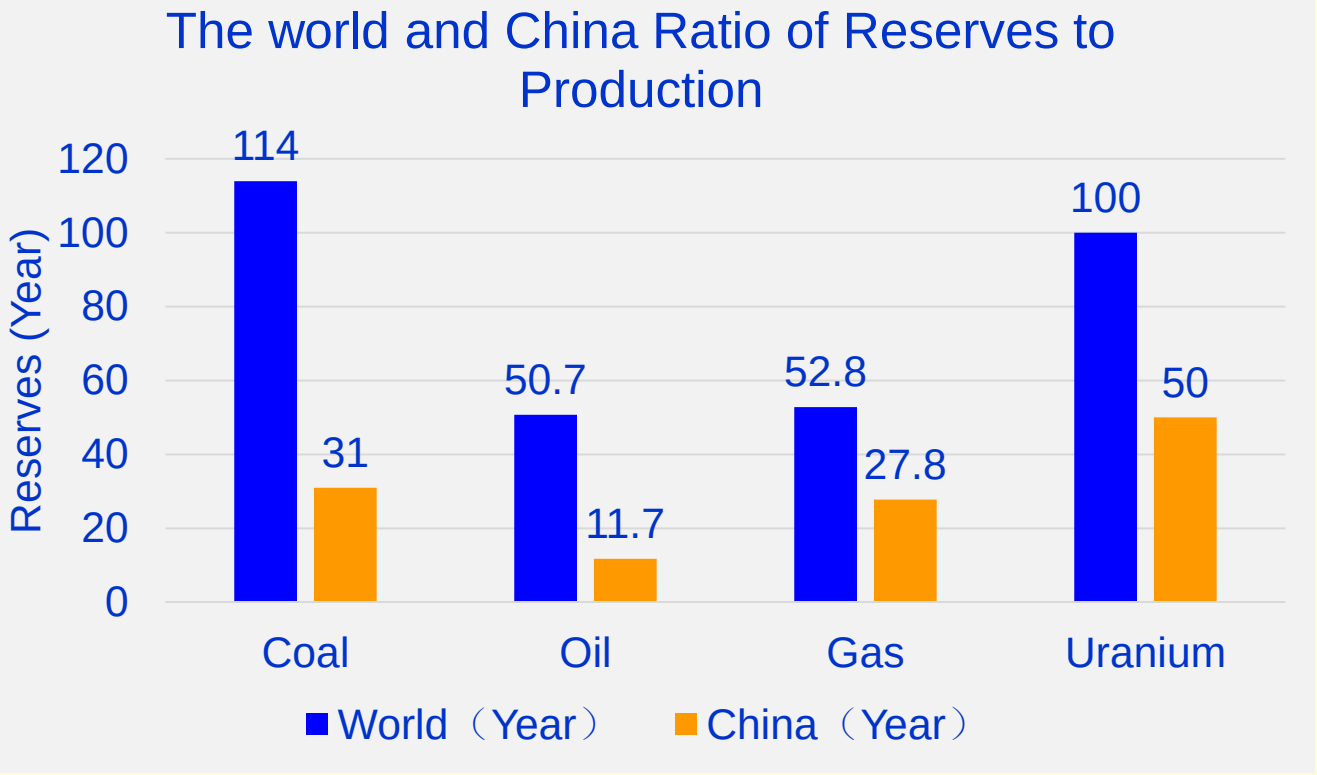
Serious Air Pollution

Dirty Fog in Beijing

China is Facing Serious Problems in Energy Supply and Air Pollution

1、The largest country in GHG emission since 2007 ;
2、The Largest country in energy consumption;
2、The largest producer and consumer of electricity ;
3、The largest importer and user of coal ;
4、The largest importer of oil and 60% of oil was imported from other countries ;
5、Serious shortage in energy supply and serious pollution in environment。

The Reserves of Traditional Energy in China is much less than World Average Level



In another 30 years ，there will be no coal, no oil and no gas in China!

China must complete the transforming of energy structure within next 20-30 years, and based on solar and other RE.

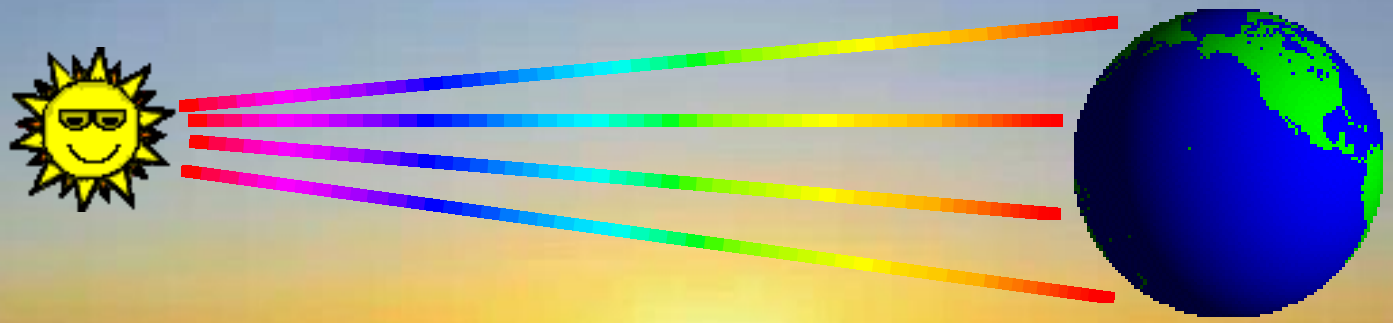
Reserves	Coal	Oil	Gas	Uranium
World	114	50.7	52.8	100
China	31	11.7	27.8	50
%	27.19	23.08	52.65	50.00

Source：BP Statistical Review of World Energy June 2016

Announced by Chinese Government in 2014

1. **Non-fossil Energy will share 15% of total energy consumption by 2020, and 20% by 2030;**
2. **Coal consumption will reach to the peak by 2020；**
3. **Primary energy consumption will reach to the peak by 2025 (4.5 billion Tce) ;**
4. **CO_2 emission will reach to the peak by 2030.**
5. **By the year of 2050, Renewable Energy will share 60% of total energy consumption.**

Year	Cumulative Installation of Solar PV (GW)
2020	200
2030	400
2040	1000
2050	2000



Thank You ! Question ?

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