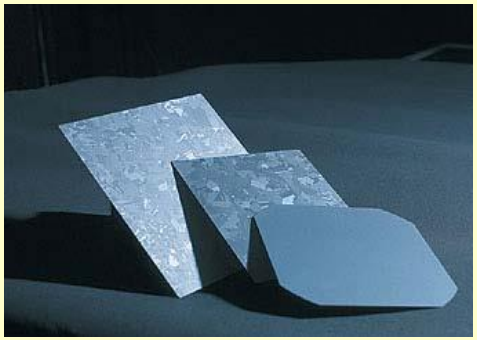
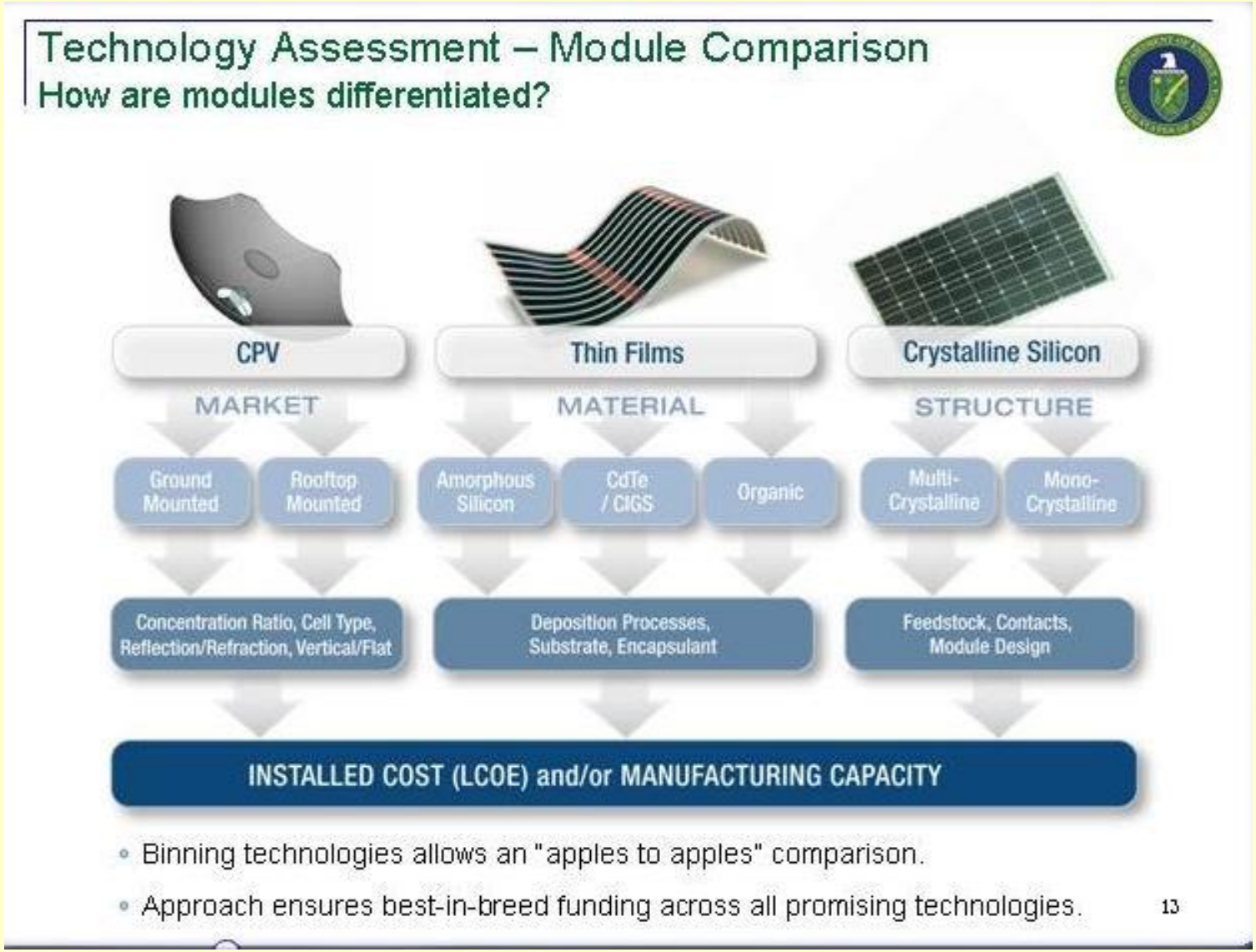
PV Industry and Technology Development in China

Wang Sicheng, ERI，NDRC

Jun. 15th, 2015, Manila

PV Technologies in China



Commercialized PV technologies are mainly 3 types.

Crystaline Silicon Solar Cells

Mono-Si Solar Cells

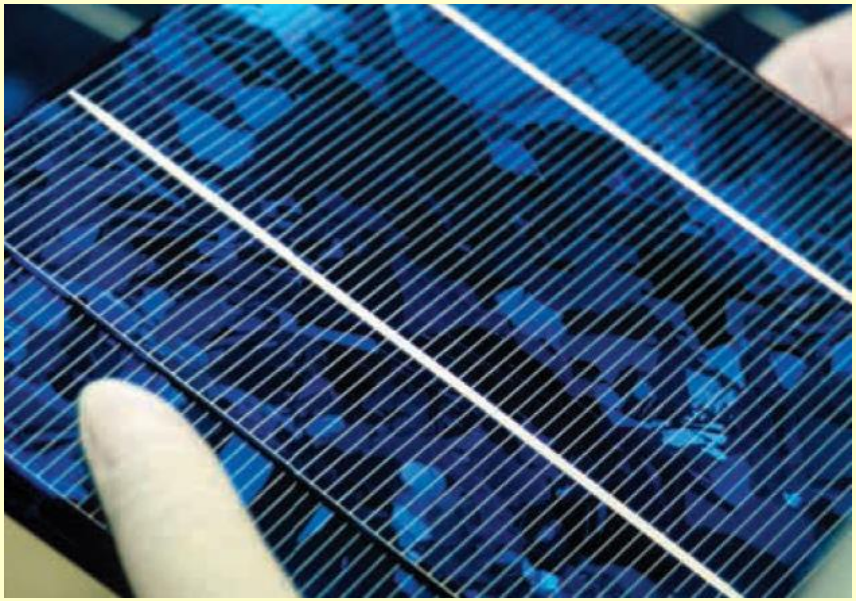
Highest Eff. In Lab.： 25.0%

Eff. of commercial cells： 18.0%

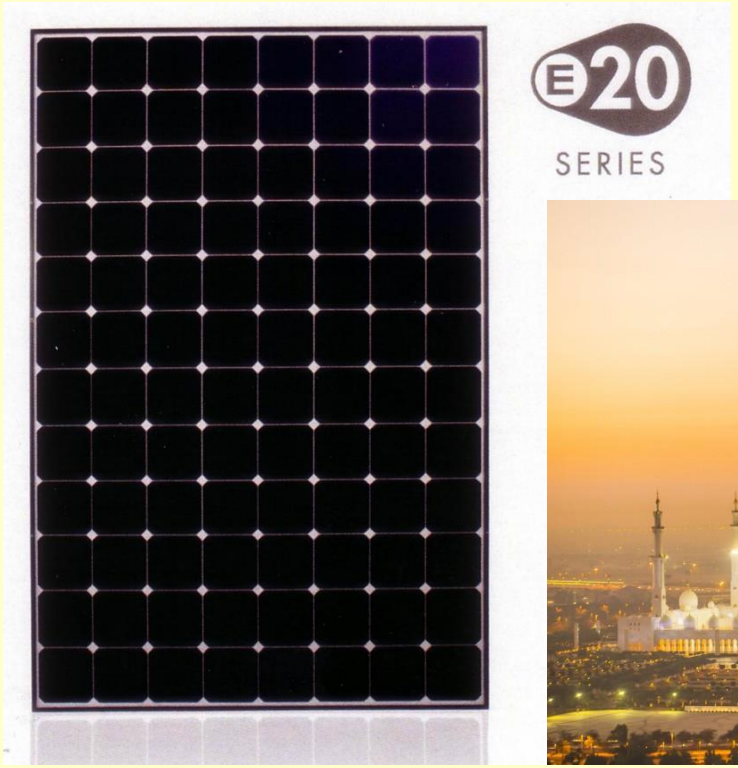
Poly-Si Solar Cells

Highest Eff. In Lab.： 20.3%

Eff. of commercial cells： 17.0%



Trina Solar Developed High Efficiency IBC PV Cells



Trina Solar's N-type IBC PV modules 21%。

SunPower's IBC PV Modules Efficiency 24%

Solar Powered Airplane: Solar Impulse 2 used SunPower's IBC PV modules.

New HIT PV Module shows at SNEC

By Inner Mongolia Clean Air Electronic Materials Co. Ltd.

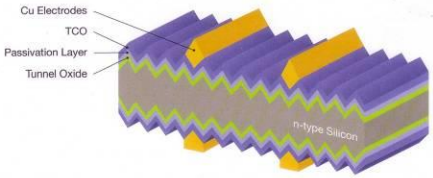
Efficiency 21.5%。

Triex™ modules utilize a hybrid cell technology which couples the best attributes of 3 different materials 1) N-type crystalline substrate, 2) Thin Film Passivation, 3) Semiconductor oxide to optimize cell and module performance while limiting costs. Silevo's breakthrough cell innovation coupled with traditional crystalline silicon (c-Si) package techniques enable Silevo's Triex modules to optimize all three performance indicators (efficiency, harvest, and cost) in order to deliver the industry's best value.

Triex 235 Watt, 18.4% Module

Triex Product Features

- **Best Performance/Cost Ratio:** Tunneling Junction cell technology with efficiencies up to 21% coupled with low cost manufacturing process optimizes end user value.
- **High Efficiency:** Total Area Module Efficiency up to 18.4% which lowers balance of system costs. Less panels, mounting structure, cabling required per given area.
- **Energy Harvest:** Tunneling Junction cell technology with -0.22%/C temperature coefficients enables up to +12% additional energy harvest in arid climates.
- **Manufactured Quality:** Highly automated advanced cell manufacturing coupled with industry proven and repeatable standard packaging techniques.



Warranties & Certification

- **10 Year Limited Product Warranty**
- **25 Year Limited Power Warranty:** 10 Year at 90% off the minimum rated power output, 25 years at 80% of the minimal rated power output.
- **IEC, UL, CEC, CE, ISO9001:** Pending TUV Rheinland Certification for IEC 61215, IEC 61730, UL 1703, TUV Safety Class II

Silevo TXRQ411-A

Silevo（Hangzhou）N-Type HIT PV Module：

- Cell Efficiency 21%；
- Module Efficiency 18.4%；
- Temperature Coff. -0.22%/℃

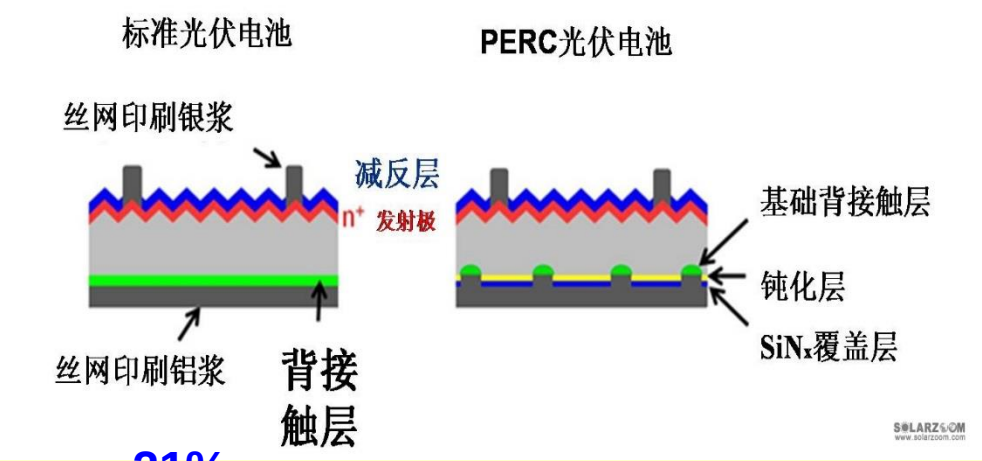
Yingli Green Energy and Canadian Solar have developed new MWT PV moduls.

Canadian Solar efficiency 21%

YGE efficiency 20.4%

Csun, JA Solar and Jinneng Solar Developed PERC PV Modules

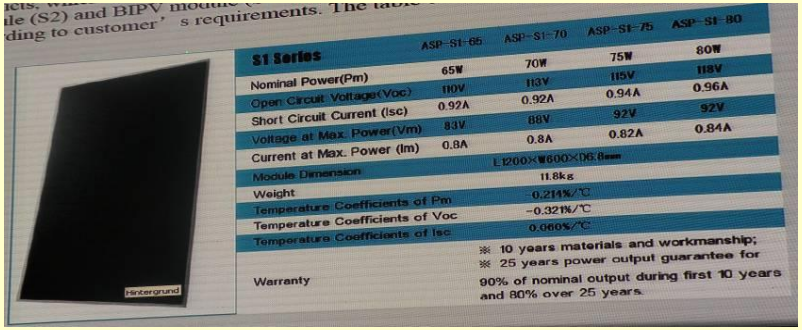
P-Type PERC Module.
Cell efficiency 21%.



21%

PERC is a P-type low-cost and high efficiency technology.
Current in China several companies are producing PERC PV modules and the cost is only around $0.6USD.

30MW CdTe manufacturing line by Advanced Solar Power (ASP)



1200 × 600 mm Standard Module，65W-80W，
Efficiency：9.0% - 11.5%
Highest：>12%。

30MW Manufacturing Line
Developed by Self. (Cost: about $0.5/Wp)

All manufacturing Facilities are developed by self

Catch-up First Solar in future?

Hanergy: the largest a-Si and CIGS Producer

8 Manufacturing base in China and total a-Si capacity 3 GW .

Hanergy has unveiled plans to add new CIGS manufacturing capacity totalling 5.25GW.

Source: Solibro/ Hanergy

Hanergy now is the largest CIGS manufacturer in the world. A 600MW production line at Caofeidian, Hebei Prov. Will be finished soon.

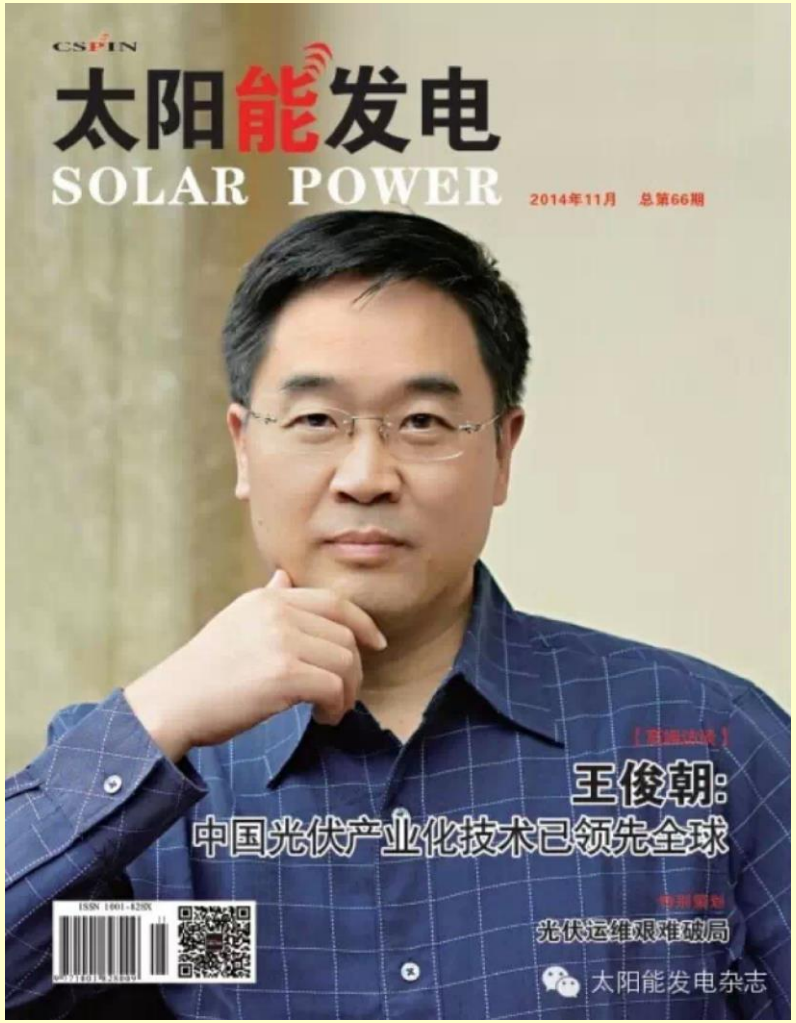
15.5% CIGS module efficiency has been reached.

Suncore Co. purchased Emcore， US Co., in 2013, and became the World Leading CPV company.

The highest efficiency of GaAs is 42.3% (500x and three junctions).

60MW in 2014

PV Manufacturing Facilities



- PV manufacturing capacity is the largest in the world ;
- PV associated materials and supporting industry are the most completed in the world ;
- PV manufacturing facilities are also catch up, not only the low-Tech equipment, but also high-Tech facilities: PECVD, multi-Si casting furnace,wire-saw machines and several aotumatic processing machines.

Different Type of Solar Trackers

East-West Tracking

Tilted East-West Tracking

Azimuth Tracking

CPV Tracking

Equatorial Tracking

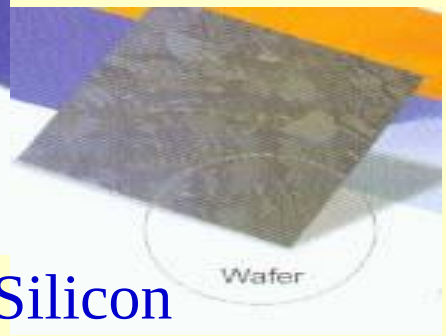
Double Axis Tracking

PV Industry in China

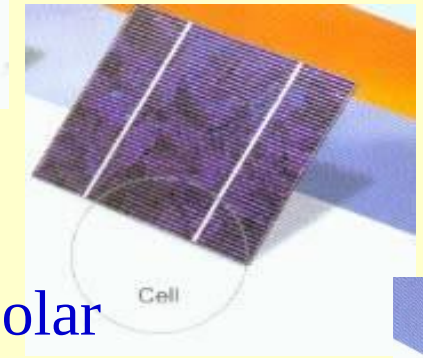
Current Situation of PV Industry in China

PV Manufacturing Chain

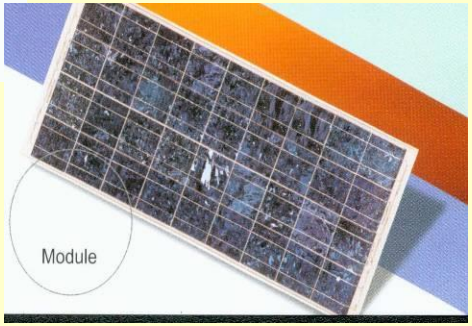
High Purely Silicon Raw Materials



Silicon Wafer



Solar Cells



Solar Modules

PV Industry in China（2014）

1. World Poly-Si production 320,000 Tons， China 138,000 Tons， shares 43%；
2. World PV wafers production 50GW， China 38GW， shares 76%；
3. World PV cells production 56GW， China 33GW， shares 59%；
4. World PV module production 50GW， China 35GW， shares 70%。

Source: China PV Industry Association（CPIA）

Poly Silicon Production in the World and China

Country	US	EU	Japan	Korea	China	Other	Total
2013 Cap.	75000	52000	25600	57000	144000	26400	380000
2013 Pro.	59000	47000	13000	40000	84000	37000	280000
2014 Cap.	75000	53000	31000	77000	158000	6000	400000
2014 Pro.	55000	51000	15000	45000	138000	16000	320000

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Year	2006	2007	2008	2009	2010	2011	2012	2013	2014
Production (Ton)	287	1093	4685	20071	45000	84000	71000	84000	136000
Capacity (Ton)	1500	5000	15000	40000	85000	160000	190000	160000	158000
Demand (Ton)	4686	10597	20400	29250	56000	134000	150000	161000	238000
Imported (Ton)	4399	9504	15715	9170	11000	50000	79000	77000	102000
Share of Import (%)	93.88	89.69	77.03	31.35	19.64	37.31	52.67	47.83	42.86

Source China PV Industry Association （**CPIA**）

Poly-Silicon Manufacturers （2014）

Company	2014 Capacity (Ton/Year)	2014 Production (Ton/Year)
GCL	68000	66800
Wacker (Germany)	52000	51000
OCI (Korea)	42000	38000
Hemlock (US)	43000	28000
REC (US)	22000	18800
TBEA Xinjiang	18000	17500
China Silicon，Luoyang	10000	9200
Tokuyama (Japan)	22000	7000
Da Quan New Energy	6500	6500
Rene Solar Sichuan	8000	5800
Total	291500	248600

Company	2014 Capacity (Ton/Year)	2014 Production (Ton/Year)
GCL	68000	66800
TBEA Xinjiang	18000	17500
China Silicon, Luoyang	10000	9200
Da Quan New Energy	6500	6500
Rene Solar Sichuan	8000	5800
South Glass, Yichang	6000	4700
ORISI Silicon Co.	5000	4450
Asia Silicon Co.	5000	4200
Shaan Xi Tianhong	3750	3000
Dun An Group	4000	3000
Total	134250	125150

Top 10 Manufacturers in the world shared 77.7% of the world total production;
Top 10 Manufacturers in China shared 90.7% of total production in China.

Source China PV Industry Association （CPIA）

Wafer Capacity and Production in China

Year	2007	2008	2009	2010	2011	2012	2013	2014	2014%
World Pro. (GW)	5.0	8.0	10.0	23.0	36.0	36.0	45.0	50.0	100.0
World Cap. (GW)	6.0	10.0	16.0	33.0	56.0	60.0	50.0	68.0	100.0
China Pro. (GW)	0.8	2.4	4.4	11.0	24.5	26.0	28.0	38.0	76.0
China Cap. (GW)	1.8	4.5	6.8	23.0	40.0	50.0	35.0	50.0	73.5

Company	Capacity MW/Year	Production MW/Year
GCL	14000	13000
Yingli	3000	2800
ReneSolar	2300	2100
Jinko	2500	2100
Longi Co.	3000	2000
LDK	3000	1700
Trina	1600	1600
Huantai Group	2000	1400
Zhonghuan Inn.	1400	1300
Jinglong	1200	1100
Total	34000	29000

Top 10 wafer manufacturers shared **76.3%** of the total wafer production in China.

Source China PV Industry Association （CPIA）

Top 15 PV Cells Manufacturers in the World and China（2014）

No.	Company	Capacity (MW)	Production (MW)
1	JA Solar	3200	3100
2	Yingli	3200	3100
3	Trina Solar	3000	2700
4	MoTech Taiwan	3000	2500
5	Hanwha SolarOne	3280	2200
6	New Sunshine Taiwan	2200	2000
7	Jinko	2000	1950
8	Gintech Taiwan	1800	1600
9	Canadian Solar	2000	1500
10	Hareon Solar	1600	1280
11	Sunpower US	1500	1250
12	Kyocela Japan	1400	1200
13	Shunfeng Int.	1500	1100
14	Sunrise Taiwan	1100	900
15	Changzhou Yijing	1000	855
	Others	38220	23065
	Total	70000	50300

No.	Company	Capacity (MW)	Production (MW)
1	JA Solar	3200	3100
2	Yingli	3200	3100
3	Trina Solar	3000	2700
4	Jinko	3000	2500
5	Canadian Solar	3280	2200
6	Harein Solar	2200	2000
7	Hanwha Jiangsu	2000	1950
8	Shunfeng Int.	1800	1600
9	Changzhou Yijing	2000	1500
10	Tongwei	1600	1280
11	Hongxi Solar	1500	1250
12	Zhongli Talesun Solar	1400	1200
13	Risen Energy Co.	1500	1100
14	Astronergy Zhejiang	1100	900
15	Motech Suzhou	1000	855
	Others	15220	5765
	Total	47000	33000

PV Cell production made in China (main land) shared 65.6% of total world PV cell production;
Top 15 manufacturers of China shared 82.5% of total PV cell production in China.

Source China PV Industry Association （CPIA）

Top 16 PV Module Manufacturers in the World and China（2014）

Company	Capacity	Production
Trina Solar	3600	3600
Yingli	4200	3400
Canadian Solar	3000	3000
JA Solar	3000	2500
Jinko	3200	2300
First Solar	2300	1846
Hanwha Solar One	2200	1700
Sharp Solar	1550	1400
Sun Power	1300	1233
Kyocera	1400	1200
REC	1000	954
Hareon Solar	1200	900
Solarworld	1230	900
Solar Frontier	980	900
ReneSolar	1200	820
Changzhou Yijing	1000	847
Others	54640	24490
Total	87000	52000

Company	Capacity	Production
Trina Solar	3600	3600
Yingli	4200	3400
Canadian Solar	3000	3000
JA Solar	3000	2500
Jinko	3200	2300
Hanwha Solar One	2200	1700
Hareon Solar	1200	900
Changzhou Yijing	1000	847
Astronergy	900	830
ReneSolar	1200	820
SunTech	1500	800
CECEP	650	610
BYD	1000	600
Risen Energy Co.	850	590
ORISI New Energy	600	570
ZNShine Solar	1000	560
Others	33900	11973
Total	63000	35600

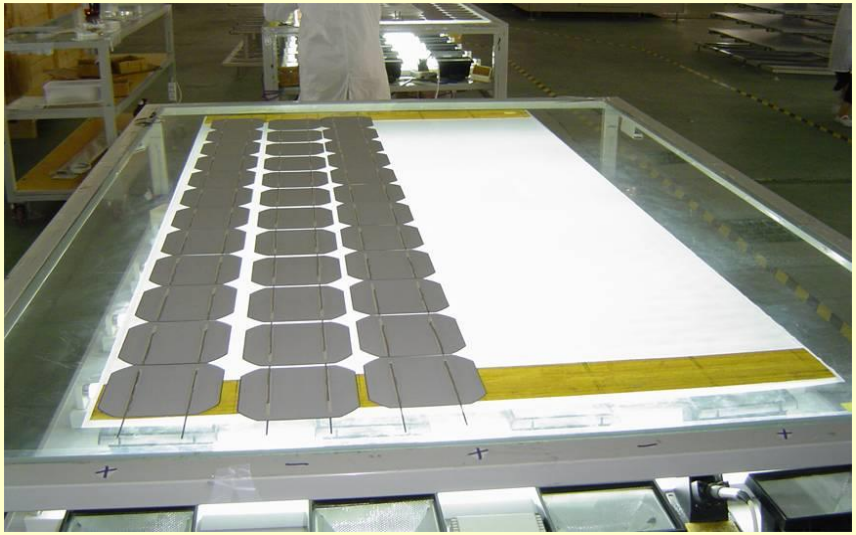
PV module production made in China (main land) shared 68.5% of total world PV module production;

Top 16 manufacturers of China shared 66.4% of total PV module production in China.

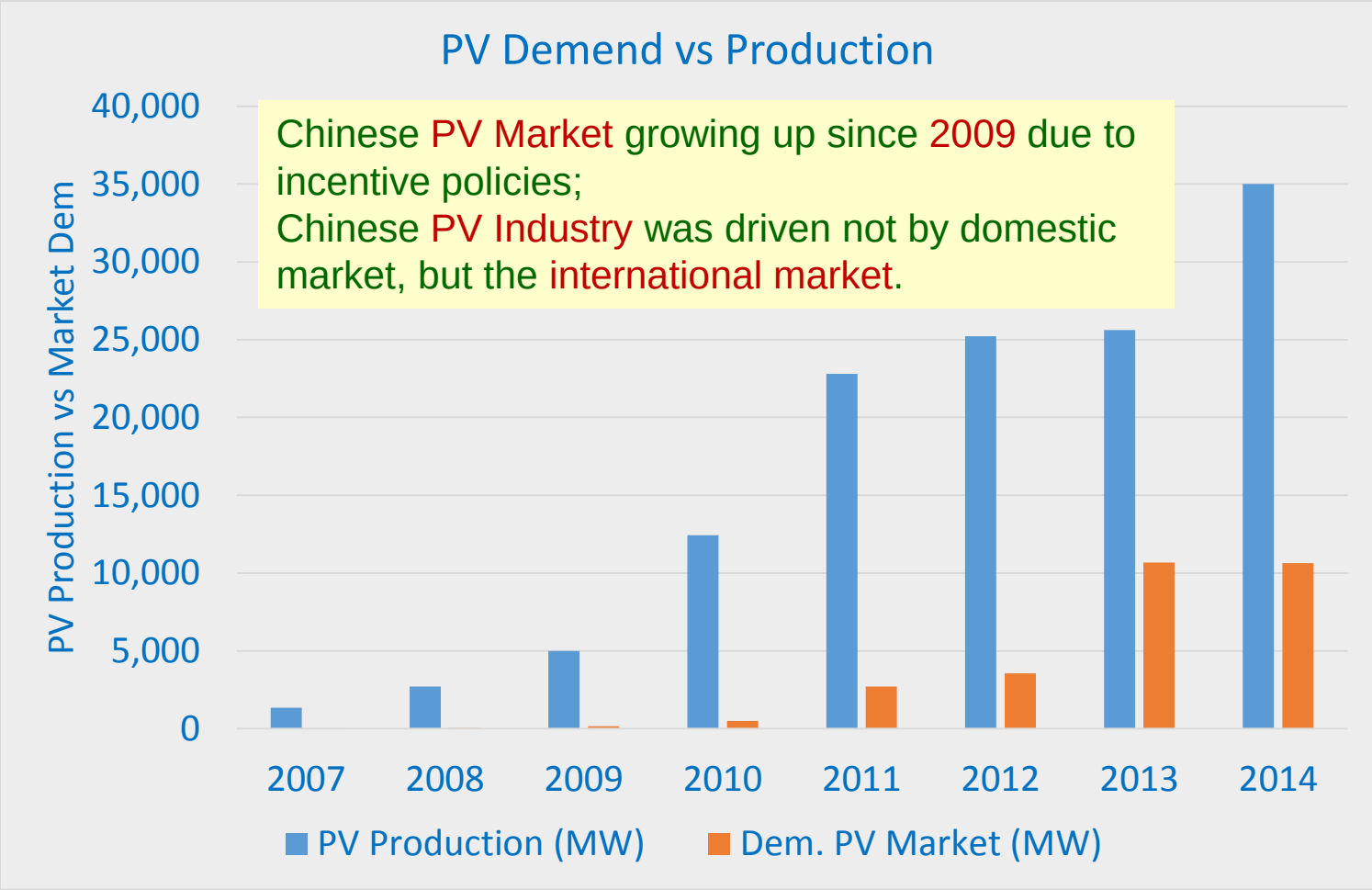
Source China PV Industry Association （CPIA）

Silicon Ingot Pullers

Solar Module Production Line



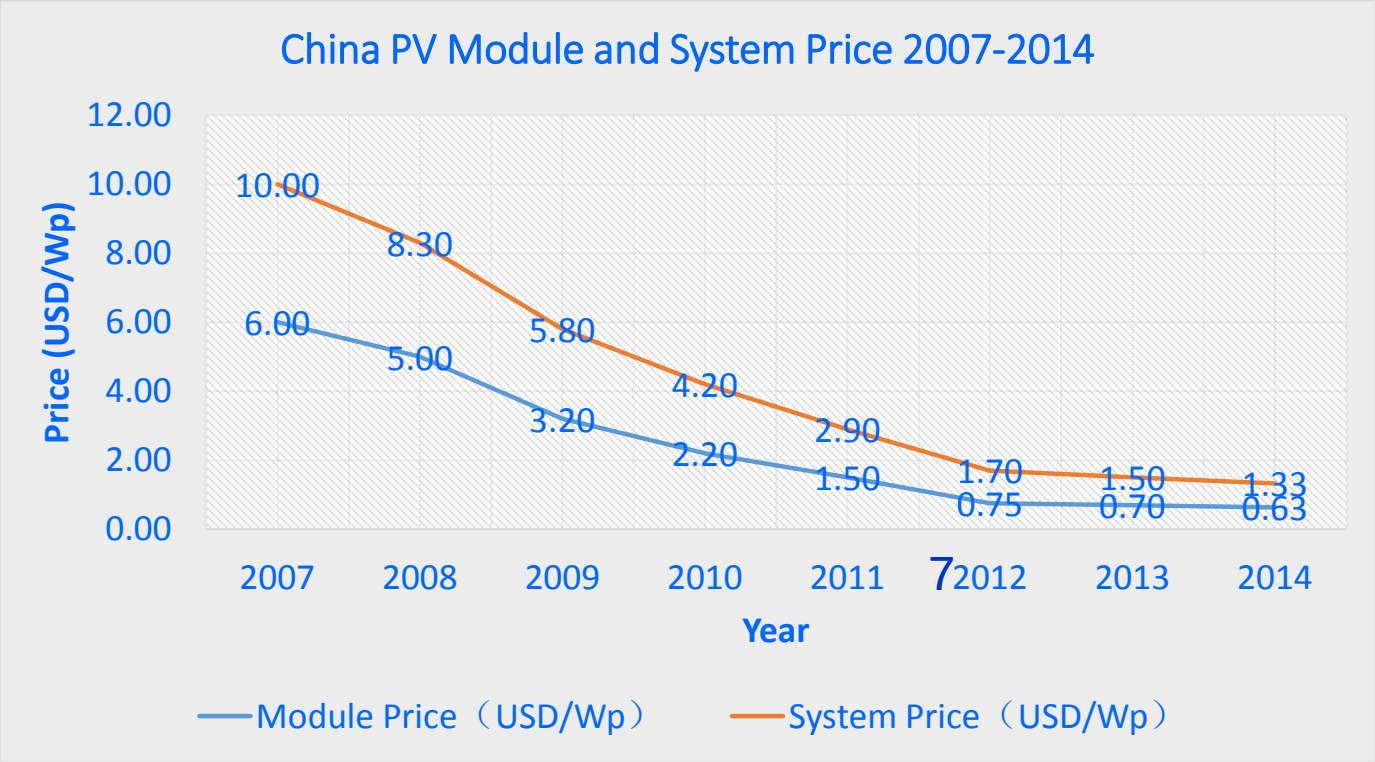
Chinese PV Industry was Driven by International Market



Year	2007	2008	2009	2010	2011	2012	2013	2014
PV Production (MW)	1,340	2,714	4,990	12,437	22,798	25,214	25,610	33,000
Dem. PV Market (MW)	20	40	160	500	2,700	3,560	10,680	10,640
Share of Export (%)	98.51	98.53	96.79	95.98	88.16	85.88	58.30	69.60

Source: NEA and CPIA

PV Module and System Price Reduction



During Last 7 Years：

- **86.4% of module price decreased;**
- **86.7% of system price decreased；**
- **76.2% of PV FIT decreased**
- **4 Yuan/kWh was set for PV in 2008 (for the 1MW PV project in Shanghai)。**

Year	2007	2008	2009	2010	2011	2012	2013	2014
Cumulative Installation (GWp)	0.10	0.14	0.30	0.80	3.20	6.70	16.28	26.84
Module Price (USD/Wp)	6.00	5.00	3.20	2.20	1.50	0.75	0.70	0.63
System Price (USD/Wp)	10.00	8.30	5.80	4.20	2.90	1.70	1.50	1.33
Feed-In Tariff of PV (Yuan/kWh)	4.0	Set through Bidding			1.15	1.00	0.9-1.0	0.9-1.0

Source: China PV Roadmap 2020,2030,2050


Thank You! Question?
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