INTERNATIONAL ENERGY AGENCY

CO-OPERATIVE PROGRAMME ON PHOTOVOLTAIC POWER SYSTEMS

Task 1

Exchange and dissemination of information on PV power systems

National Survey Report of PV Power Applications in China 2012

Final version

Prepared by

Lv Fang, Xu Honghua, Wang Sicheng

Supported by

Charlie Dou, Zhai Yonghui, Wang Yibo, Jiang Yanxing, Zhang Jia, Ma Liyun, Yang Lijuan, Tian Lu, Wang Jielu

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Definitions, Symbols and Abbreviations

For the purposes of this and all IEA PVPS National Survey Reports, the following definitions apply:

PV power system market: The market for all nationally installed (terrestrial) PV applications with a PV power capacity of 40W or more.

Installed PV power: Power delivered by a PV module or a PV array under standard test conditions (STC) – irradiance of 1000 W/m², cell junction temperature of 25℃, AM 1,5 solar spectrum – (also see 'Rated power').

Rated power: Amount of power produced by a PV module or array under STC, written as W.

PV system: Set of interconnected elements such as PV modules, inverters that convert D.C. current of the modules into A.C. current, storage batteries and all installation and control components with a PV power capacity of 40W or more.

Module manufacturer: An organisation carrying out the encapsulation in the process of the production of PV modules.

Off-grid domestic PV power system: System installed to provide power mainly to a household or village not connected to the (main) utility grid(s). Often a means to store electricity is used (most commonly lead-acid batteries). Also referred to as 'stand-alone PV power system'. Can also provide power to domestic and community users (plus some other applications) via a 'mini-grid', often as a hybrid with another source of power.

Off-grid non-domestic PV power system: System used for a variety of industrial and agricultural applications such as water pumping, remote communications, telecommunication relays, safety and protection devices, etc. that are not connected to the utility grid. Usually a means to store electricity is used. Also referred to as 'stand-alone PV power system'.

Grid-connected distributed PV power system: System installed to provide power to a grid -connected customer or directly to the electricity grid (specifically where that part of the electricity grid is configured to supply power to a number of customers rather than to provide a bulk transport function). Such systems may be on or integrated into the customer's premises often on the demand side of the electricity meter, on public and commercial buildings, or simply in the built environment on motorway sound barriers etc. They may be specifically designed for support of the utility distributed power generation. Size is not a determining feature – while a 1 MW PV system on a rooftop may be large by PV standards, this is not the case for other forms of distributed generation.

Grid-connected centralized PV power system: Power production system performing the function of a centralized power station. The power supplied by such a system is not associated with a particular electricity customer, and the system is not located to specifically perform functions on the electricity grid other than the supply of bulk power. Typically ground mounted and functioning independently of any nearby development.

BIPV: BIPV is defined as building-integrated PV, which requires that the building team along the

entire supply chain - including architects, building designers, engineers, building owners and utility companies - work together to design and build the special designed PV modules into the building's very "skin" as an element, from the inception of the project onwards, which particularly stands for the adopting of solar building material, such as solar tiles, solar façade and shingles.

BAPV: BAPV is defined as building-attached PV. In this process, the photovoltaics are a retrofit, the normal PV modules are used and not necessary to use special designed PV module, simply added to the new built or existing buildings.

NDRC: China National Development and Reform Commission

FYP: China Five-Year Plan

CPIA: China Photovoltaic Industry Alliance

Turnkey price: Price of an installed PV system excluding VAT/TVA/sales taxes, operation and maintenance costs but including installation costs. For an off-grid PV system, the prices associated with storage battery maintenance/replacement are excluded. If additional costs are incurred for reasons not directly related to the PV system, these should be excluded. (E.g. If extra costs are incurred fitting PV modules to a factory roof because special precautions are required to avoid disrupting production, these extra costs should not be included. Equally, additional transport costs for installing a telecommunication system in a remote area are to be excluded).

Field Test Programme: A programme to test the performance of PV systems/components in real conditions.

Demonstration Programme: A programme to demonstrate the operation of PV systems and their application to potential users/owners.

Market deployment initiative: Initiatives to encourage the market deployment of PV through the use of market instruments such as green pricing, rate based incentives etc. These may be implemented by government, the finance industry, utilities etc.

Final annual yield: Total PV energy delivered to the load during the year per kW of power installed.

Performance ratio: Ratio of the final annual (monthly, daily) yield to the reference annual (monthly, daily) yield, where the reference annual (monthly, daily) yield is the theoretical annual (monthly, daily) available energy per kW of installed PV power.

Currency: The currency unit used throughout this report is EUR

RES: Renewable Energy Sources

PV support measures:

Feed-in tariff: an explicit monetary reward is provided for producing PV electricity; paid (usually by the electricity utility business) at a rate per kWh somewhat higher than the retail electricity rates being paid by the customer;
Capital subsidies: direct financial subsidies aimed at tackling the up-front cost barrier, either for specific equipment or total installed PV system cost

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 23 member countries. The European Commission also participates in the work of the Agency.

The IEA Photovoltaic Power Systems 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 21 participating countries are Australia (AUS), Austria (AUT), Canada (CAN), Denmark (DNK), France (FRA), Germany (DEU), Israel (ISR), Italy (ITA), Japan (JPN), Korea (KOR), Malaysia (MYS), Mexico (MEX), the Netherlands (NLD), Norway (NOR), Portugal (PRT), Spain (ESP), Sweden (SWE), Switzerland (CHE), Turkey (TUR), the United Kingdom (GBR) and the United States of America (USA). The European Commission, the European Photovoltaic Industry Association and the US Solar Electric Power Association are also members.

The overall programme is headed by an Executive Committee composed of one representative from each participating country, 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 facilitate the exchange and dissemination of information on the technical, economic, environmental and social aspects of photovoltaic power systems. 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 China National Survey Report for the year 2012. 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.

1 Executive summary

In 2012, the annual PV installed capacity in China was 3.5GW, cumulated 7GW in total.

1) Domestic market raising

In 2012, the PV domestic was not developed as expected. The total annual installation of PV approached 3.5GW, 40% increasing than previous year. In 2012, the annual PV installed capacity in China was 3.5GW, cumulated 7GW in total; the electricity generated by PV was 9.8TWh.

2) PV technology is continual developing, production cost is continual reducing

Currently China PV industry has completely mastered the key production technologies of poly-silicon cell. The conversion rate of mono-crystal approached 17.5% and poly-crystal 16.6%. The production cost is continuously reducing, by the end of 2012, the production cost had been dropped down to <$0.6/Wp for major manufacturers.

3) Localization of the production equipment manufacturing and related materials

Mono-crystal furnace, poly-crystal casting furnace, laminating machine and so on, all can be made in China with large production scale. These domestic made equipments now have significant market share in China. The localization level of the PV related materials are increasing. PV standards, certification and testing regulation have been established.

4) Industry scale is continual growing, investment is continual increasing

The amount of exports of solar cell in China was 18GW, 12.5% increased compared with previous year, the export value of solar cell was US$12.7 billion, 43.8% decreased compared with previous year, the import value of solar cell was US$1.28billion, 36% decreased compared with previous year. In 2012, Chinese poly-silicon production capacity was 71,000 tons, decreased 15% than last year. It accounts for about 30% of global poly-silicon yield. The amount of poly-silicon imports was 82700 tons, increased 28% than last year. 2012, China's poly-silicon yield was 71,000 tons, the 1st producer in the world.

5) Retail price is dropping, stress to business operation is gradually increasing

Losses incurred at various levels in major PV manufacturers in China. The situation at middle and small businesses are even much poor. Based upon the survey made by CPIA, more than 80% of poly-silicon manufacturers were stop production, a widespread loss in the cell and module manufacture, more than 50% of middle/small PV module manufacturers were stop production, the production scale of 30% of the PV businesses were largely reduced. Many employees have been laid off.

1.1 Installed PV power

The domestic PV system market in 2012 showed an increase compared to 2011. In 2012, off-grid and grid connected PV systems with a total PV power of 3500 MW have been installed, which represents a 40% growth of the domestic market compared to the Year 2011. The cumulated total installed PV reaches 7,000 MW by the end of 2012.

Grid-tied applications more and more dominated the market for PV in 2012, with grid-connected

systems (GCS) accounting for about 3460MWp of the total installed capacity in 2012, which represents 98.9%of the total installation. In 2012 only a cumulated 40MWp were installed for rural electrification and off-grid industrial applications.

1.2 Costs & prices

In 2012, 83.3% system price has fallen down from 2007, system prices for installed PV systems in China again dropped compared to the previous years. The reduction was 43%. In 2012 average system price for typical grid-tied systems is RMB 10Yuan/Wp, about 1.25 EUR/Wp.

86.6% of PV module price has been reduced during last 6 years. It was RMB 36 Yuan/Wp in 2007, and by 2012, it was RMB 4.5 Yuan/Wp. The lowest retail price once dropped down to RMB 3.5 Yuan/W (US$0.56) in 2012. The manufacturing cost of solar cell processing stage reached RMB 0.93/W (US$0.15).

1.3 PV production

Global solar cell production capacity in 2012 was more than 70GW. In the top 15 world-leading solar cell manufacturers, China mainland occupied 9 seats; Taiwan occupied 3 seats, compare to Year 2006, the top 15 world leading solar cell manufacturers, China mainland occupied 4 seats, Taiwan occupied 1 seat. In China, the production capacity of top 10 Chinese solar cell manufacturers was about 18.66 GW, and annual yield in 2012 was 11.98GW.

Total production capacity of top 10 module manufacturers in China was 16.9GW, and annual yield in 2012 was 12.18GW The total delivered PV modules made in China was 23GW in 2012, 9.5% increased compared with last year, contributed 61.8% of global outputs. The gross output value of PV industry was more than RMB 300 billion Yuan (~37.5billion BEUR).

1.4 Budgets for PV

The China RE Law was effect on 1st Jan., 2006 to support RE and has been updated in 2009. Based on RE Law, there are two funds can be used to support RE. One of the fund is the RE Surcharge collected from all end users of electricity at the rate of 0.8 cents/kWh and about RMB 20-25 billion Yuan will be collected each year, the other is Special RE Fund directly controlled by Ministry of Finance, about RMB 10-20 billion Yuan available each year. Currently, RE Surcharge is used to subsidize electricity generated by RE (PV, wind power and biomass power) through the way of Feed-In Tariff (FIT) and the Special RE Fund is used to support government sponsored projects:

PV Building Project and Golden-Sun Demonstration: Initial investment subsidy (50%-70%), allows self-generation and self-consumption. From 2009 to 2012, two utility-scale PV station phases were approved, total approved capacity was 4,300MW，800MW is waiting for grid-connected. PV Building Project approved capacity was 500MW. In April, 2012, according to the 'Notice of Work on Golden Sun Demonstration Project', the subsidy for customer side is RMB5.5Yuan/w.

Golden Sun/PV Building combined: approved 2,830MW in 2012. In May 2012, Ministry of Finance combined with Ministry of Housing and Urban Rural Development informed, for BIPV, the subsidy was RMB 7Yuan/w, for BAPV, subsidy was RMB 5.5Yuan/w, The status of government supported projects is listed in the follow tables:

Table 1: Government Sponsored PV Projects

Utility-scale PV		
Phases	Approved Capacity	Feed-in Tariff (RMB)
2011 FIT	2000MW	FIT = 1.15 Yuan/kWh
2012 FIT	2000MW	FIT = 1.0 Yuan/kWh
Total（2009 - 2012）	4300MW	800MW waiting for grid connection
Financial Source	**Renewable Energy Surcharge**	
PV Building Project		
Phases	Approved Capacity	Subsidy to Capital（Yuan/W)
3rd phase, 2011	106 projects，120MW	BIPV 12 Yuan /W
4th phase, 2012	250MW	BIPV 9 Yuan /W, BAPV 7.5 Yuan /W
Total（2009 - 2012）	500MW	
Financial Source	**Special Fund for Renewable Energy**	
Golden Sun Demonstration		
Phases	Approved Capacity	Subsidy to Capital（Yuan/W)
3rd Phase 2011	140 projects，690MW	C-Si 9.0 Yuan /W, a-Si 8.5 Yuan /W
4th Phase 2012	167 projects, 1709MW	PV Building 5.5 Yuan /W， off-grid >7.0 Yuan /W
Total（2009 - 2012）	2870MW	
Financial Source	**Special Fund for Renewable Energy**	
Additional PV Building Project and Golden-Sun Demonstration		
Nov. 2012	2830MW	BIPV 7 Yuan /W, BAPV 5.5 Yuan /W
Financial Source	**Special Fund for Renewable Energy**	
Total Installed and Approved PV by the end of 2012 is 10500MW		

Source: Wang Sicheng, 2013

Ministry of Science and Technology (MOST) is the government unit in charge of R&D of PV. Average annual investment for R&D from MOST is about 500 million Yuan and the supporting fields cover all manufacture chain: poly-Si, wafer, solar cells, PV modules, thin-film technology, CPV, energy storage, BOS components and system engineering (Annual report of China, 2012).

2 Implementation of PV systems

The PV power system market is defined as the market of all nationally installed (terrestrial) PV applications with a PV capacity of 40W or more. A PV system consists of modules, inverters, batteries and all installation and control components for modules, inverters and batteries.

For the purposes of this report, PV installations are included in the 2012 statistics if the PV modules were installed between 2012-1-1 and 2012-12-31 although commissioning may have taken place at a later date.

2.1 Applications for photovoltaic

Since 2008, the utility-scale grid-connected PV power station has been developing in China, which becomes the dominant role of PV application.

Recent years, PV has been applied to building construction, which includes building integrated PV application (BIPV) and Building attached PV (BAPV). Building related PV receives strongly support from the government, this plays more and more important role in solar market.

From 2012, due to policy support and incentives, grid-tied distributed generation (DG) began to develop fast. In May 25th, 2012, NEA published "The Notice of Application and Approval of New Energy City and Industrial Park" with the target of 100 New Energy Cities and 1000 industrial parks. In Aug. 6th, 2012, NEA published "The Twelfth Five-year Plan of Renewable Energy Development" with the increased target of PV from 15GW to 21GW focus on distributed PV market. In Sept 14th, 2012, NEA published "The Notice of Distributed PV Demonstration Project Application and Approval" with the first-phase target of 15 GW. The following table shows the broad distributed PV power generation systems.

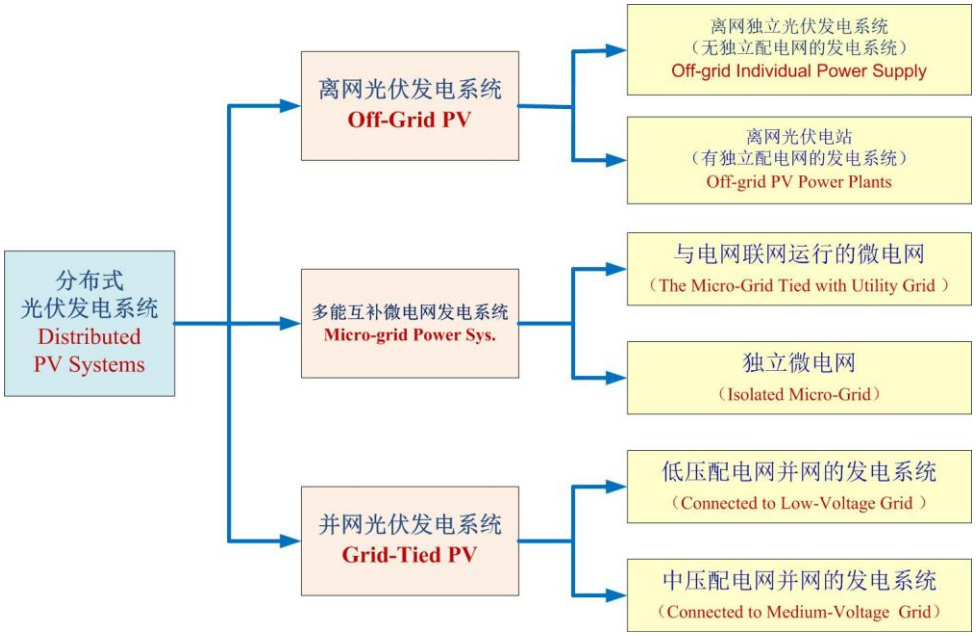


Figure 1: Broad Distributed PV Power Generations System

Three parts shall be considered by the government subsidies and policy support:

1）Power and micro-grid constructions in the un-electrified area: Rural power stations, household power supply, multi-hybrid power generation systems and micro-grid. Off-grid and micro-grid PV systems are also under the category of distributed PV power generation;

2）BIPV systems in city, grid-connected in the medium and low voltage distributed grid-tied(10kV and below), self-consumption, surplus feeding into the grid: Building Integrated Photovoltaic System and Building Attached Photovoltaic System.

3) In the power transmission side (35kV or more) and utility-scale PV power station: desert PV power station, open land PV station, beaches PV stations and so on.

2.2 Total photovoltaic power installed

The domestic PV system market in 2012 showed a significant increase compared to 2011. In 2012, off-grid and grid connected PV systems with a total PV power of 3500 MWp have been installed, which represents a 40% growth of the domestic market compared to the year 2011. The cumulated total installed PV in China reaches 7,000 MWp by the end of 2012 (Wang, 2013).

Grid-tied applications more and more dominated the market for PV in 2012, with grid-connected systems (GCS) accounting for about 3460MWp of the total installed capacity in 2012, which represents 98.9% of the total installation (Wang, 2013).

During the recent past years, the off-grid sector plays a minor role in China PV market. In 2012 only a cumulated 40MWp were installed in this sector for rural electrification and off-grid industrial applications. Table 2 shows the PV power installed in five sub-markets during 2012.

Table 2: PV power installed during calendar year 2012 in five market sectors

2012 Domestic PV Market by Sectors			
No.	**Market Sector**	**Annu.Ins.**	**Share**
		（MWp)	（%）
1	Rural Electrification	20	0.57
2	Communication&& Industry	10	0.29
3	PV Products	10	0.29
4	BIPV & BAPV	1460	41.71
5	LS[1]-PV	2000	57.14
	Total	3500	100.00

Source: Wang Sicheng, 2013

A summary of the cumulated installed PV Power, from 2000-2012, broken down into five market sectors is shown in Table 3.

[1] "Large scale" stands for utility-scale.

Table 3: The cumulative installed PV power in five sub-markets[2]

Year	Rural electrification	Telecom and Industry	Distributed Generation	Building related PV	LS-PV	Annual Inst.	Cumulated Inst.
	(MWp)	(MWp)	(MWp)	(MWp)	(MWp)	(MWp)	(MWp)
2000	2.00	0.80	0.20	0.00	0.00	3.00	19.00
2001	2.50	1.50	0.50	0.01	0.00	4.50	23.50
2002	15.00	2.00	1.50	0.01	0.00	18.50	42.00
2003	6.00	3.00	1.00	0.07	0.00	10.00	52.00
2004	4.00	2.80	2.00	1.20	0.00	10.00	62.00
2005	2.00	2.90	1.50	1.30	0.20	8.00	70.00
2006	3.00	2.00	4.00	1.00	0.00	10.00	80.00
2007	8.50	3.30	6.00	2.00	0.20	20.00	100.00
2008	4.00	5.00	20.50	10.00	0.50	40.00	140.00
2009	9.80	2.00	6.00	34.20	108.00	160.00	300.00
2010	15.00	6.00	6.00	190.00	283.00	500.00	800.00
2011	10.00	5.00	5.00	480.00	2000.00	2500.00	3300.00
2012	20.00	10.00	10.00	1460.00	2000.00	3500.00	7000.00
SubT	102.00	56.00	70.00	2380.00	4392.00		7000.00

Source: Wang Sicheng, 2013

2.3 PV implementation highlights, major projects, demonstration and field test programs

In 2012, utility-scale desert PV station faced long distance transmission and less local consumption problems. So in 2012, utility-scale dessert PV station was installed about 2GW, a stable development compare to 2011(2GW also in 2011).

However in 2012, distributed PV power generation has a rapidly development, by the end of 2012, the cumulated installation capacity of distributed PV power generation projects was about 3775MWp[3] in China's 32 provinces, about 3166.5 MWp was increased than last year.

Most of installation distributed PV power generation projects were the PV Building Projects and Golden Sun Demonstrations, the cumulated installation capacity of Golden Sun Demonstration was 3044MWp, PV Building Project was 525MWp, and other distributed power generation project was 206MWp.

Count for the PV installed capacity, Jiangsu，Shandong，and Guangdong are the top 3 provinces，were 591MWp、283MWp and 276MWp, which took market share of 15.65%、7.51%、7.3% (CGC, 2012).

[2]Before 2000, the total installed PV capacity was about 16MWp. This has been reflected in the cumulated installation in year 2000, but not to be included in the breakdown sectors.

[3]Until 2012, the cumulated distributed PV generation was 3775MW, include Golden Sun Demonstrations, and PV Building Projects, and other distributed PV projects in total was 3775MW. It came from the statistics by China General Certificate Center, which is work for the project acceptance and examination of Golden Sun Demonstrations and PV Building Projects But Wang Sicheng in the table 1 accounted for the cumulated distributed PV generation from only 2009-2012, Golden Sun was 2870 MW added to PV Building 500MW. So it was 3370MW, and less than 3775MW (by CGC). Different count years lead to the different results.

In 2012, China has done a lot of research work in the areas of promoting of PV testing, power performance and component reliability test, mainly for the sustainable operation and quality inspection standards research of PV power generation system：

（1）Detection and analysis of the photovoltaic system. Recently, China has developed the plans to carry out experiments to exam the similar photovoltaic power plants but installed in different regions, so as to analyze of variations in the relationship between the PV array installed angle and power generation.

（2）Analysis of PV modules and reliable performance. In the field of reliability test of the photovoltaic components and crystalline silicon PV module, China is focusing on the utility-scale application of the reliability analysis. Summarizing the results from domestic photovoltaic labs in recent years, it indicates the failure rates of crystalline silicon PV modules and thin film photovoltaic components decline (down from over 50% in 2007 to 14% in 2011). The main test shows the cause leads to failure of PV module performance is the environmental test (humidity-freeze test, damp-heat test, thermal cycling test). Failures include serious visual defects of PV modules, power attenuation and wet insulation characteristics of decline.

To develop the further study of photovoltaic module reliability test methods, Institute of electrical engineering, Chinese Academy of Sciences plans to develop the environment test, mechanical stress test method for crystalline silicon and thin film assembly. For example, through the strict test, the thermal cycling test and damp heat test can reflect the relationship between power attenuation and its reliability and durability of the PV module, so as to develop the different reliability test methods for different types of PV modules.

2.4 Highlights of R&D

1. Current situation of R&D

1) PV cell technology

(1) Silicon PV cell

At the present, average conversion efficiency of monocrystal and polycrystalline silicon solar cell industrialization is 18.3% and 17.1% in China. The manufacturers are continuously exploring the technologies, such as back contacts solar cell technology, bifacial solar cell technology, module front-panel glass de-reflection technology, module front-panel glass reduced-film technology, no-border module. It has been an agreement over increasing the conversion efficiency of module and reducing cost of manufacture.

Now, many manufacturers of crystalline silicon solar cell are increasing the production lines of high efficiency crystalline silicon cell. Some manufacturers, such us "Suntech" has researched a "Pluto" monocrystal silicon solar cell, its conversion efficiency has been up to 20.3%. The conversion efficiency of other solar cell has yet been 19%, such as "Panda" by Yingli solar, "Honey" by Trina Solar, "SECIUM" by JA Solar, "ELPS" by Canadian Solar. The manufacturers are using the technology of high efficiency polycrystalline silicon cell and the conversion efficiency in laboratory has been up to 19% and efficiency of mass production to 17.5%. Up to now, 15% of the solar cell produced is high efficiency crystalline silicon cell and may be up to 30% by 2015.

Because of the improving of conversion efficiency with a limited extent and increasing of industrialization production cost, new-type high efficiency solar cell technologies, such as "SE ", "PERC " and "MWT", haven't been applied in utility-scale, instead of improved metallic slurry thin grid line printing technology. Many leading manufactures of solar cell and module are cooperating with leading suppliers of material and equipment to research new technologies, new production methods, or to try out new technologies and new equipments by caution. Although, there are not considerable results released, but the investment of technology improvement by manufactures is continuing.

(2) Thin-film PV cell

Now, the industrialized production of thin-film solar cell is mainly concentrated on silicon base film, and other technical routes are covered but the product capacity is limited.

Silicon-base film solar cell: Driven by rush international research of silicon-base film solar cell, a lot of organizations are smoothly cooperation and joint efforts with each other and excellent achievements have been gotten, of which have strode into the world's advanced ranks, for example, the conversion efficiency of "micromorph" tandem solar cell with surface area of 0.25cm^2, is up to 11.8%, has been developed by Nankai university

In addition, many research results have been gotten on material stability of silica-base film solar cell by Institute of Semiconductors, Chinese Academy of Science, growing and transporting mechanisms of silicon-base film solar cell by Graduate School of USTC, in the deposition rate of silica-base film material and solar cell by Zhengzhou University.

CIGS: Xiao Weidong, is the professor of the Chinese University of Hong Kong, and the director of PV solar laboratory of Shenzhen Institute of Advanced Technology, Chinese Academy Science. His team havs developed the manufacturing equipment of GIGS thin film solar cell, which was first fully developed independently in China, and the conversion efficiency of the CIGS solar cell is up to 18.7%. This technology has been at the top of the world.

CdTe: Solar cell technology laboratory of Institute of Electrical Engineering, Chinese Academy of Science (IEE, CAS) has developed a CdTe polycrystalline thin-film solar cell, its thickness is only 2μm. It is produced through magnetron sputtering on the commercialized energy-saving glass

2) Power electronics, control and component of BOS

China has developed the design and integration technology of several 10MW centralized grid-tied PV power station and several 1MW distributed grid-tied PV system. The key equipment, such as, 1MW-stage grid-tied PV inverter, has been realized localization, technology of grid-tied PV system begins to promote the commercialization, and the development of PV micro-grid technology is basically in step with international. The efficiency of utility-scale PV power station and distributed PV system is up to 80%, the efficiency of centralized grid-tied inverter is 98.4% and the efficiency of Parallel-series grid-tied inverter, including the type with electrical transformer and the type without electrical transformer, is 95% and 97% respectively.

However, there is some difference between technology of utility-scale grid-tied PV power station, high penetration distributed PV system and micro-grid in China and advanced foreign technology, including design and integration, smart energy management system, key special equipment, power

predicting and grid connection technology.

3) Equipment

During the processing link of silicon material, there are two main production equipments: crystal growth and silicon chip, silicon bulk and silicon rod cutting. Chinese mono-crystal furnace at features and price is more excellent than import equipment and the furnace not only occupies most of the domestic market, but also begins to export in quantities into other Asian countries nearby. The equipment manufacturing technology, such as polycrystalline silicon ingot furnace and multi-wire cutting machine has made great leaps.

During the processing link of solar cell, China has got the capacity to manufacturing the equipment for the entire-line production of crystalline silicon solar cell manufacturing equipment. There are dozens of main equipments during production line of crystalline silicon solar cell and six of the equipments have dominated the production line in China and monocrystal furnace, diffusion furnace, plasma etcher, cleaning and texturing machine, module laminator, solar simulator and so on.

During the processing link of module, the main equipment, such as laminator is basic homemade and had exported into European, American, Japan and so on. However automatic laser series-welding equipment which was used by few factories has to be imported from foreign country.

About the solar cell manufacturing equipment of amorphous silicon thin film, entire manufacturing equipment of small-scale basal plate could been provided, which is about 5MW per year and small size (which is 1245mm and 635mm), The homemade manufacturing equipment of amorphous silicon thin film solar cell has been used by five or six factories. Though there are some gaps at production capacity, quality, stability, automation and so on, the groundwork of technique and equipment technology has been set.

4) Test technology and equipment

The China has placed great emphasis on the research of PV testing technology and set the professional testing laboratory, which are the foundations in continuous development and improvement of PV power technology and production. Crystalline silicon solar module and small-power inverter has been tested by variety of testers in China, such as Wuxi Quality Inspection of National Center of Supervision and Inspection on Solar PV Production Quality, China Electronics Technology Group Corporation No.18 Research Institute, PV Power System and Wind Power System Quality Testing Center of Academy of Science and so on. IEE, CAS has established some laboratories in Beijing, Lhasa and Wuxi, and is building MW-stage grid-tied inverter and PV module testing platform in Baoding. Low voltage ride through (LVRT) spot testing platform of PV power station was established at national energy solar center in Feb, 2011. It shows that China has got the testing capacity of voltage or frequency disturbance response of grid-tied PV power station, anti-islanding protection, PV power output, active and reactive power control, power quality indexes evaluation, Low voltage ride through (LVRT) and so on and has been at the forefront of the world in grid-tied PV power station testing.

Along with fast development of PV power application, China is researching to establish empirical research platforms with different forms at different areas, and research and testing demonstrations of utility-scale inverter and outdoor empirical research, developing the empirical research on the

power consumption and delivery of PV power. As well as, it will provide the practical experiences for PV power project and innovational platform for the research of new technology and production, which will actively promote mid-and-long term development goal of PV power to achieve in China.

2. R&D projects be arranged in 12th FYP

Four major research projects in the category of National High Technology Research and Development Program ("863" Program), 10 theme projects, 5 key projects have been arranged for solar power development in 12th FYP:

- One major project and one key project in material
- Two major projects and six theme projects in device, deployed year by year
- One major project and eight themes or key projects in system, deployed year by year

The followings are the projects relative with PV power.

Table 4: Relative PV Power Projects

No	Task	Program category	
		"863" project	Project of supporting plan
1	Research on utility-scale clean production of key technology of high efficiency and energy-saving polycrystalline silicon material		major
2	Research on preparation technology of solar cell key supplementary material		key
3	Research on pilot and cutting-edge technology of new-type solar cell	theme	
4	Research on design and integration technology and equipment of utility-scale PV grid-tied system	major	
5	Research on key technology of polycrystalline silicon solar cell industry with 20% efficiency and low-cost, and demonstration production line	major	
6	Research and development on manufacturing technique of GIGS thin film solar cell in utility-scale.	theme	
7	Research and development on manufacturing technique of "micromorph" tandem solar cell with 10% and more efficiency and 50MW annual capacity.	theme	
8	Research，development and demonstration on manufacturing technique of High concentration solar cell	theme	

9	Research and development on manufacturing technique of thin film solar cell with 10% efficiency in utility-scale.	major	
10	Research and development on manufacturing technology of dye sensitized solar cell module with 8% and more efficiency and 5MW annual capacity	theme	
11	Research and demonstration on technology of PV micro-grid system in high stability	theme	
12	Research on key technology and equipment of large capacity PV controller or inverter for micro-grid operation	theme	
13	Key technology and demonstration on BIPV with silica-base and high reliability		key
14	Research and demonstration on technology of hybrid power PV grid-tied system in utility-scale		key

Among 4 major projects of "863" Program, there is a project:" Research on design and integration technology and equipment of utility-scale PV grid-tied and micro-grid system". The goal is to develop international advanced-level PV system integration and engineering technology and entire key equipment, as well as establish five and more demonstrations of 100MW-stage power station and international advanced-level empirical research demonstration of PV system and balanced component. It will provide technology support for PV technology application in utility-scale and becoming the PV industry power country.

According primary forms of solar PV application in utility-scale, the project has set 3 research directions, including:

- "Research on key technology and equipment of utility-scale PV grid-tied power station",
- "Research on key technology and equipment of hybrid-power PV micro-grid"
- "Research on key technology and equipment of regional BIPV power system".

The main research contents are including:

- Technology of utility-scale grid-tied PV power station and power quality control, technology of power predicting and eco-environment monitoring in high altitudes, and technology of integration and engineering and key equipment of 100MW-stage grid-tied PV power station;
- Technology of different kinds of PV system integration, balanced component and on-line testing at the empirical research demonstration, and the technology and key equipment of hybrid-power, including PV, hydroelectric and wind energy, micro-grid integration and stable control;
- Manufacture technique, property testing technology and key equipment of PV components with different solar cell and base material, and integration technology and equipment of regional, high-density, and multi-access BIPV system; Integration technology and equipment of bi-mode BIPV system.

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

For market stimulation, China RE Law was effect on 1st Jan, 2006 to support RE and updated in 2009. Based on RE Law, there are two funds can be used to support RE. One of the funds is the RE Surcharge which is collected from all electricity end users at the rate of 0.8 cents/kWh and about 20-25 billion Yuan will be collected each year, the another is Special RE Fund directly controlled by Ministry of Finance. Currently, RE Surcharge is used to support ground-mounted LS-PV through the way of Feed-In Tariff (FIT) and the Special RE Fund is used to support government sponsored projects: PV Building Project and Golden-Sun Demonstration. Until the end of 2012, overall scale of the PV already-built and under-construction projects which could enjoy state subsidies, have more than 10GW.The status of government supported projects is please see table 1.

According to the above information estimate, the subsidies of PV project, which the government had provided was about 12billion RMB in 2012 alone. For demonstration or field test programs and R&D, Ministry of Science and Technology (MOST) is the government unit in charge of R&D of PV. Average annual investment for R&D from MOST is about RMB 500 million Yuan and the supported fields cover all manufacture chain: poly-Si, wafer, solar cells, PV modules, thin-film technology, CPV, energy storage, BOS components and system engineering.

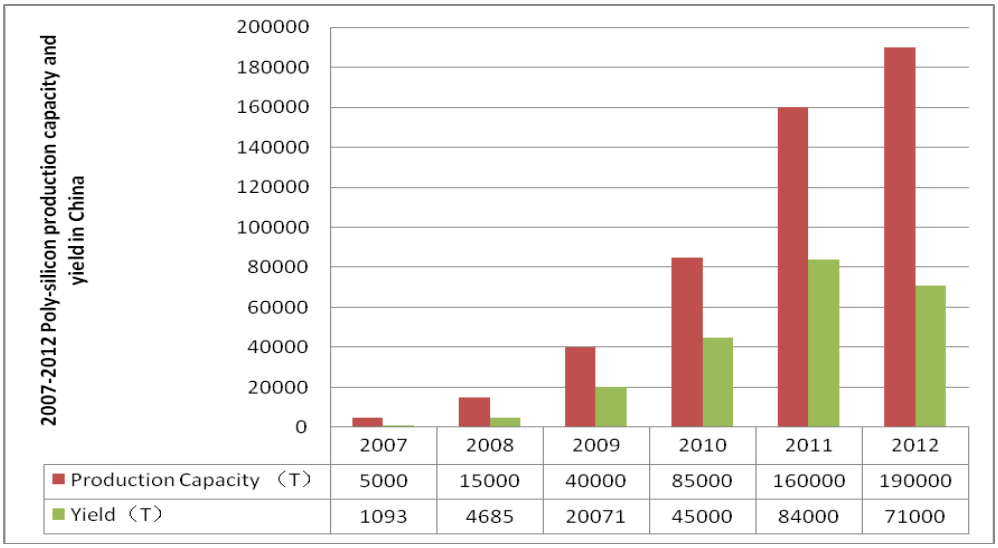
Only 4 major projects of National High Technology Research and Development Program ("863" Program), ten theme projects, five key projects of supporting plan in the areas of solar technology in 12th FYP, the overall subsidies of energy areas ware estimated at 1 billion. 2 major projects and 6 theme projects in device had received 0.46 billion, and 1 major project and 8 theme/key projects in system had got 0.54 billion.

3 Industry and growth

Benefitted by Europe PV market, China PV industry has been developing quickly since 2004, and become the largest PV manufacturing nation in the world. 21GW PV cells were produced in 2012, increased 6%（19.8GW in 2011）; The production of Chinese solar cell module is about 23GW, a year - on - year increase is about 10%, accounts for 63% of the global solar cell module production. The export is about $ 12.8 billion, a year - on - year decrease about 43%. Based upon the market demands, the PV production supply chain has been well developed. In the supply chain, about 20~30 manufacturers have real production capability of polycrystalline silicon, more than 60 manufacturers producing PV wafers, and more than 60 manufacturers producing PV cells, along with more than 330 PV module manufacturers. The revenue is over RMB 300 Billion (~36.8 BEUR).

3.1 Production of feedstock, ingots, wafers and thin film photovoltaic components

In 2012, China's poly-silicon production yields 71,000 tons, decreased 15% than last year (the production of 84,000 tons in 2011). It accounts for about 30% of global poly-silicon yield. The amount of poly-silicon imports was 82,700 tons, increased 28% than last year. Affected by the poly-silicon price fell in the global market, most of Chinese poly-silicon enterprises have been stopped production, industry concentration was improved. The yield of China's top 10 poly-silicon manufactures was 63800 tons, accounts for 89% of the China's annual yield.



	2007	2008	2009	2010	2011	2012
Production Capacity （T）	5000	15000	40000	85000	160000	190000
Yield （T）	1093	4685	20071	45000	84000	71000

Figure 2: 2007-2012 Poly-silicon production capability and yield in China

Source：CPIA, April 2013

Table 5: Annual yields of China top 10 Poly-Silicon manufacturers in 2011-2012.

Unit: Tons	2011	2012
GCL-Poly Energy Holdings Limited	29410	37000
Daqo New Energy Co., Ltd	4600	4300
Asia Silicon Co., Ltd.	2300	4100
China Silicon Corporation Ltd.	8135	4000
Sichuan Renesola Ltd	3386	3500
TBEA Silicon Co., Ltd	1500	3300
LDK Solar	11000	2500
Sichuan Yongxiang Polysilicon Co., Ltd	1400	2300
Yichang CSG Polysilicon Co., Ltd.	1500	1600
Orisi Silicon Co.,Ltd	1000	1200
Total	64231	63800

Source: CPIA 2013.

The production technology is developing; TCS hydrogenation process power consumption is keeping reduce. Currently, the average power consumption has been reduced from 70KWh/kg in 2011 to 60KWh/kg in 2012, part of advanced manufacturers have approaching below to 50KWh/kg.

The productive energy consumption and material consumption is keeping reduce, national average energy consumption fell to 120KWh/kg, some advanced enterprises reduced to 80KWh/kg.

The cost for production is also declining, some advanced manufactures costs $20/ kg and achieves to international advanced level, but most manufacture's costs still more than $30 / kg.

Until the end of 2012, China's ingot production capacity was 360,000 tons, wafer capacity was 40GW, wafer yield was 28 GW, about 16% increased than last year, accounted 70% of global yield. The wafer yield of GCL-Poly Energy Holdings was 8,000MW and was the global top 1 wafer production capacity manufacturer. LDK Solar took the second seat with wafer production capacity of 3,800MW. Yingli Solar was the third with production capacity of 2450MW. These three manufacturers also were the top 3 wafer manufactures in 2012 in the world. The production technology has been developing, the cost price is decreasing, Rene solar's cost on production was from $0.28/w decreased to $0.12 in 2012, a decrease of 57% than 2011.

Table 6: 2012 Production capacity /Yield of China Top 10 Wafer manufactures (MW)

Manufactures	2012 Solar Wafer Annual Production Capacity (MW)	2012 Solar Wafer Annual Yield (MW)
GCL-Poly Energy Holdings Limited	8000	5600
Yingli green energy holding Co., Ltd	2500	1800
Sichuan Renesola Ltd	2000	1500

Jingkong industry and commerce Group Co. Ltd	2000	1200
LDK Solar	3800	1100
Trina Solar	1200	1100
Zhenjiang Rietech New Energy Science Technology Co., Ltd	1600	1000
Jinko Solar Holding Co., Ltd	1500	900
Hareon Solar Technology Co., Ltd	1000	800
Xi'an LONGI Silicon Materials Corp	1400	800
Total	25000	15800

Source: CPIA, 2013

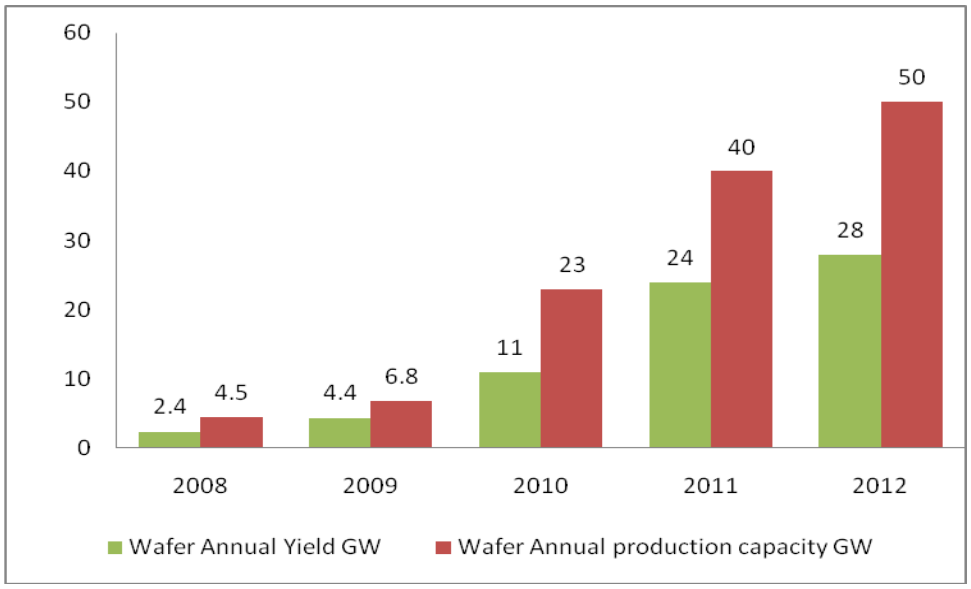


Figure 3:2008-2012 China Annual Wafer Production Capacity/Yield

Source: CPIA, 2013

3.2 Production of photovoltaic cells and modules

Global solar cell yield in 2012 was 37.4GW, the production capacity in 2012 was more than 70GW (include thin-film solar cell). In the top 10 world-leading solar cell manufacturers, China occupied 8 seats (includes China mainland and Taiwan). The total production capacity of global top 10 solar cell manufacturers in 2012 was 21.81GW; the annual delivered solar cells were 14.65GW. The manufacturing cost at solar cell processing stage reached US$0.6/W.

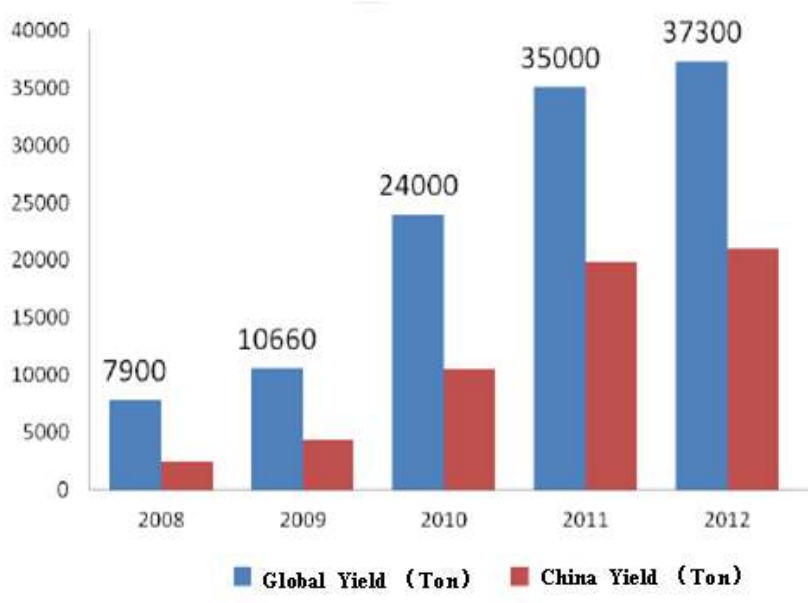
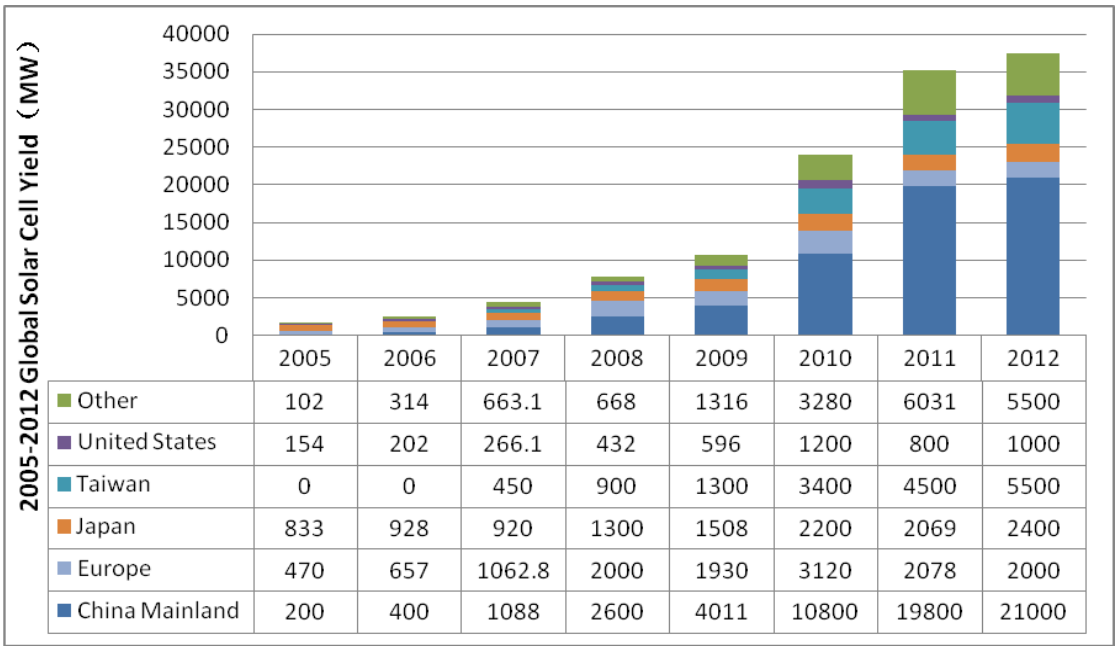


Figure 4: 2008-2012 Global/China Cell Yield (Ton)

Source: CPIA, 2013



	2005	2006	2007	2008	2009	2010	2011	2012
Other	102	314	663.1	668	1316	3280	6031	5500
United States	154	202	266.1	432	596	1200	800	1000
Taiwan	0	0	450	900	1300	3400	4500	5500
Japan	833	928	920	1300	1508	2200	2069	2400
Europe	470	657	1062.8	2000	1930	3120	2078	2000
China Mainland	200	400	1088	2600	4011	10800	19800	21000

Figure 5: 2005-2012 Global Solar Cell Yield（MW）

Source: CPIA, 2013

In 2012, China's solar cell production capacity was more than 40GW, annual solar cell output was 21GW, increased 5% than last year, accounted for 56% of the global yield. China was the top 1 solar cell yield country in 2012. The solar cell yield of China's top 10 manufactures was 12 GW, accounted for 57% of the China's annual solar cell yield, but the production capacity was about 18.6GW, only accounted for 40% of global yield.

Table 7: China top 10 solar cell manufacturers in 2012

Manufactures	2012 Annual solar cell production capacity (MW)	2012 Annual Solar cell module Output (MW)
Yingli green energy holding Co., Ltd	2450	2000
JA SOLAR Co., Ltd	2800	1800
Suntech Power Holdings Co., Ltd	2400	1700
Trina Solar	2450	1400
Canadian Solar Inc.	2400	1100
Hareon Solar Technology Co., Ltd	1560	1100
Jinko Solar Holding Co.	1500	800.
Hanwha Solar One Co., Ltd*	1300	800
48th Research Institute of CETC	1200	700
Chint Group	600	500
Gintech Energy Corporation	1500	1100
Total	11980	18660

Source: CPIA, 2013

In China, annual module production capacity was more than 40GW, the total delivered PV modules made in China was 23GW in 2012, 9.5% increased compared with last year, contributed 63% of global outputs. Total production capacity of top 10 module manufacturers in China was 16.9GW, and annual yield in 2012 was 12.18GW, accounted for 52% of China annual module yield. In China's top 10 manufactures, top six of them also the global top 10 module yield manufacturers. The top 10 solar module manufacturers in China are listed in following Table.

Table 8: 2012 top 10 solar module manufacturers in China (Unit MW)

Manufacturer	2012 Module Annual Output (MW)	2012 Module Annual Production Capacity (MW)
Yingli green energy holding Co., Ltd	2300	2450
Suntech Power Holdings Co., Ltd	1700	2400
Trina Solar	1700	2450
Canadian Solar Inc.	1600	2400
JA SOLAR Co., Ltd	1100	1500
Hanwha Solar One Co., Ltd	850	1500
Jinko Solar Holding Co., Ltd	840	1500
Hareon Solar Technology Co., Ltd	840	900
Gintech Energy Corporation	650	800
Zhongli Talesun	600	1000
Total	12180	16900

Source: CPIA 2013.04

3.3 Module prices

87% of PV module price has been reduced during last 6 years; the historic PV module price in China was shown in figure 6. It was RMB 36 Yuan/Wp in 2007, and by 2012, it was RMB 4.5 Yuan/Wp.

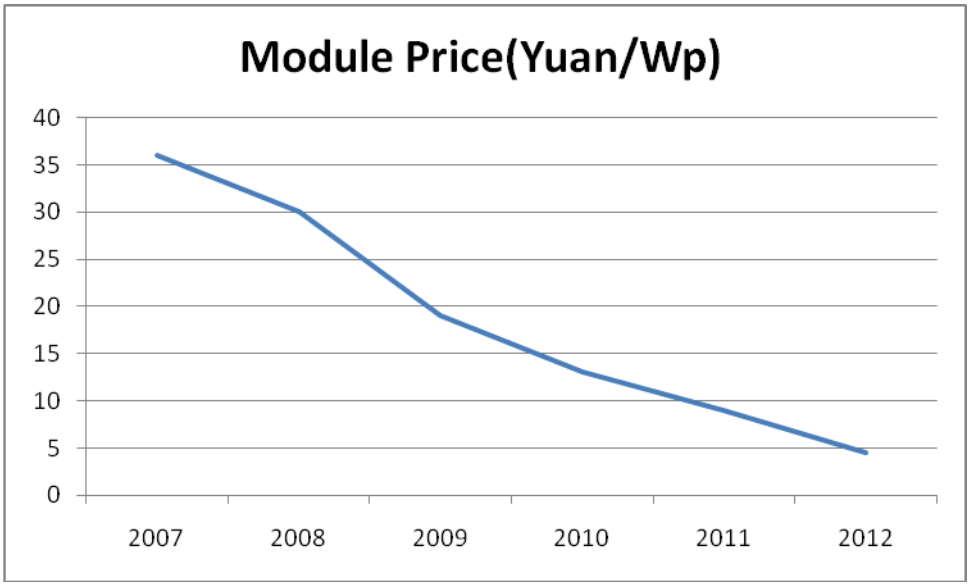


Figure 6: PV module price in China, 2007~2012

Source: Wang Sicheng, 2013

Table 9: Module price fall from 2007-2012（Yuan/Wp）

Year	2007	2008	2009	2010	2011	2012
Module Price(Yuan/Wp)	36.0	30.0	19.0	13.0	9.0	4.5

Source: Wang Sicheng, 2013

3.4 Manufacturers and suppliers of other components

1. Inverter

China inverter substantive market was formed in the second half of 2011. China inverter market was initiated in 2009 and increased sharply in 2010. With rapid development of PV market, the competition in inverter market also turn to be intense in 2011, large amount of new participants were emerged. By now, there is more than hundred of PV inverter manufacturers in China, among which, the suppliers with the annual production capacity more than 5MW are no less than 50 units. The grid inverter companies with high reputations are including: Sungrow Power, SAJ Solar, Xuji Crop., DELTA Green Tech, Samil Power, Beijing Corona, Eversolar and Action power tec. AS for off-grid inverter, its technology is relatively mature and there are a group of advanced manufactures in China.

In 2012, the turnover of China inverter market amounted to RMB 2.748 billion. Due to the fierce market competition, inverter price declined greatly. By the end of 2012, the average sale price of

large power grid inverter dropped to RMB 0.5Yuan /W (with tax). But the decline of costs is less than the sale price due to short supply of IGBT and other electronic components' firm price. Inverter cost reduction has been left with a lesser extent. According to estimates, the average costs of domestic mainstream inverters are between RMB 0.30-0.36Yuan/W. When it comes to 2013, with the distributed PV development, the supply-demand situation would be improved, and the price may increase a bit in the second half of the year.

Table 10: Increase rate of China PV inverter in 2010-2012

Year	2010	2011	2012
Turnover (RMB, billion)	1.287	1.983	2.748
Increasing Rate	530.90%	54.10%	38.60%

Source: ICT research 2013，03

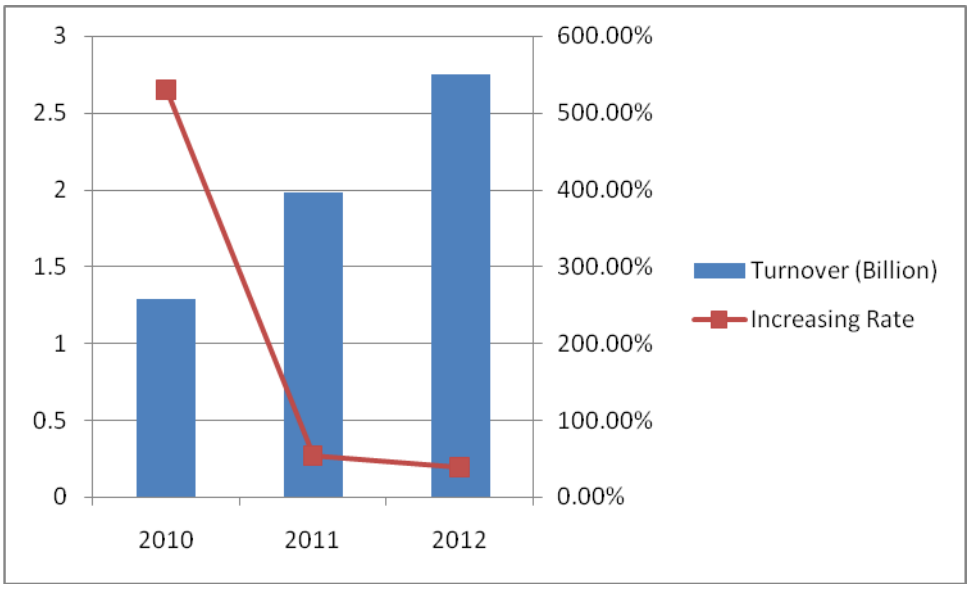


Figure 7: Increase rate of China PV inverter in 2010-2012

Source: ICT research 2013.03

2. Tracking system

Supported by the national 863 Key Projects during the 11th Five-Year Plan period, China has independently completed the 10kWp double-axis tracking system, 10kWp tilt single-axis tracking system and 50kWp level single-axis tracking system in 2008. PV tracking system has entered the stage of promotion and application now. China Solar Tracking System Industry Alliance was established in Beijing on Oct. 28, 2012. According to the patent application and public product instructions, those companies are able to provide PV tracking system products. These companies include but not limited to Zhonghuan photovoltaic System Co., Ltd, Borun New Energy Sciences & Technology Co., Ltd, Shanghai Yangyuan New Energy Sciences & Technology Co., Ltd, Beijing Corona Sciences & Technology Co., Ltd, Changzhou Zixu Photo electricity Co., Ltd, Wuxi Haosolar New Energy Sciences & Technology Co., Ltd.

With the increasing of PV installed capacity, and continue improving the performance of the

concentrated-photovoltaic, Chinese companies have also begun to intervene in the CPV field in recent years. Besides San'an Optoelectronics Co., Ltd, other companies have also intervened and researched CPV and related products in the different levels, such an Xiamen Changelight Co., Ltd, Guangdong Macro Co. ,Ltd, Zhejiang Crystal-Optech Co., Ltd, Lida Optical and Ecectronic Co., Ltd, Suzhou Dongshan Precision Manufacturing Co., Ltd and so on.

San'an Optoelectronics Co., Ltd announced that its holding subsidiary, Suncore Photovoltaic Technology Co., Ltd., signed a supply contract with Shenguang New Energy Co., Ltd. on Sep. 8, 2011. According to the agreement, Suncore Photovoltaic Technology Co., Ltd. will supply 50MW High-concentrated-Photovoltaic generation equipment to Shenguang New Energy Co., Ltd. before Jun.1, 2012. The total value of the contracted goods and related services amounted to RMB 680 million. It is understood that, the 3MW high concentrated photovoltaic grid-tied demonstration projects of Shenguang New Energy Co., Ltd. has been completed and put into operation in Qinghai Golmud.

3.5 System prices

In 2012, system prices for installed PV systems in China again dropped compared to the previous years. The reduction was 43%. In 2012, average system price for typical grid-tied systems is RMB 10 Yuan/Wp. It was decreased about 83.3% than 2007.

The PV system price in China is continuing dropping since 2007, shown as in Table 11.

Table 11: PV system price, 2007-2011

Year	2007	2008	2009	2010	2011	2012
System Price (RMB Yuan/Wp)	60	50	35	25	17.5	10

Source: Wang Sicheng, 2013

3.6 Labour places

The estimated labor placed in PV industry in China from 2008 to 2012 is shown as in Table 12. Now there are about 300,000 employees working in PV industry nationwide.

Table 12: Labor placed in China PV industry, 2008-2012

	2008	2009	2010	2011	2012
Labor Place (1,000)	200	300	300	500	300

Source: Yuwen Zhao, 11th China PV conference and Exhibition, Nanjing, Nov. 11-20, 2010

Junfeng, Li, Sichengwang, China Solar PV Outlook 2011, Aug. 2011

Secretariat of China PV Industry Alliance, April, 2012

Charlie Dou，Research on policy and improve solar explore efficiency roadmap in China-2030, April，2013

3.7 Business value of installation

In 2012, 3.5GW PV system has been installed in China, annual export of solar cell was US$12.7

billion, China industry output value was RMB 300billion Yuan, the annual import of solar cell was US$1.28 billion. The system price of PV system has been decreased significantly from 2007 to 2012 (Ref to above table and chart), which was only 17% of 2007. Except the utility-scale PV power stations, distributed generation, micro-grid and small scale off-grid PV market are also emerging.

Table 13: China PV Industry Business Value

Sub-market	Capacity installed in 2012(MW)	Price per W (from table 12)	Value (RMB)	Totals (MRMB)
Off-grid domestic	20	28 RMB/Wp	560,000,000	560
Off-grid non-domestic	20	35 RMB/Wp	700,000,000	700
Grid-connected distributed	1460	12 RMB/Wp	17,520,000,000	17520
Grid-connected centralized	2000	10 RMB/Wp	20,000,000,000	20000
Total	3500			38780
Export of PV products (module，etc.)			N/A	
Change in stocks held (module，etc.)			N/A	
Import of PV products (module，etc.)			N/A	
Value of PV business			N/A	

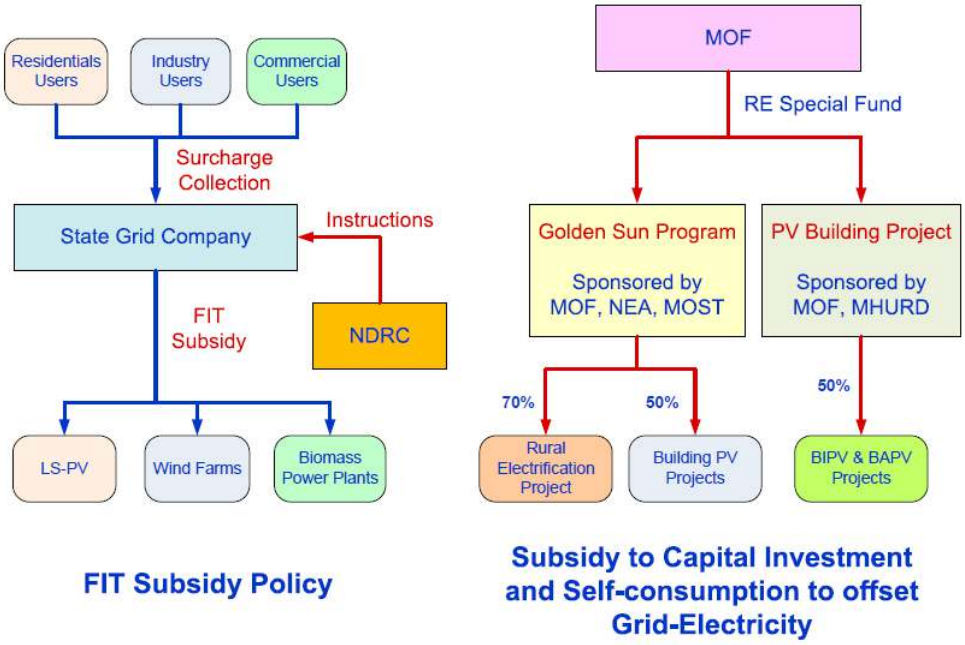
Source: Wang Sicheng, 2013

4 Framework for deployment (Non-technical factors)

There are two fundamental incentive policies in China to promote the PV Market in 2012. One is subsidy for Renewable Energy Feed-in-Tariff (FIT), another is investment subsidy.

FIT funding is from the RE Surcharge which collected from all end users of electricity at the rate of 0.8 cents/kWh and about RMB 20-25 billion Yuan will be collected each year, the another one is Special RE Fund directly controlled by Ministry of Finance, about RMB 10-20 billion Yuan available each year. As shown in the follow chart, currently, RE Surcharge is used to subsidize electricity generated by RE (PV, wind power and biomass power) through the way of FIT and the Special RE Fund is used to support the government sponsored projects: PV Building Projects and Golden-Sun Demonstration.

Figure 8: Subsidies in China



Before the end of 2012, the government sponsored projects are show as table 1.

In 2010, China's distributed PV experienced rapid development. By the end of that year, 32 of the provinces (autonomous regions) have constructed a total of about 3,775MWp distributed PV systems, an increase of 3166.5MWp over 2011. The Golden Sun Demonstration and PV Building projects accounted for the majority of the power output. Of which, the accumulated capacity of the Golden Sun Demonstration accounted for 3044MWp, while that of PV Building Projects was 525MWp and the rest of 206MWp was constructed in other distributed PV projects. The provinces of Jiangsu, Shang dong and Guangdong are among the top three in terms of the capacity of distributed PV, with the installed capacities of 591MWp、283MWp and 276MWp and accumulated market share of 15.65%, 7.51%, and 7.3% respectively.

Compared with the stable development of LSPV, the big increase of distributed PV became one of the major features in China's PV market in 2012. In the process of such development, the Golden

Sun Demonstration played an irreplaceable role in initiating the country's scaled up of distributed PV application, promoting PV technological progress and industrial development, as well as exploring ways of integrating distributed PV and grid connection. The development momentum of distributed PV will remain robust in China's future market. In the development plans of 2015 and 2020, the market share of distributed PV will both account for over 50%.

The important milestones occurred in China in 2012-2013, which were greatly promoting the development of DG PV market as follows:

- In May 2012, Premier Jiabao Wen announced "Support Self-Consumption Solar Energy Production Step into Public Utilization and Families".
- In 25th May, 2012, NEA published "The Notice of the Application and Approval of New Energy City and Industrial parks" with the target of 100 New Energy Cities and 1000 Industrial parks.
- In 6th Aug, 2012, NEA published the "The Twelfth Five-year Plan of Renewable Energy Development " with the increased target of PV from 15GW to 21GW (includes CSP) focus on Distributed PV market.
- In 14th Sep, 2012, NEA published the "The Notice of Distributed PV Demonstration Application and Approval" with the first batch target of 15 GW.
- In Oct, 2012, State Utility published the "The Regulation of Distribution PV grid connected Service".
- In Dec, 2012, NEA disseminated the PV Target, "The Twelfth Five-year Plan", from 21GW to 35GW focusing on Distributed PV market.
- In Dec, 2012, the State Council held an executive meeting presided by premier Jiabao Wen. The meeting put forward five measures, known as "Fix state measures" for the PV industry development.
- In March, 2013, the draft for comments of Feed-in Tariff (FIT) of PV based on regional solar resources and the draft subsidy policy for distribution PV were issued by NDRC
- On Jun, 14, 2013, the State Council held an executive meeting presided by Premier Keqiang Li. The meeting put forward six measures, known as "Six state measures" for the PV industry development.
- In Jun. 16, 2013, NEA presented "The work plan on pilot regional distributed PV power". It requested provincial level energy administrations to complete and present their implementation schemes for pilot regional distributed PV power and if approved, the pilot projects will be initiated by the end of July.

The difficulties and countermeasures of China's PV market in 2012 include:

1. It is necessary to coordinate relationship of the following four aspects: PV development scale, local consumption capacity, power adjustment capability, and grid bearing capacity. The planning before PV-grid connectivity shall also be improved, as well as the operation and management after the connectivity.

There was frequent adjustment of PV development target in 2012. On the one hand, the constantly increased target demonstrate China's determination to explore the potential of the domestic market to the full extent, while on the other hand, such frequent strategic target adjustment resulted in vague auxiliary grid target planning and lagging construction. The industry is facing the difficulties on connectivity of utility-scale PV development and consumption. There are also problems that significant amount of regional utility-scale PV stations connected to the grid, such as Qinghai Province, but such connectivity failed to synchronize with local grid planning, and a lack of flexible power scheduling. Such shortcomings resulted in difficulties in local consumption and grid transmission, and abandoned PV station power output. There is also the need to conduct in-depth studies on related technologies and policies of grid connectivity for high penetration ratio distributed PV system, and work out unified coordination for the related power network distribution planning.

In order to ensure the effective connectivity of PV power into the grid system, it is necessary to integrate such factors as PV development scale, local consumption capacity, power adjustment capability, and grid bearing capacity into overall consideration in planning. Meanwhile, there shall also be unified development planning for PV, wind and other types of renewable energy production and related supporting grid, especially in the northwest regions with rich PV and wind resources, to optimize PV and wind power transmission channels. In operation and management, the effective power consumption shall be promoted by focusing on issues of "power source", "power network" and management, including:

(1) Take advantages of full potential of existing peak regulation sources; further improve technological renovation of PV power system and key equipment to gradually realize functional upgrade of "grid following-grid friendly-grid supporting";

(2) Speed up the construction of intelligent grid, using ultra-high voltage power transmission and intelligent grid scheduling, control and management technologies to improve the capability of the grid to take PV power; take full advantage of the adjustment functions of distributed power storage system and client-side response to realize complementary power consumption; conduct PV power output prediction technology research for the establishment of a PV power output optimization scheduling mechanism, and integrate it into power scheduling system;

(3) Further clarify detailed regulations on connectivity and consumption of PV and other types of renewable energy so as to actively guide the optimized deployment and orderly development of PV and other types of renewable energy.

2. It is necessary to establish a market entrance threshold to eliminate backward production capacity, support the advanced and strong ones, and encourage enterprises to adopt a specialized and differentiated development.

The fat profit of the PV industry during its high speed development period in China had attracted large numbers of investors. The 31 provinces, municipalities and autonomous regions had listed PV industry as an emerging industry with priority to develop. Of 600 cities, 300 had established PV industry, of which over 100 have constructed PV industry bases. Such eruption style development had resulted in excess of production capacity. For some core equipment and major raw materials, the industry had always relied on importation. There are little differences in production lines. Compared with advanced international level, there's still a big gap in term of core and lab

technologies, which is a barrier for future sustainable development.

Based on market rules, a set of comprehensive evaluation system for enterprise technological capability, management level, market development and profitability capacities, and credit rating shall be established so as to set up a reasonable industrial threshold; resources shall be concentrated to support a few utility-scale enterprises with international competitive capability; the market based rule of survival of the fittest shall be adopted to eliminate the backward and give more market development space for the excellent ones; IP protection shall be strengthened to create a favorable environment of independent innovation, and enterprises shall be encouraged to adopt specialized and differentiated product development.

3、The domestic PV market need to be further expanded. A long term and clearly PV tariff policy system should be published, and furthermore, the appropriate business model also should be developed.

China PV industry is a typical export-oriented industry. Although under policy driven, domestic PV module consumption has exceeded 10% for the first time in 2011. But the situation of end-product markets in Europe and United States has not changed. The keys of solving China market's problems are expanding the domestic market, and releasing new policy that focuses on subsidy PV end market. In July, 2011, China NDRC published unified national utility-scale PV station FIT (except for Tibet) which has different incentive on different region. But FIT must be different from the different solar resources and different exploit mode and also need consider proprietor, developer, grid, equipment manufactures and customers' benefits.

For the distributed PV system, initial investment subsidy has an incentive impact on the initial stage in 2009, but this subsidy has been ended in 2012 and instead by new FIT subsidy that based on performance. The detailed policy will be analyzed in the chapter of "Indirect Policy Issues".

Chinese renewable energy tariff subsidies mainly come from Renewable Energy Surcharge (0.8 per cent per kWh). On the tariff surcharge, China is much lower than Germany, only account for Germany's 1/4. The amount of RE surcharge in China can't meet the development needs of renewable energy market. So it is important to raise the RE surcharge to promote the development of RE and PV power generation market.

In addition, for all customers to collect the RE surcharge, that haven't reflect on the fossil energy and high power consumption company's responsibilities. To impose carbon tax for fossil energy is not only the international trend but also important compensate measure for China's resources, ecology and environment, moreover, it also the important "open source" measure for subsidy the PV power generation.

4. It is necessary to establish a comprehensive and innovative PV financing system to create a better financing environment for PV enterprises and PV station construction.

The close down of some PV companies has led to worries from financial institutes about the long-term commitment of PV modular quality. The risks of bank investment have increased, and there are questions on companies' credit and quality commitment. Most commercial financial institutes have lost their confidence on PV companies, adopting the policy of "cut all" towards all PV enterprises. These commercial financial institutes provide huge amount of loans when enterprises

were developing smoothly, but when the enterprises got into trouble, they cut or restrict loans to all regardless the actual conditions of the enterprises. Such practice is like adding salt to injury, making even good PV companies hard to reverse the decline trend and therefore, hindered the sustainable investment to the country's PV industry.

The practice of risk transfer financing model extensively adopted currently by international PV stations shall be applied. Strategic cooperation with reputable international authoritative standard certification organizations shall be established to carry out third party due diligence to PV enterprises. Combined with such measures as design, supervision, operation and maintenance, power station remote data collection, and station classification, the third party risk transfer system as insurance for PV station comprehensive operation shall be introduced to improve the ability of PV product financing. Business innovation of banks, insurance companies and third party institutes shall be given full support to form a risk sharing model among banks, insurance companies and testing and certification institutes, to substantially reduce investment risks. On such basis, such innovative financing models as "Financing leasing power station construction", "Long term earnings as loans", "Securitization of power station assets" will be able to be carried out solidly. Financial institutes shall establish an enterprise evaluation system, relax their loan policy to leading companies, providing support to and eliminating financing obstacles for such companies.

4.1 Indirect policy issues

China's pricing policy for PV power implemented in the past year greatly promoted the development of PV power market, especially provided direct support to the construction of utility-scale PV station in China's west regions. However, the shortcomings of such policy are also appeared in the implementation process:

1、The current pricing policy is a unified national power pricing except Tibet. It fails to take considerations of differences in regional resource, and differences in types of technologies and development models;

2、The current pricing policy fails to formulate applicable terms of such pricing, thus leading to the uncertainty of project development and affected project profitability and risk control;

3、The current pricing policy only provides principles in pricing level adjustment, but fails to describe how to adjust and the extent for such adjustment, thus leading to substantial uncertainty;

4、The current pricing level is not interlinked to development scale.

1. Planning policy

In Dec.2012, the State Council held an executive meeting presided by premier Jiabao Wen. The meeting put forward five measures, known as "Fix state measures" for the PV industry

To response the strategy of State Council, in March, 2013, the draft for comments of Feed-in Tariff (FIT) of PV based on regional solar resources and the draft subsidy policy for distribution PV were issued by NDRC. The main issues of the policy are as follows:

（1）4 levels of FIT based on solar resources：0.75, 0.85, 0.95, 1.0 Yuan/kWh；

（2）For self consumed PV electricity, 0.35 Yuan/kWh of subsidy will be provided；

（3）The excess PV electricity feed-back to grid will be purchased by grid company and the subsidy of 0.35 Yuan/kWh will be provided in addition；

(4) The contract period is 20 years.

Table 14: Draft Version of PV FIT and Subsidy for Distribution PV

Classification of Solar Resources	LS-PV	Distributed PV	
	FIT	Real Income for Self-consumed PV	Subsidy for Feed to Grid
	(Yuan/kWh)	(Yuan/kWh)	(Yuan/kWh)
I	0.75	Retail grid price + 0.35	Whole sell price + 0.35
II	0.85		
III	0.95		
VI	1		

Source: Wang Sicheng, 2013

On Jun. 16, 2013, the NEA organized a meeting in Beijing on pilot regional distributed PV power. At the meeting, the NEA presented "The work plan on pilot regional distributed PV power". It requested provincial level energy administrations to complete and present their implementation schemes and if approved, the pilot projects will be initiated by the end of July.

2. Support policies

On Dec. 19th, 2012, Premier Jiabao Wen chaired the meeting of State Council to approve 5 approaches to support solar PV:

(1) To push forward shakeout and recombination of PV industry by market force (to overcome the problem of over production-capacity in PV industry in China);

(2) Government PV market development plan should be aligned with the grid development plan of utilities (to avoid the problem of delay of grid-connection and cut-off PV power plants from grid for safety);

(3) Expanding domestic PV market and focus on distributed PV (to change the situation of highly dependent on foreign market and encourage distributed PV instead of LS-PV)；

(4) To set up solar resources based Feed-in Tariffs of PV and to stop capital subsidy and move to performance based tariff subsidy (originally, only one PV FIT for whole China and capital subsidy for PV Building project and Golden-Sun Demo.);

(5) To follow the market mechanisms, reduce government interfere and prohibit local protections (to setup health market for PV in China).

On Jun. 14, 2013, the State Council held an executive meeting presided by premier Keqiang Li. The meeting put forward six measures, known as "Six state measures" for the PV industry, include:

(1) Strengthen planning and industry policy guidance, promote reasonable deployment, and focus

on development of distributed PV power application;

(2) Grid companies shall guarantee synchronized construction and production of matching grid and PV power projects, priority shall be given to PV power output plans, and full procurement of PV power;

(3) Perfection of PV power pricing support policies, formulate PV station regional grid connected benchmark price, expand the scale of renewable energy fund, and ensure that the subsidy to distributed PV power based on kWh production is timely delivered;

(4) Encourage financial institutes to take measures to alleviate financing difficulties of PV producers;

(5) Provide support to technological R&D and industrialization of key materials and equipment, and strengthen the establishment of PV industrial standards and specifications;

(6) Encourage enterprises to engage in mergers and restructuring to become better and strong, and restrain blind expansion of production capacity.

Of the Six measures, the first establishes the development direction of distributed PV, the second to solve the problems of grid connection, the third deals with subsidy, the fourth to solve financing issues, the fifth to handle research and standard questions, and the final one to solve the problems of excessive industrial concentration and over production capacity.

3. Monitoring/regulating policies

In Oct., 2012, the State Grid issued four document, including

- The "Opinion on the work of distributed PV power grid connection service (interim)",
- The "Opinion on management work of the promotion of distributed PV power grid connection (interim)",
- The "Technical specifications of distributed PV power grid connectivity (interim)",
- The "Typical design of distributed PV power connectivity system".

4.2 Standards and codes

Until April 2013, there are total 95 effective standards in China, in which, 85 are national standards, 32 industry standards, 5 local standards. 117 standards are still in the research process, 6 standards have been modified, and 111 standards have been made. The most of current standards in China are the standards for cells, modules, and PV applications. PV material standards take largest proportion of researching standards.

In the current operating PV standards, PV equipments standards, PV material standards, PV component standards, and PV application standards are mostly self-formulate, cell and module standards, and PV system standards are mostly transferred from the IEC standards. The researching standards also mostly are self-formulated, especially on the PV material, PV component, and PV system, which's autonomous innovation, lay on the world top level.

In 2012, China published 19 standards, include 14 national standards, 5 industry standards (please see the following table), which include 2 poly-silicon material standards, 1 PV device standards, 1 PV

system standards, and 1 PV application standards.

Table 15: The Photovoltaic Standards and Code were published in 2012.

NO	Standards and codes	Standards Name
1	YS/T 792-2012	Carbon-carbon composites crucible used in single crystal furnace
2	GB/T 29054-2012	Solar-grade casting multi-crystalline silicon brick
3	GB/T 29055-2012	Multi-crystalline silicon wafer for solar cell
4	YS/T 808-2012	Copper foil for solar energy equipment
5	GB/T 6495.10-2012	Photovoltaic devices. Part 10:Methods of linearity
6	GB/T 29320-2012	Technical Requirement for Tracking System of PV Station
7	GB/T 29196-2012	Technical Specification for Stand-Alone Photovoltaic Systems
8	GB/T 28866-2012	Characteristic parameters of stand-alone photovoltaic (PV) systems
9	GB/T 29321-2012	Technical Specification for Reactive Power Compensation of PV Power Station
10	GB50794-2012	Code for construction of PV power station
11	GB/T50795-2012	Code for construction organization planning of photovoltaic power project
12	GB/T50796-2012	Code for acceptance of photovoltaic power project
13	GB 50797-2012	Code for design of photovoltaic power station
14	GB/T 29319-2012	Technical requirements for connecting photovoltaic power system to distribution network
15	GB/T 19964-2012	Technical requirements for connecting photovoltaic power station to power system
16	NB/T 32001-2012	Technical requirements for photovoltaic power station environmental impact assessment
17	NB/T 32002-2012	Solar Lawn Lamp
18	GB 50787-2012	Technical code for solar air conditioning system of civil buildings
19	JGJ/T 264-2012	Code for operation and maintenance of building mounted photovoltaic system

Source: China Electronics Standardization Institute, CPIA, 2013.

Overall, China PV standards system has been formed，There are a scale of current operating and researching standards that covered main PV productions. Because the thin film cell and concentrator cell are in the developing stage with a small scale industry, standards for the material, cell and module of thin film cell and concentrator cell is still in the initial stage.

5 Highlights and prospects

China is facing serious pressure on energy supply and GHG emission. China is the world's GHG emissions nation than any other country since 2007, the largest producer and user of electricity, the largest importer of coal, and the dependence of imported oil is as high as 56%. China has to do efforts to alleviate the problems. Renewable energy (RE) development is the basic strategy in China for energy sustainability and GHG reduction. Solar PV will play a key role in renewable energy development in China.

5.1 Stakeholder initiatives and awareness raising

Here is not going to make comments on FIT, but some analysis on distributed PV subsidy policies: its subsidization method and business model is very similar with Germany "self-consumption" mode which is currently running, that is, "self-consumption, surplus feeding back grid". Since German PV has realized "grid parity", the self-consumption part does not need subsidies, but China has not yet reached its "grid parity", the self-consumption part still needs subsidies, which makes the implementation of this policy is much more complicated than in Germany.

1) Because the fixed subsidy is added on the price of power consumed by users, so the unit PV power earning is affected directly by users consumed power price. Power price for industrial and commercial use is between RMB 0.8-1.4 Yuan/kWh, that of major industrial use is between RMB 0.6-0.8 Yuan /kWh, that of public affair is between RMB 0.5-0.6 Yuan/kWh, and that of such organizations as government buildings, schools and hospitals is merely RMB 0.3-0.5 Yuan/kWh. So it becomes very complicated in selecting users and constructions, since only industrial and commercial buildings with power price higher than RMB 0.8 Yuan/kWh can be profitable to PV power operations.

2) Based on such policy, the earning of self consumed power is higher than feed-in surplus power, so it is imperative for the matching of characteristics of daily distribution of PV power production and load. If such characteristics are not compatible, the related economic benefit will be greatly reduced.

3) Because of the nature of self production and consumption, there shall be stable load in 20 years to ensure profitable. If there are events of poor business operation, close down or relocation, the impact on profitability of related PV project will be fatal.

4) It is very difficult for major power developers to get involved, so the market development is slow. Major power developers for sure will develop projects on other owners' roofs. Because of the nature of self production and consumption, developers must sign energy saving management contracts with construction owners with terms that the saved power fee will be handed over to the developers. This may bring big risks for project developers. If major power developers do not get involved and rely only on power users to construct and consume, then it will be very difficult to expand the distributed PV power market in a short period of time.

Therefore, the advantage of FIT is obvious, it is suggested that distributed PV project developers could choose the 2 business models freely, either self-consumption mode with high-risk but high profit return, or FIT mode with no risk but low income and long-term feedback period.

Whether distributed PV market can really start, it is mainly determined by the incentive policies and business models. If the policy is scientific and rational, all parties could be benefited from it, in

addition, the procedure is transparent, operational and easy for developers to get involved, it is believed that China's distributed PV market will usher a rapid development period.

5.2 Prospects

1) Development trend of solar cell

- Utility-scale power production companies are engaging in PV cell production, power station procurement may tend to be self supplied. Utility-scale power production groups are major developers for future PV market and major constructors of PV power stations. In order to control cost and product quality, power production enterprises more or less get themselves involved in cell production.
- There's fiercer price competition. Price competition is a two-edged sword. Favorable competition may promote further reduction of PV power production cost, and early realization of grid parity, but overly competition may have the side effect of "bad money drives good money out" and potential quality problems.
- The competitiveness of crystalline silicon cell is further strengthened, with more solid market position. By the end of 2012, some Chinese PV modular companies lowered their production costs to $0.6/w, lower than the cost of CdTe thin film's $0.67/w by world leading company First Soar, imposing increased operation pressure on thin film cell enterprises.
- Continued improvement of solar cell price/performance ratio, higher industrial entrance threshold. One of the important means to reduce cost is to improve product efficiency. At a time of higher rate of product homogenization, higher efficiency cell means higher added value. Major enterprises are changing their development strategies to increase R&D investment to develop high efficiency cell products. It is expected that in the near future, such research and development achievements will walk out of labs for scaled production.

2) Trend of solar market in China

In 2012, NEA released its 12th 5-Year Plan (2011-2015) for solar power generation. The updated target of cumulative solar power installation for 2015 and 2020 is listed below:

Table 16: Government Target for Solar Power (2015, 2020)

Targets for Cumulative Installation of Solar Power (GW)				
Market Sectors		**2012**	**2015**	**2020**
Distributed PV	Rural Electrification	0.102	3.0	10.0
	Communication and Industry	0.058	1.0	4.0
	PV Buildings	2.390	14.0	40.0
LS-PV and Others	PV products	0.058	1.0	4.0
	Utility-scale PV (LS-PV)	4.392	15.0	40.0
	Solar Thermal Power (CSP)	0.000	1.0	2.0
Total		7.0	35.0	100.0
Share of Distributed PV（%）		36.4	51.4	54.0

Source: Wang Sicheng, 2013

Table 17: Solar Power Target and Annual Progress Forecast

Year	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Annual Inst.(GW)	2.7	3.5	6.0	10.0	12.0	12.0	12.0	12.0	14.0	15.0
Cumul. Inst. (GW)	3.5	7.0	13.0	23.0	35.0	47.0	59.0	71.0	85.0	100.0

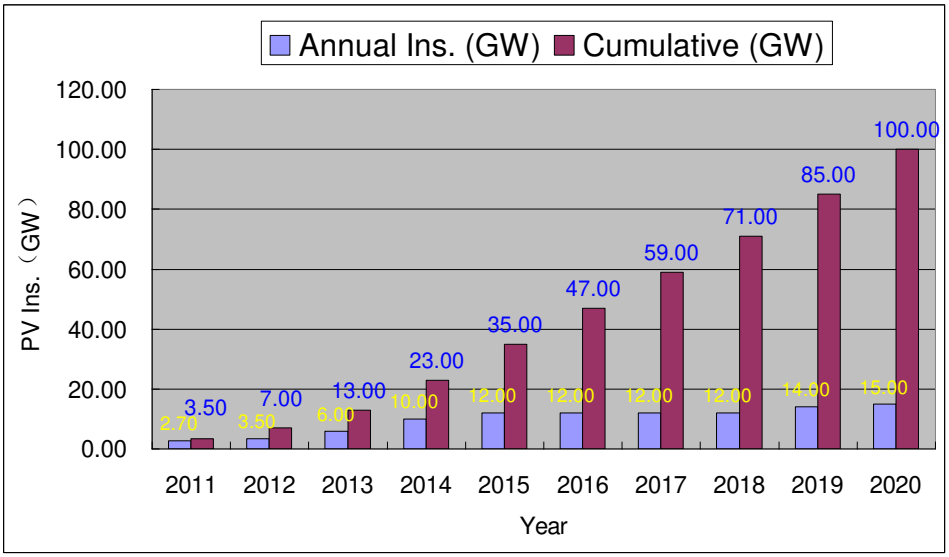


Figure 9: Solar Power Target and Annual Progress Forecast

Source: Wang Sicheng, 2013

Today, PV is not the main role in power supply in China. The situation of power supply in 2012 is listed in the following Table.

Table 18: Power Supply in China in 2012

Type	2012			
	Inst. Cap.	Generation	Share of Capacity	Share of Generation
	GW	TWh	%	%
Hydro	248.90	821.37	21.56	18.03
Wind	60.83	121.66	5.27	2.67
PV	7.00	9.80	0.61	0.22
Biomass Power	6.00	24.00	0.52	0.53
Nuclear	12.57	94.28	1.09	2.07
Subtotal	335.30	1071.11	29.04	23.51
Coal	758.11	3259.87	65.67	71.55
Gas	38.27	133.95	3.31	2.94
Others	22.79	91.16	1.97	2.00
Subtotal	819.17	3484.98	70.96	76.49
Total	1154.47	4556.09	100.00	100.00

Non-fossil Power %	29.04	23.51		
Renewable Power %	27.95	21.44		
Solar PV %	0.61	0.22		

Source: Wang Sicheng, 2013

The PV installation target for the year 2020, 2030 and 2050 is shown as bellow（China PV 2020, 2030, 2050 roadmap research）:

Table 19: PV Market Forecast for the year 2020, 2030 and 2050

Year	2012	2020	2030	2050
Basic Target (GW)	7.00	100.0	300.0	1000.0
High Target (GW)	7.00	200.0	600.0	2000.0
The high target require high efforts grid-tied-strengthen and storage tech.				

Source: Solar Energy Roadmap in China 2020, 2030, 2050

And the role of PV in power supply by the year 2050 is predicted shown in the follow table:

Table 20: PV Role in Power Supply in China by 2050

Power Source	Power Capacity (GW)	Annual Equ. Working Hours (Hrs/Year)	Production (TWh)	Share of Capacity (%)	Share of Production (%)
Hydro Power	400	3300	1320	10.22	11.00
Wind Power	1000	2000	2000	25.56	16.66
PV	1000	1400	1400	25.56	11.67
Nuclear	300	7500	2250	7.67	18.75
Biomass Power	200	4000	800	5.11	6.67
Gas Power	150	3500	525	3.83	4.37
Coal Fire Power	862	4300	3707	22.03	30.88
Total	3912		12001.6	100.00	100.00

Source: Wang Sicheng, 2013

Annex A: References, methods and accuracy of data.

[1] Annual Report of China, 2013

[2] Charlie, Dou，Research on policy and improve solar explore efficiency roadmap in China-2030. April，2013.

[3]China General Certificate Center (CGC), Statistics Report of Distributed PV Power, 2012.

[4]CNREC, China National Renewable Energy Center, 2013

[5]CPIA, Annual Report of China PV Industry 2012, April, 2013.

[6]CREIA, China Solar PV Power Policy Report: Differential Feed-in Tariffs. 2013.

[7]Wang Sicheng, Current Status of PV in China 2012

[8]Xu Honghua, Lv Fang, Wang Sicheng. Solar Energy Roadmap in China 2020, 2030, 2050. 2013.

[9]Xu Honghua, Lv Fang, Wang Yibo, Ma Liyun, and et al. 'China Photovoltaic, Long-term Plan'-the Summary of Strategic Recommendations for Promoting the Emerging PV Industries' Healthy Development.

Annex B: Country Information

This information is simply to give the reader some background about the national environment in which PV is being deployed. It is not guaranteed to be 100 % accurate nor intended for analysis, and the reader should do their own research if they require more detailed data.

1) Retail electricity prices - household, commercial, public institution

The tariffs in China are varying based upon different geographic locations, user categories and time using electricity. The following table shows the example[4].

Table 21: The tariffs in China

Unit: RMB Yuan/kWh（Tax include）

City		Beijing	Shanghai	Guangzhou	Qinghai
Household	<1Kv	0.4883	0.617	0.61	0.4271
	1~10Kv	0.4783	0.612		0.4271
	10~35Kv	0.4783			
Commercial	<1Kv	0.821	0.920	1.0178	0.2228-0.9342
	1~10Kv	0.806	0.895	0.9928	0.2210-0.9260
	10~35Kv	0.799-0.791	0.870	0.99-0.9678	0.2191-0.9179
	110Kv	0.776	0.850	0.98	
	>110Kv	0.761			
Industry	1~20Kv	0.637	0.895	0.7142	0.1450-0.5916
	20Kv	0.627		0.7142	0.1413-0.5753
	35Kv	0.617	0.870	0.6892	0.1413-0.5753
	110Kv	0.597	0.850	0.6892	
	>220Kv	0.577	0.850	0.6642	0.1376-0.5590

Source: State Electricity Regulatory Commission (SERC)

2) Typical household electricity consumption

In 2012, the average electricity consumption per person was 383.1 kWh. Average Annual Energy Consumption for Households was 5125 hundred million kWh

(Source: China Statistical Yearbook 2012)

3) Typical metering arrangements and tariff structures for electricity customers (for example, interval metering, time-of-use tariff)

[4]Many places carries out summer electricity tariff, such as Shanghai, and also, many places carried out common, peak and valley price, such as Qinghai.

- Regular metering, or prepaid card metering. The interval for regular metering is one month.

- Summer price is carrying out, which is high than other seasons.

- Common, peak and valley price structure is used. Peak price is much high than valley price so as to shift the peak load.

4) Typical household income

Table 22: Typical household income

	per capita disposable income of urban dwellers		**per-capita net incomes for rural families**	
	Amount (Yuan)	Index (1978=100)	Amount (Yuan)	Index (1978=100)
2012	21810	965.2	6977.0	954.4

Source: China Statistical Yearbook 2012

5) Typical mortgage interest rate

The mortgage interest rates in China varies time by time and varies by different bank, the following table was the rate effective on June 12th, 2012 by Bank of China.

23: The mortgage interest rates in China

Terms	**Annual interest rate %**
<= 6 months	5.85
> 6 months, <= 12 months	6.31
> 1 year, <= 3 years	6.40
> 3 year, <= 5 years	6.65
> 5 years	6.8-

6) Voltage (household, typical electricity distribution network)

- Household: 220V

- Distribution network: single phase, 220V, three phase 380V, 10KV, 35KV, 100KV, 220KV, 330KV, 500KW, and 1000KV.

7) Electricity industry structure and ownership

Five major power generation corporations: Northeast China grid company, North China Grid company limited, Center China Grid company limited, East China Grid company limited, Northwest China Grid Company Limited.

These companies all belong to State Grid Corporation of China (SGCC), and China Southern Power Grid Co., Ltd. (CSG).

They are all state-owned enterprises.

8) Retail prices of oil

The retail price of oil in China is verying periodically following with the international crude oil. The

newest retail price effective from the date of July, 2013) are:

Gasoline

90#：6.61 -6.91Yuan/liter

92#： 7.55 Yuan/liter (Only for Beijing)

93#：6.98 -8.35 Yuan/liter

95#： 8.05 Yuan/liter (Only for Beijing)

97#：7.36 -8.88 Yuan/liter

Diesel oil:

6.84 -7.51 Yuan/liter

(Data updated by July, 2013 Source: http://oil.usd-cny.com)

9) Typical annual values of kWh/kW for PV systems in China

Table 24: Solar Resources and PV Output in Western China

Solar Resources and PV Output in Western China							
Province	**Average Horizontal Solar Irradiation（MJ/m2/y)**	**Average Horizontal Solar Irradiation（kWh/m2/y)**	**PV Tilted Angle（Degree）**	**Irradiation on Tilted PV（MJ/m2/y)**	**Irradiation on Tilted PV（MJ/m2/y)**	**System Efficiency（%）**	**PV Annual Output (kWh/kW/y)**
Xinjiang	5304.84	1473.57	45	6100.56	1694.60	80	1355.68
Tibet	7885.99	2190.55	30	8832.31	2453.42	80	1962.73
Inner-Mon	6041.35	1678.15	45	6947.56	1929.88	80	1543.90
Qinghai	6142.93	1706.37	40	7064.37	1962.32	80	1569.86
Gansu	5442.78	1511.88	40	6259.19	1738.67	80	1390.93
Ningxia	5944.80	1651.33	42	6658.17	1849.49	80	1479.59
Shanxi	5513.84	1531.62	40	6340.91	1761.37	80	1409.09
Shaanxi	4730.51	1314.03	40	5440.08	1511.13	80	1208.91
Yuannan	5182.78	1439.66	28	5597.40	1554.84	80	1243.87
Average	**5798.87**	**1610.80**	**38.89**	**6582.28**	**1828.41**	80	**1462.73**

Table 25: Solar Resources and PV Output in Eastern China

Solar Resources and PV Output in Eastern China							
Province	**Average Horizontal Solar Irradiation (MJ/m2/y)**	**Average Horizontal Solar Irradiation (kWh/m2/y)**	**PV Tilted Angle (Degree)**	**Irradiation on Tilted PV (MJ/m2/y)**	**Irradiation on Tilted PV (MJ/m2/y)**	**System Efficiency (%)**	**PV Annual Output (kWh/kW/y)**
Heilongjiang	4683.69	1301.03	50	5386.24	1496.18	80	1196.94
Hebei	5008.89	1391.36	42	5609.96	1558.32	80	1246.66
Guangxi	4595.91	1276.64	25	4963.58	1378.77	80	1103.02
Jilin	5034.39	1398.44	45	5789.55	1608.21	80	1286.57
Guangdong	4478.03	1243.90	25	4836.28	1343.41	80	1074.73
Hubei	4312.92	1198.03	35	4959.86	1377.74	80	1102.19
Shandong	5123.01	1423.06	40	5891.46	1636.52	80	1309.21
Henan	4764.36	1323.43	40	5479.02	1521.95	80	1217.56
Liaoning	5067.41	1407.61	45	5827.53	1618.76	80	1295.01
Jiangxi	4832.08	1342.24	30	5218.65	1449.62	80	1159.70
Jiangsu	4855.49	1348.75	35	5341.04	1483.62	80	1186.90
Fujian	4410.74	1225.21	30	4763.59	1323.22	80	1058.58
Zhejiang	4314.60	1198.50	35	4746.06	1318.35	80	1054.68
Hainan	5125.10	1423.64	25	5381.35	1494.82	80	1195.86
Beijing	4835.52	1343.20	42	5508.00	1530.00	80	1224.00
Tianjin	5260.11	1461.14	42	5891.33	1636.48	80	1309.18
Shanghai	4729.25	1313.68	35	5202.18	1445.05	80	1156.04
Average	**4790.09**	**1330.58**		**5340.92**	**1483.59**	**80**	**1186.872**