



Empowered lives.  
Resilient nations.



# The 14th China Photovoltaic Conference (2014 China International Photovoltaic Exhibition) Policy Recommendations

JOINTLY PUBLISHED BY:

United National Development Programme

China International Center for Economic and Technical Exchanges

China Renewable Energy Society

2014. 12





## Executive Summary

The 14<sup>th</sup> China Photovoltaic Conference (CPVC 14) was jointly hosted by the China International Center for Economic and Technical Cooperation (CICETE), UNDP, the China Renewable Energy Society and the China National Renewable Energy Centre from November 19<sup>th</sup> to November 21<sup>st</sup>.

This publication summarizes the keynote speeches delivered by representatives from the government, research institutes and private sectors regarding national planning of the solar energy sector development and the technology advancement in the photovoltaic industry in order to provide policy as well as technology recommendations for the stakeholders in this field.

In his presentation “Development Roadmap of High Ratio Renewable Energy of China in 2050”, Mr. Wang Zhongying, the Director of the National Renewable Energy Center, pointed out that China needs deepening reform in the energy system and energy mechanism as well as electricity mechanism to fulfill its energy demands in 2050 and to meet the goal of sustainable development.

Representatives from the New Energy of China Electric Power Research Institute illustrated the future direction of the new energy industry. Mr. Wang Weisheng from the Institute pointed out that the research should be more targeted in order to realize effective and stable operations in the “Development direction of grid connection of distributed photovoltaic and high voltage DC and AC technology”.

The conference also provided space to private sector companies for sharing knowledge of applied technology in the businesses. Mr. Dai Mingfang, Vice President of Hanergy Holding Group Limited, introduced the “Technical Trend of Gallium Arsenide” to the audience and proposed that thin-film solar technology has the potential to change the way people use solar energy.

With the theme “Developing the Market, quality is the most important issue. Promote the Photovoltaic Industry, be Creative and show leadership”, this conference provided an opportunity to summarize and exchange on technical renovation and academic achievements in scientific creation. It also aimed to deepen the national market and develop a space for international cooperation to promote the sustainable and healthy development of the photovoltaic industry.

“In forty years, PV could provide 40% of the electricity consumed worldwide”, quoted Mr. Patrick Haverman, Deputy Country Director of UNDP China from Jorgen Randers’ book **2052: A Global Forecast for the Next Forty Years**, “China will lead the transition to solar through very large-scale, centralized, government-owned and government-operated plants using Chinese hardware.” He advocated that clean energy projects should better link with rural livelihoods where the projects are often situated. The UNDP’s Public-Private Partnership model provides companies with a unique opportunity to support local populations through employment and their Corporate Social Responsibility activities, which benefit local communities. “I hope there will be a positive response and follow up to the initiative from the private sector in today’s solar energy conference and afterwards.”

# Content

## Part I: Government Planning

Development Roadmap of High Ratio Renewable Energy of China in 2050 .....	4
Planning direction and thinking of the 13 <sup>th</sup> Five Year Plan on Photovoltaic .....	5
Photovoltaic Roadmap and Overall of the 13 <sup>th</sup> Five Year Plan .....	6

## Part II: Research Institution

Perovskite Solar Cell: Materials and Devices.....	9
Development of China’s Photovoltaic Industry.....	9
Development Direction of Grid Connection of Distributed Photovoltaic and High Voltage DC and AC Technology.....	10

## Part III: Private Sector

The latest technology and the Forecast of Photovoltaic Inversion .....	12
New Leap in the Development of Our Country’s Poly-Silicon.....	13
Development of High Efficiency Crystalline Silicon .....	13
Technical Trend of Gallium Arsenide .....	14
Current Status of the Industrialization of Condensing Photovoltaic and the Prospect Analysis .....	15
Operation and Maintenance of High Efficiency Management Power Station.....	15
<b>Annex I: Event Agenda.....</b>	<b>17</b>

*Disclaimer: This publication reflects what was discussed during the conference for knowledge sharing purposes and does not reflect the opinion of the organizers of the Conference, UNDP, CICETE or CRES.*

# **Part I: Government Planning**

## **Development Roadmap of High Ratio Renewable Energy of China in 2050**

*By Wang Zhongying, Director, National Renewable Energy Center*

### **Background:**

China and U.S had mutually agreed to address climate change during the APEC meeting. To achieve the development goals by 2030, China needs deep reformation in its energy system, energy mechanism and electricity mechanism.

### **Current issues need to be addressed:**

The barriers existing in the current energy system and mechanisms lead to competition in the energy industry. Fossil fuel and coal manufactures will compete against other energy sources in seeking growth. However, fossil fuel energy will not be able to meet the energy demand of China by 2050. Severe environment issues, such as the smog in China, require a revolution of thinking within the energy sector.

### **Proposed solution:**

The revolution of the energy sector in China must be in the process of moving from the oil and gas era towards the sustainable energy era. The first step is to realize clean energy production and gradually phase out fossil fuels, replacing them with clean energy. The second step is to elevate the electrical power level of the terminals. “The country can make successful transitions in the power system will be the one which can seize the opportunity in the energy revolution of this century.”

### **The research on development roadmap of high ratio renewable energy of China in 2050:**

The GDP of China in 2050 is estimated to be around 282 trillion (CNY). The energy needed for creating this GDP requires the energy revolution that should start with adjustment of the terminal energy structure featured with a high ratio of electric, solar energy and wind energy. However, the precondition for amalgamation of cleaner energy into the current market structure is to have a solid and viable electricity market in the first place.

# Development of China's Photovoltaic Industry

*By Wang Bohua, Secretary General, China Photovoltaic Industry Association*

**Background:** The corner stone of any industry is market and, for the PV industry, the market is greatly prospering both domestically and internationally. It is expected in that 16% of electricity generated in 2050 will be from PV.

## **Introduction of the current situation in the industry:**

**A. Polysilicon Production: Increasing yet quality needs to improve:** The annual production of polysilicon in 2014 is estimated to be over 130,000 tons. Over half of the factories haven't realized their full production capacity, however, there is still more than 40% of polysilicon being imported to China this year. The quality of the domestic product needs to be improved through technological development and costs need to be reduced.

**The polysilicon industry is expanding:** Global photovoltaic installation capacity continues to increase. Applications of PV are becoming more diverse, with wider programmatic usage: some PV projects would simultaneously address poverty reduction, agriculture, environment and climate change issues. In general, there is a gap between current production and market demand in China, but the development of the industry as a whole depends on related policies and the market.

**B. PV Modules: the main production layouts are in Asia:** low entry barriers requiring relatively small amounts of investment and the best infrastructure in the world means that production layouts are moving to Asia.

**The increasing utilization rate of PV Modules:** The utilization rate of PV modules produced by China and the exporting rate has increased to 60%.

**C. New export market needs to be expanded:** In 2014, 44% of the total of Chinese-made PV modules were exported to Japan. Precautionary movements and diversification are necessary to prevent turbulence in the international market.

**Characteristics of the Market: Imbalanced supply and demand:** The key issue is to control the pace of development. Rigid demand (national policy) adjustment could easily affect suppliers. The subsidy policy and the rigid adjustment of the PV trade barriers bring fluctuations in the market while providing opportunities, which can in turn affect the financing and development strategy and government policy. For the balance between the supply and demand, it is necessary to maintain the coherence and sustainability of policy.

## **Policy recommendation:**

Further improve the industry standardization.

Support technological innovation to realize the sustainable development of the industry.

Expand the depth and breadth of PV applications, improve the industry infrastructure including the certification system, quality supervision and industrial organization as well as enhance self-discipline.

## **Planning Direction and Thinking of The 13<sup>th</sup> Five-Year Plan of Photovoltaic**

By Xu Honghua, Deputy Director, China Renewable Energy Society

### **Background:**

During the 12<sup>th</sup> five-year plan, there were four major key themes and six priority themes in the energy field that were favored in program arrangements and financial support. The four key themes were *smart grids, clean coal, solar power* and *wind power*. In the 12<sup>th</sup> Five-year plan, the solar power sector was mapped out through materials, devices, equipment and systems. The six priority themes were: *sustainable energy technology, clean coal technology, advanced nuclear energy and safety technology, energy efficiency and energy storage technology, new power electronics and hydrogen energy fuel cell and distributed energy supply*.

The main focus of the 12<sup>th</sup> five-year plan was to fulfill the strategic demand and break through the energy bottleneck. It is also necessary to sustainably supply and produce more concise ideas of energy technology development and priorities, provide measures and suggestions about promoting the efficient and clean usage of traditional energy sources, develop new energy and utilize energy security.

### **Research in the 13<sup>th</sup> five-year plan:**

Research towards the 13<sup>th</sup> five-year plan for energy should focus on breaking through the energy supply bottleneck and meet the strategic demand need for a sustainable supply of energy. Simultaneously, a concise roadmap featuring key tasks is needed for technological development of the energy sector, as well as suggestions for the promotion of clean and highly efficient usage of traditional energy sectors alongside the development and application of new energy and energy security.

The research areas in the 13<sup>th</sup> five-year plan have 8 sub-fields, including *clean coal technology, smart grid technology, renewable energy technology, hydrogen and fuel cell technology, nuclear energy, energy storage, energy efficiency and key technologies of new energy systems and systems integration*.

### **Development ideas for the sub-fields in the 13<sup>th</sup> five-year plan:**

1. Continue the development direction featured with energy-efficient, low-cost and intelligent technology, and further solve the common technical problems and bottlenecks that are restricting the development of China's renewable energy industry;
2. To promote technical innovation and industrial upgrades in the solar, wind and other renewable energy systems and components;
3. To establish and improve industry-wide renewable energy research and testing systems which are open to the public;
4. To support the low-cost industrialized development and utilization of renewable energy and to promote the implementation of China's energy revolution strategy.

### **The general idea of strategic research in the sub-fields of the 13<sup>th</sup> five-year plan**

The proposed tasks and technology content can help solve the nation's energy problems, tackle outstanding issues and bottlenecks in the utilization of renewable energy and promote efficiency in renewable energy as well as reduce costs.

Illustrate the significance and necessity of research, practical applications and key technology contents, as well as define the expected targets.

Provide full descriptions of existing technology, existing problems and bottlenecks as well as the goals and standards expected and key technology, which requires further research.

### **Development direction of the PV industry**

Pursue the energy-efficient, low-cost and intelligent technology development; support technological innovation and improvement for the PV system and balance components.

Support the technological research for the industrialization of efficient crystalline silicon solar cells, thin-film battery and the key technology research and industrialization of new solar cells.

Support industry-wide public research testing technology.

### **Goals:**

Master the integrated design and control technology of GW PV clusters; start key technology research and demonstration of the distributed PV systems with over 50% penetration rate in different regions with different resources; realize an efficiency rate of over 80% in implemented systems while reducing the construction cost to be less than CNY 6 per watt.

Increase industrial efficiency for crystalline silicon solar cells to over 23%, with thin film battery over 20%. Establish a production line for perovskite batteries, organic batteries and other new battery technology.

### **Suggestions for key research tasks in the PV industry:**

- Research and demonstration of high energy-efficiency, low-cost and smart PV stations.
- R&D and demonstrate intelligent distributed PV generators and micro grids.

- R&D and demonstration for industrialization of high energy-efficiency, low-cost crystalline silicon solar cell.
- Research and development in the thin film solar cell industry.
- New research on high-efficiency solar cell technology.
- Research on solar cells and PV systems with demonstrations and testing techniques.

**Expected landmark results for Solar PV:**

- Demonstration of smart PV power plants and complete balanced components with a high ratio of energy efficiency.
- MW level PV high voltage grid-connected direct current power system.
- GW level photovoltaic power station clustered control system.
- Demonstration of combined fishery/PV power station for husbandry with 100MW regional distribution.
- Demonstration of 1 MW micro-grid interconnection project.
- Public research platform for novel solar cells.
- Five empirical technology public research platforms under typical climate conditions as well as public research platforms for sustainable energy integration systems technology.



## **Part II: Research Institution**

### **Perovskite Solar Cells: Materials and Devices**

*By Nam-Gyu Park, Professor, (South Korea) Sung Kyun Kwan University of Chemical Engineering*

#### **Background:**

The first perovskite solar cell was invented by a Japanese professor with a conversion efficiency rate of 3.8% in 2009. In 2010, Professor Nam-Gyu Park helped increase this efficiency rate to 10%. Afterwards, more researchers participated in the R&D of this field. Today, the perovskite cell conversion efficiency rate has reached 19.3%.

#### **Technology and Research:**

Park introduced the working mechanism for the solar cell and the chemical ingredient of perovskite and the experiments on increasing the conversion rate of the cell and ways to enhance the stability.

#### **Conclusion:**

The development of the perovskite cell was so rapid that within 2 years the 9.7% efficiency of solid-state solar cell had increased to 20.2%. If battery voltage loss can be minimized efficiency can reach 25%, which is comparable with silicon cells. In addition, suggestions on the adjustment of perovskite materials were offered.

## **Photovoltaic Roadmap and overall 13<sup>th</sup> five-year plan**

*By Wang Sicheng, Deputy Director, Photovoltaic Professional Committee of the China Renewable Energy Society*

#### **Background:**

China has become the biggest market and biggest manufacture for PV that has had a great impact on cost reduction. Currently China has a more favorable policy on distributional photovoltaic than many other places.

#### **Photovoltaic roadmap:**

The total amount of power generated by Photovoltaic power is expected to be 1 billion KW in 2050 and comprise of 20% of the total of power installations. The usage of fossil fuel power will be reduced from 70% to less than 20%, which can then truly be called a real revolution in energy transformation: from fossil fuel power to sustainable energy. Wind and PV power and should meet 50% of the electricity demand of the country.

## **Market development roadmap:**

The cost of the electricity generated by PV station can be reduced to the same as the cost from fossil fuel power stations before 2025. In the future, large power stations should supply one half of the electricity and the other half would mainly be from the distributed power stations.

## **Development Direction of Grid Connection of Distributed Photovoltaic and High Voltage DC and AC Technology**

*By Wang Weisheng, Head of the Research Institute of New Energy of China Electric Power Research Institute.*

### **Background:**

Clean energy has become the third largest power source in China. The installed capacity in Gansu, Qinghai and Xinjiang Province comprise nearly 60% of the total amount in China.

### **Four research fields should be concentrated on to realize the effective and stable operation of grid-connected PV and effective resolve:**

Network simulation: establishing a PV simulation model and analyzing the interaction between photovoltaic and grid.

Prediction: predict the PV power conversion and reduce uncertainty of PV power

Optimization: integrate solar and conventional power supply and prioritize photovoltaic

Testing: promoting the performance of grid-connected photovoltaic and ensure the safety of grid-connected PV

### **The current issues being faced:**

China is dominated by fossil fuel power that has a low level of flexibility. The power ratio needs to be adjusted.

Currently there are many technical standards in this field and are expected to be integrated and improved. Also, it is worth discussing whether the standards are applicable and practical.

The official establishment of the IEC TC8/SC 8A committee was established on July 5<sup>th</sup> 2013, responsible for the standardization of technology for the bulk sustainable energy generation grids.

**Conclusion and suggestion:**

With continuous growth in the proportion of photovoltaic power generated in the power network, PV power stations have become the inevitable trend of development with observable and predictable, controllable characteristics.

Through network-wide coordination and optimal dispatching technology on the grid side, maximum absorption of new energy can be realized.

## **Part III: Private Sector**

### **The Latest Technology and the Forecast of Photovoltaic Inversion**

*By Cao Renxian, General Manager, Sungrow Power Supply Conduct, Ltd.*

#### **The Technology Updates:**

The PV inverter is the bridge between renewable energy and power, and is highly dependent on the technology advancement of power electronics and microelectronics. The improvement of inverters' performance should focus on reducing energy loss and increasing the equipment's reliability.

#### **The Industry Updates:**

In the market, large power stations would be equipped with large power inverters. In China, there are many large power stations; The centralized inverters and string inverters dominate the market.

#### **Trend for future development:**

The concerns surrounding power and electronic inverter devices are focused on how to increase the cost-effectiveness of the devices and the system, from the points of DC, inverter, power, and system.

#### **Conclusion:**

The centralized inverters are going to advance to generating more power, being grid-friendly, and focusing on providing systematic solutions.

The string inverters will be developed in the direction of greater convenience, safety and intelligence.

The future improvement of PV inverters should focus on improving the efficiency and reliability and providing smooth, reactive, thorough support and emergency services for the power grids.

The increasing complexity and diversity of PV types require making reasonable choices of the inverter equipment based on the actual situation of the power plants, to "act according to the circumstance and provide scientific design."

## **Technical Trend of Gallium Arsenide**

*By Dai Mingfang, Standing Deputy General Manager, Hanergy Holding Group*

### **Background:**

Among all available PV technologies today, Gallium Arsenide (GaAs) is the recognized leader for performance and reliability. The technology, originally developed for usage in the satellite power systems in 1980s, is well known as the technology with the highest potential for performance in single-junction PV cells. GaAs cells and modules, with their high efficiency, small size, lightweight and extended operating temperatures are ideal for use in extreme conditions. Unfortunately, traditional GaAs cells are also extremely expensive. The best players/ producers in the world are located in Germany and the US. China, although has devoted into the scientific research for GaAs, is particularly fall behind in the production and commercialization.

### **GaAs solar cells:**

The efficiency of flexible GaAs solar cells is 8% higher than that of global monocrystalline silicon solar cells and 10% higher than that of polycrystalline silicon in mass production; the energy it generates in the same area is 2 to 3 times that of ordinary flexible solar cells. In 2014, Hanergy completed the acquisition of Alta Devices in the US and gained the GaAs flexible thin-film solar technology that boasts the highest conversion efficiency. Alta made technical strides in flexible gallium-arsenide photovoltaic, setting records for the materials systems and boasting NREL- verified 28.8 percent cell efficiencies for a single-junction solar cell and 30.8 percent for a dual-junction cell.

### **Market potential:**

Alta's thin-film solar technology allows more energy to be produced in lower light conditions than any other type of solar cell that gives it greater potential to power a wide range of mobile devices and equipment, from phones to cars. It has the potential to change the way solar energy is used.

## **Development of High Efficiency Crystalline Silicon (IBC)**

*By Feng Zhiqiang, Deputy Technical President, Trinasolar*

### **Background:**

2014 was a year of great significance in improving solar cell efficiency. Sharp Corp announced that it had achieved a cell conversion efficiency of 25.1% with a crystalline silicon solar cell. This efficiency is the second highest, after the 25.6% efficiency that

Panasonic Corp announced days earlier. Both two companies have adopted Interdigitated Back Contact (IBC) solar cell technology.

### **Technology Breakthrough:**

Having worked with the Australian National University (ANU), the solar Energy Research Institute of Singapore (SERIS) and PV Lighthouse, Trinasolar is set to commercialize an n-type mono IBC solar cell after more than three years of R&D. The Fraunhofer Callab in Germany independently tested the lab-based solar cell, confirming it could deliver a conversion efficiency of 24.4%.

## **New Leap in the Development of Our Country's Polysilicon**

*By Yang Yongliang, China ENFI Engineering Corporation*

### **Background**

Currently, polysilicon is a high purity, multicrystalline form of silicon that used as a raw material by the solar photovoltaic and electronics industry. For the first time in 2006, over half of the world's supply of polysilicon was being used for the production of renewable electricity solar power panels.

### **Industry**

Polysilicon has a relatively small scale of production in China. Energy consumption is high. Before 2005, the energy consumption of polysilicon was about 400 kWh per kilogram. Also, the industry heavily relied on imports, which made up 40% of the total demand. From 2010 onwards, China has become the largest polysilicon producer in the world, 90% of which is provided by about 10 domestic companies.

### **Technology**

Through consistent internal R&D and importing advanced technologies, polysilicon technology has achieved great breakthroughs. First of all, energy consumption is decreasing. In terms of pollution, most companies would use the silicon tetrachloride process to transform polysilicon into trichlorosilane, recycling the by-products generated. In this way, it can not only reduce the waste but also lower the costs.

### **Prospect**

Chinese companies need to invest more heavily in automation and optimization of the manufacturing processes. China is speeding ahead to become the world leader but not in a sustainable way. It is vitally important for Chinese suppliers to further enlarge their investment in R&D and innovation to further enhance efficiency in energy consumption and reduce pollution during the production.



# **Current Status of The Industrialization of Condensing Photovoltaic and The Prospect Analysis**

*By Han Lisheng, Deputy General Technical Manager, Suncore Photovoltaic Co., Ltd.*

## **CPV**

Concentrated Photovoltaic (CPV) technology produces unparalleled energy output by combining concentrating optics with tiny, highly efficient cells. The technology minimizes the amount of PV materials required, maximizes energy production and reduces the energy generation cost. CPV systems utilize multi-junction cells that are designed for the unforgiving environment of space, where temperatures can be in excess of 200°C. The MJ cell has an excellent temperature coefficient, which provides significantly more energy than silicon technology in hot climates.

## **Comparison between CPV and thin film**

Thin film requires one percent of the semiconductor material used for silicon cells. CPV has a comparative advantage over thin film: it requires just one-tenth of one percent of the semiconductor materials consumed in the silicone manufacturing process. Since optical lenses cost less than using extra semiconductor materials in the manufacturing and installation process, concentrated photovoltaic generates a kilowatt- hour output for less compared to thin-film and silicon modules. High-efficiency silicon has an efficiency of 22% while the thin film's efficiency is 13%. In terms of the overall system efficiency, CPV stands at 29%, high-efficiency silicon at 15-16% and thin film at 7-8%. However, as CPV needs optical systems to concentrate the sunbeams on a point, areas with less adequate sunlight or cloudy weather are not applicable for adopting CPV. Therefore, CPV and thin films are not suitable for substitution.

## **Challenges ahead**

According to lab results, cell efficiency is about 50% but might be less when put into mass production. Installation costs, together with on-site maintenance, would be around 8 RMB, and which can be lower with technological innovation.

# **Operation and Maintenance of High Efficiency Management Power Stations**

*By Chen Guoliang, HT-SAAE/Shanghai Solar Energy Science & Technology Co., Ltd.*

## **Background**

The number of photovoltaic power stations in China has grown rapidly since last decade. The power converses source via photovoltaic modules that convert light directly to electricity.

Even though the number of PV power stations is increasing, it is important to keep in mind that the performance ratio (PR) of existing power plants is not ideal.

### **Influencing factors of PR**

There are several factors that can potentially affect the PR value. Firstly, performance and efficiency of a solar cell depend on the temperature of the PV module. At lower temperatures a PV module is especially efficient. Also, in the morning, evening and especially in winter, when the sun is low in the sky, the value for the incident solar irradiation approaches that of power dissipation more closely than at other times of day and year. For this reason, the PR value is lower than usual at these times. Thirdly, losses due to shading are underestimated. Output of solar panels, especially crystalline technology, can be reduced by 50% with just 10-15% of shading. In a typical solar plant inverter room, control device is the main body for shading. It is true that shading cannot be avoided, but the goal is to optimize the design so that losses from shading can be minimized.

### **How to enhance PR**

It was observed in some plants that one string is placing the next string in shadow. So, one should take care with structural designs and the designer should pay special attention to thermal expansion of the material used and the site's maximum temperature. Module mismatch losses cannot be zero as there will defiantly be some manufacturing differences from one module to another. While selecting a module, one should notice that these tolerance limits are at a minimum. It is equally important to select and use a right cable size, which can potentially reduce the current in the cable which would lead to greater loss in the plant. In fact, the operating temperature of DC cable is equally important and cable routing should be done in a separate cable tray possessing slotted holes for proper ventilation to dissipate the heat generated through the DC cable.

## **Annex I: Event Agenda**

### **CPVC14 Keynote Speeches, November 19**

**Opening Ceremony** 9:00-10:00

**Opening Speeches:**

Shi Dinghuan, Director General, *China Renewable Energy Society*

Gao Jifan, Director General, *China Photovoltaic Industry Association*

Chen Jiachang, Deputy Director, *High and New Tech Bureau of Ministry of Science and Technology*

Liang Zhipeng, Deputy Director, *New and Renewable Energy Bureau of National Energy Administration*

Peng Hongbing, Deputy Director, *Electronic Information Bureau of Ministry of Industry and Information*

Patrick Haverman, Deputy Country Director, *UNDP China*

Wang Dagang, Project Director, *Renewable and Distribute Energy Department of International Copper Association*

**CPVC 14 Award Ceremony** 10:00-10:20

**Keynote Speeches I:**

Hosted by: Zhao Ying, Deputy Director, China Renewable Energy Industry; Director, Photovoltaic Professional Committee of China Renewable Energy Society

**Development Roadmap of High Ratio Renewable Energy of China in 2050**

Wang Zhongying, Director, National Renewable Energy Center; Deputy Head of the Institute of Energy Research of State Development and Reform Commission

**Development of China's Photovoltaic Industry**

Wang Bohua, Secretary General, China Photovoltaic Industry Association

**Planning Direction and Thinking of the 13th Five-Year Plan of Photovoltaic**

Xu Honghua, Deputy Director, China Renewable Energy Society; Researcher, Institution of Electrical Engineering of Chinese Academy of Sciences

**Perovskite Solar Cell: Materials and Devices**

Mr.Nam-Gyu Park Professor, (South Korea) Sung Kyun Kwan University of Chemical Engineering

**Keynote Speech Section II:**

Host by Kong Li, Deputy Director, China Renewable Energy Society

**Photovoltaic Roadmap and Overall of the 13th Five-Year Plan**

Wang Sicheng, Deputy Director, Photovoltaic Professional Committee of China

Renewable Energy Society; Researcher, Institution of Energy of the State Development and Reform Commission

**Development Direction of Grid Connection of Distributed Photovoltaic and High Voltage**

**DC and AC Technology**

Wang Weisheng, Head of the Research Institute of New Energy of China Electric Power Research Institute

**The Latest Technology and the Forecast of Photovoltaic Inversion**

Cao Renxian, General Manager, Sungrow Power Supply Conduct. Ltd.

**Keynote Speech Section III:**

Host by Zhao Yuwen, Deputy Director, China Renewable Energy Industry Association

**New Leap of the Development of Our Country's Poly-Silicon**

Yan Dazhou,, Deputy Chief Engineer, China Enfi Engineering Corp; Director, Silicon Material Business

**Development of High Efficiency Crystalline Silicon (IBC)**

Feng Zhiqiang, Deputy Technical President, Trinasolar; Director, Trinasolar Photovoltaic Science and Technology Key Lab

**Technical Trend of Gallium Arsenide**

Dai Mingfang, Standing Deputy General Manager, Hanergy Holding Group

**Current Status of the Industrialization of Condensing Photovoltaic and the Prospect Analysis**

Han Lisheng, Deputy General Technical Manager, Suncore Photovoltaic Co., Ltd.

**Operation and Maintenance of High Efficiency Management Power Station**

HT-SAAE/Shanghai Solar Energy Science & Technology Co., Ltd.