

# Feasibility Analysis of Constructing Solar Power Plant by Combining Large Scale Wind Farm\*

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Received January, 2013

## ABSTRACT

Hybrid utilization of renewable energy is one of effective method which can solve the problem that unstable of renewable energy so as not to substitute traditional fossil energy. As the typical renewable energy, solar energy and wind energy are in the van of renewable energy utilization. With the large scale utilization of solar and wind energy in the world, constructing large scale solar power plant in the large scale wind farm can make the most of ground resource combining the wind energy with solar energy. Feasibility of constructing large scale solar power plant in the large scale wind farm was analyzed in this paper, and come to a conclusion that constructing large scale solar power plant in the large scale wind farm can not also achieved the goal of mutual support of resource advantages and economizing money but also improved significantly the seasonal mismatch by combining solar with wind.

**Keywords:** Hybrid Utilization; Solar Power Plant; Wind Farm

## 1. Introduction

With the emergency of the energy shortage and necessity of environmental protection, development and utilization of renewable energy has been paid more attention by most countries from the world. In **Figure 1**, Status Report of renewable energy in the world in 2012 from World watch Institute show that the best part of generating electricity by renewable energy is wind power which installed capacity reached 238GW by 2011, the growth rate is 20% in 2011, the fastest developing renewable energy technology is grid-connected solar photovoltaic which growth rate is 74% in 2011, installed capacity reached 70 GW by 2011. As the excellent renewable energy, installed capacity of wind and solar power is growing fast in the coming years. Grid-connected wind power and solar power have intermittent fault which will influence the electrical grid stability because of the limits of time, location. With the large scale development of wind and solar energy it is the major trend that stability of renewable energy generating electricity is improved by utilizing the advantage of resources complementary in the future.

## 2. Objective of Constructing Solar Power Plant by Combining Large Scale Wind Farm

### 2.1. Complementary Utilization of Wind and Solar Energy

The wind energy is transformation from solar energy because the sun shines the earth, capacity variance of wind and solar energy is tremendous because of the variety of weather condition[1]. Wind energy and solar energy can be utilized complementary in most area (about two-thirds of total area) in China. The trend of energy change in one year is opposite, which can provide the condition for the complementary utilization of wind and solar energy.

### 2.2. The Ground Resources to be More Efficiently Utilized

Constructing the large scale wind farm and large scale solar power plant also need large areas of land to be utilized especially large scale wind farm. Considering the technology the row spacing between wind turbines is far

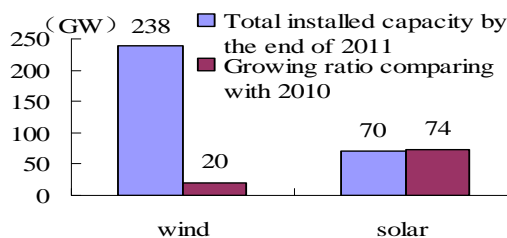


Figure 1. Utilization scale of wind and solar energy.

\*The School Fund of Inner Mongolia University of Technology (ZD201113).

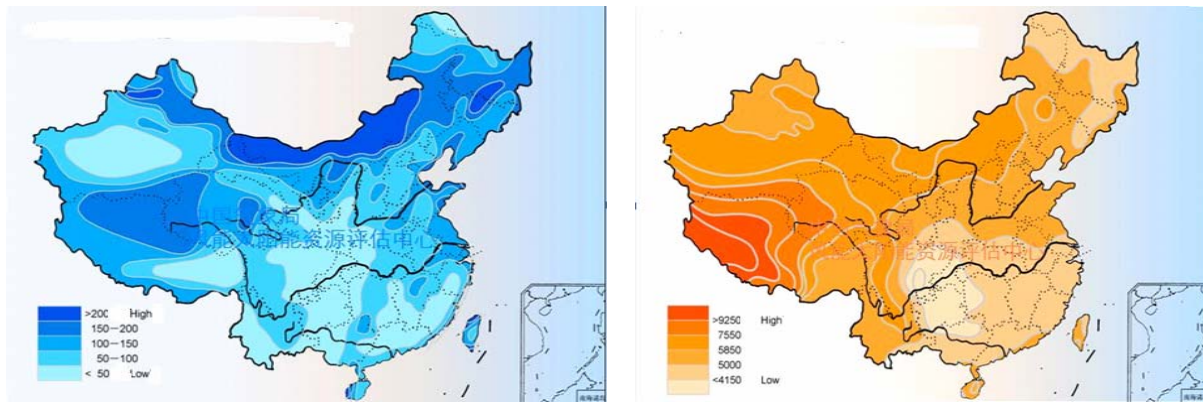


Figure 2. Resource of wind and solar energy in China.

when the large scale wind turbine were placed, which can weaken the influence of wake flow among wind turbine in the wind farm. In general the distance of row from left to right is 5 - 9 times of wind rotor diameter, the distance of row from front to back is 3 - 5 times of wind rotor diameter. Apart from the foundation of generating electricity system and supporting facilities will utilize the land less than ten percent of the whole area, there are more than ninety percent of the whole area in the wind farm is still leave unused[2-3]. So constructing large scale solar power plant in the large scale wind farm can efficiently utilize the land resource.

### 2.3. Grid-connected Generating Electricity by Complementary Utilization of Wind and Solar Energy Can Improve the Quality of Electricity and Electrical Grid Stability

Single wind power generating electricity or solar power generating electricity has the fault of generating electricity unsteadiness, which will influence the electrical grid stability. In general wind speed is low during the day and high at night, low in summer and high in winter, compared with wind energy radiant intensity of solar is opposite. Constructing the grid-connected solar power plant by combining the wind farm will deliver electrical power continuously which will not be influenced because of different seasons and different time.

### 2.4. Cost Reduction

Ground planning and complementary utilization of public accommodation and construction of grid-connected can be carried out in accordance. Compared with the single wind power plant or solar power plant, construction of the hybrid power plant will reduce the investment and the processing costs significantly. Considering from economy the obvious economic benefit can be gained by constructing the grid-connected solar power plant in the wind farm.

## 3. Condition of Constructing Solar Power Plant by Combining Large Scale Wind Farm

### 3.1. Rapid Growth Trend of Wind and Solar Energy Development in Inner Mongolia

The installed capacity of wind power in Inner Mongolia is the first in China. Up to the end of 2011 the total grid-connected installed capacity has hit 8750 MW. According to Development Plan of Wind Power in Inner Mongolia from Development and Reform Commission of Inner Mongolia, the total grid-connected installed capacity is 33000 MW will be finished by the end of 2015, compared with wind energy, total grid-connected installed capacity of solar power will reach 800 MW by the end of 2015 although utilization of solar energy is slow in the last several years.

### 3.2. Land Resources

A large scale wind farm will cover huge areas ground, in general a wind farm which installed capacity is 100 MW will cover 13 - 15 square kilometres land. Take 100 MW wind farm for instance, about 14 square kilometres land will be covered. 80 wind turbines which capacity is 1250 Kw each turbine are installed in the wind farm. The area of 80 wind turbines foundation, the area of ancillary facility and road in the wind farm are less than 2 square kilometres, more than 12 square kilometres land area leave unused.

On the other hand large scale solar power plant will also cover huge areas land because of low density of solar energy resource. For example solar photovoltaic cell per 100 Wp will cover 3.2 square meters, and 100 MW solar photovoltaic cell will cover 3.2 square kilometres. So the land areas of 100 MW wind farm are enough to reach the land demand of 100 MW solar power plant[4].

### 3.3. Abundant Natural Resource

Terrain and physiognomic of most area in Inner Mongolia

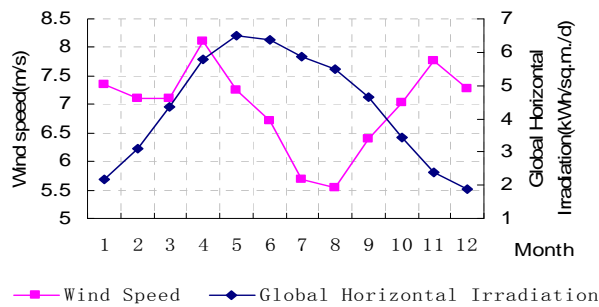


Figure 3. Complementarity of wind and solar energy in HUITENGXILE wind farm in Inner Mongolia.

is plateau, desert, hunger. Good stability and continuity is the characteristic of wind energy quality in Inner Mongolia, and no destructive typhoon and hurricane occur in Inner Mongolia. At the same time the hours of sunshine in most area of Inner Mongolia will be above 2700 hours, and the annual solar radiation amount is much, which is good for instructing solar power plant. Resource of wind and solar energy in China is shown in Figure 2.

Take HuiTengLiang wind farm for instance, the geography position (E:116°10'N:43°25') located in XiLin-GuoLe in Inner Mongolia. A figure was gotten by via of the data from satellite data of National Aeronautics and Space Administration Database. As can be seen from the Figure 3, complementarity of wind and solar energy is obviously according to the trend of energy change in one year, it shows that there is abundant complement energy resource to construct the large scale solar power plant by combining large scale wind farm.

### 3.4. Mature Technique

Development and utilization of renewable energy is one of five techniques in the field of technology in the process of world economic development. The technique of wind energy generating electricity and the technique of solar energy generating electricity were regarded as a renewable technique which has good develop prospect in the future. With the rapid and a large scale development and utilization of wind and solar energy, techniques of large scale grid-connected wind farm and solar power plant get mature day by day. The mature technique will be support to constructing large scale solar power plant by combining the wind farm.

## 4. Problem

### 4.1. Hybrid Wind and Solar Complement Controlling Technique

Large scale hybrid grid-connected wind and solar gener-

ating electricity system can provide electricity the same as conventional thermal power plant. Stability of system operating and generating electricity by wind and solar energy should be controlled. So hybrid wind and solar complement controlling technique should be researched although the controlling technique of single large scale grid-connected wind energy generating electricity system or wind energy generating electricity system is mature.

### 4.2. Reasonable Arrange of Solar Energy Generating Electricity System in Wind Farm

Taking the solar photovoltaic generating electricity for instance[5], solar photovoltaic cell is to absorb a sufficient amount of sunlight for efficient energy conversion. Reasonable arrange of solar photovoltaic cell should be done so that no shadow will influenced solar photovoltaic cell by wind turbine in large scale wind farm.

## 5. Conclusions

There are sufficient conditions to support the constructing of grid-connected large scale wind and solar generating electricity system in Inner Mongolia. Constructing large scale solar power plant by combining wind farm will enjoy an absolute advantage during the course of renewable energy's development and utilization in the future, which can make the renewable energy access to the field of electricity power, at last the market of wind and solar generating electricity will change in essence.

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