

Application of solar photovoltaic generation in the world

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Abstract. Recent years, the rapid development of solar photovoltaic has become a new hope to save the environment pollution and resource shortage in the electric power era. Countries have introduced relevant policies to support the development of photovoltaic power generation industry actively. Independent household solar photovoltaic system and Large-scale photovoltaic grid-connected system have been used successfully. However, development of countries' photovoltaic industry is uneven due to synchronized technology and resources. This paper describes the status quo of PV industry in major PV application countries.

1 Introduction

Energy is the basic of social development. Since the industrial revolution, we have experienced steam age and electrical age. Every change is accompanied with a change in the pattern of energy and marks great progress of human civilization. In the last centuries, electricity is the basis of global social and economic development accompanied with the improvement of industrialization and energy application. During this period, mining non-renewable resources and consuming fossil energy continuously leads to resource tension, air pollution, greenhouse effect, climate change and so on. Primary energy consumption is mainly concentrated in Asia Pacific, European continent, North America. As of 2013, Coal production in the Asia-Pacific region accounts for 26.7% of global coal production, but its coal use accounts for 68.8% of global consumption; Europe and the Eurasian coal production accounted for 42.4% of global coal production, but its coal use accounts for only 11.6% of global consumption. The origin and consumption areas of coal is seriously uncoordinated as traditional power production materials, therefore, the exploitation and transportation of coal may pollutes environmental. Indeed, the gap between fossil fuel reserves has caused disputes in the Middle East countries. Energy application model is changing which is aimed at reducing the impact of fossil energy on human beings. Clean energy substitution and electric energy substitution is the core of energy consumption patterns transformation. At present, wind power and photovoltaic power is the most widely used cleaning power. Wind power is limited by its geographical distribution of resources. Solar photovoltaic

has such features as simple installation, small floor area, noise free, individual household or photovoltaic grid-connected, and that it has been popularized widely [1-3]. Photovoltaic power generation will become the mainstream.

2 Distribution of global solar radiation

The distribution of solar energy resource is evidently regional which is affected by climate. Solar radiation in North Africa, Middle East, Southwestern United States, Mexico, Southern Europe, Australia, South Africa and Western China is strongest. The solar energy in the areas is best both duration and intensity of sunlight so these areas have a unique advantage in using solar power. Total solar radiation (year) in some areas was shown in Table 1. The solar radiation in North Africa and part of American is the most abundant. The distribution of solar radiation in these areas is not significant as Southern Europe, the Middle East, Australia and China. The following application of the current situation is based on Table 1 whose solar radiation is abundant. Photovoltaic power generation of countries in the areas is not all going well although those solar radiation is abundant.

3 Application of solar photovoltaic generation

Photovoltaic power generation includes independent photovoltaic system and photovoltaic grid connected system according to whether the grid is connected to the

Table 1. Total solar radiation(year) in major countries

country Radition and area	Total solar radiation(year)/ (MJ/m ²)	distribution area
Algeria	9720	
Morocco	9360	
Tunisia Libya	> 8280	
Spain	8100	
Italy	7200	
Greece	6840	
Portugal	7560	
Israel Jordan Saudi Arabia	8640	
United Arab Emirates, Iran	7920	
United States	9198-10512	First area(9.36% of US area)
	7884-9198	Second area(35.67% of US area)
	6570-7884	Third area(41.48% of US area)
China[4]	6680-8400	Western China
Australia	7621-8672	First area(54.18% of Australia's area)
	6570-7621	Second area(35.44% of Australia's area)

grid. Independent photovoltaic includes photovoltaic system with storage battery and photovoltaic system without storage battery. The cost of solar photovoltaic generation system is composed of solar panels, inverters, batteries, post-maintenance costs. The cost of solar photovoltaic generation is much higher than traditional power generation system which is counted base on the life of solar panel. Although photovoltaic grid connected technology has been put into application, it is still in the early stages of development and the technology is immature. Countries have introduced relevant supporting policies, however, the support gradually weakened in recent years. In addition, government support is not a permanent solution, because each photovoltaic system has its service life.

Factors that restricted photovoltaic power generation

industry development are as follows:

-The main raw material for solar cell silicon crystal is scarce in prophase.

-The conversion efficiency of solar panel sold on market is low as the conversion efficiency of mainstream monocrystalline silicon cell and polycrystalline silicon cell 15% -21% and the conversion efficiency of thin-film solar battery is just 6% -13%, the differences of solar cells sold on market is shown in Table 2.

-The development of solar cell manufacturing technology is uneven, the production technology is not shared.

-Photovoltaic power generation has a typical periodic, but storage battery can not achieve a large number of energy storage.

Table 2. Comparison of photovoltaic cells

Performance Types of solar cell	Monocrystalline silicon cell	Polycrystalline silicon cell	Thin film solar cell
photoelectric conversion efficiency	15%-21%	15%-18%	6%-13%(The cell can still work with weak light.)
manufacturing cost	The production cost is high, and can not be widely applied at present	Mass production can be carried out due to its low production cost with simple manufacturing process and low power consumption.	The production process is completely different from the crystal silicon battery, the process is greatly simplified, the silicon material consumption is low, and the power consumption is low
Service life	It is packaged by toughened glass and waterproof resin.Its service life is about 15-25 years	It is packaged by EVA.Its service life is shorter than Monocrystalline silicon cell.	About 10 years.Its conversion efficiency decreases obviously with time.

Photovoltaic cells on market is less redundant because the longer the time,the lower the efficiency is.Polysilicon is the main raw material for photovoltaic panels.We can get it that polysilicon industry is glut base on the data during 2010-2015.It reflects the supply of raw materials for photovoltaic cells is sufficient, while the production technology is not advanced.

3.1 Application of photovoltaic power generation in USA

United States has introduced a new bill which is aimed at solving the problem that new energy enterprise is lacking motivation in developing new technologies.New energy plan and harsh environmental requirements for fossil fuels are presented.The plan proposed that government will offer capital and technology to photovoltaic power generation industry by subsidizing raw material procurement and production[5].Renewable Energy Power Generation Tax Credit Policy (PTC) has been extended to 2020 and Federal Commercial Energy Investment Tax Credit Policy (ITC) has been extended to 2022.New gross capacity of photovoltaic power generation in United States is 7.286GW in 2015.The number is 14.726GW in 2016.PV installed capacity accounted for 39% in the whole year in 2016.The accumulated photovoltaic power installed capacity of American is 25GW by 2015.

3.2 Application of photovoltaic power generation in Germany

Germany is undoubtedly the leader in the photovoltaic industry.Germany demands the most in Europe market demand for photovoltaic power generation products which is benefited from that German government is forward-looking in terms of new energy industry and advanced industrial system and semiconductor technology.It has obvious advantage in photovoltaic industry due to its key production technology and production technics.German government revises the German renewable energy law continuously to make it

better serve the photovoltaic industry in according to domestic and international economic environment[6].The government has provided credit to feed-in-tariffs.Germany has a lot of home photovoltaic power generation system, which gave birth to the development of household energy storage market.More and more industries are participating in this market.The accumulated photovoltaic power installed capacity of Germany is 39.40GW by 2015.

3.3 Application of photovoltaic power generation in Japan

Japan is a country that is less dense and lacks natural resources.Japan is one of the countries that started the photovoltaic industry earlier.Japan has re-planned its energy development structure after Fukushima nuclear meltdowns.Subsequently,it introduced a 10-year bill in regard to renewable energy subsidies[7].The bill aims to promote the development of photovoltaic power generation industry.However,solar companies appear bankruptcy peak in Japan due to government support policy tightening and poor management.So the future of Japan's PV development trend is still unknown

3.4 Application of photovoltaic power generation in China

China's photovoltaic manufacturing production plays original equipment manufacturer in global.Failed to grasp key production technology and production technics of photovoltaic industry contributed its passive position.In view of environmental problems such as resource shortage and severe haze,China has introduced a series of supporting policies of which the core is subsidizing photovoltaic power generation equipment installation and feed-in tariffs.The pre-subsidy policy only takes into account the installed capacity without taking into account the power generation.The electricity price subsidies is reducing gradually in order to reduce the dependence of the photovoltaic industry on the policy.Industrial

development focus from the previous expansion of the scale of development to improve efficiency and profit[8-10].The accumulated photovoltaic power installed capacity of China is 43GW by 2015.

4 Development direction of photovoltaic power generation

The count shows that global power demand showed a sustained growth and areas have a shortage of electricity.Electricity is not enough to rely on traditional electricity generation,the shortage must be supplied by renewable energy power generation.Solar photovoltaic generation is bound to be the main power supply form in the future due to its innate advantages.The main factors that limit the large-scale application of photovoltaic power generation are:

-Long-term effective encouraging policies and unified planning is lacking.

-There is no uniform technical standards.

-The construction cost of photovoltaic power generation system is high.

-Conversion efficiency of photovoltaic power generation inverter is low.

-Post-maintenance costs are high and maintenance-related statutes are immature[11-12].

5 Conclusion

Solar radiation on earth is renewable and ample.Solar photovoltaic will certainly be a major player because of its simple installation,small floor area and noise free.Photovoltaic power generation has been applied in many countries in the past decades.Independent household photovoltaic power generation system can solve the problem of power supply in remote area effectively and large-scale photovoltaic grid-connected system can effectively alleviate the shortage of power supply and environmental pollution.However,PV industry still has a series of problems in terms of policy and technology, such as high production cost of power generation system,low conversion efficiency of photovoltaic inverter , grid fluctuation caused by grid connection,large amount of electric energy storage etc.At present,regardless of which country,its rapid development of photovoltaic power generation scale and policy support are closely tied.And then,what we have to do is reducing the installation cost,generation cost and maintenance cost of photovoltaic generation.It's no longer a dream that solar photovoltaic generation become the dominant as science and technology is developing.

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