

Discussion of Solar Energy Power Feasibility in Jinan

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Abstract: This paper presents the states of solar energy power technology, and points out the importance of finding new energy. According to the standard year weather date in Jinan, Shandong province, P.R.China, the frequency of solar radiant intensity is analyzed, and the solar energy power potential is discussed in Jinan. A theoretic basis for the feasibility of solar energy power in Jinan is founded.

Keywords: solar energy, power, solar radiant intensity, frequency, sunshine hours, potential

1. INTRODUCTION

With economy developing, society progressing and improving of the people's life level, power requirement is increasing by degrees. Meanwhile people have more and more expectations to the power supply. Finding new energy resource is the urgent task that faces us now.

What is the new energy? There are two features, which must be fulfilled simultaneously for the so called new energy. Firstly they are abundant and inexhaustible. Secondly they are safe and clean therefore they will not threaten human beings and damage the environment. The new energy sources presently found are solar energy, wind energy, geothermal energy, tidal energy and biomass energy. Among which, solar energy is the best ideal one. The solar energy amount, which reaches the earth, is very huge. As estimation the amount of the solar energy that reaches the earth in about 40 minutes can afford one year's energy consumption globally. Compared with the conventional energy, solar energy is clean, environment friendly and will never be used up. All these features are competitive to other conventional energy, solar energy power has a wonderful future. Unfortunately it was not researched on a large scale until first and second petroleum crises occurred because the density of solar energy is low and no easy to take it out for utilization. There was difficult to use this kind of energy. With the developing and progressing of the technology, solar energy power is increasing rapidly now. With the industrialization and the further deep technology development the efficiency and rate of performance with cost will be increased. Recently, research on solar energy develops rapidly, and present a good outlook^[1,2].

To 2050, as estimated, the scenario of all kinds energy will be: petroleum 0 (or minute); natural gases, 13%; coal, 20%, nuclear energy 10%; hydropower, 5%; solar energy, wind energy and biomass energy, 50%; others, 2%. It can be seen that 21 century is the time when solar energy is used on a

large scale.

2. THE PRINCIPLE AND THE STATUS OF SOAR ENERGY POWER

There are two solar energy power methods, solar energy power by thermal process (such as tower type, paraboloid focus type, solar chimney type, thermal photovoltaic type and temperature difference type, etc.) and solar energy power by non thermal process, such as photovoltaic power, photosensitive power, photochemical power and photobiomass power, etc. In the research and application, the widely used methods are solar thermal power and photovoltaic power.

2.1 solar thermal power

Solar thermal power is an important type of solar energy using. The principle is to collect and focus the solar energy, heat medium, drive turbine, and then electricity can be generated. Solar thermal power is a process which composed by a series of optical, mechanical, and electrical transitions. Typical solar thermal power system consists of four parts, ray focus and heat collection system, heat storage system, assistant energy system and turbine power system. Solar radiation energy is concentrated with ray focus apparatus, then reaches a collector where it is transformed into thermal energy by means of interaction with the collector surface's wavelike material^[3]. Meanwhile, water flows through collectors, absorbs heat, and is turned into superheat vapor, which is then delivered to turbines. Because of pressure drop, turbines change thermal energy into mechanical energy which drives generators, thus electricity is generated.

2.2 solar energy photovoltaic (PV) power

Application of solar energy PV power started soon after practical silicon solar cell appeared. PV power is no consumption of fuel, no limitation by regions, and no special requirement of the size. PV power can work either independent or in the power net. It is noiseless,

Table 1. Conversion efficiencies of several kinds of PV cells

product	Develop process	Product type	year		
			1991	1995	2000
monocrystalline silicon PV cell	laboratory	cells	23.0	24.0	25.0
		components	17.0	21.5	22.0
	commercialization	Middle scale	15.0	15.3	16.0
		Large scale	13.0	14.0	15.0
Amorphous silicon PV cell	laboratory	cells	9.0	10.0	13.0
		components	6.0	8.0	10.0
	Large scale	components	4.0	6.0	8.0
		components			
CuInSe ₂ cell	laboratory	cells	13.0	17.1	20.0
		components	9.0	10.2	13.0
	Large scale	components			10.0
		components			
CdTe cell	laboratory	cells	12.5	15.8	16.4
		components	6.0	8.4	9.0
	Large scale	components		6.0	8.0
		components			

Table 2. Electricity price, construction efficiency, system life-span and cost of PV power

year	PV Electricity price (cents/kWh)	PV components efficiency (%)	PV system life-span (year)	PV system cost (\$/W)
1991	40~75	5~14	5~10	10~20
1995	25~50	7~17	10~20	7~15
2000	14~20	10~20	>20	4~8
2010-2030	<6	15~25	>30	1~1.5

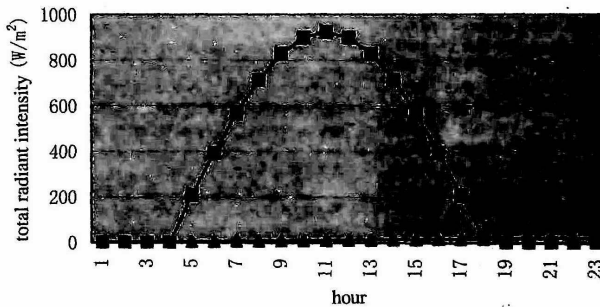


Fig. 1 Total solar radiant intensity during a day in Jianan

no pollution and safe. It doesn't need to set up electric delivery lines. Its constructing cycle is short, and its maintaining is easy. It can operate without watching. solar energy PV power has advantages that other power methods haven't. It's the important technical basis of applying solar energy on a large scale.

In the solar energy power system, the total efficiency η_{sys} consists of PV conversion efficiency of cell parts, controller efficiency, accumulator efficiency, reverse transformer efficiency and load efficiency, etc. So far conversion efficiency of system is about 17%^[4] (the conversion efficiencies and costs of several principal PV cells are shown in table 1 and table 2). Therefore raising conversion efficiency of cell parts and lowering the cost per unit of power are important and difficult in industrialization of solar energy PV power.

Since 1980's, China has successively introduced a number of American monocrystalline silicon solar

energy cell and amorphous silicon solar energy cell production equipments.. China PV industry started at that time^[5-6]. China was able to produce 8.5 MW/year of solar energy cells by the end of 2000, including 6.5MW/year of crystal silicon solar energy cells and 2.0MW/year of amorphous silicon solar energy cells. Chinese volume output of monocrystalline silicon PV cells was 1.8MW/year in 1997, and 3.0 MW/year in 2001. Price was lowered from 42~47 yuan/w in 1997 to 35~40 yuan/w in 2001. Output of amorphous silicon solar energy cells was 400kW. Price was 23-35 yuan/w, photoelectricity conversion efficiency is 4~6%. Recent research shows photoelectricity conversion efficiency of efficient crystal silicon solar energy cells reaches 21% ; GaAs solar energy cells, 23.1%; polycrystalline silicon solar energy cells, 14.5%; ray focus cells, 17%; CuInSe₂ cells, 8.0%; CdTe cells, 7.0%; microcrystalline silicon bottom cells, 12.1%; amorphous silicon

cell, 11.2%.

Table 3. Analysis on Ji'nan frequency of total solar radiant intensity

Total Radiant Intensity (W/m ²)	Frequency (hour/year)	Accumulate Frequency (hour/year)	Frequency Rate (%)	Accumulate Frequency Rate (%)
(0, 50)	332	332	7.81	7.81
(50, 100)	395	727	9.29	17.1
(100, 150)	476	1203	11.19	28.29
(150, 200)	349	1552	8.21	36.5
(200, 250)	329	1881	7.74	44.24
(250, 300)	327	2208	7.69	51.93
(300, 350)	269	2477	6.33	58.26
(350, 400)	293	2770	6.89	65.15
(400, 450)	266	3036	6.26	71.41
(450, 500)	209	3245	4.92	76.33
(500, 550)	201	3446	4.73	81.06
(550, 600)	167	3613	3.93	84.99
(600, 650)	152	3765	3.57	88.56
(650, 700)	120	3885	2.82	91.38
(700, 750)	123	4008	2.89	94.27
(750, 800)	69	4077	1.62	95.89
(800, 850)	77	4154	1.81	97.7
(850, 900)	50	4204	1.18	98.08
(900, 950)	29	4233	0.68	99.56
(950, 1000)	14	4247	0.33	99.89
(1000, 1050)	4	4251	0.09	99.98
(1050, 1100)	1	4252	0.02	100

With the development of solar energy cell technology, PV power is gradually applied, its scale is also increasing^[7]. The main tendency to develop PV power system is power net PV power system, which will soon be applied in China.

3. ANALYSIS ON SOLAR ENERGY POTENTIAL IN JI'NAN

In order to analyze solar energy power potential in Jinan, Shandong province, P.R.China, and utilize solar energy better, According to solar radiation values actually measured and criteria year's weather data^[8,9], authors discussed the variation law of total solar radiant intensity in Jinan, and frequency distributing of total solar radiant intensity (Fig.1 and Table 3). There are totally 4252 sunlight hours in Jinan a criteria year. The maximum of total hourly solar radiant intensity is 1051 W/m². The total solar radiant intensity in a year is 1.4 MW/m². If PV conversion efficiency is 10%, yearly power can be 140 kW/m².

As shown in table 3, The maximum range of Jinan distributing frequency of total solar radiant intensity is 100-150 W/m², in this range, sunlight hour is 476 hours,

which constitutes 11.9% of one year total sunlight hours; For all ranges in which total radiant intensity are 330-550 W/m², the frequency is more than 200 hours, amounting to 1238 hours, constituting 29.1% of one year total sunlight hours; For all ranges in which total radiant intensity are 550-750 W/m², the frequency is more than 100 hours, amounting to 562 hours, constituting 13.2% of one year total sunlight hours;

For all ranges in which total radiant intensity are 750-1000 W/m², the frequency is less than 100 hours, amounting to 239 hours, constituting 5.6% of one year total sunlight hours; In the ranges of above 1000 W/m², there are only 5 sunlight hours, 0.11% of one year total sunlight hours. Thus it can be seen that solar energy source in Jinan is abundant. There is huge potential of developing and utilizing this kind of energy. The outlook of applying solar energy power is bright.

4. CONCLUSIONS

4.1 solar energy sources in Jinan are abundant. In a year the sunlight hours in which total radiant intensity is more than 100 W/m² constitutes 90%, Solar energy power will find a good market in future.

4.2 Solar energy is clean energy. Solar energy power avoids pollution caused by fire power and prevents zoology damage caused by hydropower. Therefore, by means of domestic and overseas advanced technology, Jinan should make full use of local solar energy source, make an effort to develop solar energy PV power, strive for realizing PV power net system, and thus, make electricity power source more abundant to meet the needs of fast economic development.

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