

# Solar Lamps—The Eyes of Herdsmen at Night

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## Abstract

Since the western regions have good conditions of sunshine and rich solar energy resources, using solar photovoltaic (PV) energy to solve the problem of electricity supply for the local residents' life has become a major technical choice. The solar PV systems in the western regions are mainly used to solve the problem of lighting. Restricted by the level of income, the users of most PV systems can only use DC power systems without inverters, so the use of DC lamps is very popular.

At present, there are totally more than 100 DC lamp manufacturers in China. The production capacities of these manufacturers are all low and the quality of their products is also uneven. The reasons of poor product quality are as follows: some large enterprises with actual strength have not set foot in this market, holding the size of this market is too small; some small enterprises use components with inferior quality and low prices to cater for consumers' preference for inexpensive products for their low purchasing power. These reasons have led to poor product quality, short service life and high cost in service life.

The World Bank/Global Environment Facility China Renewable Energy Development Project that is underway at present has selectively inspected the products of some DC lamp manufacturers to keep abreast of the current situation of DC lamp manufacturing in China, provide a scientific basis for scientific support and other activities at the next step, and finally reach the purpose of increasing product quality, reducing production cost and serving the users through the measurement of samples and the analysis and summary of the result of inspection.

When conducting market survey for the World Bank-supported China Renewable Energy Development Project in the western regions in 1998, the authors once asked the herdsmen that already had solar PV systems at that time: "If somebody wants to buy your existing solar PV system, how much do you want the buyer pay?" Almost all the interviewed herdsmen answered: "We'd never sell them at any price, because they are we herdsmen's eyes at night."

As of the end of 2002, electricity supply was still unavailable for about 30 million persons of 7,053,790 households in 21,560 villages. Most of the persons that can get no electricity live in the outlying areas of the northwestern regions that are characterized by a broad territory but a scarce population that accounts for only 28% of China's total population. Supplying electricity through the extension of powder grids is not reasonable in economy due to many mountains, dangerous landforms and very difficult construction. However, the good conditions of sunshine and the rich solar energy resources in the western regions have made the utilization of solar PV energy a major technical choice for solving the problem of domestic electricity supply for the local residents.



The targeting area of the WB project: Inner Mongolia, Xinjiang, Qinghai, Gansu, Sichuan, Xizang



Portable Solar PV Home System

Before the 1990s, the PV electricity generation market in the outlying areas of China was mainly supported by the state poverty-alleviating program and bilateral or multi-lateral aid programs. With the development of economy in the outlying areas and the increase of the incomes of farmers and herdsmen, the PV electricity generation market in such areas has begun developing in the direction of commercialization since the 1990s. According to investigation by the World Bank/Global Environment Facility Renewable Energy Commercialization Project, the number of companies and organizations engaging in the manufacturing or selling of solar PV electricity generation systems in the western regions rose from less than 10 in the 1980s to more than 100 in 2003. Because these regions are underdeveloped in economy, there are many 10-20W small systems. The sales price of a 10W system is RMB650-700 and such a system can drive one DC lamp; the sales price of a 20W system is about RMB1,400 and such a system can drive one DC lamp and one small black-and-white TV set. The popularization of PV systems has brought along the popularization and application of DC lamps, which are very widely used in the western regions.

At present, a considerable number of enterprises in the western regions are manufacturing and selling DC lamps. However, to reduce cost, some manufacturers use low price as a means of market competition by reducing the design requirements of DC lamps and using low-quality and low-price electronic components, lamp tubes and insulation materials; at the same time, most distributors only pay attention to the prices of products but ignore product quality, and distribute a large number of DC lamps with inferior quality and low prices. At present, the DC lamps sold on the market mainly have the following quality problems: inconsistency between the actual power values of DC lamps and the values indicated on the lamps, low initial luminous flux, low luminous efficacy, no exception protection function, low rate of lumen maintenance in 2,000h, and poor service reliability.

According to the World Bank China Renewable Energy Development Project's arrangement, in 1999 the National Center for Quality Supervision and Test of Electric Light Sources (Beijing) conducted a random inspection of DC fluorescent lamps (appliances) for solar PV systems in six provinces and autonomous regions of China. The samples were mainly randomly taken from the qualified products in the finished-products warehouses of manufacturers. The technical conditions specified by the World Bank China Renewable Energy Development Project for DC fluorescent lamps (appliances) were used as the basis of inspection. The random inspection was mainly conducted for the products of small and medium-sized enterprises. As indicated by the result of inspection, though the luminous efficacies of the DC fluorescent lamps inspected conformed to the required value of more than 35lm/W, the designed luminous flux and power values of all the lamps were low; the nominal power of some lamps was 8W, but the measured value was only about 4W; and the safety indexes (e.g. the indexes of fire resistance, anti-flammability, etc.) of the materials adopted for the products of some enterprises also had problems.

To evaluate the actual quality of the DC lamp products approved during the implementation of World Bank China Renewable Energy Development Project, the project initiated another selective inspection of DC lighting appliances in 2003 to test the performance, reliability and life of DC lamps in

accordance with the project's requirements, keep abreast of the current situation of DC lamp manufacturing in China and provide a scientific basis for technical support and other activities at the next step through the measurement of samples and the analysis and summary of the result of inspection.

Totally 12 enterprises took part in the selective inspection. In comparison with the situation in 1999, though some important indexes were improved to a certain extent (for example, during the inspection in 1999, the service life of no enterprise's products was more than 1,000h; during the second inspection, the service life of eight enterprises' products was more than 2,000h).The evaluation standards is as follows

### Evaluation Standards

No.	Testing items	Standard requirements	Sample number	Evaluation condition
				Ac, Re
1	Input wattage	No more than 105%+0.5W	10	3,4
2	Lumen efficiency	No less than 40lm/W		
3	Color characteristics	SDCM $\leq$ 6 Ra $\geq$ 80 $\leq$ 4500K		
4	Lumen maintenance of 2000h	$\geq$ 80%		
5	Average life	No less than 3000h		
6	Switches	No less than 6000 次	5	1,2
7	Marking	Integrity and clarity	8	1,2
8	Lamp cap dimensions	Qualified Interchangeability	12	1,2
9	Mechanical strength	Torque level $\geq$ 3N · m		
10	Resistance to heat	The diameter of the impression is no more than 2mm	1	0,1
11	Resistance to fire	The glow-wire 30s	1	0,1
12	Removal of lamp	Power loss $\leq$ 20% or Power loss $\leq$ 1.6W(when power $\leq$ 7W)	3	0,1
13	Reverse-connection protection			
14	Pack protection test	/	One pack	/

Compared with the test made in 1999, this test indicates great improvement in quality. For instance, the highest average value of Lumen Efficiency is 55 lm/W; The highest average value of Lumen maintenance of 2000h is 90%; there are eight manufacturers whose tested results of Lumen maintenance of 2000h is qualified and Average life are above 3000 h.



However, the test also find some problems in many aspects and further improvement was

necessary. The particular result of test is as shown in the following table:

Summary statement of the conformity of the items of test

Items of test		Number of qualified lots	Number of unqualified lots	Pass rate (%)	
Initial photoelectric parameters	Input power	9	3	75	
	Luminous efficacy	12	0	100	
	Color indexes	Color coordinates	3	9	25
		Color rendering index			
Correlated color temperature					
2,000h lumen maintenance rate		8	4	67	
Average life		9	3	75	
Number of on/off cycles		7	5	58	
Safety requirements	Mark	0	12	0	
	Dimensions of lamp cap	7	5	58	
	Shock prevention				
	Soldering height				
	Mechanical strength	9	3	75	
	Heat resistance	11	1	92	
	Fire resistance	12	0	100	
Exception protection	Open-circuit protection	7	5	58	
	Transposition protection	12	0	100	
Packing protection		12	0	100	

The nonconformities discovered during the inspection mainly concentrated in the following items of test: The marks of 12 lots of samples (including the necessary precautions) were unqualified. Only seven lots had qualified open-circuit protection and the pass rate was only 58%. As for the items of test related to the quality of lamp caps, the pass rate of the dimensions of lamp caps was only 58%; the pass rate of mechanical strength was only 75% and the mechanical strength of three enterprises' products was unqualified. As for the items of test related to service life, the pass rates of 2,000h lumen maintenance rate, number of on/off cycles and average life was respectively only 67%, 58% and 75%; the service life of some samples was very short and was even under 2,000h. The pass rate of color parameters (including color coordinates, color rendering index and correlated color temperature) was only 25%. The pass rate of input power was 75%.

Though the luminous efficacies of all the DC lamps tested during the selective inspection were qualified (i.e. no lower than 40lm/W), there still existed a certain gap in comparison with the limited values of luminous efficacy for AC lamps with same specifications (for self-ballasted fluorescent lamps that are used for general lighting and whose color temperatures are under 4,000K, the initial luminous efficacy shall not be lower than 40lm/W if the power of such lamps is 5-8W; the initial luminous efficacy shall not be less than 48lm/W if the power is 9-14W). In addition, the pass rates of 2,000h lumen maintenance rate, number of on/off cycles and average life that are closely related to the expected service life were respectively only 67%, 58% and 75% and were unsatisfactory for users. Furthermore, the period of average life test conducted to test the life of DC lamps was only 3,000h, far less than the period of 6,000h required by the standard for AC lamps. The color parameters (including color coordinates, color rendering index and correlated color temperature) of only three lots of samples met the requirements of inspection and those of all the other lots were unsatisfactory. The contents of the marks of all samples were incomplete. The nominal powers of three lots of samples deviated greatly from the measured values. Some enterprises had paid insufficient attention to the quality of

lamp caps and open-circuit protection, and the insulating materials adopted by some enterprises for their products failed to pass the heat resistance test, which would lead to hidden safety perils during the use of lamps.

Most of the DC lamp manufacturers are small and medium-sized enterprises, and most of them adopt the marketing policy of larger sales at a small profit. Especially in the northwestern regions, the northeastern regions and the northern regions and the southwestern regions, the growth of the production capacity of enterprises is slow for limitation by the level of local economic development, and the quality of products still cannot meet the requirements of the relevant standards. The users of DC lamps are mainly distributed in the areas without electricity supply in the western regions. The enterprises in the western regions have an advantage in territory. They should make use of such advantage, make up their deficiencies in technology and promote their market competitiveness proceeding from increasing product quality.

The government authority in charge should take effective measures, establish reliable and authoritative circulation channels and forbid system suppliers from purchasing and supplying DC lamps with low quality and low prices to assure the popularization and application of qualified products conforming to the relevant standards. Though the price of DC lamp takes a small proportion in a whole solar PV system, it has a great impact on the popularization of solar PV systems. The poor quality of DC lamps will become a barrier for popularizing solar PV systems if no sufficient attention is paid to the quality of DC lamps.

Most DC lamp users are poor farmers and herdsmen. The enterprises engaging in DC lamp manufacturing and selling should, adhering to the principle of responsibility for users and proceeding from the long-term development of enterprises, meticulously sum up experience, strengthen scientific R&D and production management, increase the quality of after-sale service, provide the farmer and herdsman consumers with DC lamps of high reliability and good quality, ensure DC lamps will no longer be a weak link in solar PV systems, and make farmers and herdsmen always have bright and permanent eyes at night.

#### References:

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