

Value Chain Analysis of Solar Water Heater Industry

- A Case Study in the City of Dezhou

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1. Research Background

Climate change has created a serious challenge for human survival and development. All the countries around the world have recognized the need to reduce the dependence of economic development on fossil fuels and lower carbon emissions in order to cope with and mitigate the influence of climate change. The Chinese government is also increasingly concerned about low-carbon development and has been actively pursuing energy-saving and emission reduction actions to promote the optimization of energy structure. China set the target of controlling greenhouse gas emissions and reducing energy consumption per unit of gross domestic product (GDP) by 20% in the "Eleventh Five-Year Plan". However, adjustment of the industrial structure and energy structure will inevitably have a far-reaching impact on the number of jobs, employment structure and skill structure. How to actively use the opportunities of green economic development to promote the development of green jobs while promoting the transition of grey jobs into green ones, reducing the negative impact of adjustment of the industrial structure and energy structure on employment to achieve sustainable economic, social and environmental development is a problem we must solve in the process of transition into a green economy.

International Labor Organization (ILO) thinks that "it is necessary to estimate the impact of change in the way resources are used on technology, production and employment and find a suitable development strategy to reduce greenhouse gas emissions without delaying the process of poverty eradication". To this end, International Labor Organization, United Nations Environment Programme and International Trade Union Confederation jointly launched the "Green Jobs Initiative" to promote policy-making making for coordinated development of employment, poverty alleviation and climate mitigation. To support this initiative, the ILO Regional Office for Asia and the Pacific started an 18-month-long pilot project in China, India and Bangladesh to advance efforts to "promote clean development through the creation of green jobs". As part of the pilot project, this research aims at exploring ways to promote the development of the solar water heater industry and create green job opportunities through the method of value chain analysis.

2. Research Methodology

2.1 Preliminary Selection of Value Chains

After accepting the commission given by the International Labor Organization, the research team of the Institute for Labor Studies first adapted the International Labor Organization's value chain selection tools in accordance with China's actual situation and set up the eight indicators of "impact of industrial development on improving the environment", "foundation and prospect of industrial development", "principal market", "employment potential", "conformity with policy priorities", "feasibility of

external intervention and potential for change”, “innovativeness of intervention projects” and “replicability of intervention projects”. After this, the research team primarily selected the three value chains of green food, solar water heater and ecological afforestation after analyzing existing literature and interviewing relevant organizations. After carrying out a comprehensive assessment of these three industries, the research group finally decided to take the value chain of the solar water heater industry as the object of in-depth study. Result of the assessment is as follows:

Table 1: Preliminary Assessment of Value Chains

	Green Food	Solar Water Heater	Ecological Afforestation
Impact on improving the environment	Developing the green food industry can help reduce environmental pollution caused by agriculture and improve agricultural laborers' working environment.	Important areas for promoting green development are adjusting the energy structure and promoting the use of new energy. Compared with traditional gas and electric water heaters, a solar water heater can reduce about 322 kilograms of greenhouse gas emissions per square meter each year and 3220 kilograms in its 10-year life cycle.	Afforestation through carbon sequestration plays an irreplaceable role in mitigating climate change. One cubic meter of forest can absorb 1.83 tons of carbon dioxide and release 1.62 tons of oxygen each year.
Foundation of and potential for industrial development	The industry is quite mature and mainly relies on market operations. With a high degree of consumer recognition and a big market demand, the industry's market development potential is huge. From 2003 to 2007, the average annual growth rate of pollution-free agricultural products, green and organic food products reached 83%. However, compared with ordinary food, the production scale of green food is too small. The proportion of the annual physical output of ordinary food accounted for by green food is still quite low.	It has a certain technical and market development foundation and mainly relies on market operations. It has a quite high degree of consumer recognition and is of great significance for solving rural energy needs. Its market development potential is still big. From 2001 to 2007, the proportion of various types of water heaters sold across the country accounted for by solar water heaters rose from 15.2% to 38.5%. In 2007, the annual output of solar water heaters nationwide was 23 million square meters, the total inventory was 108 million square meters and the area	Carbon sequestration forestry relies on policy, but it has a huge development potential. According to industry experts' prediction, the profit link of the entire forestry industry chain will be gradually transferred to forest planting.

		owned by every thousand people was 83 square meters.	
Principal market	All parts of the country, as well as foreign markets	Currently the markets are mainly in small and medium-sized cities in the eastern region. In the near future, the central region has a great potential for development; the western region, especially rural areas where energy is relatively scarce is yet to be developed.	Mainly in forested areas
Employment potential	It is a labor-intensive industry and is conducive to full employment of rural laborers and especially suitable for increasing the employment and income of women and low-income groups.	It is a labor-intensive industry. This industry has many small and medium-sized enterprises and plays a significant role in promoting employment. Especially enterprises engaging in sales, installation, maintenance and other services create many employment opportunities. In China, one solar water heater production worker can bring employment to ten people in related service sectors. According to the estimate of relevant organizations, the whole industry provided 2.5 million employment opportunities in 2007.	Afforestation through carbon sequestration is labor-intensive work and afforestation of each mu (land unit) takes 71-135 man-days. The development of ecological forest is conducive to not only the employment of workers in forest resource-based cities, but also the employment of farmers, especially those who returned to their hometown.
Conformity with policy priorities	The state is very supportive of the development of green food. The framework of the basic systems of green food has been formed, including the technical standards system, quality certification system, sign management system and quality inspection system. In addition, many preferential policies for green food manufacturers have	At the national level, a new energy development strategy has been formulated to make the utilization of solar energy an important component of the energy strategy. At the local level, many cities have formulated regulations for mandatory installation of and subsidy for solar water heaters. In addition, to deal with the financial crisis, the state has formulated	The state attaches great importance to public welfare-oriented ecological afforestation and has worked out a series of preferential measures: firstly, it established the compensation and subsidy system for key public welfare forests; secondly, it set up the subsidy system for improved varieties of forest trees and subsidy system for investment in afforestation, tending,

	been introduced at the national and local levels, such as subsidies, remission of taxes and industrial and commercial administrative costs, credit support and land use.	policies for expanding domestic demands, including the policy of “home appliances going to the countryside” (rural users can enjoy a subsidy equivalent to 13% of the selling price). All sales enterprises won the bidding need to enhance the sales service function of outlets and especially need to carry out itinerary maintenance services and centralized training services in villages with dispersedly located farmer households.	protection and management; thirdly, it formulated and perfected forestry preferential policies, including the policy of providing discounted interest loans for forestry.
Feasibility of external intervention and potential for industrial change	The potential is quite big. Many jobholders lack appropriate funds and skills; cooperation between the various links of the value chain is impeded.	The potential is quite big. The manufacturing industry is relatively mature, but it is beset by a lack of skilled personnel; the lag of follow-up services affects further development of the industry.	The potential is quite big. Skills training for jobholders needs to be further strengthened.
Replicability of intervention projects	They can be propagated around the country.	They can be propagated around the country.	They can be propagated in forested areas.
Innovativeness of intervention projects	There are relatively more external projects, such as poverty alleviation projects and environmental protection projects.	There is quite limited external intervention, mainly rely on the development of enterprises.	External projects include projects of afforestation through carbon sequestration carried out under the clean development mechanism and projects of afforestation through carbon sequestration voluntarily undertaken by nongovernmental organizations.

2.2 Research Methods for the Solar Water Heater Value Chain

After deciding to conduct in-depth study of the value chain of the solar water heater industry, the research group presently visited the National Energy Board, the Solar Energy Society and well-known entrepreneurs in the industry and collected a large number of literature materials concerning development of the solar water heater industry. Because the International Labor Organization's value chain analysis tool mainly aims at traditional industries, the research group adjusted this tool and

and functional sugar are pillar industries of Dezhou. Dezhou has entered a period of accelerated transition towards industrialization. The municipal government set the goal of building a "low-carbon city". One of the measures is vigorously developing the solar energy industry.

As of the end of 2008, Dezhou had a total population of 5.642 million, of which 4.036 million was agricultural population and 1.426 million was non-agricultural population. There were 665 thousand urban employed persons and 1.02 million persons who worked outside the city. The registered urban unemployment rate was 3%. The city's minimum wage standard was RMB500 / month. The per capita disposable income of urban residents was RMB14,545 yuan, up 17.4% over the previous year; the per capita net income of farmers was RMB5,659 yuan, up 13.5% over the previous year.

3.2 Policy Environment for the Development of Solar Water Heaters in Dezhou

The Chinese government attaches great importance to the development of the renewable energy sector and has made utilization of solar energy an important component of the energy strategy. At the national level, the *Energy conservation Law* stipulates that the development and use of renewable energy sources shall be encouraged and supported. The *Renewable Energy Law* further explicitly stipulates that the state shall encourage organizations and individuals to install and use solar water heating systems, solar heating and cooling systems and other solar energy utilization systems. Meanwhile, it also requires "real estate development enterprises to provide necessary conditions for the utilization of solar energy in design and construction of buildings in accordance with the technical specification stipulated in the previous provision". Against the backdrop of the State strongly advocating protecting the ecological environment, developing renewable energy sources and building a resource-saving and environment-friendly society, China's solar water heater industry has been developing rapidly. In 2006, total inventory of solar water heaters across the country was 90 million square meters and the annual output was 18 million square meters, accounting for 53.6% and 78.2% of the world's total respectively.

At the provincial level, Shandong Province promulgated the Energy Conservation Regulations of Shandong Province and other legislation and policy documents to further implement relevant national regulations. The *Guidance on Accelerating the Development of the New Energy Industry* promulgated in 2009 proposed to further develop solar thermal industry, expand the industrial scale and extend the industrial chain so as to build internationally competitive scale advantages of the industry. In terms of promoting of preferential policies for the use of solar water heaters, the provincial government established a special provincial fund for energy and water conservation and stipulated that hotels rated above three star and provincial

universities and vocational schools that use solar collector systems capable of producing more than 20 tons of water above 30 degrees each day could get a subsidy equivalent to 30% of the total construction cost and basic education schools with resident students that use solar collector systems capable of producing more than 5 tons of water above 30 degrees each day could get a subsidy equivalent to 30% of the total construction cost. The amount of funds for subsidizing each project shall not surpass RMB1.5 million yuan.

In Dezhou, the Government not only supports the production of solar water heaters, but also attaches great importance to popularizing the utilization of solar water heaters. Regarding the use of solar water heaters, the municipal government drew up the *Implementation Opinions on Promoting the Application of Solar Energy in the Construction Sector* in 2007 and decided to continue to implement the "one million roofs" plan, comprehensively promote the integration of solar energy with urban residential buildings, gradually expand the integration of solar energy with public buildings and vigorously implement the "100 Village Bathroom Project" in rural areas during the "Eleventh Five-Year" period. The local government's goal is that the area of solar energy application accounts for more than 50% of the area of newly built buildings in the city and 80% in urban areas by the end of the "Eleventh Five-Year" period and the area of solar energy application accounts for more than 80% of the area of newly built buildings by 2020; solar water heaters will be installed for more than 1000 bathrooms in villages across the city to make Dezhou truly a model city in popularizing the application of solar energy.

Regarding the development of the solar energy heat utilization industry, the municipal government put forward the strategy of accelerating the construction of a solar city and gradually developing the solar energy industry of Dezhou into a strongly competitive industry cluster through measures such as supporting key solar energy enterprises to promote industrial development, enhancing the technical innovation capabilities of the solar energy industry, city brand building and promotion, implementing solar energy demonstration projects, popularization of science and cultural promotion as well as building of the solar valley.

3.3 Relevant Government Agencies

In order to promote implementation of the "Solar City" strategy, Dezhou set up a "China Solar City" Strategy Promotion Committee headed by the mayor. Its members include the Development and Reform Commission, Economic Commission, Private Economy Commission, Urban Planning Bureau, Bureau of Education, Science and Technology Bureau, Environmental Protection Bureau, Service Industry Development Bureau, Tax Bureau, Industrial and Commercial Bureau, Quality Supervision Bureau and other relevant government departments, as well as banks, trade unions, women's federations, radio stations and power supply companies. The Strategy Promotion

Committee consists of the Solar City Congress Preparatory Work Leading Group, Solar City Strategy Propaganda Leading Group, Solar Energy Industry Development Work Leading Group and Leading Group of Popularizing the Application of Solar Energy. "The office of the "Solar City" Strategy Propaganda Leading Group is located at the Propaganda Department of the Municipal Party Committee, the office of the Solar Energy Industry Development Work Leading Group is situated at the Municipal Economic Commission and offices of the other two leading groups are both set up at the Municipal Construction Commission.

At present, the division of work between the main relevant agencies is: The Economic Commission is responsible for the formulation of relevant industrial development plans and technological upgrading and investment management of enterprises; the Construction Commission is in charge of popularizing the application of solar water heaters, implementation of the "Million Roofs" and "100 Village Bathroom" plan and the solar energy demonstration project as well as overall planning of the urban landscape of the Solar City; the Propaganda Department takes charge of strengthening the propaganda to enhance the image and popularity of the Solar City. The Development and Reform Commission administrates private enterprises above the designated size and the Private Economy Commission takes responsibility for the development of county-level industrial parks and township and village-level private enterprises. Both the two departments need to strengthen their support for private enterprises in terms of loan and financing policies

4. Situation of the Value Chain of Dezhou's Solar Energy Industry

4.1 Solar Water Heater Industry Cluster in Dezhou

Dezhou currently is China's largest solar energy production base. Its annual solar energy production capacity reaches more than 3 million square meters, accounting for 70% of the province's total output and about 10% of the total national output. Because Dezhou has been committed to the solar energy industry and popularizing the application of solar energy products, it was awarded the "China Solar City" title jointly by the China Solar Energy Society, China Association of Resources Comprehensive Utilization and China Association of Rural Energy Industry in the year of 2005. In addition, Dezhou also successfully bid to host the 4th International Solar Cities Congress in 2010.

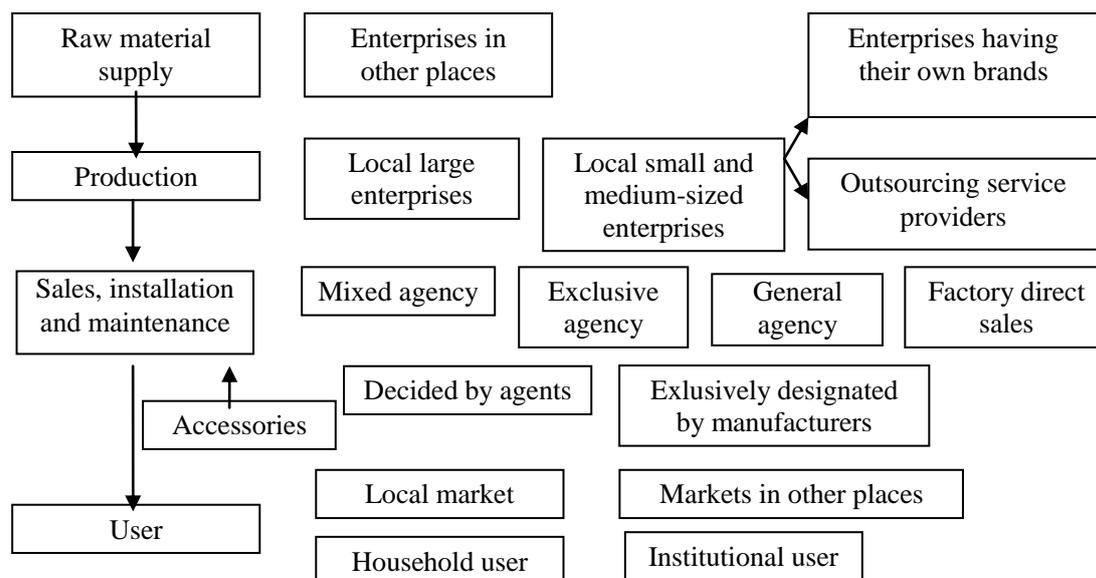
At present, solar energy enterprises of Dezhou are producing a wide range of products including high, medium and low-grade all-glass vacuum tube solar water heaters, and their customers are mainly household users in this area and other areas of the country. With regard to the number of solar water heater manufacturing and sales enterprises in Dezhou, we obtained relevant information from three sources. The data obtained

from the Dezhou Municipal Industrial and Commercial Bureau show that Dezhou has a total of more than 260 registered solar water heater manufacturers and distributors, of which more than 40 are manufacturers, including more than 20 key enterprises and other small enterprises and about 220 are distributors. About 10 thousand people are employed at the production and the sales links. Data of the Municipal Economic Commission show that there are nearly one hundred enterprises using solar energy and related enterprise in this area, of which 12 enterprises are above the designated size. Several enterprises we visited thought that there were about 100 solar water heater manufacturers and more distributors in this area. As the data from different sources vary greatly, the research group feel it is very difficult to make an accurate judgment, and can only speculate that the number grasped by the Municipal Economic Commission and Department of Industrial and Commercial is the number of enterprises that have reached a certain size and whose production is relatively stable, while the number provided by insiders is the number of all the enterprises currently engaging in solar water heater production. Among them, besides enterprises that have reached a certain size and whose production is relatively stable as mentioned above, there are also some enterprises with a small production capacity or even engaged in irregular operations.

4.2 Solar Water Heater Value Chain in Dezhou

Basic links of the value chain of the solar water heater industry include raw material supply, solar water heater production, value-added production, sales (installation and maintenance services) and end user.

Figure 1: Diagram of the Value Chain of the Solar Water Heater Industry in Dezhou



4.2.1. Principle Markets

Solar water heaters have been enjoying a rapid development in urban markets. However, such development momentum has been stagnant in recent years. The primary cause is that there are many solar water heater brands in China and their quality and performance can hardly meet consumers' requirements, especially the lack of good installation and maintenance services has led to a poor reputation of solar water heaters among consumers, dampening consumers' willingness to purchase. In addition, the design of urban buildings hasn't taken into account the installation of water heaters, making it difficult for many urban residents to use solar water heaters. On the contrary, as the rural residents have been enjoying an increasing income in recent years, and there is a demand to develop rural aquaculture, solar water heaters has been popularized relatively quickly. Products of Dezhou's large solar water heater manufacturers are oriented towards urban and rural markets across the country; small and medium-sized enterprises mainly meet the consumer demand of the city and surrounding areas; some enterprises also enjoy certain popularity in other places.

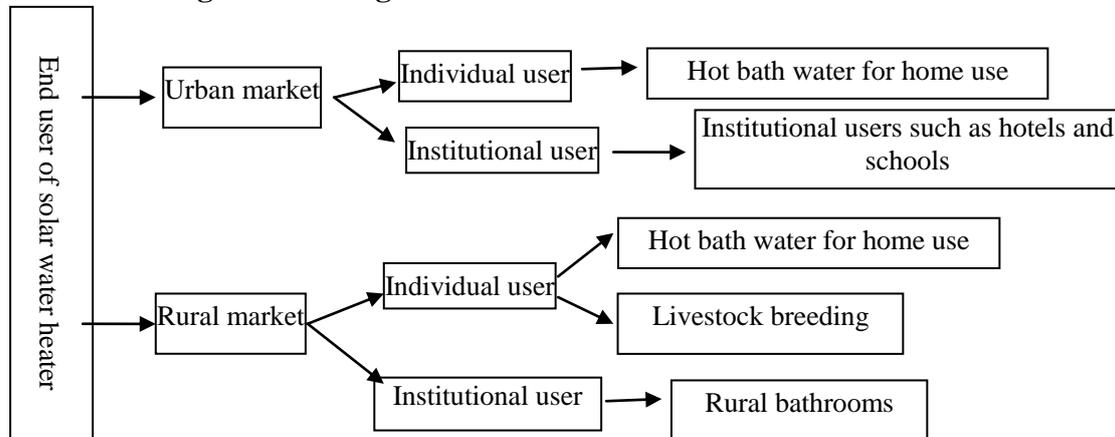
4.2.2 End Users

End users of solar water heaters are mainly dispersedly located household users, users of public hot water of collective units and users of hot water of projects integrated with buildings. Urban household users mainly use solar water heaters to provide hot water needed for daily life while rural household users mainly use solar water heaters for livestock breeding. In Dezhou, rural livestock breeders often use solar water heaters. It is reported that farmer households that breed three to five cattle or more than ten pigs will generally buy solar water heaters for providing warm water for mixing cattle feed, for cows to drink and washing cattle. For solar water heaters aimed at household consumers, manufacturers generally adopt the modes of direct selling through franchise stores, agency and distribution, sale through shopping malls and sale through building materials market.

Organization customer groups mainly refer to hotels, restaurants, schools, hospitals and other public places. Hot water projects integrated with buildings refer to large-area application projects in which solar water heaters on buildings are uniformly planned, designed, installed, checked and accepted as well as projects of central hot water supply systems capable of supplying more than 600 liters of hot water. Although the water heaters aiming at the two kinds of users need to be of high quality and excellent after-sales service is required, they sell well and are quite profitable. Only large manufactures can produce such kind of products, and manufacturers generally have dedicated marketing, installation and maintenance teams. In future, solar water heaters aimed at organization customers and projects integrated with buildings will have a relatively large potential for development. But at present, like those produced in the rest of the country, solar water heaters manufactured in Dezhou

are mainly oriented towards individual users that install solar water heaters on finished buildings and are in small local systems.

Figure 2: Diagram of End Users of Solar Water Heaters



The countryside is the major potential market for solar water heaters, so we interviewed some rural users and found the following problems:

1. There are numerous solar water heater brands in the market, making it difficult for consumers to choose a good one. Although everybody knows that product quality of large enterprises is excellent, prices of their products are relatively high and can hardly meet rural consumers' expectation for low prices.
2. Distributors do not understand solar water heater products, and sometimes cannot answer consumers' questions correctly;
3. Follow-up services are inadequate; many manufacturers haven't established an effective after-sales service system. Sometimes users even cannot find after-sales service, and some distributors use substandard accessories, leading to many problems such as water heater leakage;
4. Spending habits and income levels in rural areas still restrict the popularization of solar water heaters.

4.2.3Manufacturers

Dezhou's solar water heater manufacturers are divided into three categories: enterprises in the first category are aircraft carrier-type enterprises. They have diverse product types, possess independent research and development capabilities, master patented technologies and enjoy nationwide popularity. Enterprises in this category include the Himin Company and Yijianeng Company under Himin Solar Energy Group. Second type are regular small fleet-type enterprises and are small and

medium-sized solar water heater manufacturers. Enterprises in this category are relatively regular, having their own brands and at least enjoying certain popularity in their areas. Enterprises in the third category are “irregular troop” enterprises. Their sizes are small, production technologies are backward and quality management is chaotic. Some enterprises do not follow prescribed rules in operation and engage in shortchanging on work and materials, counterfeiting of famous brands and false propaganda. Enterprises involved in our research are enterprise in the first two categories.

(1) Large Enterprises

Himin Company, the representative of enterprises in the first category, is the world's largest solar water heater manufacturer and popularizes more than 2 million square meters of solar water heaters each year. It not only produces solar water heaters suitable for household and institutional users under different climate, water quality and building conditions, but also ambitiously develops markets in areas of integration of solar energy with buildings and solar thermal power generation. Under the local government's support, Himin Group has been building a solar valley with a total planned area of 5000 mus, which will be used as a solar energy industry gathering place that integrates supporting industries such as solar energy manufacturing, technical research and development, personnel training and tourism. In addition to direct publicity and promotion aimed at brands, spreading solar energy knowledge and popularizing popular science education are also marketing strategies of Himin Company. The “nationwide popularization of solar energy science motorcade long march activity” of Himin Group played an important role in promoting solar energy knowledge and the Himin brand. This large enterprise not only won the favor of local financial institutions, but also obtained venture capital investments of outside sources. In December 2008, the U.S. investment bank Goldman Sachs and CDH International Investment Company injected nearly 100 million U.S. dollars into Himin Group.

Himin Company directly hired more than 7,000 employees, of which managerial staff account for 1 / 3 and front-line operators and general clerks account for 2 / 3. The average age of employees is 29 years old and wages of ordinary employees are at the local medium level. Front-line employees mostly have received secondary education, vocational education and senior middle school education; managerial staff generally hold college degree or above. In terms of the type of labor contracts, the first labor contract signed usually has a term of one year for operators, two years for general managerial staff, three years for technicians and five years for senior managerial staff. There are about 60 thousand external personnel engaging in distribution and services of Himin products Himin Company now is trying to convert some of them into its own employees. The reason is that distributors generally operate on a small scale, so their employees are poorly remunerated and many of them are not covered by social

insurance, leading to a high employee turnover and a lack of skill accumulation, which is disadvantageous for the development of the Himin brand.

In the present relevant majors of vocational technical schools and universities are still considerably different from the specialty of solar heat utilization, so Himin Group innovatively tried a variety of methods of training and education. One method was setting up the “Himin Class” in cooperation with some universities. Special teaching materials are used and the curriculum is more specialized, so that students will understand the production process of Himin, skills required and corporate culture in the school. The first batch of “Himin Class” graduates have already come to work at Himin. It is said they are very enthusiastic about their work and integrated into the enterprise very quickly, solving the problems of gap between the theory learned by university graduates and practice, their difficulty of adapting to the corporate culture and high turnover that previously troubled the enterprise. The second method was establishing the Himin Vocational Secondary School, College of Engineering & Technology and Business School. At present, these three schools mainly serve Himin Group: Business School is used for in-house training to provide opportunities for outstanding in-house employees to enhance management capabilities; the College of Engineering & Technology recruits students from society and mainly trains managerial personnel, sales directors and engineering, sales and design personnel for Himin Group; the Vocational Secondary School trains production, installation and marketing personnel. The third method was that the in-house training department trained the enterprise’s employees and distributors on a regular basis. In addition, in view of the fact that many existing professional standards can not fully conform to the characteristics of the solar energy industry, Himin Group has been developing targeted professional qualification standards and training materials.

Major Problems Currently Bessetting Large Solar Water Heater Manufacturers:

1. There are few national standards for standard solar water heaters, especially there is a lack of detailed requirements for reliability during long-term use, consequently many products are unable to reach the advertised life cycle, affecting the reputation of the entire industry;
2. Some small manufacturers do not pay attention to product quality, produce fake and shoddy products or resort to abnormal methods of competition, not only affecting the development of the industry, but also posing considerable risks to users’ personal and property safety;
3. Government regulation is inadequate, the cost of cracking down on fake products is too high for enterprises;
4. There is a lack of professionals within the industry, enterprises poach each other’s talents and the brain drain problem of big enterprises is quite prominent;

5. Newly recruited university graduates have difficulty adapting to their professions and enterprises. Newly recruited university graduates' majors do not fit enterprises' needs and the theory they learned are divorced from reality, so it takes them a long time to master professional skills. In addition, many young people have difficulty integrating themselves with the corporate culture, lack loyalty to their professions and enterprises, so the turnover is high.
6. Recruitment of workers and students is quite difficult. The entire society doesn't think much of blue-collar occupations. So, despite vocational secondary schools offer scholarships to students from poor families and guarantee jobs after graduation, they still feel it is quite hard to recruit students;
7. Employees' expectation for continuously growing enterprises to pay higher wages is in conflict with enterprises' need for reinvestment. Employees believe that enterprises develop quickly and expect wage increases, but enterprises want to develop further and activities such as research and development, training and promotion of their own brands require a lot of money, so they want to keep the wage level at the local medium level;
8. At present, all product parts are produced by Himin Company itself. Although the enterprise wants to outsource part of its operations, it is worried about the difficulty of quality control after outsourcing due to inadequate development of the industry.

(2) Situation of Regular Small and Medium-sized Enterprises

Enterprises in the second category are small and medium-sized enterprises engaging in quite regular production. Such enterprises are divided into two types. Enterprises of the first type have their own brands and enjoy certain popularity in their areas and surrounding areas and their sales volume grows steadily. Their mode of production is to manufacture their own water tanks and stands, and then purchase evacuated tube collectors from other places to assemble them into finished products and sell the products under their own brands. Enterprises of the second type are production outsourcing service providers of large domestic manufacturers and produce water tanks and stands for enterprises awarding the contract in accordance with the technical standard and process provided by them. All in all, these enterprises have low degrees of automation, mostly use semi-automatic and manual production and employ few people. Many of them also concurrently run other businesses, but generally they will have 30 to 50 people engaging in solar water heater production.

Small enterprise case 1:

It is a medium-sized enterprise in its area and has its own brand, it sells around 2000 solar water heaters each year. It buys vacuum tubes and produces water cylinders and stands itself. Its

products are priced at a low to medium level and sold in both urban and rural areas. The principle market is Dezhou. Wages of sales personnel are composed of basic wage plus 10% sales commission; most employees have been working for quite a long time. Installation personnel are all covered by commercial insurance (the local policy is that enterprises must participate in old-age insurance and medical insurance, other social insurance is not mandatory). The focus of future market development is rural areas due to the rapid development of livestock breeding; urban market may develop slowly because nowadays buildings in cities are all high-rise on which solar water heaters cannot be installed.

Small enterprise case 2:

The enterprise has been developing quite fast. It sold only a few hundred solar water heaters in the first year of production. That figure grew to more than three thousand in the second year and is expected to reach ten thousand this year. It produces middle-end products and the principle market is Dezhou's surrounding rural areas. It has more than 300 distributors, mostly exclusive agents. It currently has more than 100 employees, of which over 30 engaging in solar water heater production. Besides solar water heaters, it also produces electronic instruments. Production is divided into low and high seasons. It is the low season when the weather is hot. It does not give employees time off even during the low season, or it will suffer loss of employees. Skill requirements for employees are not too high, and newly recruited employees generally will be able to operate skillfully in about one month. Different manufacturers use different equipment and production processes. Employees switching to a new enterprise must be retrained and go through a certain practice period. The average wage of employees is more than RMB1000 yuan; wages of the best production workers can reach as much as more than RMB3,000 yuan; wages of newcomers are about 700 to 800 Yuan. The employee turnover is not very high.

Small enterprise case 3:

The enterprise is purely an outsourcing service provider and organizes production according to the raw materials, equipment, processes and drawings provided by large enterprises. The enterprise has a total of more than 130 employees, 36 of which engage in solar water heater production. Its annual sales reach RMB 12 million yuan. It produced products of its own brand prior to 2000, but due to small enterprises' difficulty of creating their own brands and the high cost of development and promotion channels, it no longer produced products of its own brand after cooperating with large enterprises. Production workers engage in skilled work with low technical content and earn about RMB1200 yuan each month. Early spring is the high season when the enterprise often lacks workers; it does not need so many people during the low season. The employee turnover is quite high and only 50-60% of them can stay there for 1 to 2 years.

Problems Currently Bessetting Small and Medium-sized Solar Water Heater Manufacturers:

1. There are few national standards for solar water heaters, leading to numerous manufacturers and a great number of solar water heater brands. "It is even difficult for distributors to distinguish between the true and the false, let alone consumers". This has a negative impact on the entire industry's development.
2. Small and medium-sized enterprises do not have the ability to promote their own brands. There are many solar water heater brands on the market. To break the siege, manufacturers must step up promotion. The manager of an enterprise thought that "the key to product success is quality, publicity and promotion and reasonable price." The enterprise once advertised itself on a local TV station, which worked well for enhancing the popularity of its brand and products. However, "the cost of advertising on TV stations is high for small and medium-sized enterprises, so this method can only be used occasionally rather than in the long term".
3. Governments mainly favor large enterprises and pay little attention to and provide little support for small and medium-sized enterprises. An entrepreneur thought that "there is only one big tree with no branches and leaves in this area" and expected the government to increase support for small and medium-sized enterprises. For example, the governments' procurement projects shall be open and transparent to allow small and medium-sized enterprises to participate in competition and support shall be given to small and medium-sized enterprises in areas such as land used for factory buildings.
4. It is difficult for small and medium-sized enterprises to get financing. There is no government-funded guarantor institution and only a fully commercial guarantor institution in this area, so small and medium-sized enterprises that can not provide collateral still have difficulty in obtaining funds;
5. The test fee is high. The local technical supervision department charges RMB6000 yuan for testing each type of solar water heaters, which is hardly acceptable for small enterprises;
6. Small and medium-sized enterprises are limited in both production and financial capacity and can hardly participate in government or real estate developers' tenders alone. In addition, developers often pay by installments, which is unbearable for small and medium-sized enterprises.

(3) Problem of Industry Cluster

Although Dezhou has a large number of solar water heater manufacturers, which to some extent has formed an industry cluster, there is little communication between manufacturers, let alone division of work and cooperation. There is a lack of trust between large and small enterprises. Large enterprises think that small businesses do not know much about the industry, fall behind in quality management and affect the image of the industry while small and medium-sized enterprises complain that large enterprises take too many resources. Local small and medium-sized enterprises hope

that large enterprises can focus on the development and production of high-end solar energy products and leave low and medium-end markets to small and medium-sized enterprises; the local government hopes that leading enterprises can prompt large enterprises to outsource the production of low and medium-end products and promote the development of supporting service enterprises, such as enterprises engaging in sales and processing of parts and accessories. However, given the current situation, it is very difficult to form such a cooperation arrangement in the short term.

Some local small enterprises hope to set up an association so as to increase the ability to lobby the government and jointly participate in government tenders; prompt local banks to provide financing for small and medium-sized enterprises by providing joint guarantee for each other and make the association a platform for communication between solar energy manufacturers. However, the government wants large enterprises to participate in the association, and thinks the association cannot represent the local solar water heater industry otherwise. In addition, the government also hopes to further cooperation between enterprises through the association to promote division of labor and cooperation between large enterprises and small and medium-sized enterprises and cause large enterprises to share their research and development, testing and training capabilities with small and medium-sized enterprises. Regarding this matter, large enterprises think they are not at the same level with small enterprises and have no time to participate as their business is undergoing rapid development. Although the government hopes to carry forward the building of the association as soon as possible, it is in an awkward situation for the above-mentioned reasons.

Table 2: SWOT Analysis of Manufacturing Stage

Advantages	Disadvantages
<ul style="list-style-type: none"> • Local large enterprises have strong research and development capabilities and have successfully applied to become national laboratories; • Local large enterprises have professional testing centers and are willing to share them with other enterprises (but the test results do not play a role in approving marketing of products and only play a role of technical guidance); • There are local training schools that can train professionals specializing in solar heat utilization; • A industry cluster has already been formed and enjoys some popularity throughout the country; • Local large, medium and small-sized enterprises can meet consumers' demand for products at different 	<ul style="list-style-type: none"> • There are many small and medium-sized enterprises with little science and technology input, weak independent innovation ability and low product level; • Market development is not standardized, many enterprises engage in irregular operations, implement management in a disorderly manner and even produce fake and shoddy products, affecting the industry's overall reputation; • There is a lack of appropriate human resources, especially professional and technical personnel; • Small and medium-sized enterprises haven't spent enough effort on publicity and promotion and the popularity of their brands is low both locally and in other places; • There are many manufacturers in this

prices.	area, but raw materials and accessories are purchased respectively by various enterprises from other places, thus increasing the cost.
<p style="text-align: center;">Opportunities</p> <ul style="list-style-type: none"> • The market potential of solar water heaters is big. As income of rural residents increases, their demand for hot bath water has been growing rapidly. In addition, the development of livestock breeding drives the demand for solar water heaters; • As development of solar energy water heaters is in line with China's sustainable development strategy, the government attaches great importance to development of the industry and has formulated preferential policies; • As a solar city, Dezhou enjoys high reputation across the country, which helps enhance the brand popularity of local enterprises; • Dezhou will host the 4th International Solar Cities Congress in 2010, which helps further enhance the reputation of the city's solar energy enterprises and products. 	<p style="text-align: center;">Obstacles</p> <ul style="list-style-type: none"> • Incomes and spending habits of rural residents may limit the further expansion of rural markets; • The country's standard system for solar water heaters is imperfect and the industry regulation is ineffective, resulting in poor quality products that interfere with the market and affect the development of the industry; • At present, many urban buildings are not suitable for the installation of solar water heaters. In addition, in order to maintain the appearance of buildings, some local real estate developers prohibit owners from installing solar water heaters in property management; • There is a lack of good installation and maintenance services, dampening users' confidence in solar water heaters and affecting the industry's reputation; • There is a lack of relevant external services, small and medium-sized enterprises have difficulties getting loans and the product test fee is high; • The government's preferential policies lack operational rules and cannot benefit enterprises; • The government's attention to and support for small and medium-sized enterprises are inadequate.

4.2.4 Sales, Installation and Maintenance Services

Solar water heaters used for projects are mostly directly sold and installed by manufacturers. Solar water heaters aimed at individual users are generally sold through several distribution channels, including agents, factory outlets, market monopoly and project market sale, of which the use of agents is a quite common practice. Sales, installation and maintenance services are generally done by distributors, large manufacturers also have specialized technical department and service hotline to provide technical support for distributors. The service link has a very remarkable effect on providing employment opportunities with personnel

engaging in sales, installation & maintenance and warehousing accounting for 80% of the personnel on the entire chain. The size of distributors' businesses in urban areas ranges from 5 - 6 people (small) to more than 100 people (large), the average size is 10 - 20 people. Agents in rural areas are quite small, and some are simply family-run shops.

There are several modes of cooperation between manufacturers and distributors:

The first is exclusive agency. Large enterprises' requirement for exclusive agency is: the initial amount of accounts payable collected is RMB400-500 thousand yuan in provincial capitals, RMB300 thousand yuan in prefecture-level cities and RMB200 thousand yuan in county-level cities. In addition, an image store covering an area of no less than 100 square meters shall be built and equipped with store manager, after-sales service managers, service personnel and equipment such as telephone, fax machine and computer. Small and medium-sized enterprises' requirement for exclusive agency is a little lower. As long as distributors buy a certain number of solar water heaters at the first time, they can buy any number of solar water heaters thereafter. Exclusive distributors can only sell solar water heaters of a single manufacturer, but they can sell plumbing and heating equipment, hardware equipment and other products at the same time. Manufacturers do not have too many requirements for the location and area of distributors' stores. For example, a manufacturer we visited requires county-level agents to buy 10 solar water heaters at a time and pay a deposit of RMB1,000 yuan to prevent violations of the manufacturer's rules such as driving down the price, thus avoiding affecting other distributors. In other words, to become a county-level agent of a kind of product which enjoys a certain reputation in its area, one has to buy 10 water heaters at first and the start-up cost including the store rent is about less than RMB50 thousand yuan.

A case of distributor:

The distributor just started selling solar water heaters in February 2009 and has sold a total of more than 50 units by July. It can earn RMB300 yuan each unit. It mainly solicits consumers through its store and sometimes promotes sales in the countryside. The success of its marketing so far is mainly attributed to the sales promotion carried out by the manufacturer in the first half of the year that cut the price a lot. In addition, relatives and friends have recommended many customers. Summer is the low season for water heaters when people make do with cold water bath. Although the rural market is large and demand of livestock breeding is big, it is not an easy job mainly because farmers do not have much money. We did not know much about the brand when we chose it and just heard that the brand was well spoken of by the public. Only after we became an agent did we find that the enterprise hadn't done much in promotion, many farmers did not know the product and the product did not sell well. The manufacturer once advertised itself on a local radio station and the effect was quite good. Usually we distribute color ads provided by the

manufacturer. As Ads of various manufacturers are similar, farmers do not know how to make their choice.

The second is general agency in which the relationship between manufacturers and agents is relatively loose. Manufacturers do not restrict agents from selling other manufacturers' solar water heaters and agents are also not obligated to buy manufacturers' products in advance. Manufacturers only display some products at agents' places, and provide agent identification code for agents. This form of agency is generally used by small manufacturers and distributors generally have selling plumbing and heating equipment and hardware equipment as their main business. These stores sell solar water heaters of many brands. We saw that many stores were hanging the boards and promotional materials of solar water heaters of several brands.

The third is cross-management, which is a distribution mode currently tried by Himin. Many distributors are small in size, so they cannot manage employees well and their employees are often poorly remunerated. In order to reduce the turnover of their core employees and increase skill accumulation, Himin has begun to try the practice of paying basic wages and social insurance premiums for distributors' core employees and employees only receiving commission from distributors.

Large manufacturers have specialized training for distributors that covers skills of installation, maintenance, marketing and management. Training provided for distributors by small and medium-sized manufacturers is relatively simple.

Many distributors themselves sell plumbing and heating equipment, so usually after learning with technicians sent to install heaters for users by manufacturers once or twice, distributors' personnel will be able to carry out installation and maintenance independently. If distributors encounter technical problems in future services, manufacturers will provide support. In addition, large manufacturers can provide start-up loans for distributors.

In terms of the profit distribution mode, usually manufacturers set the market price and then sell products to distributors at a discount. The price difference is distributors' profit. In Dezhou, distributors earn a profit of 200 to 300 Yuan from each solar water heater sold. Another source of distributors' income is the profits from providing accessories to users. Manufacturers usually only provide water heaters and stands, to use water heaters, users must also have accessories such as indoor pipes, fittings, showers and faucets. Accessories are generally purchased and provided to users by distributors. In order to increase profits, some distributors will use some defective products, resulting in problems such as water leakage or seepage. Meanwhile, rural consumers often buy on credit and will reduce payment after finding quality defects in subsequent use, so the profit margin of distributors may shrink further.

Major Problems Currently Faced by Distributors:

1. Many distributors themselves do not understand solar water heater and have difficulties selecting brands. The manager of a manufacturer we interviewed thought that " less than 1% of distributors understand the products and materials, all manufacturers will say that their own products are good and distributors cannot differentiate"; a distributor interviewed indicated that the reason why he chose the brand was that "he saw the TV ad";
2. Distributors' installation and maintenance personnel lack professional skills and safety protection knowledge. Large enterprises think that compared with home appliances such as ordinary water heaters and air-conditioners, installation and maintenance of solar water heaters are much more complex. The former involves standard operations, while solar water heater has no operation standards, different installation methods are used for different climate and building conditions and a variety of knowledge and skills are involved, so the skill of installation and maintenance personnel is very important. But the small and medium-sized manufacturers and distributors we interviewed haven't realized this yet;
3. There is a lack of trust between distributors and manufacturers. Some distributors complain that manufacturers are too domineering and set rigorous conditions for agency, sales personnel make many promises but often fail to fulfill them; some manufacturers accuse distributors of failing to conduct business honestly, "emphasizing sale and ignoring follow-up services" and even using substandard accessories which will consequently affect manufacturers' credibility;
4. Manufacturers' support for distributors is inadequate; sales personnel do not understand the basics of solar water heaters and the characteristics of products sold, so it is difficult for them to sell products to consumers;
5. As small and medium-sized manufacturers haven't put much effort into publicity, rural consumers do not know these brands, therefore, distributors are under great sales pressure and the products do not sell well;
6. Rural consumers usually do not have cash until autumn, so they often buy solar water heaters on credit. Distributors need to repeatedly press for payment, which is a heavy burden. After finding defects of the product quality in use, consumers will often pay less, further reducing distributors' profit margin.

Table 3: SWOT Analysis of the Distribution Stage

Advantages	Disadvantages
<ul style="list-style-type: none"> • It does not require a large amount of funds to become distributors of small and medium-sized manufacturers; 	<ul style="list-style-type: none"> • The solar water heater industry as a whole lacks a sound follow-up service system, consumer satisfaction with services of the solar water heater

<ul style="list-style-type: none"> The requirement for installation and maintenance skills is not very high, people with experience in installation and maintenance of plumbing and heating equipment can learn very quickly. 	<p>industry is low;</p> <ul style="list-style-type: none"> Agents themselves do not know much about solar water heaters, so it is difficult for them to select solar water heaters with good quality and prices suitable for the affordability of local consumers; Many agents are not well-educated and their awareness and level of management are insufficient, service processes are not standardized and management systems are imperfect; Sellers' employees do not have enough service skills, lack strong service awareness and are replaced frequently; An agent for big brand products needs a lot of investment and has to accept rigorous conditions. As small distributors' bargaining power is relatively weak, they can only enjoy a relatively small profit margin. Some distributors use cheap accessories, affecting the use of water heaters. There is a lack of external service providers for the solar water heater industry in this area.
<p style="text-align: center;">Opportunities</p> <ul style="list-style-type: none"> As the income of rural residents has increased, they require higher quality of life, and livestock breeders' demand for solar water heaters is big, so the market potential for solar water heaters is huge in this area; The government has been vigorously promoting the use of solar water heaters. 	<p style="text-align: center;">Obstacles</p> <ul style="list-style-type: none"> There are many solar water heater brands on the market, and strenuous small and medium-sized manufacturers haven't launched strong promotion of their products, leading to low popularity of their brands, therefore, it is difficult for distributors to make sales; Many farmers buy the products on credit, and it is very difficult to press for payment

4.2.5 Raw Material Supply

For solar water heater manufacturers in Dezhou, raw materials include chemicals, machinery, electronics, glass and many other materials, of which semi-finished evacuated glass envelopes and accessories have a bigger effect on enterprises. Semi-finished evacuated glass envelopes purchased by small and medium sized manufacturers in Dezhou mainly come from 3 to 4 enterprises across the country, such as Beijing Linuo, Beijing Suoyang, Tengzhou Guangpu and Yanzhou Jindun, all of which are famous brands. Stands are also produced and supplied by specialized manufacturers. Parts and accessories of solar water heaters are usually purchased from Linyi of Shandong, because there is a special wholesale market there. Although

Dezhou has many solar water heater enterprises, it lacks a distributing center for relevant accessories. Many enterprises think that purchasing accessories from Linyi that is more than 400 kilometers away from Dezhou increases the transportation cost, so they suggest opening such an accessories terminal market in this area.

5. Suggestions for Improving the Solar Water Heater Value Chain

In conclusion, Dezhou's solar water heater industry has obvious advantages, but the constraints are also very prominent. An industry cluster of a certain size, the city's popularity in the solar energy industry and the municipal government's vigorous support for the production and use of solar water heaters are all advantages for developing the industry in Dezhou. However, problems such as irregularity in the development of the industry, lag of after-sales services, lack of human resources and inadequate government support for small and medium-sized enterprises also restrict further development of the industry. It is necessary that the government and enterprises jointly take measures to improve the industry's development environment, standardize the industry's market order, purify the industry's development environment, promote technical innovation, enhance enterprises' competitiveness and build a mode of win-win cooperation between various links of the value chain.

5.1 Creating a Conducive Macro-policy Environment

Firstly, it is necessary to further standardize the industry's market order and purify the industry's development environment. While improving the solar water heater technical standards system to provide safeguard for the industry's healthy development, we also have to strengthen market supervision and crack down on illegal acts of producing and selling fake and shoddy products.

Secondly, we should formulate preferential support policies that are operable and in favor of the industry's development. 《The Renewable Energy Law》 and 《the Circular Economy Promotion Law》 created a broad environment for the development of the solar water heater industry, but the two laws alone cannot promote healthy and stable development of the entire industry. It is necessary to strengthen policy support and provide support for the solar water heater industry in terms of financial, fiscal, tax, technology, construction, and consumer policies. For example, we can encourage enterprises to use matching funds for development and technical transformation projects through income tax relief and other means; classify solar energy heat utilization a building energy-saving technology that enjoys preferential treatment for building energy conservation; simplify the construction permit system for the installation of solar water heating systems and actively guide enterprises to voluntarily prompt the design and construction combining solar water heater and building in new residential projects; include solar water heaters into the government's

green procurement list and establish brands designated for procurement by the government; subsidize the consumption.

Thirdly, we should formulate policies conducive to the reservation of human resources and development of emerging green industries, including the solar water heater industry. We should also further improve the formulation and promotion of green jobs standards. We found out that people engaging in jobs relating to solar power utilization were closely related to the production of solar water heaters. The state has a professional standard in this regard and there are also organizations providing relevant training, but none of the enterprises we surveyed has heard of this professional standard, let alone participated in training. The solar water heater industry is an emerging industry and suffers a serious shortage of both human resources and training resources. It is recommended that the state take into account emerging industries' demand for human resources when formulating national plans for the development of job skills. It is recommended that mature technologies of green industries be introduced into training programs and support be given to organizations that promote green technologies and workers who participate in green skills training courses. In addition, many training and education institutions do not have relevant curriculum, so enterprises need to spend a lot on developing training materials and courses. The cost of employee training may exceed 2.5% of the gross payroll (turnover tax may be exempted). In this regard, we suggest that the state introduce relevant policies to provide relevant preferential tax policies for enterprises in emerging green industries that conduct training on their own.

5.2 Strengthening Support for Small and Medium-sized Enterprises

Like the home appliance and motorcycle markets, the solar water heater market is likely to undergo reshuffle in future. Only large enterprises can survive and develop. However, rural residents are limited by their income levels and spending habits and differences in their requirements for solar water heater products have widened, so small and medium-sized enterprises' low and medium-end products will still have a big market space for quite some time in future. Therefore, the policy support should be guided by the market demand and differentiation according to enterprises' sizes should be avoided. Seen from the perspective of future development, products' technical content and variability, distribution channel and quality of after-sales services will be important conditions for the survival and development of solar water heater enterprises, yet these three factors are precisely the weaknesses of many small and medium-sized enterprises. Therefore, it is necessary to strengthen the support for small and medium-sized enterprises by starting from the following several aspects:

- Encouraging small and medium-sized enterprises to carry out technical innovation and transferring technologies to small and medium-sized

enterprises to enable them to improve product design, product quality and variability so as to enhance the competitiveness of their products;

- Strengthening training for managers of small and medium-sized manufacturing enterprises and sales enterprises to enhance their management capabilities;
- Establishing an association of small and medium-sized solar water heater enterprises to promote self-discipline of enterprises and encourage cooperation among small and medium-sized enterprises, such as purchasing raw materials together to enhance their bargaining power and reduce the purchase cost, participating in bidding together and providing joint loan guarantee for each other.
- Providing financial support for small and medium-sized enterprises to solve their difficulties in financing, and provide conditions for them growing stronger and bigger;
- Stepping up promotion of local brands through a variety of means such as participating in exhibitions under the government's centralized organization.

5.3 Improving Follow-up Services

Solar water heaters must be used in coordination with water, electrical works and connected with various channels. We can say the follow-up installation service is of crucial importance for the use of solar water heaters, hence the saying “thirty percent product, seventy percent installation” in the industry.

In addition, a special marketing mode aimed at the rural market is the key to expanding the rural market. Many manufacturers have found the great potential of the rural market has, but they cannot find their way in regarding the two bottlenecks of lack of marketing channels and inadequacy of follow-up services that restrict the development of the solar water heater industry, we suggest taking measures to improve the follow-up service system. Specific suggestions include:

- Developing professional qualification standards and training materials specifically for solar water heater installation and maintenance personnel, formulating unified assessment standards and organizing efforts to carry out skill training for installation and maintenance personnel to improve the quality of after-sales services of solar water heaters;
- Helping distributors establish service processes and improve the management system;
- Carrying out training for distributors in rural areas and small and medium-sized cities, which mainly covers the basics of solar water heaters,

skills and strategies of prompting solar water heaters to local consumers, management skills for operating enterprises as well as financial knowledge;

- Urging manufacturers to participate in designing and providing training for distributors and installation and maintenance personnel and improving the relationship between manufacturers and distributors to build trust and achieve win-win.
- Providing targeted training for starting businesses and small loans for people who intend to engage in solar water heater sales services.