

**Circulating Water System Energy Saving Technology
of Hangzhou Pump Co. Ltd**

Assessment Report



2 July 2016

Assessment Report on Circulating Water System Energy Saving

Technology by Hangzhou Pump Co. Ltd

Beijing Energy Club¹

On the afternoon of July 2nd, 2016, Beijing Energy Club (BEC) carried out in-depth discussion and assessment on the high efficiency energy conservation technology for circulating water systems (CWSs) provided by Hangzhou Pump Energy Conservation Technology Co., Ltd. (hereinafter referred to as Hangzhou Pump) through its Technology Assessment Dissemination (TAD). This is the second assessment and dissemination activity organized by TAD.

Hangzhou Pump is engaged professionally in R&D, design, production and energy performance contracting (EMC) services on integrated CWSs' energy conservation technology. Hangzhou Pump originated in the Fluid Transport Institute for Energy Conservation Design of Zhejiang Industrial Design & Research Institute. It is committed to helping various companies carry out integrated energy management of energy consumption in the field of CWSs, tap the potential of energy conservation, reduce the energy consumption, and truly provide overall innovative energy management solutions. Hangzhou Pump was included in the catalogue of energy conservation and technical improvement companies, which was recommended by National Development and Reform Commission and the Ministry of Finance of the People's Republic of China in 2011. It is the only professional energy conservation company with many patent technologies specializing in the study of fluid transport in China. Since its establishment in 2008, the company's energy conservation and technical improvement has benefited Sinopec, PetroChina, CNOOC, Chinalco, Sinochem Group, HNEC, Shougang Group, China Gold, JAMG, and so on. At present, there have been hundreds of CWSs with successfully technical improvement, and the total annual energy conservation capacity is up to 700 million kWh, creating good social and economic benefits.

¹ Disclaimer: This Report has been prepared on the basis of the information that the Secretariat of Beijing Energy Club (BEC) has at its hand, the materials supplied by Hangzhou Pump Energy Conservation Technology Co., Ltd. and the discussions from the Technology Assessment & Dissemination on Jul. 2nd, 2016. BEC shall not be held responsible for any risks, losses, damages, costs or expenditures, claims, and/or any other rights of claim that may arise from any investment or other business decisions made by any business organizations or individuals in accordance with the conclusional comments contained in this Report.

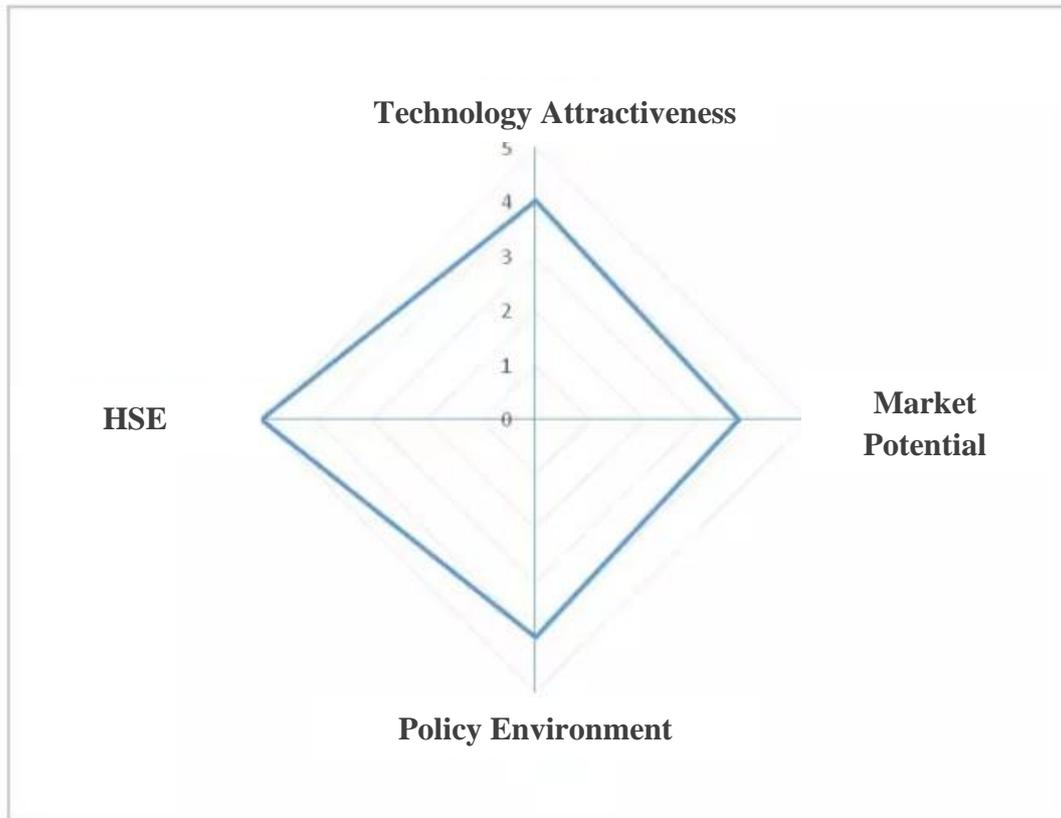
Experts participating in the assessment that very day included Mr. Mao Jiexiang, Vice President of SINOPEC Economics & Development Research Institute; Mr. Chen Xiaohua, General Engineer of Veolia Water in China; Mr. Bai Rongchun, former director of Department of Energy Conservation, State Economic and Trade Commission and former Inspector of the NDRC National Energy Administration; Mr. Liu Wenqiang, deputy director of China Center for Information Industry Development (CCID) of the MIIT, Mr. Zhi Hui, Secretary General of China Industrial Energy Conservation and Clean Production Association, and Mr. Zhai Yongping, General Consultant on Energy Technology of Asian Development Bank. Mr. Fu Chengyu, former chairman of Sinopec and honorary vice chairman of council of Beijing Energy Club, also attended the whole event and delivered his views and opinions.

At the meeting, Mr. Fan Changhai, chief engineer of Hangzhou Pump and the patented technology inventor, and Mr. Yang Qingkun, technical manager introduced high efficiency and energy conservation technology for CWSs developed independently by Hangzhou Pump; Mr. Hu Weijun, director of Manufacturing Department of Shanghai Sinopec Mitsui Chemicals Co., Ltd., and Mr. Cheng Dongzhao, deputy general manager of Henan Puyang Longyu Chemical Co., Ltd. described the application of Hangzhou Pump's high efficiency and energy conservation technology for CWSs in their companies respectively. On this basis a heated discussion was carried out.

1. Comprehensive Assessment

During the assessment, six experts had assessed Hangzhou Pump CWSs' high efficiency and energy conservation technology from four dimensions on the basis of the assessment system of clean energy technology developed by Beijing Energy Club.

According to the experts, the scores of the technology in these four dimensions are: 4.02 for technology attractiveness, 3.72 for market potential, 4.00 for policy environment, and 5.00 for health and safety environment, as shown below.



2. Technology Attractiveness

For the attractiveness of high efficiency and energy conservation technology for CWSs of Hangzhou Pump, the experts carried out the assessment mainly on technology maturity, technological innovation (intellectual property rights and patents) and technical complexity, as well as advancement, advantage/disadvantage in comparison with similar or alternative technologies. For this dimension, the comprehensive average score is 18.5 (Given the full score is 23, 18.5 can be converted to 4.02 according to the 5-score system).

Technology Maturity

At present, Hangzhou Pump's high efficiency and energy conservation technology for CWSs has been commercially applied. It has successfully implemented hundreds of energy conservation and technical improvement projects for CWSs. Through continuous improvement and perfection, the energy conservation effect of the technology has been highly recognized at the EMC.

Thanks to the support of patent technology, optimal and efficient equipment, rich experience and flexible model of cooperation and benefit sharing, Hangzhou Pump's high efficiency and energy conservation technology for CWSs can be applied extensively in various large-scale industries involving chemical, petrochemical, coal-based chemical, iron and steel plant, power plant and other energy conservation

improvements. The experts had unanimously agreed that the technology can be regarded as a mature energy conservation solution to CWSs.

Technical Patent

Hangzhou Pump has a series of patented technology and proprietary technology. It is the unique professional energy conservation company under the protection of the patent law specializing in the fluid conveyance study in China. Among them, four domestically leading patent technologies constitute the basis of its overall optimization.

1. A Correction method of online fluid system (Patent No.: ZL20071066873.2) (now as the proprietary technology of Mr. Fan Changhai). The precise determination is conducted on operating conditions of CWSs, to input various parameters into the mathematics model of patent technology, calculate the pipeline characteristics curve of actual working condition, find out the optimal working condition point of system operation, re-design the efficient water pump matching with the pipeline characteristics curve, and ensure the required flow of the maximum system heat exchange. The technical improvement means of water pump replacement is used to achieve the goal of reducing energy consumption while eliminating water pump cavitation, vibration, closing valve, over-current, high motor temperature and other abnormal phenomenon in the operation of water system so as to optimize the system in nature.

2. Assembly and working condition detection method for circulating pumps in water cooling system (Patent No.: 201310062873.0). According to the principle of optimal system working conditions, the professional hydraulic mathematical model is established through the detection and parameter acquisition of operating condition for CWSs, so as to find out the factors causing high energy consumption and the optimal operating condition point, design and produce the efficient fluid transmission equipment matching with the system and replace the existing equipment of CWSs. In doing so, the system is always kept in the best operating condition, achieving the purpose of energy conservation and consumption reduction.

3. Method and device for reducing circulating pump lift of high-level circulating water system (Patent No.: ZL201010204888.2). The invention belongs to the technical field of cooling and CWSs, and particularly relates to a method and device for solving the issue of high pressure water return in high-level CWSs. The above high-level CWSs includes cooling tower, water tank, circulating pump, heat exchange equipment and connecting pipe. The heat exchange equipment includes several heat exchangers at different water levels. Circulating water is conveyed by the water mains to heat exchangers and then collected back to the water patent tube through the auxiliary water return tube of heat exchanger and then to the cooling tower. It is characterized by the procedures that the said circulating water is conveyed into the cooling tower through the auxiliary water return tube of heat exchanger to facilitate pressure relief. With the method, the high pressure circulating pump in system can be changed into a low pressure circulating pump so as to reduce the lift of circulating

pump and resolve the energy waste issue that people have been eager to solve but yet succeed.

4. A Boosting and Exhausting Device of Air Conditioning Water System (Patent No.: ZL200520116220.7). In order to maintain a stable positive pressure of central air conditioning water system, an expansion tank is always provided at the top of building and connected directly with the water return cylinder of air conditioning water system through water pipe. In operation especially at start up, it is easy to generate bubbles due to pressure fluctuations. When the top layer is in a low water pressure, bubbles cannot be discharged from water pipe so as to cause the air stagnating and form “gas jam”, seriously affecting the cooling effect of air conditioning. A Boosting and Exhausting Device of Air Conditioning Water System does not change any facility of air conditioning water system, and can eliminate “gas jam” to make it in a normal operation so as to solve the technical issue that need to be solved urgently in the air conditioning water system.

Comprehensive Advancement

The experts highly recognized the advancement of Hangzhou Pump’s high efficiency and energy conservation technology for CWSs. Hangzhou Pump could put forward a set of energy conservation solution through energy consumption monitoring and problem diagnosis. After operating for some time, the effects are assessed for improvement. Therefore, the technology as a whole can be regarded as the most advanced in China, specially reflecting as follows:

The first is to find out issues on the basis of complete monitoring and diagnosis. Collect the data of the whole CWSs all the year. Take a year as a complete analysis cycle. Find out the key points of CWSs’ energy loss or main link for the energy efficiency improvement through diagnosis and analysis.

The second is to provide an overall solution. Put another way, optimize the entire pipeline including valve improvement, matching between pipeline and pump and others. It involves not only the energy conservation of motor, but also the overall optimization of motor and pump valve and pipeline system.

The third is to put forward the key design parameters of water pump. The technology involves elaboration on hydraulic pump energy and provides a set of design and manufacturing data for pump manufacturers. In different seasons, the CWSs are of variable loads and cooling capacity; the efficient operating range of some existing pumps is very narrow. With the technology of Hangzhou Pump, most of the time, pumps can operate efficiently despite of variable loads and changing climate.

2. Market Potential

For any market potential of Hangzhou Pump’s high efficiency and energy conservation technology for CWSs, the experts mainly evaluated from three aspects including target market scale, market development speed and economic performance.

The comprehensive average score of experts was 11.2 (Given the full score is 15, 11.2 can be converted to 3.72 according to the 5-score system). It is worth to note that the score of the experts was more conservative considering that the energy conservation work had not been valued highly in the company level. The experts focused on the domestic market, and the technology has not applied internationally. The possible effect of international market in the future was not considered for the market potential assessment.

Target Market

The application field and energy conservation potential of high efficiency and energy conservation technology for CWSs has been introduced in detail in the technical introduction report. The report tries to give the potential scale of target market on the basis of the discussion results of assessment experts.

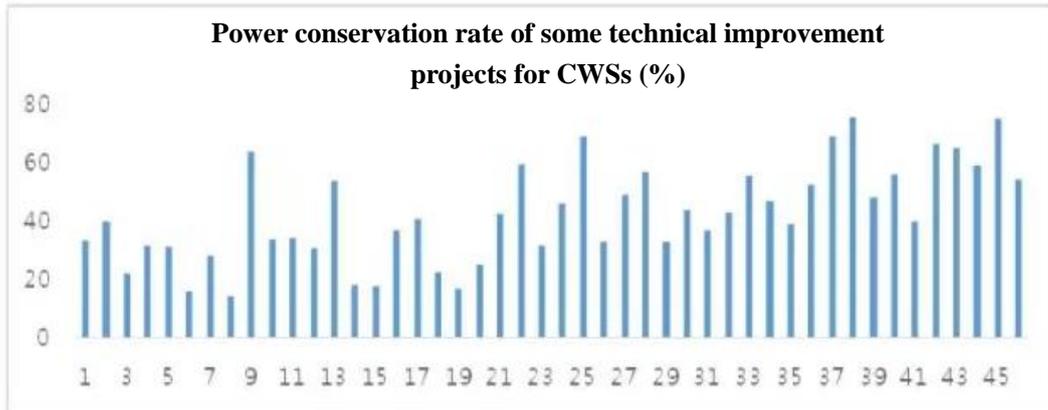
The experts believed that the market potential of the technology is very large. According to Hangzhou Pump's report, the power consumption capacity of CWSs accounted for 11% of industrial power consumption capacity. Accordingly, we can estimate that the power conservation potential of improvement for CWSs in China is about 70 billion kWh annually (for the energy conservation potential of specific industries, refer to the technical introduction report). But the total power conservation capacity of technical improvement completed currently by Hangzhou Pump just reaches 700 million kWh annually, which accounts for only one percent of the energy conservation potential. Therefore, the market prospect is very broad in the future.

Market Development Speed

Hangzhou Pump is the only company that is able to improve CWSs systematically in China. After the improvement, the power conservation proportion of CWSs is high mostly between 20% and 50%, some as high as 70% and more with powerful market competitiveness. For the development speed of domestic market in the future, most experts chose "Fast" or "Very Fast" as the answer.

Technology and Economy

In the data provided by Hangzhou Pump, there is not any detailed content on the technical and economic assessment. According to the verbal communication between the experts and the technology owner, the corresponding investment payoff period is short because the power conservation rate of technical improvement is very high. From the power conservation rate of actual project (see the following figure), the project with the rate less than 20% is very few, and the rate of some projects reaches up 70% and higher. Therefore, the return rate of technical improvement for energy conservation is very high. Due to good economic returns, some current energy conservation service companies no longer need to be supported by the state subsidies but fully embark on the market oriented road.



3. Policy Environment

For domestic policy environment faced by the high efficiency and energy conservation technology for CWSs, the experts mainly assessed from two aspects such as industrial policy support level and market development level. The comprehensive average score of the experts was 8.0 (Given the full score is 10, 8.0 can be converted to 4.00 according to the 5-score system).

China pays attention to energy conservation and emission reduction. According to the assessment experts, the National Development and Reform Commission had released the catalogue of the 8th batch of energy conservation and emission reduction technologies, including a few hundred of energy conservation and emission reduction technologies. Under the support of the Ministry of Science and Technology of the People’s Republic of China (MOST), the Ministry of Industry and Information Technology of the People’s Republic of China had carried out topic research as well as screening and dissemination of energy conservation and emission reduction technologies, and released more than 600 technologies in 11 industries. MOST had also carried out 14 special studies and carried out the screening of energy conservation and emission reduction technologies.

China also strongly supports the implementation of energy conservation and emission reduction technologies in terms of taxation. In accordance with the *Regulation on the Implementation of the Enterprise Income Tax Law of the People’s Republic of China*, the income of a company incurred from the projects of environmental protection, energy and water saving, which meet the relevant requirements, shall, from the taxable year of the first production and business income from the project, be exempted from the corporate income tax from the first year to the third year, and 1/2 of the corporate income tax shall be decreased from the fourth year to the sixth year. The company engaged in the technical improvement of high efficiency and energy conservation for CWSs is able to enjoy the “three-year exemption and three-year half payment” policy of the income tax.

For the EMC, both central and local governments have also given substantial subsidies. In addition to providing tax relief for energy conservation companies, both central and local governments also provided significant subsidies for the energy conservation work of companies in accordance with the energy conservation capacity (the subsidies of central government had been stopped at the end of 2015). The subsidy standard per ton of standard coal in Beijing, Shanghai and other large cities is between 500 yuan and 600 yuan. (See the attachment).

The national carbon emission trading market will be launched fully in 2017, and the technical improvement for energy conservation and emission reduction will bring a considerable income for large energy consumption companies. Carbon emission permit trading pilots have been implemented in 7 provinces and municipalities (including Shenzhen, Shanghai, Beijing, Guangdong, Tianjin, Chongqing and Hubei) in China, and all of them had been in online transaction. The National Development and Reform Commission had issued *China 2015 Annual Report on Anti-climate Change Policy and Actions*. Till to the end of August 2015, the accumulated transaction place quota of 7 carbon emission trading pilot was about 40.24 million tons, the turnover was about 1.2 billion yuan, the average transaction price was 30 yuan/ton, the accumulative auction quota was about 16.64 million tons, the turnover was about 800 million yuan, and the average transaction price was 48 yuan/ton. 1000 kWh of power conservation can reduce 0.915 tons of carbon dioxide emission. There is 27~44 yuan of potential benefit from the point of view of carbon trading.

4. Impact of Health, Safety and Environment (HSE)

HSE assessment is to identify and evaluate any possible risk on health, safety and environment of the technology in the production and application scenarios. The comprehensive average score of experts on the dimension was 14.0 (Given the full score is 14, 14.0 can be converted as 5.00 according to the 5-score system).

All the experts agreed that there is not any hidden danger of Hangzhou Pump's high efficiency and energy conservation technology for CWSs to human health and safety, and it is an environmental friendly, safe and reliable environment protection technology with resource conservation. This can save the electric energy that is equivalent to reducing the consumption of coal power that can not only reduce the emission of sulfur dioxide, nitrogen oxide, soot and other normal pollutants but also reduce the emission of greenhouse gas (GHG). After calculation, the conservation of 700 million kWh is equivalent to that of about 230,000 tce so as to reduce the emission of 640,000-ton carbon dioxide, 82-ton sulfur dioxide, 117-ton nitrogen oxide, and 12-ton soot.

The energy conservation and emission reduction effect and potential of technical improvement for CWSs are striking. Through technical improvement for energy conservation, Hangzhou Pump had already saved about 700 million kWh of power

consumption in accumulation. If this number is converted to 5,000 annual utilization hours, it means building one less 140MW power plant, and the energy conservation can bring a negative watt. The energy conservation potential of CWSs in three petroleum and petrochemical corporations is very large. Through preliminary calculations, the energy conservation potential is 10 billion kWh, and that of national chemical industry is 45 billion kWh. If 5,000 annual utilization hours are still used for calculation, it is equivalent to building 9 less 1000MW of large thermal power plants.

5. Technology Development Prospect and Risk Analysis

As a whole, Hangzhou Pump’s high efficiency and energy conservation technology for CWSs has characteristics such as mature technology, good economy and better market potential. Therefore, the development prospect of the technology is good with little risk.

But the experts also proposed some issues that the technical improvement project possibly faces. For example, Hangzhou Pump does not have its own equipment manufacturing plant and engineering team, so it faces risks that the manufactured equipment cannot be delivered on time or the project cannot be implemented on schedule. These risks are of certain uncontrollability.

In large corporations such as petrochemical companies, the safety management is very strict, and external construction teams will sometimes face certain limits when going into a plant. The experts suggested that Hangzhou Pump’s construction team should carry out the construction together with these companies’ construction teams.

The experts argued that Hangzhou Pump is responsible for all the risks while carrying out the EMC of technical improvement project. Because Hangzhou Pump provides fund and technology to carry out the construction according to its efficiency and the companies of CWSs do not undertake any risk. The experts had also proposed risk-averse methods on how to control the above risks. The first is to choose large and powerful enterprises that will not close down within a foreseeable period, and the revenue sharing after technical improvement can be guaranteed. The second is to determine the benefit sharing proportion reasonably, this is very crucial in the agreement, and it has a very important relationship with the power conservation rate of technical improvement.

In addition although the market potential on technical improvement project for energy conservation is enormous, it is necessary to improve the business mode because of relatively decentralized projects, high transaction cost and difficult dissemination in public relation. These questions will be discussed in another report “Dissemination and Proposal”.

Attachment: List for Central and Local Government Incentive Policies of EMC in Each Region during the 12 th Five-Year Period			
Province/municipality	Details of central	Local additional incentive (yuan/ton)	Total

	and local incentives and subsidies (yuan/ton)			Provincial and municipal financial incentives	Investment amount %	Additional incentive	support amount of single project (in principle)
	Central	Local	Total				
Beijing	240	260	500	450	15-20		≤4.5 million yuan
Tianjin	240	120	360				
Guangxi	240	60	300				
Henan	240	60	300				
Shandong	240	60	300			1 million yuan of bonus for outstanding energy conservation contribution company/1 million yuan of bonus for each significant energy conservation result/50,000 yuan of bonus for each outstanding energy conservation result	
Jiangxi	240	60	300				
Fujian	240	60	300				≤3 million yuan
Anhui	240	60	300				
Zhejiang	240	60	300				

Jiangsu	240	60	300				≤2 million yuan
Heilongjiang	240	60	300			Issue honorary award certificates and medals and 50,000 yuan to advanced energy conservation companies. Issue honorary award certificates and medals and 50,000 yuan to outstanding energy conservation achievement	
Jilin	240	60	300				
Liaoning	240	60	300	150			
Shanxi	240	160	400	350		Carry out special awards according to the actual annual energy conservation capacity after project implementation and the standard that is not more than 400 yuan/ton standard coal.	
Hebei	240	60	300				
Ningxia Autonomous Region	240	60	300			Give awards to the top 10 companies in annual ranking. Among them, 2 first prizes with 1 million yuan respectively for award; 3 second prizes with 800,000 yuan respectively for award, and 5 third prizes with	

						500,000 yuan respectively for award.	
Guangdong	240	80	320				≤2 million yuan
Gansu	240	60	300				
Hainan	240	120	360	330			≤3 million yuan
Guizhou	240	60	300				
Hunan	240	60	300				
Hubei	240	60	300				
Qinghai	240	60	300	100	50		
Shanghai	240	360	600		50		≤6 million yuan
Sichuan	240	60	300				
Yunnan	240	60	300				
Inner Mongolia Autonomous Region	240	150	390				
Shaanxi	240	60	300				
Chongqing	240	120	360	200			
Xinjiang Autonomous Region	240	60	300				