

# THE CHINA MOTOR SYSTEMS ENERGY CONSERVATION PROGRAM: ESTABLISHING THE FOUNDATION FOR SYSTEMS ENERGY EFFICIENCY

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## ABSTRACT

Industrial electric motor systems consume more than 600 billion kWh annually, accounting for more than 50% of China's electricity use. There are large opportunities to improve the efficiency of motor systems. Electric motors in China are approximately 2-4% less efficient on average than motors in the U.S. and Canada. Fans and pumps in China are approximately 3-5% less efficient than in developed countries. More optimized design, including appropriate sizing and use of speed control strategies, can reduce energy use by 20% or more in many motor-driven system applications. Unfortunately, few Chinese enterprises use or even know about these energy-saving practices. Opportunities for motor system improvements are probably greater in China than in the U.S. or Europe.

In response to this opportunity, China has established the *China Motor Systems Energy Conservation Program* in cooperation with the United Nations Industrial Development Organization and the US Department of Energy, and the Energy Foundation. This paper will describe the overall structure of the program. Elements include work to develop minimum efficiency standards for motors, a voluntary "green motor" labeling program for high-efficiency motors, efforts to develop and promote motor system management guidelines, and an intensive training, technical assistance and financing program to promote optimization of key motor systems in two pilot provinces, Shanghai and Jiangsu.

This year, an international team of experts is working with twenty Chinese experts in a series "train the trainer" sessions designed to assist the Chinese experts integrate a systems approach into their work in Chinese industry. We will focus on progress to date including plant assessment techniques and significant considerations in adapting market-based voluntary program techniques to the Chinese business environment.

## BACKGROUND

The China Motor System Energy Conservation Program is a direct outgrowth of activities undertaken by the China State Development and Planning Commission (SDPC) and the United States Department of Energy (USDOE) since 1997 as the result of a China-U.S. bilateral cooperation agreement. The Energy Conservation Law, put into place by the Chinese government in 1999, includes optimization of motor systems as a specific policy objective. The Chinese government has demonstrated a strong interest in improving industrial motor systems through its financial and in-kind support of workshops, industrial site visits, and other activities already

completed under this agreement. Chinese officials view optimization of motor systems as one of the few activities that can yield near term benefits to Chinese industrial enterprises such as reduced operating costs and increased system reliability. These benefits are extremely important to industries trying to manage a difficult transition to open competition. Improved equipment design, more optimized system integration, and improved operations and maintenance practices can reduce motor system energy use by 20% or more, providing substantial energy and emissions savings (e.g., CO<sub>2</sub> and SO<sub>x</sub>) while reducing factory operating costs and contributing to the economic viability of the factory. If 50% of electric motor systems in China are better optimized to achieve 20% average energy savings (a reasonable long-term goal), Chinese enterprises will save the equivalent of more than US\$4 billion annually and carbon emissions will decline by more than 25 MMT annually.

## **PROGRAM OVERVIEW**

The purpose of the China Motor System Energy Conservation Program is twofold: to develop a variety of education materials, analysis tools and standards for promoting motor system optimization in China and to put a local infrastructure in place in two provinces (Shanghai and Jiangsu) to promote greater efficiency in industrial motor driven systems. This is an important first step in a planned ten-year effort by the Chinese government to establish and train a network of motor system optimization experts throughout China, and to use these experts to assist individual factories to implement motor system improvement projects.

Primary funding for the pilot program is being provided by the United National Foundation (UNF) with substantial in-kind contributions from USDOE and SDPC. Additional funding is being made available from the Energy Foundation. The United Nations Industrial Development Organizations (UNIDO) is administering the program on behalf of UNF. The intent is to use lessons learned in the pilot phase of this project to develop an integrated program model that can serve as the foundation for a national program.

Shanghai and Jiangsu were selected for the pilot program because they expressed strong interest, included a significant industrial base, have organizational support, and have a small cadre of energy professionals who can be trained on the technical specifics of motor system optimization. Program objectives for the project period of 3 years, include the following activities:

- (i) Develop a series of educational materials and application tools (e.g., software) to assist motor system experts and factory engineers to assess and better optimize motor systems;
- (ii) Revise existing Chinese national standards on the economic operation of motors, fans and pumps;
- (iii) Train 10-16 motor system optimization experts who will work in Shanghai and Jiangsu;
- (iv) Implement and evaluate a series of 8 to 12 motor system improvement demonstration projects in different industrial sectors in Shanghai and Jiangsu and prepare case studies of these projects;
- (v) Train ~400 Shanghai and Jiangsu factory managers and engineers and provide technical assessments to at least 32 Shanghai and Jiangsu factories to assist them to identify and undertake their own motor system optimization projects;
- (vi) Evaluate the different project components and assess how the project can be improved; and
- (vii) Assist the Chinese government to plan for and lay the groundwork for a major national motor system improvement program.

## **PROGRAM ELEMENTS**

A primary subcontractor, the China Energy Conservation Investment Corporation (CECIC) was selected by UNIDO in August 2001 through a competitive bidding process. CECIC is responsible for overall management of program implementation activities, including contracting with local agencies in Jiangsu and Shanghai. These subcontracts were signed in October 2002. A substantial evaluation component is also included to determine the effectiveness of the pilot programs. Evaluation is the responsibility of a Project Management Office (PMO) established by the SDPC. Preliminary evaluation results are anticipated in early 2003. The pilots will be completed by late 2004

UNIDO selected a Chief Technical Advisor (CTA) for the project in March 2001 to assist UNIDO in forming an International Team of Experts, selecting the Chinese experts to be trained, and to provide assistance to CECIC in developing an implementation framework for project management, reporting, and fiscal management.

An International Team of Experts was assembled by August 2001 to develop educational materials and application tools to assist motor system experts and factory engineers to assess and better optimize motor systems. This team is responsible for developing educational materials and application tools to assist Chinese motor system experts using their own material and information from existing motor system programs, most notably in the U.S. and the U.K. Topic areas will include: motors and drives, pumping systems, compressed air systems, and fan systems. Post-training technical support will also be provided for plant assessments, project development, and case study preparation.

The ultimate success of the program is dependent on the ability of the Chinese experts to understand and apply the systems approach in conducting plant assessments, develop projects, and train factory personnel on the benefits of undertaking additional projects using the systems approach. In addition, it is anticipated that some of these experts will form a core group that will be prepared to train other experts as part of a future national program. The pilot program has a fixed budget for 12 weeks of intensive training of the Chinese experts over a 10-month period by the International Team. For these reasons, selection of the Chinese experts was a critical element. CECIC, the Shanghai and Jiangsu Energy Conservation Centers, and the CTA finalized selection of 22 experts in a series of interviews with the candidates in December 2001, based on a set of criteria approved by the International Team. The selected experts are a mix of Energy Center staff and engineers from key industries in the two provinces. A group of 22 was selected to allow for attrition while still meeting the program target of 10-12 trained Chinese system optimization experts.

### **International Team of Experts**

Program Administrator  
Robert Williams, UNIDO

Chief Technical Advisor  
Aimee McKane, Lawrence Berkeley National Laboratory

Motors & Drives Experts  
Hugh Falkner, AEA Technology  
Vestal Tutterow, Lawrence Berkeley National Laboratory

Pumping System Experts  
Steven Bolles, Process Energy Solutions  
Gunnar Hovstadius, ITT Fluid Technologies

Fan System Expert  
Ronald Wroblewski, Productive Energy Solutions

Compressed Air System Experts  
Wayne Perry, Kaeser Compressors  
Tom Taranto, Pneumatech/ConservAIR

### **Chinese Project Management and Implementation**

Project Management Office  
Dai Lin, ERI

China Energy Conservation Investment Corporation  
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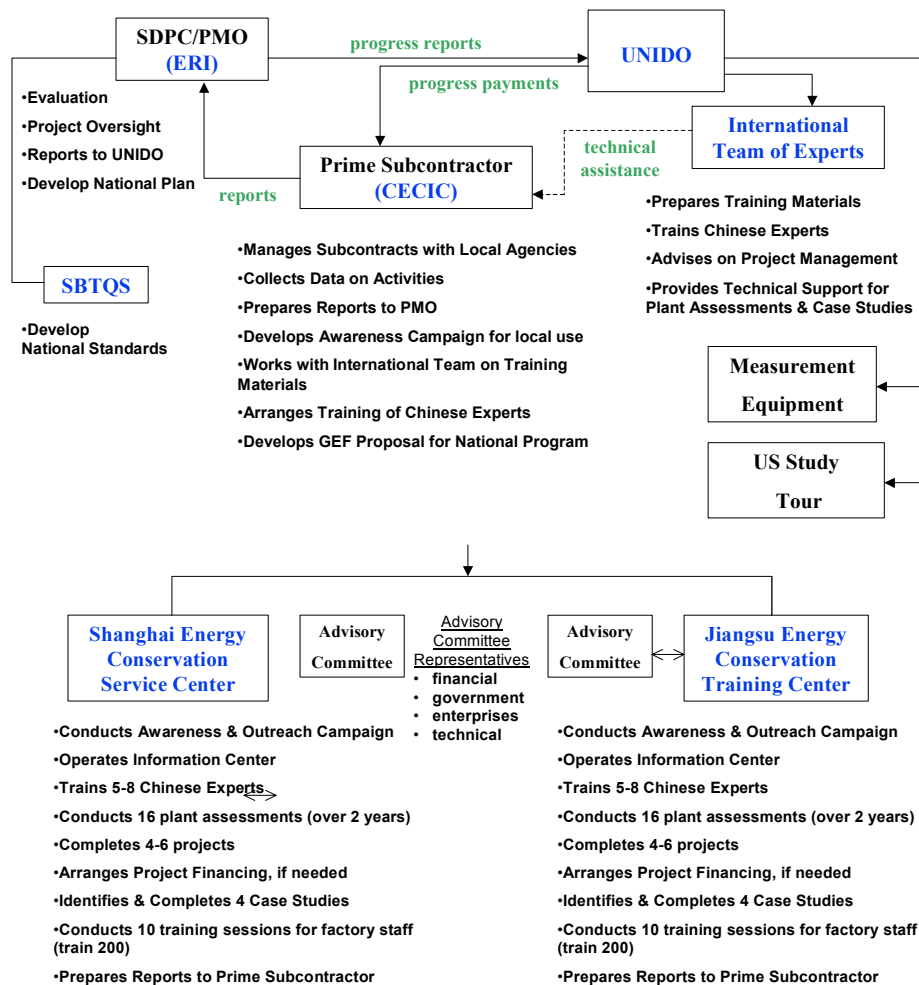
Shanghai Energy Conservation Service Center  
Ye Wen Baio

Jiangsu Energy Conservation Training Center  
Li Yuqi

## **PROGRAM ACTIVITIES**

The pilot Program officially started with an inception meeting in Nanjing, China in December 2001. At this time, the training schedule through January 2003 was fleshed out in detail and the CTA provided financial management training. The period from January – March 2002 was used to develop and translate pump system training materials, select and order measurement equipment kits in consultation with the International Team, and identify factory sites for the first training session. The program focus through January 2003 is on building an infrastructure of trained system optimization experts in Shanghai and Jiangsu provinces. This is being accomplished by a series of three training sessions conducted by the International Team.

## China Motor System Energy Conservation Program



**Figure 1- Program Elements**

The training developed by the International Team for the Chinese experts combines classroom instruction, hands-on practice with measurement instruments, and onsite assessment of motor-driven systems at selected Chinese factories. Despite the considerable challenges resulting from differences in language and industrial practices as well as the physical difficulties inherent in conducting onsite training at factories, this model of instruction is beginning to produce results.

In April, the first train-the-trainer session on pumping systems was held in April 2002 in Shanghai. A meeting of the instructors, CTA, CECIC, and the senior members of each Energy Center was held immediately after completion of the training to review and discuss the students' written evaluations and instructors' observations. The "lessons learned" from these discussions were incorporated into the written report prepared after each training session and taken into consideration in preparing for the next training session.

In May 2002, training materials were prepared and factory sites selected for the motor/drive and fan system training (classroom and onsite training on measurement and plant assessment techniques). In addition, the

International Team developed pumping system materials for use by the Chinese experts providing training to technical and managerial staff at factory sites.

In June 2002, the second train-the-trainer session on motors/drives and fan systems was held in Jiangsu province (Nanjing). The Pump System Experts returned at the end of the training to observe and assist the Chinese experts with measurement techniques and plant assessment reporting. At the request of the Chinese experts, additional training was given on project development and financing issues. The Pump Experts also observed the Chinese experts conducting their first factory training sessions on pumping systems and the benefits of implementing energy efficiency projects. Again, the experts training was followed by a discussion of lessons learned and preparation of a written report.

During July and August 2002, the Compressed Air Experts developed training materials and CECIC had them translated. Final preparations were made for measurement equipment purchases and factories for onsite training. In addition, the Motor/Drive and Fan System Experts began preparation of the materials for the Chinese experts to use in factory training. The third train-the-trainer session on compressed air systems is being held in Shanghai in October.

The Motor/Drive and Fan System Experts will be returning in November 2002 and the Compressed Air System Experts will be returning to Nanjing and Shanghai in January 2003. The purpose of these trips will be to observe factory training by Chinese experts and to provide additional technical assistance on measurement and plant assessment techniques. The International Team will also be available via email for several months to review plant assessment reports and case study descriptions.

## **LESSONS LEARNED**

Cultural differences between Western and Chinese students surfaced during classroom training. Chinese students are accustomed to lecture-style instruction and require encouragement to interact with instructors and each other. Also, the Chinese experts are receiving training on all aspects of systems optimization for a pumps, fans, motor/drives, and compressed air. The next step for the Chinese experts will be to start thinking about areas of specialization, by system type and also by function. For example, in the US and the UK, some individuals become very skilled in the use of measurement instrumentation, while others become very skilled in determining what to measure and how to interpret the data collected. We expect that this will occur as individual strengths surface during the training. Intensive practice is essential to developing facility in the use of complex measurement equipment.



Another issue that surfaced is the need for standardization and quality control in plant assessments and report development. These could be accomplished by: standard report formats; plant wide general assessment approach (utility and facility information reporting); consistent use of standardized units for pressure and flow; standard spreadsheets for calculations; instrumentation procedures; and review of reports by senior members.

Finally, although the Chinese experts are making very good progress in developing system assessment skills, there is an ongoing need for technical assistance from the international experts as the Chinese experts begin to apply their system assessment skills in plants.

## **NEXT STEPS**

The Chinese experts have already begun conducting plant assessments and developing projects. In 2003, the primary program focus will be on pilot program objectives to: conduct 16 plant assessments in each province, complete 4-6 projects, develop case studies on these projects, and conduct training for 200 factory representatives in each province. A US study tour is also planned for mid-2003.

Development of national standards for the efficient operation of motors, fans, and pumps has begun and will be completed with the cooperation of the State Bureau of Quality and Technical Supervision in 2003.

An interim program evaluation will be completed during the first quarter of 2003 and the results from this evaluation will be used as an input to improving the pilot and planning a national program. UNIDO, USDOE, and the Chinese government will work to secure sources of international funds for a national program. The objectives for the national program are to: continue working on refining the skills of the Chinese experts who have participated in the pilot program; expand the program to additional provinces with the assistance of these Chinese experts and the International Team; and gradually transition over several years to a training program for system optimization experts that is offered by a core group of Chinese experts who have developed their skills as the result of the pilot program. It is anticipated that training under the national program will be extended to the design institutes to integrate system optimization techniques into new system design.

In the final year of the pilot program (2004), a comprehensive program evaluation will be completed. It is anticipated that the pilot program model will be refined and applied in other countries with an emerging industrial sector.

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