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FEATURE ARTICLE

# Lessons For Industrial Energy Efficiency Cooperation With China

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*China's energy hunger is immense and growing, especially in the energy-intensive industrial sector, which consumes roughly two-thirds of all energy in China. International cooperation since the 1990s has recognized the importance of improving energy efficiency in China's industrial sector, ranging from provincial pilot projects involving industry-government energy saving contracts, to the development of energy service companies nationwide; from cement sector benchmarking tools to energy performance standards for Chinese industry. When the country's energy consumption surged surprisingly in the early 2000s, the Chinese government has since adopted a more aggressive portfolio of energy strategies in the industrial sector, catalyzing numerous new international cooperative efforts. This paper examines those efforts to provide lessons learned and insights for ongoing collaboration. The most effective cooperation has created an active exchange of international best practices and connected individual projects with wide-reaching Chinese policies and more of this kind of cooperation is needed. In addition, cooperation needs emphasis on capacity building to improve industrial energy efficiency, such as assisting national and local energy conservation centers, increasing support for auditing and benchmarking tools, developing energy management guidance based on international best practice, establishing a program for certified energy managers, and—perhaps the most challenging—targeting new policy cooperation to address the structural roots of energy consumption. Such efforts could not only help China reduce its energy demand and $CO_2$ emissions, but also could help China, the United States and other countries develop energy efficient and low-carbon economies.*

## CHINA'S CHALLENGES IN PROMOTING ENERGY EFFICIENCY

China's policymakers have long focused on promoting energy efficiency, with early successes occurring between 1980 and 2002, when the country's energy use per unit of gross domestic product (GDP) decreased an average of 5 percent annually. These improvements were in large part due to government energy efficiency policies and programs, especially those focused on the industrial sector, which consumes roughly two-thirds of all energy used in China. Central to the success was the Chinese leadership's introduction of an energy strategy that prioritized resource conservation. Numerous policies and programs—including financial incentives for energy efficiency investments and establishment of over 200 Energy Conservation Centers (ECCs) throughout the country to help implement energy saving policies—successfully reduced energy use while the economy grew rapidly (Price et al., 2001; Sinton et al., 1998; Sinton et al., 1999; Sinton & Fridley, 2000; Wang et al., 1995).

The decline in energy use per unit of GDP suddenly reversed in 2002 and economic energy intensity increased an average of 3.8 percent per year between 2002 and 2005. There are many reasons for this reversal, but the dismantling of the energy efficiency policies and programs from the 1980s and early 1990s as China moved to a more market-oriented economy in the 1990s certainly played a role.

Recognizing the significant consequences of this trend in terms of energy security, environmental pollution, and the cost of energy as a share of GDP, the National People's Congress set a target within China's 11th Five-Year Plan (FYP) to reduce the energy intensity of China's economy by 20 percent from 2006 to 2010.[1] This target will be challenging to meet, because economic growth proceeded at a faster pace than expected from 2004 to 2008 (GDP growth rates of 9.6 to 13.1 percent), while structural shifts in the economy saw the rise of energy-intensive industries (Lin et al., 2006).[2] To achieve the national goal, provinces, cities and enterprises were also assigned targets, and significant efforts have been made to both enforce and realize this goal (Zhou et al., 2009).

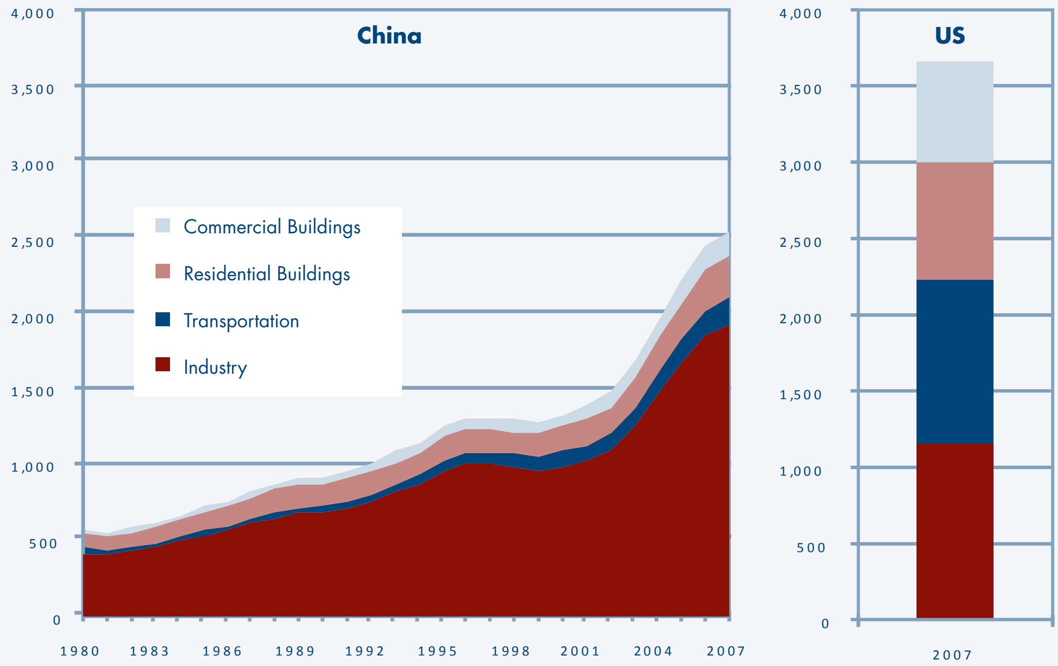
*…national energy consumption levels in the United States and China are very close, while U.S. per capita energy consumption is still nearly five times higher than that in China*

Reports on the progress towards the 20 percent intensity target have been issued and updated several times a year during the 11th FYP period. Official reports in 2009 found that energy intensity was reduced—1.79 percent in 2006, 4.04 percent in 2007, and 4.59 percent in 2008 (NDRC, 2009a; NDRC, 2009b). Thus, at the end of the third year of the 11th FYP, it appeared that close to 10 percent reduction had been realized, roughly half of the goal. Because changes in technology, energy management, and enterprise structure take time, it was not surprising that improvements would start slow and pick up speed. However, by the spring of 2010, the Chinese government and analysts were seriously concerned that the target might not be met. The cumulative intensity reduction was reported to be 14.38 percent through 2009, but the first quarter of 2010 witnessed an *increase* (worsening) of 3.2 percent, year-on-year (*China Daily,* 2010). In response, Premier Wen Jiabao called on officials to use an "iron hand" and increase efforts to close down inefficient enterprises and achieve the target. Also during this time (2009-2010), China's National Statistical Bureau was in the process of reconciling data from quarterly and annual reporting, with the large-scale and less-frequent census data. In July 2010, NBS released updated and revised statistics showing progress might yet be on track: revised year-on-year reductions of 2.74 percent in 2006, 5.04 percent in 2007, 5.20 percent in 2008, and 3.61 percent for 2009 (NBS, 2010), The progress updates indicate that cumulatively, energy intensity declined by 15.6 percent from 2006 through 2009, bringing the country closer to its target in 2010.

Even with China's efforts, energy use and energy-related carbon dioxide ($CO_2$) emissions continue to grow as the country meets energy demands related to urbanization and manufacturing goods for both domestic consumption and export. Figure 1 shows that China's total energy use more than quadrupled from 558 Mtce in 1980 to 2,539 Mtce in 2007 (NBS, various years) but still had not reached the energy consumption level of the United States (U.S. EIA, 2008a). Analysis in 2010 indicates that national energy consumption levels in the United States and China are very close, while U.S. per capita energy consumption is still nearly five times higher than that in China (BP, 2010; IEA 2010). Due to differences in fuel mix and efficiency, China's emissions of energy-related $CO_2$, however, surpassed those of the United States in recent years. (See Figure 2).

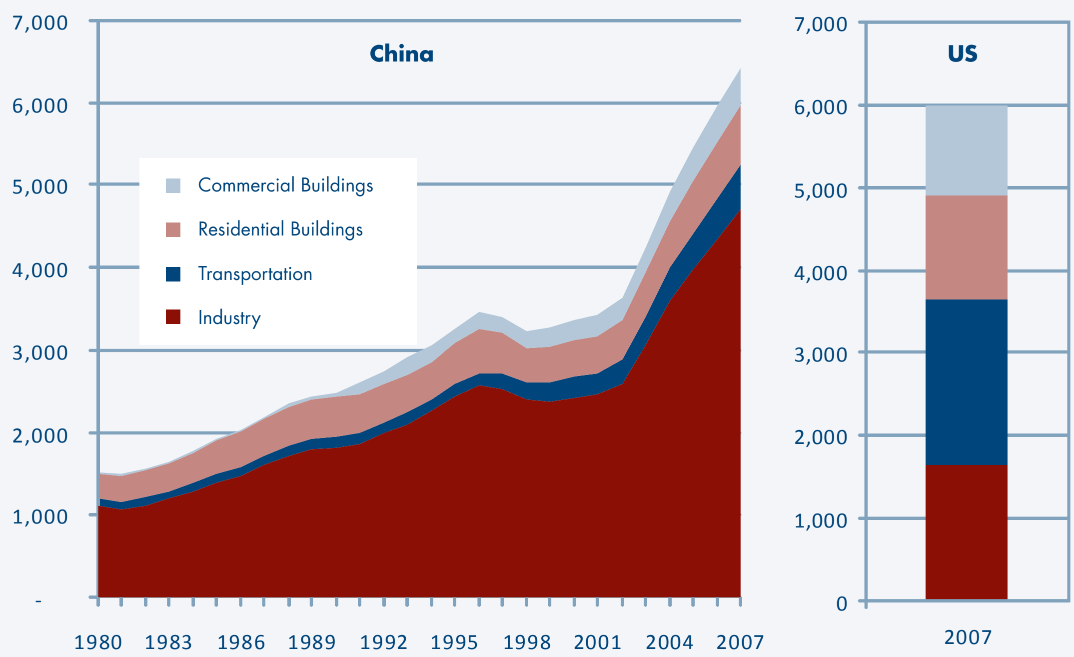
Central to this article is an exploration of the growing challenges China faces—along

## FIGURE 1. ENERGY CONSUMPTION BY MAJOR END-USE SECTOR IN CHINA (1980-2007) AND THE UNITED STATES (2007)




Sources: NBS, various years; U.S. EIA, 2008a.

## FIGURE 2. ENERGY-RELATED $CO_2$ EMISSIONS FOR CHINA (1980-2007) AND THE UNITED STATES (2007)



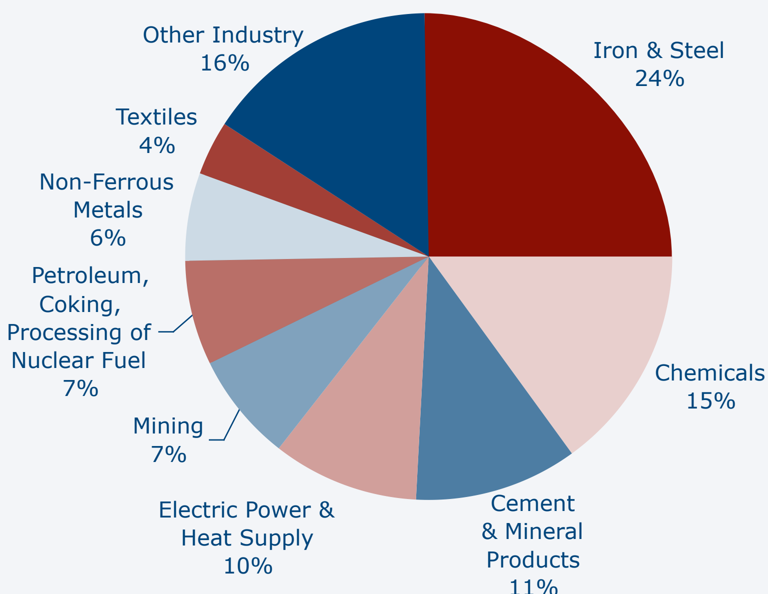

Sources: US EIA, 2008b. Note: China emissions calculated using 1996 revision of IPCC default carbon emission factors; commercial fuels only, not including biomass.

with its international cooperation partners—in strengthening industrial energy conservation in order to lower the sector's energy consumption and $CO_2$ emissions. We begin by examining Chinese energy efficiency initiatives in the industrial sector, from data reporting to energy saving contracts between government and enterprises. Next we analyze international cooperation with China on industrial energy efficiency, focusing on a few examples of cooperation led by multilateral, bilateral, and nongovernmental organizations, and synthesizing lessons learned. Recognizing the importance of capacity building for ongoing energy management, the article then highlights developments in Chinese energy conservation institutions, which sets the stage for concluding recommendations for future cooperation, especially between the United States and China, to improve energy efficiency of China's industrial sector.

## CHINESE ENERGY EFFICIENCY INITIATIVES IN THE INDUSTRIAL SECTOR

For international cooperation to be effective in China, it must be based on a good understanding of China's own efforts and institutions. This section thus focuses on initiatives the Chinese government is taking to improve the energy structure of its economy, especially industrial production. Figures 1 and 2 above show the dominance of the industrial sector in both energy use and energy-related $CO_2$ emissions. In 2007, this sector was responsible for 75 percent of the country's energy consumption and contributed 73 percent of the energy-related $CO_2$ emissions. This growth in energy consumption and related emissions was driven by the fact that China's industrial sector is heavily based on production of energy-intensive commodities such as iron and steel (ferrous metals); chemicals; and cement (along with other non-metallic mineral products). As shown in Figure 3, those three sub-sectors accounted for half of China's industrial energy consumption in 2007. Table 1 shows that production of energy-intensive products grew significantly between 2000 and 2007. Even though the energy efficiency of production improved during this period (see Table 2), the rapid growth in absolute volume of industrial production overwhelmed the efficiency gains.

### FIGURE 3. CHINESE INDUSTRIAL ENERGY CONSUMPTION, BY SUB-SECTOR (2007)




Source: NBS, 2008

### TABLE 1. INDUSTRIAL PRODUCTION GREW RAPIDLY, 2000 - 2007 (MT)

| Product | 2000 | 2007 | Average Annual Growth Rate |
|---|---|---|---|
| Cement | 597 | 1361 | 12% |
| Plate Glass | 184 | 539 | 17% |
| Crude Steel | 129 | 489 | 21% |
| Chemical Fertilizer | 32 | 58 | 9% |
| Paper & Paperboard | 25 | 78 | 18% |
| Primary Plastic | 10.9 | 31.8 | 17% |
| Soda Ash | 8.3 | 17.7 | 11% |
| Caustic Soda | 6.7 | 17.6 | 15% |
| Ethylene | 4.7 | 10.3 | 12% |

Source: NBS, 2008.

### TABLE 2. ENERGY INTENSITY IMPROVED IN CHINESE INDUSTRY, 2000 - 2007

| Product | Unit | China 2000 | China 2007 | International Advanced Level |
|---|---|---|---|---|
| Steel<br>*comparable energy consumption* | kgce/t | 784 | 668 | 610 |
| Cement<br>*comprehensive energy consumption* | kgce/t | 181 | 158 | 127 |
| Ethylene<br>*comprehensive energy consumption* | kgce/t | 1125 | 984 | 629 |
| Electrolytic aluminum<br>*comprehensive AC electricity consumption* | 2 kWh/t | 15480 | 14488 | 14100 |
| Power supply<br>*Coal consumption for coal-fired electricity* | gce/t | 392 | 356 | 312 |

Source: Feng Fei et al., 2009.
Notes: [gce/t] = grams coal equivalent per metric ton of product; and [kgce/t] = kilograms coal equivalent per metric ton of product.

The 11th FYP period has been a dynamic time for energy conservation efforts in Chinese industry. In support of the 20 percent energy intensity improvement target for 2010, the government promoted Top Ten Priorities and Ten Key Projects for Energy Conservation that were outlined in the 2004 *Medium and Long-Term Energy Conservation Plan* (NDRC, 2004). The Top Ten Priorities are:

1) Establish a system for monitoring, evaluating, and public reporting of energy intensity;
2) Eliminate and/or reduce production from inefficient industrial processes, technologies and facilities, reduce production from inefficient industrial facilities, encourage high technology industry, and shift production away from energy-intensive industries;
3) Implement Ten Key Projects;
4) Implement Top-1,000 Enterprises Energy Efficiency Program;
5) Strengthen existing and create new financial incentives for energy efficiency, including preferential tax policies on energy conservation;

6) Strengthen energy conservation laws, regulations and standards (e.g., mandatory appliance labels; more aggressive enforcement of building energy codes);
7) Strengthen government programs to gather energy data;
8) Establish a national energy conservation center;
9) Promote energy efficiency and conservation in government agencies; and,
10) Expand media programs; strengthen training of energy conservation professionals.

Table 3 lists the Ten Key Projects, along with their stated goals and the expected energy savings and related $CO_2$ emissions reductions that these projects will realize during the 11th FYP.

### TABLE 3. TEN KEY PROJECTS FOR ENERGY SAVINGS

| | Key Projects | 11th FYP Stated Energy-Saving Goals | Energy Savings During 11th FYP (Mtce) | $CO_2$ Emission Reductions During 11th FYP ($MtCO_2$) |
|---|---|---|---|---|
| 1 | Renovation of coal-fired industrial boilers | 35 Mt of coal | 25 | 60.5 |
| 2 | District level combined heat and power projects | 35 Mtce/yr in 2010 | 85 | 205.7 |
| 3 | Waste heat and pressure utilization | 7 Mtce/yr in 2010 | 21 | 50.8 |
| 4 | Oil conservation and substitution | 38 Mt of oil | 8 | 19.4 |
| 5 | Motor system energy efficiency | 20 TWh/yr in 2010 | 7.5 | 18.2 |
| 6 | Energy systems optimization | Not stated | | |
| 7 | Energy efficiency and conservation in buildings | 108 Mtce | 100 | 242 |
| | Energy-efficient lighting saving | 29 TWh | 3.56 | 8.6 |
| 9 | Government procurement of energy efficient products | Not stated | | |
| 10 | Monitoring and evaluation systems | Not stated | | |
| | **Total** | | 250 | 605.2 |

Source: NDRC, 2006a.
Note: Values are based on final (site, or end-use) electricity, electricity generation, transmission, and distribution losses are not included; value for oil conservation and substitution includes only 8 Mtce for oil conservation because 7 of the 8 efforts outlined focus on fuel substitution, while only one focuses on oil saving. Conversions: 2.42 $MtCO_2$/Mtce; 1 tce = 29.7 GJ = 27.8 MBtu.

### Reporting and Analysis of Energy Consumption and Conservation

The collection and analysis of high-quality data to monitor progress provides the foundation for implementation and evaluation of any energy policy. In support of two of the Top Ten Priorities that focus on strengthening systems and programs related to energy intensity data collection, in 2007, China's State Council announced an implementation scheme and methods for collection of statistics, monitoring, and evaluation of energy intensity reduction work (NDRC, 2004; NDRC, 2007a). In addition, *China's Energy Conservation Law* of 2007 formally established the responsibility of local governments to implement an energy statistics collection and reporting system. The law required that energy-consuming enterprises develop systems for energy measurement and collection of energy statistics, and mandated that large energy-consuming enterprises report their energy consumption annually. The National Bureau of Statistics has developed online energy data collection forms to facilitate reporting by the country's top 1,000 energy intensive enterprises.[3] The reporting requirements and energy intensity goals encourage enterprises and local officials to give more attention to energy efficiency; for example, Shandong and Guangdong provinces have developed robust programs, beyond the national requirements. However, only a subset of reported data is made available publicly, so it is difficult to affirm the energy levels that correspond to reported intensity improvements. International experience with balancing publicly available data and business-sensitive information can offer approaches for China as it strengthens its data gathering and reporting procedures (WRI, 2009; Seligsohn, 2010).

### Top-1000 Enterprises Program

Launched in 2006, China's Top-1000 Enterprises Energy Efficiency Program aims to achieve significant energy savings in China's largest energy consuming industries. The program involves voluntary agreements, or energy contracts, between the large enterprises and local governments. (See Box 1). The goal of the program is to save 100 Mtce in 2010 (relative to projected increases), which translates to energy savings of about 20 Mtce per year (NDRC, 2006b). If the program is successful, it could contribute somewhere between 10 and 25 percent of the energy savings needed to reach China's 20 percent target in 2010.[4]

Top-1000 Program components include: energy audits, benchmarking, energy reporting,

Cement Sector Energy Efficiency Cooperation through the Asia-Pacific Partnership. Onsite Assessment of Cement Plant, Shandong Province, October 2009.
Photo credit: Tom Zhou, United Nations Industrial Development Organization-International Center for Materials Technology Promotion (UNIDO-ICM)

development and implementation of energy action plans, and monitoring by local governments. Two international cooperation programs—the China Sustainable Energy Program (CSEP) and the End-Use Energy Efficiency Program (EUEEP) that are detailed below—have provided funding, technical assistance, and project management for a number of activities focused on these 1,000 large enterprises. Discussion is underway among China's decision-makers to expand the Top-1000 Program to include additional enterprises under the 12th FYP. Already, many provinces have extended the program to cover additional enterprises; for example, Shandong and Jiangsu provinces have both implemented Top-100 programs targeting the 100 largest local energy-consuming enterprises in addition to the Top-1000 enterprises in their province.

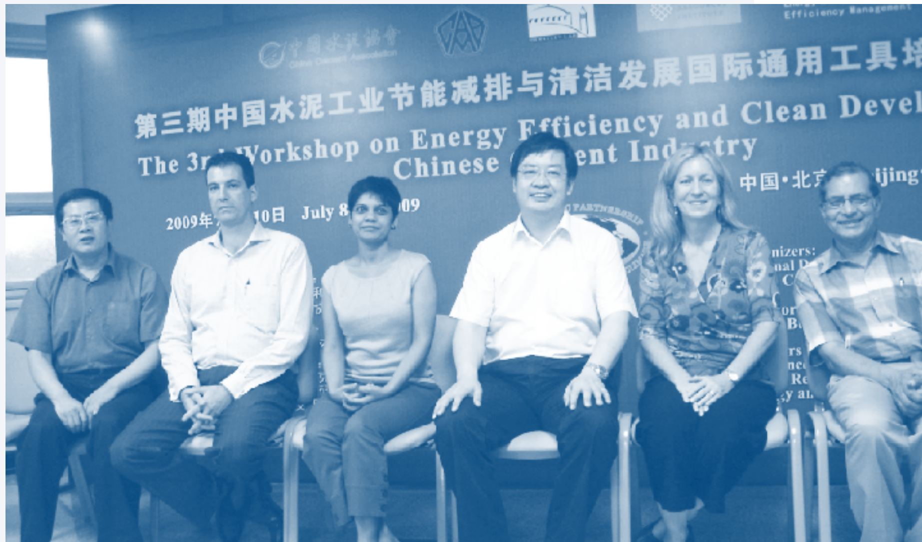
Some weaknesses of this program include: (1) the lack of a detailed assessment of enterprise energy efficiency potential as a basis for target-setting; (2) difficulties with energy auditing and implementation of benchmarking; (3) lack of a central repository or mechanism for information dissemination; and (4) the need for continual improvement in the area of monitoring, reporting, and verification of data in China (Price et al., 2009; National Audit Office, 2009). Even with these weaknesses, evaluations by NDRC and NBS showed that the Top-1000 enterprises saved 20 Mtce in 2006 (NDRC & NBS, 2007); 38 Mtce in 2007 (Zhao, 2008); 36 Mtce in 2008 (NDRC, 2009c); and 29 Mtce in 2009 (NDRC, 2010). These savings represent avoided energy consumption due to improvements in energy intensity, indicating that the large Top-1000 enterprises have achieved savings beyond their targets.

### Auditing & Benchmarking at Industrial Enterprises

Recent activities in industrial sector energy auditing and benchmarking were driven by a National Development and Reform Commission (NDRC) requirement that the

## Box 1. ENERGY EFFICIENCY CONTRACTS WITH INDUSTRY (VOLUNTARY AGREEMENTS)

In 2003, the Economic and Trade Commission (ETC) of Shandong Province undertook a target-setting energy-efficiency agreement pilot project with two iron and steel enterprises that was modeled after successful international industrial voluntary agreement programs. The main participants in the pilot project were two iron and steel enterprises in Shandong Province—Jinan Iron and Steel (Jigang) and Laiwu Iron and Steel (Laigang)—and the Shandong ETC; State Economic and Trade Commission (SETC); and the China Energy Conservation Association (CECA). The agreements had a base year of 2002 and set performance targets for 2005. Over this period, Jinan Iron and Steel saved 292,000 tce (8.6 PJ) and reduced energy consumption per ton of steel by 9.5 percent. Laiwu saved 130,000 tce (3.8 PJ) and reduced its energy intensity by 9 percent. The pilot was considered a success due to the achievement of the targets along with the knowledge gained related to establishing targets, energy management within the companies, making energy-efficiency investments, and establishing energy-efficiency policies at the provincial level. The pilot was used as a model for the Top-1000 program (Hu, 2007; Price et al., 2003; Price et al., 2004; Wang Liting, 2007).



Cement Sector Energy Efficiency Cooperation through the Asia-Pacific Partnership. Train-the-trainers workshop (Beijing, October 2009), which focused on training participants in three tools: LBNL BEST-Cement energy saving tool; WRI/WBCSD GHG Protocol under the Cement Sustainability Initiative (CSI); and the DOE/E3M PHAST tool for energy saving in process heating. Photo Credit: Lawrence Berkeley National Laboratory

Top-1000 enterprises undertake such activities as key elements of the program. In October, 2006 NDRC conducted a series of training sessions for the Top-1000 enterprises in five locations across China covering enterprise energy auditing, an example of energy audits in a power plant, and the application of benchmarking in large-scale power plants (Dai, 2007; NDRC, 2006c).[5] *The Guide to the Enterprise Energy Auditing Report and the Enterprise Energy Conservation Plan Auditing Report* provides guidelines and training materials for undertaking an energy audit (NDRC, 2006d). In 2007, the China National Institute of Standardization (CNIS) began the process of developing an energy auditing standard (Dai, 2007).

In 2007, the Top-1000 enterprises undertook energy audits that documented current energy consumption levels and identified energy efficiency opportunities. While some Top-1000 enterprises had the expertise to conduct audits and identify opportunities, a number lacked qualified auditing personnel and needed to hire outside experts, whose technical expertise and abilities varied widely, with some in need of significant training (Lu, 2006; Jiang, 2006). Although the quality of audits was uneven, the number conducted has been impressive: by August 31, 2007 a total of 967 energy audit reports and 836 energy conservation plans had been completed and submitted to NDRC by the 30 provincial level governments (Dai, 2007).

Several provinces have expanded energy auditing activities beyond the Top-1000 program. For example, in Jiangsu Province, the city of Suzhou developed high-quality energy auditing procedures and reporting guidelines for nearly 400 enterprises (NDRC, 2009d). Top-1000 enterprises in the city, along with other "key energy companies" consuming more than 5,000 tons coal equivalent (tce) per year, are included in the auditing program (Suzhou ECC, 2009). NDRC has promoted Suzhou's example nationwide, and especially recommended its audit report format as a template to other localities.

In 2007, NDRC issued the *Plan for Implementing Energy Efficiency Benchmarking in Key Energy Consuming Enterprises* (NDRC, 2007b). Although NDRC's guidance to the Top-1000 enterprises indicated that benchmarking should be undertaken in all sectors covered by the program, benchmarking efforts to date have focused only on the most energy-intensive steel, cement, and chemicals sectors. (See Box 2 for benchmarking initiatives in China's cement sector).

Both the CSEP and EUEEP programs have provided financial and technical support for these efforts, and the Energy Research Institute (ERI)—a think tank within NDRC—has coordinated the project activities. Achievements to date, including development

## Box 2. Benchmarking Tools for Energy Saving in China's Cement Industry

Benchmarking activities in the cement sector were coordinated by the China Cement Association (CCA). For the End-Use Energy Efficiency Program (EUEEP) effort, the CCA developed Implementation Guidelines for Energy Efficiency Benchmarking of Cement Enterprises, provided training and information dissemination and developed analysis tools for use by cement enterprises. Four cement enterprises participated in a benchmarking pilot project (Zhou, 2009; Zeng, 2009). China Sustainable Energy Program (CSEP) provided additional funding (along with the U.S. EPA, U.S. State Department, and Dow Chemical Company) to expand the cement benchmarking effort to include international assistance from Lawrence Berkeley National Laboratory (LBNL) and the China Building Materials Academy (CBMA).

LBNL, CBMA, CCA, and Energy Research Institute (ERI) developed the Benchmarking and Energy-Saving Tool (BEST) for the cement industry in China. BEST-Cement benchmarks a cement plant's energy use to an identical hypothetical plant that uses best practice to identify those processes with the largest gaps between actual and best practice energy use. Both domestic (China) and international best practice values are used. BEST-Cement for China also provides information on approximately 50 energy-efficiency measures, including their initial capital cost, energy savings, and simple payback time.

of benchmarking guidebooks and experiences with pilot plants testing the benchmarks, as well as difficulties encountered were discussed at the 2009 *International Workshop on Energy Efficiency Benchmarking* (Ma, 2009; Zhang Chunxia, 2009; Zhang Jintong, 2009).

### Industrial Energy Efficiency Standards

The establishment of energy efficiency standards for industrial processes and products complements auditing, benchmarking, and energy-saving contracts with individual enterprises. Energy efficiency standards can reach across industry, shifting the mix of energy intensity and improving the overall efficiency of the industry.

During 2007-2008, China's General Administration of Quality Supervision, Inspection and Quarantine developed and published energy efficiency standards for 22 industries—ranging from caustic soda and steel to flat glass and synthetic ammonia industries. The standards recommend energy efficiency levels for existing, new, and advanced enterprises, with advanced levels comparable to international best practice. For example, China's Ministry of Construction approved a revised standard that establishes maximum allowable energy consumed per unit of cement (or conversely stated, minimum energy performance standards, known as MEPS), as well as specified targets for improved energy intensity. The standards were delineated for coal and electricity consumption, for different cement processes, and for different sized plants (MOC, 2007).

Even when standards are established, significant effort is needed for implementation and enforcement. To that end, the Chinese government, with international support, has been developing guidance documents and holding training sessions for industrial enterprises and local government officials for the 22 developed standards. Work in progress includes standards for: industrial boilers, kilns, air conditioning, motor systems, insulation, electric transformers, draft fans, and air compressors (see section on EUEEP for further discussion).

### Financial Incentives for Energy Conservation

The overall government budget for energy efficiency improvement and pollution abatement in 2007 was 23.5 billion (B) Yuan ($3.08B)[6] (MOF, 2008). Specifically, this funding was allocated to support implementation of the Ten Key Projects, elimination of inefficient facilities, and installation of environmental protection measures. In 2008, the government budget for these activities increased to 27B Yuan ($3.91B) (MOF, 2008) and includes 7.5B Yuan ($1.087B) for the Ten Key Projects and 4B Yuan ($580M) for phasing out inefficient plants. China Construction Bank contributed additional funds of 14.8B Yuan ($2.15B), resulting in total financing of 41.8B Yuan ($6.059B) (MOF, 2008). This public spending leveraged investments of over 50B Yuan ($6.5 B) for over 8,000 energy-saving projects by the Top-1000 enterprises alone in 2007 (Zhao, 2008). The magnitude of additional spending by other industrial enterprises as well as in other sectors of the economy is not known. Even so, it appears that energy efficiency investments are climbing toward the recommended yearly private sector investment levels of 150B to 200B Yuan ($20B to $26B)[7] that are needed to reduce the growth rate of energy use to half of the projected growth rate of the economy over the next 15 to 20 years (Lin, 2005; Levine, 2005).

A portion of the overall funding is being used by the Ministry of Finance (MOF) and NDRC to award enterprises 200 to 250 Yuan ($26 to $33) for every ton of coal equivalent (tce) saved in east and midwest China, respectively, for the implementation of five of the Ten Key Projects (Lu 2007; Jiang, 2007). MOF allocated 7 billion Yuan to support 546 industrial energy efficiency projects in 2007 ("Central Fiscal Fund," 2007; Central Government Website, 2008). The rewards and rebates are paid to enterprises with energy metering and measuring systems that can document proven savings in 2007 of at least 10,000 tce (0.29 PJ) from the 546 energy saving technical transformation projects. Assuming an average emissions factor for China of 2.42 tons $CO_2$ per ton coal equivalent, this funding is equivalent to $12 to $15 per ton of $CO_2$ emissions reduced.

As a means to reform energy costs to push conservation in industries, in 2004, the Chinese government instituted a differentiated electricity pricing policy, in which electricity prices can be set based on the enterprise energy intensity level for high energy-consuming industries (such as electrolytic aluminum, ferroalloy, calcium carbide, caustic soda, cement, and steel).

*… officials will not be promoted if their jurisdiction fails to meet energy conservation targets.*

Enterprises fall into one of four categories based on their level of energy efficiency—encouraged, permitted, restricted, and eliminated—and are charged increasingly higher electricity rates (with surcharges up to 30 percent of the average price of electricity per kWh) in order to phase out inefficient enterprises (Moskovitz et al., 2007). Between 2004 and 2006, approximately 900 firms in the eliminated category and 380 firms in the restricted category had closed, invested in energy efficiency, or changed production processes. Not all provinces embraced the differentiated pricing policy—for example, Inner Mongolia still favored heavy industry with lower electricity prices. In 2007, the policy was adjusted to allow local provincial authorities to retain revenue collected, providing stronger incentives to enforce implementation (Moskovitz, 2008). The pricing reforms are a crucial element in promoting conservation and warrant international cooperation and support.

The State Council also aimed incentives for meeting efficiency targets at government personnel. In November 2007, the State Council established an evaluation system stating that officials from regions, organizations and companies must meet their energy conservation reduction targets in order to participate in annual rewards programs or to be conferred honorary titles. Similarly, leaders in state-owned or state-controlled enterprises must meet targets to be considered for annual evaluation award programs. In addition, officials will not be promoted if their jurisdiction fails to meet energy conservation targets (Zhou et al., 2009). While ambitious on the surface, in practice these financial incentives for energy efficiency indicate a small, but notable shift away from China's "apparent unwillingness to use economic and financial incentives… [and] to integrate energy efficiency into other sector policies" (Andrews-Speed, 2009). There thus exist many opportunities for international organizations to work with policymakers on designing stronger financial incentives.

### Challenges Ahead: Economic Structure, Urbanization and Climate Change

Along with incremental energy efficiency improvements in industry, the Chinese central government recognizes that larger changes in economic structure are needed to meet its energy and environmental targets. During the 11th FYP period, efforts at structural change included financial mechanisms (e.g., tax changes, small changes in electricity pricing) to discourage inefficient, energy-intensive enterprises, as well as outright industry closures. China's small plant closure policy requires certain outdated capacity to be retired during

**TABLE 4. SMALL PLANT CLOSURES AND PHASE-OUT OF OUTDATED CAPACITY -- RESULTS (2008)**

| Industry | Unit | 11th FYP Capacity Closure Targets | Realized Capacity Closures 2006-2008* | Share of Target Achieved 2006-2008 |
|---|---|---|---|---|
| Cement | Mt | 250 | 140 | 56% |
| Iron-making | Mt | 100 | 60.59 | 61% |
| Steel-making | Mt | 55 | 43.47 | 79% |
| Electricity | GW | 50 | 38.26 | 77% |
| Pulp & paper | Mt | 6.5 | 5.47 | 84% |
| Alcohol | Mt | 1.6 | 0.945 | 59% |
| Monosodium glutamate | Mt | 0.2 | 0.165 | 83% |
| Electrolytic aluminium | Mt | 0.65 | 0.105 | 16% |
| Citric acid | Mt | 0.08 | 0.072 | 90% |
| Coking | Mt | 80 | n/a | n/a |
| Ferroalloy | Mt | 4 | n/a | n/a |
| Calcium carbide | Mt | 2 | n/a | n/a |
| Glass | M weight cases | 30 | n/a | n/a |

Sources: State Council, 2007; Feng Fei et al., 2009; *NDRC, 2009a and 2009b.
Notes: [Mt] = million metric tons of production; [M weight cases] = million weight cases of glass, in which there are 50 kg per case.

the 11th FYP in 13 industrial sub-sectors, which will save an estimated 118 Mtce.[8] Table 4 lists the targeted and realized capacity closures for these industries.

However, past experience with the closure of inefficient, polluting enterprises has proven challenging. In the late 1990s, plant closures to reduce pollution were often short-lived, as small enterprises—important to local economies—would secretly reopen, leading the State Environmental Protection Administration (SEPA, now elevated in status and called the Ministry of Environmental Protection) to describe the situation as "glowing embers rekindling" (*si hui fu ran*). Thus it remains to be seen how long the current round of plant closures will hold. Other policy mechanisms explicitly aimed at a structural shift away from heavy industry are still needed.

Another important driving force behind the rise of industrial energy consumption is the rapid pace of urbanization in China. The production of iron, steel and cement—energy-intensive materials essential for new buildings and roads in China's expanding urban centers—accounted for more than one-third China's industrial energy consumption in 2007. (See Figure 3). Between 1990 and 2007, 290 million rural residents moved into China's cities, resulting in an urbanization share of 45 percent. ERI predicts that urbanization will grow to 67 percent by 2025, with China's urban population expanding from 594 million in 2007 to 958 million people in 2025. Thus, urban planning and structural economic shifts are urgently needed, along with energy efficiency measures in industry, to temper massive increases in energy demand.

In addition to energy intensity, carbon intensity is gaining attention as the Chinese government is showing greater leadership on climate change. As illustrated in Figures 1 and 2, China's industrial sector is responsible for an especially large share of the country's energy-related $CO_2$ emissions due to the extremely high proportion of coal in the energy mix (73 percent in 2005). In August 2009, China's National People's Congress (NPC) issued statements expressing China's commitment to participate in international climate change negotiations and at the domestic front, the NPC remarked:

*We should make carbon reduction a new source of economic growth, and change the economic development model to maximize efficiency, lower energy consumption and minimize carbon discharges* ("Top legislature endorses," 2009).

Attention to carbon intensity, along with energy intensity and urbanization, albeit challenging, could provide even greater impetus for energy conservation in China.

## INTERNATIONAL COOPERATION ON INDUSTRIAL ENERGY EFFICIENCY

The Chinese government has long engaged in international partnerships to address energy and environmental challenges. As international cooperation with China grows with the challenges of energy security and climate change, it is important to learn from past experience—both successes and failures—to carry out effective cooperation. The analysis here focuses specifically on industrial energy efficiency cooperation, i.e., efforts to reduce energy use in industrial sectors such as iron and steel, cement, chemicals, and other heavy industries. The reasons for this emphasis are twofold: (1) the significant share of industrial energy consumption in China's economy (75 percent in 2007); and (2) the ability of energy efficiency and conservation to address multiple goals of energy security, economic strengthening, air quality, water quality and conservation, and climate change. Cooperation in other sectors—such as buildings, transport, appliances, and city planning for low-carbon development—is important but is not the focus of our paper. Similarly, cooperation on carbon capture and storage (CCS), which does not save energy but rather enables ongoing consumption of polluting fuels and mining operations, is not included here.

Within the realm of industrial energy efficiency, we examine international cooperation programs with China that have been in place long enough to have some results to evaluate. We identify newer initiatives that have begun in the past few years, and highlight promising aspects, but their actual results can only be revealed with time. For a typology of cooperation efforts, we draw on comprehensive comparative analyses of energy efficiency cooperation (e.g., WEC, 2004; Sugiyama & Ohshita 2006), as well as current analysis of industrial programs. Rather than say very little about many programs, we chose to highlight lessons learned from a sub-set of programs. The programs highlighted represent a rich variety of international organizations and differing forms of cooperation with a wide spectrum of Chinese partners. The types of cooperative efforts (with examples) include:

On-site Energy Assessment and Training at a Cement Plant in Henan Province, through Asia-Pacific Partnership.
Photo Credit: Lawrence Berkeley National Laboratory

- **Type of cooperating organization:** multilateral (United Nations Development Programme [UNDP]); regional (Asia-Pacific Economic Cooperation [APEC]); bilateral (government-to-government); nongovernmental; and coalitions of international organizations.
- **Mode of cooperation:** policy development; market development (financial mechanisms); technical assistance; technology development (installations, research, or demonstration projects); training and capacity building for government officials, enterprise managers, technicians, financiers; and public education and outreach.
- **Chinese partners:** central government (NDRC, Ministry of Environmental Protection [MEP]); national research institutes (ERI, China Building Materials Academy [CBMA]); universities (Tsinghua, Tongji); provincial governments (Jiangsu, Shandong); Energy Conservation Centers; city-level governments (Suzhou); industry associations and enterprises.

In terms of evaluation criteria, we looked for cooperative efforts that contributed to systemic change and large savings of energy and carbon, which include: (1) studies that led to new standards and policies; (2) development of procedures and tools for policy implementation; (3) pilot projects at the local level that led to provincial and national programs; (4) development of greater expertise and stronger institutions (i.e., capacity building); (5) enhanced engagement of businesses and the financial sector; and (6) technological cooperation that led to substantial energy and carbon savings. We also looked for programs that contributed to the development of both high-level and working-level relationships among partners, since effective strategies come out of understanding and respect on all sides. Cooperation promoting a shared sense of purpose is especially needed between the United States and China, which together and apart are the world's largest energy consumers and carbon emitters.

Table 5 provides a list of major cooperative

## TABLE 5. INTERNATIONAL COOPERATION ON INDUSTRIAL ENERGY EFFICIENCY IN CHINA[1]

| Cooperation Program | Lead Foreign Organizations[2] |
|---|---|
| ***Multilateral Cooperation*** | |
| End-Use Energy Efficiency Programme (EUEEP) | United Nations Development Programme (UNDP)/ Global Environment Facility (GEF) |
| Energy Conservation Project on Energy Service Companies (ESCOs) | World Bank/ Global Environment Facility (GEF) |
| China Utility-Based Energy Efficiency Finance Program (CHUEE) | International Financing Corporation (IFC), Finland, Norway |
| Efficient Motors Program | United Nations Industrial Development Organization (UNIDO) |
| Energy Efficiency Indicators Project | International Energy Agency (IEA)/ World Bank |
| ***Regional Cooperation*** | |
| Energy Conservation and Resource Management – Demand-Side Management (DSM) | Asian Development Bank (ADB) |
| Asia Pacific Partnership (APP) for Clean Development and Climate | Australia, Canada, China, India, Japan, South Korea, and the US |
| Energy and Environment Programme (EEP) | European Union (EU) |
| ***Bilateral Cooperation*** | |
| US-China bilateral cooperation<br>• U.S.-China 10-Year Energy and Environment Cooperation Framework<br>• US-China Partnership for Climate Action | US State Dept., Dept. of Energy (DOE), Dept. of Commerce (DOC), US Environment Protection Agency (EPA)<br>US Agency for International Development (US AID), Institute for Sustainable Communities (ISC), World Resources Institute (WRI), Lawrence Berkeley National Laboratory (LBNL) |
| California-Jiangsu cooperation on DSM and Efficiency Power Plants (EPP) | State of California, Natural Resources Defense Council (NRDC), US-China Alliance to Save Energy |
| Japan-China bilateral cooperation<br>• Technology cooperation on clean and efficient energy technology<br>• Japan-China Energy Conservation and Environment Forum<br>• Human Resource Training for Energy Conservation | Ministry of Economy Trade and Industry (METI), New Energy Development Organization (NEDO), Energy Conservation Center Japan (ECCJ), Institute for Energy Economics Japan (IEEJ), Japan External Trade Organization (JETRO), Japan International Cooperation Agency (JICA) |
| UK-China bilateral cooperation<br>• -"Low Carbon High Growth" projects, Low Carbon Development Zones<br>• - Cement sector efficiency<br>• - Business carbon auditing, de-carbonization of supply chains, low-carbon technology funding | British Foreign & Commonwealth Office (UK FCO) - Strategic Programme Fund;<br>British Dept. for International Development. (UK DFID) |
| ***Nongovernmental Cooperation*** | |
| China Sustainable Energy Program (CSEP) – Industry Program | US Energy Foundation, LBNL |
| Cement Sustainability Initiative (CSI) | World Resources Institute (WRI), World Business Council on Sustainable Development (WBCSD) |

Notes: This list includes major cooperation efforts on industrial energy efficiency in China during the past ten years, but is not fully comprehensive. For a more comprehensive view of energy efficiency cooperation in China and East Asia, see: World Energy Council (2004); Sugiyama and Ohshita (2006); Ohshita (2008).

efforts focused on industrial energy efficiency in China. A brief description and analysis of six of these cooperative efforts is given below, highlighting the reasons for success and challenges encountered.

**Example 1. China Sustainable Energy Program—Industry Program**

One of the most extensive and effective industrial energy programs run by a U.S. organization is the Energy Foundation's China Sustainable Energy Program (CSEP). Started in 1999, CSEP focuses on policy development cooperation, providing grants to Chinese and international experts to promote sustainability in China's energy system, supporting energy efficiency and renewable energy. As an independent nongovernmental organization (NGO) with a strong network of energy experts, the Energy Foundation has been remarkably effective in China. By funding Chinese institutes and international policy practitioners to work collaboratively, CSEP fosters the sharing of international best practices and the development of policies suited to local conditions. Grants are awarded based on a project's ability to promote Chinese priority policy objectives, and deliver policy change that leads to $CO_2$ emissions reductions. With grant decisions made three times per year, CSEP grantees are able to act quickly and contribute to the development of timely policies.[9]

One key reason for CSEP's effectiveness is the guidance provided by two high-level Chinese advisory groups: a Senior Policy Advisory Council (PAC) composed of minister-level officials; and a group of Dialogue Partners composed of directors-general of pertinent ministries. The PAC meets annually to focus on policy objectives and strategies.[10] These two advisory groups set the direction of CSEP and provide project feedback to ensure that policy development activities are politically salient. CSEP funding is then channeled to Chinese research institutes and universities that develop national policies. The "top-down" national policy efforts are then complemented by "bottom-up" pilot initiatives at the provincial and local levels, where implementation mechanisms can be tested and strengthened (Ogden, 2005; Sugiyama & Ohshita, 2006).[11]

Another organizational feature that contributes to the program's success is the Beijing office of CSEP. The office is staffed with full-time Chinese energy policy experts—each focused on a specific program area—who facilitate close connections to key government officials and academic researchers in Beijing and elsewhere in China. The office provides significant support for collaborative efforts, from matching domestic and international experts, to providing a physical meeting place with decision-makers.

One example of CSEP industrial cooperation is benchmarking in the cement sector. A team of organizations, including ERI, CBMA, China Cement Association (CCA), and Lawrence Berkeley National Laboratory (LBNL), worked together to develop the BEST-Cement energy efficiency assessment tool for China in support of China's Top-1000 Program and the 20 percent energy intensity savings goal (Perlin, 2008). In order to train cement plant engineers in its use as well as to disseminate the tool throughout China, CSEP funded the project team to conduct four workshops in 2008 in Shandong, Hebei, Shanxi, and Sichuan provinces in which about 300 cement plant staff from over 200 cement facilities were trained in the use of BEST-Cement. This work through the Energy Foundation has led to further efforts supported by the U.S. government, noted below. In addition, experts working on CSEP cement efficiency projects communicated and coordinated with related international efforts, such as the large UNDP efficiency program, also described below.

**Example 2. End-Use Energy Efficiency Programme**

Another significant industrial energy initiative is the End-Use Energy Efficiency Programme (EUEEP), which is a four-phase, twelve-year effort to improve energy efficiency in China's major end-use sectors: industry and buildings.[12] Implemented by the UNDP and China's NDRC, the Programme draws funding from the Global Environment Facility (GEF), UNDP, the Chinese government, and the private sector.[13] The EUEEP utilizes an integrated approach, combining policy development cooperation with capacity building and market development. The impetus for the Programme came from China's 1998 *Energy Conservation Law*, and the Programme aims at providing direct, comprehensive and sustained support for this and other Chinese energy policies (Heggelund et al., 2005). If fully implemented, the cumulative emissions reduction from this UNDP-NRDC initiative is estimated to range from 42.4 to 76 million tons of carbon over the 12-year program lifetime (Kan, 2008; GEF/UNDP, 2002).

The EUEEP has been conducting industrial sector activities in four main areas (Kan, 2008):

(1) supporting the implementation of enterprise energy agreements for the Top-1000 Program, including energy benchmarking, target setting, and actions;
(2) energy efficiency design codes for industrial facilities (e.g., cement plants and related equipment) in support of China's Ten Key Projects;
(3) energy efficiency standards and systems for equipment in the industrial, residential, and service sectors (e.g., design standards, labels, and training on industrial motors), in support of China's Medium- and Long-Term Energy Conservation Plan; and,
(4) energy information system for reporting and management, for energy-intensive industries in the Top-1000 Program.

Relevant cross-cutting activities include support for eight Energy Conservation Centers, training materials, and the development of energy efficiency financing options.

The EUEEP experienced a slow start up as it created its Project Management Office (PMO) and established procedures and priorities with NDRC. Activities then increased rapidly and by November 2007, the EUEEP PMO committed $9.2 million to 67 signed sub-contracts with domestic and international experts.[14] Those sub-contracts included benchmarking projects coordinated by ERI and the China Energy Conservation Association (CECA), which led to the launch of six benchmarking projects with two enterprises each in three sectors—chemical, cement, and iron and steel. The objective of the benchmarking has been to use pilot projects to develop sector-specific tools that can be shared widely with other enterprises. The EUEEP PMO is coordinating with other benchmarking cooperation efforts (including European Union and LBNL activities through the Energy Foundation), and in August 2009, the EUEEP held an international seminar to share results on the development and piloting of energy benchmark guidelines.

With EUEEP support, the China Cement Association developed energy conservation design codes for cement making, specifying minimum energy performance standards (coal and electricity) for clinker and cement production (MOC, 2007). The Ministry of Construction approved the codes in November 2007, marking an important step for energy conservation in China's large highly energy intensive cement sector. The cement standards went into effect in May 2008, leading the way for other industry system codes (Kan, 2008).

By 2009, EUEEP achievements on motor system standards included the completion of 40 plant assessments and 16 case studies by four motor system service organizations. Those organizations, along with ten Energy Conservation Centers, sent 1,015 energy engineers for training on the energy optimization of fan, pump, motor, and air compressor systems (Kan, 2008). These achievements build on work started in 1997 by LBNL and U.S. Department of Energy (DOE), which then led to support by the United Nations Industrial Development Organization and the Energy Foundation for the China Motor Systems Energy Conservation Program conducted between 2001 and 2004 (LBNL, 2006; Williams et al., 2005).

Training materials for cement and other sectors have been developed, including boilers, kilns, motor systems, and energy management and financing in the industrial sector. CECA prepared materials for boilers and kilns, while Tsinghua University prepared energy management materials. The EUEEP funded the China National Institute of Standards (CNIS) and others to develop standards and guidance documents on electric transformers, draft fans and air compressors. More than 360 trainees have benefited from direct training under the Programme, and over 2,000 trainees have been involved indirectly (Kan, 2008).

### Example 3. World Bank/GEF Energy Conservation Project (ESCO Project)

In 1997, the World Bank/GEF Energy Conservation Project introduced the concept of Energy Service Companies (ESCOs) to China to facilitate financial and technical aspects of energy efficiency improvements. The two-phase project represents a large, sustained effort to create a new energy efficiency institution in China, particularly in the industrial sector. During Phase I of the project, three ESCOs (also known as Energy Management Companies or EMCs in China) were established in Shandong, Liaoning, and Beijing. Phase I of the project had funding of $51 million, from the World Bank, GEF, the European Commission, and the NDRC.

Phase II of the project, running from 2002 to 2010, has already witnessed significant growth of ESCO organizations in China. A World Bank news report from January 2008 noted that, "ESCOs in China saved about as much energy in 2006 and 2007 as France would have consumed in standard-grade coal in the last two years" (World Bank, 2008a). Chinese ESCO projects started in 2006 led to energy savings estimated at 21 Mtce. The 2006 energy savings were the result of about 100 ESCOs financing over 400 energy conservation projects in 16 provinces, totaling $280 million in investment. Bob Taylor, China energy expert formerly with the World Bank who was integral in launching this ESCO program, noted that rapid growth in ESCOs in 2007 resulted in investment levels twice as large as those seen in 2006.

External observers and those involved in the World Bank China ESCO effort have noted key challenges in China (Blanchard, 2005; Dressen, 2003), including:

- Lack of local project financing;
- Small capitalization and lack of credit history of emerging ESCOs; and,
- Huge need for industrial energy efficiency projects, but financing terms for building-sector projects have been more favorable.

Recognizing that China's fledging ESCOs still need better access to capital, the World Bank and NDRC launched a follow-on Energy Efficiency Financing Project in 2008 (World Bank, 2008b). The project will use an additional $200 million World Bank loan and $13 million GEF grant. The financing project works with three Chinese national banks to foster the development of large-scale energy efficiency loan programs. The banks, in turn, target lending in the $5-10 million range for ESCO projects in heavy industries.

The Asian Development Bank, U.S. Department of Commerce, Japan, and others have also been engaging in ESCO cooperation and funding mechanisms aimed at industrial (and building sector) energy efficiency projects in China. Further discussion on the institutional development of ESCOs in China is provided in the next section.

### Example 4. U.S.-China Bilateral Cooperation

As in many bilateral efforts, larger political dynamics between the two countries influences cooperation. Until recently, Congressional restrictions have strongly limited the activity of the U.S. Agency for International Development (USAID) in China, resulting in other countries and multilateral institutions taking the lead in environmental and energy cooperation with the Asian giant. Nevertheless, several federal agencies have supported cooperation efforts to advance energy efficiency in Chinese industry, namely: DOE, the Environmental Protection Agency (EPA), the Department of State, and the Department of Commerce. National research institutes have also played a crucial role.

U.S.-China energy cooperation has become a higher priority over the past year, with a turning point taking place in July 2009, when both countries signed the U.S.-China Memorandum of Understanding to Enhance Cooperation on Climate Change, Energy and the Environment (U.S. Department of State, 2009). The MOU states the intent of both countries to:

*…strengthen and coordinate our respective efforts to combat global climate change, promote clean and efficient energy, protect the environment and natural resources, and support environmentally sustainable and low-carbon economic growth.*

The July 2009 MOU laid the foundation for a suite of agreements Presidents Barak Obama and Hu Jintao signed in November of the same year, just prior to international climate negotiations in Copenhagen. These agreements have encouraged further bilateral engagement between the countries on energy and climate cooperation, which indicates emerging joint cooperation on industrial energy could hold more promise. (*Editor's Note: For a fuller review of U.S.-China energy cooperation, see Feature by Joanna Lewis in this CES issue*). Highlights of bilateral cooperation over the past five years in the industrial energy sphere are reviewed below.

*U.S.-China Energy Policy Dialogue and Projects*

In 2004, the U.S. DOE and China's NDRC initiated the U.S.-China Energy Policy Dialogue as a means for discussing energy cooperation between the two countries. The dialogue enables the United States and China to exchange information on energy security measures, including strategic petroleum reserves and energy policies to attract investment in infrastructure development. The dialogue also enables the exchange of views on other energy issues of concern to both countries, such as the use of market and regulatory measures to promote energy efficiency and reduce environmental impacts.

In 2007, the dialogue led to the signing of a Memorandum of Understanding (MOU) on further energy efficiency cooperation in China's industrial sector. The DOE conducted industrial energy auditing activities under the MOU in support of China's Top-1000 Program (U.S. DOE, 2007). A team of DOE-assembled industrial energy efficiency experts worked with a counterpart Chinese team to conduct on-site plant energy efficiency assessments at Top-1000 Program enterprises. NDRC identified the China Standards Certification Center (CSC) as the counterpart for the DOE team, which was led by Oak Ridge National Laboratory with assistance from DOE energy experts and LBNL. The teams—which included a DOE-qualified expert on steam systems and a crosscutting expert from DOE's Industrial Assessment Centers—completed facility screening worksheets along with energy assessment of one ammonia plant. As part of the energy assessment, the DOE team provided auditing equipment to CSC. In addition, DOE translated and modified its "Quick PEP" tool, which provides an overview of the amount of energy a plant purchases and generates, identifies major energy-consuming industrial systems at the plant, and describes the plant's energy-saving potential (U.S. DOE, 2008).

*U.S.-China Cement-Sector Cooperation*

Another example of industry-focused efficiency collaboration between the United States and China is an effort led by the EPA. Since 2004, the EPA and China's MEP pursued a bilateral agreement to evaluate and control the unintentional releases of dioxins and furans from cement kilns in China. Much of the focus of this effort was on incomplete combustion in the kiln, which can be mitigated by improving the kiln's energy efficiency. EPA funded LBNL, CBMA, and a DOE energy expert to undertake a detailed energy audit of two cement kilns in Shandong Province and make recommendations for energy efficiency improvements. The two plants implemented a number of the recommendations, improved their energy efficiency, and reduced their emissions of persistent organic pollutants. Unfortunately, the EPA's ability to engage in international cooperation with China—especially related to industrial efficiency—was limited by budget cuts over the past several years. To fill the gap, nongovernmental funders stepped in to enable much-needed collaboration on energy efficiency. As one example, the Energy Foundation supported translation and localization of EPA's EnergyStar industrial efficiency guidance manuals in China. These sector-specific manuals include the energy-intensive cement, steel, and chemical sectors.[15] Beyond the manuals, other elements of the EnergyStar for industry program are valuable resources for cooperation with China and an untapped opportunity. Since 2008, multiple U.S. government agencies have support energy efficiency cooperation in China's cement sector, building on earlier efforts supported by government and private foundations. The BEST-Cement tool developed by LBNL is being used to develop baseline energy consumption information as well as to identify energy-efficiency improvement opportunities in 42 of China's largest cement plants through the U.S. State Department-funded project.

*Comprehensive Program to Improve Energy Efficiency, Increase the Use of Alternative Fuels and Raw Materials, and Reduce Emissions in the Cement Sector in China.*

The managers in the 42 plants also are being trained in the use of the Cement Sustainability Initiative's (CSI's) cement-sector specific $CO_2$ Quantification Protocol, developed by the World Resources Institute and the World Business Council for Sustainable Development, as well as apply the U.S. DOE Process Heating Assessment and Survey Tool (PHAST). Initial training in the use of these tools took place during a three-day workshop in Beijing in July 2009. In October/November 2009, international experts accompanied selected trainees as well as collaborators from the China Building Materials Academy and the China Cement Association to three cement plants located in three Chinese provinces to conduct on-site assessments using the tools. Chinese experts are completing similar assessments at the remaining 39 plants during 2010.

BEST-Cement and the CSI cement sector tools are also being used for training in Guangdong and Jiangsu provinces in October 2010 as a component of the Partnership for Climate Action Program funded by USAID and managed by the Institute for Sustainable Cities (ISC) and World Resources Institute (WRI).

*Pollution Prevention and Energy Efficiency (P2E2) Financing Program*

The Pollution Prevention and Energy Efficiency (P2E2) environmental financing program involving the U.S. EPA and Department of Commerce in China illustrates bilateral cooperation focused on financing mechanisms (U.S. Commercial Service, 2007). Launched in June 2006, the P2E2 program is based on an eight-year cooperative framework agreement between the EPA[16] and MEP. This public-private financing program utilizes Hong Kong's legal and financial systems to mobilize private sector capital together with management and technology from the United States, China and other countries for energy conservation projects in China. The P2E2 program became a regular part of the annual agenda of the U.S.-China Joint Commission on Commerce and Trade, and a component of U.S. trade missions to China (U.S. Commercial Service, 2007; U.S. DOC, 2008), as well as U.S. activity through the Asia Pacific Partnership (U.S. Commercial Service, 2008). In mid-2007, the U.S. Commercial Service noted at least 20 Hong Kong ESCOs carrying out P2E2 projects in the Pearl River Delta and elsewhere in China in numerous industries (e.g., aluminum, cement, electronics, food processing, iron and steel, power generation, real estate and textiles) (U.S. Commercial Service, 2007). Unfortunately, these P2E2 projects have not reported estimates of energy saved or pollution reduced.[17]

The U.S.-China P2E2 program has some overlap with the World Bank ESCO program in China, and makes use of World Bank (IFC) guarantees and Asian Development Bank funding. But, based in Hong Kong, the EPA's P2E2 utilizes a different institutional framework and includes an environmental component[18] along with energy services. The P2E2 program also differs from many international energy efficiency cooperative efforts by originating from an agreement with China's MEP, rather than NDRC. China's banks and industries have been interested in the program because of stronger energy conservation policies under the 11th FYP. Thus the U.S. trade-focused P2E2 program benefits from policy development cooperation work by other U.S. and international organizations. The P2E2 program has now evolved into a private-sector effort, highlighting a promising new trend in U.S.-China energy cooperation.

### *U.S.-China Partnership for Climate Action*

One new and promising initiative, launched by USAID in December 2009, is the U.S.-China Partnership for Climate Action. This is the first major cooperation effort by USAID with China focused on climate change and including an industrial component. The partnership seeks to promote energy efficiency and reduce greenhouse gas emissions in three arenas: (1) the industrial sector, (2) the electric power sector, and (3) at the city level. To develop and test approaches, the initiative will take place in two Chinese provinces—Guangzhou and Jiangsu—and work with provincial and national government agencies. The three-year effort has $6 million in U.S. government funding, supplemented with $3.4 million from the private sector. Key implementing organizations include the U.S.-based Institute for Sustainable Communities and World Resources Institute (WRI), along with the GE Foundation, the Regulatory Assistance Project (RAP), and LBNL. On the Chinese side, partners include: Guangdong Economic and Trade Commission, the China Electricity Council, the Energy Research Institute, the China Clean Development Mechanism Fund, and Tsinghua University (USAID, 2009).

The Partnership is quite new, and time will tell if its promising start is sustained and bears fruit. The Partnership's industrial component is still relatively small and would do well to increase activities on industrial energy conservation. Projects that make even stronger connections across: (1) urban demand for energy and infrastructure; (2) industrial production in response to that demand; and (3) electric power production for both cities and industry, would be productive.

### *Emerging Opportunities for U.S.-China Industrial Energy Cooperation*

Since 2010, new developments in U.S.-China cooperation indicate some progress for the promotion of industrial energy efficiency. In March 2010, U.S. Energy Secretary Steven Chu announced $37.5 million of DOE funding for a new U.S.-China Clean Energy Research Center (CERC). The effort will leverage an additional $75 million of funding from grantees and from

China. The CERC, to be housed in existing facilities, will focus on technology research in three areas: building energy efficiency; clean coal (including carbon capture and storage); and clean vehicles (DOE, 2010). While this is an exciting development in U.S.-China energy technology cooperation, the new Center does not have a focus on industrial energy efficiency. Substantial enhancement of industrial energy efficiency can come from improved energy management and operations, and from technology already available. Yet collaboration on even more efficient industrial technology is still needed, and is an area for future cooperation.

In May 2010, in conjunction with the U.S.-China Strategic and Economic Dialogue, the two countries held the first U.S.-China Energy Efficiency Forum in Beijing. Whereas other U.S. institutions (e.g., LBNL, DOE, EPA) have been engaged in efficiency cooperation with China for years, this was the first high-level bilateral forum with efficiency as its main theme. The Energy Efficiency Forum was accompanied by a Renewable Energy Forum and a Biofuels Forum, all led by DOE (WRI ChinaFAQs, 2010). The Energy Efficiency Forum, with NDRC as the lead Chinese agency, drew more than 200 participants from government agencies, research institutions, and industry. The plenary session of the forum focused on energy-efficiency policies, measures and progress in both the United States and China. The forum also included four separate sessions on building energy efficiency, industrial energy efficiency, appliance energy efficiency, and the ESCO market (LBNL 2010).

One notable outcome from the Energy Efficiency Forum for industrial energy efficiency was the signing of an MOU on university-based alliances with industry. China's newly formed University Alliance for Industrial Energy Efficiency (UAIEE) was modeled in part on the U.S. Industry Assessment Centers (IACs), a network of 23 university-based centers affiliated with DOE. The IACs have been conducting energy audits in U.S. industries and educating energy professionals since 1976.19 Formation of the new Chinese Alliance came about with support of the Energy Foundation, following an initial meeting of Chinese university representatives and IAC Directors in 2008. LBNL and Oak Ridge National Laboratory facilitated the new China-U.S. partnership and signed the MOU on behalf of U.S. IACs. This partnership has potentially large significance, as it could foster vast institutional capacity for industrial energy efficiency in China, with thousands of Chinese engineering students and professors working with thousands of staff in enterprises and local governments.

### Example 5. Japan-China Bilateral Cooperation

Japan's energy efficiency cooperation with China has been ongoing for over 20 years, and has had a strong technology focus (e.g., technology-related feasibility studies and demonstration projects, and training) (Ohshita, 2003; Ohshita, 2008). Japan's early energy efficiency cooperation in China began in the 1980s and involved training and infrastructure as one component of development aid. During the 1990s, the Japanese government spent billions of Yen annually in China on technology-focused cooperation, in the areas of energy efficiency, cleaner coal technologies and photovoltaics (NEDO, 2007).

Between 1992 and 2002, Japan's Ministry of Economy Trade and Industry and the affiliated New Energy and Industrial Technology Development Organization led 18 industrial energy efficiency technology demonstration projects in China. Nine of the 18 projects targeted the iron and steel industry; other projects spanned several industrial sub-sectors, including chemical, petrochemical, cement, and electric power. Heat recovery technologies were prominent, such as Japan's coke dry-quenching (CDQ) technology.[20] The cooperation efforts were successful in technical terms, but unfavorable policy and market conditions did not encourage technology diffusion in China during the 1990s and into the new millennium (Ohshita & Ortolano, 2006). By 2009, however, spurred by 11th FYP energy goals, nearly 100 CDQ units were in operation in Chinese steel plants. The CDQ units were mainly manufactured through Japan-China joint ventures or by Chinese manufacturers, rather than imported from Japan (Ueno, 2009).[21]


On-site Energy Assessment and Training at a Cement Plant in Henan Province, through Asia-Pacific Partnership.
Photo Credit: Lawrence Berkeley National Laboratory

Recognizing the importance of technical training and capacity building, Japan has provided training related to energy management and policy, mainly implemented by the Energy Conservation Center of Japan (ECCJ). As one example, the Japan International Cooperation Agency and ECCJ established a pilot Energy Conservation Technology Training Center during the 1990s in the port city of Dalian (JICA, 2004). The Dalian center was equipped with energy monitoring devices and typical industrial machinery (e.g., motors, pumps, boilers), and Japanese engineers held multiple rounds of training sessions. However, as the Chinese government shifted budget priorities and reduced funding to send trainees, the Dalian training center had difficulty sustaining itself.

In some ways, Japan's energy technology cooperation with China was ahead of its time, seeking to build awareness and promote the diffusion of efficient technology before policy requirements and incentives were in place in China. The lack of technology diffusion during the timeframe of the cooperation programs (1992 to 2002), China's rapidly growing economy, Japan's slowing economy, and concerns about protection of intellectual property, led Japan to reevaluate its mode of cooperation with China. Since 2006, Japan has emphasized business-to-business activities and promotion of Japanese technology in its energy conservation cooperation with China (ANRE, 2007; 2008). The Japanese government is also giving more attention to 'soft' cooperation in the form of high-level policy dialogue—through large, formal forums—and policy research exchange among government research institutes (e.g., China's ERI and the Institute for Energy Economics in Japan). Examples of Sino-Japanese cooperation are provided in Table 6. Thus for Japan, its mode of cooperation with China has shifted toward government-to-government policy exchange and business-to-business technology exchange. Important lessons learned from the Japan-China experience are that Chinese enterprises will purchase efficient technologies that meet their needs and circumstances. Foreign technology providers and governments would do well to learn and carefully consider those needs and circumstances, and market suitable technology in response, as well as engage in policy cooperation to promote standards and incentives for energy efficiency.

### Example 6. UK-China Cooperation

As another example of bilateral cooperation involving energy efficiency and conservation in Chinese industry, the UK has been developing a

## TABLE 6. EXAMPLES OF SINO-JAPANESE OPERATION ON ENERGY CONSERVATION

| | |
|---|---|
| March 2010 | **5th Japan-China Energy Conservation and Environment Forum** METI and NDRC signed two Memoranda of Understanding, to continue the annual Forum, and to continue Training for Human Resources for Energy Conservation, to grow the capacity of Chinese Energy Managers. |
| November 2009 | **4th Japan-China Energy Conservation and Environment Forum** Japan and China agreed to cooperate on 42 projects in the areas of energy saving and environmental protection, including 22 Business Promotion Model Projects. The Energy Conservation Center Japan (ECCJ) also signed and agreement with its Chinese counterpart, to develop the capacity of the National ECC in China. |
| February 2009 | **Sino-Japan Energy Saving Policies Seminar.** Organized by China's Energy Research Institute (ERI) and the Institute for Energy and Economy, Japan (IEEJ). |
| September 2007 | **2nd Japan-China Energy Conservation and Environment Forum (Beijing).** Nearly 1,000 people attended, including ministerial-level and working-level officials. Agreed on 10 Business Promotion Model Projects, including:<br>• Energy efficiency retrofit of a textile factory in Xian (Kyushu Electric)<br>• Energy Efficiency Financing Scheme (JBIC, Mizuho Bank, and China's Exim Bank)<br>• ESCO cooperation with Japanese Association of ESCOs and China's Energy Management Company Association (EMCA) |
| April 2007 | **Joint Research on Energy Policy (China's ERI and Japan's IEEJ).** Japan and China agreed to launch the first joint energy policy research between the two countries' top energy research institutes with a 3-year MOU. |
| October 2006 | **Chinese Study Missions on Energy Efficiency Policy to Japan.** Study missions in support of China's Energy Conservation Law; Chinese central, local, and energy conservation center officials to study design and implementation of energy efficiency institutions, and development of energy efficiency standards. |
| May 2006 | **1st Japan-China Energy Conservation and Environment Forum (Tokyo).** Led by Ministry of Economy, Trade and Industry (METI) and NDRC, with nearly 850 people attending, the Forum included ministerial-level dialogue and sectoral discussion sessions (e.g., steel, autos). Agreed upon several study missions to exchange ideas on energy efficiency promotion. |

Note: This table provides a few examples. For a more comprehensive list and discussion, see: ANRE, 2008 and Ohshita, 2008.

strong and consistent effort through its climate cooperation with China. Formally launched with the signing of an MOU in 2006, the UK has a robust climate change program, with over twenty staff stationed in China across the British Embassy in Beijing and the Consulates–General in Hong Kong, Guangzhou, Shanghai and Chongqing.[22] Funding comes from multiple sources, primarily the Foreign Cooperation Office Strategic Programme Fund, and from the Department for International Development.[23] As an important component of the UK Strategic Programme Fund, climate change cooperation involves several efforts, notably the *Low Carbon High Growth Programme,* which includes industrial efficiency projects. Other UK-China climate change cooperation includes: (1) a program on impacts and adaptation, in conjunction with the Swiss Development Agency; (2) collaborative energy research projects on *New and Renewable Energies and on Cleaner Fossil Fuels* funded by more than £14 million; (3) projects coordinated with the UK-China Sustainable Development Dialogue; and (4) a £10 million fund for supporting low-carbon technology start-ups.[24]

*The Low Carbon High Growth Programme* alone supports 37 policy research projects with Chinese partners. Funding through 2009 exceeded £8 million with a further £1 million for new projects in 2010 (roughly $1.6 million in 2010 just for this one program). Examples of program outcomes include: (1) identification of low-carbon pathways for seven cities and three provinces in China; (2) sharing international best practice on tracking emissions in China's carbon-intensive cement industry; (3) identifying opportunities for clean energy technology in China; and (4) developing standards for tracking and reducing carbon emissions in industry and other sectors.

While industrial energy efficiency is but one component of UK-China cooperation, the structure and modes of cooperation are worth noting for their effectiveness. With staff on the ground in China in multiple economic centers, the cooperation is informed by a deeper understanding and by relationships developed over time. Cooperative efforts look to new directions (emphasizing carbon management and the response of economic activities to climate change) and still are connected to Chinese domestic policies and priorities (e.g., FYP goals). Projects under the programs are required to have specific and measurable performance indicators.[25] In stark contrast to many U.S. efforts in China, for UK initiatives the funding keeps flowing, enabling multi-year programmatic efforts. Coordination is sought for efforts that touch on activities of multiple government agencies in both countries, thereby avoiding contradictory or duplicative efforts.

After four years of living and working in Beijing in the UK Embassy Climate Change team, James Godbar (2010) shares insightful advice for cooperation with China:

> *The means is often as important as the end and 'learning by doing' is critical to ensuring a shared understanding. China's willingness to undertake small-scale pilots allows policies and ideas to be adapted to the China context. Developed nations can learn from this and we should be careful not to expect any country to simply take our models and policies and apply them without first adapting them.*

### Summary and Findings on International Cooperation

This review of international programs has highlighted important successes and challenges in the increasingly robust bilateral and multilateral industrial energy efficiency programs in China. By combining the above review with previous analyses of energy efficiency cooperation with China (Baldinger & Turner, 2002; WEC, 2004; Sugiyama & Ohshita, 2006; Ohshita 2008); as well as drawing on analyses of U.S.-China cooperation more broadly (Lieberthal & Sandalow, 2009; Pew Center-Asia Society, 2009; NRDC, 2009; Wolfson, 2009), we have identified factors for success, which can be drawn upon to inform new and ongoing U.S.-China cooperation efforts. (See Table 7). The new Obama-Hu agreements plus expanding activities by the U.S. DOE offer opportunities for more ambitious cooperative efforts with China on energy and climate, particularly in the industrial energy sphere. There is still a need for even more U.S.-China cooperation on efficiency and conservation in industry, including efforts to reduce demand for energy-intensive industrial products, and efforts to strengthen the capabilities of Chinese energy institutions. The following sections of the report offer more information for capacity building efforts, and conclusions and recommendations for future cooperation.

## TABLE 7. FACTORS FOR SUCCESS – INDUSTRIAL ENERGY EFFICIENCY PROGRAMS IN CHINA

| |
|---|
| Top-Down Approaches: Working jointly on policy development cooperation at the central government level to create a "top-down" push and incentives that foster market development to complement technology cooperation. |
| Bottom-Up Approaches: Working jointly on programs and pilot projects to support local-level ("bottom-up") implementation of policies to connect individual projects to specific policy initiatives. |
| Joint Strategy Setting: Working jointly with Chinese partners to develop strategies that are suited to Chinese institutions and conditions (beyond 'one-way' information transfer). |
| Building Relationships at Multiple Levels: Fostering relationships with key Chinese decision-makers, through choice of working-level partners, high-level advisory boards, and regular communication. Fostering long-term relationships among working-level experts ("on-the-ground" presence) is crucial. |
| Enhancing Capacity: Focusing on personnel capacity building and strengthening of Chinese institutions. |
| Targeted Plans and Tools: Developing sector-specific implementation plans and tools that can be used across the country (e.g., benchmarking tools and audit guidelines). |
| Financing: Complementing policies with financing mechanisms to leverage business resources and enable local implementation. |
| Coordination: Including coordination with other international cooperation efforts, leveraging limited government resources available for energy conservation. |

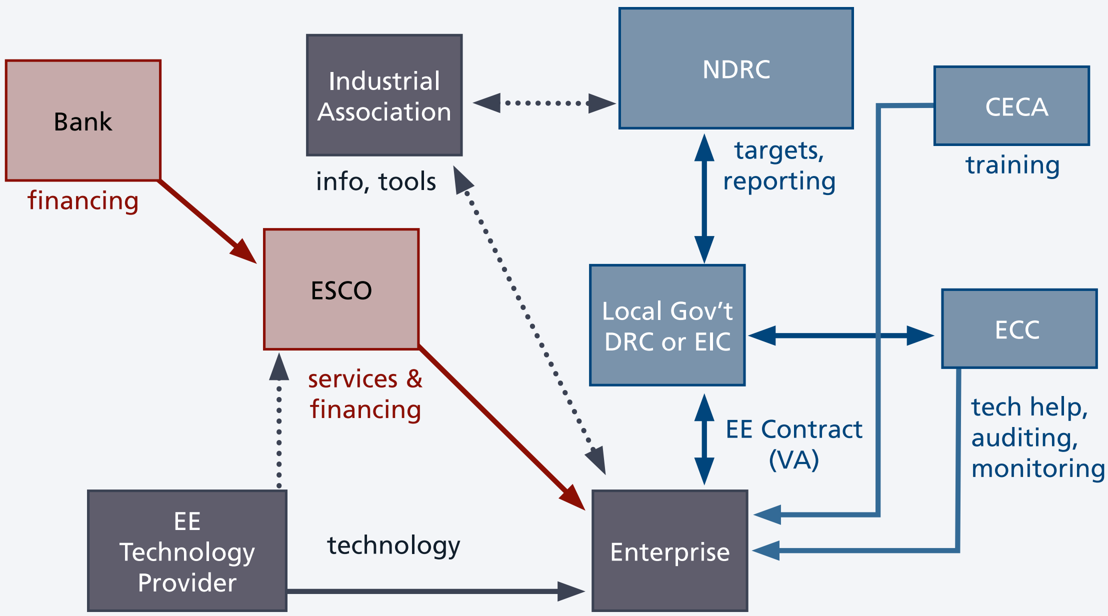
Based on Sugiyama and Ohshita, 2006; Ohshita, 2008

## A KEY LINK IN ADDRESSING CHINA'S INDUSTRIAL ENERGY CHALLENGE: STRENGTHENING ENERGY EFFICIENCY INSTITUTIONS

Energy and environmental cooperation has shown that technology and money are not always the limiting factors; often, strengthening institutions and personnel capabilities—through training, policy support, and more staff dedicated to energy efficiency—are crucial elements for success. The term 'capacity building' is frequently used in cooperation, but is often used loosely, making it difficult to see the shape and outcome of capacity building. The best capacity building efforts clearly identify: who is engaging in training or exchange; their role in implementing policy or carrying out efficiency initiatives in enterprises; exactly *what knowledge or skills* they are acquiring; and *how* the newly gained capacity connects with the *priorities* of the institution and government policies.

In order to ensure sustained effectiveness of current energy-saving programs in China, the country's energy efficiency institutions need strengthening. Figure 4 illustrates the interaction among Chinese energy efficiency institutions at present. The following discussion highlights the development of some of these institutions

### FIGURE 4. ENERGY EFFICIENCY INSTITUTIONS IN CHINA: COMMON RELATIONSHIPS




Source: Authors. Notes: The relationships among these institutions take varying configurations across China and frequently change; this is one snapshot.
NDRC = National Development and Reform Commission; CECA = China Energy Conservation Association; ECC = Energy Conservation Center; DRC = local Development and Reform Commission; EIC = local Economic & Information Commission (reports to MIIT); EE = Energy Efficiency; ESCO = Energy Service Company.

both at the national and local levels. These institutions are a fascinating mix of domestically-conceived organizations and those created with the help of international cooperation, yet always with Chinese characteristics.

**Energy Conservation Centers**

China's Energy Conservation Centers (ECCs) are a collection of government agencies at the provincial, municipal and city level that help industrial enterprises save energy through assistance with reporting requirements, audits, monitoring and training. Established in the 1980s, ECCs originally reported up through the industrial ministries. In the 1990s, energy intensity declined, but ECCs weakened and lost financial resources when the industrial ministries were disbanded during bureaucratic restructuring. National attention shifted away from energy conservation and between 2002 and 2003, a 22-year trend—in which energy use per unit of GDP declined each year—was reversed (NBS, various years).

In 2005, ECCs started a period of revitalization with encouragement from the central government and assistance from international organizations to achieve national energy conservation goals. The capabilities of ECCs vary widely across provinces (Price et al., 2008). The ECCs in several coastal provinces and municipalities are showing renewed leadership, with the strongest activity in Shanghai, Jiangsu, Beijing, Guangdong, Shandong, Tianjin, Fujian, and Hebei. Those same eight centers have been engaged in international cooperation with UNDP/GEF EUEEP involving: support for energy audits; co-financing of auditing equipment (electricity meters for motors; combustion monitors for boilers, kilns); and training for center staff.[26] Some of the eight centers have also engaged in cooperation projects with Energy Foundation's CSEP, Japan's ECCJ, and others. The Chinese government itself has been increasing investment in energy conservation institutions. In 2007, the government provided funding to twenty ECCs to support energy auditing and monitoring activities.[27]

Even with this support, ECCs in many provinces are still in need of more funding, staff, training, equipment and national coordination. The centers are granted authority from the national level, but their staff and budget are mostly controlled at the local level (a typical *tiao-tiao kuai-kuai* administrative organization).[28] In addition, there is no national center to coordinate activities and information. The China Energy Conservation Association (CECA) provides training and materials to local ECCs and industry, but it is a fairly small stand-alone association rather than a coordinating government agency. Moreover, CECA does not have local offices. As such, CECA takes a "train-the-trainers" approach in its work with local government, local ECCs and enterprises.[29]

One of China's Top Ten Priorities, announced in 2004 as part of the *Medium and Long-Term Plan for Energy Conservation* (NDRC, 2004), is the establishment of a new National Energy Conservation Center that would develop energy conservation policies, regulations, research programs; provide energy conservation training programs and coordinate international cooperation. However, limitations on the size of central government agencies, as well as deliberations about which ministry would have dominant control, slowed efforts to launch the center. Wishing to fill the gap, the Energy Foundation—in cooperation with China's ERI—created the Center for Industrial Energy Efficiency (CIEE) in 2008. This nongovernmental, nonprofit center has the mission of promoting industrial energy efficiency through information sharing, coordinating cooperation and training and providing consultation to support policy implementation.[30] As one example of CIEE activities, in July 2009, CIEE worked with ERI, the Energy Foundation, and the Energy Management Company Association (EMCA) to organize an industrial energy efficiency workshop in Chengdu, involving enterprises, government officials and international experts. NDRC did proceed with establishing a new National Energy Conservation Center (NECC), announced in 2008. This center's role is still evolving; for example, NECC is charged with helping to implement energy saving goals of the Five-Year Plan, but does not yet oversee energy audits or local ECCs. The NECC signed an MOU with its Japanese counterpart (ECCJ) in 2009, engaging in training efforts and development of energy management systems. U.S. government support and exchange with the new Center could further enhance its development.

## Energy Management Companies

As noted earlier, the development of Chinese ESCOs began with three pilot companies in Shandong, Liaoning and Beijing in 1997, through the support of the World Bank and the GEF (World Bank, 2003). China's 20 percent energy intensity goal has been a boon for ESCO

institutions, as they are sought out by local governments and enterprises under pressure to deliver measurable energy savings by 2010. From its fledgling start in 1997, China's ESCO industry has grown substantially in the past few years. By 2008, roughly 50 core companies were active, 185 ESCOs31 had joined China's Energy Management Company Association (EMCA), and nearly 400 firms had reported some experience with energy performance contracting (World Bank, 2008c). Investment has also grown rapidly; energy performance contracting investment rose to $1 billion in 2007, to $1.5 billion in 2008, and early estimates indicate ESCO investments were significantly higher in 2009.32

Chinese ESCOs have mainly followed a shared savings model, especially in the buildings sector (Zhao, 2007). Under the shared savings model, ESCOs provide technical services and financing to their clients, bearing both performance and credit risk, and sharing the savings. (See Figure 5). The ESCOs also obtain insurance and coordinate design, equipment and construction for their clients. For industrial clients in China, a guaranteed savings model—dominant outside of China—is becoming more common, where the client obtains financing from a bank and technical services from an ESCO, thereby spreading the risks of a project. By 2007, a survey by EMCA showed that shared savings contracts accounted for 66 percent of projects (in number) but only 25 percent in investment value, while guaranteed savings contracts had a smaller 38 percent share in number but a larger 71 percent share in investment value (World Bank, 2008c). This difference in share is explained by project size: building sector energy efficiency projects have an average size of $400,000, while industrial projects have an average size of $1.7 million (World Bank, 2008c).

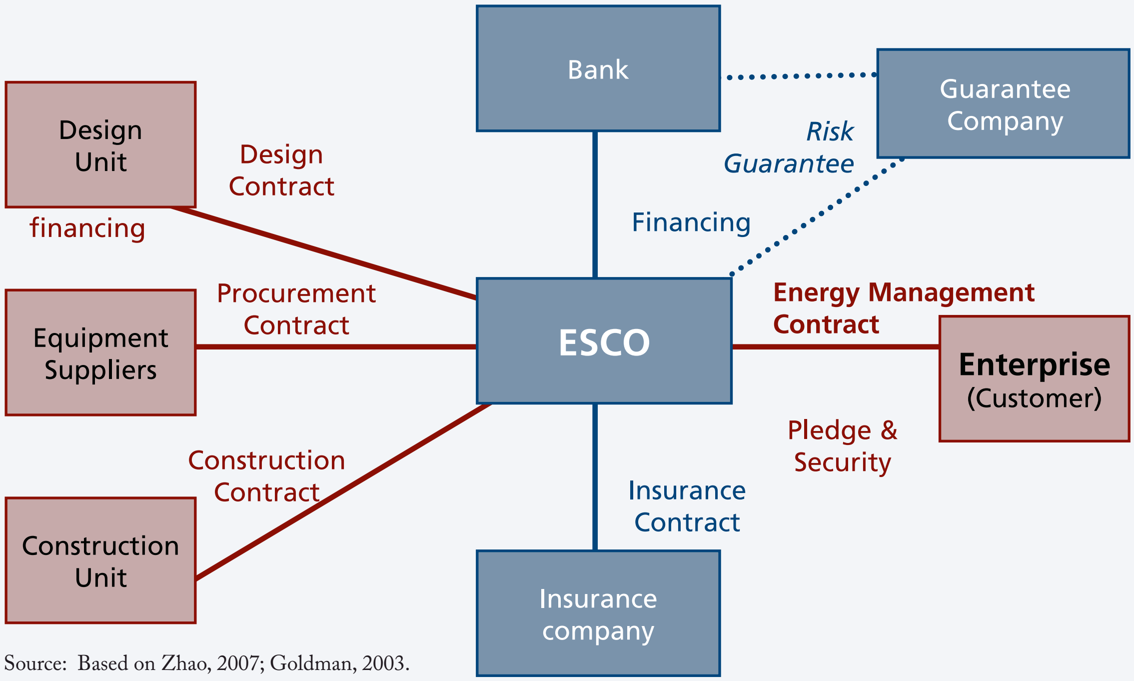
### *Capacity-Building Needs for China's ESCOs*

In terms of institutional development, China's ESCO industry needs ongoing outreach to spread the concept and practice of energy performance contracting. The concept is still unfamiliar to many potential clients, financial professionals, and energy technology providers. Because many of China's ESCOs are relatively small firms (roughly half have registered capital less than $670,000), financial and technical capacity are weak. All of China's ESCOs need improved access to financial institutions and further support of government policy, including contracts with more government-owned enterprises. Even China's strongest ESCOs would benefit from more interaction with international markets and training, as well as ongoing technological innovations (World Bank, 2008b). For example, if Chinese ESCOs could expand their portfolio of services, and be better supported by financing from both banks and customers, their capabilities would be greatly enhanced. Cooperation efforts are needed at multiple levels (central, provincial, enterprise) to further strengthen this growing institution in China.

## Industry Associations

Industry associations can serve an important function of exchanging information on energy efficient equipment and best management practices among member companies as well as playing the important role of a go-between for industry and government, facilitating policy dialogue and target-setting for industrial sectors (not just individual enterprises), and in international collaboration. Chinese industry associations are in a transitory stage and are still developing their role. In the 1990s, Chinese industry associations were government agencies, both overseeing and managing state-owned enterprises. With administrative reforms implemented over the past decade, including the disbanding of industrial ministries, NDRC has taken on the oversight functions once held by government-run industry associations and it has shifted management down to the enterprises.

FIGURE 5. ESCO STRUCTURE IN CHINA: SHARED SAVINGS MODEL




Source: Based on Zhao, 2007; Goldman, 2003.

With this transition, Chinese industry associations are facing problems of unclear status, limited responsibility, and weak authority. Moreover, some staff are former government officials rather than employees with direct industry experience.[33] Other industry association staff may be highly respected company presidents, such as Xie Qihua, chairwoman of the China Iron and Steel Association (CISA) and Shanghai Baosteel Group Corporation.[34] In this transitory stage, Chinese industry associations are gaining experience with activities such as information exchange and coordinating activities. For example, in 2005, Japan Iron & Steel Federation (JISF) and CISA held the first large business-to-business gathering focused on energy conservation and environmental protection. Nearly 200 attendees participated, including representatives from Japanese and Chinese iron and steel companies as well as high-level government officials from both countries.[35] Subsequent meetings of the two steel associations have addressed methodologies for data gathering and analysis, energy and water saving technologies, and other related concerns.[36] Chinese industry associations are becoming stronger and exerting more influence among enterprises and in government policy, so engagement with them is important. U.S. and Chinese industry associations have been interacting under the auspices of the Asia-Pacific Partnership. However, concerns over competitiveness add tension in some industrial sectors, such as steel. Facilitation by research institutes, NGOs, and nonprofit business-focused organizations (such as the World Business Council on Sustainable Development) can help with industry association interactions.

## Enterprise Energy Managers

In order for an organization to effectively manage any resource or task, it needs knowledgeable staff with decision-making authority. Managing energy resources is no exception. As part of China's Top-1000 Program, most participating enterprises established an energy management office and assigned one or more staff to the office.37 The skill level of newly assigned energy managers varies greatly. Many have undergone one-time training through workshops offered by CECA or provincial ECCs, but do not have other specialized training. Some energy management staff are high-level engineers certified through the Chinese system.38 Some enterprise technical staff and managers, as well as local government officials, have participated in energy efficiency training programs through international cooperation with Japan, EUEEP, Energy Foundation, EPA, DOE, and others.

Draft versions of China's Energy Conservation Law required enterprises to have energy managers and created a certification system.[39] The draft provisions were modeled in part after Japan's Energy Law and the Japanese system of requiring certified energy managers in energy-intensive enterprises. But the provisions were not included in the final version of the law. Bilateral and multilateral dialogue concerning development of an energy manager system in China is ongoing. The NDRC initiated two pilot projects, in Tianjin and Shandong, underway in 2010. Those pilot projects have some engagement with Japan (through ECCJ) examining and adapting elements of Japan's comprehensive energy management system, such as a certification program for energy managers. The outcome of the pilot projects will inform new national initiatives in China.[40]

Further exchange with China on the U.S. experience with energy management training and tools is an option, such as DOE's government-focused Industrial Facilities Initiative under the Federal Energy Management Program, and voluntary training for the private sector under the DOE Industrial Technologies Program (ITP).[41] Exchange involving the DOE Superior Energy Performance programs is also being explored.[42] It is crucial that the exchange become two-way; the different structure of Chinese industry and industry-government relations necessitates an approach adapted for China. Both the United States and China could benefit from establishing a national training and certification system for energy managers in industry.

## LESSONS LEARNED AND RECOMMENDATIONS FOR U.S.-CHINA COOPERATION

Recent recommendations for increased U.S.-China cooperation emphasize a topical focus on energy efficiency as a means of addressing energy, economic and environmental challenges in both countries (Lieberthal & Sandalow [Brookings Institution], 2009; Pew Center-Asia Society, 2009; NRDC, 2009; Wolfson, 2009). For example, the Pew Center-Asia Society "roadmap" for cooperation (2009), calls for U.S.-China cooperation on "best practices for energy efficiency standards and labeling programs, as well as for benchmarking programs targeting energy intensity in heavy industry." Recommendations also emphasize the need for capacity building and the importance of monitoring and enforcement. As to the structure of cooperation, recent briefings call for better use of existing working groups—as well as new forums—to sustain activities and relationships.

The next step is to develop more details for realizing these recommendations, drawing insights from the challenges and successes of international projects taking place in China's industrial energy sector. Cooperation involving the development of efficiency standards and policy implementation plans has already yielded results and has promising potential. Lessons learned from experience in capacity building should be heeded in ongoing cooperation. Future efforts should also take note of the most effective working groups and forums, paying attention to who is involved, how agendas are set, and how interactions are structured. Most importantly, Sino-American cooperation on industrial energy conservation must aim for large savings of energy and carbon emissions.

In this article, we have reviewed China's energy trends, examined initiatives to reduce energy intensity and analyzed China's experience with international cooperation to identify factors for successful industrial energy efficiency programs. (See Table 7). We further examined the development of Chinese energy conservation institutions, to better understand needs for capacity building. Among the most important lessons learned are:

*Future efforts should also take note of the most effective working groups and forums, paying attention to who is involved, how agendas are set, and how interactions are structured.*

- **Cooperation must be a two-way exchange, adapting international experience to fit Chinese conditions.** Successful cooperation involves working jointly with Chinese partners to identify needs and resources. Cooperation initiatives with poor outcomes have frequently been one-sided, with an external push of one country's agenda or technology without regard for Chinese needs and conditions. Trade promotion disguised as cooperation has often backfired. Rather, cooperation based upon international best practice and adapted to the Chinese context has worked well. In terms of technology cooperation, foreign and Chinese firms have benefited from assessments of the Chinese market and matching of best-fit technology.
- **Cooperation projects should be programmatically linked to Chinese policy initiatives ("top-down" push, including economic incentives)**. Isolated efforts, conducted without the support of a policy framework, may yield limited results or quickly fade. It is necessary to conduct pilot projects to spur policy development; and for lasting results, pilot projects should be connected with policy cooperation. Technology cooperation in the absence of policy or economic incentives has produced disappointing results. Cooperation that starts and stops due to political funding cycles can also fall short of fulfilling expectations. Individual projects conducted as part of an overarching program, such as the UNDP End-Use Energy Efficiency Programme, have proven most effective.
- **Cooperation must be sustained by fostering relationships through regular forums and requires competent, highly qualified staff.** The most successful cooperation involves ongoing working-level relationships between international experts and Chinese partners, as well as regular high-level dialogue. The Energy Foundation's China Sustainable Energy Program is a prime example of productive, ongoing relationships among experts. Large, formal meetings are important stepping stones, but they need to be complemented with on-the-ground, sustained interaction among experts and practitioners. Limited results occur when either side awards positions based on political rather than professional considerations.
- **Local-level initiatives, in addition to national cooperation, must be carried out to realize implementation of Chinese policies ("bottom-up" approach).** Policy statements and circulars are essential steps, but alone, they do not achieve results. The most successful cooperation efforts have conducted local-level implementation projects, such as the Shandong pilot project on Energy Efficiency Contracts with Industry, which led to China's Top-1000 program. (See Box 1). This on-the-ground experience can be used to enhance and inform policy, thereby encouraging broader achievements in energy conservation.

Based on the lessons learned from cooperation experience to date, and considering the needs and resources of both the United States and China, we make the following recommendations for future cooperation on industrial energy conservation:

- **Align U.S. cooperation efforts with China's policies and programs.** Directly connect U.S. cooperation to the implementation of specific Chinese policies to maintain the support of Chinese partners.
- **Support the new National Energy Conservation Center, and support the capacity building of existing local Energy Conservation Centers.** A National center would enable better coordination and information sharing among local-level centers. Development of sector-specific or equipment-specific capabilities at ECCs is also needed. Ongoing working-level collaboration (e.g., LBNL and ERI, California and Jiangsu) should be used as a foundation. The initial exchange between U.S. Industrial Assessment Centers (IACs) and their Chinese counterparts in July 2009—and subsequent signing of the MOU by China's University Alliance for Industrial Energy Efficiency (UAIEE), LBNL, and Oakridge National Laboratory (on behalf of U.S. IACs)—is a promising development.[43]
- **Increase cooperation with important Chinese industrial associations and research institutions** to develop and deliver sector-specific information for energy audits, energy benchmarking and identification of energy-efficient technologies and measures. Groups such as the U.S. Business Council for Sustainable Development, WBCSD, WRI, and LBNL can facilitate exchange with industrial associations.
- **Increase support for auditing and benchmarking tools in conjunction with sector associations, and in coordination with other international cooperation efforts.** We recommend greater support for international collaborative efforts such as translating and "localizing" guidelines from the EPA Energy Star industry program, and the DOE Industrial Technologies Program.
- **Develop detailed energy management guidance based on international best practice.** Such guidance could include developing a framework to standardize, measure and recognize industrial system optimization efforts. The guidance should consider international standards and Chinese circumstances to be effective.
- **Establish a program for certified energy managers at large energy-consuming enterprises and continue support for energy management training in the United States and China.** Training and study tours should be closely connected to implementation of specific Chinese policies. They should be aimed specifically at enterprise and government personnel that are playing a lead role within the Top-1000 Program and in other key energy conservation policies and programs.
- **Develop new policy cooperation programs to address the structural roots of China's energy and carbon upswing.** Both the United States and China could benefit from analyzing international experience (e.g., Europe and Japan) in this arena. In particular, a focus on urbanization is needed to address the demand for energy-intensive industrial products (cement, steel, glass, plastic). More U.S.-supported programs should promote urban planning for sustainable land use, green building design, efficient transportation (especially public transit), and urban energy conservation in both China and the United States. Bilateral programs that target China's goals to promote a Low-Carbon Economy are also needed to realize structural change. British cooperation programs offer a good example of cooperation to promote a shift toward low-carbon production, green technology, and information and service sectors. The new U.S.-China Partnership for Climate Action, supported by USAID, is a good move in this direction, and U.S. bilateral programs can do more

In closing, we highlight the goals and strategies noted in the July 2009 U.S.-China Memorandum of Understanding to Enhance Cooperation on Climate Change, Energy and the Environment (U.S. State Department, 2009), which are consistent with the recommendations offered here. The MOU states:

*Both countries commit to respond vigorously to the challenges of energy security, climate change and environmental protection through ambitious domestic action and international cooperation. Toward this end, both countries intend to transition to a low-carbon economy, carry out policy dialogue and cooperate on capacity building and research, development and deployment of climate-friendly technology.*

*Both countries resolve to pursue areas of cooperation where joint expertise, resources, research capacity and combined market size can accelerate progress towards mutual goals…. Wherever possible, cooperation should seek to include expertise from all sectors of society and provide incentives for engagement at the sub-national level as well as by the business and academic sectors and non-governmental organizations.*

In comparison to other international cooperation efforts with China, the U.S. government engagement on energy efficiency and climate needs greater effort and considerably more consistency over time. The July 2009 MOU, which led to the November 2009 Obama-Hu agreements, the May 2010 U.S.-China Energy Efficiency Forum, and associated new efforts related to energy saving in industry are very welcome developments. This renewed cooperation could produce multi-year funding flows, enabling U.S. and Chinese counterparts to work together, fostering working-level relationships that will need to be maintained over the years. As the two countries move forward on industrial energy cooperation we encourage that both sides keep in mind the lessons learned and recommendations offered here and we look forward to much-needed energy savings that can come from mutual cooperation.

## ACKNOWLEDGEMENTS

*Support for Stephanie Ohshita's research came in part from Japan's Central Research Institute of the Electric Power Industry (CRIEPI), under USF-CRIEPI Contract No. 10702433. Additional field research was made possible by grants from Japan's New Energy and Technology Development Organization (NEDO), and the University of San Francisco Faculty Development Fund. Gratitude goes to the many interviewees in Tokyo, Beijing, California, and New York.*

*Support for Lynn Price's research is provided by the Energy Foundation's China Sustainable Energy Program, the U.S. Environmental Protection Agency, the U.S. Department of Energy, the U.S. State Department, the Institute for Sustainable Communities, and Dow Chemical Company through the U.S. Department of Energy under Contract No. DE-AC02-05CH11231.*

*Stephanie Ohshita and Lynn Price would like to thank to colleagues in the China Energy Group at the Lawrence Berkeley National Laboratory and the Energy Foundation's China Sustainable Energy Program for facilitating interviews and discussing developments in energy cooperation with China. We would also like to acknowledge our many Chinese colleagues who have collaborated with us on a number of interesting projects since the 1990s.*

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## ENDNOTES

1 Energy intensity of the economy is defined as the amount of energy per unit of economic output, often expressed in China as metric tons of coal equivalent per 10,000 RMB (in fixed currency).

2 The target was based on an annual economic growth rate of 7.5 percent, which indicated that 640 million tons coal equivalent (Mtce) should be saved by 2010. With GDP growth 8.5 or 9.5 percent, energy savings of 670 or 700 Mtce, respectively, would be needed (Feng, 2007).

3 Online energy data collection forms cover: 1. Basic Information of Key Energy-Consuming Enterprises; 2. Energy Consumption Structure; 3. Energy Balance Table (Physical Quantity); 4. Comprehensive Energy Consumption Per Unit of Product; 5. Explanation of Factors Affecting Energy Consumption Per Product/Production; 6. Completion of Energy-Saving Targets; 7. Self-Assessment of Energy Conservation Targets Responsibility; 8. Major Energy-Consuming Equipment; 9. Implementation Situation of National Standards on Reasonable Energy Consumption; 10. List of Scheduled Energy Conservation Technological Transformation Projects; 11. Changes in Energy Conservation Projects Comparing to Previous Year; 12. Summary Table of Key Energy-Consuming Enterprises.

4 The variation in energy savings is due to the fact that the required energy savings depends upon trends in GDP growth.

5 The training materials are available at: http://hzs.ndrc.gov.cn/jnxd/t20061108_92567.htm.

6 Based on a currency conversion factor of US $1 = 7.63329 RMB (average rate in June 2007).

7 Based on a currency conversion factor of US $1 = 7.63329 RMB (average rate in June 2007).

8 It is assumed that this represents net energy savings.

9 For more information on Energy Foundation's China Sustainable Energy Program, see the program website: http://www.efchina.org.

10 For example, the CSEP 10th PAC Meeting, focused on "Enhancing Implementation of China's 2010 20% Energy Efficiency Target," was held in Tianjin in November 2007.

11 For more information on the China Sustainable Energy Program, see the program website: http://www.efchina.org

12 More information about the UNDP/GEF EUEEP can be found on the program's Chinese-language website: http://www.eueep.cn. Much of the information presented in this report comes from personal communication with staff of the UNDP Beijing Office and staff of the EUEEP project management office (PMO) in Beijing.

13 The first phase of the Programme (June 2005 to December 2009) had a budget of US $80 million, of which $17 million was funded by the GEF, $31 million by government, and $32 million from the private sector (Kan, 2008). An additional $156 million of leveraged funding was expected from the private sector, for total financing of $236 million for the first phase (UNDP-NDRC EUEEP PMO, 2007).

14 Personal communications with EUEEP PMO staff in Beijing, and He Ping of the UNDP Beijing office, 12 – 14 November 2007.

15 The EPA EnergyStar industrial efficiency manuals can be found at: http://www.energystar.gov/index.cfm?c=industry.bus_industry_info_center#industry_resources

16 For more information on the 2003 MOU, which established the Working Group on Clean Air and Clean Energy between the EPA and China's currently-named Ministry of Environmental Protection, see: http://epa.gov/international/air/chinaair.html.

17 For current information on US DOC efficiency financing cooperation with China, the P2E2 program, see: http://www.buyusa.gov/hongkong/en/p2e2.html.

18 USAID has also launched a Sustainable Buildings Partnership with China For information about USAID activity in China, including energy efficiency and climate work, see: http://www.usaid.gov/rdma/countries/china.html.

1 7 Personal communication with Ahmad Ganji, Professor and Director of the San Francisco State University IAC. 5 May 2010, San Francisco. See also the IAC website: http://www1.eere.energy.gov/industry/bestpractices/iacs.html

1 8 Coke dry quenching technology, or CDQ, recovers heat energy from red-hot coke used in steel making. Rather than quenching with water, CDQ uses inert gases and a heat exchanger to cool the coke and utilize the heat energy to generate steam or electricity. The process yields higher quality coke as well as energy and water savings.

19 For more information on the domestic and international activities of the Energy Conservation Center of Japan, see the ECCJ website: http://www.eccj.or.jp/index_e.html.

20 For more information about UK climate change cooperation efforts with China, especially under the Strategic Programme Fund, see: http://ukinchina.fco.gov.uk/en/about-us/working-with-china/spf

21 For further information on UK-China climate cooperation from the British Embassy in Beijing, see: http://ukinchina.fco.gov.uk/en/about-us/working-with-china/climate-change/uk-china-cooperation/

22 For an overview of UK-China climate collaboration, see: http://hi.baidu.com/jarryinbeijing/blog/item/59527cadb0bda2c07cd92ab7.html

23 Requirements for project proposals under UK-China Low Carbon High Growth cooperation can be found

at:http://ukinchina.fco.gov.uk/en/about-us/working-with-china/spf

[24] Based on personal communications with staff of CECA, UNDP/GEF EUEEP PMO, and Japan's ECCJ; Beijing and Tokyo, 2006 – 2009.

[25] Funds allocated included 4M RMB ($571,000) each to: Xinjiang, Ningxia, Qinghai, Gansu, Yunnan, Guizhou, Sichuan, Shanxi and Guangxi; 3M RMB (US $429,000) each to: Jiangxi and Neimeng; 2.4M RMB (US $343,000) each to: Liaoning, Helongjiang, Jilin, Hubei, Henan, Shannxi, Hunan, Anhui and Chongqing (Price et al., 2008).

[26] Chinese administrative structure is often referred to as tiao-taio kuai-kuai, a system of vertical and horizontal hierarchies. For example, the National Development and Reform Commission (NDRC) has a network of local-level Development and Reform Commissions that report up to the national level (vertical structure). However, decision about local-level DRC staffing and salaries are often made by other local-level government offices (horizontal structure). As a result, the administrative structure has both tension and balance.

[27] Personal communication with Jiang Yun, CECA, 13 November 2007, Beijing; and 29 July 2009, New York.

[28] Personal communication with Wang Jianfu, Deputy Director, CIEE. 30 July 2009, New York. For more information on CIEE, see their website (in English and Chinese): http://www.cieec.org.cn.

[29] To be categorized as an ESCO, a firm must be a "commercial, profit-seeking company that invests in, or facilitates investments in, energy efficiency projects in other [host] enterprises, using energy performance contracting" (World Bank, 2008a).

[30] Recent estimates of ESCO investment come from the World Bank-NDRC Energy Conservation Project Management Office.

[33] Based on observations during multiple workshops and field visits in Beijing, 2005 – 2007, as well as interviews with Japanese industry associations active in China.

[34] Xie Qihua is known as the 'iron lady' in China and among the global steel community. See, for example, http://www.chinadaily.com.cn/bizchina/2006-01/07/content_597789.htm.

[35] A brief English-language summary of the meeting is available on the JISF website: http://www.jisf.or.jp/en/activity/warm/meeting/index.html.

[36] Personal communications with members of JISF and Nippon Steel, Tokyo and Beijing, 2005 – 2007.

[37] Personal communication with Jiang Yun, CECA, 13 November 2007, Beijing.

[38] Personal communication with staff of ECCJ, 21 February 2008, Tokyo.

[39] Personal communication with Jiang Yun, CECA, 13 November 2007, Beijing; and 29 July 2009, New York.

[40] Personal communication with Bo Shen, LBNL, 2 August 2010, Berkeley, CA.

[41] For more information on the US DOE Federal Energy Management Program for industry, see: http://www1.eere.energy.gov/femp/program/industrial_facilities.html.

[42] For announcement in July 2010 of international collaboration involving the U.S. DOE Superior Energy Performance program, see: http://www.energy.gov/news/9233.htm

[43] For more information on the US network of university-based Industrial Assessment Centers, see http://www1.eere.energy.gov/industry/bestpractices/iacs.html.

金 木 水 火 土

FEATURE BOX

# Role Models: Young and Old Community Members in China Inspire Local Action to Save Energy

By Matthew A. DeGroot

In Doumen Township, not far from Macau in southeastern China, Zhao Jingjing helps her neighbors identify household energy savings opportunities. She explains how low-energy appliances, turning off unneeded lighting, managing thermostats, and calibrating water heaters can lead to lower energy bills. She circles back regularly to answer questions and check on their progress. Each month, she checks her apartment complex's electric meter to compare readings, and runs calculations to convert their energy savings into greenhouse gas (GHG) emissions. So in addition to helping her neighbors save energy—and money—she tracks how they have helped reduce climate disruption.

Zhao is one of 400 "Green Guardians" in Doumen, a new volunteer force committed to educating their fellow citizens about energy use and the dangers of climate disruption. The Green Guardians have undergone extensive training in the science, economics, ethics and mechanics behind energy efficiency and climate change, and have become respected and sought after experts. Just in the last six months, they helped their community reduce its residential energy use by more than 10 percent.

They also happen to be nine-years old.

The Green Guardian education initiative is one part of the Guangdong Environmental Partnership (GEP) program, a unique public-private partnership that targets energy and GHG reductions in Guangdong, China's most industrialized province and "factory to the world." This component of GEP focuses on building the capacity of grassroots stakeholders to collaborate on identifying and implementing priority energy and environmental projects in their communities.

Many environmental initiatives in China focus on identifying a "silver bullet" solution at the macro level—a stronger policy, newer technology, or better business practice that will magically spark a wave of change and result in better environmental performance across the country. While critical, these top-down measures often fail to account for the challenges and barriers to implementing complex new programs at the provincial and local levels. They can also ignore or discount the diversity and richness of local environmental actions already underway in China.

Zhao and her fellow Guardians are demonstrating the power of coordinated grassroots action, and their community is taking note. Part of a pilot initiative at Nanmen Elementary School in Doumen, their efforts have proven so successful that local officials, business leaders, and school administrators have committed to scaling up the program in every primary and middle school in the township in the coming year. Moved in part by Doumen's experience, other townships and urban neighborhoods across Guangdong will soon initiate their own "Green Guardian" pilot programs. All told, their efforts will mobilize close to 3,000 Guardians and reach over 20,000 families and citizens by 2011.

While inspiring, the Green Guardian initiative is just the beginning. "We engage stakeholders from all backgrounds in the target communities in solving their own problems," says Wan Yang, program manager for the Institute for Sustainable Communities (ISC), which designed and is implementing the GEP program. "Government officials, business owners, citizen leaders, educators—all have a role in setting priorities, identifying the most critical energy projects, and managing them through to completion." ISC helps each community establish a "multi-stakeholder committee" with representatives from each constituent group, to oversee local initiatives. By facilitating non-traditional partnerships, the program helps communities discover and draw on a diverse array of local resources and expertise. The committees also help ensure local ownership of the projects and their successes.

While Doumen's multi-stakeholder committee chose to focus initially on public outreach and residential energy efficiency, the impact of the Green Guardian program has kindled a new awareness of what is possible. Local factories and businesses are now planning an initiative to reduce energy use in their manufacturing processes. Public officials are eyeing a solid waste management project that would divert organic waste from landfills to a new composting operation, reducing the cost and emissions associated with chemically produced fertilizers. Schools are reaching out to local businesses to get them directly involved in supporting their new curriculum on sustainable development. These new relationships and activities are producing a critical mass of momentum toward reducing energy use,


Zhao Jingjing, a student in China, is reducing her family's carbon footprint and recording the results on this calendar. Over the next 3 years, "Green Guardians" like Jingjing will educate 20,000 family and community members on how to prevent climate disruption. "I'm so proud of my daughter," said Zhao's father. "What you are doing really means a lot to us." Photo Credit: Wu Qiubo decreasing GHG emissions, and improving environmental health.

Other GEP demonstration communities include Sanjiao, which is training factory managers to increase energy efficiency and has already secured commitments from several local manufacturers to reduce energy use by 20 percent in the coming year. Urban Guanlan, near Hong Kong, is installing green roofs on more than 1,000 residential apartment buildings, mitigating their "heat island" effect and reducing demand for air conditioning in the summer months. The three demonstration communities also benefit from each other. As noted above, Sanjiao and Guanlan will soon replicate Doumen's Green Guardian program in their own schools. Meanwhile, Doumen's factories are learning from the successes of Sanjiao's industrial efficiency initiative.

The communities are also demonstrating that, while government policies and new business practices are critical, people from all walks of life have something to contribute in driving positive change. They are finding that the power of this collective achievement is transformative—when people witness their neighbors taking action and achieving a real impact, it produces a ripple effect that inspires everyone to get involved. Together, these communities are creating new models for locally driven energy and climate actions in China that can be replicated across Guangdong and eventually, the entire country.

*The Institute for Sustainable Communities is a Vermont-based NGO that gives passionate, committed people the tools and skills they need to inspire active citizenship, protect the environment, and take on climate change. Their projects combine technical expertise and leadership training with strategic investments in local organizations around the world, in order to spark creative solutions and lasting change around the world. ISC is currently focused on strengthening democratic institutions and citizenship in transition countries, helping communities in the US and China become more resource efficient and transition to low-carbon economy, and supporting sustainable community development—particularly in areas recovering from natural disasters or vulnerable to climate disruption.*

*ISC has been working in China since 2007. The community-based portion of the Guangdong Environmental Partnership program is made possible through generous financial contributions from the U.S. Agency for International Development, the Rockefeller Brothers Fund, the Citi Foundation, and the Japan Foundation Center for Global Partnership. For more information on ISC's China work see: http://www.iscvt.org/where_we_work/china/*

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FEATURE BOX

# Building New Clean Water Networks in China: Challenges and Opportunities for Protecting Lake Tai

By Kexin Liu and Peter Marsters

## GOING GREEN

Green is "in" today in China—green five-year plans, green energy policies, green banking, and green cities are all the rage. Over the past year columnist Tom Friedman of The *New York Times* has written countless op-eds on China's green revolution. However, after nearly all of China's major lakes turned green from toxic algae, the public response and newspaper headlines were clearly less positive.

China's lakes are facing a pollution crisis and the most publicized on this front is Lake Tai, China's third largest lake that lies on the border of Jiangsu and Zhejiang provinces. Despite years of investment in pollution control, Lake Tai remains stubbornly green with toxic cyanobacteria blooms stemming from the multitude of industrial, agricultural, and municipal pollution sources. This large yet shallow 2,250 square kilometer lake is the lifeblood of the surrounding provinces and for Shanghai as well. The Lake Tai basin is China's second most prosperous industrial and agricultural area, producing 17.4 percent of the country's GDP in 2009. The lake supplies water to 30 million people in the watershed and also supports a rich fishing industry.

In August 2009, the China Environment Forum (CEF) at the Woodrow Wilson International Center for Scholars and its partners—the Institute of Developing Economies (IDE) in Japan and the Center for Environmental Management and Policy (CEMP) at Nanjing University—began a two-year project that aims to build a network of U.S., Japanese, and Chinese business, civil society, research, and government representatives to explore market, public-private partnership, and multi-stakeholder strategies to stem pollution problems in Lake Tai. The project is supported by a grant from the Japan Foundation's Center for Global Partnership and internal resources from the three partners. The exchanges as well as research by the project partners will inform a trilingual brief—due out in mid-2011—on strategies and tools for lake protection that are applicable to China and outline specific opportunities for international—especially joint U.S.-Japanese—water cooperation in China.

## ASSEMBLING THE TEAM FOR BUILDING A CLEAN WATER NETWORK

The first activity carried out for this project was a two-day workshop at Nanjing University in January 2010 that brought together a diverse group of government, NGO, industry, and research professionals from the Lake Tai watershed to participate in highly interactive discussions with their international counterparts. Participants learned about some of the key drivers of Lake Tai's complex pollution problems and discussed possible policy, market, transparency, and scientific strategies used in the United States and Japan that could prevent and/or remediate pollution in Lake Tai.

Following the Nanjing workshop, CEF and its partners formed a tri-national research team to participate in two exchanges to explore water pollution prevention strategies in lakes in the United States and Japan. The Chinese team includes Nanjing University researchers, local government officials, grassroots green groups, and one proactive businessman. Many on the team are participants in CEMP's community roundtable in Yixing, which aspires to create multi-stakeholder dialogues to promote better lake protection efforts and inform the design of a water pollution trading pilot project. Japanese researchers from IDE have been assisting CEMP in joint research on the community roundtable project.

## BAY AND LAKE RESTORATION IN THE UNITED STATES

The second major activity of the project concluded in August 2010 with Chinese and Japanese members of the Lake Tai research team visiting Washington, DC; Annapolis, Maryland; Chicago, Illinois; and Northern Indiana to study strategies, partnerships, and lessons learned in controlling water pollution in the United States. The group kicked off their exploration by visiting the Chesapeake Bay Foundation and the EPA's Chesapeake Bay Program in Annapolis—meetings that the Washington, DC-based World Resources Institute helped arrange. Like Lake Tai, the Chesapeake Bay suffers from excessive nitrogen and phosphorus pollution, with most coming from municipal waste and agricultural runoff. In another parallel to Lake Tai, the Chesapeake Bay's water quality has continued to drop despite years of investment and progress in lowering point source pollution from industry and municipalities. Stormwater, a very expensive problem, is the only source of pollution that is growing in the Chesapeake Bay. While urban runoff faces strict regulation, the same is not true for agricultural runoff. Discussions in Annapolis introduced the Lake Tai team to the environmental scorecard tool that was developed by Chesapeake Bay Foundation to help broadly and clearly distribute information about the bay's environmental quality in order to galvanize more effective action by all stakeholders.

In workshops in Washington, DC the group learned about the evolution of water pollution regulation under the Clean Water Act and gained insight into progress and challenges facing water pollution trading pilot projects in a handful of U.S. states. In a number of meetings in Washington, DC and Chicago, the growing role of NGO-business partnerships was a theme that intrigued the Chinese and Japanese participants, for in China the business community has rarely engaged in multi-stakeholder water protection activities or acts of environmental leadership.

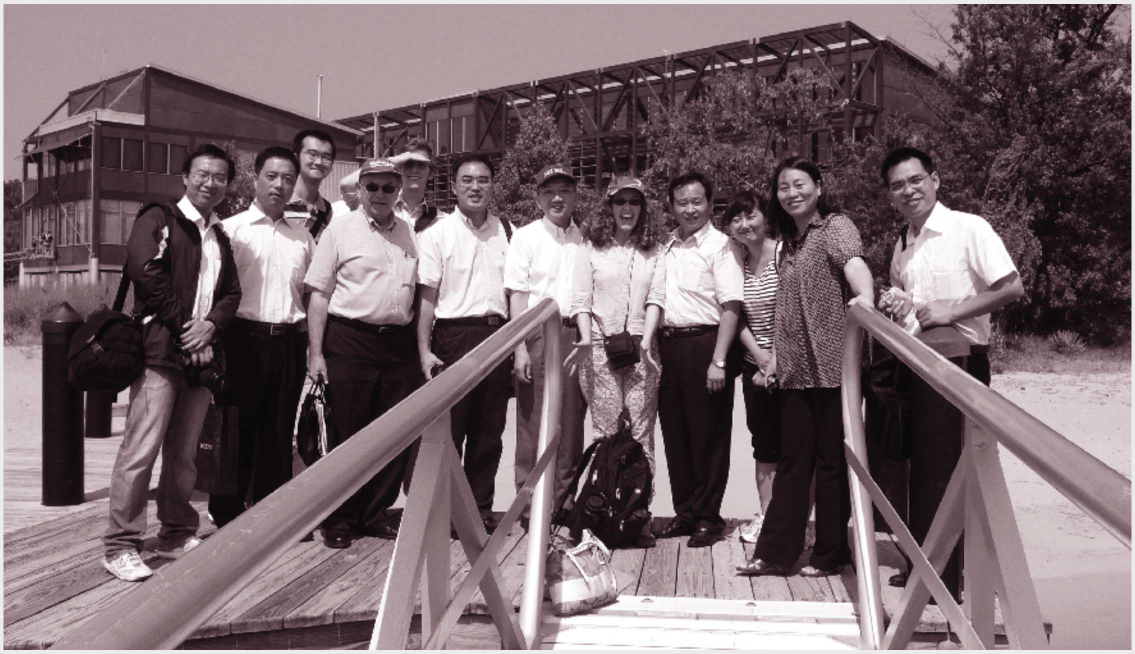
The two days of talking to researchers, NGOs, and business representatives who have been key in driving the creation and implementation of the Great Lakes Restoration Plan in Chicago and Northern Indiana exposed the Lake Tai group to a unique model of multi-stakeholder cooperation that has improved the governance of the largest lake basin in the United States. Andy Buchsbaum, a key organizer of the Chicago meetings, illustrated the magnitude of the challenge in bringing together so many players to agree on restoring the Great Lakes by noting that the water from the basin could cover China with eight inches of water. While strolling next to the shoreline of Lake Michigan outside the Shedd Aquarium where the daylong workshop took place, the Chinese participants expressed their awe to see such an enormous city coexisting next to a large and clean lake—a rarity in China.

The group exchanged views with prominent scholars and professionals about the protection of the Great Lakes. Welcoming the group was special assistant to Richard Daly, the Mayor of Chicago, Joe Deal, who highlighted how the Mayor's office has been a key convener of city officials from Lake Michigan's basin to promote exchange and collaboration in lake protection. The daylong discussions painted a clear picture of how the business and NGO communities in the Great Lake Basin came together to push for the creation of the Great Lakes Water Resource Compact. John Austin, Director of the Great Lakes Economic Initiative of the Brookings Institution, introduced the study commissioned by the Great Lakes Business Council that carried out an extensive cost-benefit analysis of protecting the basin. Andy Buchsbaum explained that the Brookings study along with duel pressure from the business and NGO communities in the basin helped break political logjam among the eight U.S. states and two Canadian provinces in the basin, which led to the finalizing and signing of the Compact. Because the basin is so large and the problems so diverse, nearly 400 NGOs have come together to form the Healing Our Waters Coalition to oversee the implementation of the compact. Jon Allan, a senior executive at CMS Energy, a major utility provider in Michigan, and Doug Roberts from the Michigan Chamber of Commerce talked about how and why the business community has been proactive in multi-stakeholder initiatives to protect the Great Lakes.

Despite the Compact, pollution threats to the lake still continue, an issue illustrated by Henry Henderson from the Natural Resources Defense Council as he described the ongoing conflict around the BP Whiting oil refinery plant expansion that began in 2008 and is expected to be completed in 2011. Both the expansion, which was undertaken to process oil mined from Canada's tar sands, and the State of Indiana's permit allowing BP Whiting additional discharges into Lake Michigan were met with fierce opposition and legal action from a coalition of local NGOs and politicians out of concern these emissions will seriously degrade the water and air in Lake Michigan. A boat tour of the shore of the heavily industrialized northwest Indiana showed members of the Lake Tai research team some of the lingering challenges facing the southern shore of Lake Michigan. The group also learned about some impressive examples of lakeshore revitalization and protection in conversations with representatives from local businesses, government agencies, and NGOs in Northern Indiana, and from a visit to the Indiana Dunes National Park that directly neighbors massive steel facilities, spreading miles along the lakeshore.

## WRAPPING UP

The second and final year of this project will



The Lake Tai study group poses before the Chesapeake Bay Foundation office in August 2010. Photo Credit: Ran Liping wrap up with a research exchange in Japan that will include a one-day symposium in Tokyo and one day of meetings with business, government, and NGOs working on clean water policies and projects and green supply chains in Tokyo. The group will also take a two-day trip to meet with experts who have worked to promote multi-stakeholder initiatives to clean up Lake Suwa and Lake Biwa. Additionally, CEF will produce a trilingual policy brief which will highlight U.S. and Japanese market, public-private partnership, and public participation strategies and tools that are applicable to China, outlining specific opportunities for joint U.S.-Japanese water cooperation in China. The brief will target policymakers, practitioners, and research audiences. Additionally, summaries and media of the project will be posted online and in the *China Environment Series* issue 12.

While the group of participants from China is small, the team comprises key stakeholders in lake and water protection and we hope that our research, workshops, and networking will help empower them to truly "green" Lake Tai.

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# FEATURE BOX

## Cooperative Competitors: Building New U.S.-China Climate and Energy Networks

By Peter Marsters

### CROUCHING SUSPICIONS, HIDDEN POTENTIAL

Over the past five years, China has taken considerable steps towards low-carbon development, with aggressive targets, policies, and investments focused on the renewable and energy efficiency sectors to help address the country's huge energy consumption and stem severe air pollution problems. As the global leader in clean energy investments, China has become the world's largest exporter of solar panels, and Chinese wind power companies have begun to enter the global market. China's progressive energy policies and priorities to decarbonize its economy have attracted considerable international investment, giving rise to pilot projects in nearly every type of energy technology—renewables, cleaner coal, biofuels, and shale gas. On the greenhouse gas front, China has the world's largest laboratory for clean technology projects and carbon capture and sequestration pilots.

In the United States, China's "green revolution" has sparked a broad range of reactions ranging from calls for U.S. action to create policies and promote investments to help the U.S. clean technology market catch up to China to complaints that the Chinese government provides its wind and solar industry with excessive subsidies that give Chinese companies unfair competitive advantage in the global clean energy markets. Unfortunately, perceiving China's progress in advancing cleaner energy as a win-lose situation could lead the United States to focus solely on protectionism and competition, rather than passing energy and climate legislation to develop domestic markets. Moreover, the view that China is "stealing" green jobs overlooks the opportunities for fruitful areas of bilateral clean energy cooperation that could enable the United States to take advantage of a growing global market.

In November 2009 just after Presidents Obama and Hu met in Beijing to sign nine new bilateral energy agreements, the Wilson Center's China Environment Forum (CEF) launched a new initiative—Cooperative Competitors: Building New U.S.-China Climate and Energy Networks. This initiative, made possible through seed funding from Blue Moon Fund and Rockefeller Brothers Fund, as well as support from USAID and Vermont Law School, builds on CEF's thirteen years of convening dialogues of diverse policy, business, NGO, and research experts to examine China's energy and environmental challenges.

Through examination of topics such as black carbon, sub-national climate cooperation, power sector decarburization, smart grid, solar power, and green transportation, the meetings and publications under the Cooperative Competitors initiative have begun to explore the true benefits and challenges facing U.S-China clean energy cooperation. By helping to promote dialogues among energy practitioners in both countries, CEF hopes to help identify some promising areas of clean energy and climate collaboration that can benefit the environment and promote more sustainable energy production for both countries.

## THE U.S.-CHINA CLEANER COAL CHALLENGE

The Cooperative Competitors meetings have drawn expertise from business, government, research, and NGO communities to discuss a broad spectrum of climate and clean energy issues facing the United States and China. With both countries highly dependent on coal—comprising roughly 50 percent of electricity production in the United States and 80 percent in China—many meetings have focused on cleaner coal issues. The project has stimulated broader and more in-depth discussion about how private and public stakeholders in the United States and China can collaborate to deliver favorable outcomes in mitigating climate change, addressing increasing energy demand and maintaining economic growth. The "Cleaning Up King Coal" meeting held on May 12, 2010 illustrated the potential benefits of private sector cooperation, featuring speakers from Clean Air Task Force (CATF) and Future Fuels LLC who discussed how Chinese technology can offer cleaner coal solutions to the United States in the form of carbon capture and sequestration ready coal fired power plants. Future Fuels is the exclusive U.S. licensee of an advanced coal gasification technology developed by China's Thermal Power Research Institute. As Ming Sung, Chief Representative in the Asia Pacific for CATF, stated, "investments by one country can reduce the cost of a technology worldwide, increasing the likelihood that carbon capture and storage will be deployed widely in time to help avert the worst consequences of climate change."

At CEF's "Electricity with Chinese Characteristics" meeting on June 24, 2010, Jim Williams from the San Francisco-based environmental consultancy E3, explained that one of the major challenges facing China's efforts to promote renewable energy and energy efficiency is the difficulty in assessing the actual cost of decarbonizing the power sector. The gap in understanding these costs is due to a lack of "soft technology"—analytical methods, software models, and institutional processes. Without the ability to assess the true costs of electricity, policymakers in China are unable to determine the level of greenhouse gas reductions that

could be achieved in the power sector for a given cost. U.S. Federal Electricity Regulatory Commission Chairman Jon Wellinghoff, who has made several visits to China to meet with his counterparts, believes that collaboration in the power sector could be mutually beneficial, resulting in net climate and economic benefits for both the United States and China.

## MIND THE (WATER-ENERGY) GAP

While most of the Cooperative Competitors meetings have focused on new or emerging business, NGO, or bilateral energy partnerships or challenges facing energy policy and governance in China, a session on September 22, 2101 highlighted a striking gap in the United States and China on the clean energy front. In both countries there is little or no understanding about the impact that new energy investments will have on freshwater resources. At the September meeting speakers from Circle of Blue (COB) presented the results of their investigation into the water footprint of shale gas, tar sands, biofuels, solar power, and dams in the United States. To meet the projected 40 percent increase in energy demand by 2050, the United States is developing a massive number of non-conventional fuel projects that will have a crippling impact on the nation's water security. Soy biofuel gas uses 6,000 times more water than conventionally refined petroleum-derived fuel. Freshwater protection and energy development are not being looked at as a single issue; COB speaker Keith Schneider noted that as rising energy demand collides with declining water supplies, the United States is facing but not yet addressing a national choke point. CEF will be embarking on research and meetings to identify and examine the water-energy choke points in China.

*CEF research briefs that distill the insights gained from Cooperative Competitors research, meetings, and networking will be posted online in English and Chinese.*

*Peter V. Marsters has been CEF's assistant for over a year, focusing his research on green cars and the water-energy nexus in China and the United States. He can be reached at: peter.marsters@wilsoncenter.org.*

Some speakers in our Cooperative Competitors meeting series in 2010 included (L to R): Ming Song (Clean Air Task Force); Jim Williams (E3); Fritz Kahrl (E3); and Keith Schneider (Circle of Blue). Photo Credit: David Hawxhurst.