

ENERGY EFFICIENCY IN CHINA: A ROAD MAP FOR AMERICAN COMPANIES

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Introduction

Rapid economic growth and market reforms have stimulated increased demand for foreign investment in advanced high-efficiency energy technologies that will help China solve its serious energy and environmental problems. American energy efficiency businesses are starting to take the China market seriously. Honeywell Inc., with sales of \$250 million in China in 1994, has formed a joint venture with a China Petrochemical Corp. (Sinopec) to retrofit its oil refineries with process controls. Insulation giant Owens-Corning Fiberglass Co. intends to invest \$100 million in China between 1995 and 2000. A third case is Armstrong International, which has formed a joint venture with China's General Machinery and Engineering Corp. to improve steam system efficiency in a variety of industrial applications.

Power Shortages and Pollution

China's economy has been growing at an average of 8-9 percent per year since 1980. While China has been successful in decoupling growth in fuel use from economic expansion, supply and end-use efficiencies are still low by world standards. As a result of these

inefficiencies and China's history of limited investment in the electric power sector, the power supply from China's grids is insufficient to meet current demand. In fact, black-outs are now so common that many local newspapers carry notices, rather like weather reports, of planned outages. To address electric power shortages, the Ministry of Electric Power plans to increase installed generating capacity, which totals less than 200 gigawatts (GW) at present, to 300 GW by the year 2000. However, neither China's capacity to manufacture large power generators nor its capital resources are sufficient to achieve such a tremendous expansion.

China's heavy reliance on coal also imposes large environmental costs on the country. Respiratory disease from coal smoke inhalation, acid rain, and greenhouse gas emissions are a few of the most serious consequences of China's coal use. A combination of low-cost energy efficiency initiatives and capacity expansion offer China its best chance to ameliorate power shortages and environmental problems.

Recognizing the need for efficiency, the Chinese government invested significant resources in improving efficiency in key

energy-intensive industries, as well as in improving the efficiency of motors, fans, and pumps in all industries in the 1980s. The government's goal for the 1990s has been to shift responsibility for efficiency investment from the public to the private sector. The State Planning Commission's China Energy Conservation Investment Company (CECIC) was recently converted from a grant-making to a lending institution. CECIC's loans, which totaled \$300 million in 1993, are supplemented by funds from local governments, and each loan requires the enterprise to contribute a share of the investment.

The government has also issued energy standards and a range of additional energy efficiency regulations which are now embodied in China's draft "Energy Conservation Law." If the law is passed later in 1996, hundreds of local energy conservation technology service and monitoring centers will be authorized to conduct audits and report their findings to the government. A new Global Environment Facility and World Bank project will also convert several of these local energy conservation centers to energy management companies with the ability to assess, finance, and manage in energy efficiency projects. A new Green Lighting program sponsored by China's State Economic and Trade Commission will promote another market-based approach to energy efficiency. The program will encourage companies to get their products certified for quality and efficiency in order to earn a label that will help them outsell cheap imitations.

Opportunity Areas

As market forces set in, China's leading industrial firms are investing in advanced industrial process controls, steam traps, new motors, boilers and furnaces in order to stay competitive. Ubiquitous power

shortages make cogeneration an attractive option for many plants, although low, controlled prices for delivered heat in most areas is still a serious barrier to full development of this market. City governments are under pressure to reduce pollution and costs by modernizing district heating systems. Foreign developers of hotel and office buildings are buying efficient lighting, thermostatic control systems and appliances in order to provide state-of-the-art service and keep maintenance costs down.

Industrial Equipment and Processes

Industry currently consumes just over two-thirds of China's total commercial energy. The types of equipment that consume most of China's coal and electric energy are depicted in Figure 1. Studies of energy use in state-owned enterprises conclude that China has the technical potential to save 40-50 percent of total current energy consumption by adopting the world's most advanced technologies. While this type of wholesale replacement of equipment is not necessarily economically feasible, the figure serves as a useful technical reference point.

An analysis of China's industrial boilers and furnaces provides striking evidence of the potential for savings through industrial equipment upgrades. China's industrial boilers consume 8.6 quadrillion Btu of coal annually, about one third of the nation's end-use energy. If boiler efficiency were raised from the current 65 percent average to the 80 percent average attained by developed countries, energy input to boilers could be reduced by 1.6 quadrillion Btu per year.

Industrial furnaces consume about one quarter of China's end-use energy. Industrial processes, such as steel and glass production and copper smelting, use 25 to 110 percent more energy per unit of

output primarily because of the low efficiency of the furnaces. If China utilized advanced furnaces, the energy input would be reduced by about 40 percent, thus 2.7 quadrillion Btus per year could be saved.

The energy conservation potential described above does not even include town and village enterprises (TVEs), which use inefficient, polluting, secondhand equipment and are supplied by small, inefficient power plants. Significantly for foreign investors, in many areas TVEs are surpassing state-owned enterprises in terms of investment capability and technical sophistication, thus providing a ready market for efficiency investments with good economic returns.

According to case studies sponsored by the Global Environment Facility, a wide range of industrial efficiency improvements are economically as well as technically feasible. Table 1, which provides illustrative internal rates of return for various projects, clearly suggests that rates of return are high enough to justify investment in many cases, as long as the projects meet other selection criteria.

Reducing the cost of high efficiency electric motors is a particularly promising area for foreign investment. Chinese manufacturers already produce a series of high efficiency asynchronous motors called the YX series. However, such motors cost up to 50 percent more than lower-efficiency Y series motors. Although the incremental cost of YX series motor can be recovered fairly quickly, many motor users are unwilling to pay the high initial cost. Therefore, Chinese manufacturers of high efficiency motors would like to license foreign technology or form a joint venture in order to lower the price of their motors.

Foreign investment is also needed to promote the use of waste gas for power production in the iron and steel industry. Waste gas produced by blast furnaces can be used to generate electricity at low cost while reducing factory emissions. For example, a 6 MW generator with a capital cost in the range of 15-25 million yuan, and no fuel cost because it runs on waste gas, can produce 36 GWh annually. Assuming an electricity price of 0.6 yuan per kWh, the value of energy produced would total more than 20 million yuan, enabling the plant to recoup its investment in less than two years. The Beijing Energy Efficiency Center (BECon) has identified eight steel plants in China that are interested in using this technology.

Cogeneration

Cogeneration accounted for almost 12 percent of China's installed thermal power generation capacity in 1993. The central government began supporting the development of cogeneration in the 1980s because it solved several problems at once: power supply expansion, energy conservation, and environmental protection. Responsibility for small-scale cogeneration is now shifting to provincial and local governments and the private sector, creating demand for foreign investment in this area.

The textiles, food, medicine, paper, oil refining and chemical fertilizer industries are particularly strong candidates for cogeneration development. Geographically, the potential for cogeneration development is greatest in China's northern and eastern provinces because of the combination of low winter temperatures and high levels of industrialization. However, the booming coastal provinces to the south may also have great market potential because the

demand for electric power is growing more rapidly. In areas of electric power shortage, newly built plants can charge higher prices than the "going rate" for electricity sales to local customers because actual transactions prices are usually negotiated between the electric power producer and the local government on a case-by-case basis. Heat sales, on the other hand, usually are not a promising source of income because the government heavily regulates heat prices to keep them affordable for residential customers.

In-plant cogeneration units serving a single enterprise are likely to be the most profitable types of projects. Small district cogeneration facilities would be the next most profitable, followed by large central cogeneration plants. A larger system tends to be more expensive than a small one because the heat distribution system accounts for a higher percentage of the total cost and the construction period is longer. Also, government control of electricity and heat prices constrains the profitability of the larger projects.

While several foreign companies have expressed interest in investing in cogeneration in China, no joint venture has yet been announced. That may change soon if the cogeneration workshop scheduled for June 4 and 5 in Washington, DC was successful. The workshop was organized by Lawrence Berkeley National Laboratory, Energy Resources International, and the China Cogeneration Society. At this writing, ENRON, Foster Wheeler-Pyropower, Bechtel, Community Energy Alternatives, K&M Engineering, General Power, Skadden Arps., Cogen Technologies, General Electric (GE), GE Capital, McGuire Woods, Southern Electric International, Entergy, and Westinghouse were expected to attend.

Buildings: Lighting, Controls, and Insulation

China's markets for lighting, controls, and insulation is currently divided into low-cost residential buildings, usually designed and funded in China, and state-of-the-art commercial buildings, often designed and funded by foreign developers. While the former represents a much larger number of buildings and tremendous technical potential, it currently represents a much smaller market for high-efficiency products.

Unfortunately, at present, there is little incentive for efficient residential construction in China because municipalities are under pressure to provide housing as quickly and as cheaply as possible. Efficient construction represents a relatively high initial cost while the cost of energy waste can be spread out over a long time. Demand for efficient residential buildings will remain low until new policies or changes in the market foster its growth. Some cities, however, are fostering introduction of efficient building technologies by sponsoring "building efficiency zones," a nationwide effort supported by the Ministry of Construction.

Several American companies have begun marketing efficient building products in China, primarily targeting the commercial sector. Honeywell and Johnson Controls have successfully penetrated the market for thermostatic controls in China's commercial buildings. Johnson intends to continue to market primarily to China's commercial building market, while Honeywell has a long-term goal of providing integrated control systems for water and air heating and cooling in all types of Chinese buildings.

Owens-Corning has set its sights on China's huge residential building sector. The company announced the formation of a \$25 million insulation joint venture with Shanghai Building Materials Corp. in 1995. Because of the high risk involved, Owens-Corning's plants in China are initially producing fiberglass pipes for municipal sewage systems. Meanwhile, the company is seeking policy changes at the municipal level to spur investment in residential building efficiency. The firm is also encouraging design institutes to specify the use of insulation in residential building construction.

Several American companies have also done business in China's efficient lighting market. For example, two American companies contributed to the formation of joint ventures that produce compact fluorescent lamps in China. Pacific Resources Inc. supplied the capital for the venture, while Mitor Industries Inc. sold the jointly owned enterprise two turn-key production facilities, technology licenses, and technical training.

Consumer Goods: Appliances

China's electrical appliance industry is booming. By the year 2000, refrigerator production may reach 8 million units per year, and production of room air conditioner units may reach 6 million units per year. Based on data for 1994, 62 percent of urban homes are equipped with a refrigerator, up from less than one percent in 1981. The rate of air conditioner ownership increased from zero to 5 percent during the same period. Ownership of clothes washers grew from 6 percent to 86 percent between 1981 and 1993. Demand for appliances is expected to continue to grow as more urban area residents buy air conditioners and residents of smaller cities and well-off

rural areas purchase their first washing machines and refrigerators.

American appliance manufacturers have not exported their products to China because the combination of transportation costs and import duties would price them out of the market. Until recently, these companies have attempted to penetrate the appliance market only through technology licensing and technical assistance contracts. Now foreign manufacturers have begun breaking into the market through joint ventures. The U.S. firms Carrier, Whirlpool, and Philco all invested in air conditioner manufacturing joint ventures last year.

The Chinese government allowed the formation of air conditioner joint ventures, but barred most joint ventures in the refrigerator industry because it judged Chinese refrigerator manufacturers to be successful without foreign investment. The government is most interested in approving joint ventures in those sectors that are judged to be in dire need of investment and with those state-owned enterprises that are on the verge of bankruptcy.

Getting Started

Companies interested in learning more about energy efficiency business in China may wish to contact the Beijing Energy Efficiency Center (BECon), the U.S.-China Energy Efficiency Teams, and the U.S.-China Business Council.

BECon's purpose is to serve as China's window on advanced energy efficiency technologies and market-oriented policies. Its activities include policy analysis, business development, training and public education. BECon can help companies get their bearings in China's energy efficiency market by providing general background

information, targeted market studies, and introductions to potential partners. BECon can also help companies market their products in energy efficiency training sessions or demonstration projects.

The U.S.-China Energy Efficiency Teams, organized by the U.S. Department of Energy (DOE) and an interagency Chinese coordinating group, are umbrella groups designed to facilitate business development by providing American companies with direct access to Chinese agencies and firms. DOE can direct companies to the appropriate team leader to learn more about specific activities, such as study tours, financing, demonstration projects, and business workshops. The U.S.-China Energy Efficiency Information Exchange Team publishes a monthly electronic bulletin, China EE Info, summarizing the activities of the other teams and related events. Back issues of the bulletin are available on the World Wide Web at <http://w3.pnl.gov:2080/china>. The bulletin provides references to valuable resources such as the China Energy Databook, which contains information about China's energy resources, supply, consumption, efficiency, prices, and energy-related pollutant emissions. More information about the Databook and other related publications from Lawrence Berkeley Laboratory is available at <http://eande.lbl.gov/EAP/china.html>.

Another helpful organization, particularly for large companies, is the U.S.-China Business Council. The council represents the interests of American companies working in China to both the American and the Chinese government. The council's magazine, China Business Review, contains articles on a wide range of subjects, from banking reform to product distribution in China, all specifically

addressing the concerns of American firms.

These three organizations can help smooth the often bumpy road to doing energy efficiency business in China .

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Figure 1
Energy Use by Equipment Type in China, 1990

SOURCE: Beijing Energy Efficiency Center; Pacific Northwest National Laboratory.

Table 1
Estimated Internal Rates of Return for Selected Energy-Efficiency Investments in China

Sector	Investment	IRR (%)
<i>Steel</i>	• Conversion of open hearth furnace to basic oxygen furnace	16
	• Adoption of continuous casting	19
	• Reheating furnace renovation	36
	• Blast furnace gas recovery	41
<i>Aluminum</i>	• Kiln renovation	84
<i>Ammonia</i>	• Medium-sized plant restructuring	20
	• Small plant waste heat recovery	71
<i>Caustic Soda</i>	• Adopting membrane electrolyzer	29
<i>Cement</i>	• Medium-sized kiln renovation	15
	• Conversion from wet to dry process	19
	• Small-scale kiln renovation	35
<i>Pulp and Paper</i>	• Adoption of cogeneration	25
	• Black liquor recovery	25
<i>Textiles</i>	• Cogeneration in printing and dyeing	38
	• Caustic soda recovery	58
	• Computerized energy management	>100

SOURCE: World Bank.