

## Industrial Energy Efficiency Policy in China

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### ABSTRACT

Chinese industrial sector energy-efficiency policy has gone through a number of distinct phases since the founding of the People's Republic in 1949. An initial period of energy supply growth in the 1950s, 1960s, and 1970s was followed by implementation of significant energy efficiency programs in the 1980s. Many of these programs were dismantled in the 1990s during the continuing move towards a market-based economy. In an effort to once again strengthen energy efficiency, the Chinese government passed the Energy Conservation Law in 1997 which provides broad guidance for the establishment of energy efficiency policies. Article 20 of the Energy Conservation Law requires substantial improvement in industrial energy efficiency in the key energy-consuming industrial facilities in China. This portion of the Law declares that "the State will enhance energy conservation management in key energy-consuming entities." In 1997, the industrial sector consumed nearly 30 EJ, or 76% of China's primary energy. Even though primary energy consumption has dropped dramatically in recent years, due mostly to a decline in coal consumption, the Chinese government is still actively developing an overall policy for energy efficiency in the industrial sector modeled after policies in a number of industrialized countries. This paper will describe recent Chinese government activities to develop industrial sector energy-efficiency targets as a "market-based" mechanism for improving the energy efficiency of key industrial facilities.

### Industrial Energy Consumption Trends in China

Globally, the industrial sector accounts for about 40% of primary energy use. In 1995, developing countries used an estimated 48 EJ for industrial production, over one-third of world total industrial primary energy use (Price et al. 1998). Industrial output and energy use in developing countries is dominated by China, India, and Brazil. China alone accounts for almost 30 EJ (National Bureau of Statistics 1999), or about 23% of world industrial energy use.

China's industrial sector is extremely energy-intensive and accounted for 76% of the country's total energy use in 1997. Figure 1 shows that industrial energy use in China grew from 12.5 EJ in 1980 to 29 EJ in 1997, at an average rate of 5% per year (Sinton et al. 1996; National Bureau of Statistics 1999). This growth is five times faster than the average growth that took place in the industrial sector worldwide during the same time period.

Recent statistics indicate, however, that overall growth in energy consumption in most sectors in China has been dropping dramatically since reaching a peak of 38.9 EJ 1996. In 1999, total primary energy use in China was an estimated 32 EJ, 18% below the 1996 level (Sinton and Fridley 2000). It appears that a large portion of this decline is due to closing

of both state-owned and non-state factories and a significant drop in the use of coal (Sinton and Fridley 2000; China Online 1999).

The industrial sector can be divided into light and heavy industry, reflecting the relative energy-intensity of the manufacturing processes. In China, about 80% of the energy used in the industrial sector is consumed by heavy industry. Of this, the largest energy-consuming industries are chemicals, ferrous metals, and building materials (Sinton et al. 1996).

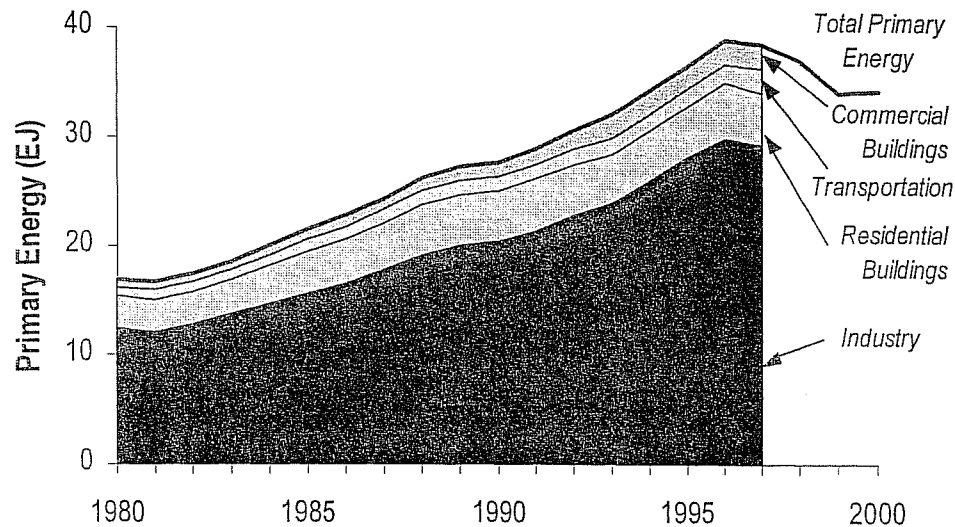


Figure 1. Energy End Use Consumption by Sector in China, 1985 and 1997

## History of Energy Efficiency Policy in China

Energy-efficiency policy in China has evolved greatly since the People's Republic was established in 1949, moving through three main phases: "Soviet-Style" energy policy, initial reforms, and the current transition period.

### "Soviet-Style" Energy Policy (1949-1980)

During this period, rapid growth in energy supply was the main energy policy in China. Energy prices were subsidized, a central allocation system provided energy primarily to the industrial sector, and little attention was paid to the environment or energy efficiency. As a result, China's rapidly growing energy system was extremely inefficient (Levine 2000).

### Initial Reforms (1981-1992)

In 1980, following a meeting of more than 100 non-governmental energy experts who declared that China's energy policy was in a crisis situation and required radical reform, the Chinese government implemented an extensive series of reforms beginning with the Sixth Five-Year Plan which took effect in 1981 (Levine 2000). The government announced that it would place equal emphasis on development of energy supply and energy conservation in order to ensure an adequate supply of energy, emphasizing energy conservation in the near term (Lu 1993). Many energy-efficiency policies and programs were developed and

implemented by the central government. Most of these programs were directed toward the industrial sector.

Energy management offices, departments, and agencies were established at all levels of government to implement, manage, monitor, and enforce the numerous rules, standards, and programs related to energy conservation. The Office of Energy Conservation Work in the State Council oversaw all of the efforts, including offices in conservation, resources, electricity conservation, science and technology, and standards. Ministries for specific industrial sectors, such as the Metallurgy Ministry, focused on sector-specific issues. The China Energy Conservation Association, the National Supervising Center of Energy Conservation, and the Energy Conservation Testing Technology Service Centers, along with provincial energy conservation agencies, were also established.

Energy efficiency and energy conservation management for the industrial sector during this period involved controlling energy intensity and energy supply through the use of quotas. Energy conservation goals were set in the form of physical energy intensity standards for various manufacturing processes. Other standards addressed industrial equipment such as boilers and motors. Success in attainment of the standards was considered when allocating energy supply quotas for industrial enterprises (Sinton et al. 1998; Liu et al. 1994). Other energy management efforts included dissemination of energy-efficient technologies and products, retiring energy-intensive mechanical and electrical devices, restricting energy-wasting production practices, and monitoring enterprise energy conservation.

Low interest loans for energy conservation projects, tax breaks for energy-efficient products, and monetary energy conservation awards for enterprises were all used to encourage investment in energy efficiency. Funding for energy-efficiency investments was provided by the newly established China Energy Conservation Investment Corporation (CECIC). During this period, energy-efficiency funding for capital construction, retrofits, and transformation projects was equivalent to \$16.5 billion (1995 US\$) (Sinton et al. 1998).

Information on energy use and intensities was gathered through the national resources conservation and comprehensive utilization network and statistics were compiled by the energy statistical reporting system. National, local, and sectoral energy conservation technology service centers were also established. Education and training programs included the establishment of energy conservation training centers. Over 200 energy conservation centers were established during this period to provide energy monitoring and efficiency services, develop and promote energy-saving technologies, and perform feasibility studies (Liu et al. 1994).

An analysis of the energy savings that resulted from these energy-efficiency efforts found that if energy intensity had remained frozen at 1977 levels, then China would have used 80 EJ in 1995, more than twice as high as the actual consumption of 36 EJ that year (Sinton et al. 1998). Decomposition analyses have shown that most of the energy savings during this period were due to reductions in energy intensity, not structural shifts toward less energy-intensive industry (Huang 1993; Lin 1992; Palmer 1992; Sinton 1996; Sinton and Levine 1994; Worrell et al. 1997).

### **Transition to a Market-Based Economy (1993-Present)**

In 1993, the Chinese government enacted a number of significant financial reforms, initiating China's transition to a market-based economy. Energy price reforms included

deregulation of coal prices, increases in oil prices, and partial deregulation of electricity prices. A simplified tax code introduced in 1994 eliminated tax rate reductions and tax breaks on energy-efficiency technology development and investment projects. Some banks also began to reduce low-interest lending for efficiency projects.

In 1997, the Chinese government passed the Energy Conservation Law which provides broad guidance for the establishment of energy-efficiency policies in China. Article 20 of the Energy Conservation Law requires substantial improvement in industrial energy efficiency in 7200 key energy-consuming industrial facilities in China. This portion of the Law states that “the State will enhance energy conservation management in key energy-consuming entities.”

A number of provincial administrations have formulated implementing regulations in accordance with the Energy Conservation Law: Shandong, Shanghai, Beijing, Zhejiang, Jiangsu, Shanxi, Gansu, Sichuan, Yunnan, and Hubei. Although a review of the Shandong, Zhejiang, and Shanghai implementing regulations characterized them as vague (Wang, 1999), they are still an important step toward providing provincial governments with the tools required to implement energy conservation programs within their jurisdictions.

Energy quotas were eliminated and monitoring of energy intensity levels declined as a result. In 1998, most industrial ministries were demoted to the bureau level and placed under the authority of the State Economic and Trade Commission (SETC). Industrial bureaus were merged into a single Industrial Management Department within SETC in 2000. Statistical collection diminished as state control over enterprises weakened.

In 1999, SETC issued a catalogue of “Outdated Technology Processes and Products” initiating an effort to phase out non-competitive processes or products that consume too much energy or are polluting. The two volumes of this catalogue address 11 industrial sectors (China Environmental Review 2000). SETC also mandated closure of some inefficient petrochemical plants as well as hundreds of small cement and glass plants, mainly in northern China, small refineries, coal mines, sugar mills, and paper mills for financial, energy efficiency and environmental reasons. This campaign was extended in 2000 to include over 200 small iron and steel plants (China Daily 2000a and 2000b; Nengyuan 2000 ).

### **Current Situation**

The 10<sup>th</sup> Five-Year Plan will be promulgated in March 2001. A number of energy efficiency policies will be included in this Plan. Proposed policies include a renewed focus on energy end-use efficiency and productivity improvement, development of supporting regulations for the Energy Conservation Law at the local and sectoral levels, formulation of annual energy conservation plans to improve energy utilization efficiency and productivity, formulation of preferential economic policies to support energy conservation demonstration and dissemination projects, enhanced energy management of key energy-using enterprises, and harnessing of grass-roots social forces to save energy. In addition, targets for specific energy consumption levels for key energy-intensive industries have been recommended (see Table 1) (Chen 2000a). The 10<sup>th</sup> Five-Year Plan will also take into account the terms of accession to the World Trade Organization, including exposing many industrial enterprises to international competition (Sinton et al. 1999).

**Table 1. Proposed 10<sup>th</sup> Five-Year Plan Targets for Specific Energy Consumption for Key Energy-Intensive Industries**

Energy-Intensive Industrial Sector	Specific Energy Intensity Unit	1995	2000	2005	Annual % Decline 1995-2000	Annual % Decline 2000-2005
Iron and Steel	GJ/ton	33.3	31.7	30.9	-1.0%	-0.5%
Copper	GJ/ton	40.4	37.5	34.6	-1.5%	-1.6%
Aluminum	kWh/t	14736	14100	13800	-0.9%	-0.4%
Synthetic Ammonia	GJ/ton	43.3	40.6	37.5	-1.3%	-1.6%
Cement Clinker	GJ/ton	6.0	5.5	5.3	-1.8%	-0.6%
Synthetic Fabrics	kWh/t	1955	1500	1350	-5.2%	-2.1%
Oil Refining	GJ/ton	0.5	0.5	0.4	-0.7%	-0.8%

Recently, the State Economic and Trade Commission announced a conservation plan for industrial consumption of water and oil which sets limits during the 10<sup>th</sup> Five-Year Plan. This plan calls for fuel-saving efforts in power plants, petrochemical factories, steel plants, building material production firms, and chemical plants. Reductions of almost 0.5 EJ annually are expected (China Online 2001).

There are a number of policies and projects focused on improving industrial sector energy efficiency in China. Table 2 provides a list of a number of these projects and shows that they focus on areas such as improving energy efficiency of specific technologies, providing training in energy conservation technologies and practices, developing standards and labels, information dissemination and demonstration, and industrial sector policy development. This diverse array of projects addresses a number of critical areas of industrial energy efficiency, but none of these projects is focused on development of a comprehensive policy for industrial energy efficiency in China. Only two projects, the Chinese Energy and Carbon Scenarios project which is analyzing the effect of different policy scenarios on the energy use and related carbon dioxide emissions of all sectors in China and the Industrial Sector Energy Efficiency Policy Development: Developing Chinese Regulatory Infrastructure Project, which is described in detail in the next section of this paper, address development of such a comprehensive policy.

### **Development of a Comprehensive Policy for Industrial Sector Energy Efficiency in China**

In 1999, the China Energy Conservation Association (CECA) began a project with the goals of 1) “developing implementing regulations and relevant standards for the Energy Conservation Law to promote industrial energy conservation and improvement of energy efficiency” and 2) “promoting the new planning in energy-intensive sectors for energy efficiency to reduce energy consumption of key enterprises” (CECA, 2000a). This project has undertaken a number of research efforts to determine the best approach for reaching these goals. These efforts include analyzing international industrial energy efficiency policies and programs and their adaptability to China, analyzing the status and opportunities for energy conservation in key energy-intensive industrial sectors, and reviewing existing energy conservation regulations and policies and making recommendations for new regulations and policies that work well under a “market-based” economy. Following completion of this research, CECA will recommend an overall policy scheme for improving energy efficiency

in industry, a pilot sector and geographic location to further evaluate this scheme, and implementing regulations and relevant standards for this scheme.

**Table 2. Current Projects Related to Industrial Sector Energy Efficiency in China**

Area of Focus	Title of Project	Funding/Participating Organizations
Technology	Energy-Efficient Motors and Boilers Technology Cooperation	China Clean Air and Clean Energy Technology Cooperation (CACETC, formerly Technology Cooperation Agreement Pilot Project, TCAPP)
	Motor Test Laboratory and Test Procedure Project	GTZ, China Electric Power Research Institute (EPRI)
	Boiler Efficiency Improvement	Global Environmental Facility (GEF), United Nations Development Programme (UNDP), United Nations Industrial Development Organization (UNIDO)
	Efficient Industrial Boilers	World Bank, Global Environmental Facility (GEF)
	Energy Conservation and Greenhouse Gas Emissions in TVEs	Global Environmental Facility (GEF), United Nations Development Programme (UNDP)
	Energy Efficiency and Pollution Control in Township and Village Enterprise Industries	China Ministry of Agriculture, World Bank, United Nations Development Programme (UNDP)
	Center for Environmentally Sound Technology Transfer to Small and Medium Enterprises	State Development Planning Commission, United Nations Industrial Development Organization (UNIDO)
Training	China Motor System Energy Conservation Program	State Development Planning Commission, United Nations Industrial Development Organization, United Nations Foundation (UNF), United States Department of Energy, Lawrence Berkeley National Laboratory, American Council for an Energy-Efficient Economy
	Sino-US Motor Systems Team	State Development Planning Commission (SDPC), China Energy Conservation Investment Corporation (CECIC), United States Department of Energy, Lawrence Berkeley National Laboratory, American Council for an Energy-Efficient Economy
	China Energy Conservation Project: Energy Service Companies	State Economic Trade Commission (SETC), World Bank, Global Environmental Facility (GEF)
Standards and Labeling	China Energy Efficiency Program: Labeling and Certification Program for High Efficiency Motors	International Institute for Energy Conservation
Information Dissemination and Demonstration	China Energy Conservation Project: Energy Conservation Information Dissemination Center	State Economic Trade Commission (SETC), World Bank, Global Environmental Facility (GEF), AEA Technology Environment
Policy Development	Clean Production Pilot Projects in Taiyuan City and Shandong Province	China Council for International Cooperation on Environment and Development, State Environmental Protection Administration (SEPA), State Economic Trade Commission (SETC), United Nations Environment Programme (UNEP)
	Cogeneration Policy Project	China Energy Conservation Investment Corporation (CECIC), United States Department of Energy, Lawrence Berkeley National Laboratory, Energy Resources International
	Chinese Energy and Carbon Scenarios Project	Beijing Energy Efficiency Center (BECon), Lawrence Berkeley National Laboratory, Energy Foundation
	Industrial Sector Energy Efficiency Policy Development: Developing Chinese Regulatory Infrastructure Project	China Energy Conservation Association (CECA), Lawrence Berkeley National Laboratory, Energy Foundation

## Analyzing International Industrial Energy-Efficiency Policies

There are many types of policies and programs that have been used in countries worldwide to improve energy efficiency in the industrial sector. These policies and programs include regulations, standards, taxes, investment tax credits, rebates, agreements or sector targets, reporting, benchmarking, audits, assessments, information dissemination, demonstration, and research and development. Some of these policies and programs are implemented in specific industrial sectors. For example, agreements and targets are usually made with an association or entity representing a particular sector such as the iron and steel or cement industries. Other policies and programs are directed at equipment that is found in many sectors. For example, regulations or standards for motors will affect motor energy use in almost all industrial sectors.

The most effective way to improve industrial energy efficiency is through an *integrated approach*, where a number of policies and programs are combined to create a strong overall industrial energy-efficiency policy that addresses a variety of needs in many industrial sectors. Such an integrated approach can be found in the industrial sector voluntary agreement programs that were established in a number of countries in the 1990s.

Agreements to meet specific energy use or energy-efficiency targets are used widely in the industrial sector (Bertoldi 1999; Chidiak 1999; Hansen and Larson 1999; Krarup and Ramesohl 2000; Mazurek and Lehman 1999; Newman 1998). Such agreements, which are typically but not always voluntary, are defined as “agreements between government and industry to facilitate voluntary actions with desirable social outcomes, which are encouraged by the government, to be undertaken by the participants, based on the participants’ self-interest” (Storey, 1996). An agreement or target can be formulated in various ways; two common methods are those based on specified energy-efficiency improvement targets and those based on specific energy use or carbon emissions reduction commitments. Either an individual company or an industrial subsector, as represented by a party such as an industry association, can enter into such agreements.

CECA staff compiled a comprehensive library of documents on international industrial sector energy-efficiency policies. Many of these documents have been translated into Chinese and have been compiled into a document for distribution among Chinese energy analysts and policymakers (CECA 2000b). CECA also held a two-day workshop in which experts from around the world presented information on the industrial energy-efficiency programs in their countries. These presentations covered the Long Term Agreements on Energy Efficiency Improvements in the European Union, International Experience in Industrial Standards and Labeling Programs, Standards and Labeling in the Motors Industry, The “Best Practice” Programme: Experiences with Demonstration and Dissemination in the UK, The Establishment and Operation of a University-Based Center for Energy Efficiency Audits of Industrial Plants, and The Industrial Energy Efficiency Network in Norway. Chinese experts then made a number of presentations on the Chinese situation and the applicability of the international energy-efficiency policies to China (CECA 2000c).

Following the workshop, CECA staff established a Policy Research Team to more fully review the information on international energy-efficiency policies for the industrial sector. The Team recommended that China further investigate using a “new operational approach that fits in with the market-oriented economy” and noted that voluntary agreements could be introduced to guide enterprises in improving their energy efficiency (CECA 2000a).

## Analyzing the Status and Opportunities for Energy Conservation in Key Energy-Intensive Industrial Sectors

As a nation-wide industrial energy conservation association, CECA has extensive contacts with industry experts. A number of these experts have analyzed the status and opportunities for energy conservation in the following key energy-intensive industrial sectors: iron and steel, chemicals, petroleum refining, building materials, and nonferrous metals (Chen 2000b; Li and Xu 2000; Song 2000; Xu 2000; Yu 2000). Overall, these analyses show that Chinese industries use significantly more energy per tonne of product than the “international advanced level” (Li and Zeng 2000). Table 3 provides a comparison of the Chinese energy intensity to the international advanced level energy intensity in 1998 for a number of key energy-intensive industries.

**Table 3. Comparison Between Chinese and International Advanced Level Energy Intensity for Selected Industries, 1998**

Industry	China (GJ/tonne)	International Advanced Level GJ/tonne
Iron and Steel	27.5	19.3
Cement	4.2	2.9
Large Synthetic Ammonia	40.6	27.8
Alumina – Bayer Method	16.6	14.7
Alumina – Complex Method	44.5	19.0

Preliminary analyses indicate, however, that if China were to adopt a policy of energy-efficiency sector targets and related programs in which individual industrial sectors committed to specific improvements in energy intensity over a given time period in exchange for governmental support in the form of financial incentives, information programs, demonstration programs, and training programs, significant energy savings could be realized. For example, we estimate that if the energy used per tonne of steel produced continued to decline at the historical (1980-1996) rate of 1.5% per year, then the Chinese steel industry would consume about 44 EJ between 2000 and 2010. If the energy intensity improvement rate doubled to 3.0% per year, then the steel industry would consume only 32 EJ over this period, saving 12 EJ or 28% of business-as-usual energy consumption.

### Reviewing Existing Energy Conservation Regulations and Policies

CECA experts, in collaboration with widely recognized industrial energy-efficiency professionals in China, have also reviewed existing energy conservation regulations and policies in China. Of the 127 regulations for energy conservation that were published between 1979 and 2000, CECA recommends that 75 be eliminated or revoked and 12 be revised. The experts found that “China’s existing regulations and standards for energy conservation are not integral nor adaptive to the market-oriented economy” and they recommend that “regulations and policies to be developed should fit the market economy system and reflect a combination of mandatory means with non-mandatory ones” (Lu 2000).



## Next Steps and Future Directions

CECA's Policy Research Team is currently developing a scheme in which the policies and programs that were effective in the past can be re-introduced in the context of a market economy and new policies and programs can be initiated, following examples from successful industrial energy-efficiency programs in other countries. The Policy Research Team is focusing on the use of sector agreements as an integrating energy-efficiency policy for the industrial sector in China. Sector agreements, similar to those in The Netherlands, could re-introduce such concepts as targets for energy intensity improvement, audits, benchmarking and could augment existing financing, demonstration and information dissemination programs. Development of such an integrating policy for improving energy efficiency in the industrial sector, which includes clear targets for improvement and effective supporting programs to help enterprises achieve their goals, can provide the foundation for achieving significant progress in the effort to make China's industrial enterprises more energy-efficient, cleaner, and ultimately more competitive.

CECA's Policy Research Team has chosen the iron and steel sector for the pilot program. This sector is large and energy-intensive, but has a limited number of key and major local enterprises. Within the sector, there are several leading energy-efficient enterprises that can serve as role models for other enterprises. A sector association, the China Iron and Steel Association, was established in 1998. Finally, accession of China to the WTO is especially significant to the steel industry because of the high quality and low costs of some foreign steel products. Thus, enterprises in this sector will be motivated to improve their energy-efficiency in lights of increasing international competition.

The Policy Research Team has also chosen Shandong province for the pilot program. In general, the iron and steel sector in Shandong is advanced and the steel enterprises in Shandong have significant influence on the other enterprises of the country. There is relatively large energy-efficiency potential in these enterprises. Shandong province is the first of the provinces in China which established local ECL implementing rules and regulations and is always active in energy conservation. There is an Energy Management Center in Shandong which is among the first established in China. This province has shown enthusiasm for the pilot of a new energy conservation mechanism. The economic development level of Shandong is among the best in China. Although Liaoning and Hebei provinces have more steel plants and more steel capacity, their economic development level is low.

## Conclusions

China is at a crossroads between the past, in which the central government controlled energy use and directed energy conservation policy and the future in which a liberalized market, reduced government involvement, and international competitive pressure following admission to the WTO will all influence industrial sector policies, including those affecting energy efficiency. Chinese policy analysts are looking beyond their borders to see what types of programs have been effective in improving energy efficiency in industry in order to devised policies to help the currently inefficient Chinese industrial sector to reduce waste and costs, improve products and productivity, and ultimately compete successfully in an open international market. Such policies must consider the history of energy-efficiency policy in

China, the unique characteristics of these Chinese industrials sector, and the rapid changes currently taking place in China.

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