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Constraining Energy Consumption of China's Largest Industrial Enterprises Through the Top-1000 Energy-Consuming Enterprise Program

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ABSTRACT

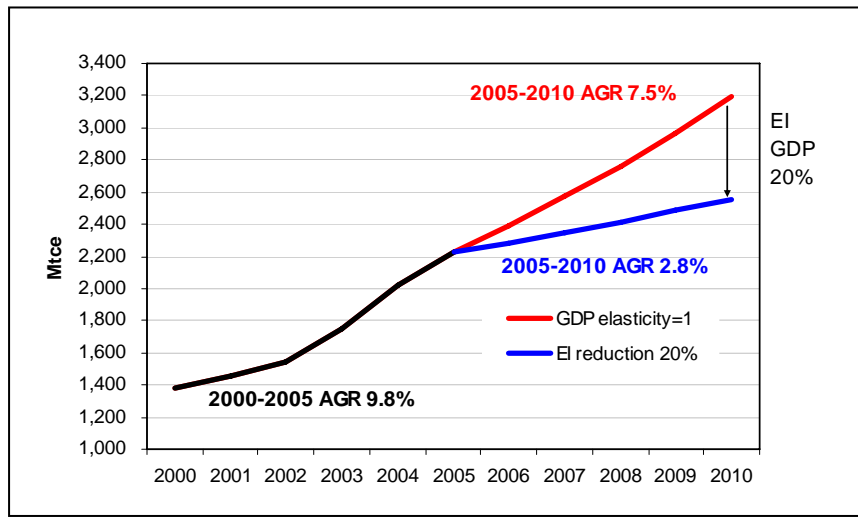
Between 1980 and 2000, China's energy efficiency policies resulted in a decoupling of the traditionally linked relationship between energy use and gross domestic product (GDP) growth, realizing a four-fold increase in GDP with only a doubling of energy use. However, during China's transition to a market-based economy in the 1990s, many of the country's energy efficiency programs were dismantled and between 2001 and 2005 China's energy use increased significantly, growing at about the same rate as GDP. Continuation of this one-to-one ratio of energy consumption to GDP – given China's stated goal of again quadrupling GDP between 2000 and 2020 – will lead to significant demand for energy, most of which is coal-based. The resulting local, national, and global environmental impacts could be substantial.

In 2005, realizing the significance of this situation, the Chinese government announced an ambitious goal of reducing energy consumption per unit of GDP by 20% between 2005 and 2010. One of the key initiatives for realizing this goal is the Top-1000 Energy-Consuming Enterprises program. The comprehensive energy consumption of these 1000 enterprises accounted for 33% of national and 47% of industrial energy usage in 2004. Under the Top-1000 program, 2010 energy consumption targets were announced for each enterprise. Activities to be undertaken include benchmarking, energy audits, development of energy saving action plans, information and training workshops, and annual reporting of energy consumption. This paper will describe the program in detail, including the types of enterprises included and the program activities, and will provide an analysis of the progress and lessons learned to date.

Introduction

China's 11th Five Year Plan, announced in 2005, established an ambitious goal of reducing energy intensity, defined as energy consumption per unit of GDP, by 20% between 2005 and 2010 or an average of 4% per year. Even though China's GDP increased at an average annual growth rate (AGR) of 9.8% from 2000 to 2005, the current goal assumes an average GDP growth rate of 7.5% from 2005 to 2010, which implies that energy use will only increase at an AGR of 2.8%. However, both GDP and energy use have been growing much faster recently. In 2005, total energy consumption reached 2,225 million tons of coal equivalent (Mtce), equivalent to 62 quadrillion British thermal units (Quads) or 65 exajoules (EJ) (NBS, 2006), a 9.5% increase from 2004, while the GDP growth rate was 9.9%. If China's energy/GDP elasticity is 1 and GDP grows 7.5% per year, total energy consumption in 2010 will reach 3,192 Mtce (89 Quads, 93 EJ). Achievement of the 2010 20% energy intensity target will require a reduction in energy use to 2,552 Mtce (71 Quads, 75 EJ), or a savings of 640 Mtce (18 Quads, 19 EJ). Figure 1 illustrates energy consumption in 2010 given a GDP AGR of 7.5% and an energy/GDP elasticity of 1 based on recent trends as well as the energy consumption required to meet the 20% savings target if GDP grows an average of 7.5% (Lin et al., 2007).

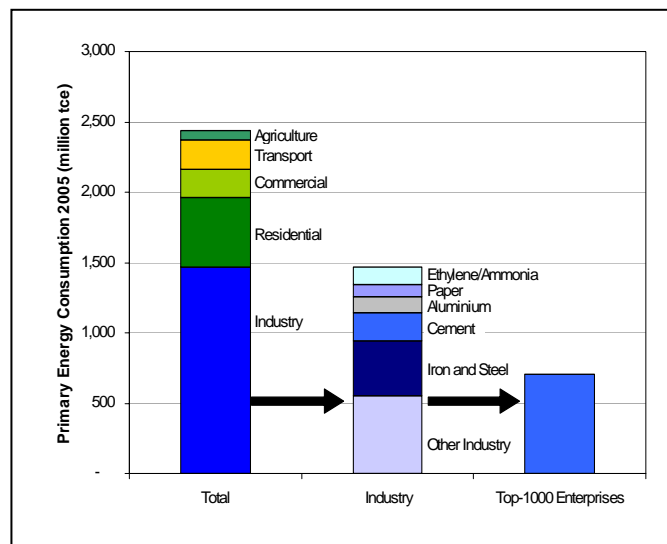
Figure 1. Recent and Projected Trends in Energy Consumption in China, 2000-2010



Lin et al., 2007

One of the key initiatives for realizing China’s 20% energy intensity reduction goal is the Top-1000 Energy-Consuming Enterprises program which has set energy-saving targets for China’s 1000 highest energy-consuming enterprises. Figure 2 shows China’s total primary energy consumption in 2005, along with the energy consumption of the industrial sector broken into large sub-sectors. In 2005, the industrial sector primary energy consumption was 1,416 Mtce (39 Quads, 41 EJ), or 64% of China’s total primary energy consumption (Lin et al., 2007). The comprehensive energy consumption of China’s 1000 most energy-intensive enterprises amounted to 673 Mtce (18.7 Quads, 19.7 EJ) in 2004, accounting for 33% of national energy consumption, and 47% of industrial energy usage (Wang, 2006a). The goal of the Top-1000 Energy-Consuming Enterprises program is to realize savings of 100 Mtce (2.8 Quads, 2.9 EJ) from the expected 2010 energy consumption of these 1000 enterprises.

Figure 2. Primary Energy Consumption of China, China’s Industrial Sector, and the Top-1000 Energy-Consuming Enterprises



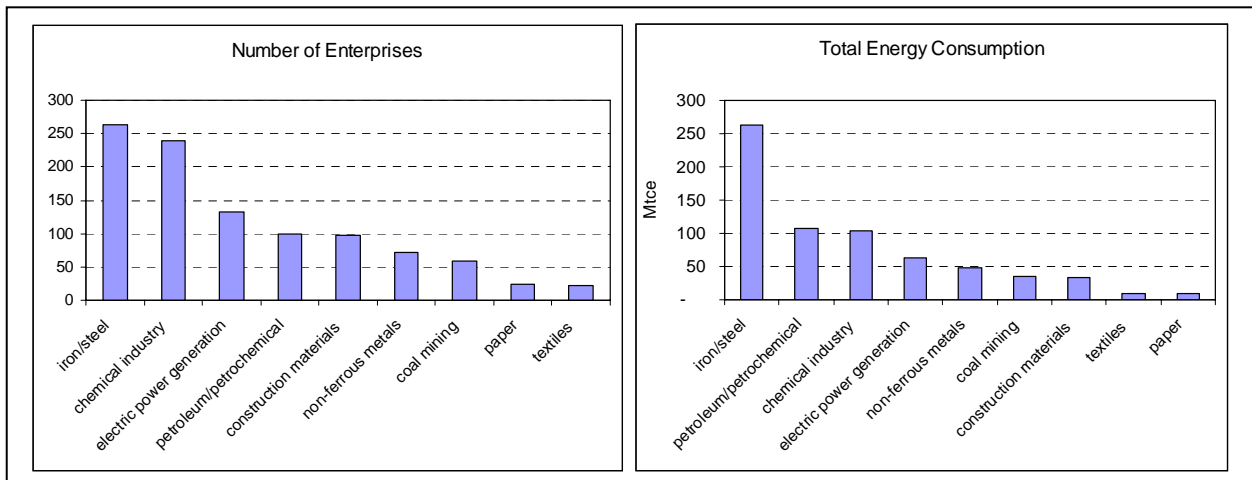
Source: Jiang et al., 2007, note: 1 tce = 29.7 GJ = 27.8 MBtu

Characterization of the Top-1000 Industries

The industries included in the Top-1000 Energy-Consuming Enterprise program are large-scale, financially independent enterprises in nine major energy consuming industries: iron and steel, petroleum and petrochemicals, chemicals, electric power generation, non-ferrous metals, coal mining, construction materials, textiles, and pulp and paper. Figure 3 provides information on the number of enterprises and the energy consumption by sector. The iron and steel and chemical industries dominate in terms of number of enterprises; the iron and steel enterprises also dominate in terms of energy consumption.

In 2004, these enterprises consumed an average of 0.67 Mtce of comprehensive energy each, equivalent to 18.5 trillion Btu (TBtu) or 19.6 petajoules (PJ). Average energy consumption per enterprise ranged from a low of 0.35 Mtce (9.8 TBtu, 10.3 PJ) for the enterprises in the building materials sector to a high of 1.07 Mtce (29.8 TBtu, 31.4 PJ) for the enterprises in the petroleum and petrochemicals sector. The energy consumption of the enterprises in the iron and steel sector was also high, averaging 1.0 Mtce (27.8 TBtu, 29.3 PJ); all of the remaining enterprises averaged 0.67 Mtce (18.5 TBtu, 19.6 PJ) or lower.

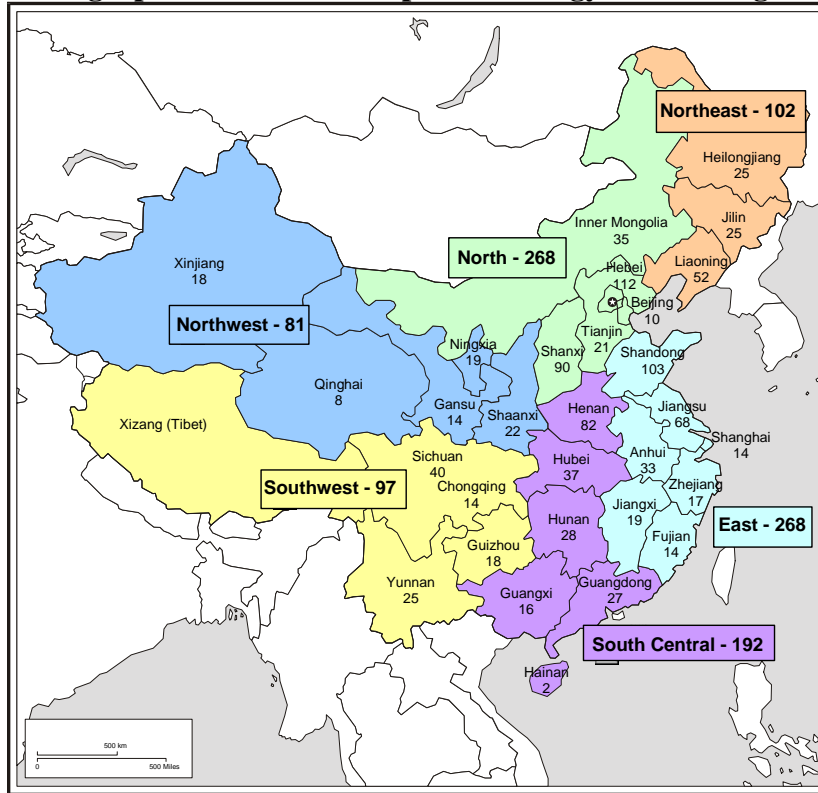
Figure 3. Number of Enterprises and Total Energy Consumption by Sector of the Top-1000 Energy-Consuming Enterprises



Note: 1 tce = 29.7 GJ = 27.8 MBtu

Figure 4 shows that the Top-1000 program enterprises are spread throughout China, with the largest number of enterprises in the coastal area of the East Region (268 enterprises) where Shanghai as well as a number of more developed provinces are located and the North Region (268 enterprises), followed by the South Central Region (192 enterprises) where Guangdong and the Pearl River Delta industrial area are located. The Northeast, Southwest, and Northwest Regions have 102, 97, and 81 enterprises, respectively.

Figure 4. Geographic Location of Top-1000 Energy-Consuming Enterprises



Description of the Top-1000 Energy-Consuming Enterprise Program

Background

China's Top-1000 Energy-Consuming Enterprise Program is modeled on international target-setting programs (also called voluntary or negotiated agreement programs). These types of target-setting programs that focus on energy efficiency improvement and reduction of energy-related GHG emissions by industry have been implemented in industrialized countries since the 1990s. A number of these national-level programs are now being modified and strengthened, while additional countries, including some recently industrialized and developing countries, are adopting these type of agreements in an effort to increase the energy efficiency of their industrial sectors (Price, 2005).

These programs are “essentially a contract between the government and industry, or negotiated targets with commitments and time schedules on the part of all participating parties” (IEA, 1997). These programs typically have a long-term outlook, covering a period of five to ten years, so that strategic energy-efficiency investments can be planned and implemented. A key element is that they focus the attention of all actors on energy efficiency or emission reduction goals.

The essential elements of such programs include the assessment of the energy-efficiency potential of the industrial facility as well as target-setting through a negotiated process. Participation by industries is motivated through the use of both incentives and disincentives. Supporting programs and policies, such as facility audits, assessments, benchmarking, monitoring, information dissemination, and financial incentives all play an important role in

assisting the participants in understanding and managing their energy use and GHG emissions in order to meet the target goals. Some of the more successful voluntary agreement programs are based on the use of a mechanism to reduce environmental regulations or taxes for participants (Price, 2005).

Shandong Province undertook a target-setting energy efficiency agreement pilot project with two iron and steel enterprises in 2003 which was modeled after successful international industrial voluntary agreement programs, taking China-specific conditions into consideration (Price et al., 2003). 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), the Shandong Economic and Trade Commission (ETC), the State Economic and Trade Commission (SETC), and the China Energy Conservation Association (CECA).¹ The agreements had a base year of 2002 and set performance targets for 2005 (Price et al., 2003). 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 company, 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.

Target-Setting for the Top-1000 Energy-Consuming Enterprises

The major targets of the Top-1000 Energy-Consuming Enterprise program are to significantly improve the top-1000 enterprises' energy efficiency; reduce unit energy consumption to domestic best practice level for all major products; have some enterprises attain either international best practice levels or sector best practice levels; improve the energy efficiency of each sector; and achieve energy savings of approximately 100 million tons of coal equivalent in the 11th Five-Year period. This program target has been broken down to the provincial level. All participating enterprises have signed energy conservation agreements with local governments and have promised to reach the energy savings target in the next five years. For example, China's National Development and Reform Commission (NDRC) signed an agreement with the Beijing Municipal Government covering ten enterprises within Beijing's jurisdiction. The Beijing Municipal Government, in turn, signed energy-efficiency target contracts that include energy saving amounts with each of the ten enterprises.

Achievement of the energy-saving targets has been added to the provincial government evaluation system wherein the responsible individuals will be evaluated each year on whether or not the targets under their jurisdiction have been achieved. Use of the evaluation system in this manner provides strong incentive to government officials to assist the enterprises in achieving the energy-saving targets.

Expectations of the Top-1000 Energy-Consuming Enterprises

According to the action plan of the program, the Top-1000 enterprises are expected to establish an energy conservation organization, formulate energy efficiency goals, establish an energy utilization reporting system, conduct energy audits, conduct training, formulate an energy conservation plan, adopt energy conservation incentives, and invest in energy efficiency improvement options. The enterprises are required to report their energy consumption by fuel

¹ The SETC was disbanded and many of its functions, including oversight of the Shandong Province Voluntary Agreement pilot, were transferred to the new National Development and Reform Commission (NDRC).

quarterly to the National Bureau of Statistics (NBS). The Top-1000 reporting is directly to NBS online via a website, not through regional statistical bureaus. The data collection is done in this manner to improve accuracy and reliability, to make it easier for the enterprises, and to reduce work for regional statistical bureau staff members. NBS will release information on average or total energy use or energy use by industry, but not by specific enterprise. Enterprise-specific data will, however, be provided to NDRC. Every July NBS will release energy use statistics for previous year and in August they will release energy use statistics for 1st half of the current year.

Role of the Government

A number of government departments and entities are involved in the Top-1000 program, including the Department of Resource Conservation and Environmental Protection of NDRC (which promotes energy saving in China), the National Bureau of Statistics (which collects and manages statistical information of enterprises in China), the State-owned Assets Supervision and Administration Commission (which manages major state-owned enterprises in China), the Office of National Energy Leading Group, and the General Administration of Quality Supervision, Inspection and Quarantine.

In October, 2006 NDRC conducted a series of training sessions in five cities across China for the Top-1000 enterprises. The sessions covered the topics of energy and energy conservation measurement, energy statistics, enterprise energy auditing, an example of energy audits in a power plant, the ten major energy conservation projects in the 11th Five Year Plan, major energy saving technologies in nine energy-consuming industries, guidelines for energy conservation plans for enterprises, application of benchmarking in large scale power plants, an introduction to the Kyoto Protocol Clean Development Mechanism, and energy performance contracting and the Energy Conservation Service Industry Committee of China Energy Conservation Association (NDRC, 2006).

The government is in the process of further developing the Top-1000 program. The State Council Decision on Strengthening Energy Conservation Work, issued in 2006, outlines a number of policies that are being developed in support of the 20% target (State Council, 2006). While these policies are not explicitly for the Top-1000 program, many of them will provide support to the Top-1000 enterprises. Such policies include:

- *Strengthen energy conservation management in major energy consuming enterprises*

Major energy-consuming enterprises should establish a strict management system and an effective incentive mechanism in energy conservation; further encourage the enthusiasm of the large number of employees in energy conservation. Strengthen the foundation work, deploy full-time staff to implement energy conservation goals and responsibilities to the workshop, teams and individuals; and strengthen supervision and inspection work. Departments and local governments at all levels should strengthen the tracking, guidance and supervision of energy consumption status in major energy-consuming enterprises; regularly publish energy use in major enterprises. Among them, NDRC should sign letters of responsibility for energy conservation goals, with provincial governments and the state-owned enterprises, and strengthen energy-saving responsibility and assessment.

- *Intensify government support to energy conservation*

Governments at all levels should support efforts to promoting energy-saving technologies and products, pilot and demonstration projects, dissemination and training, information services, and rewarding. All necessary expenses in energy conservation should be included in

government budgets. During the 11th Five-Year Plan period, the state will set aside a certain amount of funds for the support of major energy-saving projects, demonstration projects and the promotion of efficient and energy-saving products.

▪ *Implement fiscal policies and tax incentive for energy conservation*

NDRC should in conjunction with relevant departments to expedite the formulation of the "energy saving product inventory". The Ministry of Finance, Taxation Administration should expedite the study and propose specific tax incentive policies for products included in the "energy saving product inventory" and submit it to the State Council for approval; tighten implementation of the policy and measures that restrict export of high energy-consuming, high pollutant and resource products; research and establish energy-saving promotion measures such as fuel taxes, and tax policy that would restrict trade of high energy-consuming processing, and curb irrational energy consumption; expedite research and implement taxation reform plans on different types of energy and mineral resources in a timely manner; according to market changes and resources condition, properly increase the levy standard on resource related taxes.

▪ *Explore energy conservation financing channel*

Various financial institutions should increase credit support for energy conservation projects, promote and lead all sectors of society to strengthen investment on energy conservation. Enterprises should be encouraged to direct financing through the market, and accelerate their technological transformation in energy conservation.

▪ *Implement energy conservation reward system*

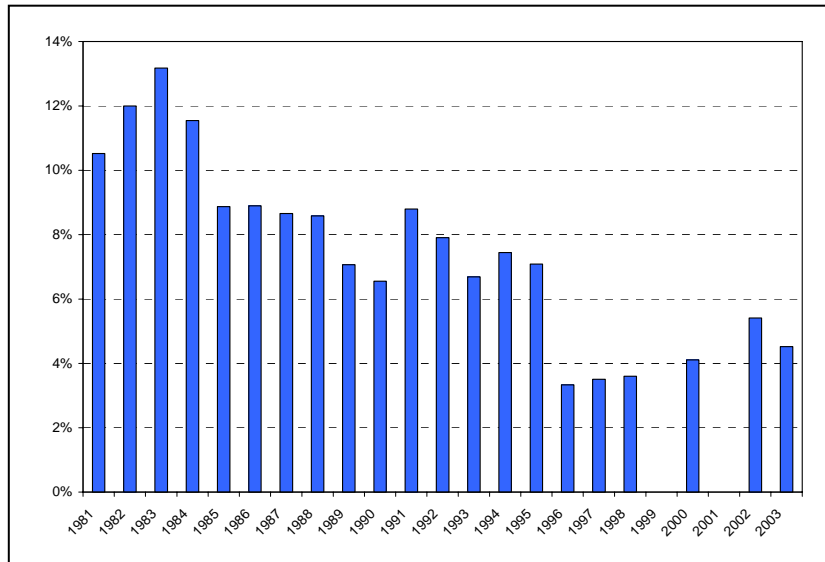
Each region and department should commend and reward units and individuals who have made remarkable achievements in research and dissemination of energy conservation technology, and in energy conservation management. Energy producing units and energy consuming units should formulate scientific and rational rewarding measures, reward and commend groups and individuals that contributed to energy conservation work, include the rewards in total wage checks, according to the unit's situation.

At the Energy Foundation's *Forum on Implementing China's 2010 20-Percent Energy Efficiency Target* in November 2006, a number of near-term policy recommendations were made including that government should cover the cost of energy audits, planning, and other expenditures related to achievement of the Top-1000 program targets; government should give priority to technical renovation expenditures of the Top-1000 enterprises, discount government loans should be made available for the energy-savings projects of the Top-1000 enterprises, government should increase expenditures on energy-saving research, development, and dissemination, and government should increase the budget for energy conservation (Wang, 2006b). The following policies were also recommended: award a portion of enterprises within the Top-1000 program based on annual evaluation results and benchmarking; establish "special expenditure for energy conservation" and arrange establishment of a special fund; integrate investment within the general budget and national bond investment; provide fiscal subsidies; create a special energy conservation fund; establish an enterprise income tax credit for investment, accelerating depreciation, deduction for R&D expenditures; revise tariff policy; establish a consumption tax; and establish an energy tax (Wang, 2006b).

Recommendations for increased government spending on energy efficiency are based on the low level of such spending in China during the late 1990s and early 2000s, which may have led to an increase in energy use per unit of GDP after 2002 following a long period of decline in

energy intensity since the 1980s. Figure 5 shows the decline in government investment in energy conservation as a percentage of government investment in energy supply from a high of about 13% in 1983 to levels closer to 4% and 5% in recent years. If government energy efficiency investment is to increase to the 10% to 15% levels seen earlier, then spending on the order of 40 to 60 billion RMB per year is required. A calculation of the investment required to reduce the growth rate of energy to half of the projected growth rate of the economy over the next 15 to 20 years estimated that investments of 150 to 200 billion RMB are needed (Lin, 2005, Levine, 2005).

Figure 5. Share of Energy Investment in Energy Efficiency in China, 1981-2003



Source: Lin, 2005.

Activities to Date

The Top-1000 Energy-Consuming Enterprise Program was announced in April, 2006 with the issuance of the *1,000 Enterprise Energy Conservation Action Implementation Plan* that outlined the program. Over the summer of 2006, targets were set for each enterprise by NDRC in order to reach the overall savings target of 100 Mtce (2.8 Quads, 2.9 EJ). As described above, NDRC held training workshops in October 2006 to inform the enterprises of various aspects of the program. Since then, enterprises have been asked to perform energy audits and to develop energy action plans outlining how they are going to meet their energy-saving targets. The enterprises have found this task difficult due to the lack of qualified auditing personnel and institutions.

NDRC is currently selecting enterprise energy conservation projects for funding. Projects of the selected enterprises will receive energy conservation financial support from the national bond. Many enterprises are preparing proposals for this funding; those enterprises involved in the Top-1000 program will be given priority.

Results

In 2006, the energy consumption per unit of GDP declined 1.23% compared with 2005. According to preliminary estimates by the NBS, China's energy consumption of 2,460 Mtce (68 Quads, 72 EJ) was 9.3% higher than 2005, including a 9.6% increase in coal, 7.1% increase in crude oil, and 19.9% increase in natural gas (China Daily, 2007). Although the annual target of 4% reduction in energy intensity was not reached, this is the first drop in this metric since it began to increase in 2002. Since the Top-1000 program and other efforts to reduce energy intensity 20% were just launched in early- to mid-2006, it is expected that their impact will continue to increase over time in pursuit of the 4% per year energy intensity reduction goal. In fact, NDRC recently reported that the steel industry – which is the sector with the largest number of enterprises and highest total energy consumption in the Top-1000 program – experienced a decrease in overall energy consumption of 8.8% between 2005 and 2006 and unit energy consumption for producing one ton of steel declined 7.1% (Gao, 2007).

Discussion and Recommendations

The initial activities undertaken through the Top-1000 program are important first steps because they focus enterprise attention on energy efficiency. It is crucial that additional Top-1000 program activities to promote energy savings are effectively designed and executed to ensure that the energy savings targets are realized. There is much experience with energy-saving target-setting policies and programs around the world that can be adapted to the Top-1000 program. There is also experience from the Energy Foundation-sponsored energy efficiency agreement pilot program in Shandong Province.

Based on a recent assessment of the status and plans related to the Top-1000 program, the following recommendations are offered:

- Establish a package of *effective supporting policies* designed explicitly for the Top-1000 program as soon as possible in order to provide enterprises with appropriate incentives and support for achieving their targets
- Direct *energy efficiency investment incentives* – such as subsidies, grants, loans, and tax relief – towards expensive yet high energy-saving investments that may be otherwise disregarded by enterprises due to the high initial investment costs
- Develop *supporting policies at the provincial level* that can supplement national-level supporting policies by offering increased or supplemental incentives, further technical support, and additional publicity
- Produce a *Shandong Province case study* describing the policies and energy management systems implemented in the Energy Efficiency Agreement Pilot Project in order to understand and disseminate lessons learned
- Assess the possible application of *energy taxes or other fiscal mechanisms* within the Top-1000 program
- Evaluate establishment of a *system of awards* for enterprises that meet their targets – and possibly a system of penalties for those that fail to meet their targets – in terms of how the award funding would be generated and whether such awards could be offered at a level that would provide motivation to enterprises

- Have sector associations or other sector-specific experts develop *energy efficiency information sources* for identifying energy-savings technologies and measures for the Top-1000 enterprise sectors
- Develop *benchmarking tools* in conjunction with sector associations or other sector-specific experts to assist with evaluation of each enterprise's energy efficiency potential, to provide a simplified energy auditing tool, and to assist in development of each enterprise's energy action plan
- Develop detailed *energy management guidance documentation* based on international best practice, including a framework to standardize, measure and recognize industrial system optimization efforts
- Review a sample of the *enterprise audit reports* to determine whether they are comprehensive and high-quality and to identify areas where further training related to specific elements of energy auditing could improve audit quality
- Establish a *database or directory of energy auditing entities*, identifying their areas of expertise
- Review a sample of the *enterprise energy action plans* to determine whether they are comprehensive and high-quality and to identify areas where further training related to specific elements of development and use of energy action plans could improve their quality
- Develop *enterprise-level monitoring and reporting guidelines* that include not only reporting on annual energy use, but also information on annual production levels, enterprise organizational changes, and on progress on the specific energy-saving activities outlined in the enterprise action plan be developed.
- Explore the potential for development of an *energy and greenhouse gas management tool* based on the World Resources Institute/World Business Council for Sustainable Development's Greenhouse Gas Protocol and testing of the use of this protocol in specific Top-1000 industrial sectors
- Ensure that an *evaluation system* is in place that is capable of providing feedback on program and policy design so that the Top-1000 program can be adjusted during the 2005 to 2010 period if such adjustments are indicated by the evaluation and so that the evaluation results from the Top-1000 program can be effectively used to design any similar post-2010 programs
- Engage key sector-focused 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, working with provincial-level energy conservation centers and technical universities to build their sector-specific capabilities
- Establish the *National Energy Conservation Center* and/or another national-level energy information dissemination and training center as soon as possible to play a coordination role for many elements of the Top-1000 program
- Conduct a limited number of *study tours* to countries in Europe and other countries with strong target-setting programs for enterprise representatives from enterprises that are playing a leading role within the Top-1000 program
- Evaluate the possibility of holding an *industrial energy efficiency conference* similar to ACEEE's Summer Study on Energy Efficiency in Industry in China in order to

- expose more Chinese to the latest developments in industrial sector research on energy-efficient technologies, measures, policies, and programs
- Establish a *Chinese/English language website* that provides information on international experience with supporting policies, program elements, program development and design, and program delivery for target-setting programs to compliment and link to NDRC's Top-1000 Program website
 - Coordinate with *international programs that can contribute to key Top-1000 program elements* such as the United Nations Development Program/Global Environmental Facility End-Use Energy Efficiency Program, the EU-China Energy and Environment Programme for Promotion of Benchmarking Tools for Energy Conservation in Energy Intensive Industries, U.S. Department of Energy Industrial Technologies Program, the Jiangsu Demand-Side Management, and the U.S. Environmental Protection Agency/State Environmental Protection Administration/Asian Development Bank Private Sector Financing Project in order to ensure that advantage is taken of overlapping activities and that collaborative efforts are undertaken whenever possible
 - Coordinate with *international programs that have a Chinese industrial energy efficiency component* such as the Asia Pacific Partnership for Clean Development and Climate, the Clean Development Mechanism of the Kyoto Protocol, and the International Energy Agency – World Bank Energy Efficiency Indicators Project in order to ensure that advantage is taken of overlapping activities with the Top-1000 program and that collaborative efforts are undertaken whenever possible

These recommendations are based on lessons learned from international best practice experience in similar programs around the world, considering the current status of the Top-1000 program as well as other activities related to industrial energy efficiency in China. Development of a robust program is essential for assisting the Top-1000 enterprises in reaching – and perhaps surpassing – the ambitious goals of the Top-1000 program and China's 20% energy intensity reduction target.

Acknowledgments

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