

Efficiency Improvement and Energy Conservation in China's Power Industry

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Energy efficiency improvement in the power sector has been a key area for China to take actions. In the power sector, unit coal consumption, self consumption, and transmission are performance indicators. In the context of resource, technology, economic development pattern and power industry development, Chinese power industry has made impressive progress and in the mean time is faced with a series of challenges and further opportunities in improving energy efficiency and conservation.

1. Status quo of Chinese Power Industry

(1) power generation in 2005

China's electricity output reached 2474.7 billion kwh in 2005. China generated 2018 billion kwh of coal-fired electricity last year, accounting for 81.5%; 395.2 billion kwh of hydro power, around 16.0%; 52.3 billion kwh of nuclear power, about 2.1%; and 9.2 billion kwh of the other sources such as wind, landfill methane and biomass, about 0.4%.

(2) Total stalled capacity in 2005

By the end of 2005, China accumulated a total installed capacity of 508.41GW, of which, coal-fired capacity is about 384.13GW, 75.6 %; hydropower 116.52GW, 22.9%; nuclear 6.85GW, 1.3%; and others 0.91GW, about 0.2%.

(3) Major performance indicators in 2005

In 2005, per kWh electricity on average in the coal fired plants consumed 374.00 gce. The larger the generation unit, the smaller amount of coal consumption for unit of electricity output is. For unit generating capacity at 300MW, coal consumption rate is at 341.88 g/kwh; for those units with 600MW, the number is 326.34g/kwh. For supercritical units, the rate is at 320.58 g/kwh, comparable to, or even higher than OECD levels.

With respect to internal use of electricity by the power industry, the average number is 5.82%. For 300 MW units, the self consumption rate is 4.75%; for 600 MW units, the number is slightly lower, being 4.66%.

In terms of power transmission losses, the average figure is pretty low, being 7.18% for national power grids.

(4) Major pollutants in power industry in 2004

In the coal-fired power sector, conventional pollutants are the major concerns, accounting for 50% of the national totals. In particular, SO₂ emissions were on the increase instead of reductions as required by the government. Table 1 provides an overview of the pollutants in total and in unit electricity terms.

Table 1 total and per unit of electricity emissions of pollutants

	Total(million tons)	Unit emission rate(g/kwh)
SO ₂	12.0	6.63
NO _x	6.5	3.59

Soot emissions	2.75	1.52
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2 Future development of Chinese power industry

In the next 5 to 15 year, demand and production of electricity are projected to increase fast (table 2). As compared to 2006 level, the generating capacity from hydropower will be nearly doubled. Renewables and nuclear will experience fastest expansion though their share in total is somewhat negligible. Coal power will also increase by some 50% in capacity but in absolute terms coal stands the biggest increase.

Table 2 Projected demand and supply of electricity, 2010 and 1020

		2006	2010	2020
Total electricity demand trillion kWh		2.74	3.60	5.10
Installed capacity GW	total	570	770	970
	Coal-fired electricity	430	557	650
	Hydro power	130	172	250
	Nuclear power	8	12	40
	Renewable	2	10	30

Performance in the Chinese power sector will improve steadily (table 3). Per unit electricity generation is projected to consume 54 grams less than the number in 2005, being 320 g/kWh, close to the OECD level now. Reduction of internal consumption will be only 0.72 percentage points, but this can be significant considering the scale of power generation and operation of desulphurization. As the location of power generation and load areas do not match well, electricity is often transmitted thousand kilometers for consumption. Even a small percentage reduction in power transmission loss can save considerable amount of energy.

Table 3 Major indices for Chinese power industry in 2010 and 2020

	Coal Consumption per unit of electr. (g/kWh)	Internal use of electr. Over total generation %	Power transmission losses %
2005	374.00	5.82	7.18
2010	360.00	5.50	6.65
2020	320.00	5.10	6.20

Source: Medium and long term energy plan, 2005—2020, 11th five year plans, NDRC related documents

3. Problems in Chinese Power Industry on Efficiency Enhancement and Energy Conservation

(1) High dominance by coal-fired power

The percent of thermal electricity over the total installed capacity exceeds 75%, and the

coal-fired electricity output is over 80%. As is well-known, high rate of dominance by coal-fired electricity is not in favor of power system in terms of cost-effectiveness. Due to fluctuation of electricity load, coal burning has to be adjusted accordingly in order to adapt to changes in the load. Compared with hydro power and gas power, coal-fired power is less flexible and cost-effective in the face of the changing load.

(2) high proportion of low efficiency units

There are 6911 power generation units with the capacity larger than 6.00 GW, totaling 393GW, averaging 56.9 MW per unit. There are only 333 units with capacity larger than 300 GW, accounting for less than 40% of the total installed capacity. As a result of large numbers of small coal-fired units, China's average coal consumption is 50g/kwh more than the advanced world standard. Currently 100 million tce per year are wasted in power generation in China, based on the advanced world standard.

(3) high rate of power transmission and distribution losses

The loss in electricity transmission and distribution accounts for 7% among the total generation, as compared to 2%—2.5% in most developed countries. Generally speaking, 45.0billion kwh is wasted each year due to the loss in electricity transmission and distribution.

(4) Backward energy conservation technologies

China is in general some 20 years behind the developed nations in the use of electricity saving, with respect to both products and technology. The conventional technology and measure is relatively backward, which can not meet the demand for the electricity conservation driven by the updating technology and advanced equipment in electricity system.

(5) Inferior demand side management

Total electricity consumption for lighting takes up 13% of total consumption in China. Although green lighting products have been introduced, the market is full of the conventional inefficient products and a variety of inferior, faked and counterfeit goods. Compared with the incandescent lamp, green lighting products can save electricity by 80%. Currently 3 billion incandescent lamp are in use in China. If 1.2 billion can be replaced by the energy-saving lamp, the electricity saving will be as much as the total generation of another Three Gorges Power Plant. If the widely used refrigerators and air-conditioners are totally replaced by energy-saving products, 4.65billion kWh electricity will be saved, about 1.55 tce.

(6) Low corporate performance with respect to profit making

According to the report released by NDRC, there are 1280 loss making enterprises in the power sector in 2005, with a total deficit of 12.7 billion RMB. Owing to increase in price of coal, the performance of many coal-fired power plants is getting worse. Given the fact that an enterprise is loss-making, it is normally difficult *for enterprises to attach importance to the efforts on efficiency improvement and energy conservation.*

(7) ineffective market mechanisms

In spite of enterprise reform and market liberalization, healthy and orderly market mechanisms for the power industry have not been established for competitive market operations. Many power plants have not been separated entirely from the power grids. Limited competition is unable to reward the efficient performers and drive out the inefficient ones. Price mechanism does not have effective linkage from coal-generation-transmission-consumers. Current institutional settings cannot guarantee optimal allocation of electricity generation resources. Those factors are obstacles for the power industry's further development, falling into the pattern of "high input, high waste, and heavy pollution, while low output and low efficiency".

4. Suggestions in promoting sustained and sound development of the power industry

It is stipulated that the binding target should be well treated to lower the energy consumption per unit of GDP by 20% during "the 11th Five Year " period. So the task for this year is to reduce the energy consumption per unit of GDP by 4%. Unfortunately, during the first half of 2006, the energy consumption per unit of GDP increased by 0.8% nationally. And in the power industry, the energy consumption per unit of value added increased by 0.8%.

(1) Phase out backward generating capacities with low efficiency

It is necessary to take compulsive measures to eliminate those conventional condensing and coal-fired units under 100 MW and those conventional small coal- and oil-fired units under 50 MW capacity. If the conventional small coal-fired units can be wiped out and replaced by the high-efficiency supercritical units of 600 MW and above in the future 15 years, energy conservation will be up to 100 million tce in China each year.

(2) Change in resource use pattern

It is highly advisable for China to improve energy efficiency and to optimize energy structure by constructing supercritical and ultra-supercritical units of 600 MW and 1.0GW unit capacity level. 300 GW of newly added coal-fired installed capacity use the supercritical technology till 2020, compared with 2005, 155 million tons raw coal can be saved each year, assuming average generation time at 5000 hours per year.

(3) Equipment upgrading and technology innovation

Currently, 16 million tons oil is consumed each year in China's power industry, 60% for unit's start-stop, and 40% for low load flame stability. With the wide-spread of new technologies substituting oil, oil consumption will be reduced substantially. Self consumption in power plants will be decreased significantly if the low-efficiency equipments such as cooling fans, water pump, and large-scale electricity engines can be upgraded with new technologies. "Energy Conservation in 1008 enterprises more than 180,000 tce" has been developed in nine sectors, including electricity, by the national government.

(4) Development of hydro power

The construction cycle of small hydro power is relatively short and the financial cost is low. The cost-effectiveness of the small hydro power originates from its independence on high voltage substation and power lines by distributing power supply in nearby area, and its low loss imposed by resettlement compensation. Large amount of hydro resource is widely distributed in China, about 550 GW. Total exploitable capacity 400 GW, the largest in the world. Total capacity of existing hydro power is at 120 GW so far, about 25% of the total capacity. According to some studies, the right level for hydro power development in China can be 60% of the total installable capacity, about 350 GW. In terms of hydro power development, the world average currently amounts to 38%, and the developed countries at 70%.

(5) Renewable energy development

Renewable energy development in China is behind not only the developed countries but also some developing countries such as India. Renewable energy accounts for 5.5% in the total electricity generation in India. In 2004, wind power in India reached total installation capacity of 3 GW, 3 times more than that in China. Some studies indicate that the cost of coal-fired plants is 50% lower than that of wind power in China, but if external cost is considered, total cost of the former will be 50% higher than that of the latter. It is necessary for the policy design on RE to break through the obstacles of the conventional thinking. RE enhancement will be achieved through taking effective actions at national level, mobilizing various social forces.

(6) market-oriented policy reform

The determinants of electricity structure come from national energy strategy and the policy measures. In a market economy, financial and tax policies are the significant instruments for the government management and regulation on energy structure. Unfortunately, there are many irrational policies on energy development. For example, the existing VAT (value added tax) to some extent restricts the hydro power construction. **Total investment** is the lump-sum cost during the hydro power construction, therefore, total investment should be deducted regularly according to the life expectancy of hydro dam, instead of imposing the VAT directly based on the revenue from electricity sale each year. The latter actually increases the burden of hydro power. Take wind power for another example, the existing VAT imposed on wind power is too high, which should be reduced at least equal to the coal-fired power. Moreover, import of RE equipments from foreign countries with domestic capital should enjoy tariff exemption and VAT exemption on import.

(7) further enhancement of the power market mechanism

It is necessary to establish the following six mechanisms: (1) online electricity price formation mechanism suited to the competitive price in power generation; (2) linkage mechanism between the electricity and the coal, and between the online electricity price and the sale electricity price; (3) reasonable compensation mechanism for electricity price considering the cost of environmental protection and desulfurization; (4) price-incentive mechanism encouraging the development of renewable energy, such as wind and solar

energy; (5) transmission and distribution price mechanism promoting the healthy development of electricity grid; (6) electricity price for sale mechanism reflecting the scarcity of resources, and the reality of supply and demand.

National Development Reform Commission (NDRC) has established the adjustment programme on the electricity price. Since June 30, 2006, the national average sale price of electricity has been increased by 0.025 RMB/ kWh, in order to address the increase of coal price, the heavy cost of renewable energy, the desulfurization of power plant, and the financing shortage of power grid construction.

First, Encourage enterprises to install desulfurization facilities. The electricity price reform clarified that 0.015 RMB/ kWh will be increased for the purpose of promoting desulfurization of the power plant.

Second, Based on "Renewable Energy Law," the additional 0.001 RMB/ kWh can attribute to the fact that the generation price of renewable energy is higher than that of the conventional energy. Because the additional cost should be shared in order to enhance the utilization of renewable energy in the nationwide.

Third, The differential policy on electricity price will be implemented to constrain the non-rational development of the high energy-consumption industry and to facilitate the structural optimization and industrial upgrading. Enterprises in six high-energy-consumption industries are categorized as three types including elimination, constraint, and permit & encourage. 0.02 RMB/ kWh and 0.05 RMB/ kWh are respectively charged on the type of elimination and constraint.

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