

“Transformation of China’s Energy Structure from Dependence on Coal During the 12th Five-Year Plan Period”

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Abstract. China started the new Five-Year Plan (FYP) period, setting the target that coal, which accounts to 70% of primary energy supply, will be substantially reduced, and hydro, natural gas, nuclear and renewable energy will be expanded. This article analyzes background and prospect of China’s effort in shifting away from coal. Main findings are: firstly, the economic efficiency of coal has changed as a result of market based reforms in coal sector; secondly, Chinese enterprises have succeeded in catch-up of wind power technology, which resulted in sharp cost reduction. In conclusion, fuel switch from coal will be come to realization by competition among coal and other energies for their economic efficiency.

Keywords: China, energy structure, coal, natural gas, wind power, 12th Five-Year Plan

1. Introduction

China started the new FYP period in 2011, setting targets that coal consumption, which accounts to 70% of primary energy supply, will be substantially reduced, and hydro, natural gas, nuclear power and renewable energy consumption will be expanded. However, we should note that although in the late 1990s, China had tried to reduce the dependence on coal, but in fact, the ratio of coal had increased reversely since 2003. The objective of this article is to analyze the background of China’s effort in shifting away from coal and to consider whether this target can be come to realization or not.

2. China’s Economic Growth and Role of Coal

Fig. 1 shows energy consumption in China, from 1979 to 2010, China’s economy grew by 9.9% and energy consumption grew by 5.6% annually. Partly due to energy efficiency improvements, more importantly due to severe energy shortage, the growth rate of energy consumption was lower than that of the economic growth. Fig. 1 also shows change of ratio of coal in primary energy structure. In 2010, coal was still the main energy source, accounted to 70% in primary energy consumption. However, before the mid of 1970s, the ratio of coal was kept declining, it only started to increase when the economy started to grow rapidly in 1980s. The reason is that coal sector was exposed to the market forces much earlier than the other energies. Owing to deregulation, the number of township mines grew surprisingly, at its peak, there existed more than 80 thousand mines, and those coal mines were able to greatly increase the production, even though each mine was quite small, average annual production was only 8 thousand tons (Horii [2000]). Because township mines utilized cheap labor force at rural areas, and saved capital investment by use of poor facilities, their coal price was much cheaper than that of state-owned mines. To compete with township mines, the price of state-owned mines also remained at lower level, and to cover deficit, government delivered large amount of subsidies until mid-2000s. As a result, coal had been the cheapest energy and highly competitive with other energies.

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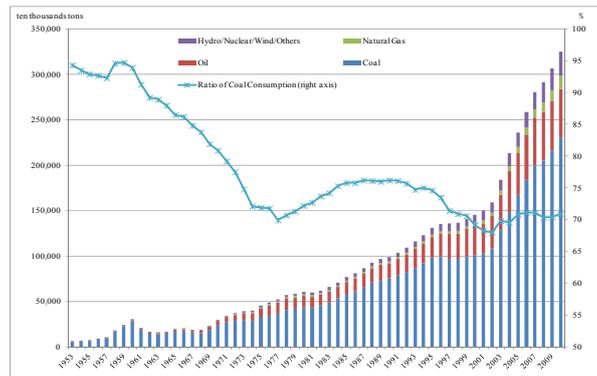


Fig. 1: Changes of energy consumption in China

Source: *China's Statistics Yearbook*, each year

In 1998, Chinese government initiated the policy campaign to shut down small coal mines, most of which were township mines, because those small mines had caused serious problems, such as resource degradation, environment damage and surprisingly many fatal accidents. Consequently in the late 1990s to 2002, the ratio of coal in primary energy consumption started to decline again. At that time, some scholars advocated China finally started to shift away from coal. However, since 2003, energy demand grew more rapidly due to economic boom, only coal could contribute to satisfy energy demand through recovery of township mines' production. In addition, coal price was still more competitive than any other energy.

3. Change of Economic Efficiency of Coal in Recent Years

However, in the 12th FYP, Chinese government has set up the targets to greatly reduce the ratio of coal. As shown in Fig. 2, the ratio of non-fossil fuel energy would be raised to 11.4% from 7.5% in 2010, and CO₂ emission intensity would be reduced by 17%. Fossil fuels, more specifically, coal would be greatly affected by these new targets. Based on the detailed information, the ratio of coal would be cut back by 7%, and the gap would be covered by natural gas (4%) and hydropower, nuclear power, wind power and PV, whose power generating capacity would increase to 6 times as large as the level of 2010.

This article would show that the 12th FYP target to shift away from coal is feasible, different from the situation in the late 1990s. What differs from before is great progress in the market based price reforms in the coal industry. The rise of coal price resulted in changes of the competitiveness of coal with other energies. Due to the price hike, the economic efficiency of coal was weakened.

Since 2003, China started market based reform in coal sector. Before, around 60% of coal, especially supplied for power plants, was traded in planned economy way, in which there was government's intervention to pricing and state-owned mines were forced to sell coal to power plants by cheaper price. As the gap between intervened price for power use and market oriented price for non-power use was getting wider, state coal mines started to escape from this trade system. Finally in 2006, when discounted rate of power use coal to non power use reached to 35.5%, state-owned mines refused this trading system and therefore most of coal came to be traded based upon market prices. As shown in Fig. 3, coal price, which was kept at low levels before 2003, started to increase rapidly. Coal price in 2008 was 2.5 times higher than that of 2000. The important outcome of coal price rise was improvement of business conditions for state-owned mines, which resulted in drastically increased investment. Therefore, without depending on township mines, coal production capacity has been expanding in these years.

In addition, production cost in 2008 also grew significantly as government imposed higher VAT rate on the coal industry, enhanced collection of raised resource tax, as well as strengthening regulation for coal production safety. In other words, the government stopped to maintain the low pricing policy by providing subsidies, promoted the market based reforms, and the external costs in relation to resources, environment and safety started to be internalized into coal price. Due to stricter regulation and raised surcharge, the share of township mines turned to decrease, which also influenced to keep coal price upward.

11th Five-Year Plan			12th Five-Year Plan		
Category	Target (based on 2005 level)	Actual	Target (based on 2010 level)	Category	Target
Reduction of energy use per unit of GDP	20%	19.1%	16%	Percentage of non-fossil fuel from primary energy consumption	11.4%
Reduction of water use per unit of value-added Industrial output	30%	31.3% ¹	30%	Reduction of carbon emission per unit of GDP (based on 2010 level)	17%
Reduction of chemical oxygen demand (COD)	10%	12.45%	8%	GDP from Strategic Emerging Industries (SEIs)	8%
Reduction of sulfur dioxide (SO ₂)	10%	14.29%	8%	Reduction of nitrogen from ammonia (based on 2010 level)	10%
				Reduction of nitrogen oxides (based on 2010 level)	10% ²
				Annual energy consumption	4 billion tons of coal equivalent

Fig. 2: Energy and environmental targets in the 11th and 12th FYP

Source: China Greentech Initiative [2011]

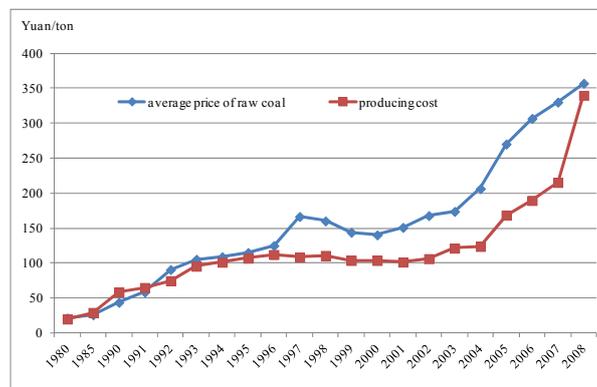


Fig. 3: Changes of average selling price of coal in China

Source: *China Coal Industry Statistics 1949-2004* and *China Coal Industry Yearbook 2007 and 2008*.

As a result of upward coal price, in some areas the cost of coal-fired power plants was higher than that of other plants. In 2010, in 22 of 32 regional electricity networks, the wholesale price of coal-fired plants was higher than 0.35 Yuan/kWh, the average price was 0.38 Yuan/kWh. In contrast, in many areas the wholesale price of hydro was lower than coal-fired plants, for instance, 0.16 Yuan in Guangxi Province, 0.25 Yuan in Three Gorges, and 0.30 Yuan in Guizhou Province (China Electricity Council [2011], pp. 99-100). In the last few years, 43% of the coal-fired power plants were suffering losses due to the price hike of coal, while hydropower plants have been profitable.

Natural gas is also getting more and more competitive. Before 2003, when coal was mostly traded under the similar system with planned economy period, natural gas price was much higher than coal. However, calculated in same heat value, natural gas price on May 2010 was 2.05 Yuan/m³, 61% lower than coal (Cui, [2011], p. 182). The reason is because, except for gas supplied for industries, all domestically produced natural gas is sold at government's authorized prices. For the benefits of the residential users, the price of town gas, which accounts to 34% of the total consumption, was kept at low levels. Under the price hike of coal over the last few years, although natural gas price was adjusted upwards several times, but natural gas price was still lower by 39% in the beginning of 2011.

It is likely that natural gas price would go up in future, as demand for natural gas would certainly be increased because of its price competitiveness. However, currently the demand for natural gas has been controlled to lower level through command and control measures. Except for town gas use, there were certain restrictions of natural gas use for power and industries. However, such anti-market based system might result in inefficient use of town gas because of cheap price and insufficient supply to the users with indeed needs. Thus, natural gas pricing would be the next agenda for reform, but probably Chinese government will promote adjustment of gas price gradually in consideration for acceptability of society.

4. Enhanced Competitiveness of the Wind Power

In the 12th Five-Year Plan, wind power is also positioned as a promising alternative energy replacing coal. Since 2006, wind power has been developing rapidly in China. By 2010 the installed capacity of wind turbines has reached 45GW, which accounted to 4.7% of the total installed generation capacity, and China has become number one in the world, exceeding United States. The growth rate was surprising, considering the fact that the installed capacity of wind turbines was only 470MW in 2002.

One of the factors that contributed to rapid development of wind power is substantial cost reduction. It is believed that even though wind power is the most economically efficient of all renewable energies, but wind power is still not able to compete with fossil power plants. However, the wholesale price of wind power in China is around 0.5-0.6 Yuan, which might be competitive with coal-fired plants in those areas far away from the coal producing area, such as Guangdong, where the wholesale price of coal-fired plants was 0.496 Yuan/kWh.

In 2010 the investment cost for wind turbine got cheaper by 30% than in 2008, and it is only half, compared with in 2006. At first, the wind power technology was imported from foreign countries, and in 2004 the share of foreign makers accounted to 75%, capturing large market share. However, as shown in Fig. 4, the market share of Chinese enterprises increased very rapidly, by 2009 the share of Chinese enterprises grew to 87%. The growth of Chinese makers was the primary driver of the cost reduction in wind power turbines. Chinese government played critical role in developing domestic wind power makers. In 2005, the government set the regulation that the local content of wind turbine components must reach above 70%, otherwise the wind farm projects would not be approved. As a result, foreign enterprises either invested to build components plants inside China or transferred technology to the local component suppliers. Although this regulation was abolished in 2010, following strong protests from the US, but China already succeeded in establishing supplier system with lower production cost.

In building up wind power market, Chinese government promoted the policy requiring major power enterprises to raise the ratio of renewable energy to their total power generating capacity, as 3% in 2010 and 8% in 2020. Consequently, power enterprises had incentives to develop renewable energy for expanding conventional generating capacity. Then, it would be quite reasonable that wind power, the most economically efficient renewable energy, was chosen. In addition, since 2003, Chinese government has invested on wind power projects, and more importantly, those projects adopted competitive bidding, instead of “Feed-in Tariff” approach. Therefore, both power enterprises and government had given wind turbine makers pressure to reduce costs.

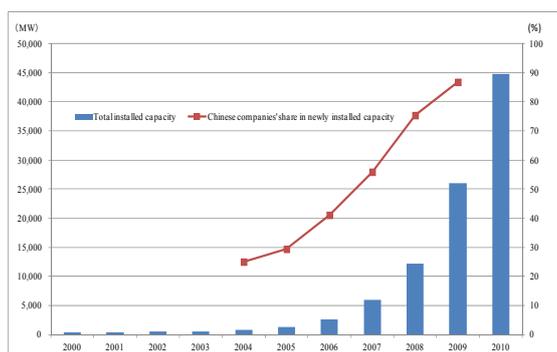


Fig.4: Growth of installed wind turbine in China and the changes of the market share of local suppliers

Source: Wang, Ren, and Gao [2011], p. 207

5. Concluding Remarks

This article can be summarized as below. Followed by the market based reform in coal industry, coal price has been rising and price advantage, which is the biggest reason why coal has been kept as dominant primary energy in China, has been disappearing. That’s why in the 12th Five-Year Plan, ambitious targets are set for natural gas and hydropower. Comparing to coal, the price advantage of natural gas and

hydropower has been strengthened. In terms of wind power, in addition to the improved market conditions due to the price hike of coal, as the government adopted supporting policies to Chinese makers, which helped to reduce production cost, all these would facilitate the development of wind power. If costs could be cut further during the 12th FYP period, the ratio of wind power could be further expanded.

6. References

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