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Electricity Restructuring in China: The Elusive Quest for Competition

by

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Abstract

The continuation of China's remarkable economic growth will depend on continued increases in electricity supply. China has commenced a program of electricity sector restructuring, with the announced aim of relying on markets and competition to provide incentives for attracting private investment and encouraging efficiency. However, a close examination of the generation markets being created suggests that truly free wholesale prices are likely to be both high and volatile. This may be the reason that these prices have not yet been freed – and it may not bode well for true market liberalization in the future.

Keywords: electricity restructuring, competition, China

JEL codes: L94, O13, P28, Q48

1.0 Introduction

The continued success of China's rapidly growing economy and the accompanying economic reforms will depend in no small measure on continued growth in the electricity sector. In an effort to attract private investment into the sector – especially the generation component of the sector – and to insure the efficient use of that investment, the Chinese government has undertaken a major and fundamental electricity sector restructuring, including the now standard reform strategy of the separation of the assets and operations of generation from those of transmission and distribution. The contemplated outcome includes a generation sector characterized by independent enterprises competing among each other for access to the transmission grid and so for customers, with free wholesale prices both insuring that the most efficient generation assets are called into production and providing a return to the owners of those assets.

However, it is not at all clear how realistic or likely this contemplated outcome is, either politically or economically. Politically, the Chinese government has so far been unwilling to allow either wholesale or retail electricity prices to increase in line with increases in costs, most notably increases in the price of coal; as in Russia, for example, the government has continued to regard the prices of electricity and other public services as a weapon for fighting inflation rather than as a mechanism of resource allocation. Economically, certain aspects of the electricity sector that are not likely to change quickly – especially the heavy dependence on coal generation and the limited interregional transmission capacity – may render generation competition difficult, volatile, and ineffectual at achieving the goals of restructuring.

In this paper we outline the basic inherited structure of the Chinese electricity sector as well as the overall reform plans and the progress achieved to date. We then examine closely the six primary regional markets that are considered by the government as likely to be the loci of wholesale competition when it appears. We discuss why competition may be ineffective in these markets and consider policies with the potential to make beneficial reform outcomes more likely.

2.0 The Chinese Electricity Sector

2.1 Background

The Chinese electric power industry has grown into the second largest in the world, with installed capacity rising from 1.85 GW in 1949 to 713.29 GW in 2007, an average annual growth rate of 10.8 percent.[1] The vast majority of generation plants are either coal powered – almost 78 percent of total capacity in 2007 – or hydro powered – over 20 percent. Nuclear plants account for only about 1 percent of capacity. Although the Chinese electricity industry has been expanding dramatically, per capita installed capacity is still at a low level of 0.5 KW, and per capita annual electricity consumption in

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[1] See the websites of the China Electricity Council, www.cec.org.cn, and State Power Information Network, www.sp.com.cn/zgdl/dltj/default.htm.

2006 was only around 2149 KWh.[2] In the long run, a massive expansion of power infrastructure will still be needed if average consumption is to approach world levels.

When China began its transformation from a centrally planned to a market-oriented economy in 1978, the already rapidly growing demand for electricity suggested the crucial nature of reforms in the electricity sector. However, electricity has been one of the last sectors for the introduction of, and reliance on, market mechanisms. The shortage of public funds and the desire for a separation of government administration from business were the main political reasons to launch the reforms in the electricity sector. In particular, the central government wanted to encourage rapid infrastructure expansion and improvement of power generation efficiency in the reforms undertaken after 1986. As the reforms are still ongoing, it is impossible to draw a simple conclusion regarding their success; there are still many challenges confronting Chinese electricity policymakers.[3]

One important issue going forward will be the strengthening of the rule of law in general and of regulation and competition law in particular. On August 31, 2007, China passed its first comprehensive antimonopoly law (hereinafter the Law), to become effective on August 1, 2008. How to get regulatory regimes aligned with the current framework of the Law will be a serious challenge for policymakers. An independent competition commission is to be set up under the State Council to assume the main responsibility for investigating possible anticompetitive conduct. However, the Law does not state clearly how it will be applied in regulated industries. In addition, as the Chinese electricity industry was originally operated by the provincial governments, their residual controls "die hard". Even though the market mechanism has been nominally introduced into the reforms and its use is one of the stated main objectives of the policymakers, the central government continues to exercise extensive investment planning and social policy intervention, as well as price controls, in electricity and the other strategic energy sectors. The Law does not state how an enforcement agency is to deal with such an “administrative monopoly”, and this raises critical questions regarding its implementation.[4]

2.2 The structure of the Chinese electricity sector

We begin with the introduction of the players in the Chinese electricity market, followed by a discussion of the fuel structure and of the transmission and distribution of the electricity industry. We will also discuss barriers to entry, especially for foreign investors, and pricing policy.

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[2] Office of the National Energy Leading Group (2007) at http://www.chinaenergy.gov.cn/news_20866.html

[3] Detailed discussions of the history and current status of Chinese electricity reforms include Berrah, *et al.* (2001), Development Research Center (2002), Xu (2004), Yeoh and Rajaraman (2004), Zhang and Heller (2004), IEA (2006), Xu and Chen (2006), Yang (2006), and State Council (2007).

[4] See Zhang and Zhang (2007), Deng and Leonard (2008), and Wen (2008).

2.2.1 The players

The incumbent monopoly generator, transmitter, and distributor of electricity, the State Power Corporation (SPC), was broken up in late 2002. The generation assets of the SPC were divided into five generation companies: Huaneng Group, Huadian Power, Guodian Power, Datang Power Group and China Power Investment Company. Each of the generation companies was designed to control no more than 20 percent of China's national generation capacity. The transmission grid was separated from generation operations and then further separated into two power grid operators, the State Power Grid Company and the South China Power Grid Company. Transmission and distribution are to continue to be regulated monopolies, with power supplied from a competitive generation sector.

The State Electric Regulatory Commission (SERC) was established in March 2003 to oversee the power industry and to issue licenses to environmentally qualified operators. SERC is the equivalent of the U.S. Federal Regulatory Energy Commission (FERC), through it is currently limited to regulating only the electricity industry (while FERC covers a wider range of energy industries). It is expected that, over time, other energy sectors will be overseen by SERC. SERC is also in charge of proposing amendments to the electric power law and drafting regulations on competition in the electricity market. It is the first regulatory commission in the public utilities sector, and it is also in the process of helping the seven state-run operators (five generation companies and two power grid operators) to adopt modern corporate governance practices.

The powerful National Development and Reform Commission (NDRC) is the government’s primary economic policymaking and planning agency. It is the institution charged with formulating strategic and long-term plans for development of the electricity sector, planning the spatial distribution of major electricity investment projects, and arranging state investment funds for infrastructure. It also examines electricity prices and formulates, monitors, and enforces the government’s pricing policy. Allocating tariff regulation to a broad government policy body like NDRC rather than a sectoral regulator like SERC is unique to China. This transitional arrangement may be intended to last only until the SERC has demonstrated the capacity to successfully establish and put into operation electricity markets, in addition to administering its other functions. This arrangement also allows the NDRC to maintain ultimate control over tariffs instead of ceding that power to an independent body before the transitional issues are addressed (e.g. stranded costs and cross subsidies).

The Ministry of Finance (MOF) takes the responsibility of establishing a financial management system, monitoring costs, and carrying out financial inspections for the state-owned enterprises in the electricity sector. It also establishes a taxation policy for the sector.

Other institutions and organizations also participate into the regulatory framework of the electricity industry. The environmental protection agency is the institution that enforces environmental laws, regulations and standards. The technical supervision agency stipulates and enforces technical and safety standards and regulations. The State-Owned Assets Supervision and Administration Commission (SASAC) is responsible for supervising and administrating state-owned assets.

The current market structure of the power industry and its governmental regulatory departments is illustrated in Figure 1.

Electricity demand is dominated by the industrial sector, which accounted for over 75 percent of total power consumption in 2007. Residential and commercial consumption account for just under 11 percent and 9 percent, respectively. Unlike some other developing countries, agricultural consumption of electricity in China is relatively quite small, accounting for only 4 percent.[5]

Some large industrial customers have their own fixed power suppliers for historical reasons. In addition, the NDRC is gradually increasing the freedom of industrial customers to choose particular generation sources in their regions. Especially in Guangdong province, some industry consumers are allowed to organize and build up their own thermal generators. The largest power consumers have more and more power to influence generation decisions.

2.2.2 Fuel structure

The Chinese electricity generation market has been experiencing rapid demand growth since the mid 1980s due to both high-speed economic growth and increasing living standards. By 2007, total generation capacity reached 713.29 GW, with system capacity increasing roughly by 60 GW each year between 2003 and 2007. Total generation capacity of 660 GW is projected by the end of the 11th Five-Year Plan (2006-2010) and 1080 GW by 2020.

China is a coal- and hydro-rich country. In fact, it has the world's largest exploitable coal and hydropower capacities. As a result, coal and hydro are the two largest components in the country's electricity generation fuel structure (Figure 2). As of 2007, 77.73 percent of total generation capacity was powered by coal, and 20.36 percent by hydro. In 1992, China introduced nuclear power as part of its fuel structure. As of now, nuclear power contributes only about 1 percent of the nation's total generation capacity. Plans to expand nuclear power have not been very successful due to high costs and lack of funding. However, according to an official of the Electricity Designing Institute of the State Power Corporation, the country's nuclear power generation capacity will grow to 36-37 GW, which will account for roughly 4 percent of China's total generation capacity, by 2020.

Resource development and utilization are major challenges for the Chinese government, since the country's fuel resources are located predominantly in the northern and western parts of the country while major load centers are located in the eastern coastal areas. Although coal-based generation will remain dominant in the near future,

[5] http://www.china.com.cn/economic/zhuanti/08jjbg/2008-01/31/content_9624958.htm.

hydropower will play an increasingly important role in the generation fuel structure. This is largely due to the Chinese government's commitment to develop the relatively underdeveloped hydro-rich western region and the adverse impact that coal generation has on the environment. China also plans to include natural gas in its electricity fuel structure. The capacity of natural gas generation is planed to reach 36 GW by 2010.[6]

2.2.3 Transmission and distribution

As of 2000, China had 707,142 km of transmission lines of 35kV and above in operation. Formally there have been seven regional networks (Northeast, Northwest, North, East, Central, South, and Guangdong) and five provincial networks (Shandong, Fujian, Xinjiang, Hainan, and Tibet). Currently, the South China Power Grid controls transmission and distribution networks in the southern regions (Southwest plus Guangdong), while the State Power Grid controls in the rest of the country. The standard frequency of the electricity system is 50 Hz.

In some rural regions, there also exist regional independent distribution companies, which might have their own generation plants or purchase electricity directly from the national grid. These independent distribution companies mainly concentrate in areas where there are small hydro generators. They might also have their own transmission network, where it is not convenient or economical for the national grid to supply energy.

The fragmented heritage of the national transmission grid has made and will continue to make the integration of regional wholesale markets a challenge for the government. Another challenge, in light of the different locations of resources and electricity demand, is the transmission of resources and power broadly from West to East. This is also connected with a broader government policy of increasing development in the West in order to address the widespread poverty there, a policy termed “Open Up the West”.[7]

The Chinese government hopes to create a unified national power grid network by 2020. The West-East Electricity Transfer Project, as proposed in the 10th Five-Year Plan, requires the construction of three major west-east transmission corridors: North, Central, and South. The transmission capacity of each corridor is expected to reach 20 GW in 2020.

The North corridor portion of the project covers three regional power networks (Northwest, North and Northeast) and the Shandong provincial power network. This corridor can transmit power up to 620 miles; it is mainly made up of AC transmission lines. The construction and expansion of the North corridor is expected to help the development of Shanxi, west Inner Mongolia, and Ningxia coal power bases.

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[6] http://www.hwcc.gov.cn/nsbd/NewsDisplay.asp?Id=166518.

[7] A dissenting view suggests that a continued role for the Western provinces as raw materials supplier to the industrial East will only entrench and exacerbate the subsidiary role of the former. See Oakes (2004).

The Central corridor portion covers three regional power networks (Sichuan-Chongqing, Central, and East) and the Fujian provincial power network. It is composed mainly of DC transmission lines and can transfer power between 620 and 1,370 miles. The construction of the Three Gorges, the Jinshajiang, and the Sichuan hydropower stations is the direct result of developing the Central corridor.

The South corridor mainly covers one regional power network (South) and the Hainan provincial power networks. This corridor uses both AC and DC transmission and can send power between 620 and 930 miles. The main purpose of the expansion of the South corridor is to transfer power into Guangdong province, which is one of the major load centers. The development of hydropower stations along several rivers in the South corridor will aid in achieving this goal.

2.2.4 Barriers to entry

Although the Chinese government has improved market conditions for investment in the power sector, significant barriers still exist for non-state investors, especially foreign investors. These include

- Risk. Foreign investors perceive higher economic, political, and legal risks than the government acknowledges. Although these investors are generally optimistic about the future market in China, they often mention that the ratio of profitability to risk is higher in other countries.
- Return on investment. Despite its professed desire to rely on market forces, the Chinese government continues to closely regulate electricity generation, generally allowing a 12 to 15 percent rate of return on investment in these and other infrastructure projects. Foreign investors expect higher rates based on the perceived risks mentioned above. Few foreign companies will invest in any large project if return on investment is less than 15 percent, even at their own domestic facilities.
- Complexity. Foreign investors may not be comfortable with, or even familiar with, the complex project-approval process in China. Approval is required from many governmental agencies at different levels, each of which takes time and money. This process is not transparent to newcomers.
- Legal issues. Foreign investors are not confident that the Chinese legal system will be unbiased in the event of a dispute with local counterparts. They also worry about the enforcement of contracts with power grid operators and fuel suppliers. The negotiation of power-purchasing agreements has thus been difficult and time-consuming.[8]
- High tariffs and taxes. Foreign investors expect low import tariffs and tax rates. Import tariffs for power units smaller than 350 MW are 38 percent, though larger units are taxed at only 6 percent. High income taxes also reduce net profit. While the government has reduced import tariffs in recent years, some favorable policies enjoyed

[8] "Broader institutional weaknesses, of which corporate governance, limited contract enforcement, and weak intellectual property rights provide particularly relevant examples, … endanger future growth, especially in sectors that build on the accumulation and exchange of advanced technologies." (Brandt, Rawski, and Sutton, 2008)

by foreign investors, including tax deductions and exemption policies, have been abolished.

- Lack of mutual understanding. Chinese and foreign partners often lack a mutual understanding of each other's culture and business practices, hindering cooperative projects. Both sides need more experience cooperating in the electric power market.

For domestic investors, the barriers to entry are not as serious as for foreign investors, because the legal framework of Chinese Electricity Law includes certain provisions designed to facilitate entry. As the NDRC emphasized, for those who apply for the licenses and are technologically adapted to the network, licensing authorities have a maximum of only thirty days for investigation. After this time limit, either the licenses are issued, or the authorities are required to issue refusal announcements and explanations.

2.2.5 Price regulation

In order to encourage investment in the late 1990s and early 2000s, the central government established a special tariff paid to all newly developed generators. For older power plants built before 1985 with state grants covering the costs of equipment and construction, the generation price was set by the NDRC in an orthodox way that covered only the operating cost of power plants and transmission and distribution. However, the reformed policy fixed a tariff formula for new generation capacity on a cost-plus basis which guaranteed a 12-15 percent rate of return and offered an accelerated capital repayment schedule, usually over only ten years for plants with a much longer lifetime. The reform acknowledged that electricity produced by new capacity would be more costly than that from the older, nationally financed plants because the latter had incurred no or subsidized capital costs and often benefited from cheaper fuel supplies under central planning. In effect, the new policy allowed wholesale prices to be set individually on the basis of the approved cost of a power plant or even of an individual generating unit. For new plants, nearly as many generation prices were adopted as there were new plants or units. Table 1 illustrates the cost-tariff relationship of one representative power plant in Guangdong Province. Table 2 presents the national averages of these two tracks of generation prices.

In 1999, the SPC began to experiment with wholesale market competition among generators on a very limited basis in six provinces. The experience followed a very crude English power pool model. Typically, each province selected a certain number of power producers to participate in a limited competition that served only a small fraction of market demand. The bulk of demand continued to be met by the planned dispatch, with reductions in dispatch caused by oversupply allocated to all power producers in proportion to their existing generation. Even power companies with power purchasing agreements (PPAs) were forced to reduce their contracted off-take hours. Essentially, the power generators forced to participate were the twelve largest independent power producers (IPPs). For each, the total power capacity was divided into a contractual amount and a smaller (typically 10 percent) that was forced to compete. The contractual amount was dispatched as usual every day at the politically set price. The 10 percent beyond the contractual amount was bid into the grid at market price. The IPPs were free to make their own decisions whether to compete or not on a daily basis.

Simulation of competition began in July 2000, with no actual financial settlements. The experiment of wholesale market competition was generally inconsequential because its scope was extremely limited and the experiment was halted as soon as the power markets became tighter in 2001, alleviating the pressure on power producers to lower prices or compete for dispatch on the grid.

Finally in 2002 and 2003, the State Council issued several policy statements concerning electricity price regulation, which summarized the results of the experiment and provided a preliminary framework for future wholesale competition.[9] In March 2005, the NDRC issued three interim provisions for the regulation of wholesale, retail, and power transmission and distribution prices, which are the milestones for the new pricing regime in the Chinese electricity industry.[10] In this new price scheme, the NDRC decided to implement a structure of two-part electricity prices after generation competition was applied in the wholesale market. This two-part electricity price consists of a capacity price and a system marginal price. The capacity price is determined by the price administrative department of the government, while the system marginal price is set through market competition. The government will use a cost-plus formula in the calculation of the capacity power price. The wholesale price will thus be linked directly to fuel cost. As for the retail price, the government will control it during the early stages of this new price scheme but has stated its intention to allow retail prices to be determined by market forces after distribution activities are separated from retailing activities. Under such a new price scheme, competition would be encouraged and expanded in the wholesale market and be gradually introduced into the retail market.

3.0 Competition in Generation

It is clear that an important component of the Chinese electricity restructuring plan as stated and publicized is the creation of competition among generation companies. The "Plan for the Reform of the Electric Power System" issued by the State Council in April 2002 calls for unbundling generation from transmission and distribution in order to create a system of "accessing the power grid through competition". More recently, a report from the State Council titled "China's Energy Conditions and Policies", issued in December 2007, notes that "the price mechanism is the core of the market mechanism", and that "the Chinese government … has propelled electricity tariff reform to ensure that electricity generation and selling prices are eventually formed by market competition." The broad strategy of vertical separation and the creation of "upstream" competition has

[9] See "State Council issues the reform plan for the regulation of electricity industry" (2002), available at http://www.china5e.com/laws/index2.htm?id=200608080001; "State Council issues the reform plan for the price regulation of electricity industry" (2003), available at http://www.china-environment.cn/uploadfile/pdf/ener/7/030709%E9%9B%BB%E5%8A%9B0709.pdf.

[10] See http://www.sepc.com.cn/outer/main/viewArticle.jsp?id=6b62e762a99513fe1aa3; http://www.sepc.com.cn/outer/main/viewArticle.jsp?id=cc44132da3c2cb8f0fcc; http://www.sepc.com.cn/outer/main/viewArticle.jsp?id=04c14ecac2b39de981f2.

become a standard, even a "default", strategy for the restructuring of natural monopolies around the world (Newbery, 1999; Pittman, 2003, 2007b; Xu, 2004).

But how realistic is this plan for China? To begin with, what form would such generation competition take? In China as in Russia (Pittman 2007a), *ex ante* discussions and analyses of generation market competition have taken existing regional designations as provisional geographic markets. In China's case these designations divide the country into six regions (excluding Tibet, which we also exclude from our analysis), as shown in Figure 3: North, Northeast, Northwest, East, Central, and South. In fact, also as in Russia, actual geographic generation markets will probably turn out to be smaller than these regions once real market operation begins, especially during times of peak demand when transmission congestion becomes likely.

This is likely for two reasons. First, historically China's transmission system was highly fragmented. It is only recently that investments in the grid have begun to address this situation in a serious way, and despite these investments, interconnection remains weak, not only among these six regions but also within them (IEA 2006). Second, even the smallest of these regions, the East, is much larger than geographic generation markets that have been typical of countries that have already created these markets. A recent example is the geographic markets found by the U.S. Department of Justice and FERC in their investigations of a proposed merger of electricity companies in the PJM region of the northeastern United States; the geographic market delineated by these agencies was considerably smaller than East China during periods of low demand, and during periods of peak demand, network congestion caused it to become smaller still.[11]

For this reason, the provision of the government's generation sector unbundling and restructuring plan that limited the share of any single firm in any single region to 20 percent may not be effective in limiting firm shares in the actual geographic markets that come into being with the introduction of competition. For the same reason, our analysis below of the competitive structure of these regions may err on the side of optimism.

However, there are other serious reasons to be concerned about the likely outcomes if prices and competition are freed in these markets, as is called for by the government's reform strategies. We may divide these reasons into particular aspects of electricity markets and particular aspects of *Chinese* electricity markets.

As has been noted elsewhere (Borenstein and Bushnell, 1999; Borenstein, *et al*., 1999), a number of characteristics of electricity and electricity markets make it more difficult to create workably competitive markets in this sector than in many others; to put

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[11] See Competitive Impact Statement, U.S. v. Exelon and Public Service Enterprise Group, August 10, 2006, available at http://www.usdoj.gov/atr/cases/f217700/217717.htm. For broader discussions of the case, see Armington, et al. (2006) and Wolak and McRae (2007).

it another way, electricity markets that appear to be competitive using the normal tools of industrial economics may in fact not operate competitively.[12]

The demand for electricity is very inelastic in the short run; this has to do with its essential nature as a household product, its small cost share but crucial role in commercial and industrial applications, and the exceeding rarity of real-time pricing, even for the largest industrial users. At the same time, supply is very inelastic as capacity utilization nears 100 percent: the product itself is not storable (though hydro ponds and pumped storage may perform this function indirectly), and unit costs tend to increase dramatically as one moves from baseload nuclear and coal plants, through mid-merit combined cycle natural gas plants, to peaking natural gas and oil plants. The combination of inelastic demand and inelastic supply means that the returns to the anticompetitive withholding of output may be quite high.

Two additional factors exacerbate the incentives of generation firms to withhold output and their ability to do so. First, wholesale electricity markets typically take the form of auctions or quasi-auctions, operating on hourly offering bids from generation firms. This means that these firms play the competitive "game" in these markets a very large number of times: 24 times a day, 168 times a week, 8760 times a year. It seems not unlikely that profit-seeking generation firms in such an environment will study each other's behavior and learn to behave (tacitly) cooperatively rather than competitively. Second, the typically steep slope of the market cost curve as market capacity is approached and as higher cost generation units are called into production may create perverse incentives for firms that own both one or more of these high-cost peaking plants along with one or more of the much lower cost baseload plants. If a particular gas or oil fired plant would be just barely profitable at a particular wholesale price level, it follows that shutting down that plant would sacrifice very little profit; yet if that plant operates at a very steep point on the industry supply curve, shutting it down could have a large impact on price and thus yield large inframarginal rents to the firm's baseload plants.

Problems like these may take especially acute form in the special circumstances of China. First of all, China's dramatic economic growth has placed a large burden on the electric power system; the situation is generally and broadly one of new supply trying to catch up to rapidly growing demand. Thus in China, as in many other developing countries, the most important task of electricity reforms is to attract private investment into the system, rather than, as in developed countries, increasing efficiency (Gnansoumou and Dong, 2004; Zhang and Heller, 2004). For the same reason, freed electricity prices are likely to increase.

But second, despite its expressed desire for markets rather than bureaucrats to determine outcomes, the government has thus far been unwilling to allow electricity prices (wholesale or retail) to increase in response to cost increases, fearing the political results of increased inflation (Oakes, 2004; IEA, 2006). The best known recent example has been the increase in coal prices in response to high levels of demand along with transport bottlenecks; rather than allow the price of coal-generated electricity to increase

[12] Lien (2008), among others, is not so pessimistic.

as a result, the government attacked the problem by seeking to re-regulate coal prices, as well as allowing generation companies to suffer a margin squeeze (Yeoh and Rajarma, 2004; IEA, 2006).[13] More generally, "missing from plans for further reform is the removal of electricity price-setting authority from state control" (Yeh and Lewis, 2004).

The third problem for China is a structural one. As noted above, cost curves in wholesale electricity markets tend to become fairly inelastic as market capacity levels are neared; still these curves tend to exhibit a classically curved shape as generation plants of different technologies and efficiencies are called into service. Figure 4 shows a stylized example from the PJM-East region of the northeastern US discussed earlier. The curve begins with a low and flat "baseload" component of nuclear and hydro plants, moves up a bit to baseload "coal" plants and then to natural gas fired "combined cycle plants", finally increasing its slope to a virtually vertical range as gas and oil fired "efficient peakers" and "super peakers" are called into production. Cost curves in many generation markets around the world would look more or less like this one.

But China is different. As of 2007, 77.7 percent of China's generation capacity is coal fired, and 20.36 percent is hydro. Oil makes up most of the rest, with very small shares for nuclear and gas. As we will discuss below, the system is even more dependent on coal in the coal-rich North and Northeast regions. In other regions hydro generation may provide some flexibility; we will discuss the important issues involving the incentives of hydro producers momentarily. But for now, note that a system with nothing but coal plants would exhibit a cost curve with an appearance less like the cost curve in Table 1 and more like the bottom and right-hand-side *axes* of Figure 4: a large region of low and fairly flat costs – its small rise accounted for by different efficiency levels of the different coal plants – followed by a vertical line as market capacity is reached.

Note further how a system with such cost curves – and very inelastic demand – operates as demand increases and supply tries to keep up. If and when demand is below capacity, market prices will tend to equal the very low marginal costs of the marginal coal plant. The resulting low prices are great for customers, of course, but they provide little margin to encourage existing or new firms to invest in the business. (A common policy response is to institute a regime of capacity payments – which the Chinese government has proposed – but at this point the system starts to become highly regulated, apparently raising the question of the degree to which one is still relying on markets to determine outcomes.) When demand is at capacity, prices may increase a great deal and in a highly volatile way: there is little demand response to these price increases, and the short-run supply response is small as well. As noted above, the Chinese government has already shown an unwillingness to allow electricity prices to rise along with coal prices; it seems quite unlikely that the government would tolerate high and volatile prices in

[13] For the most recent examples, see Amy Lam, "Coal prices hold down power profit," *China Daily*, March 27, 2008, and Steven Mufson and Blaine Harden, "Coal Can't Fill World's Burning Appetite," *Washington Post*, March 20, 2008. As the latter reports, "China has done little to contain demand. Indeed, the government has limited electricity rate increases for years, encouraging greater use. Concerned about climbing inflation, Beijing on Jan. 10 turned once again to Communist-style measures, freezing electricity prices even as coal and oil prices soared."

response to movements in demand above and below capacity levels. And yet those are exactly what would be expected in markets with cost curves like these.

With this background, let us examine the structure of the six regional generation "markets" as they are currently configured. In order to conserve space, we present only the flood season capacities; this biases the summary discussions in the direction of reducing the apparent dominance of coal. (Dry season capacities are available upon request.)

3.1 The North and Northeast regions.

Tables A1 and A2 show the generation plant level structures in the North and Northeast regional markets.[14] Plants are grouped by parent company, and companies are then ordered by decreasing regional market share.

The main factor that stands out from Tables A1 and A2 is the overwhelming dominance of coal generation in these two regions. Of 66 generation plants in the North, 60 are coal fired, accounting for 93.3 percent of flood season capacity. Five plants (5.7 percent of capacity) are hydro, and one (1 percent) is oil fired. Of the 21 generation plants in the Northeast, 18 are coal fired, accounting for 86.5 percent of flood season capacity, while three hydro plants account for the remainder.

The North and Northeast are coal-dependent regions that will exhibit reverse L-shaped wholesale electricity cost curves, except to whatever extent the small amount of hydro capacity is used in a capacity-shaving manner. Free, uncontrolled wholesale markets seem likely to exhibit large price fluctuations, from slack period low prices that return no margin to generation companies to peak period high and volatile prices that transfer large sums from electricity consumers to generation companies without having much output increasing effect in the short run.

3.2 The Northwest and Central regions.

Tables A3 and A4 show the generation plant level structures in the Northwest and Central regional markets.

The Northwest and Central regions are made up entirely of coal and hydro generation plants. In the Northwest, coal accounts for 65.5 percent of generation capacity in the flood season and 88.5 percent in the dry season; in the Central region, home of the Three Gorges dam, coal's shares are 48.5 percent in the flood season (after the promised exports of Three Gorges power are accounted for) and 72.5 percent in the dry season.

Let us consider the issue of hydro generation a bit more closely. In the Central, South, and East regions, coal generation capacity is supplemented by a good deal of hydro capacity – most famously from the Three Gorges Dam project, but from a large (and increasing) number of other dam projects as well (McCormack, 2001). Hydro

[14] Plant level data are obtained from enterprise and government web sites.

generation may provide supply-side responsiveness to wholesale electricity price signals where water may either be stored directly in holding ponds or pumped back into ponds for later release. Thus it is possible for hydro generators to perform a "peak shaving" function that significantly increases the efficiency of the system overall: they may store water when wholesale prices are low in order to release it when prices are high, thus obviating the need to call expensive "super peakers" into operation.

However, there are situations and conditions under which hydro generators cannot or do not perform such a function. They *cannot* do so when river flows are so high as to overwhelm the capacity of the storage ponds – a frequent occurrence during flood seasons in many countries. In that circumstance hydro plants with storage ponds become indistinguishable from "run-of-river" plants: they generate power as the river flows. They *do not* or may not do so when they are not provided with the incentives to do so. This may occur under a variety of circumstances:

- When government-owned hydro plant managers are not rewarded for profit maximizing behavior (which seems to occur most often when governments decide to allocate low-cost hydro to particular end users for political reasons);
- When, on the contrary, hydro plant managers are maximizing profits, but they enjoy market power and so have incentives to allow prices to increase;[15] and
- When, and to the degree that, releases of water for hydro generation are constrained by irrigation requirements and/or restrictions regarding reservoir levels and changes.[16]

One indicator of the likely lack of hydro flexibility in the flood season in China is that policymakers have already determined that almost one-third of the electricity output from the Three Gorges project during flood season will be exported from the Central region to the South and East regions.

Returning to Tables A3 and A4, it is clear – especially in the Central region, and especially in the flood season – that the incentives and freedom of maneuver faced by hydro generation companies will be crucial determinants of the performance of wholesale electricity markets. If hydro producers are willing and able to shave wholesale price peaks, prices will behave with a good deal more stability and predictability than if they are not.

Note, however, two possible sources of additional concerns regarding competitive conditions in these markets. First, despite stated government reform policies to the contrary, a single firm, the China Power Investment Corporation, holds over 30 percent of Northwest regional generation capacity in the flood season. Similarly, even after accounting for mandatory exports, the China Three Gorges Project Corporation holds about one quarter of Central regional generation capacity in the flood season. To the extent that these two firms have the ability to affect the timing of their releases of water, they may have the incentive to allow prices to increase during periods of peak demand and enjoy the resulting high profits.

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[15] The interesting literature on this issue includes Kelman, *et al*. (2005), Arellano (2003, 2004), Førsund and Hoel (2004), and Hoel (2004).

[16] See, e.g., Crampes and Moreaux (2001), Edwards (2003), and Atkinson and Halabí (2005).

Second, in the Central region, three generation companies hold capacity portfolios with a mix of coal fired and hydro plants: China Guodian Corporation, China Datang Corporation, and China Power Investment Corporation. If and when these hydro plants have no flexibility, this mix will not create anticompetitive incentives. However, if and when they are flexible, their owners may enjoy the incentives discussed earlier to reduce hydro production at the margin in order to raise market price and create inframarginal rents for the baseload coal plants. Again, this is in addition to similar incentives that may accrue to CPIC in the Northwest and Three Gorges in the Central region as a result of their relatively high single-firm market shares.

3.3 The South and East regions

Tables A5 and A6 show the generation plant level market structures in the South and East regions. These two regions have the most diverse generation portfolios, including in both cases some nuclear capacity and some oil and/or gas fired capacity. Still, coal accounts for 81 percent of flood season generation capacity in the South, and (baseload) nuclear another 5 percent; it is only in the South that hydro's large share combines with a bit of oil and gas to reduce the share of coal to 55 percent (with nuclear at 6 percent). In neither region do peaking plants powered by oil or gas seem likely to have sufficient capacity to give much gradual rise to the market-wide generation cost curve; as in the Northwest and (especially) Central regions, most flexibility, if it exists, will come from hydro.

Furthermore, in the South there are multiple generation companies that hold mixed technology portfolios that may create incentives to reduce output at peaking plants in order to generate inframarginal profits at baseload plants; these include China Huaneng, China Datang, China Huadan, and the State Development and Investment Company, with their mixes of coal and hydro, and the Guangdong Yudean and Shenzhen Energy Groups, with their mixes of coal and gas.

4.0 Discussion

The analysis presented here suggests that, as currently designed, and for reasons of both technology and producer incentives, uncontrolled Chinese generation markets are likely to exhibit both high and volatile prices – an outcome that the Chinese government has thus far been unwilling to permit.

A number of ameliorative measures could be considered. Markets where a single firm has a large share of generation capacity may be more likely to operate competitively if that firm is divested of one of its existing plants; this type of deconcentration strategy had some success in the UK, where the initial unbundling of the market created generation companies with market power (Newbery, 1999). Similarly, the potentially anticompetitive incentives created by mixing baseload and peaking plants under the ownership of a single firm could be removed by dividing such firms into single-technology enterprises. Of course, there may be economies of scale deriving from one firm's ownership of multiple plants, and the ownership of plants with varying technologies should diversity some risk borne by the firm; we take no position on whether these costs may outweigh any procompetitive benefit of restructuring along these lines.

Especially to the degree that market difficulties are caused by the dominance of coal in particular regions, this problem may be addressed by increased investments in long-distance transmission capacity that makes power generated from other sources available to a particular regional market. As noted above, investments like this are already taking place, but there is still a long way to go if significant geographic barriers to interregional power flows are to be reduced.[17]

Similarly, to the degree that coal price increases are the result of bottlenecks in rail transport, the ongoing investments in rail infrastructure improvement may help to address such problems. However, as with the electricity sector, investments in the Chinese railway sector must work hard just to keep up with economic growth, much less to ease bottlenecks (Pittman, 2004).

Increases in nuclear generation capacity would help to address concerns about greenhouse gas emissions and other air pollutants, but since nuclear plants are baseload capacity and extremely inflexible, this would not address many of the problems addressed here. On the other hand, further development of natural gas generation, including generation from coastal plants powered by imported LPG, could insert more flexibility into these markets.

Finally, long-term contracts between generation companies and either large industrial users or local distributors generally have the effect of reducing the incentives for the generation companies to manipulate output and prices in spot markets.[18] (On the other hand, long-term contracts may under some circumstances facilitate collusion among generation companies.)[19] And increases in real-time metering for large customers may increase the elasticity of demand in wholesale markets and thus reduce the returns to output reduction.

More broadly, the analysis presented here would seem to suggest that it may be a long time before the Chinese government allows completely free wholesale electricity prices – and, more broadly still, that such hesitation would reflect not only political but also economic realities: it is not at all clear that, for a commodity as basic and important as electricity, uncontrolled prices that fluctuate wildly without having much short-term impact on either demand or supply enhance anyone's welfare. Whether the ameliorative policies suggested here will be sufficient to address these problems, or whether a

[17] Peyrouse (2007) reports hopes and plans for future imports into China of power generated in Central Asia, especially hydro power, but this remains only a long-term prospect. Evans, et al. (2008) and Valeri (2008) discuss the welfare benefits of increasing transmission capacity across existing geographic markets in, respectively, New Zealand and Great Britain/Ireland.

[18] See, e.g., Kelman, *et al*. (2005), Bushnell, *et al.* (2007), and Anderson and Hu (2008).

[19] See, e.g., Harvey and Hogan (2000) and Green and Le Coq (2007).

reconsideration of the entire electricity restructuring strategy is called for, would seem appropriate topics for further debate.

References

Anderson, Edward J., and Xinmin Hu, "Forward contracts and market power in an electricity market," *International Journal of Industrial Organization* 26 (2008), 679-694.

Arellano, M. Soledad, "Diagnosing and Mitigating Market Power in Chile's Electricity Industry," University of Cambridge, Cambridge Working Papers in Economics CWPE 0327, 2003.

_____, "Market Power in Mixed Hydro-Thermal Electric Systems," working paper, Universidad de Chile, April 2004.

Armington, Elizabeth, Eric Emch, and Ken Heyer, "The Year in Review: Economics at the Antitrust Division, 2005-2006," *Review of Industrial Organization* 29 (2006), 305-326.

Atkinson, Scott E., and Claudia Elizabeth Halabí, "Economic Efficiency and Productivity Growth in the Post-Privatization Chilean Hydroelectric Industry," *Journal of Productivity Analysis* 23 (2005), 245-273.

Berrah, Noureddine, Ranjit Lamech, and Jianping Zhao, "Fostering Competition in China's Power Markets," World Bank discussion paper, 2001.

Borenstein, Severin, and James B. Bushnell (1999), "An Empirical Analysis of the Potential for Market Power in California's Electricity Industry," *Journal of Industrial Economics*, 47, 285-323.

_____, _____, and Christopher R. Knittel (1999), "Market Power in Electricity Market: Beyond Concentration Measures," working paper PWP-059r, Program on Workable Energy Regulation (POWER), University of California Energy Institute, February.

Brandt, Loren, Thomas G. Rawski, and John Sutton, "China's Industrial Development," in Brandt and Rawski, eds., *China's Great Economic Transformation*, Cambridge, UK: Cambridge University Press, 2008.

Bushnell, James B., Erin T. Mansur, and Celeste Saravia, "Vertical Arrangements, Market Structure, and Competition: An Analysis of Restructured U.S. Electricity Markets," NBER working paper 13507, October 2007.

China State Power Information Center, 2004, www.sp-china.com.

China Statistical Yearbook: National Bureau of Statistics of China, www.stats.gov.cn/english/.

Crampes, C., and M. Moreaux, "Water resource and power generation," *International Journal of Industrial Organization* 19 (2001), 975-997.

Deng, Fei, and Gregory K. Leonard, "Incentives and China's New Antimonopoly Law," *Antitrust* (spring 2008), 73-77.

Development Research Center of the State Council of the P.R.C., "Strategies for China's Electricity Reform and Renewable Development," (China Sustainable Energy Program, The

David and Lucile Packard Foundation in Partnership with The Energy Foundation), Industrial Economics Research Department, 2002.

Edwards, Brian K., *The Economics of Hydroelectric Power*, Northampton, MA: Edward Elgar, 2003.

Evans, Lewis, Graeme Guthrie, and Steen Videbeck, "Assessing the Integration of Electricity Markets Using Principal Component Analysis: Network and Market Structure Effects," *Contemporary Economic Policy* 26 (2008), 145-161.

Førsund, Finn R., and Michael Hoel, "Properties of a non-competitive electricity market dominated by hydroelectric power," Memorandum No. 07/2004, Department of Economics, University of Oslo, 2004.

Gnansounou, Edgard, and Jun Dong, "Opportunity for inter-regional integration of electricity markets: the case of Shandong and Shanghai in East China," *Energy Policy* 32 (2004), 1737-1751.

Green, Richard, and Chloe Le Coq, "The Length of Contracts and Collusion," working paper CSEMWP-154, Center for the Study of Energy Markets, February 2007.

GETRC, *Guangdong Electric Power Development and Future Trends*, Guangdong Energy Techno-economic Research Center, 1999.

Harvey, S. and W. Hogan, "California electricity prices and forward market hedging," working paper, Harvard University, 2000.

Hoel, Michael, "Electricity prices in a mixed thermal and hydropower system, Memorandum No. 28/2004, Department of Economics, University of Oslo, 2004.

IEA, *China's Power Sector Reforms: Where to Next?* Paris: International Energy Agency, 2006.

Kelman, Rafael, Luiz Augusto N. Barroso, and Mario Veiga F. Pereira, "Market Power Assessment and Mitigation in Hydrothermal Systems, *IEEE Transactions on Power Systems* 16:3 (2001), 354-9.

Lien, Jeffrey, "Electricity Restructuring: What Has Worked, What Has Not, and What Is Next," Economic Analysis Group, Antitrust Division, U.S. Department of Justice, EAG Discussion Paper EAG 08-4, April 2008.

McCormack, Gavan, "Water Margins: Competing Paradigms in China," *Critical Asian Studies* 33 (2001), 5-30.

NDRC, *Annual Report 2002*, Beijing: National Development and Reform Commission, www.sdpc.gov.cn.

Newbery, David M., *Privatization, Restructuring, and Regulation of Network Utilities*, Cambridge, MA: MIT Press, 1999.

Oakes, Tim, "Building a Southern Dynamo: Guizhou and state power," *China Quarterly* 178 (2004), 167-187.

Peyrouse, Sebastien, “The Hydroelectric Sector in Central Asia and the Growing Role of China,” *China and Eurasia Forum Quarterly* 5 (2007), 131-148.

Pittman, Russell, “Vertical Restructuring (or Not) of the Infrastructure Sectors of Transition Economies,” *Journal of Industry Competition & Trade* 3 (2003), 5-26.

_____, “Chinese Railway Reform and Competition: Lessons from the Experience in Other Countries,” *Journal of Transport Economics and Policy* 38 (2004), 309-332.

_____, “Restructuring the Russian Electricity Sector: Re-creating California?”, *Energy Policy* 35 (2007a), 1872-1883.

_____, “Make or buy on the Russian railway? Coase, Williamson, and Tsar Nicholas II,” *Economic Change and Restructuring* 40 (2007b), 207-221.

Que, G., "Electricity retail price: cross-subsidies and international comparison and reforms", *Electric Technical Economics* 2 (2003).

State Council of the People’s Republic of China, “China’s Energy Conditions and Policies,” Information Office, December 2007.

SPC, *Annual Report 2002*, Beijing: State Power Corporation, www.sp.com.cn.

Valeri, Laura Malaguzzi, “Welfare and competition effects of electricity interconnection between Great Britain and Ireland,” working paper, Economic and Social Research Institute (Dublin), January 2008.

Wang, X., Chai, G., “Review of Economic Policy in the Electricity Industry During the 9th Five-year Plan and Future Prospect”, in SPC (Comp.), *Summary of the Electricity Industry Performance during the 9th Five-year Plan*, Beijing: China Electric Power Press, 2001, pp. 266-277.

Wen, Xueguo, “Market Dominance by China’s Public Utility Enterprises,” *Antitrust Law Journal* 75 (2008), 151-171.

Wolak, Frank A., and Shaun D. McRae, “Merger Analysis in Restructured Electricity Supply Industries: The Proposed PSEG and Exelon Merger (2006),” working paper, Department of Economics, Stanford University, November 2007.

Wu, J.,Y. Yang and B. Sun, "Discussion on the issues of the electricity industry in the 11th five-year plan", *Electric Technical Economics* 1 (2004).

Xu, Shaofeng, and Wenying Chen, “The reform of electricity power sector in the PR of China,” *Energy Policy* 34 (2006), 2455-2465.

Xu, Yi-Chong, *Electricity Reform in China, India and Russia: The World Bank Template and the Politics of Power*, Northampton, MA: Edward Elgar, 2004.

Yang, Hongliang, “Overview of the Chinese Electricity Industry and its Current Uses,” University of Cambridge, working paper CWPE 0617, February 2006.

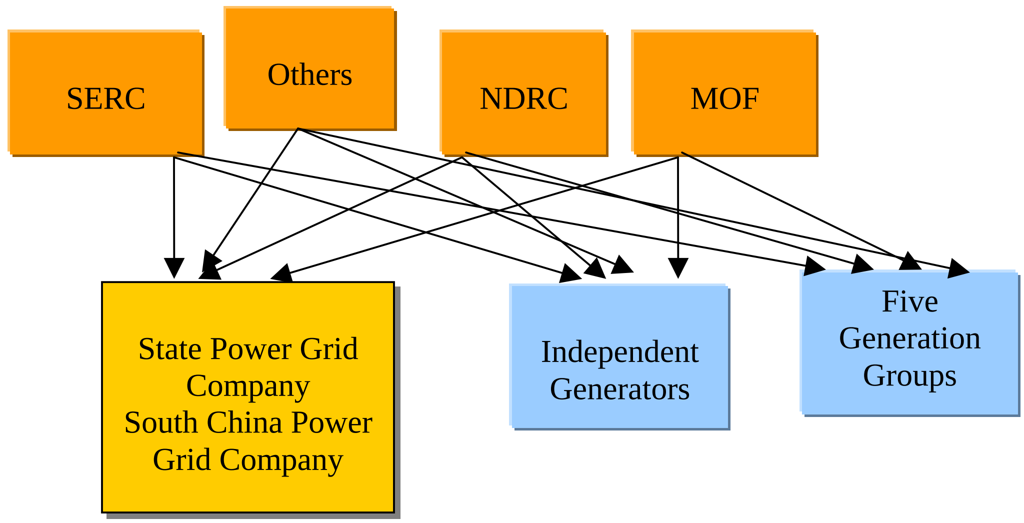
Yeh, Emily T., and Joanna I. Lewis, “State Power and the Logic of Reform in China’s Electricity Sector,” *Pacific Affairs* 77 (2004), 437-465.

Yeoh, Boon-Siew, and Rajesh Rajaraman, “Electricity in China: The Latest Reforms,” Electricity Journal 17 (April 2004), 60-69.

Zhang, Chi, and Thomas C. Heller, "Reform of the Chinese Electric Power Market: Economics and Institutions", Program on Energy and Sustainable Development, Stanford University, working paper, January 2004.

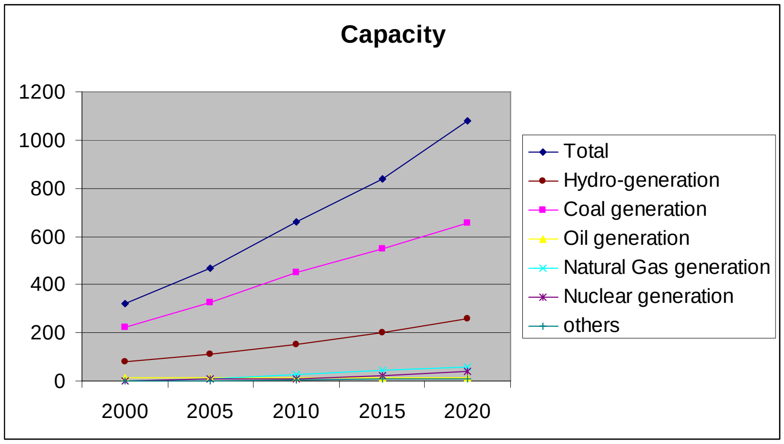
Zhang, Xinzhu, and Vanessa Yanhua Zhang, “The Antimonopoly Law in China: Where Do We Stand?”, *Competition Policy International* 3 (2007), 185-201.

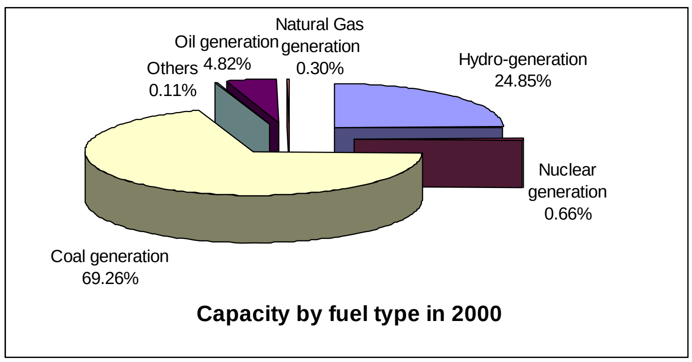
Figure 1: the institutional and market structure



Source: NDRC, 2002, year report

Figure 2: Fuel structure of electricity generation（2002）





Source: Wu et al. (2004)

Table 1: "Cost Plus" Tariff of a Representative Power Producer in Guangdong Province (1999) Yuan(USD)

Capital cost		
capital cost by capacity	Yuan/KW	6000
interest rate	Percent	10
payback period	Year	12
annual capital cost	Yuan/KW	880
operating hours	Hour	5000
Unit capital cost	***Yuan/KWh***	***0.176***
Fuel cost		
coal	Yuan/ton	300
coal consumption	Gram/KWh	475
Unit coal cost	***Yuan/KWh***	***0.143***
O&M cost	***Yuan/KWh***	***0.002***
Total cost	***Yuan($)/KWh***	***0.321(0.039)***
Misc.	Yuan/KWh	0.018
Tax & Profit	Yuan/KWh	0.10
Tariff	***Yuan($)/KWh***	***0.439(0.053)***

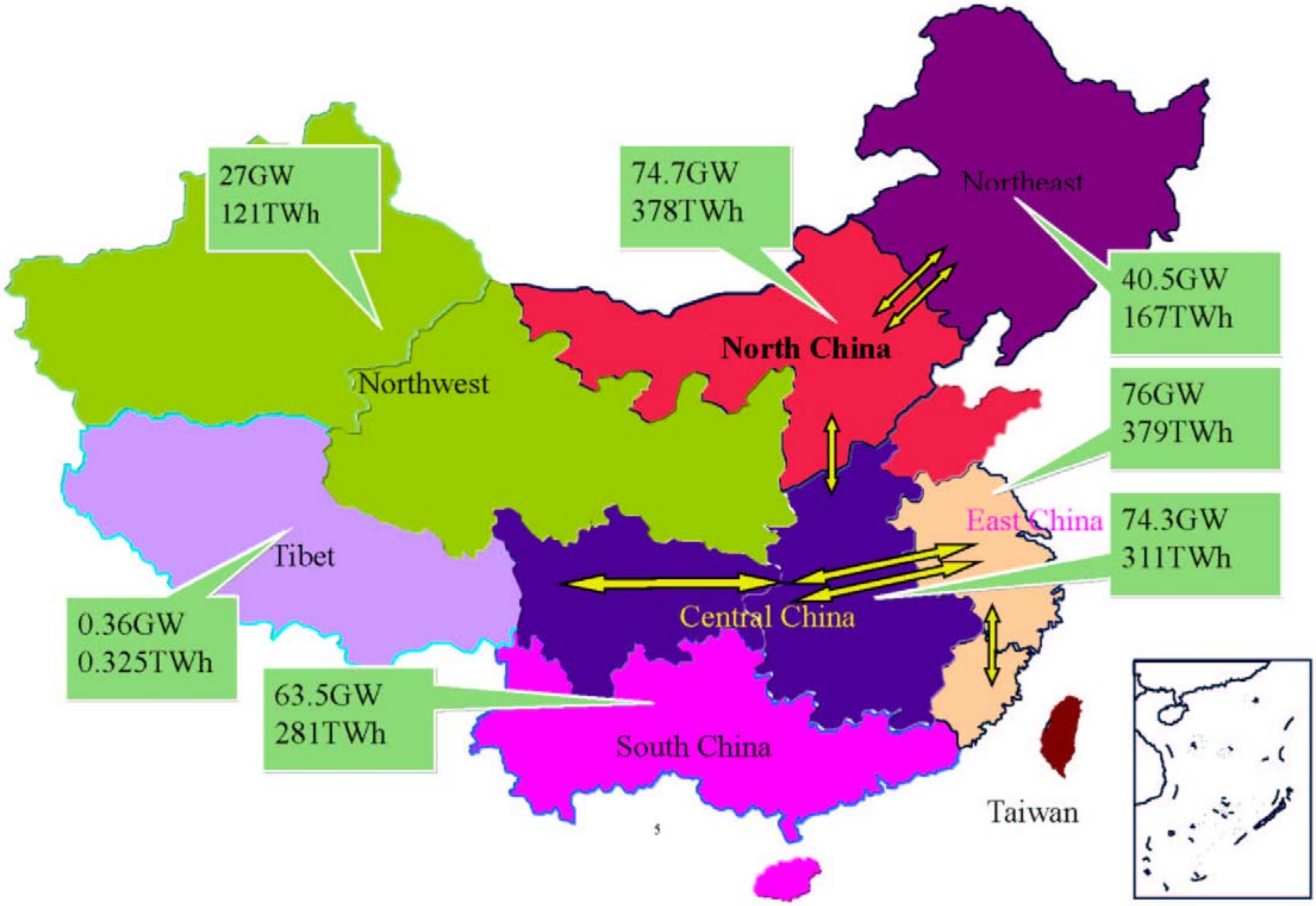
Source: GETRC (1999)

Table 2. 2002 National Average Prices paid to Power Generators

	$/KWh
Industry average	0.035
Capacity built before 1985	0.029
Capacity built after 1985	0.040
Vintage 1997 (62 plants)	0.050
Vintage 1999-2000 (70 plants)	0.043

Source: NDRC (2002)

Figure 3



27GW
121TWh
74.7GW
378TWh
Northeast
40.5GW
167TWh
North China
Northwest
76GW
379TWh
East China
74.3GW
311TWh
Tibet
0.36GW
0.325TWh
Central China
63.5GW
281TWh
South China
Taiwan

Figure 4

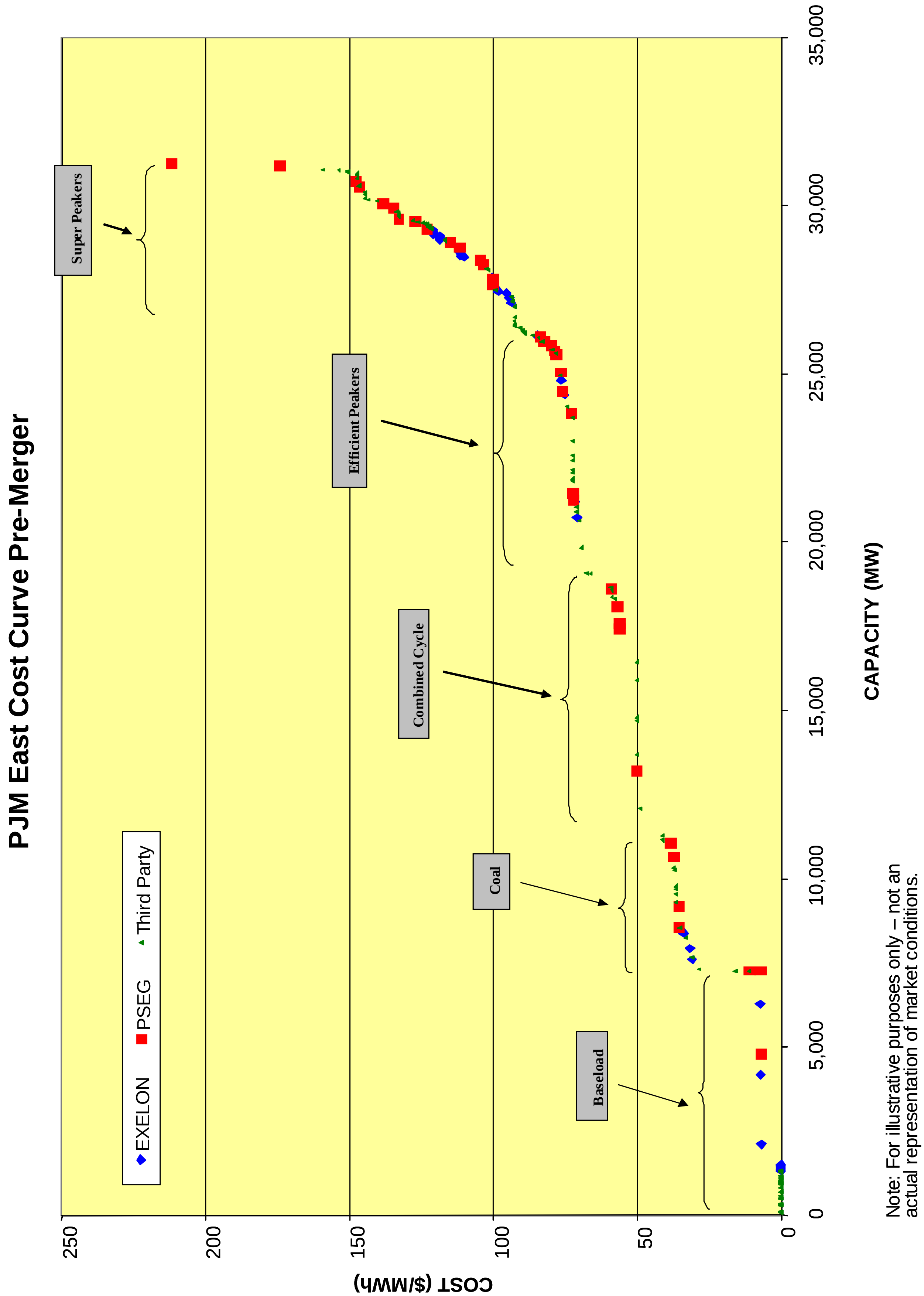

PJM East Cost Curve Pre-Merger
EXELON
PSEG
Third Party
Super Peakers
Efficient Peakers
Combined Cycle
Coal
Baseload
COST ($/MWh)
250
200
150
100
50
0
CAPACITY (MW)
0
5,000
10,000
15,000
20,000
25,000
30,000
35,000
Note: For illustrative purposes only – not an actual representation of market conditions.

Table A1

Market	Province	Generation Plant	Owner	Technology/Feul	Flood Season Capacity (MW)	Owner Subtotals	Owner Cumulative Subtotal	Percent of Capacity	Cumulative Percent of Capacity
NORTHERN MARKET									
North Market	Inner Mongolia	Tuoketuo	China Datang Corporation	Coal-fired	3,600				
North Market	Shanxi	Yangcheng	China Datang Corporation	Coal-fired	3,300				
North Market	Hebei	Zhangjiakou	China Datang Corporation	Coal-fired	2,400				
North Market	Tianjin	Panshan	China Datang Corporation/ Shenhua Group?	Coal-fired	2,200				
North Market	Hebei	Douhe	China Datang Corporation	Coal-fired	1,550				
North Market	Hebei	Dingzhou	China Datang Corporation	Coal-fired	1,200				
North Market	Hebei	Wangtan	China Datang Corporation	Coal-fired	1,200				
North Market	Shanxi	Yuncheng	China Datang Corporation	Coal-fired	1,200				
North Market	Hebei	Matou	China Datang Corporation	Coal-fired	1,000	17,650	17,650	18.28%	18.28%
North Market	Inner Mongolia	Dalate	China Huaneng Group	Coal-fired	3,000				
North Market	Inner Mongolia	Fengzhen	China Huaneng Group	Coal-fired	2,400				
North Market	Shandong	Dezhou	China Huaneng Group	Coal-fired	2,400				
North Market	Inner Mongolia	Yimin	China Huaneng Group	Coal-fired	2,200				
North Market	Inner Mongolia	Shangdu	China Huaneng Group	Coal-fired	1,800				
North Market	Hebei	Shang'an	China Huaneng Group	Coal-fired	1,300				
North Market	Hebei	Danfeng	China Huaneng Group	Coal-fired	1,200				
North Market	Shandong	Xindian	China Huaneng Group	Coal-fired	1,000				
North Market	Tianjin	Yangliuqing	China Huaneng Group	Coal-fired	975				
North Market	Shandong	Rizhao	China Huaneng Group	Coal-fired	700	16,975	34,625	17.58%	35.85%
North Market	Shandong	Zouxian	China Huadian Corporation	Coal-fired	4,400				
North Market	Shandong	Weifang	China Huadian Corporation	Coal-fired	1,800				
North Market	Shandong	Shiliquan	China Huadian Corporation	Coal-fired	1,225				
North Market	Tianjin	Dagang	China Huadian Corporation	Coal-fired	1,200				
North Market	Inner Mongolia	Baotou Hexi	China Huadian Corporation	Coal-fired	1,200				
North Market	Shandong	Laicheng	China Huadian Corporation	Coal-fired	1,200				
North Market	Shandong	Qingdao	China Huadian Corporation	Coal-fired	1,200				
North Market	Shandong	Huangdao	China Huadian Corporation	Coal-fired	730				
North Market	Beijing	Beijing second Coal-fired	China Huadian Corporation	Coal-fired	200	13,155	47,780	13.62%	49.48%
North Market	Shanxi	Shentou second	China Power Investment Corporation	Coal-fired	2,000				
North Market	Shanxi	Zhangze	China Power Investment Corporation	Coal-fired	1,640				
North Market	Inner Mongolia	Tongliao	China Power Investment Corporation	Coal-fired	1,400				
North Market	Shanxi	Hejin	China Power Investment Corporation	Coal-fired	1,300				
North Market	Shanxi	Shentou first	China Power Investment Corporation	Coal-fired	1,300				
North Market	Inner Mongolia	Baiyinhua	China Power Investment Corporation	Coal-fired	1,200				
North Market	Inner Mongolia	Huolinhe	China Power Investment Corporation	Coal-fired	1,200	10,040	57,820	10.40%	59.87%
North Market	Shanxi	Datong second	China Guodian Corporation	Coal-fired	2,400				
North Market	Shandong	Heze	China Guodian Corporation	Coal-fired	1,450				
North Market	Hebei	Longshan	China Guodian Corporation	Coal-fired	1,200				
North Market	Shanxi	Taiyuan first	China Guodian Corporation	Coal-fired	1,200				
North Market	Shandong	Liaocheng second	China Guodian Corporation	Coal-fired	1,200				
North Market	Shandong	Feixian	China Guodian Corporation	Coal-fired	1,200				
North Market	Shandong	Shiheng	China Guodian Corporation	Coal-fired	1,200	9,850	67,670	10.20%	70.07%
North Market	Inner Mongolia	Yuanbaoshan	State Grid Corporation of China	Coal-fired	2,100				
North Market	Shanxi	Xilongchi	State Grid Corporation of China	Hydro (Pumped Storage)	1,200				
North Market	Hebei	Qinhuangdao	State Grid Corporation of China	Coal-fired	1,000				
North Market	Hebei	Zhanghewan	State Grid Corporation of China	Hydro (Pumped Storage)	1,000				
North Market	Shandong	Tai'an	State Grid Corporation of China	Hydro (Pumped Storage)	1,000	6,300	73,970	6.52%	76.60%
North Market	Hebei	Huanghua	Shenhua Group Co. Ltd.	Coal-fired	1,200				
North Market	Shanxi	Hequ	Shenhua Group Co. Ltd.	Coal-fired	1,200				
North Market	Inner Mongolia	Zhunge'er	Shenhua Group Corporation Limited	Coal-fired	660				
North Market	Hebei	Sanhe	Shenhua Group Co. Ltd.	Coal-fired	0	3,060	77,030	3.17%	79.77%
North Market	Shandong	Yunhe	Shandong Luneng Group Co. Ltd.	Coal-fired	1,240				
North Market	Shandong	Liaocheng Coal-fired	Shandong Luneng Group Co. Ltd.	Coal-fired	1,221	2,461	79,491	2.55%	82.31%
North Market	Hebei	Xibaipo	Hebei Xibaipo Power Ltd.	Coal-fired	2,400	2,400	81,891	2.49%	84.80%
North Market	Hebei	Xingtai	Hebei Xingtai Power Generation Co. Ltd.	Coal-fired	1,800	1,800	83,691	1.86%	86.66%
North Market	Shanxi	Liuzhou	Liuzhou Power Generation Co. Ltd.	Coal-fired	1,400	1,400	85,091	1.45%	88.11%
North Market	Inner Mongolia	Daihai	Beijing Engergy Investment Holding Co., Ltd. (PowerBeijing)	Coal-fired	1,200	1,200	86,291	1.24%	89.35%
North Market	Hebei	Hengshui	China Resources Power Holdings Co. Ltd.	Coal-fired	1,200	1,200	87,491	1.24%	90.60%
North Market	Inner Mongolia	Huhehaote	Inner Mongolia Electric Power Corp	Hydro (Pumped Storage)	1,200	1,200	88,691	1.24%	91.84%
North Market	Inner Mongolia	Haibowan	Inner Mongolia Haibowan Electricity Co.,Ltd	Coal-fired	1,200	1,200	89,891	1.24%	93.08%
North Market	Shanxi	Wangqu	Luneng Group	Coal-fired	1,200	1,200	91,091	1.24%	94.33%
North Market	Shanxi	Wuxiang	Shanxi Hexin Electric Power Development Co. Ltd.	Coal-fired	1,200	1,200	92,291	1.24%	95.57%
North Market	Shanxi	Yangquan second	State Energy Resources Investment Co.	Coal-fired	1,200	1,200	93,491	1.24%	96.81%
North Market	Shanxi	Wanjiazhai	Yellow River Wanjiazhai Hydroelectric Development Co Ltd.	Hydro	1,080	1,080	94,571	1.12%	97.93%
North Market	Shandong	Longkou	Shandong Century Electric Power Development Co., Ltd.	Coal-fired	1,000	1,000	95,571	1.04%	98.96%
North Market	Shandong	Shengli oil field	Shengli Oil Production Co.	Oil	1,000	1,000	96,571	1.04%	100.00%
						NORTHERN TOTAL	**96,571**		

Table A2

Market	Province	Generation Plant	Owner	Technology/Feul	Flood Season Capacity (MW)	Owner Subtotals	Owner Cumulative Subtotal	Percent of Capacity	Cumulative Percent of Capacity
NORTHEASTERN MARKET									
Northeastern Market	Heilongjiang	Shuangyashan	China Guodian Corporation	Coal-fired	2,020				
Northeastern Market	Jilin	Shuangliao	China Guodian Corporation	Coal-fired	1,200				
Northeastern Market	Liaoning	Zhuanghe	China Guodian Corporation	Coal-fired	1,200				
Northeastern Market	Liaoning	Kangping	China Guodian Corporation	Coal-fired	1,200				
Northeastern Market	Jilin	Fengman	China Guodian Corporation	Hydro	1,010	6,630	6,630	22.33%	22.33%
Northeastern Market	Liaoning	Qinghe	China Power Investment Corporation	Coal-fired	1,800				
Northeastern Market	Liaoning	Dalian	China Power Investment Corporation	Coal-fired	1,400				
Northeastern Market	Liaoning	Fuxin	China Power Investment Corporation	Coal-fired	1,400				
Northeastern Market	Liaoning	Liaoning	China Power Investment Corporation	Coal-fired	1,100				
Northeastern Market	Jilin	Hunjiang	China Power Investment Corporation	Coal-fired	900	6,600	13,230	22.23%	44.56%
Northeastern Market	Jilin	Jiutai	China Huaneng Group	Coal-fired	2,640				
Northeastern Market	Liaoning	Yingkou	China Huaneng Group	Coal-fired	1,800				
Northeastern Market	Heilongjiang	Hegang	China Huaneng Group	Coal-fired	1,200	5,640	18,870	19.00%	63.56%
Northeastern Market	Heilongjiang	Ha'erbin Third	China Huadian Corporation	Coal-fired	1,600				
Northeastern Market	Heilongjiang	Fula'erji Second	China Huadian Corporation	Coal-fired	1,200				
Northeastern Market	Liaoning	Tieling	China Huadian Corporation	Coal-fired	1,200				
Northeastern Market	Heilongjiang	Mudanjiang Second	China Huadian Corporation	Coal-fired	1,020	5,020	23,890	16.91%	80.46%
Northeastern Market	Jilin	Baishan	Jilin Changbai Hydro Power Group	Hydro	1,800	1,800	25,690	6.06%	86.53%
Northeastern Market	Liaoning	Suizhong	Shenhua Group Co. Ltd.	Coal-fired	1,600	1,600	27,290	5.39%	91.92%
Northeastern Market	Liaoning	Pushihe	State Grid Xin Yuan Co. Ltd.	Hydro (Pumped Storage)	1,200	1,200	28,490	4.04%	95.96%
Northeastern Market	Liaoning	Jinzhou	China Datang Corporation	Coal-fired	1,200	1,200	29,690	4.04%	100.00%
					NORHTEASTERN TOTAL		29,690		

Table A3

Market	Province	Generation Plant	Owner	Technology/Feul	Flood Season Capacity (MW)	Owner Subtotals	Owner Cumulative Subtotal	Percent of Capacity	Cumulative Percent of Capacity
NORTHWESTERN MARKET									
Northwestern Market	Qinghai	Laxiwa	China Power Investment Corporation	Hydro	4,200				
Northwestern Market	Qinghai	Lijiaxia	China Power Investment Corporation	Hydro	1,600				
Northwestern Market	Qinghai	Gongboxia	China Power Investment Corporation	Hydro	1,500				
Northwestern Market	Qinghai	Longyangxia	China Power Investment Corporation	Hydro	1,280	8,580	8,580	30.30%	30.30%
Northwestern Market	Shanxi	Hancheng second	China Datang Corporation	Coal-fired	2,400				
Northwestern Market	Shanxi	Weihe	China Datang Corporation	Coal-fired	1,300				
Northwestern Market	Ningxia	Daba	China Datang Corporation	Coal-fired	1,200	4,900	13,480	17.31%	47.61%
Northwestern Market	Gansu	Jingyuan	China Guodian Corporation	Coal-fired	2,000				
Northwestern Market	Shanxi	Baoji second	China Guodian Corporation	Coal-fired	1,200				
Northwestern Market	Ningxia	Shizuishan second	China Guodian Corporation	Coal-fired	1,200	4,400	17,880	15.54%	63.15%
Northwestern Market	Shanxi	Tongchuan	China Huaneng Group	Coal-fired	1,200				
Northwestern Market	Gansu	Pingliang	China Huaneng Group	Coal-fired	1,200				
Northwestern Market	Shanxi	Qinling	China Huaneng Group	Coal-fired	1,050	3,450	21,330	12.18%	75.33%
Northwestern Market	Shanxi	Pucheng	China Huadian Corporation	Coal-fired	1,200				
Northwestern Market	Ningxia	Lingwu	China Huadian Corporation	Coal-fired	1,200	2,400	23,730	8.48%	83.81%
Northwestern Market	Qinghai	Qiaotou	Qinghai Qiaotou Power Co Ltd.	Coal-fired	1,325	1,325	25,055	4.68%	88.49%
Northwestern Market	Shanxi	Jinjie	Shenhua Group Co. Ltd.	Coal-fired	1,200	1,200	26,255	4.24%	92.72%
Northwestern Market	Gansu	Liujiaxia	State Grid Corporation of China	Hydro	1,160	1,160	27,415	4.10%	96.82%
Northwestern Market	Gansu	Lanzhou Aluminum	Lanzhou Aluminum Co. Ltd.	Coal-fired	900	900	28,315	3.18%	100.00%
Northwestern Market	Xinjiang				0	0	28,315	0.00%	100.00%
					NORTHWESTERN TOTAL		28,315		

Table A4

Market	Province	Generation Plant	Owner	Technology/Feul	Flood Season Capacity (MW)	Owner Subtotals	Owner Cumulative Subtotal	Percent of Capacity	Cumulative Percent of Capacity
CENTRAL MARKET									
Central	Sichuang	Xiluodu	China Three Gorges Project Corporation (CTGPC)	Hydro	12,600				
Central	Hubei	Three gorges	China Three Gorges Project Corporation (CTGPC)	Hydro	8,000				
Central	Sichuang	Xiangjiaba	China Three Gorges Project Corporation (CTGPC)	Hydro	6,000	26,600	26,600	24.33%	24.33%
Central	Sichuang	Pubugou	China Guodian Corporation	Hydro	3,300				
Central	Jiangxi	Fengcheng	China Guodian Corporation	Coal-fired	2,400				
Central	Hubei	Jinmen	China Guodian Corporation	Coal-fired	1,800				
Central	Jiangxi	Jiujiang	China Guodian Corporation	Coal-fired	1,350				
Central	Jiangxi	Huangjinbu	China Guodian Corporation	Coal-fired	1,200				
Central	Sichuang	Jiangyou	China Guodian Corporation	Coal-fired	1,200				
Central	Sichuang	Jintang	China Guodian Corporation	Coal-fired	1,200				
Central	Sichuang	Baima	China Guodian Corporation	Coal-fired	900	13,350	39,950	12.21%	36.54%
Central	Henan	Sanmenxia	China Datang Corporation	Hydro	2,870				
Central	Henan	Shouyangshan	China Datang Corporation	Coal-fired	2,200				
Central	Hunan	Xiangtan	China Datang Corporation	Coal-fired	1,800				
Central	Chongqing	Pengshui	China Datang Corporation	Hydro	1,750				
Central	Hunan	Jinzhushan	China Datang Corporation	Coal-fired	1,200				
Central	Hunan	Leiyang	China Datang Corporation	Coal-fired	1,000				
Central	Henan	Luoyang	China Datang Corporation	Coal-fired	960				
Central	Henan	Anyang	China Datang Corporation	Coal-fired	800	12,580	52,530	11.50%	48.04%
Central	Sichuang	Jinping second	Ertan Hydropower Development Co. Ltd.	Hydro	4,800				
Central	Sichuang	Jinping first	Ertan Hydropower Development Co. Ltd.	Hydro	3,600				
Central	Sichuang	Ertan	Ertan Hydropower Development Co. Ltd.	Hydro	3,300	11,700	64,230	10.70%	58.74%
Central	Hubei	Xiangfan	China Huadian Corporation	Coal-fired	2,400				
Central	Sichuang	Guang'an	China Huadian Corporation	Coal-fired	2,400				
Central	Henan	Xinxiang	China Huadian Corporation	Coal-fired	1,250				
Central	Henan	Xinxiang baoshan	China Huadian Corporation	Coal-fired	1,200				
Central	Hunan	Shimen	China Huadian Corporation	Coal-fired	1,200				
Central	Sichuang	Luzhou	China Huadian Corporation	Coal-fired	1,200				
Central	Hunan	Changsha	China Huadian Corporation	Coal-fired	0	9,650	73,880	8.83%	67.57%
Central	Henan	Yaomeng	China Power Investment Corporation	Coal-fired	2,400				
Central	Hubei	Dabieshan	China Power Investment Corporation	Coal-fired	1,200				
Central	Henan	Jiaozuo	China Power Investment Corporation	Coal-fired	1,200				
Central	Hunan	Liyujiang Second	China Power Investment Corporation	Coal-fired	1,200				
Central	Hunan	Wuqiangxi	China Power Investment Corporation	Hydro	1,200				
Central	Jiangxi	Guixi	China Power Investment Corporation	Coal-fired	1,100				
Central	Henan	Zhengzhou	China Power Investment Corporation	Coal-fired	1,000	9,300	83,180	8.51%	76.07%
Central	Chongqing	Luohuang	China Huaneng Group	Coal-fired	2,600				
Central	Hubei	Yangluo	China Huaneng Group	Coal-fired	2,400				
Central	Hunan	Yueyang	China Huaneng Group	Coal-fired	1,300				
Central	Henan	Qinbei	China Huaneng Group	Coal-fired	1,200	7,500	90,680	6.86%	82.93%
Central	Henan	Hebi	Henan Investment Group	Coal-fired	2,200				
Central	Henan	Yahekou	Henan Investment Group	Coal-fired	1,900	4,100	94,780	3.75%	86.68%
Central	Hubei	Bailianhe	State Grid Corporation of China	Hydro (Pumped Storage)	1,200				
Central	Henan	Baoquan	State Grid Corporation of China	Hydro (Pumped Storage)	1,200				
Central	Hunan	Zhexi	State Grid Corporation of China	Hydro	950	3,350	98,130	3.06%	89.74%
Central	Hubei	Shuibuya	Hubei Qingjiang Hydroelectric Development Co Ltd.	Hydro	1,600				
Central	Hubei	Geheyan	Hubei Qingjiang Hydroelectric Development Co Ltd.	Hydro	1,200	2,800	100,930	2.56%	92.30%
Central	Hubei	Gezhouba	China Gezhouba Group Co. Ltd.	Hydro	2,715	2,715	103,645	2.48%	94.79%
Central	Hubei	Ezhou	Hubei Energy Group Co. Ltd.	Coal-fired	1,800	1,800	105,445	1.65%	96.43%
Central	Henan	Xiaolangdi	Yellow River Water & Hydropower Development Co.	Hydro	1,800	1,800	107,245	1.65%	98.08%
Central	Hubei	Hanchuan	Hubei Hanxin Power Generation Co. Ltd.	Coal-fired	1,200	1,200	108,445	1.10%	99.18%
Central	Hubei	Danjiangkou	Hanjiang Group Co. Ltd.	Hydro	900	900	109,345	0.82%	100.00%
Central	Hunan	Yiyang	Hunan Yiyang Power Generation Co. Ltd.	Coal-fired	0	0	109,345	0.00%	100.00%
						CENTRAL TOTAL	109,345		

Table A5

Market	Province	Generation Plant	Owner	Technology/Feul	Flood Season Capacity (MW)	Owner Subtotals	Owner Cumulative Subtotal	Percent of Capacity	Cumulative Percent of Capacity
SOUTHERN MARKET									
South Market	Yunnan	Xiaowan	China Huaneng Group	Hydro	4,200				
South Market	Yunnan	Jinghong	China Huaneng Group	Hydro	1,750				
South Market	Yunnan	Manwan	China Huaneng Group	Hydro	1,550				
South Market	Guangdong	Shantou	China Huaneng Group	Coal-fired	1,200				
South Market	Guangdong	Shantou haimen	China Huaneng Group	Coal-fired	1,200				
South Market	Hainan	Haikou	China Huaneng Group	Coal-fired	1,200	11,100	11,100	11.98%	11.98%
South Market	Guangxi	Longtan	China Datang Corporation	Hydro	4,900				
South Market	Guangdong	Sanbaimen	China Datang Corporation	Coal-fired	1,200				
South Market	Guangxi	Yantan	China Datang Corporation	Hydro	1,200				
South Market	Guangxi	Tianshengqiao first	China Datang Corporation	Hydro	1,200				
South Market	Guangxi	Heshan	China Datang Corporation	Coal-fired	1,000	9,500	20,600	10.26%	22.24%
South Market	Guizhou	Pannan	Guizhou Jinyuan Power Group Co. Ltd.	Coal-fired	1,200				
South Market	Guizhou	Qianbei	Guizhou Jinyuan Power Group Co. Ltd.	Coal-fired	1,200				
South Market	Guizhou	Nayong first	Guizhou Jinyuan Power Group Co. Ltd.	Coal-fired	1,200				
South Market	Guizhou	Yaxi	Guizhou Jinyuan Power Group Co. Ltd.	Coal-fired	1,200				
South Market	Guizhou	Qianxi	Guizhou Jinyuan Power Group Co. Ltd.	Coal-fired	1,200	6,000	26,600	6.48%	28.72%
South Market	Guangdong	Ling'ao	China Guangdong Nuclear Power Group	Nuclear	4,000				
South Market	Guangdong	Dayawan	China Guangdong Nuclear Power Group	Nuclear	1,800	5,800	32,400	6.26%	34.98%
South Market	Guangdong	Huilai	Guangdong Yudean Group Co. Ltd.	Coal-fired	1,200				
South Market	Guangdong	Zhanjiang	Guangdong Yudean Group Co. Ltd.	Coal-fired	1,200				
South Market	Guangdong	Shajiao first	Guangdong Yudean Group Co. Ltd.	Coal-fired	1,200				
South Market	Guangdong	Shaoguan	Guangdong Yudean Group Co. Ltd.	Coal-fired	1,150				
South Market	Guangdong	Qianwan gas	Guangdong Yudean Group Co. Ltd.	Gas-fired	1,050	5,800	38,200	6.26%	41.24%
South Market	Guangxi	Guigang	China Huadian Corporation	Coal-fired	1,200				
South Market	Guizhou	Dafang	China Huadian Corporation	Coal-fired	1,200				
South Market	Guizhou	Wujiangdu	China Huadian Corporation	Hydro	1,100				
South Market	Guizhou	Silin	China Huadian Corporation	Hydro	1,000	4,500	42,700	4.86%	46.10%
South Market	Guangdong	Mawan	Shenzhen Energy Group Co.Ltd.	Coal-fired	1,800				
South Market	Guangdong	Heyuan	Shenzhen Energy Group Co.Ltd.	Coal-fired	1,200				
South Market	Guangdong	Shenzhen east gas	Shenzhen Energy Group Co.Ltd.	Gas-fired	1,050	4,050	46,750	4.37%	50.47%
South Market	Yunnan	Dachaoshan	State Development and Investment Co.	Hydro	1,350				
South Market	Guangxi	Qinzhou	State Development and Investment Co.	Coal-fired	1,200				
South Market	Yunnan	Qujing	State Development and Investment Co.	Coal-fired	1,200	3,750	50,500	4.05%	54.52%
South Market	Guangdong	Huizhou	China Southern Power Grid Co. Ltd.	Hydro (Pumped Storage)	2,400				
South Market	Guangxi	Tianshengqiao second	China Southern Power Grid Co. Ltd.	Hydro	1,320	3,720	54,220	4.02%	58.53%
South Market	Yunnan	Xuanwei	China Guodian Corporation	Coal-fired	1,200				
South Market	Yunnan	Xiaolongtan	China Guodian Corporation	Coal-fired	1,200				
South Market	Guizhou	Anshun	China Guodian Corporation	Coal-fired	1,200	3,600	57,820	3.89%	62.42%
South Market	Hubei	Three gorges	China Three Gorges Project Corporation (CTGPC)	Hydro	3,000	3,000	60,820	3.24%	65.66%
South Market	Guangdong	Taishan	Shenhua Group Co. Ltd.	Coal-fired	3,000	3,000	63,820	3.24%	68.90%
South Market	Guizhou	Goupitan	Wujiang Hydropower Development Co. Ltd	Hydro	3,000	3,000	66,820	3.24%	72.14%
South Market	Guangdong	Zhuhai	Guangdong Zhuhai Power Co. Ltd.	Coal-fired	2,400	2,400	69,220	2.59%	74.73%
South Market	Guangdong	Guangzhou	Guangzhong Pumped Storage Power Joint Venture Co.	Hydro (Pumped Storage)	2,400	2,400	71,620	2.59%	77.32%
South Market	Guangdong	Yangxi	Pearl River Investment Co. Ltd.	Coal-fired	2,400	2,400	74,020	2.59%	79.91%
South Market	Guangdong	Zhujiang	Guangzhou Zhujiang Power Co. Ltd.	Coal-fired	1,900	1,900	75,920	2.05%	81.96%
South Market	Guangdong	Shajiao third	Guangdong Guanghope Power Co.Ltd.	Coal-fired	1,800	1,800	77,720	1.94%	83.90%
South Market	Guangdong	Huangpu	Guangdong Yuehua Power Company Ltd.	Coal-fired	1,350	1,350	79,070	1.46%	85.36%
South Market	Guangdong	Zhanjiang Aoli	China National Petroleum Co.	Orimulsion Oil	1,200	1,200	80,270	1.30%	86.66%
South Market	Guangxi	Fangchenggang	CLP Power Asia Limited	Coal-fired	1,200	1,200	81,470	1.30%	87.95%
South Market	Guangdong	Shanwei	Guangdong Red Bay Generation Co. Ltd.	Coal-fired	1,200	1,200	82,670	1.30%	89.25%
South Market	Guizhou	Nayong second	Guizhou Electric Power Co.	Coal-fired	1,200	1,200	83,870	1.30%	90.54%
South Market	Yunnan	Diandong	Yunnan Diandong Energy Co. Ltd.	Coal-fired	1,200	1,200	85,070	1.30%	91.84%
South Market	Guangdong	Huizhou gas-fired	Guangdong Huizhou LNG Power Co. Ltd.	Gas-fired	1,050	1,050	86,120	1.13%	92.97%
South Market	Guizhou	Guangzhao	Guizhou Qianyuan Power Co. Ltd.	Hydro	1,040	1,040	87,160	1.12%	94.09%
South Market	Guizhou	Sanbanxi	China Power Investment Corporation	Hydro	1,000	1,000	88,160	1.08%	95.17%
South Market	Guizhou	Panxian	Guizhou Qiangui Electric Power Co. Ltd.	Coal-fired	1,000	1,000	89,160	1.08%	96.25%
South Market	Guangdong	Nanhai first	King Sung Eletnc Power Group	Coal-fired	1,000	1,000	90,160	1.08%	97.33%
South Market	Guangdong	Hengmen	China National Offshore Oil Co. (CNOOC)	Oil	950	950	91,110	1.03%	98.36%
South Market	Guangxi	Laibin	Guangxi Fangyuan Elctric Powre Co. Ltd.	Coal-fired	950	950	92,060	1.03%	99.38%
South Market	Guangdong	Hengyun	Guangzhou Hengyun Enterprise (Group) Co. Ltd	Coal-fired	570	570	92,630	0.62%	100.00%
						SOUTHERN TOTAL	92,630		

Table A6

Market	Province	Generation Plant	Owner	Technology/Feul	Flood Season Capacity (MW)	Owner Subtotals	Owner Cumulative Subtotal	Percent of Capacity	Cumulative Percent of Capacity
EASTERN MARKET									
East Market	Jiangsu	Taicanggang	China Huaneng Group	Coal-fired	2,650				
East Market	Zhejiang	Yuhuan	China Huaneng Group	Coal-fired	2,000				
East Market	Jiangsu	Taicang	China Huaneng Group	Coal-fired	1,800				
East Market	Zhejiang	Changxing	China Huaneng Group	Coal-fired	1,450				
East Market	Jiangsu	Nantong	China Huaneng Group	Coal-fired	1,400				
East Market	Shanghai	Shidongkou first	China Huaneng Group	Coal-fired	1,200				
East Market	Shanghai	Shidongkou second	China Huaneng Group	Coal-fired	1,200				
East Market	Anhui	Chaohu	China Huaneng Group	Coal-fired	1,200				
East Market	Shanghai	Shidongkou Gas-fired	China Huaneng Group	Gas-fired	1,050				
East Market	Jiangsu	Huaiyin	China Huaneng Group	Coal-fired	1,000	14,950	14,950	12.59%	12.59%
East Market	Zhejiang	Jiaxing	Zhejiang Provincial Energy Group Co. Ltd	Coal-fired	3,000				
East Market	Zhejiang	Beilun	Zhejiang Provincial Energy Group Co. Ltd (51%) / China Guodian Corporation (47%)	Coal-fired	3,000				
East Market	Zhejiang	Zhenhai	Zhejiang Provincial Energy Group Co. Ltd	Coal-fired	1,800				
East Market	Zhejiang	Wenzhou	Zhejiang Provincial Energy Group Co. Ltd	Coal-fired	1,450				
East Market	Zhejiang	Taizhou	Zhejiang Provincial Energy Group Co. Ltd	Coal-fired	1,350				
East Market	Zhejiang	Lanxi	Zhejiang Provincial Energy Group Co. Ltd	Coal-fired	1,200				
East Market	Zhejiang	Leqing	Zhejiang Provincial Energy Group Co. Ltd	Coal-fired	1,200				
East Market	Zhejiang	Xiaoshan	Zhejiang Provincial Energy Group Co. Ltd	Coal-fired	950	13,950	28,900	11.74%	24.33%
East Market	Shanghai	Waigaoqiao	China Power Investment Corporation	Coal-fired	5,000				
East Market	Anhui	Pingyu	China Power Investment Corporation	Coal-fired	2,400				
East Market	Shanghai	Wubang	China Power Investment Corporation	Coal-fired	2,075				
East Market	Jiangsu	Changshu	China Power Investment Corporation	Coal-fired	1,200	10,675	39,575	8.99%	33.32%
East Market	Zhejiang	Wushashan	China Datang Corporation	Coal-fired	2,400				
East Market	Anhui	Luohe	China Datang Corporation	Coal-fired	2,400				
East Market	Jiangsu	Xutang	China Datang Corporation	Coal-fired	1,250				
East Market	Anhui	Ma'anshan second	China Datang Corporation	Coal-fired	1,200				
East Market	Fujian	Ningde	China Datang Corporation	Coal-fired	1,200				
East Market	Anhui	Tianjia'an	China Datang Corporation	Coal-fired	1,100				
East Market	Anhui	Huaibei	China Datang Corporation	Coal-fired	1,050	10,600	50,175	8.92%	42.24%
East Market	Jiangsu	Jianbi	China Guodian Corporation	Coal-fired	2,100				
East Market	Jiangsu	Taizhou	China Guodian Corporation	Coal-fired	2,000				
East Market	Fujian	Fuzhou	China Guodian Corporation	Coal-fired	1,400				
East Market	Jiangsu	Changzhou	China Guodian Corporation	Coal-fired	1,200				
East Market	Anhui	Tongling yongfeng	China Guodian Corporation	Coal-fired	1,200				
East Market	Anhui	Bengbu	China Guodian Corporation	Coal-fired	1,200				
East Market	Fujian	Fuzhou Jiangyin	China Guodian Corporation	Coal-fired	1,200	10,300	60,475	8.67%	50.92%
East Market	Jiangsu	Wangting	China Huadian Corporation	Coal-fired	1,300				
East Market	Zhejiang	Banshan	China Huadian Corporation	Coal-fired	1,300				
East Market	Anhui	Suzhou	China Huadian Corporation	Coal-fired	1,200				
East Market	Anhui	Wuhu baoding	China Huadian Corporation	Coal-fired	1,200				
East Market	Fujian	Kemen	China Huadian Corporation	Coal-fired	1,200				
East Market	Jiangsu	Qishuyan	China Huadian Corporation	Coal-fired	1,100				
East Market	Jiangsu	Yangzhou	China Huadian Corporation	Coal-fired	1,000	8,300	68,775	6.99%	57.90%
East Market	Hubei	Three gorges	China Three Gorges Project Corporation (CTGPC)	Hydro	7,200	7,200	75,975	6.06%	63.97%
East Market	Jiangsu	Yangzhou second	China Resources Power Holdings Co. Ltd.	Coal-fired	2,400				
East Market	Jiangsu	Changshu second	China Resources Power Holdings Co. Ltd.	Coal-fired	1,200				
East Market	Jiangsu	Pengcheng	China Resources Power Holdings Co. Ltd.	Coal-fired	1,200				
East Market	Anhui	Fuyang	China Resources Power Holdings Co. Ltd.	Coal-fired	1,200	6,000	81,975	5.05%	69.02%
East Market	Fujian	Houshi	Huayang Power Co. Ltd. (Taiwan)	Coal-fired	3,600	3,600	85,575	3.03%	72.05%
East Market	Fujian	Putian Gaz	China National Offshore Oil Co. (CNOOC)	Gas-fired	1,400				
East Market	Fujian	Jinjiang Gaz	China National Offshore Oil Co. (CNOOC)	Gas-fired	1,400	2,800	88,375	2.36%	74.41%
East Market	Zhejiang	Tianhuangping	State Grid Corporation of China	Hydro (Pumped Storage)	1,800				
East Market	Jiangsu	Yixing	State Grid Corporation of China	Hydro (Pumped Storage)	1,000	2,800	91,175	2.36%	76.76%
East Market	Jiangsu	Ligang	Jiangsu Ligang Power Co. Ltd.	Coal-fired	2,600	2,600	93,775	2.19%	78.95%
East Market	Zhejiang	Qinshan second	Nuclear Power Qinshan Joint Venture Co. Ltd.	Nuclear	2,600	2,600	96,375	2.19%	81.14%
East Market	Anhui	Tianji	Huaihu Coal & Power Co. Ltd.	Coal-fired	1,200				
East Market	Anhui	Fengtai	Huaihu Coal & Power Co. Ltd.	Coal-fired	1,200	2,400	98,775	2.02%	83.16%
East Market	Zhejiang	Ninghai	Shenhua Group Co. Ltd.	Coal-fired	2,400	2,400	101,175	2.02%	85.18%
East Market	Jiangsu	Tianwan	Jiangsu Nuclear Power Co.	Nuclear	2,000	2,000	103,175	1.68%	86.87%
East Market	Jiangsu	Xuzhou	Guohua Xudian Co. Ltd.	Coal-fired	1,900	1,900	105,075	1.60%	88.47%
East Market	Jiangsu	Zhenjiang	Zhenjiang Dagang Thermal Power Generation Co. Ltd.	Coal-fired	1,700	1,700	106,775	1.43%	89.90%
East Market	Fujian	Shuikou	Fujian Shuikou Power Generation Co. Ltd.	Hydro	1,400	1,400	108,175	1.18%	91.08%
East Market	Zhejiang	Qinshan third	Third Qinshan Nuclear Power Co.Ltd.	Nuclear	1,400	1,400	109,575	1.18%	92.25%
East Market	Shanghai	Baoshan	Baoshan Steel Co.	Coal-fired	1,200	1,200	110,775	1.01%	93.26%
East Market	Jiangsu	Shazhou	Shazhou Electric Power Generation Co.	Coal-fired	1,200	1,200	111,975	1.01%	94.27%
East Market	Fujian	Songyu	Xiamen Huaxia Int'l Electric Power Development Co, Ltd.	Coal-fired	1,200	1,200	113,175	1.01%	95.29%
East Market	Jiangsu	Zhangjiagang	Zhangjiagang Shazhou Electric Power Co. Ltd.	Coal-fired	1,200	1,200	114,375	1.01%	96.30%
East Market	Zhejiang	Tongbai	Zhejiang Tongbai Electric Power Generation Co. Ltd.	Hydro (Pumped Storage)	1,200	1,200	115,575	1.01%	97.31%
East Market	Jiangsu	Xiagang	Jiangsu Sulong Power Co. Ltd.	Coal-fired	1,100	1,100	116,675	0.93%	98.23%
East Market	Jiangsu	Tianshenggang	Tianshenggang Electric Power Generation Co.	Coal-fired	1,100	1,100	117,775	0.93%	99.16%
East Market	Jiangsu	Xinhai	Xinhai Electric Power Generation Co.	Coal-fired	1,000	1,000	118,775	0.84%	100.00%
						EASTERN TOTAL	118,775		