Chapter 9

Deregulation, Competition, and Market Integration in China's Electricity Sector

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CHAPTER 9

Deregulation, Competition, and Market Integration in China's Electricity Sector

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This report presents an updated and expanded review of reforms in China's electricity sector. It aims to examine the impact of reforms on competition, deregulation, and electricity market integration in China. The findings are used to draw policy implications for electricity market development, particularly the promotion of energy market integration (EMI).

Keywords: electricity sector, reforms, unbundling, energy market integration and China

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Introduction

East Asia Summit (EAS) members have been actively promoting energy market integration (EMI) in their individual economies as well as within the EAS block. Among various energy products, electricity plays an important role in EMI as it allows member-countries to be connected through cross-border power grids. China as an EAS member has been the world's largest electricity user as well as producer since 2011. The country has also been engaged in cross-border trading in electricity with several other EAS members (namely, Lao PDR, Myanmar, and Viet Nam). Internally, China's electricity sector has undergone dramatic changes, and further restructuring is anticipated in the near future. Thus, a study of China's electricity sector may help elicit important insights into issues such as deregulation, competition, and market integration. The findings may also have implications for other EAS member economies that are undertaking a similar trajectory of reforms.

Several existing studies have focused on China's electricity sector. For example, the role of the private sector in China's power generation was the theme of a World Bank (2000) conference. Also, an Asian Development Bank (ADB) report examined electricity demand and investment requirements (Lin 2003). Several years later, a study by the International Energy Agency or IEA (2006) discussed further reforms after the 2002 restructuring and provided policy recommendations for the Chinese government, while Yang (2006) presented a brief review of China's electricity sector.

More recently, a short report by ADB (2011) provided observations and suggestions about China's electricity sector; an IEA (2012) project explored the policy options for low-carbon power generation in China; and an ERIA discussion paper (Sun *et al*., 2012) examined barriers to private and foreign investment in China's power sector. However, these existing research works are either outdated or concerned with a specific issue. Thus, this study aims to present an updated examination of various issues in China's power sector, especially on reforms and market integration. It begins with a review of China's electricity industry, followed by a discussion of major reforms in the

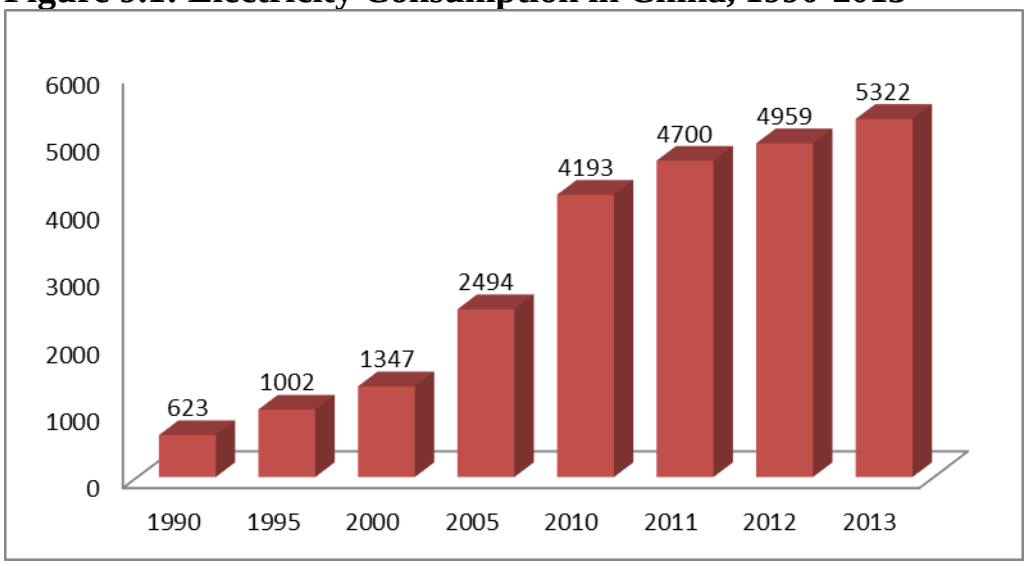
sector. The challenges and implications are then explored. The paper concludes with some policy recommendations.

China's Electricity Sector

Demand for electricity has seen robust growth for decades in China (Figure 9.1). In particular, it doubled between the years 1990 and 2000 and trebled between 2000 and 2010. In 2011, China overtook the United States as the world's largest power consumer with a consumption share of 21.8 percent of the world's total, while the US share continuously declined to 20.3 percent (Figure 9.2). Power demand in China is now more than the combined total consumption in Japan, Russia, India, Germany, Canada, and Brazil. However, on a per-capita basis, China's power consumption is only a fraction of that in major economies such as the United States and Japan (Figure 9.3).

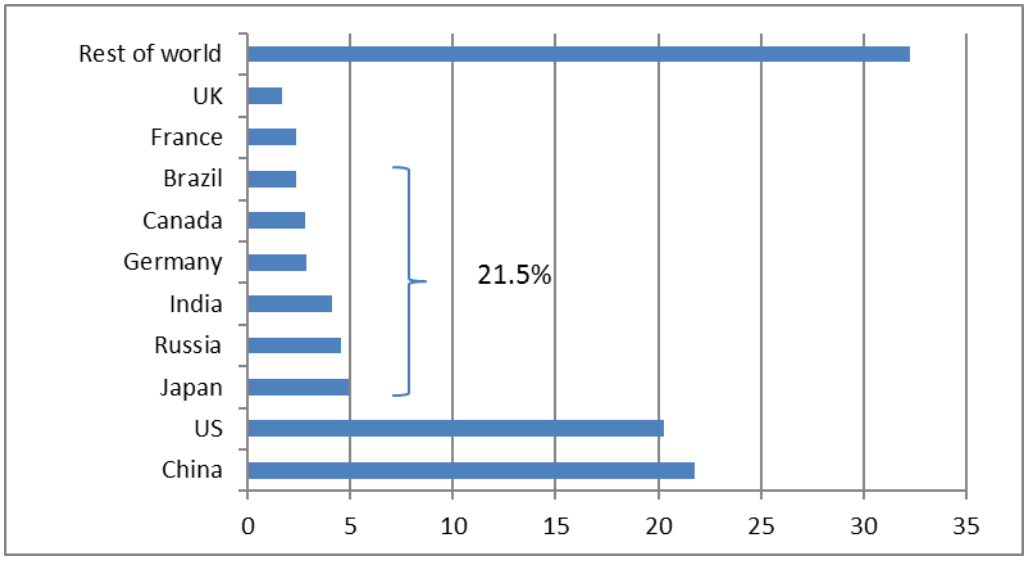
While the Chinese economy flourishes, there remains considerable room for further growth in both per-capita and total electricity consumption. For example, electricity demand in China will reach 8,767 terawatt hours (TWh) in 2035, according to the ADB (2013). That level would double China's total consumption in 2010. In terms of per-capita consumption, China would only proximate the current level of demand in Russia or Japan. According to J. Wu (2013), China's per-capita consumption of electricity in 2050 will reach 9,300 kilowatt hours (KWh), which is close to the current consumption level in high-income OECD economies in 2011 (WDI, 2013).

Figure 9.1: Electricity Consumption in China, 1990-2013



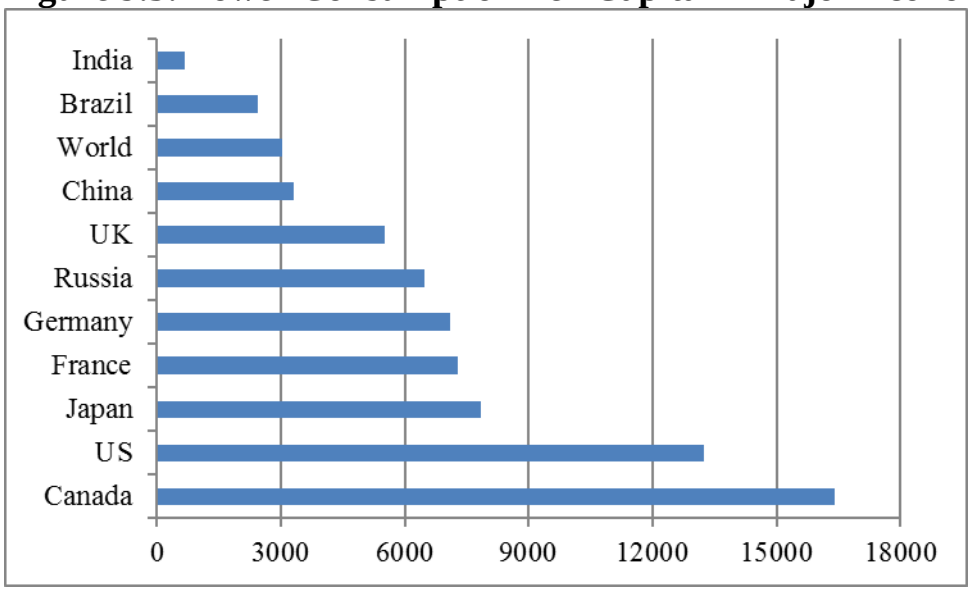
Note: The unit on the y-axis is TWh.
Source: NBS (various issues) and NEA (2014).

Figure 9.2: Consumption Shares (%) in Major Economies in 2011



Source: The numbers are calculated using data from WDI (2013).

Figure 9.3: Power Consumption Per-Capita in Major Economies in 2011



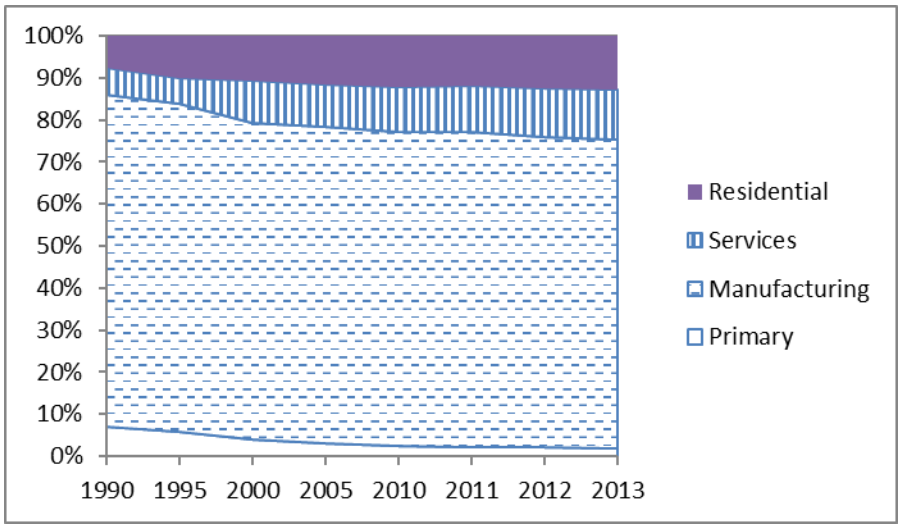
Note: The unit of measurement is kilowatt hours (kWh).
Source: WDI (2013).

At the sector level, manufacturing still accounts for the lion's share of China's total electricity consumption due to the ongoing rapid industrialisation (Figure 9.4). In 2013, the manufacturing sector used 73.5 percent of China's total electricity consumption, which is slightly smaller than its 79.3 percent share in 1990. Therefore, while manufacturing's share of China's electricity consumption is still high, it is declining. In comparison, the Japanese manufacturing sector's share dropped from 70.2 percent in 1973 to 29.7 percent by 2011. Likewise, that of South Korea slid from 69.0 percent in 1973 to 52.3 percent by 2011 (OECD, 2014). If these are any indications of China's own trajectory, then the country's manufacturing's share of electricity consumption is expected to also continue to fall in the coming decade.

However, power consumption in the service and household sectors grow faster than that in the primary and manufacturing sectors. For example, the average percentage growth rates during 2005-2013 are 3.4 percent for the primary; 9.6 percent, industrial; 12.1 percent, service; and 11.3 percent, residential sector. As a result, consumption shares of households and services increased from 7.7 percent and 6.2 percent in 1990, to 12.8 percent and 11.8 percent in 2013, respectively. During the period 1973-2011, these shares respectively rose from 19.1 percent and 10.5 percent, to 30.9 percent and 38.8

percent in Japan; and from 12.1 percent and 18.3 percent, to 13.1 percent and 32.3 percent in South Korea (OECD, 2014). There is, hence, considerable room for growth in the electricity consumption of China's own household and service sectors.

Figure 9.4: China's Electricity Consumption Shares By Sector, 1990-2013



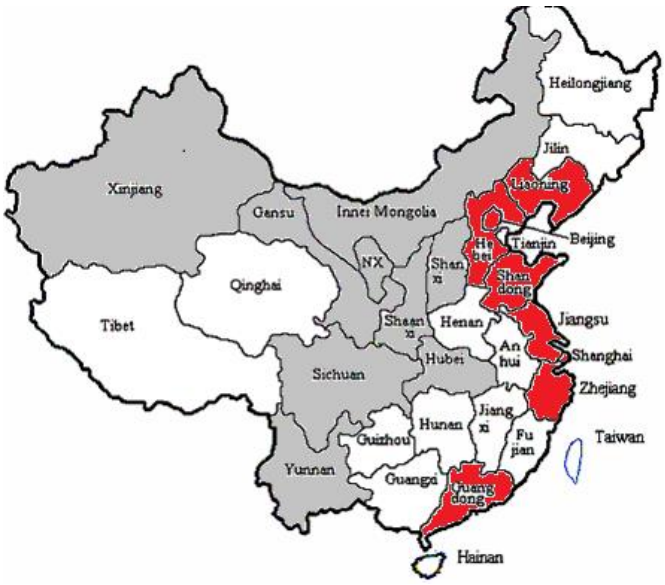
Source: Author's own estimates using data from the NBS (various issues) and NEA (2014).

One of the features in China's electricity sector is the uneven distribution of resources across its regions. In particular, the coastal regions tend to be net importers of electricity while the western regions are net exporters (Figure 9.5). Thus, cross-regional electricity trade in China is inevitable. This requires efficient transmission lines and an integrated market. For example, Xinjiang's power grid was connected with the northwest power grid in 2010 and has since exported electricity to the rest of the country, including Jiangsu and Zhejiang (CP, 2013). In 2013, the total power exported from Xinjiang amounted to 6 TWh, according to Xinhua News Agency (2014a).

There is also some cross-border power trading between China's Yunan province and Lao PDR, Myanmar, and Viet Nam. The first cross-border transmission between China and Lao PDR took place in 2001; and that between China and Viet Nam in 2004. China reportedly exported 3.2 gigawatt hours (GWh) to Viet Nam and 0.2 GWh to Lao PDR in 2013. In the same

year, Yunan also imported about 1.9 GWh from Myanmar (MOC, 2014). So far, the total power exchanges are valued at about US$1.5 billion. Heilongjiang in Northeast China has also been importing electricity from Russia amounting to about 13 GWh since 1992.[2] Imported Russian electricity is anticipated to reach 3.6 GWh in 2014.

Figure 9.5: Power Supply and Demand Situations By Region

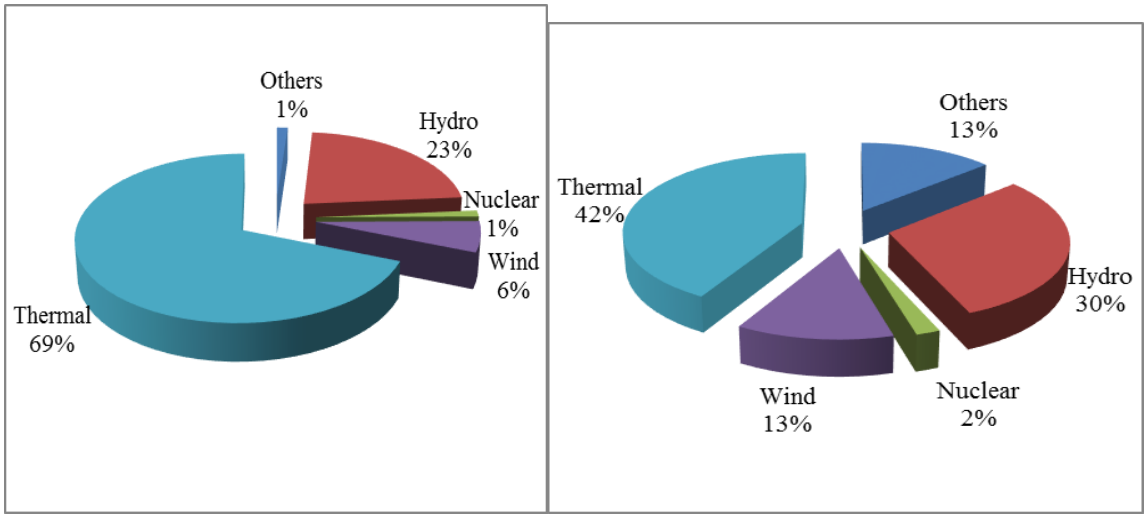


Note: Power exporting and importing regions are painted in black and red, respectively. Regions without colour have either small deficits or surplus in power supply.
Source: Author's own drawing.

By 2013, China's total installed generation capacity amounted to 1,247 gigawatts (GW), of which 862 terawatts (TW) are sourced from thermal, 280 TW from hydro, 75 TW from wind, and 15 TW from nuclear power plants (NEA, 2014). Clearly, thermal power facility takes the dominant share (Figure 9.6). According to a Bloomberg (2013) report, China's generation capacity will be more than double in 2030, with large expansions in wind and solar energy-powered generations. This changing trend is already taking place. Of the newly installed generation capacity in 2013, more than a half is based on non-thermal sources (Figure 9.6).

[2] These import statistics were reported by Xinhua News Agency (2014b).

Figure 9.6: Structure of China's Generation Capacity, 2013



(a) Total installed capacity (b) Newly installed capacity

Sources: NEA (2014).

The structure of production output is generally consistent with the pattern of generation capacity. Coal-fired generators still dominate thermal production and account for the largest share, followed by hydropower (Table 9.1). The market is divided between fossil fuel generation (coal, oil, and gas) with a share of 80.9 percent, and non-fossil fuel production with a share of 19.1 percent in 2011.

In the near future, coal will remain a main fuel in China. Coal-fire power is projected to still secure about 43 percent of the market share in China by 2050 (J. Wu 2013). This has serious environmental consequences. It also leaves China far behind its neighbours in terms of international environmental perspectives. For example, Germany will reportedly reduce its use of coal in electricity generation and increase the share of renewables from the current 25 percent to 80 percent in 2050 (The Economist, 2014). Meanwhile, in that same year, China's electricity production is projected to still be divided equally between fossil fuels and non-fossil fuels (J. Wu, 2013).

Table 9.1: China's Electricity Output Shares (%) in 2011

Fossil fuels	Shares	Non-fossil fuels	Shares
Coal	78.953	Nuclear	1.831
Gas	1.781	Hydro	14.822
Oil	0.168	Wind	1.491
		Solar	0.054
		Biofuels	0.668
		Waste	0.229
		Others	0.003
Sub-total	80.902	Sub-total	19.098

Source: IEA (2013)

Evolution of Reforms in the Power Sector

China's electricity sector began with a single vertically integrated utility, which the government through its Ministry of Power Industry owns and operates. Following the global trend of deregulation, a series of reform initiatives were implemented. The first reform initiative in China's power sector was the introduction of independent power producers (IPPs) into the generation sector in the 1980s (IEA, 2006). At one point, IPPs in China cornered a 14.5 percent market share (Sun, *et al*., 2012). By the late 1990s, all non-state generators provided more than half of the country's total electricity supplies (Wu, 2013; Du, *et al*., 2009).

The participation of IPPs and other non-state generators were argued to play a critical role in the growth of China's power generation. While fuel and equipment prices increased dramatically, competition helped reduce the cost of generation and boosted output growth to overcome investment inadequacy and power shortage in the country in the 1990s.

The second major change was the corporatisation of the electricity businesses, thus establishing the State Power Corporation (SPC) in 1997 (Sun, *et al*., 2012). This represents the first move to separate businesses from regulatory

activities. The SPC was state-owned and a typical vertically integrated power supplier. It later became the main focus of electricity sector reforms in China.

The third wave of reforms was initiated in 2002. China's ambitious program involved the unbundling of power distribution, grid management, and generation. The goal was to introduce competition into the electricity industry. Due to this round of reforms, the SPC was divided into two grid companies, five generation companies, and two auxiliary companies (i.e., the Power Construction Corporation of China and China Energy Engineering Group Co Ltd). The two grid companies are the State Grid Corporation (SGC), which owns five regional grids; and South China Grid Corporation (SCGC), which operates the grid that interconnects five southern regions (Figure 9.7). Meanwhile, the five power generation companies are China Huaneng Group, China Huadian Group, China Datang Co., China Guodian Co., and China Power Investment Co. (Shi, 2012). These five power providers together captured a market share of about 40 percent in 2006 (Zhang, 2008).

Figure 9.7: Map of China's Main Power Grids

Source: Author's own drawing.

In the area of institutional development, the promulgation of the Electricity Act in 1995 was a hallmark. The Act laid the foundation for reforms in 1997

and 2002. To strengthen regulatory functions, the State Electricity Regulatory Commission (SERC) was formed in 2003. Its role is to promote reforms and create a market-based power industry with competing players and to set prices according to supply and demand situations in the market. Following the formation of SERC, a series of regulatory rules were released in 2005, including the first major revision of the 1995 Electricity Act (Table 9.2). Those rules and the Act have since guided the supply and demand of electricity, grid access, infrastructure development, and energy preservation in China.

However, it is argued that after almost a decade, SERC as an independent regulatory body still falls behind its stated goals (Shi, 2012). For example, open bidding for grid access was pilot-tested in two regional markets (Northeast and East China) but was later suspended. Government also still plays the key role in price setting. In 2013, SERC and National Energy Administration (NEA) merged to form the current NEA.

Table 9.2: China's Electricity Sector Reform Initiatives

Periods	Reform initiatives
1979	Establishment of the Ministry of Power Industry
1980s	Introduction of IPPs
1995	Release of the Electricity Act
1997	Establishment of SPC
2002	Split of SPC into SG and SCG
2003	Formation of SERC
2005	Revision of the Electricity Act
2008	Formation of NEA
2010	Establishment of NEC
2013	Merger of SERC and NEA
2014	Pilot reforms in Yunnan and Inner Mongolia

Source: Author's own work.

In March 2014, right after the National People's Congress (NPC) and Political Consultative Conference (PCC), reforms in the electricity sector gained new momentum. During the two political gatherings, a consensus was reached to deepen economic reforms, including those in the power sector.

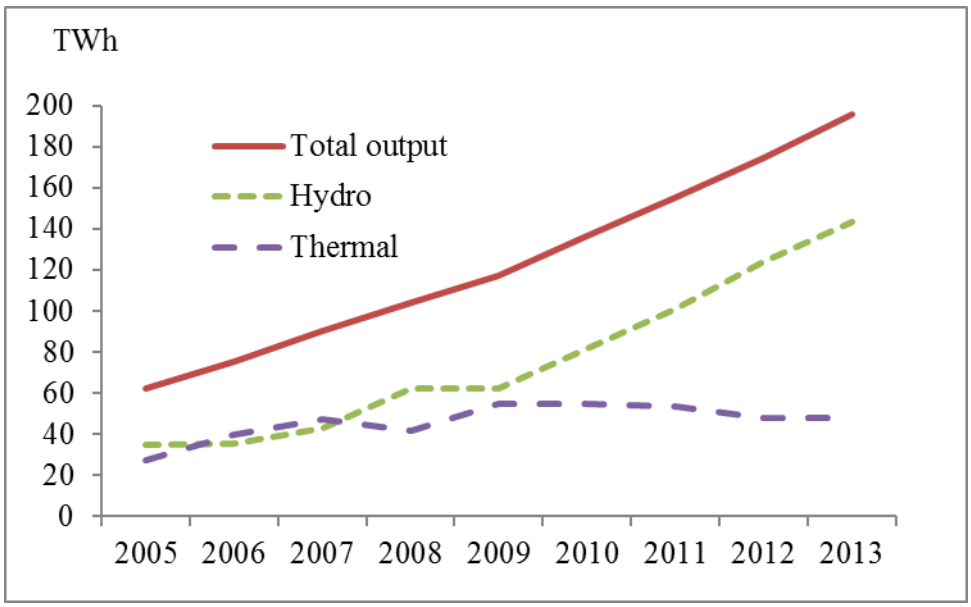
On 18 April 2014, the National Energy Commission (NEC) held the second meeting of its kind after the first gathering in 2010. The NEC, which is led by China's prime minister, is the most powerful energy institution. Its board consists of officials from the central bank; other government bodies responsible for the environment, finance, and energy; state-owned enterprises (SOEs), etc. This latest meeting stressed the need to construct ultra high-voltage (UHV) electricity transmission lines as well as China's commitment to the use of nuclear energy. In addition, NEC reaffirmed the reform of the electricity sector, particularly by introducing the direct purchase and sale of electricity between generators and large consumers. Yunnan province was designated to pilot test the scheme immediately.

Reform Initiatives in 2014: Yunnan and Inner Mongolia

The country's policymakers recently gave Yunnan and Inner Mongolia the go-signal to implement the latest reform initiatives. These initiatives include the direct purchase and sale of electricity between large consumers and generators and the development of smart grids. One main reason these two regions were selected for this initiative is the presence of an oversupply of power in their areas. Yunnan's power supply is dominated by hydroelectricity, which accounted for over 70 percent of the total production in the area and is still growing rapidly (Figure 9.8). In 2013, total production and consumption of electricity in Yunnan reached about 196 TWh and 146 TWh, respectively.

Oversupply coupled with inadequate transmission facility means that some hydro power plants could not operate at full capacity. As the current design allows the users and suppliers to negotiate electricity sale prices directly, such negotiation is expected to lower the price of electricity so that the region may be able to develop some power-intensive industries. Meanwhile, transmission prices are currently set according to past practices. However, future prices are anticipated to be set through a public consultation process. The sum of the two (sale and transmission prices), plus some considerations to account for transmission power losses, would be the final electricity price.

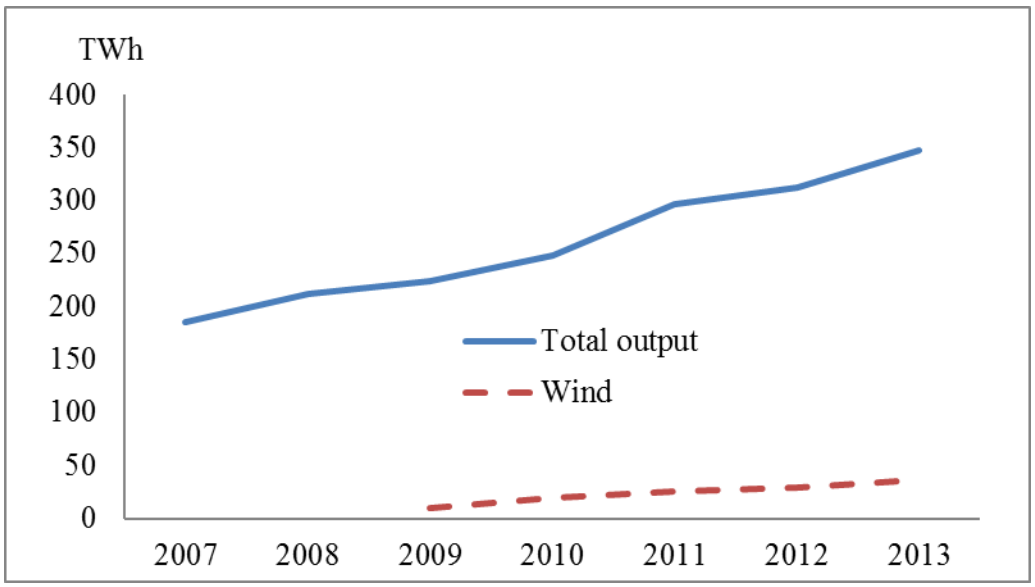
Figure 9.8: Electricity Production in Yunnan



Inner Mongolia also experienced a rapid growth in electricity supply, although slower than that in Yunnan (Figure 9.9). Wind power accounted for about 10 percent of electricity output in 2013. This share is expected to increase to 15 percent in 2015.[3] Reforms in this region will focus on developing smart grids as well as creating policies to accommodate the growth of renewable energies (REs). Currently, there is no other detailed information available yet. However, one known area needing immediate action is the excess supply of wind power in Inner Mongolia. This needs to be resolved so that wind farms will not have to shut down, as what had occurred in recent years. Thus, the connectivity between REs and inter-regional transmission are the priorities in this region.

[3] This number was cited in ASKCI (2014).

Figure 9.9: Electricity Production in Inner Mongolia



Challenges Ahead

Further reforms in China's electricity sector have been well articulated by policymakers as well as scholars. But actions have been stalled in the aftermath of the power blackout in California and supply interruption at home during severe winter weather in 2008. The current energy policy priorities include the commitment to invest in nuclear power plants along the coastal area and the construction of UHV power lines for long distance power transmission. As mentioned earlier, Yunan and Inner Mongolia were selected as pilot-testing areas for direct power sales and purchase, but the implications of this test are yet to be assessed. The proposed new reforms will, however, face several challenges.

While the Electricity Act was promulgated in 1995 and revised in 2005, the Chinese power regulatory body (SERC) is vested with lesser authority compared to its supposed counterparts such as the Federal Electricity Regulatory Commission (FERC) in the United States. The SERC has to work with two other powerful institutions; namely, the National Development and Reform Commission (NDRC) and State-owned Asset Supervision and Administration Commission (SASAC). Through its offices, the NDRC is essentially responsible for energy pricing, strategic planning, project approval,

and energy efficiency. Meanwhile, SASAC is the shareholder of the power sector's state-owned enterprises (SOEs), including the SGC and SCGC. Thus, the first challenge posed is how to strengthen the autonomy and authority of the regulatory body, the SERC, so as to truly separate regulation from business activities. In 2013, the State Council merged SERC with the National Energy Administration (NEA). This consolidation demonstrates the government's intent to have a single independent regulatory body for the electricity sector.

Nonetheless, the NEA still has to continue to work with NDRC and SASAC in one way or another. The recent NEC meeting indicates policymakers' resolve to carry out reforms in the power sector. As for its effectiveness, one just has to wait and see.

The second challenge is the need to unbundle power generation and transmission. In the 1990s, IPPs and other non-state invested power plants owned a large market share in power generation. This was due to incentives such as guaranteed returns, and prices and purchases offered to the private sector in the 1980s, when the Chinese economy was experiencing severe power shortage. Since the late 1990s, China's electricity market has become a buyers' market. When China became a World Trade Organisation member in 2001, the business environment for the private sector completely changed. Foreign investors were hit hard and started withdrawing from the Chinese market. Between 1998 and 2002, foreign investment share in the electricity sector fell from 14.3 percent to 7.5 percent (Chen, 2012). By the late 2000s, this share dropped to almost zero.

In the newly introduced scheme in Yunnan, the electricity price for a large power user is composed of two parts. One part is the agreed price directly negotiated between a generator and the consumer. The second part is the transmission cost determined currently by using historical information and eventually through public consultation. However, little has been discussed about the practice and conduct of public consultation. Its implementation is yet to be tested.

Third, pricing reform has been debated for years, but no action was ever taken. Several pilot tests for grid access bidding had been abolished. Since

electricity generation is dominated by coal-fired technology, the price of coal matters in the determination of electricity prices. The coal market is now deregulated; hence, coal price is very much set by market conditions. However, the electricity price is still regulated. Thus the upstream and downstream prices in the electricity sector are delinked. This delink has caused a lot of problems.

Urgent pricing reforms are therefore needed. As a first step, large electricity users, initially in seven provinces, have been allowed since 2004 to directly purchase electricity from the generators. By 2013, this reform was expanded to more than 10 provinces (Smartgrids, 2014). However, the direct purchase arrangement did not catch on, and in fact was stopped in most regions by 2014. The main problem stemmed from the lack of coordinated reforms in other aspects of the electricity business (such as unbundling).

In early 2014, Chinese policymakers and their advisors initiated the same reform measure anew in Yunnan. They remain convinced that large electricity users should be allowed to directly purchase power from generators and that this practice could lead to further deregulation.

Finally, while electricity market integration is the key for effective reforms, China's power market remains fragmented due to several factors:

1) Cross-regional trade in electricity is still limited, and institutional facilities for cross-regional trade are underdeveloped;
2) The price of electricity has been controlled by the government for a long time. The invisible hand of the market forces plays no role in price setting nor in affecting supply and demand;
3) Although the country's grid networks are interconnected, the capacity and efficiency of long distance transmission of electricity is still constrained. Hydropower stations in Yunnan cannot operate at full capacity as surplus output cannot be sent out of the province. This is the same constraint seen in the wind and solar power production in Inner Mongolia, where the lack of smart grids hindered the utilisation of the existing facilities recently.

Conclusions and Policy Recommendations

China has made substantial progress in the electricity sector's deregulation, competition, and market integration. Major changes took place particularly in the late 1990s and early 2000s. These changes helped China overcome power shortage, complete the construction of a national grid and introduce multiple players in the electricity sector in a short period of time. However, the reforms seem to have stalled in recent years. China still has a long way to catch up with developed economies such as the United States, the United Kingdom, and Australia in market and institutional development in the electricity sector. Although the national grids are physically interconnected, the country's electricity market remains fragmented. Thus, the electricity sector has not realised the maximum benefits of an integrated market.

Because of the dominance of state-owned enterprises in the market, governments at various levels can always find ways to intervene in businesses. As a result, electricity pricing and business activities are still tightly controlled and the role of the markets' invisible hands is limited, not to mention complete unbundling of generation, transmission and distribution of electricity. To overcome these shortcomings, five policy recommendations are made. These cover pricing reform, institution-building, market integration, private participation and foreign investment, and renewable power sources.

Recommendation 1: Getting the electricity price right. China has made major efforts to improve the pricing mechanism of main fuels such as coal and oil. These fuels' domestic prices now move closely with international prices. However, electricity price in China is still tightly controlled and hence, cannot respond in a timely manner to the changing conditions in the fuel markets. This situation can affect the generation sector gravely when the fuel prices are very volatile.

It is important to introduce reforms in electricity pricing so as to get the electricity price right. A gradual approach could be adopted. The first step may be to allow direct negotiations between generators and large power users. The second step could involve the separation of the transmission business from the distribution side. The third step may be to expand the direct negotiation of sales to medium-size power users and allow for bidding for

transmission. The policy makers' endorsement of the pilot schemes in Yunnan and Inner Mongolia is encouraging and a step toward the right direction.

Recommendation 2: Building an independent regulatory institution. Successful implementation of electricity sector deregulation in major economies such as the United States and the United Kingdom started with the establishment of an independent regulatory body. In China, the electricity sector is now composed of multiple players. China has been successful in the corporatisation of the electricity businesses initially. In terms of regulatory responsibility, multiple parties (NEA, NDRC, and SASAC) are also involved. None of those institutions can function independently of each other. This has come about partly due to the historical role of NDRC in central planning. Formerly called the National Planning Commission (NPC), the NDRC was responsible for the country's economic plans and strategies. Under the current regime, the NDRC maintains some of the functions of the old NPC. Therefore, vested interests make it impossible for either of the trio to have the ultimate authority in electricity regulation. Here is where there is a need to consolidate the regulatory tasks for execution by a single, independent body. China's telecommunication sector has been relatively successful in deregulation and may be able to offer lessons for the electricity sector.

Recommendation 3: Promoting electricity market integration. While the main power grids in China are physically interconnected, the Chinese market is still fragmented. This is largely due to the monopoly of the grid companies and the highly regulated nature of the entire sector. An integrated electricity market would help smooth demand and use regional resources more effectively. Also, given China's vast land area, infrastructure development becomes vital for the efficient transmission of power over long distances. The country's current plan to build several ultra-high voltage transmission lines across the nation seems to be the right move.

A more integrated market can help maintain stable supply and price of electricity, which is often a prerequisite for the introduction of drastic reforms. Thus, market integration and reforms mutually re-enforce each other.

Recommendation 4: Expanding the role of private players. In the 1990s, the private sector (particularly foreign IPPs) played an important role in helping overcome supply shortage and capital inadequacy in the Chinese market. However, ever since China became a WTO member in 2001, preferential policies towards private investment have been removed, leading almost all the private players to move out of the country's electricity sector. State-owned enterprises have now become the main players, mainly because their government connection helped them cope with large losses during bad times. This outcome is against the aim of reform efforts in the electricity sector. Thus, government policies are urgently needed to remove barriers to private participation and to invite non-SOEs back to the power sector.

Recommendation 5: Encouraging the development of renewables. China still overwhelmingly relies on fossil fuels for electricity generation. To control environmental pollution and meet the country's international climate change commitments, renewable energy should play an important role. In particular, China is currently enjoying the growth of hydropower, which is the main non-fossil source of power. When hydropower resources are exhausted, renewables will be the only source of growth in non-fossil energy. Renewable resources are, however, only available in certain conditions and their exploration only becomes economically feasible if technology is available or if supported by specific government policies. In the case of Inner Mongolia, for example, wind farms are not fully utilised because of infrastructure deficiency or lack of government support.

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