

Balance of power

China's power system is torn between supply, demand and politics

For three days in an average week, factories in Foshan's Shunde district have to work to keep their own lights on. As power cuts take effect in this small part of Guangdong province, home to Chinese home appliance manufacturers like Midea, Galanz and Kelon, diesel-powered generators hum to life to keep production going.

"It's impossible for any factory, if they rely on public utilities," said a Shunde factory operator, who asked that both his name and industry be withheld. "They cannot survive."

He spoke enviously of Dongguan, an industrial base to the northeast. "They only have a day or two of blackouts in a week."

In fact, Shunde's power proved so problematic that the factory operator applied to his local government to build a small coal-fired cogeneration plant to provide electricity and steam for his factory. Now he has more than enough power – and at a discount of around 40% on public utility prices.

He even enjoys a small but profitable sideline selling electricity and steam to neighboring factories.

This sideline is not officially permitted. But, with Shunde's local government eager to attract investment, there is room for flexibility. "When the county or local city has three blackout days [a week], it has to do something to fix its own problems," said the factory owner.

The troubles in Shunde reflect the continuing struggle of China's power system to provide reliable electricity supplies, especially in areas of high demand. Faced with a situation in which both generation and transmission are under strain, Beijing finds it difficult to reconcile its political desire to supply cheap, universal electric-



ity with the economic realities of power.

In recent months, policymakers have ramped up their efforts to address these problems. At the National People's Congress in March, a National Energy Bureau was established to consolidate decision-making. This followed a white paper issued by the State Council in December 2007 that outlined the main challenges for energy development in China and proposed strategies for facing them.

Demand pressures

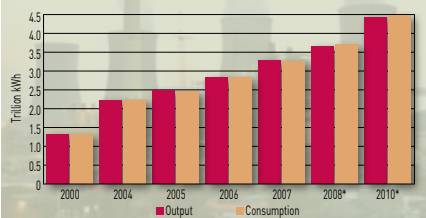
Despite a renewed government emphasis, however, the complexity of fixing problems in a system rife with disconnects means a hard road ahead for Beijing.

At the root of the troubles is a surging demand for energy. Energy, which includes but is distinct from power, refers to both the direct use of energy resources, such as oil and coal, and the secondary use of those resources through conversion into electric power.

For years, China kept energy demand in check. Dr Mark Levine, head of the China Energy Group at the Lawrence Berkeley National Laboratory in California, said strong policies limiting energy growth ensured that the country's energy demand grew less than half as fast as its

Feeding the beast

China's power output and consumption



* Predicted
Source: National Bureau of Statistics



China Foto Press

GDP between 1980 and 2000.

"That was a remarkable policy achievement," said Levine. "[But] suddenly, in 2001, all that changed."

Underlying demand for commercial buildings, roads, bridges and other infrastructure revealed itself dramatically. Between 2000 and 2006, China grew so quickly that energy use during this period exceeded the country's total historical energy use to 2000, said Levine.

Put another way, according to the International Energy Agency's (IEA) *World Energy Outlook 2007* report, the increase in China's energy demand between 2002 and 2005 was equivalent to Japan's total annual energy consumption in 2005.

Electric power consumption has also increased rapidly, and driven by China's growing economy, this rise will continue. China's National Bureau of Statistics has forecasted total power consumption of 3.7 trillion kilowatt-hours (kWh) in 2008, up 14% from 2007. By 2010, consumption is expected to hit 4.5 trillion kWh.

"These are phenomenal growth rates," said James Brock, a Beijing-based independent energy analyst who spoke to CHINA ECONOMIC REVIEW shortly

before his death in March. "And even though we've added on 100 gigawatts (GW) last year ... you're really pushing the physical capacity to deliver."

Playing with prices

The huge demand increases have prompted Beijing to introduce caps on power tariffs even as prices of raw materials have risen. In doing so, the government may have aggravated the problem.

While power tariffs have been capped, coal prices have been liberalized. Enforcing these caps, said Manop Sangiambut, an analyst with CLSA in Shanghai, could have the undesired effect of worsening inflationary pressures in the long run as the gap between tariffs and commodity prices increases.

"This structure is not sustainable," Sangiambut said.

The exact mechanism by which power tariffs are set in China is kept from outside view. However, as power is more expensive in regions where primary energy sources, such as coal, are pricier, the tariffs appear to be set on a cost-plus basis, said Sangiambut. This means tariffs are designed to cover all operating costs >>

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>> plus a certain percentage. The National Development and Reform Commission (NDRC), the agency that effectively runs power policy in China, establishes tariff schedules outlining power prices for different classes of users and kinds of demand. Then, provincial and some municipal pricing bureaus tweak tariffs based on local policies and development priorities.

Independent power producers, or IPPs, sell power to the grid, which then sells it on to users according to the NDRC's tariff schedules. The tariffs reflect Beijing's political concerns rather than market forces, with poorer agricultural users enjoying the lowest rates.

"When you have the government running a business like the power business... they use it to solve their social and welfare problems," said Bill Ruccius, former China head of power company AES and now a Hong Kong-based consultant with Asia Energy Products.

"The farmers get electricity for nothing. [The government] gives it away. If this ever changes... well, in places where there are elections, they'd get voted out."

A rock and a hard place

The IPPs continually lobby for tariff increases, but to little effect. They remain caught between rising commodity prices – namely coal – on the one hand, and low tariffs on the other. The head of a foreign-based IPP operating in China said that this gap squeezes generators and discour-



THE FACE OF BUREAUCRACY: State Grid is responsible for power transmission and distribution

ages the building of new power plants.

"A lot of operators are running into the red because of that," he said.

China's IPPs arose out of government reforms which led to the separation of power generation from transmission and distribution. The five big state-owned IPPs – Huaneng, Datang, Huadian, China Power Investment Corp and Guodian – cover most of China's generation. Meanwhile, State Grid Corporation of China (State Grid) and China Southern Power Grid Corporation control transmission and distribution.

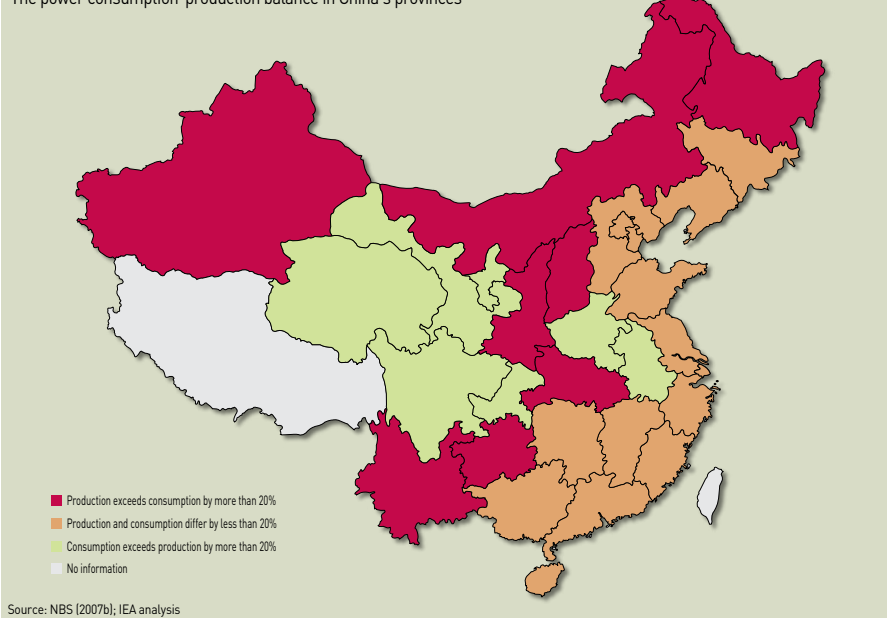
The reforms, completed in 2002, have served to make generation – or lack thereof – an easy target for criticisms about China's power system.

"The problem is they can build a factory to produce something in a few months," said Dominic Yin, chairman of both Greater China Environmental Protection and the China committee of the Independent Power Producers Forum in Hong Kong. "But if you build a power plant, it takes several years."

Lags exacerbated by factory owners frequently failing to schedule demand with the grid before bringing facilities online. This leads to shortfalls as the system tries to adapt to new demand.

Demand and supply disparities

The power consumption-production balance in China's provinces



Scheduled shutdowns

Rather than allowing power shortages to manifest themselves as brownouts, China's grid prefers to cut power to service areas. On the upside, this allows the country to avoid unscheduled outages and maintain power stability. However, said Brock, "It's common in China for the grid to call a factory and say, 'Next Wednesday, no power for you. Deal with it'."

The prevalence of these power cuts belies a system in which generation capacity has mostly kept up with demand. In fact, in raw numbers, China's power output has outpaced consumption for the last several years. The national statistics can be misleading, though.

"On the average, they've caught up," said Ruccius. "But you've got to look at China as really maybe 15 different, completely separate power markets."

Long distances between resource bases and major load centers, limited inter-connection and varying levels of demand mean that the state of power can vary significantly among provinces.

This fragmentation points to one of the fundamental problems in China's power system: Whereas the heaviest demand and expected demand increases in China come from developed coastal regions in the east and southeast, energy resources overwhelmingly lie elsewhere.

For example, about 80% of China's coal resources exist in China's northwestern provinces of Shanxi, Inner Mongolia, Shaanxi, Xinjiang, Ningxia, Hebei, Gansu and Qinghai, according to the IEA's *World Energy Outlook 2007*. But only 6% of China's coal can be found in richer coastal regions.

"There is a mismatch between the load centers and the resource centers," said François Nguyen, senior policy advisor for electricity markets at the IEA. A solid transmission infrastructure is required to link the two, he added. Providing this is the responsibility of State Grid and China Southern Power Grid.

While there is some room for inde-

pendent investment on the generation side, the two state-run grid companies effectively control the grid. As such, they are more focused on ensuring the overall security of the power supply than on maximizing efficiency or profits. This agenda led to the creation of a nationwide electricity network, but as rising demand puts the power supply system under increasing stress, its shortcomings have become clear.

Outdated infrastructure

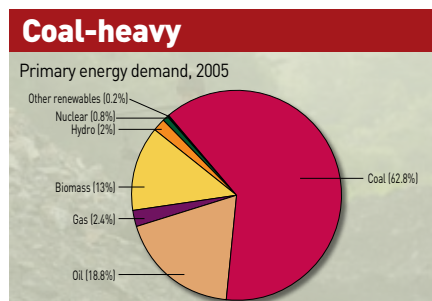
In particular, China has lacked adequate investment in high- and ultra-high-voltage power lines, used to transmit electricity over long distances. These lines have

the potential to reduce transmission losses and carry electricity more economically, said Nguyen, effectively placing more power plants near resource centers within range of load centers.

State Grid reported that by the end of 2006, China had over 282,000 kilometers of transmission lines of 220 kilovolts (kV) and above, with another 40,000km planned. However, the numbers don't tell the whole story. While approximately two-thirds of China's high-voltage transmission system consists of lines of 220kV and above, construction of higher voltage lines of over 750kV has only recently emerged in China. Nguyen drew a comparison to Canada, which has had 735kV transmission lines since the late 1960s.

John Goss, CEO of Hong Kong power and energy communications firm Ceejay International, put it more bluntly: "China [has had] quite dated technologies, if you can call them technologies."

Even as new high-voltage transmission lines have gone up, new construction has lagged creation of supply. Nguyen notes that many developed countries experience similar delays. Power plants are built in one location, he said, but >>



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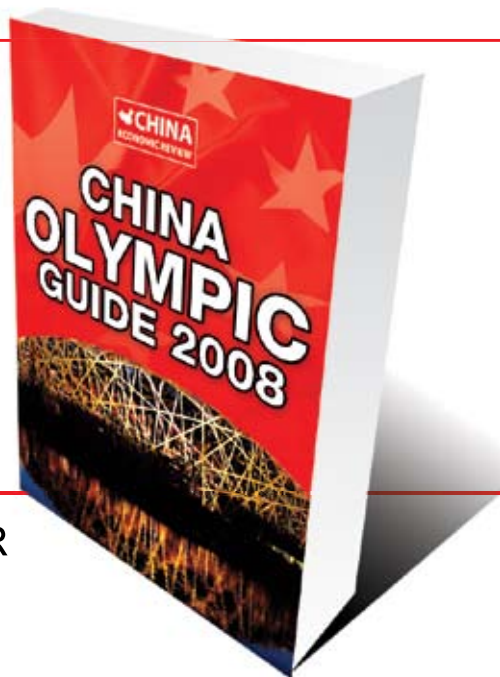
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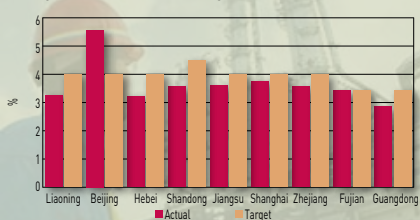


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Dialing it down

Energy intensity reduction targets and outcomes, 2005-06



Source: State Council (2006), NBS (2007), IEA analysis

>> transmission projects typically travel through corridors and necessitate the involvement of different provinces and municipalities. The need to mitigate the environmental impact of transmission projects can lead to further delays.

Although these obstacles have meant that transmission has not been able to keep up with demand, Goss said that it presents China with an opportunity to leapfrog several generations of transmission technologies.

"It's a bit like someone in the Middle East, who's never seen a telephone, suddenly gets the latest Nokia," said Goss.

Improvements on the way

Well aware of the opportunities, Beijing and the grid companies have begun pouring money into extending and improving networks. Two new 800kV transmission projects are currently under construction that will link Yunnan to Guangdong in 2010 and Sichuan to Shanghai in 2011. A 1,000kV ultra-high-voltage project connecting southeast Shanxi province to Nanyang in Henan and Jingmen in Hubei is

Uphill task: Foreigners target the energy sector

Foreign investors hoping to cash in on the estimated US\$2.74 trillion that China will invest in its power infrastructure between 2006 and 2030 may find their services are little needed.

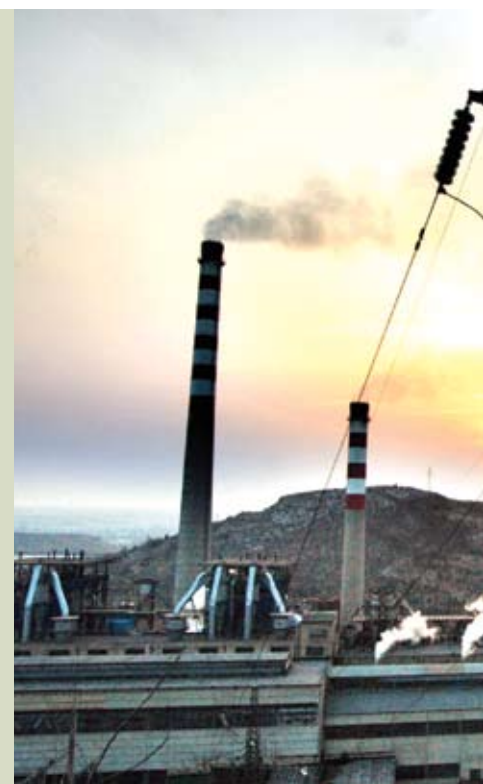
"It's now getting very difficult for foreign investors," said one foreign-based independent power producer (IPP). "I can honestly tell you, there's not much advantage [that foreign firms have] over local players in China."

China's power sector is increasingly self-sufficient in supplying the capital, technology and management skills it once required from foreigners. Thus, while legal and regulatory barriers to foreign investment in power are low, such investment is by no means a sure bet.

The promise of entering a huge market has allowed Chinese players to extract concessions from foreign companies. China permitted early agreements with companies such as GE and Siemens on the condition that those firms would share their technology with Chinese partners. Now, the IPP said, foreign companies only maintain a technological edge in areas such as nuclear and wind power.

In addition to the difficulty of proving their worth over local firms, foreign players investing in China must contend with a system that puts greater risks in the hands of producers.

In most Asian countries, generators sign long-term power purchasing agreements (PPA) with the grid to guarantee a return on their investment, said CLSA analyst Manop Sangiambut. The PPA obliges the grid to purchase a



certain amount of power from the plant at a specific tariff, effectively reducing the plant's investment risk. China, however, does not use long-term PPAs. Instead, the grid signs interconnection agreements with plants to dispatch power without specifying quantities.

Rapidly growing demand for power works to offset some of the risk of building a new plant. But the IPP noted that foreign investors accustomed to operating with PPAs may find the lack of guaranteed returns worrisome.

expected to be operational by the end of 2008. In all, the IEA expects China to invest US\$1.5 trillion in transmission and distribution between 2006 and 2030, 54.6% of the country's total expected investment in power – US\$2.74 trillion – over that period.

But Beijing knows that money alone will not solve its power problems. The State Council white paper published last year described the government's goal as building "a stable, economical, clean and safe energy supply system, so as to support sus-

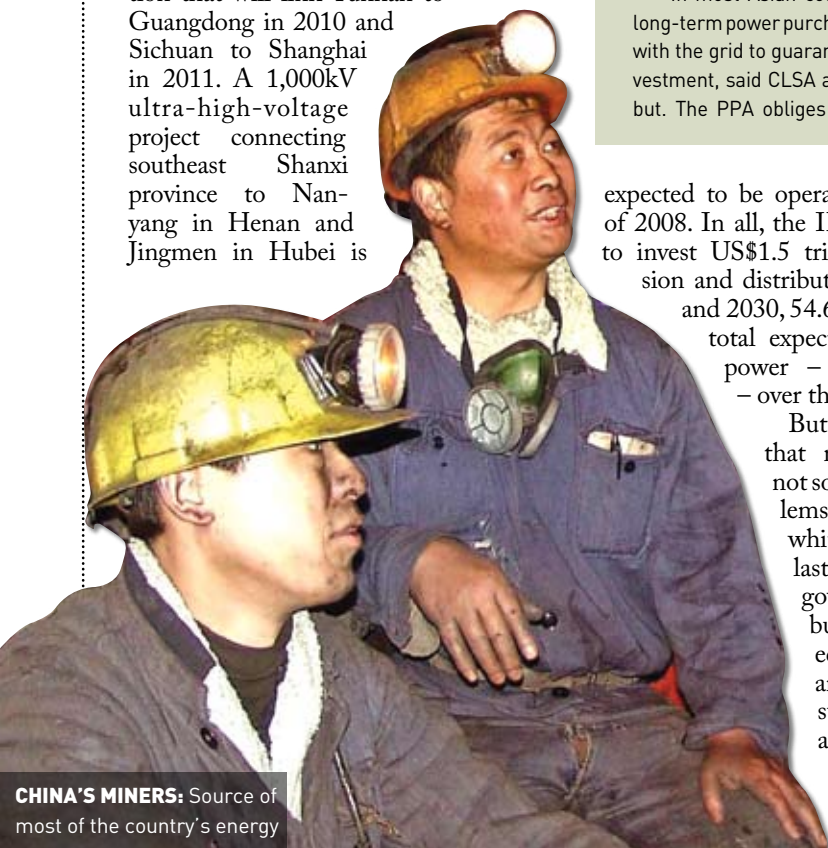
tained economic and social development with sustained energy development."

The white paper also noted the need for policy coordination and deepening energy system reforms. This need is to be addressed in part by the establishment of a new National Energy Bureau (NEB), combining the policymaking and advisory responsibilities of several energy bodies into one.

Regulatory concerns

Doubts remain, however, over the NEB's structure and whether it will help Beijing reach its goals. Christine Loh, founder of Hong Kong think tank Civic Exchange, said that because the NEB lies within the NDRC, the latter agency has effectively retained control of the energy portfolio.

Meanwhile, Levine questions why the



CHINA'S MINERS: Source of most of the country's energy



LOCAL HEGEMONY: China's power sector is becoming less reliant on foreign expertise

Photo:ex

That is especially true, he said, in less developed provinces, where generators may face delays in recouping money from the grid.

The IPP said there are still some opportunities for foreign investors in areas like cogeneration plants, which provide both electricity and steam. Thanks to regulations allowing plants some freedom in the pricing of steam, cogeneration facilities can be more profitable than traditional power plants.

Ultimately, the best way to mitigate risks is to ensure that investment goals align with the government's power priorities. "Anyone going to China must first understand what the government really wants," said the IPP.

NDRC wants to separate energy supply from demand by placing energy efficiency activities within a separate NDRC bureau.

Other observers are wary about some policies suggested in the white paper. Ruccius, for example, believes Beijing will have to address the coal price gap, but cautions that pursuing a market system for pricing tariffs would drive prices sharply upward.

As Beijing ponders policy, users of power are finding ways to make do. The 2007 *China Business Report* by the American Chamber of Commerce in Shanghai reported that while 24.8% of its members suffered some electricity rationing in 2007, only 0.4% were curtailing investment in China as a result. Those numbers were down from 2006, when 53.3% said they had suffered power shortages, and 1.9% were cutting back on investments in China.

In Shunde, the factory operator continues to run his coal plant for himself and his neighbors as he monitors developments in Beijing. Anxious to maintain stability, the central government has turned a blind eye to operations like his, which are officially discouraged. "They give us these gaps to survive," he said. "It's breathing space."

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STEEL: Energy-intensive and supposed to become less so

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► Unwelcome waste: Getting tough on energy

Experts have bemoaned China's poor record on energy efficiency, but power-hungry industries may at last be feeling the government's cooling grip. In a series of statements and policies, Beijing has established aggressive targets for improving efficiency. Crucially, observers say, it seems to be serious.

"I've never seen a more active effort on energy efficiency in the 20 years I've been working with China. It's just a complete turnaround," said Dr Mark Levine, head of the China Energy Group at the Lawrence Berkeley National Laboratory (LBL) in California.

The energy efficiency he refers to is not simply that of compact fluorescent bulbs and energy-saving appliances. Rather, a primary target has been industries, which the International Energy Agency (IEA) says are China's largest final users of energy.

Exact numbers for wasted energy in China are hard to come by. What is known is that after years of the country's GDP growing at a faster rate than its energy use, this position was reversed between 2001 and 2006. Instead of falling, China's energy intensity – a measure that compares energy use and GDP growth – rose rapidly.

According to LBL scientist Lin Jiang, rising energy intensity in China could lead to bottlenecks in energy and transport, serious environmental problems and a tightening in the global resources market.

The 11th Five-Year Plan, introduced in 2006, set goals aimed at addressing these issues. One goal is to reduce energy intensity by 20% by 2010. Given China's economic growth rates, this would necessitate a reduction of energy intensity by about 5% over each of the

plan's years. Progress has not been good so far. Levine said energy intensity fell by only 1.23% in 2006, 3% in 2007, and will likely fall between 4 and 5% this year. But he believes the genesis of the 20%-by-2010 goal shows that the government is committed.

As part of the drive to reduce energy intensity, Beijing identified the 1,000 most energy-intensive enterprises in China – which together account for about 50% of total industrial energy demand – and set efficiency targets for each one, said François Nguyen, senior policy advisor for electricity markets at the IEA. Similar programs have been introduced by provincial-level governments.

Levine said another promising sign has been the government statement that all officials and heads of enterprises with energy responsibilities would have bonuses, promotions, rewards and recognition made contingent on the fulfilment of energy goals.

Nevertheless, both Levine and David Buxbaum, a partner at Anderson & Anderson in Guangzhou, have reservations about how effectively it will be enforced.

"I don't underestimate the power of the Chinese government to enforce those rules. But it has to have the will to do so," Buxbaum said, noting that efficiency restrictions have so far been unsuccessful.

There are indications that the government's will is growing stronger. The IEA's Nguyen cites the closure of a significant number of small, inefficient coal-fired power plants. And some enterprises are confirming direct government requests to produce more efficiently, though one said the exercise was in a "market research stage."

Out of thin air

Wind energy is booming in China but it is struggling to fulfill its potential

When glimpsed from afar, the huge wind turbines look impossibly silent. Eleven machines, with 34-meter-long rotor blades, have been erected on the fringe of a large recreational park in Shanghai's Nanhui district, about 34 kilometers from the international airport in Pudong.

Each of the General Electric-made units can generate 1.5 megawatts (MW) of power an hour. Standing 65m above ground, these giants dwarf the Shanghai Wind Power Museum. It was built to commemorate the facility that surrounds it, one of the city's first wind farms.

Inside the museum you are treated to a short video presentation detailing the imminent disasters facing the world unless renewable energy is embraced. Wind power, naturally, is presented as an ideal choice. The World Bank was suitably convinced by such arguments, investing US\$13 million in the Nanhui project, which was set up in 2006.

Wind energy is China's renewable-energy poster-child. The country has wind to spare along its coast and arid western



and northeastern regions. It also has the world's fifth-largest amount of installed wind power capacity.

"China is working very hard to reduce its dependence on coal," said Richard Spencer of the World Bank, who worked on the Nanhui project. "And it looks to nuclear, hydro and wind, particularly, to replace coal. Wind is very important."

Wind energy produces a kilowatt-hour of electricity at about twice the cost of a coal-fired power plant, according to one analyst's estimate. By comparison, the same output from a photovoltaic cell is about five times more expensive.

Growing pains

The National Development and Reform Commission (NDRC), the agency effectively responsible for national energy policy, recently doubled China's installed wind capacity target to 10GW by 2010. Chinese wind turbine manufacturers are reporting booming business, and wind farms are mushrooming across the country.

But the industry appears to be facing growing pains. The wind farm/grid operator relationship is beset by technical and policy problems, which are an obstacle to getting wind farms online and adding to the electricity supply. As a result, only 4GW of China's 6GW installed capacity actually finds its way into the power grid.

A major reason for the gap is the industry's rapid recent expansion, triggered by the enactment of the Renewable Energy Law in 2005, which mandated grid companies to buy renewable energy. In-

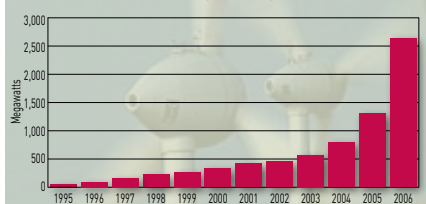


TALK OF THE TOWN: China's wind power industry is booming

China Foto Press

Blowing strong

China's total installed wind power capacity



Source: China Wind Energy Association

stalled wind power capacity that year was about 1.3GW. New installed capacity increased exponentially in the next two years, leaving China with 3.3GW of total installed capacity at the end of 2007.

While remote, windy areas are the ideal location for wind farms, these regions are often poorly served by transmission lines. This creates a mismatch between the grid's reach and the wind-farm studded landscape of northern and western China, to the chagrin of developers.

"We do meet some technical problems in connecting to the grid in some of our projects," said Xie Chang Jun, general manager of Longyuan Electric Power Group Corp, China's largest wind power developer. "We feel integrating wind power to the grid is critical for the commercial development of large-scale wind energy [in China]."

Problems abound even if transmission lines are available. Because China's grid was designed to work with coal-fired plants, which produce a steady stream of power, it has trouble accepting the intermittent power produced by wind farms.

"[Wind energy] is coming like shockwaves," said Frank Haugwitz, a renewable energy researcher in Beijing. "Sometimes it is less, sometimes more. This makes it difficult for the grid to absorb."

The smart way

What's needed are "smart grids," a collection of technologies and standards that would allow grids to allocate intermittent power effectively. For example, these grids would manage supply based on hourly power-generation forecasts from wind farms, said Caitlin Pollock, an analyst at Emerging Energy Research in Washington DC.

According to industry observers, the technology for these "smart grids" this already exists. It's a matter of execution.

The market is dominated by developers who are linked to the big five state-owned power producers. Longyuan, for example, is a subsidiary of China >>

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► Special concessions: The price of wind

Prices for wind power in China are decided in two main ways. If a project's installed capacity is below 50 megawatts, it is subject to provincial or municipal government approval and oversight. Larger projects go to the central government and may be part of a National Reform and Development Commission-led (NDRC) concession program.

The vast majority of China's wind farms were locally approved, but regulations among provinces differ. Most adopt a bidding system along the lines of the national concession program, although Guangdong has a feed-in tariff, or fixed price, for wind power. Policies like this are seen as being key to wind power's success in countries like Germany.

Under the annual concession program, which began in 2003, developers submit bids to the NDRC, which chooses several projects each year. According to the Chinese Wind Energy Association (CWEA), 11 projects were approved between 2003 and 2006, with a total installed capacity of 2.45 gigawatts.

Industry observers had criticized the concession program because approval was granted to bids with the lowest price. These often came from companies linked to the big five power generation companies, which could cope with slim margins or losses on wind power if it meant they could meet their government-mandated renewable energy quota.

The NDRC responded by modifying the program. As it stands now, firms that bid closest to the average bidding price are selected for projects.

"The evaluation criteria based on the lowest price caused abnormal on-grid prices, which were bad for the sector," said Hu Runqing, an associate research professor at the NDRC's Center for Renewable Energy Development. "The important change happened in the fifth round in March 2007. Such a regulation guided bidders to offer a reasonable price."

Observers say the concession program has been changed for the better.

"It's a dramatic shift," said Justin Wu of research firm New Energy Finance. "The NDRC has reformed the system."



BRIGHT FUTURE: With help, wind power can overcome its teething problems

►Guodian Group. Analysts say that Beijing's policy goals often override the profit motive at these companies. For example, firms may find it easier to secure large wind projects and grid connections, but paradoxically, they may have to do so at a loss.

"Financials are not the main reason for them," said Qin Haiyan, secretary general of the China Wind Energy Association. "Policy is the main reason. The conditions here are different from in Europe."

Geographical disparities

Wind-power developers are regulated in two major ways in China: an NDRC-led concession program or approvals by provincial governments.

As the concession program is dominated by state-linked companies, foreign developers typically have to deal with provincial governments, which isn't easy. Some provinces offer favorable policies, like a fixed price for wind power. Pricing policies are murkier elsewhere, which makes participation difficult for smaller foreign players in particular.

"It's not like other countries where you're developing wind [and] you go through the same type of checklist," said Gerald Page, CEO of Han Wind Energy. His firm's 50MW farm in Inner Mongolia, the first stage of a larger project, is waiting for approval by local authorities.

For all the problems facing wind energy development in China, the industry remains sanguine. They point out that obstacles will crop up in any young industry, particularly one that has grown as quickly

as wind energy has in the last two years.

According to Sebastian Meyer, director of research firm Azure International, the gap between installed and grid-connected capacity could just be a matter of timing. He says grid companies typically start connecting power plants between January and April, so wind turbines installed in the preceding months may have to wait their turn to be connected.

"Anything that's installed will also usually be commissioned," he said. "It's just a time thing."

Indeed, Qin, of the China Wind Energy Association, says the longest he has heard a wind farm wait to get connected is six months. However, even Meyer admits that a lack of centralized data makes it difficult to tell exactly which wind farms are getting connected and which aren't.

Despite the wind energy industry's explosive recent growth, it satisfies less than 1% of China's power needs. Steve Sawyer, secretary general of the Global Wind Energy Council, says that China could get 10% of its electricity from wind power by 2020. This isn't inconceivable. Denmark currently gets about 20% of its electricity from wind turbines, while Spain gets around 10%. Of course, China's electricity consumption, which came to 3.24 trillion kWh in 2007, is the equivalent of about 100 Denmarks.

But if government policy and the burgeoning wind power industry have their way, the figure will grow.

"At this point, there's enormous demand, so the pie is big enough for everybody," Sawyer said. ♦