

INCENTIVES NEEDED TO ENERGIZE CHINA'S WIND POWER SECTOR¹

Debra Lew and Jeffrey Logan²
March 2001

Wind power could play an important role in China's electricity sector, but key barriers must be addressed before this clean energy source meets its potential.

Electricity consumption in China grew by 10 percent last year raising anew questions about how the country will power its factories, businesses, and homes over the coming decades. China's traditional power choices—coal and hydro—have significant environmental and social repercussions that have become increasingly serious political and economic issues. Natural gas has received much attention lately as an alternative, but renewable energy sources such as wind are also gaining favor.

China has been developing its wind resources for over a decade but had only about 345 megawatts of installed capacity—equivalent to the output of a small coal or gas-fired plant—by the end of 2000. For comparison, Germany led the world with 6,100 megawatts, while the U.S. and India had 2,500 and 1,100 megawatts, respectively. The Tenth Five-Year Plan (2001-2005) calls for a nearly five-fold increase in China's wind capacity by 2005 to 1.5 gigawatts.³ Given proper incentives, however, China could easily surpass this target.

China's wind power resources are abundant. Approximately 250 gigawatts of exploitable wind resources exist at a height of 10 meters above ground, with world-class winds along coastal regions of Guangdong and Fujian and excellent sources in parts of Inner Mongolia, Xinjiang, Shandong, Liaoning, and Zhejiang. Today, most grid-connected wind turbines are installed at a height of at least 50 meters. Because wind speeds typically increase with altitude, China's total wind potential could far exceed 250 gigawatts.

The pollution mitigation potential of wind power is significant. If China develops even one-half of its conservatively-estimated wind resources, it could generate about 275 billion kilowatt-hours of power each year—about one-fifth the country's current demand—displacing the need for 135 million tons of coal and the accompanying two million tons of sulfur dioxide and 70 million tons of carbon emissions.

Technical, commercial, and regulatory barriers restrain expansion of wind power in China. Wind-generated electricity is still relatively expensive and technical problems need to be solved before wind can contribute more significantly to China's power mix. Wide-scale manufacture of large, high-quality turbines inside China could lower costs compared to the units it currently imports. Most imported wind turbines currently rely on

¹ Portions of this paper were published in China Online (www.chinaonline.com) on 12 March 2001.

² Debra Lew is a Senior Project Leader for the National Renewable Energy Laboratory in Golden, Colorado. Jeffrey Logan is Senior Research Scientist for Battelle Memorial Institute in Washington, DC.

³ A gigawatt, or one million kilowatts, is the size of a typical large power plant. By the end of 2000, China's entire power sector had 317 gigawatts of installed electrical generating capacity.

concessionary financing, but these subsidies may actually slow development of a sustainable market for wind power. New financial and regulatory incentives, such as tax breaks and competitive bidding for planned projects, could accelerate the development of a market for wind power in China.

China's wind development efforts can be divided into two classes: rural (off-grid or household) and grid-connected. China is the world's largest manufacturer of small turbines, with roughly 170,000 small turbines installed, totaling 42 megawatts of capacity. Some regions in China, notably Inner Mongolia, already have well-developed rural wind energy programs that play an important role in improving the quality of life for hundreds of thousands of Chinese living in remote areas. While off-grid wind power provides clean, relatively cheap power to herders, farmers, and villagers, the impact of these units on China's energy sector is small compared to what grid-connected wind farms can achieve. With that in mind, the remainder of this commentary restricts itself to grid-connected wind issues.

Economic Issues: Competing with Entrenched Powers

Costs to construct wind farms, currently around \$1,000 per kilowatt, continue to decline, especially when developers take advantage of economies of scale. Large wind farms in the U.S. now produce power for about five cents per kilowatt-hour. The recent surge in natural gas prices has made wind power very attractive in some regions of the country, although a federal tax credit of 1.5 cents per kilowatt-hour is instrumental in making wind power competitive in the U.S.

In China, wind power is still considered expensive relative to the competition. Coal and hydropower has been supported and subsidized for decades. As a result, Chinese coal-fired power plants are relatively inexpensive to build and fuel, resulting in costs of as little as three cents per kilowatt-hour. Chinese wind power, on the other hand, currently costs between five and 12 cents. One reason costs are high is that most Chinese wind farms are small, preventing them from achieving economies of scale. Large wind farm developers can improve their economies by negotiating lower prices for equipment, land, and labor.

The environmental benefits of wind power—namely the elimination of harmful emissions—are often ignored in prices. New regulations introduced by the State Environmental Protection Agency in September 2000, however, increase the fee on sulfur dioxide emissions from roughly \$25 to \$100 per ton. Including this cost in the price of power could make wind power more competitive. Other health and environmental damages due to coal combustion still need to be considered in the future.

China has recently begun restructuring its power sector to lower costs and improve efficiency. Competition is being introduced among some generators. As this occurs, one issue to address is how the cost of wind power, if higher than other generation sources, is covered. Currently, many wind power developers are subsidiaries of provincial utilities. The incremental cost of wind power, if any, is not passed onto consumers but instead drawn from utilities' profits. Moreover, because the buyer and seller of power are often

the same company, there is no incentive to reduce wind power prices. However, this does limit the amount of wind power that the utility is willing to buy. In addition, export of wind power across provincial boundaries is difficult. A proposed Inner Mongolian wind farm in a World Bank project is facing delays because other provinces are unwilling to purchase this wind power.

But the most important issue relating to wind power economics is technology. The key to lowering the cost of wind power is through continued progress in improving materials, engineering, and manufacturing processing.

Wind Technology: Further Localization Needed

China is trying with some success to develop its own wind turbine technology, both to ensure self-sufficiency and to further cut capital costs. Labor costs in China are considerably lower than in industrialized countries, so it is thought that “localizing” the production of wind turbines could result in units that are 10 to 40 percent less costly than imports. Currently, however, Chinese turbines are more expensive than imported units, reflecting the immature state of domestic production capability.

China is a world leader in manufacturing micro and small wind turbines (100 to 3,000 W), but it did not attempt to produce large units (100 kW and above) until a decade ago. Several companies in China produce 200 to 300-kW wind turbines, either as joint ventures or under license to foreign companies. Only about 10 percent of the components in these turbines need to be imported. Demand for these is low because imported 600 and 750-kW units are more cost-effective and have a reputation for higher quality. Larger units of 1,500 kW and above are now being installed in Europe and the United States, and should soon appear in China.

In 1996, the State Development Planning Commission began the Ride the Wind (*Chengfeng*) program. The Chinese government set up two joint ventures between Chinese companies and international wind manufacturers and essentially traded development of 240 megawatt of wind farms in return for local manufacturing of the 600 and 660 kW turbines. However, this program has faced difficulties due to the limited market for the locally manufactured turbines. Developers are reluctant to use locally manufactured wind turbines, especially when foreign soft loans are used to finance the purchases with hard currency. Only two of these locally manufactured turbines had been installed by the end of 2000: a 600 kW turbine from the Nordex-Xi’an Aero-Engine Group and a 660 kW turbine from the Made-Yituo Group.

The Ninth Five-Year Plan called for greater local manufacturing of large-scale wind turbines. Xinjiang Wind Energy Company (XWEC) was the first Chinese company to commercially manufacture large-scale wind turbines with mostly Chinese components. The company bought a license from the German manufacturer, Jacobs, to build a 600 kW turbine, and began manufacturing in mid-1998 with successively larger fractions of local components. Ten turbines have been successfully operating for the last two years, the newest of which has 78 percent locally manufactured components.

To further promote localized manufacturing, SDPC has required that all new wind farms have at least 40 percent local components before they are approved for construction. Furthermore, the State Economic and Trade Commission (SETC) has set up the National Debt program, which provides favorable loans for wind farms that have locally manufactured components. Already 80 megawatts have been approved in the National Debt program.

Selected Projects: Building Markets for Wind Power

Capital for infrastructure projects such as wind farms is often limited in China, but Danish, Dutch, German, Spanish, and American governments often provide concessionary loans. For example, the Government of Denmark has provided zero interest loans for 10- year terms for their turbine manufacturers to gain access to the Chinese market. Concessionary loans help the Chinese wind sector in the short run by facilitating installations of wind farms. Over the long run, however, they stifle the development of a sustainable commercial market because wind installations are limited to those that obtain concessionary finance. By its nature, concessionary financing is limited. In addition, these loans are tied to purchase of equipment from the host country, reducing competition and discouraging use of Chinese-manufactured equipment.

In addition to distorting the market and limiting development of wind power, subsidies reduce competition and encourage high capital costs. To address this issue, the World Bank and Global Environmental Facility (GEF) approved the Renewable Energy Development Project in 1999 to promote commercialization of wind energy in China through competitive bids for 190 megawatts of wind turbines at five wind farms.⁴ This also includes technical assistance for local production, standards and certification, and commercial development. The Bank hopes this project will establish clear and consistent guidelines for power purchase agreements and foreign investment. This path-breaking project has faced a number of difficulties including difficulty finding buyers for its wind power in Inner Mongolia and delayed final project approvals due to internal struggles within the Chinese government.

In late 2000, the Asian Development Bank and GEF approved a \$98 million project for 78 megawatts of wind power at three wind farms in Xinjiang, Heilongjiang, and Liaoning. The GEF is providing a \$6 million grant and a \$6 million interest-free "contingent loan". This loan will be repaid if the wind farms are successful, but will be converted into a grant if they are not. This approach allows GEF to help bear the perceived risks associated with wind farms while helping to build confidence in the new technology.

Build-operate-transfer (BOT) financing mechanisms, in particular have the potential to reduce costs by introducing competition. A near-commercial model project has been built by the Dutch developer NUON on Nan'ao Island, as a BOT project with foreign investment. The 24 MW wind farm became operational in June 1998 and will be run by Nuon for 20 years before transfer to the local utility. The power purchase agreement

⁴ Project loan financing of US\$100 million and a Global Environment Facility grant of US\$35 million will support the wind power activities in Inner Mongolia, Hebei, Fujian, and Shanghai, as well as a project to provide households and businesses with standalone photovoltaic systems in northwestern China.

(PPA) allows for payments of \$0.065/kWh during the first year, rising three percent annually for the next 10 years. This is significant since this is the first time the Chinese government has allowed a utility to enter into a PPA with a foreign entity for a wind farm, agreeing to both pay hard currency and index the price to inflation. After this project was implemented, however, approvals for wind farms of this scale were moved out of the hands of provincial government and into the Central government, and no such commercial projects have been approved since.

Recent Policy Initiatives to Build Wind Markets

The Chinese government has taken other important steps to expand the use of wind power, some with greater impact than others. In 1999, SDPC and the Ministry of Science and Technology (MOST) issued a circular to support renewable energy. Renewable energy power projects would have priority in securing loans from Chinese banks at reduced interest rates. Grid administrators would need to allow for nearest interconnection and purchase all interconnected power generated by renewable energy. Wind farm developers would be paid on a cost-plus basis, with slightly higher profits given to domestically manufactured wind farms.

In practice, there have been problems implementing this policy. While incremental costs are supposed to be shared within the grid, the policy does not specify whether this is the regional or local grid. Utilities often still do not allow all renewable energy projects to connect to the grid. And prices paid for wind power vary, with utility-sponsored projects sometimes receiving high prices than other developers. Discussions with local renewable energy experts indicate that projects taking advantage of this 1999 announcement have not yet been approved. The lack of clarity in this policy is slowing project development.

Other new measures hold more promise. The Tenth Five-Year Plan proposes market-based policy instruments such as a mandated market share (also known as renewable portfolio standard) policy to promote renewable energy. This policy would be a legal requirement that some share of electricity comes from renewable energy and a market-based instrument, such as trading of green certificates, would be introduced to share the incremental costs and benefits among the regions in China. However, the details on how such a policy can be implemented in China remain to be determined. The World Bank and GEF are preparing a Strategic Partnership for Renewable Energy that will assist in development of this mandated market share policy for China.

In an effort to address both the competition and economies of scale issues, SDPC announced in late 2000 that they would award 5 concessions for wind farm development of up to 100 MW each. An international competitive bid would be held. Current plans would award winners with power purchase agreements that would guarantee a power purchase price for 15 years. SDPC hopes that the competition and large-scale development will result in costs of 5 cents per kilowatt-hour.

Key Incentives to Build Commercial Wind Markets

Worldwide, 3,500 megawatts of wind capacity was installed last year, making wind the fastest growing energy source. Global wind power capacity now stands at 17,000 MW.

Where wind power has flourished around the world, it has mainly been driven by policies that create a favorable climate for grid-access and purchase prices. For example, the German Electricity Feed-in Law has promoted wind development through favorable power purchase prices. In the U.S., investment and production tax incentives accelerated wind development in the 1980's and 1990's. Now, green pricing and mandated market share (also called renewable portfolio standards) policies, may become significant drivers for renewable energy in some states.

In China, however, the market for wind power has developed more slowly than anticipated, largely due to a lack of incentives for wind developers. Barriers preventing a more robust market for wind power in China include:

- *High costs.* Developers have been given little incentive to lower the cost of power produced at wind farms. Pressure from market competition is needed to trim costs and improve efficiency. China's recent offering of wind concessions to the lowest bidder is a good starting point.
- *Limited wind resource assessment data.* Project developers need more information about China's wind resources in order to minimize risk and choose the best sites. China should develop a more comprehensive database of wind resources, although international assistance might be needed to accelerate these activities.
- *Immature local manufacturing capability.* China is taking steps to develop local manufacturing capability for wind turbines. Progress has been rapid, but more time and incentives are needed to further improve quality and lower costs. Market demand for wind turbines must be strengthened in order to send appropriate signals to manufacturers.
- *Difficulty in securing project approval and negotiating power purchase agreements.* This problem is not unique to wind power, but has been generally improving over the past few years as overall transparency within China improves. Accession to the World Trade Organization should further accelerate the process to a market-based, rule-of-law driven economy.
- *Failure to account for the full environmental benefits of wind power.* China has become more serious in fighting its pollution problems, including new fines for sulfur dioxide emissions. Additional environmental externalities associated with coal combustion should be accounted for to level the playing field for wind.
- *Subsidized financing for imported wind turbines.* Soft loans from wind turbine exporters may delay emergence of a commercial market in China. Wind projects that do move forward are limited to those that offer concessionary finance. In the long run, it will be in the foreign manufacturers' own interest to eliminate these subsidies.

As costs continue to decline, wind power may soon be able to compete directly with other power sources in China, especially in regions where coal is expensive. Incentives are needed to overcome the barriers described above and accelerate the learning process of what policies work best. Rather than imposing developing targets, financial incentives such as tax credits for wind production will better serve the development of China's wind power industry. China's accession to the World Trade Organization could also help to establish the overall environment needed to create a sustainable market for wind power.