

## Energizing China's Economy

*The moderate growth of China's energy sector has not hampered its soaring economy.*

BY JAMES P. DORIAN

China, the last of the major Communist nations, has made massive strides during the past two decades toward becoming an industrialized nation with a market-driven economy. Its people—a fifth of the world's population—are still among the world's poorest, but rapid industrialization and urbanization are preparing them to make China a major economic power in the 21st century.

The rising economy and rising health standards are already having a profound impact on China's welfare. In the second half of the 20th century, for instance, the lifespan of the average person in China has doubled.

But there have been some costs as well. The environmental deterioration accompanying rapid industrialization and urbanization is using up about a seventh of China's gross national product and may take a heavy toll on the nation's health during the next few decades.

Despite the dramatic rise in China's economy, the country's energy consumption has grown at

a much more modest pace. Unlike other developing countries in Asia, both the amount of energy and carbon consumption per dollar of gross domestic product have decreased dramatically in China during the past two decades. With average GDP growth rates about 10 percent and growth rates of energy consumption averaging 5 percent, China shattered the traditionally held notion that economic growth and energy consumption are intrinsically coupled. Nevertheless, in 1994, China overtook Russia and is still today second only to the United States among the largest energy consumers in the world.

China's experience suggests that energy limitations may not be a constraint to rapid economic growth. Indeed, China's economy has managed to thrive despite limitations in energy supplies and low energy efficiencies. Whether or not China can sustain this level of growth remains to be seen.

### Supply and Demand

China's energy system is

primarily fueled by coal. Today, 75 percent of China's power system relies on coal, the highest of any major world economy. Although coal once provided over 90 percent of China's energy supply, that portion began to decline in the 1960s as new oil and gas fields were brought online, and it reached a low of 69 percent in 1976. Since about 1980, however, the importance of coal and hydropower has slowly increased in terms of production and consumption, while the shares of oil and natural gas have experienced relative decline.

The most significant energy policy change China has experienced during the past few decades has been in the way energy is mobilized, processed, and used. In 1980, for example, only a fifth of the coal consumed was burned in utility plants to generate power and heat for end users. The vast majority was consumed directly in boilers, stoves, and other self-standing units. By 1998, the proportion of coal consumed by utility plants had increased to about a third.

China has basically two energy systems. One system feeds into

industrialized and urban zones and is dominated by fossil fuels. The other system, which is rural and largely agricultural, is dominated by biomass; 75 percent or more of the country's rural population depends largely on wood, straw, and dung for its daily heating and cooking needs.

### **Coal**

As the world's largest producer of coal, China produces about 1.6 billion tons a year. The country's resource base is more than sufficient to support this production. At 115 billion tons, China's proven coal reserves are the third largest in the world, following the former Soviet Union and the United States.

Most of China's easily accessible high-quality coal is located in northern China. Coal from the southern part of China is generally higher in sulfur and ash, making it costly and potentially environmentally damaging for many uses. Consequently, large amounts of coal are shipped from China's north to its south, putting a great strain on the transportation system, especially the railroads.

Since the early 1980s, the central government has encouraged the development of small, collectively and individually owned coal mines in rural areas to alleviate local shortages. The result has been a remarkable shift in the source of coal output. Between 1980 and 1993, 70 percent of the growth in production came from new rural mines, which now account for more than 40 percent of China's coal output.

The development of rural mines may soon slow, however, because of a push for greater

mine safety and more economic use of coal resources. Rural mines are generally small and poorly equipped—often requiring no more than a few farmers with hand tools, ropes, and baskets—and they tend to waste a large fraction of usable resources. The problems with rural mines may spur construction of more capital-intensive, highly mechanized mines.

### **Oil**

China's oil resources are not large by world standards; the total resource base is estimated at 72 billion barrels. Of this amount, up to 24 billion barrels are proven reserves. This ranks China's oil reserves 10th among oil-producing countries, just ahead of Nigeria.

The easily reached oil fields in northern and northeastern China have been in production since the early 1960s, and output at China's largest oil fields has peaked. Most exploration has been near basins that are currently in production, but development of oil fields in the far northwest and offshore has accelerated in recent years to meet long-term demand. This development has often occurred in conjunction with foreign partners.

In 1999, China produced a little under 3.2 million barrels a day of crude oil, making it the fifth largest oil producer in the world, tied with Norway. Onshore production accounted for about 90 percent of total production.

In recent years, China has altered its domestic oil policy in the face of rapid growth in demand and the shift from being a net exporter to a net importer.

Indeed, after abandoning a long-held policy of self-reliance, China has come to depend heavily on foreign resources for oil and gas. Since the oil price collapse of 1986, which raised national concern over high dependence on oil exports, China's exports of crude oil have declined continuously, while competition from imports has grown significantly.

In 1998, when domestic suppliers began cutting back production because they could not meet the competition, the government clamped down on imports but has eased off on some restrictions since then.

### **Natural Gas**

With less than 1 percent of the world's supply, China's estimated natural gas resources are small by global standards. Today, only about 1 percent of China's energy comes from natural gas. In 1999, China produced and consumed about 24.3 billion cubic meters of natural gas from a known reserve of 1.37 trillion cubic meters.

Exploration and development of new wells has been relatively neglected, but an analysis of China's geologic formations suggests that natural gas resources may be much greater than earlier estimates indicated. Determining the magnitude and location of these resources is critical to China's future commercial energy resources.

Though China's investment in natural gas development actually decreased in the late 1980s, some new gas fields have recently been discovered and are now being exploited. Perhaps the most significant of the new gas fields are the offshore fields near

Hainan, which are now connected to Hong Kong via a pipeline. Exploration of Shaan-Gan-Ning region in northwestern China has also uncovered substantial gas resources. Large-scale production is just beginning there. To encourage foreign investment in the development of China's vast natural gas reserves, China has been gradually increasing gas prices and reducing subsidies.

In 1999, China produced 24.3 billion cubic meters of natural gas. With the additional fields coming into production, China expects to produce about 30 billion cubic meters by 2005.

### **Electricity**

China's electric power generating capacity is the fourth largest in the world, with installed capacity of about 254 gigawatts in 1998. Since the early 1980s, the Chinese government has put great emphasis on construction of new power plants to meet the nation's burgeoning demand. The government has set a goal of doubling capacity by 2015.

Without substantial foreign investment and imports of generation and transmission equipment, however, China is unlikely to meet its ambitious electricity generation goals. As in many industrializing countries, China's energy industries have often been unable to keep pace with demand—which leads many to assume that growth is constrained by lack of adequate energy supply. In fact, official Chinese statements on the subject often cite limited energy-production capacity as a constraint to growth.

In the late 1980s, many parts of China suffered coal shortages

so severe that some power plants had to shut down for lack of fuel. There were also instances of regions commandeering coal shipments by military force to keep their power plants running. Problems persisted in the 1990s. While coal supplies are now more than adequate to meet demand, oil and electricity are still in short supply in some regions.

Newspapers and other sources have reported that electricity shortages idle as much as 30 percent of China's industrial capacity. And during even a short stay in China a visitor may experience the common problem of power outages. Indeed, industrial managers have often complained about the security and quality of power supply.

Nevertheless, China has maintained nearly double-digit economic growth in the face of frequent power shortages. Growth has been so fast that the threat of inflation has led to repeated attempts by the central government to rein in investments. As it turns out, limited availability of capital has often overshadowed infrastructural bottlenecks—such as limited and unreliable electric power—in dampening investment.

Whether China's economy would have grown faster if energy supplies had consistently met demand is, of course, a matter of speculation. The speed of economic development in China suggests that insufficient energy supplies probably have not constrained total growth. Relative energy shortages, however, have probably helped shape the direction of growth, for instance, by offering greater support to the small-scale service and light manufacturing sectors,

which do not require a highly reliable electricity supply.

### **Coal Dominance**

China's major energy supply concerns will continue to center around coal for the foreseeable future. Improvement in the coal-supply system will require heavy investment in new, large, highly mechanized underground and surface mines and transport facilities to make sure the products from these mines make their way to end users, regardless of where they are situated.

China's leaders and coal corporations recognize the cost and environmental benefits of investing in a coordinated program to develop the nation's coal supply but are often hindered by a lack of funds and access to the latest mining, processing, and combustion technologies. Clearly, China could benefit from the transfer of technology from abroad.

Rapid expansion of China's natural gas supplies is key to modernizing the nation's energy system, but the prospect for this expansion is doubtful. Indeed, while recent large natural gas finds are encouraging, a great deal more exploration is needed to determine whether China will be able to meet new demand from its own fields. An alternative is to pipe in gas from the huge fields in Russia and perhaps central Asia.

### **Cleaner Technology**

Notwithstanding its increase in natural gas production, China's power-generation system will remain dependent on coal over the long-term. The speed with which cleaner coal-burning technology can be devised and

the extent to which other sources of electricity can be brought into play will be critical.

Because coal will remain the cornerstone of China's power system, the nation is now considering expanding the use of clean-coal technologies, such as advanced fluidized bed boilers and integrated gasification/combined cycle systems, both of which generate electricity with much greater efficiency and less pollution.

If China is to maximize the efficiency of its power system, it may combine increased efficiency in generation with increased efficiency in transmission and distribution. Currently, the inefficiency of China's grid—particularly its low-voltage grid—allows for significant losses of power.

In keeping with China's interest in modernizing its electric distribution system, the potential for improved efficiency in distribution remains high. China is on the verge of extending electric power to more than 100 million rural Chinese who have never had electricity. The extent to which China enjoys access to foreign equipment designers and manufacturers who can provide the newest and most-efficient technologies will determine the speed of progress in this area.

### **Hydro and Nuclear Roles**

Development of an efficient, far-reaching transmission system will also allow China to fully exploit its huge untapped hydropower potential, most of which is situated in outlying areas far from demand centers. Indeed, hydro, which generates about 6 percent of China's total electricity production, remains the country's largest under-

utilized renewable energy source. To date, only 12 percent of China's hydropower resources—which collectively could contribute 380 gigawatts of generating capacity—have been developed.

Unfortunately, as long as most of China's available funds for hydropower development are being invested in the massive Three Gorges Project—the world's largest dam will add 18.2 gigawatts of generating capacity when completed in 2009—prospects are dim for building many smaller hydropower projects, which can be constructed in much less time.

Meanwhile, China has three operating nuclear reactors, which contribute about 1 percent to the country's total electricity production. Six other reactors are planned or under construction. By 2020, the share of nuclear power used for electricity generation is expected to increase to 4 percent.

China would like to become a major nuclear power and build many more plants. The likelihood of that happening, however, depends on many factors. The provinces must be willing to invest in the nuclear capacity; and local populaces must be willing to accept nuclear power plants and fuel cycle installations, including waste repositories. Since China does not have a significant domestic nuclear fuel industry, the country will likely have to depend on foreign suppliers, at least until the domestic nuclear fuel supply can be expanded. And, of course, China must have the political determination necessary to remain committed to a technology that can prove both costly and risky.

### **Biomass**

Currently, renewable energy sources—other than hydropower—contribute about a fifth of China's primary energy. Most of the renewable energy, which is used by rural households, is derived from biomass. China has extensive experience in the application of anaerobic digestion technologies, a network of research centers, and large capacity to manufacture anaerobic digesters. The country presently operates over 6 million household-scale bio-gas digesters and around 500 industrial units. Though most rural biomass users will prove resistant to change, a reduction in the use of biomass fuels would increase soil fertility while reducing erosion and desertification.

### **An Uncertain Energy Future**

As China expands its energy industry to meet future demand, it faces several barriers to success. Foremost is the challenge of redirecting capital away from other projects and toward the energy sector and infrastructure projects that will support it. Since 1990, China's investment in its energy sector has declined from 19 percent of the overall budget to less than 10 percent in 1996, and even less by the late 1990s.

Although the absolute amount has risen by more than 80 percent, China's energy investments have been dwarfed by the increases in investments in other sectors—including heavy construction—which have soared during the same period. The *Far Eastern Economic Review* estimates that, to support projected economic growth, China needs to spend up to US\$400 billion

(CNY3.3 trillion) a year, for at least a decade, on roads and highways, electric power, telecommunications, and water and sanitation sectors, to sustain sufficient growth in infrastructure.

Of particular importance is China's transportation infrastructure, including roads, rails, pipelines, waterways, and port facilities. China's boom in trade, both foreign and domestic, has stretched the nation's transportation capacity to the limit. Its distribution system annually must move more than 1 billion tons of coal and 150 million tons of crude oil, in addition to several hundred million tons of steel, cement, wood, fertilizer, grain, and other commodities.

China is also experiencing a steadily rising volume in imports

of crude oil and petroleum products, but its ports currently lack sufficient facilities for storing them, despite annual investments of US\$6 billion (CNY8.3 billion) in port facilities in recent years.

Because China's energy system will continue to be based on coal, continued growth over the coming decades in total energy consumption, and therefore carbon emissions, is virtually certain. Regional and international pressures to reduce pollutant emissions will also continue to grow, persuading China to improve end-of-pipe emissions controls and expand energy services through end-use efficiency. China, however, is now focused more on domestic environmental issues, such as urban air quality and water

supply, than international concerns such as global climate change.

One of the greatest challenges facing China, therefore, will be how to meet the country's energy needs in the new millennium while balancing environmental preservation.<sup>1</sup>■

*James P. Dorian is an energy and resources economist for the state of Hawaii, in Honolulu.*

#### **NOTE**

1. This article is adapted from "China's Energy Future: Its Role in Sustaining Growth," by J. Sinton, D.G. Fridley, and J.P. Dorian, originally published in *China's Economic Future: Challenges to U.S. Policy*, A Joint Economic Committee Report to the U.S. Congress, Washington, DC (August 1996).