China's Challenging Fast Track

Far more energy will have to be produced — and conserved — to power the expanding economy and protect the environment

by Wei Zhihong

China's economy is on a fast track, with growth projected to quadruple in the first two decades of this century. A mix of clean and affordable energy sources will be needed to fuel and sustain development.

Since China opened to outside markets in the 1980s, the national economy has expanded steadily, with an average annual growth rate of 9.6% in gross domestic product (GDP) from 1980 to 2000. Development has stayed strong in this century, and GDP grew 9.1% in 2003, the highest rate in the past six years. For the first time, per capita GDP topped $1000, reaching $1090 last year.

How to best manage and sustain growth is driving energy decisions. Analyses show that China has entered a stage of manufacturing, chemical, and heavy industrial development that is energy intensive. At the same time, demands for energy at home and in businesses are growing among China's population of 1.3 billion people. As consumption grows, so do concerns about air, water, and land pollution in the context of sustainable energy development.

Shortages in Boom Times

China consumes more energy than any country except the United States. Entering this century, the country's energy consumption has grown from 924 million tonnes of oil equivalent (Mtoe) in 2001 to an estimated 1080 Mtoe in 2003.

Alongside energy growth stands energy shortages, especially in electricity generation. Electricity generation does not sufficiently meet the demand for industrial production and people's daily needs in more than 20 Chinese provinces, and demand exceeded supply in five of six regional electricity grids in 2003.

It is not surprising that serious power shortages have arisen, for a number of reasons. Firstly, over the past two years, demand for electric power has grown at a monthly rate of more than 15%. Meantime, new power generation capacity

Photo: Morning traffic in Beijing. Credit: Petr Pavlicek/IAEA

has lagged greatly, with annual growth rates falling from 6.8% in 2000 to 5.3% in 2002.

Secondly, production investment has increased rapidly, notably in energy-intensive sectors such as metallurgy, building materials, and chemical industries to support boom expansion of automobile and construction sectors. Today, the production output of steel (210 million tons in 2003), coal (1400 million tons in 2002), and cement has elevated China among the world's top producers.

Thirdly, the country has experienced water shortages in recent years, and especially in 2003. This, in turn, has reduced hydropower generation, which previously accounted for 16% to 20% of total electricity production.

Fourthly, China's coal trade has been reformed in a market-oriented economy, with the State no longer guiding coal prices. The price for coal has risen on average between 10-15 yuan per ton in response to demand and transportation costs. On the other hand, the price of other thermal power sources is still guided by the State, rather than being market driven and responsive to coal price fluctuations. This situation hinders development of coal-fired power generation, which accounts for 80% to 90% of Chinese electric power production.

Energy & Economic Trends

China has a diverse energy base. The country has the world's highest level of exploitable hydropower resources, third highest level of proven coal reserves, and considerable oil and natural gas resources. Coal remains the main fuel, accounting in 2002 for two-thirds of total primary energy consumption. The consumption shares for oil, natural gas, hydropower and nuclear energy were 23.3%, 2.7%, 7.7% and 0.4%, respectively. Renewable sources, mainly wind, solar, and geothermal energy, together accounted for 0.3%.

In terms of energy projections, the electricity shortages of 2003 focused attention on the importance of forecasting supply and demand and steps to improve it. Energy facilities need quite a long time to be built before they can serve consumption centers and end users. Key forecasting factors include social and economic development, such as population, urbanization, GDP, national economic structure, and technological progress.

Because of China's large population pressures, there is no doubt that China will continue to implement its family planning policy over the longer term. It is expected that population will slowly increase from 1.26 billion in 2000 to about 1.475 billion people in 2020. More than half of the population, or 52%, is expected to live in or near cities by 2020, compared to 36% today.

Regarding economic development, an ambitious target was set in late 2002 to have China's GDP quadruple to the year 2020. To reach the target, an annual average growth rate of GDP would be about 7.2% a year. Achieving this target by 2020 would move China's world GDP ranking to third place, behind the USA and Japan, and increase per capita GDP to US $2945, nearly three times today's level.

In terms of technological progress, the aim is to reduce energy intensity, particularly in primary industries. The targets assume that energy intensity will go down continuously, and decrease by 40% to 50% by 2020.

Projections in energy demand foresee that coal's share will decrease from 66% in 2000 to 60% in 2010 to 54% in 2020. At the same time, cleaner energy and non-carbon energy — especially natural gas, nuclear energy and renewable energy — will see great development, as their combined share in total primary energy is projected to grow from 2.9% in 2000 to 15.6% in 2020.

When Less is More

Energy conservation measures are being emphasized as especially important factors to consider. Appeals from research institutes and energy experts call for elevating the energy conservation strategy to a much higher level in national policy. It is estimated that 60% of energy conservation potential in China exists in the industrial sector.

Since 1980, through national policies, great achievements in energy conservation have been obtained, owing to efforts by central and local governments, industrial sectors, and energy end users. Studies indicate that energy-saving measures during the period resulted in a reduction of 773 Mtoe, and contributed to environmental protection by cutting roughly 20 million tons of sulphur dioxide emissions, 263 million tons of cinders, 13 million tons of ashes and dust, and 440 million tons of carbon emissions.

The potential savings and impacts over the next two decades could be considerable. Research teams at Tsinghua University have noted, for example, that energy use per unit of major industrial products in China is 25% to 90% higher, on average, than those in developed countries. It is estimated that the energy saving potential could reach 70 Mtoe in the near term by means of technology improvements. Additionally, up to 210 Mtoe could be saved from structural adjustments in industrial and product sectors.

Realizing potential benefits will have to overcome barriers arising from China's transition to a more market-oriented economy, and the establishment and implementation of rules and legislation, including those in China's Energy Conservation Law promulgated in the late 1990s.

Options & Choices

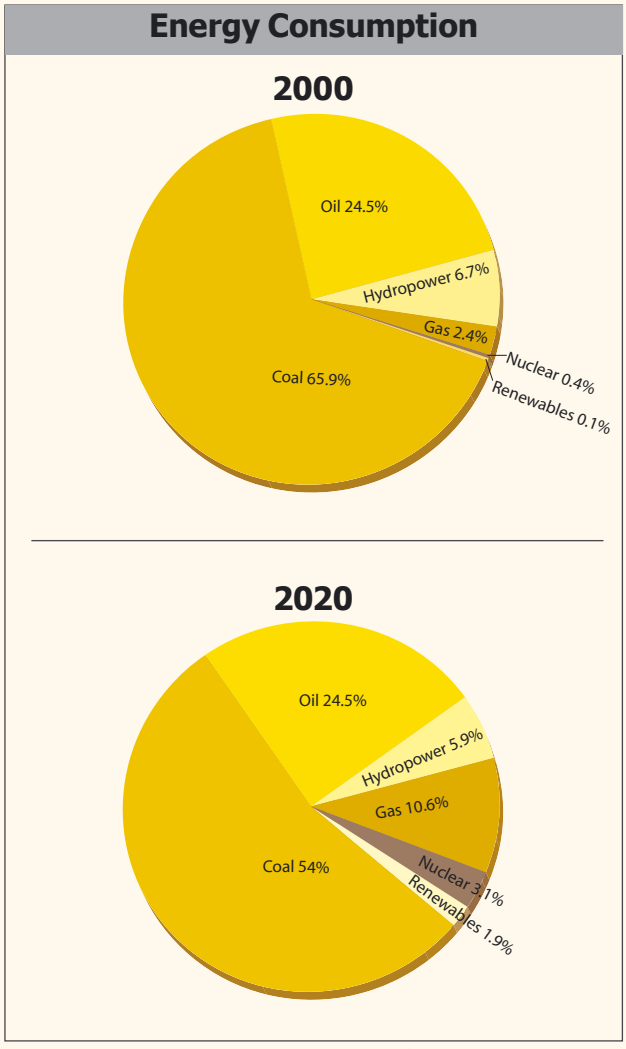
Oil resources in China are very limited, and oil imports accounted for about 30% to 40% of demand over the past decade. The proportion is projected to reach 52% in 2020,

China's Future Energy Demand

Energy demand is rising fast in China, and the mix of energy is changing. Coal's share of total primary energy consumption is projected to decrease in coming decades, with natural gas, nuclear power, and renewable energy sources on the rise.

Looking at nuclear power, China today operates nine nuclear plants and has two more under construction, based on data reported to the IAEA. Nuclear today provides about 1.4% of total electricity generation, and plans call for building enough nuclear plants to produce up to 36 GW of electricity by 2020.

Plans include developing advanced types of nuclear plants. China's Institute of Nuclear and New Energy Technology is hosting topical meetings and workshops in 2004 on high-temperature gas reactors (HTGRs) which the country has developed. They include an IAEA workshop on safety demonstration and market potential for HTGRs in September 2004 in Beijing. For more information, visit the IAEA web pages at www.iaea.org/programmes/ne/nenp/nptds/htgr/.



Source: Tsinghua University, Beijing

assuming domestic production capacity of 200 million tons and consumption of 420 million tons.

Natural gas, nuclear power, and renewable energy sources are the most feasible options in an energy substitution strategy.

China's natural gas industry is just in the initial stages, though it grew rapidly over the past decade. Production has doubled since 1990, to reach 32.7 billion cubic meters in 2002. Four major gas fields are developed (Shanganning, Chuanyu, Qinghai and Xinjiang) in west China, and a few fields operate in east China. Plans are to expand natural gas output to up to 150 billion cubic meters by 2020, if pipeline construction proceeds as planned. Even then, however, domestic gas production would fall short of the projected demand of 220 billion cubic meters.

Alongside other initiatives, China is pursuing international cooperation for developing and importing natural gas. An agreement with Russia includes importing natural gas and building a pipeline from northern Siberia to China. Work is expected to start in 2005, with operation planned in 2010.

Nuclear power development still is in early stages, though China started building plants in the late 1980s. Three nuclear power stations where a combined nine units are in operation have a total capacity of 6100 megawatts (MW). All are located in east coastal areas, where the economy is well developed but energy resources are poor.

Nuclear's potential is linked to demands for easing serious power shortages on the east coast and other areas. In 2003, China's National Development and Reform Commission promulgated a long-term programme of nuclear power development that sets a target of 36 gigawatts (GW) in total capacity by 2020. The programme aims to help reduce dependence on coal and contribute to a cleaner energy structure.

In China nuclear power mainly replaces coal-fired power. Cost comparisons in China's east coastal regions show that grid prices of nuclear power now are higher than for coal. However, when the costs of installing desulphurization equipment at coal plants is calculated, then nuclear's price competitiveness improves.

To reach the 2020 nuclear target, strategic measures need to be adopted. They should address attaching priority to development in east coastal regions; investing in the most economic and mature nuclear reactor technologies; and identifying the best funding approaches.

At this time, funding limitations hinder nuclear development, since top priority is given to hydropower and other thermal power sources. Past nuclear financing modes were mainly dependent on domestic investment, but they are not

suitable to the current situation. Foreign funds will become a very important financing source, though this has raised, and will continue to raise, issues related to such partnership ventures, including plant ownership.

When it comes to renewable energy, the Chinese government has paid great attention to its research and application since the 1980s, on environmental and other grounds. Next to hydropower, wind energy remains important. By the end of 2002, China had built around 30 wind farms, mainly in Xinjiang Uygur Autonomous Region, Inner Mongolia Autonomous Region, and Guangdong province. Counting smaller wind turbines, the total capacity from wind power was about 485 MW.

Solar and biomass energy also have been developed, with biomass on a larger scale. Currently the total annual output of agricultural residues is 700 million tons (equivalent to 210 Mtoe), 51% of which is used for fuel. About 250 to 300 million tons are consumed per year in rural areas, mainly for space heating and cooking.

Though renewable energy now plays a small role in China, it is important for improving environmental quality and people's living standards in rural areas. New targets for production have been set to 2010 in governmental guidelines.

Future directions emphasize improving the country's institutional management and organization of renewable energy development; expediting hydropower development, notably small and medium-sized projects; enhancing biomass production and use; developing solar technologies; expanding wind power to serve remote areas; and improving the financial framework, including questions of taxation, subsidies, and energy pricing for governmental and private sector involvement.

A Challenging Future

Chinese efforts are accelerating to address environmental protection and global climate change in the context of energy development. Coal's heavy use has resulted in serious consequences. Air pollution is caused by emissions of sulphur dioxide, carbon dioxide, and dust, and studies show that 85% of sulphur dioxide and 76% of carbon dioxide emissions are from coal combustion. China is now the second biggest carbon dioxide emission country in the world, and studies indicate it could rise to the top in decades ahead.

Additionally, areas affected by acid rain have reached about 40% of China, ranking the country among the three main heavy acid rain regions, next to Europe and North America. About one-third of coal is consumed by thermal power plants, but only a small fraction of plants have been equipped with desulphurization technologies.

More efforts are being made to reduce sulphur and carbon emissions, through development of cleaner energy sources

Credit: Vadim Mouchkin/IAEA

Demands for energy at home and in business are growing among China's 1.3 billion people.

and technologies, improved institutional coordination , and governmental policies and directives.

China is also actively pursuing measures in cooperation with other countries to combat global climate change. A white paper on population, environment, and development — called "China's Agenda 21" — incorporates a priority programme of concrete, operational projects. Almost all projects are included in national or local government plans for social and economic development. Development of clean energy and production systems are placed in an important position.

As China moves ahead, many issues will influence the country's sustainable development. The importance of energy strategies cannot be over-emphasized. Apart from other major strategies, such as population control, promoting clean energy is the most important to curb pollution and improve standards of living. Efforts should be focused on energy efficiency improvements, energy substitution of coal with natural gas and nuclear power, and renewable energy development, especially in rural areas of the country.

Some new mechanisms, rules, and policies already are in place to steer China's transition from a centrally planned economy to a socialist market economy. On the energy front, further steps will be needed to assure a path of sustainable development.

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