Sikh families board a special train in Amritsar, India, to visit pilgrimage sites in Pakistan. Such cooperation between the two countries is limited. There have been discussions, but little progress, toward building a natural-gas pipeline from Iran through Pakistan to India.
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CHAPTER FIVE

China and India

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With huge populations and rapidly developing economies, China and India play a critical role in global energy markets. Both countries are among the largest and fastest-growing energy consumers in the world. Looking toward the future, both countries need to balance growing demand for energy against limited domestic supplies and rising dependence on imports. With heavy use of coal for industry and power generation and increasing use of oil for motor vehicles, both countries also face serious environmental challenges.

Policymakers in China and India have been concerned for some time about securing sufficient energy to fuel economic growth and meet the rising expectations of their large populations. To supply these needs, both countries have limited domestic reserves of fossil fuels, particularly of oil and natural gas (Figure 5.1). In recent years, rising energy prices and growing dependence on imports from the Middle East have brought concerns about energy security to the forefront of the policy agenda.

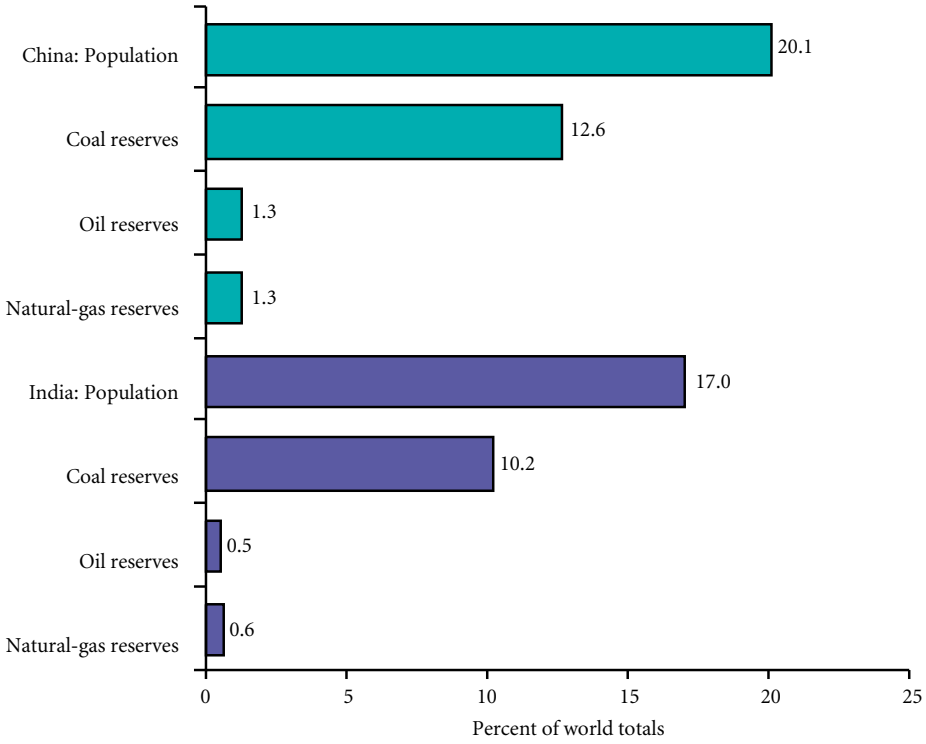
These concerns are not limited to policymakers in China and India. As Asia's two largest countries compete in world markets for energy supplies, they create insecurity for other countries in the Asia-Pacific region and around the world.

In the 10 years from 1995 to 2005, China and India together accounted for one-third of all the growth in global demand for oil. And this pattern is projected to continue. Over the next 20 years, demand for oil, natural gas, and other energy sources will rise much more quickly in China and India than in the world as a whole. Thus energy consumption in these two countries—and the policies they pursue to supply their energy needs—will be of tremendous importance for the rest of the world.

While there are many differences between China's and India's energy situation, a number of similar characteristics stand out. Demand for oil is skyrocketing in both countries, driven primarily by the growing number of motor vehicles. Demand for natural gas is also increasing rapidly, albeit from a much smaller base. With their limited reserves of oil and natural gas, domestic production lags further and further behind consumption.

Coal is the principal energy source in both countries, and both have large coal reserves. But concerns about the environment are prompting efforts to improve coal-burning technologies and to switch to other, cleaner, fuels. Energy-security policies in China and India also include a strong emphasis on hydropower and nuclear power to produce electricity. And lastly, to reduce dependence on Middle-Eastern suppliers, state-owned companies in both

Figure 5.1. Share of China and India in global population and global reserves of coal, oil, and natural gas, 2005 (percent)



Sources: PRB (2005); BP (2006).

countries are aggressively looking for new sources of oil and natural gas. These efforts to diversify energy sources may slow down increasing dependence on imports from the Middle East, but they will not halt the overall trend.

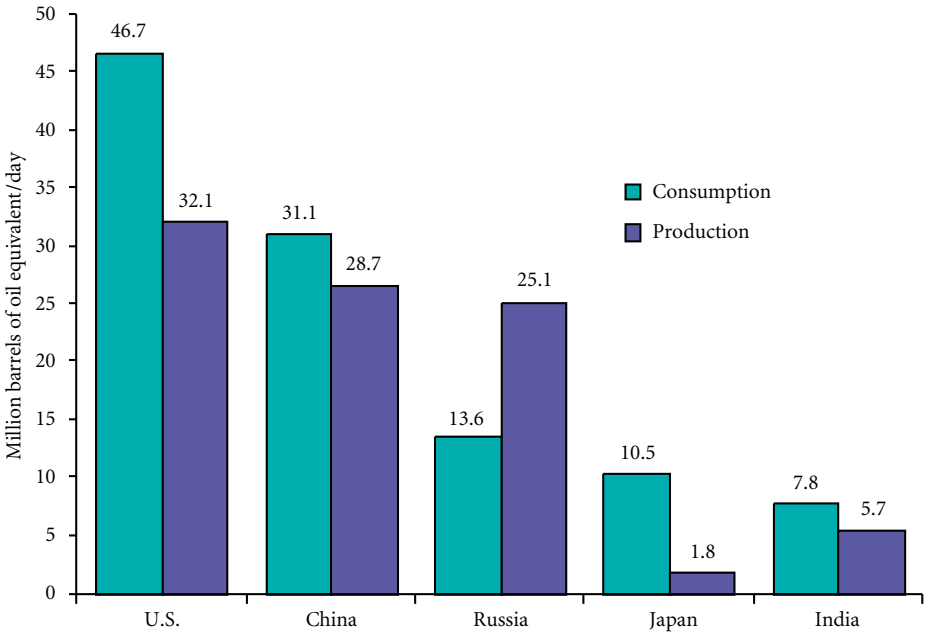
Demand for energy outpaces supply

China. China ranks second in the world in total primary commercial energy consumption, although a distant second after the United States (Figure 5.2). In 2005, consumers in China used primary commercial energy equivalent to 31.1 million barrels of oil per day (boe/d) (Appendix Table 5.1). They also used approximately 4.4 million boe/d of non-commercial energy from combustible biomass sources such as woodfuel, charcoal, and agricultural waste.

China uses so much energy because its population is so large. On a per-capita basis, China's primary commercial energy consumption is well below the world average. In 2005, per-capita primary commercial energy consumption for the world as a whole was 11.8 barrels of oil equivalent per annum (boe/a), compared with only 8.7 boe/a in China. Even with the addition of non-commercial energy, per-capita energy consumption in China was 9.9 boe/a, about 15 percent below the world average. This low level of per-capita energy consumption points to a strong potential for future growth.

Between 1980 and 2005, primary energy consumption increased at an average annual rate of 5.3 percent, linked to China's economic growth (Table 5.1 and

Figure 5.2. Primary commercial energy consumption and production by world's five largest users, 2005 (million barrels of oil equivalent per day: boe/d)



Sources: BP (2006); FACTS Global Energy (2006).

Figure 5.3). Consumption of all major sources of commercial energy increased steadily except during a five-year period between 1996 and 2000 when coal consumption went down. This exception to the overall trend stemmed from a decline in the use of coal in the residential and industrial sectors and a slowdown in the growth of coal use for power generation. Growth of coal consumption has since rebounded. Over the next 10 years, consumption of every type of commercial energy is expected to continue to grow steadily.

On the supply side, China has relatively abundant coal reserves (Table 5.2) but faces a major challenge in meeting the growing demand for oil and natural gas. In 2005, the Chinese produced 28.7 million boe/d of primary commercial energy—8 percent less than they used. The balance was made up of imports. Today, the Chinese are net importers of oil, and over the next five years they will also become net importers of natural gas. Overall, the gap between energy supply and demand is expected to widen, and increasing shortfalls will have to be supplied by imports.

India. At the global level, India ranks fifth in total primary commercial energy consumption after Russia and Japan (Figure 5.2). In 2005, the Indians used 7.8 million boe/d of primary commercial energy (Appendix Table 5.2) plus an estimated 4.2 million boe/d of non-commercial energy from combustible biomass. On a per-capita basis, primary commercial energy consumption in India is even lower than in China—at 2.6 boe/a in 2005. Adding non-commercial energy use results in an estimated 4.0 boe/a of total per-capita energy consumption. As in China, this low level of energy use points to enormous potential for growth.

Over the past 25 years, primary commercial energy consumption has been

Table 5.1. Annual growth rate of primary commercial energy consumption in China and India by source, 1980–2005 and 2005–2015 (percent)

Time period	Percent annual growth											
	Coal		Oil		Natural gas		Hydro-power		Nuclear power		Total	
	China	India	China	India	China	India	China	India	China	India	China	India
1980–2005	5.1	5.4	5.3	5.6	4.9	14.3	8.1	2.2	33.9[a]	7.4	5.3	5.5
2005–2015	4.2	2.2	5.0	3.5	11.1	9.0	7.8	5.1	17.7	12.7	5.0	3.7

Sources: OECD/IEA (2006); FACTS Global Energy (2006).
Note: Data for 2015 are projections.
[a] For 1993–2005.

Table 5.2. Proven reserves of fossil energy in China and India, beginning 2006

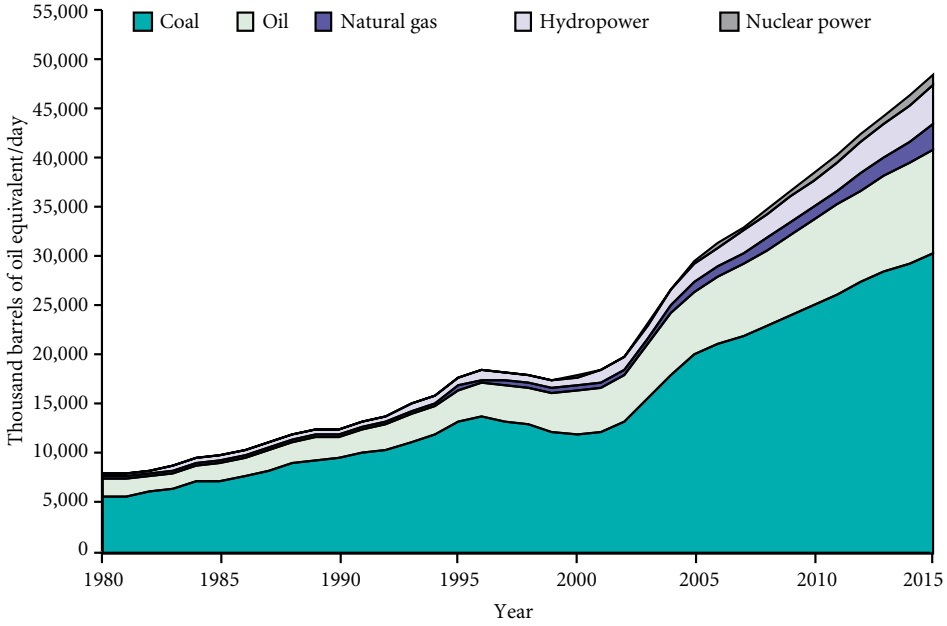
Country	Coal	Oil	Natural gas
China			
Reserves	114.5 billion tonnes	16.0 billion barrels	83.0 trillion cubic feet
Reserve-to-production ratio (R/P) (years)	52	12	47
Share of global reserves (percent)	12.6	1.3	1.3
India			
Reserves	92.4 billion tonnes	5.9 billion barrels	38.9 trillion cubic feet
Reserve-to-production ratio (R/P) (years)	217	21	36
Share of global reserves (percent)	10.2	0.5	0.6

Source: BP (2006).
Note: The reserve-to-production (R/P) ratio is the reserves remaining at the end of 2005 divided by production in 2005. The result is an estimated number of years that existing reserves can be expected to last if production continues at the same rate and no new reserves are discovered.

growing even more quickly in India than in China—at an average annual rate of 5.5 percent (Table 5.1 and Figure 5.4). As in China, projections indicate that energy consumption in India will continue to grow steadily over the next 10 years, albeit at a much slower rate.

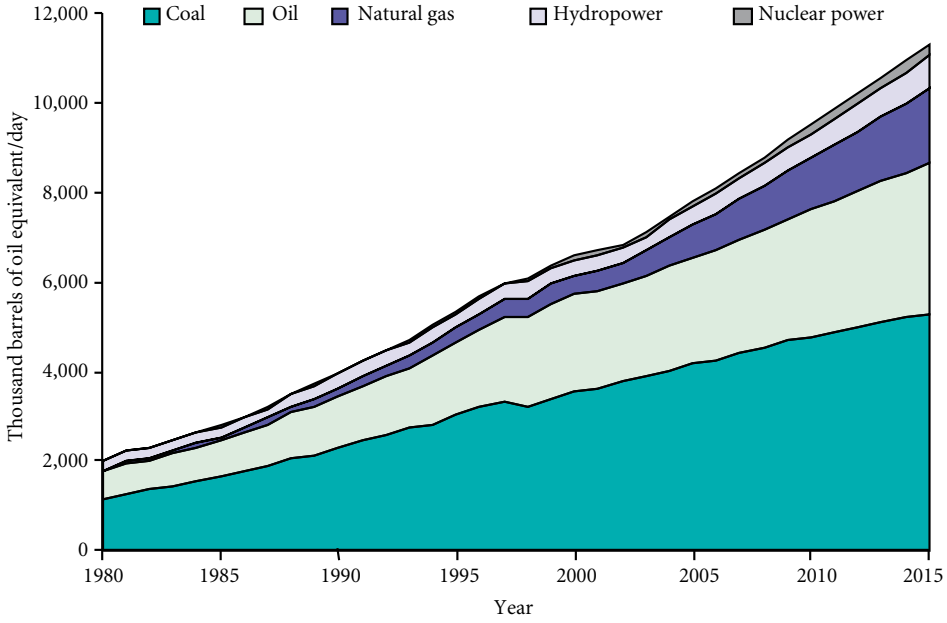
As in China, India has relatively abundant supplies of coal but very limited reserves of oil or natural gas. In 2005, the Indians produced 5.7 million boe/d of primary commercial energy—27 percent less than they used. Thus more than one-fourth of India's primary commercial energy was imported. India is already a net importer of coal, oil, and natural gas, and in the future, imports of all three commodities are expected to increase.

Figure 5.3. Primary commercial energy consumption from five leading sources, China, 1980–2015 (thousand barrels of oil equivalent per day: boe/d)



Source: FACTS Global Energy (2006).
Note: Consumption levels for years after 2005 are projections.

Figure 5.4. Primary commercial energy consumption from five leading sources, India, 1980–2015 (thousand barrels of oil equivalent per day: boe/d)



Source: FACTS Global Energy (2006).
Note: Consumption levels for years after 2005 are projections.

The dominant role of coal

Coal dominates commercial energy use in both China and India. The two countries have the third and fourth largest proven coal reserves in the world after the United States and Russia. China is the world's largest producer and consumer of coal, while India ranks third.

Coal is used primarily to generate electricity and also for industrial production. Because of their large domestic reserves, coal is relatively cheap in both countries, but coal combustion creates substantial health and environmental problems. For this reason, both China and India are trying to move away from coal toward cleaner fuels—most notably natural gas—but these efforts come at a higher cost and greater dependence on imports.

China. Coal is the most important source of primary commercial energy in China, with high consumption levels supported by large domestic supplies. China has estimated coal reserves of 114,500 million metric tonnes, 13 percent of the world total. At 2005 production levels, China's coal supplies should last an estimated 52 years, if no future domestic sources are discovered.

In 2005, three-fourths of all the coal used in China was for electricity generation. At the same time, coal fueled slightly more than three-fourths (78 percent) of all electricity generated in the country. Residential and commercial use has declined steeply—from 22 percent of all coal used in 1985 to 11 percent in 1995 and only 4 percent in 2005.

Apart from environmental concerns, coal production in China has been plagued with problems of mine safety, inefficiency, unlicensed mining operations, and over-mining. As a result, the government has closed many small, privately owned operations, reducing the total number of coal mines in the country from about 80,000 in the late 1990s to 28,000 today. In 2005, the eight largest state-owned coal mines accounted for 23 percent of total coal production.

In the past, China purchased technology and equipment from abroad but sought little foreign investment in the coal-mining sector. This situation is likely to change, however. As China seeks to build larger coal-production facilities and to meet higher environmental standards, foreign investors and providers of advanced technologies may find new opportunities to participate in China's coal sector. Countries likely to become involved include Australia, Germany, Japan, and the United States.

Between 1980 and 2005, coal consumption increased at an average rate of 5.1 percent a year (Table 5.1). This was somewhat slower than the average annual increase in total primary commercial energy consumption, at 5.3 percent. As a result, the share of coal in China's energy mix is going down—from 73 percent in 1980, to 70 percent in 2005, and to a projected 64 percent in 2015 (Table 5.3).

China has long been a net coal exporter, producing 2.1 billion tonnes in 2005 and consuming 2.0 billion tonnes. Yet an increasing amount of coal is also

Table 5.3. Proportion of total primary commercial energy consumption in China and India by source, 1980, 2005, and 2015 (percent)

	Percent of total primary commercial energy consumption											
	Coal		Oil		Natural gas		Hydro-power		Nuclear power		Total	
Year	China	India	China	India	China	India	China	India	China	India	China	India
1980	73.0	55.8	20.8	30.1	3.1	1.2	3.1	12.2	0.0	0.7	100.0	100.0
2005	69.7	54.6	20.8	29.7	2.8	9.1	5.9	5.6	0.8	1.0	100.0	100.0
2015	64.3	47.2	20.7	29.0	4.9	15.0	7.7	6.4	2.4	2.4	100.0	100.0

Sources: OECD/IEA (2006); FACTS Global Energy (2006).
Note: Data for 2015 are projections.

imported to meet booming demand in the southern part of the country. It is cost-effective to import coal because the primary consuming region is far from the main domestic centers of supply. In 2005, China exported 60 million tonnes of coal, primarily to Japan, the Republic of Korea (South Korea), Taiwan, and India (in order of importance), and imported 24 million tonnes, primarily from Australia, Indonesia, and Vietnam.

Over the next 10 years, China's coal production is expected to increase steadily, rising to 3.0 billion tonnes by 2015. Consumption is forecast to grow even faster, however. Over the next 5 to 10 years, China is likely to become a net coal importer.

India. Coal is the most important source of primary commercial energy consumption in India, although its share is not as high as in China. As in China, the importance of coal is diminishing—from 56 percent of total commercial energy use in 1980, to 55 percent in 2005, and to a projected 47 percent in 2015 (Table 5.3).

India has estimated domestic coal reserves of 92,445 million tonnes, 10 percent of the world total. At 2005 production levels, India's domestic coal supply will last more than 200 years.

In 2005, India produced more than 426 million tonnes of coal and imported nearly 38 million tonnes (BP 2006; FACTS Global Energy 2006). Although low in sulfur, Indian coal has a high ash content and low calorific value, making it unsuitable for metallurgy. As a result, India's steel industry imports coal for coking, mainly from Australia and New Zealand. India exports small quantities of coal to Bangladesh, Bhutan, and Nepal.

The importance of coal in India's energy mix is based on the country's large domestic reserves and the predominance of coal in the power sector. Today, almost three-fourths of India's electricity is generated from coal. Given that the demand for electricity is expected to grow at an average annual rate of 5–7 percent through 2015, the demand for coal will also rise significantly. Frequent

power cuts around the country are an indication of growing demand that the current production system is struggling to meet.

Nearly 90 percent of the coal produced in India comes from the state-owned Coal India Limited (CIL) and its subsidiaries. There has been a move to bring greater dynamism and efficiency into this sector by relaxing government controls over pricing and distribution and allowing private-sector participation in coal mining. Foreign participation has also been initiated, subject to certain clearances. These changes are an attempt to make coal production more competitive and to tackle the emerging problem of demand outstripping supply.

The high ash content of Indian coal raises special environmental concerns, which have contributed to a trend toward stricter pollution standards. The government now requires coal to be washed to remove ash before it is shipped to new generating plants, to environmentally sensitive areas, or over distances of more than 1,000 kilometers (km). India currently has a capacity to wash 63.5 million tonnes of coal a year—less than one-sixth of total coal production.

The government is also promoting a switch to natural gas for power generation. Any new gas-fired power plants that are built will probably be sited far from coal deposits in locations where piped or liquefied natural gas (LNG) can compete with coal in terms of costs. Yet with prices of oil and natural gas rising steadily, it will be difficult to replace coal, which is much less expensive. Large hydropower projects, which could fill some of the demand for electricity, are meeting stiff resistance from local communities on environmental grounds. All of these factors point to the continued importance of coal in India's energy sector.

Oil—primary focus of security concerns

In both China and India, oil is at the heart of growing concerns about energy security. Compared with their huge populations, both countries have low domestic reserves. This was manageable in the past when China and India had little manufacturing capacity, low use of electricity, and small numbers of motor vehicles. The situation is changing dramatically, however, with economic growth. Over the next 10 to 15 years, oil consumption is expected to increase rapidly in both countries, driven primarily by the transportation sector. Both countries need to ensure a sufficient supply of transportation fuel for the growing number of motor vehicles, and they also need oil for power generation and as feedstock in the petrochemical and industrial sectors.

Despite some new oil discoveries in recent years—in Rajasthan in India and the Tarim Basin and offshore in China—domestic production has remained stagnant in both countries. In 2005, 44 percent of the oil consumed in China and 73 percent of oil consumed in India was imported. The trend is toward even larger oil imports and greater dependence on the primary source or supply, the Middle East.

China. Oil is the second-largest source of primary commercial energy in China, although a distant second after coal, accounting for 21 percent of consumption in 2005 (Table 5.3). Between 1980 and 2005, oil consumption increased at the same rate as total commercial energy use, averaging 5.3 percent a year (Table 5.1 and Figure 5.3).

At this rate of increase, China recently overtook Japan as the largest oil consumer in Asia. Projections indicate that total oil consumption (petroleum products plus direct use of crude oil) will reach 8.6 million barrels per day (b/d) in 2010 and 10.5 million b/d in 2015. These projections are very sensitive to alternative assumptions, however. Demand growth could be faster or slower depending on the growth of the economy, price changes, and other factors.

At the beginning of 2006, China had 16 billion barrels of proven oil reserves, or 1.3 percent of the world total (BP 2006). The Chinese government claims to have much larger oil resources, however, including proven plus probable and possible reserves. Based on 2005 production levels and the internationally accepted estimate of China's oil reserves, China's domestic oil supply is projected to last another 12 years unless significant new sources are discovered (Table 5.2).

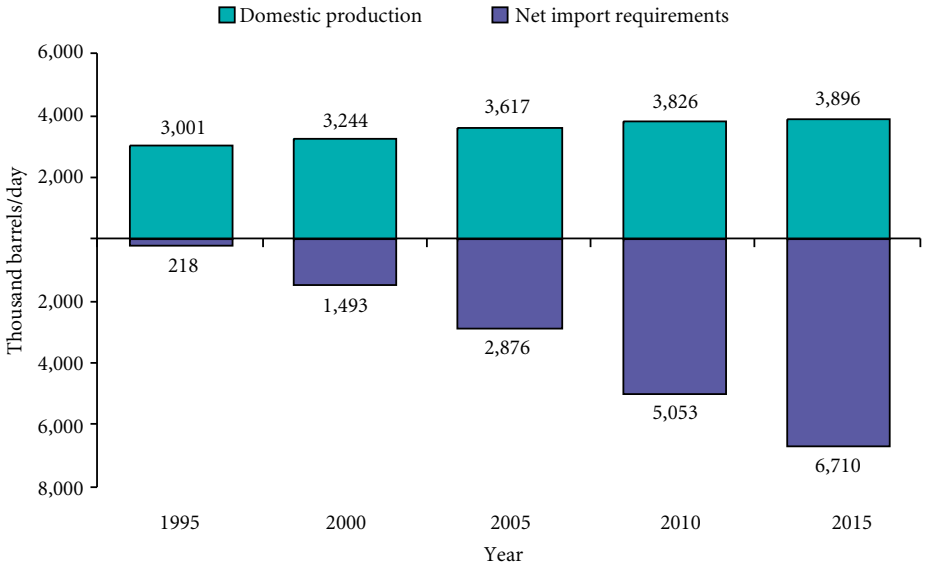
While consumption has grown dramatically since 1980, China's domestic production of crude oil has stagnated. In 1993, China shifted from a net oil exporter to a net importer, and imports (including both crude oil and petroleum products) have risen steadily ever since (Figure 5.5). In 2005, China produced 3.6 million b/d of oil but consumed 6.5 million b/d. During the year, China imported nearly 3.4 million b/d of crude oil and refined products and exported 500,000 b/d, resulting in net imports of 2.9 million b/d. Net oil imports are expected to continue rising for the foreseeable future in line with rising consumption.

Nearly one-half of Chinese oil imports come from the Middle East (Figure 5.6), and despite government efforts, this proportion is growing. Because of price volatility in global oil markets and rising oil imports from a region that is considered unstable, energy security has become a major concern for Chinese policymakers.

India. As in China, oil is the second most important source of primary commercial energy in India after coal. Oil accounted for 30 percent of total consumption in 1980 and 2005, projected to decline slightly to 29 percent in 2015 (Table 5.3). Between 1980 and 2005, oil consumption grew at an annual rate of 5.6 percent, slightly faster than in China (Table 5.1).

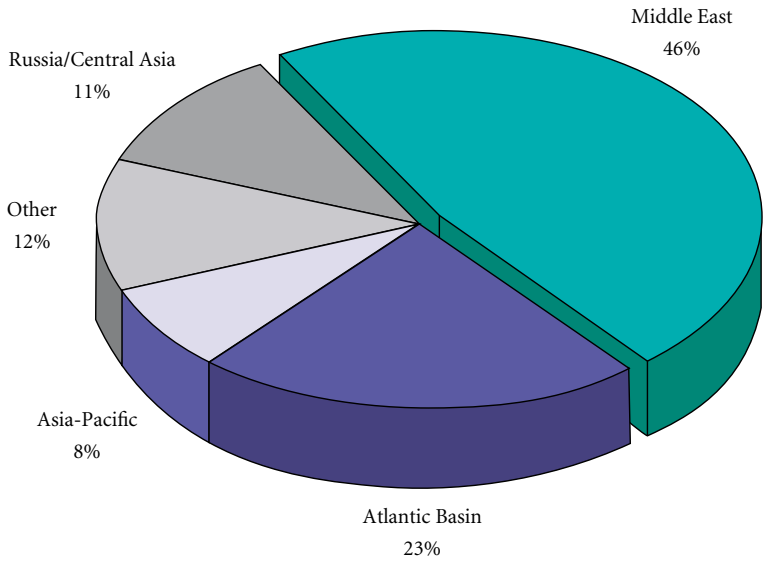
In recent years, consumption growth has slowed down, and this trend is likely to continue. Between 2005 and 2015, oil consumption is projected to increase at an annual rate of 3.5 percent. There are several reasons for this trend. India's economic growth is increasingly concentrated in sectors such as information technology that do not require intensive use of energy, and

Figure 5.5. Domestic oil production and net import requirements, China, 1995–2015 (thousand barrels per day: b/d)



Source: FACTS Global Energy (2006).
Note: Domestic production and import requirements for years after 2005 are projections.

Figure 5.6. Sources of China's crude-oil imports, 2005 (percent)



Source: China, General Administration of Customs (2006).
Note: Total crude-oil imports in 2005 were 2.5 million barrels per day (b/d).

consumption of natural gas is increasing, substituting to some extent for oil. Government efforts to reduce the use of oil in the public-transportation sector have also played a role in slowing consumption growth.

At the beginning of 2006, India had proven domestic oil reserves of about 5.9 billion barrels, less than 1 percent of the world total (Table 5.2). At 2005 production levels, India's domestic oil supply will last an estimated 21 years.

India produced 645,000 b/d of crude oil in 2005 and consumed 2.4 million b/d. The balance, two-thirds of India's oil consumption, was supplied by imports. With production likely to plateau or even decline in some of India's mature oil fields, the country will continue to be heavily dependent on imported oil, even if new domestic sources are discovered (Figure 5.7).

India is likely to require about 2 to 3 million b/d of imported crude oil over the next few years. Currently, India is far more dependent on the Middle East for oil than is China. In 2005, the Middle East accounted for more than two-thirds of India's crude oil imports (Figure 5.8). The Atlantic basin, comprising West Africa and Europe, came a distant second, providing less than one-fifth of imports.

Dependence on the Middle East is not likely to change. Atlantic-Basin crude oil contains less sulfur than oil from the Middle East, making it easier to refine to meet increasingly stringent environmental standards. Existing and new refineries in India are currently being upgraded, however, to improve the processing of Middle-Eastern grades of crude oil to reduce their sulfur content. The motivation is financial: Middle-Eastern oil sells at a discount because of its low quality, and freight costs are also low because the region is close to India.

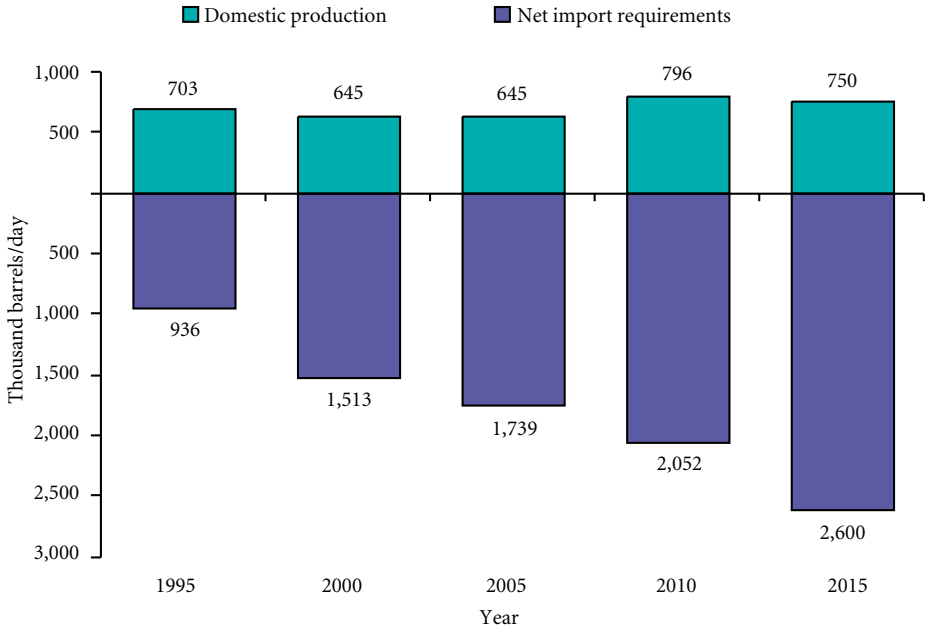
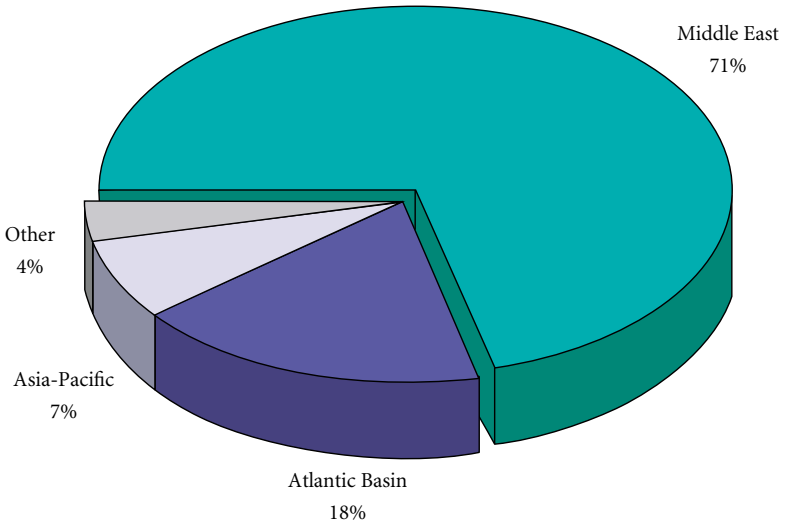


Figure 5.7. Domestic oil production and net import requirements, India, 1995–2015 (thousand barrels per day: b/d)

Source: FACTS Global Energy (2006).
Note: Domestic production and import requirements for years after 2005 are projections.

Figure 5.8. Sources of India's crude oil imports, 2005 (percent)



Source: FACTS Global Energy (2006).
Note: Total crude-oil imports in 2005 were 2.0 million barrels per day (b/d).

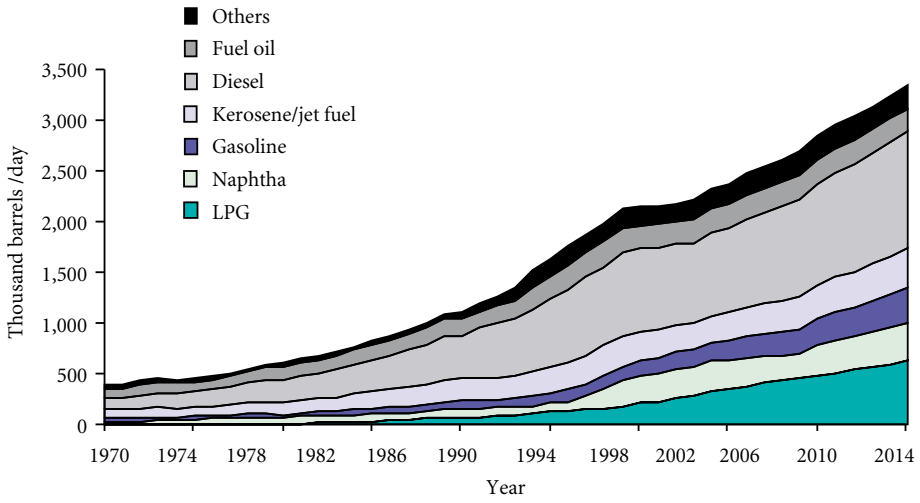
The mix of petroleum products in India's overall oil consumption is of particular interest because India is emerging as a major exporter of petroleum products, refined largely from imported crude oil. Consumption of liquefied petroleum gas (LPG, consisting of propane and butane) is growing, mainly used as household cooking fuel (Figure 5.9 and Appendix Table 5.3). Naphtha consumption is also growing in India's petrochemical industry, and gasoline consumption is growing due to rising numbers of privately owned vehicles. In recent years, demand for other petroleum products has been steady or declining.

India currently exports diesel, gasoline, naphtha, and fuel oil. Juxtaposing shifts in demand with projected changes in India's refining capacity indicates that India will continue to have a deficit of LPG, most of which is currently purchased from the Middle East (Figure 5.10). The more significant trend, however, is India's emergence as an exporter of all other petroleum products.

These surpluses have arisen as a consequence of over-projecting domestic demand. Many of India's oil refineries were built in the late 1990s and early 2000s to supply the domestic market. The recent slowdown in consumption growth has transformed India from a major importer of petroleum products to an exporter. India's surpluses have contributed to surpluses in the regional market and have depressed the profitability of refinery operations throughout Asia and the Pacific.

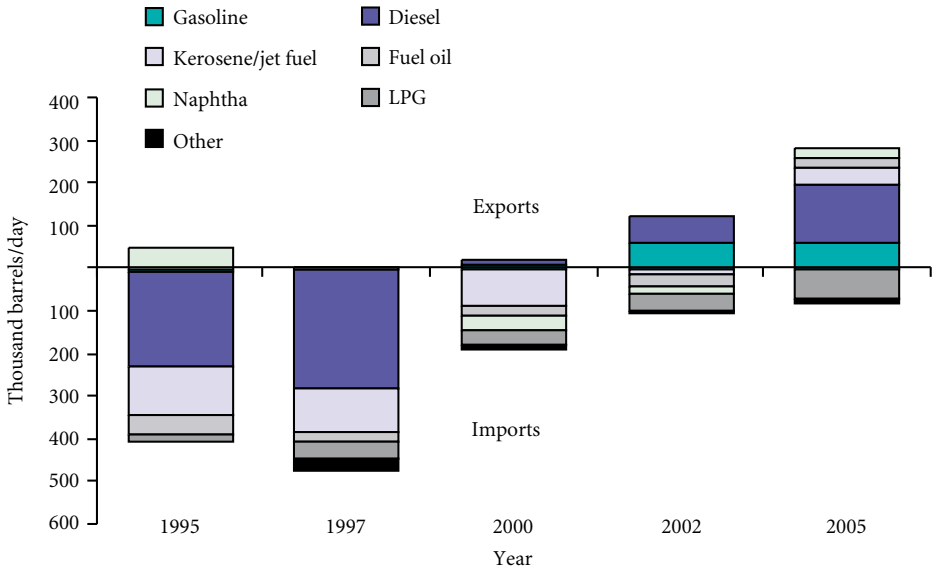
Despite this situation, refining capacity in India is slated to continue to expand. As a result, India will remain an important petroleum-product exporter through the end of this decade. To meet domestic demand plus excess refining capacity, India will be forced to import expanding supplies of crude oil.

Figure 5.9. Consumption of petroleum products in India, 1970–2014 (thousand barrels per day: b/d)



Source: FACTS Global Energy (2006).
Note: Consumption levels for years after 2005 are projections.

Figure 5.10. India's trade in petroleum products, 1995–2005 (thousand barrels per day: b/d)



Source: FACTS Global Energy (2006).
Note: Exports and imports are on net basis.

Natural gas

Natural gas accounts for a very small percentage of primary commercial energy consumption in China and India, but this percentage is growing fast. Both countries have strong incentives to increase natural-gas use: to reduce dependence on imported oil and to help control urban air pollution. Up to now, both countries have relied primarily on domestic sources of natural gas, but this situation will change as consumption goes up. Over the long term, both countries will be forced to increase natural-gas imports significantly.

China. In 1980 and 2005, natural gas accounted for only 3 per cent of primary commercial energy consumption in China, projected to rise to 5 percent by 2015 (Table 5.3). The Chinese government's plan is to double the share of natural gas in the nation's overall primary commercial energy consumption by 2015, requiring increases in both domestic production and imports.

After a late start, China's natural-gas industry has developed rapidly since the late 1990s. Today, China's gas consumption is supplied almost entirely from domestic sources. Spurred by the high demand for energy in general and for electric power in particular, domestic pipelines are under construction. One terminal to process imported LNG is now in operation, and a second is under construction.

The first terminal, recently completed in Guangdong Province, received its first shipload of LNG in May 2006. This terminal has a capacity to receive and process up to 3.7 million tonnes per annum (t/a). The second terminal, in Fujian Province, has a targeted completion date of 2008 and a projected capacity of 2.6 million t/a. Thus together, total LNG imports through these two terminals could reach 6.3 million t/a. In addition to these two projects, the China National Offshore Oil Corporation (CNOOC), the China National Petroleum Corporation (CNPC or PetroChina), and the China Petrochemical Corporation (Sinopec) have proposed several LNG terminals for development over the next 10 years.

Although it is unlikely that all of these projects will materialize, Chinese facilities to receive and process imported LNG will undoubtedly expand over the next decade, reaching a projected capacity of 18.5 million t/a in 2015. There appears to be a gap between planned LNG receiving capacity and projected LNG imports, however, suggesting that China's new LNG terminals may be substantially underutilized. Regional and global LNG markets are becoming tighter, and it is unlikely that China will be able to purchase enough LNG to meet its ambitious goals for increased consumption. LNG imports are conservatively projected to reach 14 million t/a by 2015, equivalent to 1.8 billion standard cubic feet per day (scf/d). This would only utilize about three-fourths of planned capacity.

On the domestic side, China has 83 trillion standard cubic feet (scf) of proven natural-gas reserves, 1.3 percent of the world total. At the 2005 production level of 4.9 billion scf/d, China's current proven reserves will last another 47 years.

Most of the increase in oil consumption in China and India has been, and will continue to be, driven by the demand for fuel in the transportation sector. This has important implications for the mix of petroleum products required from the nations' refineries and also for national efforts to curb urban air pollution.

Transportation fuel has become the largest source of air pollution in many Asian countries. Although still lagging behind Australia, Japan, New Zealand, South Korea, Taiwan, and some Southeast-Asian nations, China and India are both making efforts to promote cleaner use of gasoline and diesel in the transportation sector.

China has been moving toward higher emission standards since the late 1990s. This effort began with the phasing out of leaded gasoline. In 2004, the government introduced Euro II emission norms, which limit the sulfur content in gasoline and diesel used in automobiles to 500 parts per million (ppm). In July 2005, Beijing introduced Euro III standards, which limit the sulfur content to 150 ppm in gasoline and 350 ppm in automobile diesel. Shanghai and Guangzhou are also scheduled to adopt these more stringent standards. By 2007, China plans to adopt Euro III standards throughout the country. Euro IV standards (a maximum of 50 ppm of sulfur in both gasoline and diesel for automobiles) will be adopted in Beijing in time for the 2008 Olympics, to be followed by Shanghai and Guangzhou in 2010.

Commuters battle traffic and haze during rush hour in Chiang Mai, Thailand. To help control urban air pollution, India and South Korea have started using compressed natural gas (CNG) in some public-transportation vehicles. © REUTERS/Sukree Sukplang/Landov

India first embarked on an aggressive program to tighten quality specifications for petroleum products in the early 2000s and then shifted to a more moderate approach. In April 2005, Euro III emission norms came into force in Agra, Ahmedabad, Bangalore, Chennai, Delhi, Hyderabad, Kanpur, Kolkata, Mumbai, Pune, and Surat. Euro II norms are currently being adopted throughout the country. The plan is to extend Euro III norms to the rest of India by 2010 and to raise standards to the Euro IV level in the nation's 11 largest cities. In addition, the Indian Supreme Court decreed that public-transportation vehicles in Delhi be converted to use compressed natural gas (CNG).

Other specifications for refined oil products are also being tightened in India. Higher product standards mean higher production costs, however. To meet higher standards, Indian refiners need to invest heavily in desulfurizing and treatment facilities. Because local refiners have been unable to complete these upgrades in time to meet higher specifications, retailers have had to resort to costly imports of diesel and gasoline as a stopgap measure.

Domestic production is projected to rise significantly above 2005 levels, however—to 9.2 billion scf/d in 2015. Assuming this level of domestic production growth plus rising imports, China can be expected to have 12 billion scf/d of natural gas to supply domestic consumption by 2015. If China's domestic gas production grows more slowly than these projections assume, and if some of the planned import projects do not materialize, then natural gas available for consumption could be as much as one-third lower.

China currently has no international pipelines for importing natural gas, but the government is exploring opportunities for constructing pipelines, possibly from Sakhalin or western Siberia by 2015 and from Kazakhstan and Turkmenistan by 2020. Increased use of natural gas will also require a network of domestic pipelines. China has accelerated the construction of new gas pipelines since the mid-1990s, building more pipelines in the past decade than during the previous four decades combined. Urban distribution networks have also expanded. The largest of the newly built natural-gas pipelines is the 4,000-km West-East pipeline. Others are mainly in western, northwestern, and northern China, plus a few offshore.

Cost is a major concern. Natural gas is expensive, even if it is produced domestically, because China's gas fields are far from centers of consumption, requiring huge investments in long-distance pipelines. And international prices are going up. Consumers may be unwilling to pay high prices for energy derived from natural gas in spite of government efforts to expand this sector.

Currently, industrial use accounts for nearly one-half of China's natural-gas consumption because natural gas is an important component in fertilizer production. In 2005, residential/commercial use accounted for 21 percent of natural-gas consumption, while electric power generation and heating accounted for 8 percent. Over the next 10 years and beyond, growth in natural-gas consumption will be led by the power and residential sectors. Consumption in the chemical sector and other industrial sectors will also increase, but at a slower pace. The transport sector will also consume more natural gas in the form of CNG.

India. Natural gas plays a central role in India's energy policy, promoted as an alternative fuel for environmental reasons and to reduce dependence on oil imports. Although consumption levels are still modest, natural gas is the fastest-growing source of energy in India, growing from 1 percent of primary commercial energy consumption in 1980, to 9 percent in 2005, and to a projected 15 percent in 2015 (Table 5.3).

In 2005, India imported 4.5 million tonnes of LNG, accounting for about one-fifth of total natural-gas consumption. A policy to increase the use of natural gas will inevitably translate into greater demand for LNG imports. This is because anticipated consumption cannot be met out of domestic production, and international pipelines are still at the discussion stage.

Petronet LNG Limited received India's first shipment of imported LNG in

2004, making India the fourth LNG importer in Asia. These first imports were purchased under a 20-year contract with RasGas of Qatar and were received at the newly constructed Dahej terminal in Gujarat. Shell's Hazira terminal, also in Gujarat, began receiving imported LNG in April 2005. Recently, the Gas Authority of India Limited (GAIL) and the Indian Oil Corporation (IOC) signed a 25-year contract to import LNG from the South Pars field in Iran. IOC and GAIL are planning to partner with Iran's Petropars to develop a gas-liquefaction plant in Iran, which will produce LNG for export to India and other countries.

The Foreign Investment Promotion Board (FIPB) approved 12 prospective LNG import-terminal projects in the mid- to late-1990s, but not all of them are expected to be constructed. The Dahej terminal has a capacity to receive 7.5 million t/a, and the Hazira terminal has a capacity of 5.0 million t/a. A third terminal, at Dabhol, is nearly complete, but construction was suspended when Enron went bankrupt. Recently, the government has set up a Special Purpose Vehicle (SPV) to revive the Dabhol facility, and it is expected to be at least partly operational by the end of 2007. Additional LNG import terminals have been proposed for several locations. At the same time, the domestic pipeline infrastructure is being developed to carry locally produced natural gas and re-gasified LNG to various parts of the country.

India, Bangladesh, and Myanmar are discussing construction of an international gas pipeline, and there are also discussions about building a pipeline from Iran to India through Pakistan. Despite these talks, it is unlikely that India will receive natural gas through international pipelines until at least 2015.

Up until now, most imported LNG has been directed to India's industrial sector, primarily substituting for more-expensive naphtha in refineries and other industries. The government is promoting the use of natural gas for power generation, however, and as an alternative transport fuel in the form of CNG. In the future, the power sector will certainly be the most important user. In addition, natural gas will be used increasingly as a component of fertilizer.

Hydropower and nuclear energy

Given the rising cost of oil and natural gas and concerns about dependence on imports, both the Chinese and Indian governments are placing increasing emphasis on domestic sources of energy. At the same time, both countries are trying to slow down the expansion of coal consumption because of negative health and environmental impacts. All of these concerns point to a renewed emphasis on hydropower and nuclear energy.

China. China's energy planners have traditionally placed heavy emphasis on hydropower. Hydropower accounted for 3 percent of China's total primary commercial energy consumption in 1980, rose to 6 percent in 2005, and is projected to rise to 8 percent by 2015 (Table 5.3). About two dozen large

RUSH TO INVEST IN ENERGY PRODUCTION OVERSEAS

Both China and India view overseas investment as a critical component of efforts to secure future energy supplies. China began investing in overseas oil and natural-gas projects in the early 1990s and intensified investment activities toward the end of the decade. In recent years, the Chinese state-run oil companies have been engaged in an all-out effort to expand overseas. Faced with escalating demand for petroleum products combined with stagnating domestic production, the Indian government has also encouraged local oil companies to invest in exploration and production projects in other countries.

Judging from their investment record to date, Chinese and Indian companies have a long way to go to develop a successful overseas-investment strategy. In many instances, the Chinese and Indians have bid on projects that the major international oil companies deemed too risky or unprofitable. In the late 1990s, for example, the Chinese company CNPC paid substantially higher prices for oil exploration and pipeline projects in Venezuela and Kazakhstan than the major international oil companies were willing to pay.

Chinese and Indian oil companies have also bid up prices by competing against each other and against companies from other

hydropower projects have been constructed over the past few decades with a minimum installed capacity of 1,000 megawatts (MW) each. At the end of 2005, China had approximately 117,000 MW of installed hydroelectric capacity, including part (9,800 MW) of the gigantic Three-Gorges project. Upon its full completion in 2009, the Three-Gorges hydropower plant will be the world's largest, with a capacity of 18,200 MW. Current government plans call for continued construction of hydropower facilities, with emphasis on both very large and small projects.

China did not begin building nuclear power plants until 1982, despite early development of indigenous nuclear technology. Nuclear energy accounted for less than 1 per cent of primary commercial energy consumption in 2005. In light of current electricity shortages, however, nuclear energy is poised to grow more quickly in the future. It is projected to provide nearly 3 percent of China's total primary commercial energy by 2015.

The first Chinese nuclear power plant, at Qinshan in Zhejiang Province, started commercial production in 1993. The next two plants went into production in 1994, at Daya Bay in Guangdong Province. Four more plants began producing power in 2002, followed by one in 2003 and one in 2004. These nine plants brought China's total installed nuclear-power capacity to 6,856 MW at the end of 2004. Following the completion of a tenth plant, at Tianwan, China had a total installed nuclear-power capacity of 8,956 MW at the end of 2005. Current plans include nuclear power plants in three additional locations that will bring total capacity up to nearly 15,000 MW.

According to several observers, the Chinese government plans to increase nuclear power dramatically in the longer term—to 40,000 MW by 2020. This would comprise 4 percent of China's total capacity to generate electricity. To reach this target, at least 2,000 MW of new nuclear power needs to be added every year between 2005 and 2020.

China has enough domestic uranium resources to meet short- and medium-term fuel requirements for the expansion of nuclear power. Construction and operation of nuclear facilities are expensive, however, and the government has to provide full support to sustain this source of energy. In addition, over the long term, further exploration will be needed to increase domestic uranium supplies.

India. Current hydroelectric capacity in India is 32,335 MW, or 26 percent of total installed power capacity. While hydroelectric power is an important source of energy, its share has declined over time (Table 5.3). Between 1980 and 2005, consumption of hydropower grew at an average annual rate of only 2.2 percent, compared with the 5.5 percent annual growth for primary commercial energy consumption as a whole (Table 5.1).

The growing demand for electricity in India has led to a renewed interest in hydropower. The government plans to add another 9,815 MW of hydropower

countries such as Brazil and Malaysia. In October 2005, for example, CNPC won the bid to take over PetroKazakhstan for US$4.18 billion, a high price that resulted from competitive bidding. In some instances, Chinese and Indian companies have been able to cooperate, as demonstrated by joint investments in Syria and Sudan, but such cooperative ventures are highly challenging for policymakers in both countries.

In their search for new sources of energy, China and India face a market that is dominated by the developed countries and the major international oil companies. For this reason, they are forced to focus on countries whose regimes, for various reasons, are at odds with the United States and other Western nations. Such countries include Bolivia, Cuba, Iran, Myanmar, Sudan, Syria, and Venezuela. Energy enterprises in these countries may be vulnerable to disruption as a result of internal dissension or external intervention.

Do China's and India's overseas oil and natural-gas investments actually promote their energy security? On the surface, it is always helpful to have a variety of supply options. But the cost has been high in economic terms. Both China and India have good supplies of labor and access to well-developed engineering and drilling technologies. Companies in both countries need to make better use of these advantages and seek out investment opportunities that are actually profitable.

by 2010, to be developed largely by national and state government bodies but including joint ventures with the private sector. Constraints on future projects include an unfavorable tariff structure, negative environmental effects, shortage of long-term finance, problems of land acquisition, and difficulties in resettling affected populations. To address these problems, the government has set out a National Policy for Hydropower Development that includes provision of financing, gives priority to upgrading and renovation of existing projects, and provides government support for land acquisition, resettlement, and catchment-area development.

India has been using nuclear power to generate electricity since 1969, but on a small scale. Although use of nuclear power grew by 7.4 percent a year between 1980 and 2005, the share of nuclear power in India's primary commercial energy consumption is still low, at around 1 percent in 2005.

India is not a signatory to the Nuclear Non-Proliferation Treaty and until recently was prohibited from international trade in nuclear technology and materials. To address global concerns about nuclear proliferation, the Indian government has introduced legislation on Weapons of Mass Destruction and their Delivery Systems. The goal is to gain international acceptance so that India can collaborate with other countries on nuclear technology.

In July 2005, the United States and India signed an agreement lifting the U.S. ban on the sale of non-military nuclear technology and materials to India and providing assistance to develop India's nuclear-power capability. U.S. President George Bush expressed his intention to strengthen this relationship during a visit to India in March 2006, and the 2005 agreement was ratified by the U.S. Senate nine months later.

Partly because India was banned from international trade in nuclear materials and technologies, Indian scientists have achieved self-reliance in the entire nuclear fuel cycle. India is also working to achieve self-sufficiency in uranium exploration and mining, heavy-water production, design and construction of reactors, and management of nuclear waste.

In 2005, nuclear power accounted for 3 percent of India's electricity generation. With completion of the Tarapur-4 reactor in September 2005, India now has 15 nuclear-power reactors in operation with a combined capacity of 3,150 MW (Fesharaki and Murata 2006). Thirteen of India's reactors use domestic uranium, but the other two require enriched uranium, which is not available from local sources. This enriched uranium was imported from Russia before the Nuclear Non-Proliferation Treaty went into effect. Although India's domestic uranium reserves are limited, it has abundant reserves of thorium, and new technologies are currently being developed to use these large thorium reserves as nuclear fuel.

Eight additional nuclear reactors are under construction. Expected to be operational by 2008, they will more than double the current installed capacity to 6,730 MW. All are owned and operated by the state-owned Nuclear Power

Corporation of India. As these construction projects indicate, nuclear power is expected to play a growing role in India's energy sector. Plans are to have 20,000 MW of nuclear capacity by 2020, half of the capacity that is planned in China.

Despite fears over the safety of nuclear reactors and the disposal of radioactive waste, the expansion of nuclear energy is based on other—overriding—concerns. These include India's growing dependence on oil imports, rising oil prices, escalating demand for electricity, increasing pollution from the use of fossil fuels, and public resistance to large hydroelectricity projects.

Policies to enhance security of energy supplies

In looking toward the future, policymakers in China and India face a similar challenge—to assure adequate energy supplies that will support rapid economic growth and meet the rising aspirations of their huge populations. To achieve these goals, policymakers in both countries are trying to diversify sources of energy and reduce dependence on imports. Both countries have also taken measures to increase strategic energy stocks and improve the efficiency of energy markets.

China. To enhance energy security, the Chinese government emphasizes reliance on domestic energy sources and stresses that coal will continue to be China's most important fuel. Policymakers call for diversifying sources of energy imports, improving links with international energy markets, establishing a national petroleum storage system, developing alternative fuels to replace oil, and adopting more energy-efficient technologies.

A full-fledged energy-security policy is still evolving in China (Gao 2003; Wu 2002), but discussions include the following objectives:

- Enhance domestic oil and natural-gas exploration and production
- Reduce dependence on oil by promoting the use of natural gas and nuclear power and developing liquefaction technologies to produce gasoline and diesel from coal
- Set up government-controlled strategic oil and natural-gas stocks and raise mandatory stockpile requirements for large oil companies
- Help develop a regional energy community and a regional energy-security system
- Establish an oil futures market
- Diversify sources of oil and natural gas by increasing the share of imports from Russia and Central Asia
- Expand overseas investment by state oil companies, particularly in the Middle East, the Asia-Pacific region, Russia, and Central Asia
- Increase investment in oil and natural-gas infrastructure and open additional routes for imports

One serious concern is that China has just started a national strategic petroleum-storage system. The current stockpile system is fragmented, and facilities are in the hands of individual refineries, pipeline companies, and sales agencies. There is a National Office of Strategic Petroleum Stockpiling, however, housed in the Energy Administration under the National Development and Reform Commission (NDRC). The current target, to be achieved by 2008, is to have 100 million barrels of oil in storage, about 25 days of the net oil imports or 14 days of the oil consumption projected for that year. China is setting up a special government agency and consortium to manage the necessary storage facilities, and the state oil companies may also be involved. The longer-term target is to have 189 million barrels in storage by 2010, about 37 days of projected net imports or 22 days of projected consumption.

China began investing in overseas oil and natural-gas assets in the early 1990s and stepped up these efforts in the latter part of the decade. Since 2000, the Chinese state oil companies have greatly expanded overseas investments, an initiative strongly favored and encouraged by the Chinese government. The state oil companies have been able to take advantage of the central government's concern about energy security to achieve their business objective of expanding operations around the world. This international thrust has become a cornerstone of the overall investment strategy of every state oil company in China.

The most active of China's state oil companies in this area is CNPC and its publicly listed subsidiary PetroChina. CNOOC and Sinopec have also been active in overseas investment. In addition to these three, Sinochem Corporation and two state-owned companies—China International Trust and Investment Company (CITIC) and China Zhenhua Oil Co. Ltd.—have begun investing in oil operations overseas.

CNPC/PetroChina was the first Chinese state oil company to invest in the overseas oil sector, initiating an investment in Peru in 1993. The company currently has production-sharing contracts, joint-venture projects, lease contracts, and other projects in Algeria, Azerbaijan, Canada, Ecuador, Indonesia, Iran, Kazakhstan, Mauritania, Myanmar, Nigeria, Oman, Peru, Sudan, Syria, Turkmenistan, and Venezuela.

CNOOC's overseas investments are mainly in Algeria, Australia, Canada, Indonesia, Kazakhstan, Kenya, Morocco, Myanmar, and Nigeria. Sinopec has projects in Algeria, Azerbaijan, Brazil, Canada, Ecuador, Iran, Kazakhstan, Kuwait, Saudi Arabia, and Yemen.

India. Given concerns about India's dependence on imported oil from the Middle East, policymakers are pursuing several options to improve the country's energy security. To increase domestic supplies, the government is trying to attract foreign companies to participate in oil exploration and production. So far, this approach has met with limited success, and, in fact, most new licenses have been awarded to local firms.

The government is also encouraging Indian oil companies to participate in oil and natural-gas exploration and production projects overseas. The argument is that control of overseas oil fields can help ensure the security of India's oil supply. This policy holds great appeal for Indian oil companies that find participating in overseas projects a promising way to invest their cash holdings and consolidate their position in the industry. The main company involved is Oil and Natural Gas Corporation (ONGC) Videsh Limited, or OVL, which is the overseas arm of ONGC India. OVL is currently involved in exploration and production projects in Côte d'Ivoire, Egypt, Iran, Iraq, Myanmar, Nigeria, Sudan, Syria, and Vietnam.

The third aspect of India's energy-security strategy is to develop strategic oil stocks. This approach has been considered for some time, but concrete action has been inhibited by the cost involved. Currently, the plan is to maintain a stock of crude oil equivalent to about 15 days of consumption (approximately 38 million barrels), increasing eventually to an equivalent of 60 days of consumption. The oil stocks would include mandatory inventory requirements for refiners plus government-held stocks financed by a tax on refiners and importers.

Continuing energy challenges

China and India face a long list of energy challenges. These include ensuring adequate supplies to meet future energy demand and reducing the adverse health and environmental effects of energy use. How China and India manage these issues will affect the welfare of more than one-third of the world's population.

Both countries have to deal with a rapidly expanding demand for energy, and both have large rural areas where the supply system for commercial energy is weak. To the extent possible, both need to move away from coal to cleaner—but more expensive—fuels. Both need to deregulate domestic energy markets and put foreign energy investment on a more rational footing to help ensure the security of future energy supplies. And both countries need to moderate the growing consumption of all types of energy without risking a political backlash or sacrificing economic growth.

Commercial energy consumption is nearly four times as large in China as in India, and environmental problems are much more severe. China is much more heavily dependent than India on coal, and China faces severe problems related to coal use, including urban air pollution, acid rain, transportation bottlenecks, and production safety. China also has a long way to go to improve energy efficiency and increase energy conservation.

India is already more heavily dependent than China on energy imports, and in the future, India will face increasing shortfalls in domestic supplies of oil and natural gas. India's population is also growing much faster than China's. Today, nearly one-third of India's one billion people live in poverty, presenting the government with the daunting challenge of providing affordable energy to the

rural and urban poor. The government has approached this problem by controlling energy prices and subsidizing the price of LPG and kerosene, the main commercial energy sources used by the poor. At the same time, however, India's energy markets need to move toward privatization and deregulation in order to attract foreign investment. These two priorities—deregulating markets and providing energy to the poor—tend to be conflicting, which poses a challenge for policymakers.

In addition to domestic concerns, energy policies in China and India have an important impact on the Asia-Pacific region and the world. The rapid increase in oil consumption and oil imports in China and India contributes to higher oil prices worldwide. Consumption trends in China and India also affect the world market for natural gas. And finally, energy use in China and India can have adverse environmental effects on neighboring countries, the Asia-Pacific region, and the world as a whole.