CHAPTER 3

CHINA'S ENERGY AND ENVIRONMENT POLICIES AND ACTIVITIES

SECTION 1: CHINA'S CURRENT ENERGY PICTURE

> "The Commission shall investigate and report exclusively on—
>
> . . .
>
> "ENERGY—The effect of the large and growing economy of the People's Republic of China on world energy supplies and the role the United States can play (including joint research and development efforts and technological assistance) in influencing the energy policy of the People's Republic of China. . . ."

Introduction

China's economy, energy use, and environment are inextricably linked. A secure energy supply is needed to fuel economic growth. Energy consumption, particularly combustion of carbon fuels, produces environmental pollution, and this pollution has direct economic and social costs. Eliminating or mitigating the effects of pollution, or moving to nonpolluting energy sources, also entails economic costs and requires changes in personal, community, corporate, and national behavior and often can be accomplished only with the government's concerted initiative.

These linkages are not unique to China; China and the United States face similar challenges in devising energy policy, securing sufficient energy supplies to support the national economy and the desired standard of living, and addressing such related issues as climate change. Acting Assistant Secretary of Energy for Policy and International Affairs Katharine Fredriksen testified before the Commission about China's approach to these challenges:

> *China's energy consumption patterns will continue to impact global energy markets and the environment over the coming decades. . . . China is thus, like the United States, constrained by ever-growing demands for energy resources and the need to balance its energy requirements with environmentally responsible policies. The size of our two countries and our combined impact on global energy markets inextricably link our energy security goals.*[1]

Given the importance to China of a reliable energy supply to fuel its economic growth, and the reality of global commodity markets, it is understandable that energy security has become an important consideration for China's domestic politics and foreign policy. What China does in this arena likely will have a large impact on the United States and therefore on U.S.-China relations.

This section of the Commission's Report outlines the basic facts and figures of China's energy picture—its growing consumption and constrained supply and the environmental impacts of its energy use. Based on this picture, in the following section (sec. 2) the Commission examines the energy challenges facing China and how China is dealing with them and considers how the United States can promote improved energy security for both countries by supporting and urging China to strengthen global energy markets; invest in clean, efficient energy production; and mitigate pollution.

China's Energy Consumption

The International Energy Agency's (IEA) *World Energy Outlook: China and India Insights, 2007* states, "In less than a generation, China has moved from being a minor and largely self-sufficient energy consumer to become the world's fastest-growing energy consumer and a major player on the global energy market."[2] China quadrupled its gross domestic product (GDP) between 1980 and 2000 while only doubling the amount of energy it consumed—a notable accomplishment. However, with its adoption of policies promoting energy-intensive industries such as steel and cement, this trend reversed between 2002 and 2005, and energy consumption has increased dramatically.[3] This growth in energy consumption reflects how economic priorities have affected consumption patterns. Government-supported industrial production raised demand for coal-fired electricity generation, and increased car ownership that was enabled by rising incomes in the increasingly prosperous economy fueled demand for oil.

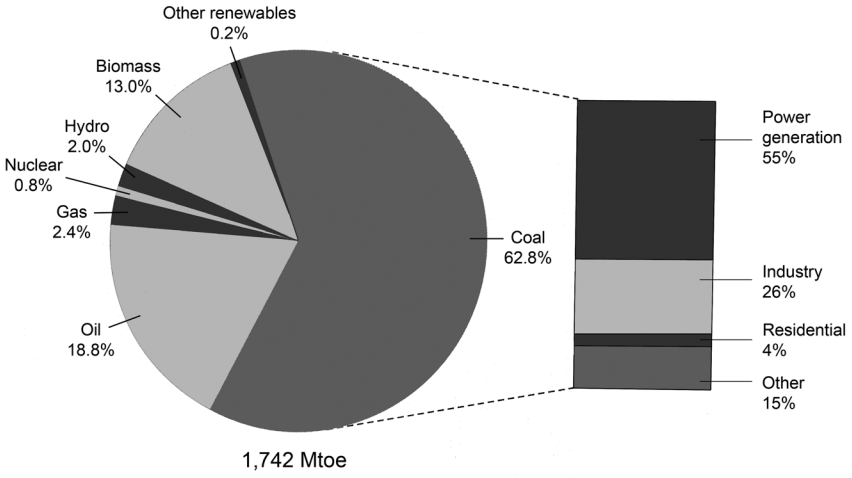
Manufacturing consumes 60 percent of the energy China uses, with the bulk of that attributable to production of aluminum, steel, chemicals, paper, and cement.[4] The IEA *World Energy Outlook* reports, "Soaring energy use is both a driver and a consequence of the remarkable growth in the country's economy—especially in heavy industry."[5] The iron and steel sector is the largest consumer of energy in China, accounting for nearly 28 percent of total industrial energy use in 2005.[6] China manufactures one out of three tons of steel produced globally, and at present its surging economy consumes approximately 85 percent of this steel domestically.[7] This is an exception in China's economy, however. China exports a large amount of energy-intensive products. For example, one out of two foundations poured in the United States uses Chinese cement.[8] The IEA's *World Energy Outlook* published in 2007 estimates that the energy embedded in China's domestic production of goods for export equaled 28 percent of the country's total energy consumption in 2004. (However, the IEA emphasized the speculative nature of this estimate, noting that calculating embedded energy is very difficult because of the nature of global trade and outsourcing.)[9]

A growing share of energy demand comes from China's growing transportation sector. That sector was responsible for 29.8 percent of China's total petroleum consumption in 2005, and this consumption is expected to increase to 47 percent in 2030. In 2020, the transportation sector will consume 6 million barrels of oil per day.[10] As Chinese society becomes more affluent, many Chinese people are seeking to use their wealth to purchase cars. As a result, China has become the world's second-largest vehicle market and the third-largest vehicle producer.[11] This growth is projected to increase as China's economy grows and the nation's population becomes increasingly urbanized. The IEA predicts that by 2030, more than half of China's oil consumption will fuel the transportation sector.[12]

The Composition of China's Current Energy Demand

Coal supplies approximately 63 percent of China's energy consumption, and China is the largest coal consumer in the world. Coal-burning power plants supply 80 percent of China's electricity.[13] Nearly 19 percent of China's energy demand is met with petroleum products, and China's consumption of 7.2 million barrels per day in 2006 ranks second in the world behind U.S. consumption.[14] In addition to consuming coal and oil, China uses natural gas, renewable energy, and nuclear energy. Collectively they supply the remaining 19 percent of China's energy demand.[15]

Total Primary Energy Demand in China, 2005



Source: International Energy Agency, 2007.

The *World Energy Outlook* reports that China will overtake the United States in energy consumption by 2010.[16] If China's economic growth stays on its current trajectory, by 2030 its projected energy consumption will surpass that of the United States by 20 percent—compared with 2005, when China consumed 25 percent less energy than the United States.[17] This is a sea change—with profound implications for the United States and the world. Through 2030, the proportional distribution of China's energy demand among coal, oil, and other resources is not expected to change significantly, but that demand is expected to increase at an annual growth rate of 3.2 percent. The *World Energy Outlook* projects that through 2030, the increased energy demand from China and India—two of the world's largest emerging economies—will comprise more than 45 percent of the increase in world energy demand.[18]

China's Energy Supply

In securing its energy supply—a priority for achieving energy security—Beijing must balance several competing factors affecting both the reliability and the availability of energy supplies. Edward Steinfeld, an energy and China expert at the Massachusetts Institute of Technology, writes,

> *The nature of China's 'energy security' challenge goes beyond the fact that growth and modernization alone are not solutions to the supply-demand gap. In the broadest sense, energy security involves the accommodation of difficult-to-reconcile objectives: adequate energy for long-term economic growth, energy that can be secured without exposure to undue geopolitical risk, energy supply and utilization consistent with long-term public health, and energy supply flexible enough to meet rising popular expectations for public and private goods.*[19]

To manage these challenges, China seeks a reliable fuel supply from an array of sources.

China has abundant coal resources and is the world's largest coal producer. Its recoverable reserves are the third largest in the world, behind the United States' and Russia's.[20] Despite its high level of coal production and the fact it exports a portion of that production, China became a net importer of coal in the first six months of 2007, with imports primarily from Australia, Vietnam, and Indonesia.[21] This apparent paradox has a logical explanation: China concluded that it is more efficient and economical to avoid transportation bottlenecks between the interior regions where China's coal is mined and coastal regions, which consume the majority of supplies, by exporting some of the coal it has produced while importing some coal directly to the consuming locations in coastal areas. The IEA expects coal production to increase in China, but this expectation hinges on the government's restructuring of the coal industry to address the transportation bottlenecks and improve mining productivity.[22]

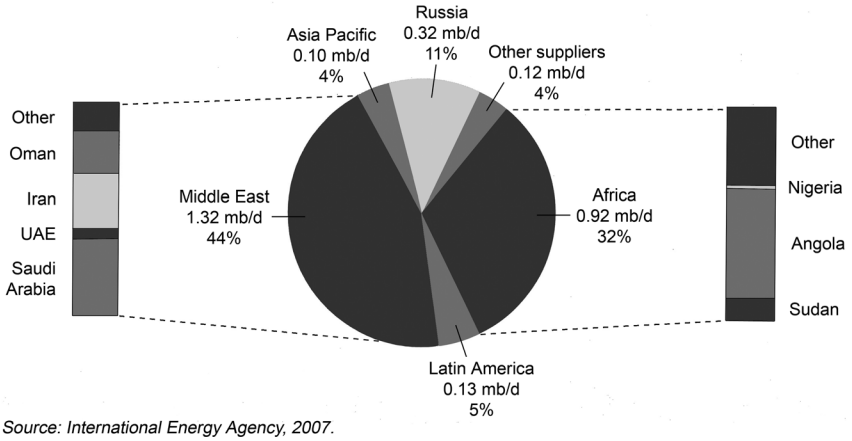
In 2007, the U.S. Energy Information Administration estimated that China produced 3.9 million barrels of oil per day,[23] the majority on land. The IEA's *World Energy Outlook* notes that most of China's onshore oil production fields are more than 50 percent de-

pleted. Without the discovery and exploitation of new reserves, China's domestic oil production is expected to level off by 2012 and then decline.[24]

To meet its demand of 7.5 million barrels per day, China must import approximately 3.7 million barrels per day.[25] Of these imports, 80 percent were in the form of crude oil. China's imports of refined oil products primarily consisted of fuel oil.[26] These imports are expected to increase to 13.1 million barrels per day by 2030. By 2010, China is projected to overtake Japan to be the world's second largest oil importer after the United States.[27]

China is largely reliant on the international market for obtaining oil imports. It purchases the majority of its imports from Middle East and African production. In 2006, Angola became the single nation supplying the largest amount of crude oil to China, with Saudi Arabia as the second largest supplier.[28] Russia supplied 11 percent of China's oil imports (delivered overland by rail).[29]

China's Crude Oil Imports by Origin in 2006



Source: International Energy Agency, 2007.

The great majority of these imports must traverse the Malacca Strait south of Singapore. This is recognized as a point of substantial—and discomforting—vulnerability in the supply chain, because it is a natural chokepoint where passage can be obstructed and because China and other countries rely on an active U.S. naval presence to secure the ability to traverse the strait. For this reason, China's government has supported the search for alternative overland delivery routes and for sources whose production more easily could be transported to China via those routes. Toward this end, China has fostered relationships with Central Asian nations, particularly Kazakhstan, and also Russia, and has sought to obtain oil produced by, or transported through pipelines across, those nations. Moreover, to secure a readily available emergency supply, China is building a strategic petroleum reserve and intends to stock up to 100 million barrels of oil, equivalent to approximately 30 days of oil imports.[30] By comparison, the U.S. strategic reserves have an estimated 727 million barrels, equal to 58 days of import protection.[31]

In addition to purchasing oil on the international market, the government of the People's Republic of China (PRC) has supported purchasing equity oil stakes abroad, which allows for ownership of the resources "in the ground." This strategy encourages China's state-owned oil companies to identify and purchase unproduced oil resources abroad and seek production opportunities for those resources. China has acquired exploration and production stakes in countries across four continents, including Sudan, Venezuela, Indonesia, Iran, Kazakhstan, Russia, Canada, and Nigeria.[32] The amount of China's current equity production—estimated to be 600,000 barrels per day—is far from sufficient to supply the country's entire oil import demand—even the current demand, much less the projected growing demands of the future.[33] Depending on both circumstances within China and the condition of the global oil marketplace, Chinese state-owned oil companies sometimes transport the equity oil back to China, and at other times they sell it on the open market if it is profitable. Furthermore, these investments provide Chinese oil companies with experience in exploring and developing oil resources and in honing their business and diplomatic skills as they compete with international oil companies for development contracts.[34]

A Survey of China's Interests in Land-based Energy Investment Projects in Asia

Partnering Country	Type of Project	Details	Time Started/ Completed
Bangladesh	Coal Mine	In June 2005, the China National Machinery Import and Export Corporation joined forces with Xuzhou Coal Mining Group Company Ltd. and signed a contract to control the management and production of the Barapukuria mine in Bangladesh.[35]	Unclear
Bangladesh	Nuclear Cooperation	In April 2005, an agreement was signed between China and Bangladesh on "nuclear cooperation." In this agreement, China will assist Bangladesh in exploring for nuclear minerals as well as construction of a 600-megawatt nuclear power plant.[36]	Unclear
Burma	Oil and Gas	Multiple oil and gas exploration deals were signed by China National Petroleum Corporation and Myanmar's Energy Ministry between October 2004 and January 2005. An additional deal was signed January 2008 related to three deep-sea blocks off the Rakhine coast.[37]	Unclear

A Survey of China's Interests in Land-based Energy Investment Projects in Asia—Continued

Partnering Country	Type of Project	Details	Time Started/ Completed
Burma	Oil Pipeline	In March 2007, Chinese and Burmese companies stated their intent to begin construction of the China-Myanmar oil pipeline later the same year. The city of Chongqing may be the destination for this pipeline and will build a refinery to process the oil imports.[38]	Project is currently "under discussion." As of March 2008, construction had not been initiated.
Kazakhstan	Acquisition of Petro-Kazakhstan	After approval by a Canadian court, China National Petroleum Corporation acquired PetroKazakhstan from a Canadian company.[39]	Initial approval in October 2005. Exact date of acquisition unclear.
Kazakhstan	Oil Pipeline	In 2006, China and Kazakhstan built an oil pipeline from central Kazakhstan to Xinjiang Province of China. A second pipeline is being constructed between China and Kazakhstan that will carry oil and gas from Turkmenistan.[40]	Unclear
Kyrgyzstan	Electricity/ Power Stations	Chinese electric company representatives are considering constructing electric power stations in Kyrgyzstan. The Chinese also are interested in investing in existing power infrastructure such as the Sarydzhaz and Kambarat hydropower stations.[41]	Unclear
North Korea	Oil	In December 2005, China and North Korea signed a deal jointly to develop offshore oil reserves. No specific information was provided on the location of these offshore sites.[42]	Unclear
Pakistan	Electricity/ Power Station	In April 2008, China's Dongfang Electric Corporation and Pakistan's government signed a deal to construct the Chichoki Malian Power Plant in Pakistan.[43]	"Within a year" from April 2008. No specific month for target completion provided.

A Survey of China's Interests in Land-based Energy Investment Projects in Asia—Continued

Partnering Country	Type of Project	Details	Time Started/ Completed
Pakistan	Electricity/ Power Stations	In April 2001, Pakistan announced that it would set up a 600 megawatt nuclear power plant at Chashma in the Mianwali district of Punjab with Chinese assistance. An additional 300 megawatt nuclear power plant was completed in Chashma with Chinese assistance in 2001.[44] China and Pakistan sealed the agreement in October 2008.	600 megawatt Chashma Plant: Unclear 300 megawatt Chashma Plant: Completed March 2001
Turkmenistan	Gas/Oil Pipeline	In April 2006, China and Turkmenistan signed an agreement to build a gas pipeline to Guangzhou, China.[45]	Construction began February 22, 2008. Completion date unclear.
Uzbekistan	Oil and Gas	In June 2006, China National Petroleum Corporation announced plans to invest $210 million in gas and oil exploration in Uzbekistan.[46]	Unclear
Uzbekistan	Gas Pipeline	In May 2007, Uzbekistan announced that it will build a gas pipeline to China with an annual throughput capacity of 30 billion cubic meters. No details have been provided on when the project will be completed or which companies will be involved.[47]	Unclear

Notes:

1. China has expressed its desire to join the Iran-Pakistan-India gas pipeline project. No statements have yet been made indicating official inclusion of China in the project. ("Iran Gas: China Waits as India Wavers," *Asia Times*, March 6, 2008. *http://www.atimes.com/atimes/South_Asia/JC06Df03.html*).
2. In addition to the major energy deals listed above, many cases of smaller, less extensive Chinese energy investments have been discovered. These cases generally are of Chinese companies purchasing minority stakes in Central Asian energy companies. For example, in March 2003, British Gas International agreed to sell its 8 percent stake in Agip Kazakhstan North Caspian Operating Company (AgipKCO) to China's Sinopec International Petroleum and Production Corporation ("Kazakhstan Economic Review," *Kazkommerts Securities*, January–March 2003. *http://www.kazakhstaninvestment.com/support-files/ker-mar2003.pdf*).

The country's proven natural gas reserves amount to 2 percent of world reserves and are located primarily in offshore regions and in western and north-central China.[48] In addition to its domestic production, China began importing liquefied natural gas (LNG) in 2006[49]—both via pipeline from Central Asia and Russia and by sea to LNG terminals located in southeastern China.[50] The IEA

projects that imports of natural gas will increase from 12 billion cubic meters in 2010 to 128 billion cubic meters in 2030.[51]

Natural gas has not been an important source of fuel for China in the past, but because the government has established goals for consuming cleaner burning fuels, the use of natural gas is expected to increase.[52] Indeed, since 2000, China's consumption of natural gas has more than doubled, to more than 60 billion cubic meters in 2006.[53] However, the projected increase of natural gas supplies to Chinese households and businesses would require expensive construction of a huge infrastructure consisting of pipelines, terminals, and gasification facilities designed to process imported liquefied natural gas.[54] With the government's plan to increase China's natural gas consumption to comprise 10 percent of its energy usage, the expense of developing the necessary infrastructure is estimated to be $50 billion.[55] Adding to this challenge is the fact that most of China's natural gas is produced in the central and western regions of the country, and demand is concentrated in the southern and eastern regions—and, consequently, the transportation infrastructure and network will have to span a considerable distance.[56]

China's use of renewable energy sources has increased in recent years, in part due to government policies encouraging investment in such sources. China's main renewable source is biomass-organic matter that can be converted into a fuel source.[57] This source supplied 13 percent of the nation's total energy consumption in 2005, and its consumption of biomass is the largest in the world. In China, biomass resources include agricultural waste, scraps from forestry industries, and municipal waste.[58] Hydropower also is a significant resource, producing nearly 16 percent of the country's total electricity generated in 2005.[59] The IEA estimates that small-scale hydropower serves as the main power generation source for about one-third of China's counties, and the potential for further hydropower development in China is considered by experts to be the highest in the world.[60] However, with more frequent incidents of water shortages in several regions in China, this growth may be checked.

China has increased its development of wind and solar power generation. Wind power capacity doubled between 2005 and 2006. As a result of government incentives supporting investment, wind power capacity is expected to increase to the point where it will supply 1.6 percent of China's electricity production by 2030.[61] In comparison, the United States obtains from wind power roughly 1.2 percent of the energy it consumes, and the amount is growing. The United States leads the world in the rate at which it is increasing its wind power capacity; China ranks second, adding 3,287 megawatts of incremental capacity in 2007.[62] Solar power generates less electricity, but China is the world leader in deploying solar thermal systems for building heat and hot water supply.[63]

China's Search for Alternative Energy: Civil Nuclear Power

As China seeks to diversify its energy supply and increase its use of clean energy technologies, it is looking increasingly toward nuclear power to meet future energy needs. Not only does nuclear power represent a more technologically sophisticated power

source—with all the diplomatic weight and prestige that come from possessing and using this technology—but it also is carbon neutral and can generate significant amounts of power. Furthermore, China realistically can strive for self-sufficiency in nuclear power.

China's first civil nuclear reactor went on line in 1991. At present, China has 11 reactors with a total of nine gigawatts of capacity—approximately 2.4 percent of China's total power generation capacity.[64] China's civil reactors are located primarily in Guangdong and Zhejiang provinces, and six new reactors are under construction in Fujian, Guangdong, Zhejiang, and Liaoning provinces.[65] China has adopted plans to increase significantly the number of operational nuclear reactors in the next 15 years, but even with this expansion, nuclear power is expected to meet only 5 percent of China's total power generation needs.

The state-controlled firms China National Nuclear Corporation and China Guangdong Nuclear Power Holding Co., Ltd., have constructed and operated China's civil nuclear plants. But new power companies China Huaneng Group and Datang Corporation—also state owned—are beginning to compete in this market. Also, in May 2007, the State Nuclear Power Technology Corporation was established by the State Council to manage adoption of new nuclear reactor technologies, including purchasing overseas technology. China has a National Nuclear Safety Administration, and new plants must receive the approval of this administration as well as the Ministry of Environmental Protection.[66]

China plans to increase its nuclear power capacity to 60 gigawatts by 2020, and this ambitious goal has several consequences. First, more than 16 provinces in China are lobbying Beijing aggressively to approve the construction of new nuclear plants. If most or all of these siting requests are approved, the locations of China's nuclear power plants will be greatly diversified, and competition may develop among provinces seeking to develop champion production sites. Such competition could have positive effects such as improving the efficiency of nuclear production and design; it also could have negative effects such as precipitating a decline in nuclear plant construction or reducing adherence to energy production safety standards. Andrew Kadak of the Massachusetts Institute of Technology testified before the Commission that China's nuclear safety compliance is strong compared to the safety compliance of other energy industries, principally because China's nuclear energy community understands the catastrophic effects of a nuclear accident.[67] However, he also stated that with China's nuclear expansion, "the regulatory oversight of construction and operation must be expanded at a pace to assure that the same level of quality of the first plants is maintained for all future plants."[68] He noted that Chinese engineers could benefit from training in the United States to improve safety in the country's nuclear plants.[69]

Second, China is seeking access to new foreign technologies to increase its nuclear power and to improve the training and expertise of its nuclear engineers and scientists. China has approved purchases of reactors from Westinghouse and Areva as well as a deal with Russia to construct a uranium enrichment plant.[70] When it sold four AP1000 third-generation-technology reactors to China, Westinghouse agreed to transfer the technology for the construction

and design of the units.[71] China's desire to gain access to this technology is directly linked to its desire to be self-reliant in reactor design and construction project management and to utilize international cooperation to leapfrog its nuclear technology and capabilities to a new generation.

Third, China has expanded its strategy to acquire foreign energy resources to include the acquisition of uranium equity mining stakes. China has uranium mining prospects in Kazakhstan, Angola, and Australia.[72] With its purchase of two nuclear plants from Areva, China Guangdong Nuclear Power Group also purchased a 24.5 percent stake in UraMin, an Areva subsidiary with uranium mines in Africa.[73]

China is coupling its civil nuclear power expansion with an expanded effort to export nuclear energy technology. The United States will be hard-pressed to criticize China for exporting the technology if such sales are conducted carefully and in compliance with accepted international norms (including international export control regime safeguards designed to prevent proliferation). After all, the United States is selling its civil nuclear technology to China. Nonetheless, when she testified before the Commission in May 2008, Deputy Assistant Secretary of State for International Security and Nonproliferation Patricia McNerney said that China's nuclear energy cooperation with other nations, particularly with Pakistan, should be carefully monitored, especially given China's past proliferation record.[74]

Constraints on China's Energy Supply

In addition to natural constraints imposed on the country's available energy resources, China's energy supply faces structural constraints. For example, as the country's economic growth rate has soared, China's transportation infrastructure has not kept pace. This has resulted in serious transportation bottlenecks between production areas in the central and western parts of the country and urban coastal regions that are the primary energy-consuming areas. These bottlenecks prevent economical and efficient delivery of coal, oil, and refined petroleum products and increase their costs to consumers.

Consonant with the central government's energy policy, the government controls energy prices. China must manage disparities between a liberalized upstream energy market and a controlled downstream energy market.[75] For example, with electricity prices set by the state to protect consumers, and coal prices set by the market, electricity producers cannot increase electricity rates to keep pace with coal prices. This has resulted in electricity shortages, because power companies are either unable to purchase fuel or unwilling to operate at a loss.[76] To shield companies from this disparity and to keep them afloat, the government provides subsidies.[77] This encourages higher demand from consumers because retail prices are cheaper than they would be if they were set by the market, and it distorts the economy because it requires the government to pay the difference. The United States has complained that such subsidies are actionable violations of China's trade commitments.

Coal-based power companies receive some subsidies, but research conducted by Edward Cunningham, a Ph.D. candidate at the Massachusetts Institute of Technology, found that this covers the cost of only a small proportion of most plants' total fuel supply. The IEA reports that, as coal prices in China have been permitted to rise to the world price, some power companies and coal mining firms are seeking to protect themselves from the effects of electricity price controls by integrating their operations.[78]

Prices for crude and retail oil products in China remain fixed well below world prices. This places a significant burden on China's state-owned oil companies that have refining activities. These companies purchase oil on the world market and then must sell their refined products to consumers—often at a loss to the company. The effects of this pricing policy are becoming more acute as global oil prices rise. Much as is the case with respect to electricity production, the government must provide significant subsidies to keep oil refiners in business, especially as the domestic market's consumption of imported oil products is increasing.[79]

Energy subsidies for electricity production and oil refining firms impede China's efforts to reduce the growth of energy consumption because they reduce the consumption disincentive of higher prices. Increased consumption not only heightens China's energy supply challenges but also results in increased environmental pollution, especially given the level of China's dependence on coal.

The Environmental Impacts of China's Energy Consumption

China's energy consumption and reliance on fossil fuels have resulted in environmental pollution that affects public health, air and water quality, and—at the heart of the Communist Party leadership's concern—the economy. A 2007 World Bank report entitled *The Cost of Pollution in China: Economic Estimates of Physical Damage* estimates the total cost of air and water pollution is about 5.8 percent of China's gross domestic product (GDP) annually, or 781 billion RMB ($112 billion).[80] Jonathan Schwartz, assistant professor at the State University of New York at New Paltz, noted that, as estimated by China's Ministry of Environmental Protection, the direct cost of pollution damage to China's economy, as a percentage of China's annual GDP (that was approximately $2.2 trillion in 2005), is between 8 and 13 percent, or a cost approximating $200 billion in 2005.[81] In human costs, an estimated 750,000 people die in China of pollution-related illnesses every year.[82]

A continued decline in China's environment likely will raise these costs and could hinder future growth. Given that the Communist Party has staked its legitimacy on maintaining rapid economic development, if the costs to prevent and mitigate pollution increase to the point where they impede economic growth—a distinct possibility—citizens might begin to question the party's governance. Pollution already is causing problems for the government, with the frequency and size of protests over local environmental conditions increasing.

Air pollution resulting from China's combustion of fossil fuels is comprised of several byproducts, including carbon dioxide, sulfur

dioxide, nitrous oxide, mercury, and particulate matter, and it affects both the local environment and the global environment. China, in fact, is home to 20 of the world's 30 most polluted cities, primarily as a result of China's coal consumption.[83] One-third of urban residents in China breathe heavily polluted air.[84] China's heavy reliance on coal also results in China being the world's leading emitter of sulfur dioxide, a major cause of acid rain that damages soil and water quality,[85] from which approximately one-third of the country suffers.[86] China has set targets to lower sulfur emissions, but in 2006 only four provinces met their targets and national emissions increased overall.[87] As reserves of clean (bituminous) coal grow smaller and China begins to use more lignite coal with a lower energy output and higher sulfur content, it is probable sulfur emissions will grow.[88]

Coal burning in China produces approximately 25 percent of global mercury pollution,[89] which directly threatens human health, wildlife, and fish and can enter the water supply. As Daniel Jaffe, a professor of Atmospheric and Environmental Chemistry at the University of Washington-Bothell, explained in his testimony, mercury has a biocumulative effect, and over time the increase in mercury in contaminated water and fish can result in serious neurological impacts, especially in children.[90]

These effects are felt by China's population, which daily confronts the soot, dust, and unseen byproducts of coal combustion. It also is important to recognize that air pollution has no boundaries: The effects of China's air pollution are global in their reach. During the Commission's August 2008 trip to Asia, Japanese officials expressed concern about the effect of China's air pollution on air quality in Japan. Some of China's pollution also reaches the United States. U.S. scientists on the West Coast have used a variety of tools to trace the flow of air pollution from Asia (including China) to the United States[91] and have documented the transport of three pollutants: ozone, particulate matter, and mercury. Studies show that the effect on local air quality of pollutants from Asian sources on most days is relatively small, but on a few days per year, the Asian pollutants can constitute a large fraction of the regulatory standard[92] and push local pollution beyond the acceptable levels of minimum air quality standards.

Scott Fulton, principal deputy assistant administrator for International Affairs at the U.S. Environmental Protection Agency (EPA), testified that EPA has not credited a share of U.S. pollution to sources from any individual country. However, EPA has commissioned a study to assess the significance of the international transport of air pollutants, the results of which will be released in 2009. In this study, Mr. Fulton noted, researchers will document the flow of pollution into and out of the United States and will also assess the impact of these flows on U.S. and international objectives for improving air quality and mitigating climate change.[93]

Carbon dioxide has been linked to global climate change, and China's emissions—as well as those of all other countries—will have long-term effects on the world's climate. China surpassed the United States in 2007 as the world's largest contributor of carbon dioxide, with an approximate production of six billion tons of CO_2.[94] China ranks second in the world after the United States in

terms of historic total CO_2 emissions (cumulative emissions production), and its per capita emissions rank lower than those of the United States.[95] China emits 4.3 tons of CO_2 per $1,000 of production, compared to the U.S.' emissions of 2.6 tons of CO_2 per $1,000 of production.[96] China's comparatively poor energy efficiency is to blame for its greater emissions per unit of economic output.

China's CO_2 emissions have been increasing steadily since 2002.[97] The surprise for many forecasters was how fast they grew. While they were expected to increase between 2.5 and 5.0 percent each year between 2004 and 2010, in actuality it appears they will have increased by at least 11 percent a year over that period.[98]

China's role as the "world's factory" has exacerbated the country's environmental problems and carbon emissions, as energy-intensive, high-polluting industries have been established or have relocated there from elsewhere. China's infrastructure boom and urbanization likewise have caused significant growth in energy-intensive, high-polluting industries such as steel, aluminum, and cement,[99] the production of which primarily has supplied the needs of the domestic market, according to a study by Trevor Houser and others, published by the Peterson Institute for International Economics.[100]

With economic development continuing along its current trajectory, China is projected to produce more than 40 percent of new, energy-related carbon dioxide emissions globally between now and 2030.[101] These projections signify that China's contribution to global climate change is increasing concomitantly with its rising economic power.

Conclusions

- China's total energy consumption is growing and is projected to surpass that of the United States in 2010. By 2030, China will consume 25 percent more energy than the United States. The effects of such consumption growth already are influencing world energy markets, the global availability of energy resources, and the price of these resources.
- Coal remains China's primary fuel source, and China's coal consumption is expected to increase. This will increase China's already troubling emission of pollutants, notably including carbon dioxide, and will exacerbate the challenge of reducing China's pollution.
- China's energy consumption results in environmental consequences that have real economic and human costs. The cost of pollution has been reported to equal 781 billion RMB ($112 billion) per year, and pollution-related illnesses cause an estimated 750,000 deaths per year in China. Continued declines in environmental quality potentially could hinder the nation's economic growth and possibly lead to a challenge of the Communist Party's authority.
- The pollution produced by China's energy consumption increasingly is reaching and harming other portions of the world, including the United States. If current projections for China's emis-

sions are realized and production of these emissions is not substantially mitigated, major international tensions may appear.

- China's carbon dioxide emissions are the largest of any nation and are projected to grow significantly. Global efforts to address climate change must consider the impact of China's current and future emissions.