China’s Coming Demand for Energy

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We begin by sketching what China’s economy will look like in 2025, two decades from now. It is desirable to do this quantitatively, both to indicate the practical possibilities open to China and to demythologize statements that suggest large magnitudes—“the next economic superpower”—without specifying what they are. Of course, no one really knows what China will look like in two decades, and indeed a range of outcomes is possible. In its recently released “Global Scenarios to 2025” the Royal Dutch/Shell (oil) Company allows China’s growth to vary from 6.7 to 8.4 percent a year, depending on the nature of the external (world) economic and political environment. As we shall see, others would allow the possibility of even lower growth rates. For sake of concreteness, I will build here upon the 2025 projections of the US Department of Energy, yielding a growth in dollar terms of 7.2 percent a year. They will not necessarily be correct, but they represent an internally consistent projection that is reasonably optimistic about China’s growth, and ties that growth to projections of energy demand, an important source of interaction between China and the rest of the world, both in economic and in environmental terms. We can then address the implications of this growth, and take excursions from the baseline projection.

Table 1 presents the projected GDP and population of China, India, Japan, and the USA in 2025, compared with 2000. GDP is reported in US dollars of 2005 (adjusted from 1997 dollars in the original source). We need to allow for some real appreciation of
the Chinese currency (rmb) relative to the dollar over the next two decades. Similarly for India. I allow, somewhat arbitrarily, one percent a year. (The yen appreciated 0.8 percent a year against the dollar over the period 1950-1975, although all this appreciation was concentrated in the period 1971-1975.) This would bring China’s GDP in 2025, measured in dollars, to $7.4 trillion, larger than Japan’s projected GDP in that year if allowance is made for the upward revision of 16.8 percent in China’s GDP for 2004 made in December 2005, which is not included in these figures. (It would be larger still if the appreciation of the rmb is greater than one percent a year.) It would amount to about ten percent of gross world product. It would be just over one-third the projected size of the US economy in that year. India’s GDP will reach $2.75 trillion, modestly larger than Germany today, but with an assumed growth rate (in dollars) of 6.5 percent remains much smaller than China. China’s population will have grown to 1.4 billion, and India’s to nearly 1.4 billion, while Japan’s population will have declined to 120 million. The USA will have grown to 351 million, all figures drawn from medium projections by the US Census Bureau.

Several observations can be made about these projections. First, they assume that China will grow at 7.2 percent a year over the period, in dollar terms. This is only slightly lower than its 7.4 percent annual growth rate over the period 1980-1998 as calculated by the economic historian Angus Maddison (1997), but considerably below the 9.9 percent official growth figures, and below actual growth in the past few years. The drop is partly due to a significant drop in the growth rate of the population, to 0.5 percent a year, and an even sharper drop in the growth of the potential labor force, as children born under the one-child policy reach adulthood. In other words, China is assumed to do well economically, meeting its official aspiration of quadrupling GDP when measured in dollars (although not quite when measured in rmb). Japan is assumed to grow at 1.7 percent a year, despite its drop in population and even sharper drop in labor force; the USA is assumed to grow at 3.1 percent – lower than in recent years – with population
Second, however, China remains a relatively poor country, with GDP per capita only about one-twelfth that of Japan and the USA (the gap will be considerably lower in terms of purchasing power parity, on which more below). But Chinese will be five times richer than they were in 2000, and all Chinese under the age of fifty will have grown up in a period of rapid economic growth and increasing prosperity.

Third, the dynamics of population change are quite different in the four countries. America’s population continues to grow, albeit at a somewhat slower rate. The number of 20-24 year-olds, the group that is just leaving its education and entering the labor force, will grow by 0.6 percent a year to 2025. The same age group in Japan, in sharp contrast, is expected to decline at 1.4 percent a year, so that by 2025 this age group will be only 70 percent as large as it was in 2000. China is in between, with the 20-24 year-old group declining at 0.7 percent a year, down 16 percent from 2000. All three countries have aging populations due to increased longevity, but it is most rapid in Japan because of low natality. China will experience a significant drop in total population after 2035. India, in contrast, continues to grow albeit at declining rates.

A fourth observation is that China will be the world’s second largest national economy, but little more than one-third the size of the USA in terms of economic output - roughly equal to the size of the USA in 1993. If it chooses, China will thus have considerable scope for internationally relevant policies, whether in military expenditure or in foreign aid, provided sufficient tax revenues can be raised. (In 1993 Americans paid in taxes 29 percent of their GDP, compared with 16 percent in China in 2004.

One sometimes sees much larger numbers, even suggestions that China’s economy could be larger than that of the United States by 2025 (see, e.g., The Economist, April 1-7, 2006, p.84). These presentations compare GDPs using so-called purchasing-power parity conversion rates, rather than market exchange rates. Purchasing power
parity (ppp) is necessary when comparing standards of living between countries, since an important part of a family’s expenditures is on locally produced goods and especially labor services, and these are much cheaper in poor countries, reflecting lower overall productivity. In terms of ppp, China’s GDP in 2002 was 4.6 times what it was at market exchange rates, and already 70 percent larger than Japan’s economy, whereas at market exchange rates Japan’s GDP was 3.5 times that of China. There are however two serious problems with using ppp-based GDP for these comparisons.

The first is conceptual. China is tied to the world economy at market prices mediated by market exchange rates, not ppp. All trade in goods and services and foreign investment takes place at market exchange rates, and even local goods and services are linked to traded goods by the opportunity cost of land, labor, and capital – factors that could earn more in the trade sector will move there, as circumstances permit. China is not a market economy in every respect, but prices are largely determined freely, influenced by the prices of traded goods. These days some argue that the rmb is “under-valued,” and suggest that it should be appreciated by as much as 25 percent. Such an adjustment, should it occur, would close only a small portion of the large difference between the existing exchange rate and the so-called ppp rate. As noted above, an allowance for appreciation by one percent a year, 28 percent over 25 years, has been assumed in the projection used here.

The second problem is practical. China’s ppp exchange rate is based on fragile US-China price comparisons made in the mid-1980s for roughly 300 goods and services, some of which involved heroic assumptions to make them comparable. Moreover, the necessarily arbitrary choice of weights to add up these goods or services makes a large difference to the final result, by a factor of three between Chinese expenditure weights and US expenditure weights (see Maddison (1998)).

For geo-political or geo-economic purposes, market exchange rates, perhaps smoothed over several years, provide the relevant basis for comparing market economies.
The choice makes a big difference: China’s economy is already 70 percent larger than Japan’s when calculated at ppp; but only slightly more than one quarter of Japan at market exchange rates. China’s ability to trade or invest abroad is determined by market exchange rates, not by ppp. China demonstrated the importance of market exchange rates even in the military arena when it purchased military aircraft and ships from Russia, presumably at Russia’s export prices, despite a known strong preference for producing military equipment at home. In effect, China indicated that it could not produce comparable weapons at competitive cost domestically.

A larger China of course has implications for the world economy. Demand for food, energy, and other resources will be much higher. By the same token, the supply of manufactures and other goods and services will be much higher. Of special interest will be China’s demand for energy, especially coal (with its tendency to pollute) and oil (with its limited domestic supply). On the Department of Energy projection, China’s total demand for energy will grow at 4.1 percent a year to 2025, as opposed to 1.3 percent in the United States and 0.5 percent in Japan. These growth rates allow for continued increases in energy efficiency, but no major breakthroughs during the next two decades. By 2025 China will be consuming 14.2 million barrels of oil a day, well over twice Japan’s consumption, and over half that in the United States. By 2025, on these projections, China will account for 12 percent of world oil consumption, and for 22 percent of the increment in consumption between 2002 and 2025.

Coal consumption, mainly to generate electricity, will more than double to 3.2 billion tons, 39 percent of total world consumption, with important implications for air pollution, absent dramatic improvements in the way coal is consumed, and for emissions of carbon dioxide, an important greenhouse gas. These figures imply that energy efficiency in China remains much lower than in the USA and especially than in Japan, despite significant improvement. China will have great demand for infrastructure of all
kinds – power, transport, housing, and urban services as the country becomes much more urbanized.

The DOE’s reference case, reported in Table 2, is only a best guess, built on assumptions about world and national economic growth, changes in energy efficiency, and prices of energy. The DOE also provides, around its reference case, “high growth” and a “low growth” variants. These vary up and down the assumed rates of economic growth, but do not change the relationship of energy consumption to growth, nor the assumed price trajectory for energy (especially oil). This latter point requires some explanation, since higher or lower world economic growth might be expected to influence energy prices. However, the projections are to 2025, two decades hence, so supply is assumed to respond to increased demand. The DOE’s price trajectory assumes a gradual fall in the price of oil to $31 a barrel (2003 dollars) in 2010, whereupon oil prices rise at 0.8 percent a year through 2025, to just under $35. This price trajectory influences demand for energy, and also oil production by non-OPEC countries. OPEC is assumed to fill the gap between world oil demand and non-OPEC oil supply. Thus OPEC (in practice, Saudi Arabia and the neighboring Gulf oil producers, plus Venezuela) is assumed to be the residual supplier of oil under all the projections, adapting production as required. The assumption is that Saudi Arabia and others can produce the incremental oil profitably in this price range. Simmons (2005) has controversially questioned this assumption, arguing that Saudi Arabia is currently operating at or even beyond its optimal extraction rate. If Simmons is correct – his argument has been widely disputed – of course oil prices would have to rise further in the presence of steadily increasing world demand for oil, and that price increase would induce users to reduce their demand for energy, to develop additional supplies of liquid fuels (especially oil sands and perhaps coal liquefaction), and to substitute alternative fuels for oil.

Under the high growth projection, mature economies are assumed to grow 0.5 percent a year faster, and emerging markets 1.0 percent faster, than in the reference case.
Under the low growth projection economic growth is assumed to be correspondingly lower. World demand for oil reaches 132.3 mbd under the high growth projection (versus 119.2 in the reference case), and China’s demand for oil reaches 16.1 mbd, just over 12 percent of the world total. Under the low growth projection, world demand for oil reaches 107.7 mbd, and China’s demand for oil is 12.5 mbd, just under 12 percent of the world total.

By 2025 China’s total imports will amount to perhaps $1.8 trillion, roughly three times Japan’s imports and two-thirds of US imports but modestly more than imports by the European Union from non-member countries. Thus China will be a major market for the products of many countries, roughly on the scale of the United States at present (Cooper, 2005).

China’s transition period for full compliance with WTO rules and the terms of China’s WTO accession will expire at the end of 2006. Compliance is not likely to be complete by then, however, since many commitments run strongly contrary to well-established Chinese practices, and Beijing is unable to control the entire country except on a few issues of the highest priority. But compliance will gradually take hold in the coming decades, and by 2025 China is likely to be much more transparent and rule-bound, at least in the arena of commercial activity, than it is now. Foreign businessmen will play a significant role in that transformation, and not incidentally will provide an important source of information to the central government, independent of official channels, on what is happening around the country.

By 2025 completion of the Doha Round of trade negotiations will have been in the distant past and the ten-year transition period following completion of multilateral trade negotiations will have concluded, so the trading world of 2025 will be governed by the outcome of the Doha Round, even though a post-Doha round of trade negotiations may have been launched. If the aspirations of APEC of several years ago are realized (the target date was 2020), world trade would be completely free of tariffs and other
restrictions on imports. The discriminatory features of the preferential trading arrangements which are currently proliferating rapidly would have been obliterated, or at least greatly attenuated, by such a development.

China has played a conservative, low-key role in international economic organizations, and that is likely to continue because the evolving status quo has served China’s interests well. As noted, China will provide a huge domestic market for imports, giving the rest of the world a great interest in China’s trade policy and practices.

All the above assumes China stays on its current growth path, which in turns assumes continued peace and prosperity in the world, so trade can continue to grow unimpeded. Even so, China’s internal requirements remain formidable. It must grow the private and township sectors enough to compensate for declining employment in the state-enterprise sector. To close many loss-making enterprises it must create a social safety net (unemployment compensation, pensions, health care) for urban employees. It must deal with rapid growth in demand for water, waste disposal, and new housing in urban areas. It must greatly improve agricultural productivity, partly through large and more efficient irrigation projects, partly through improved seeds and techniques of farming. And it must address the widening regional inequalities of growth and income, in part through significant investments in infrastructure within and to the central and western parts of the country.

A team at the RAND Corporation, responding to a request by the US Defense Department, produced in 2003 a study of various adverse scenarios, along with estimates of their negative impact on Chinese growth over the period 2005-2015 (Wolf et al., 2003). The possible adversities cover a socially disruptive increase in unemployment, increased corruption, a major epidemic (focused on AIDS, written before SARS), failure to solve the emerging shortage of water in northern China, a major disruption in world oil supplies, a domestic financial crisis, a sharp decline in inward foreign direct investment, and a military conflict over Taiwan or elsewhere. Others are imaginable, for example a
severe world recession or a significant reversion to protectionism in Europe and the USA, neither of which is likely but both are possible. Each scenario has an adverse impact on China’s growth ranging from 0.3 to 2.2 percent a year on the assumptions made in the study, lowering China’s GDP by 3 to 24 percent by 2015 from an unspecified base line. None of these adversities may materialize, but the Rand authors consider this implausible. If one occurs, others may be triggered, at least in part, because of interdependencies among them. Good luck as well as skillful management will be required for China to continue on a course of sustained growth.

Continued rapid growth in China requires peace and prosperity in the rest of the world. China thrives on a benign international environment, and China’s current leaders understand that well. Legitimacy of the Chinese Communist Party (CCP) depends on delivering economic prosperity at home, as does the “peaceful rise” of China in the society of nations. China will have at least two sets of new leaders by 2025. If the leaders of 2025 are around 60 years in age, they will have been born around 1965 and reached college age in the radically changed environment of 1985. Their parents will have been the victims, or in a few cases the perpetrators, of the Cultural Revolution.

As China grows, its dependence on imported materials will also grow. China has ample coal and is rich in some other minerals, but in general China is not a resource-rich country and it has already become dependent on imports of iron ore to feed its voracious demand for steel, of copper, and especially of oil, where domestic exploration has so far produced only disappointing results. China is also a large absorber of foreign technology, and so far has demonstrated only limited capacity to generate new indigenous technology. That may change with the large increase in college graduates, including engineers, combined with greater incentives and fewer inhibitions to think creatively than has characterized China in the past – another major challenge.
China's Energy Consumption and Outlook

Table 3 provides basic information on China's primary energy consumption in 1990 and 2001, and the reference case projection of China's energy use to 2025 by the US Department of Energy. It can be seen there that China is heavily dependent (nearly two-thirds in 2001) on coal, the most carbon-intensive fossil fuel, mainly for electricity generation but also for industrial and household use. Oil accounted for just under one quarter of primary energy use. Over the next 25 years the relative importance of coal is expected to decline, while that of oil rises (as more Chinese acquire automobiles, and truck traffic increases). But because of rapid growth, the use of coal is nonetheless expected to more than double by 2025, from an already large base. China is taking significant steps to increase the use of natural gas in households, industry, and especially for the generation of electricity, and to increase nuclear power, both of which are expected to grow rapidly, but by 2025 nuclear and hydro together still account for only eight percent of China's primary energy consumption. It is noteworthy that the EIA assumes that China over this period grows at "only" 6.2 percent a year, over a percentage point less than China's 7.2 percent growth aspiration, and that energy growth, averaging 4.6 percent a year, is only three-quarters as rapid as GDP growth, implying considerable improvements in efficiency in the use of energy as well as changes in the structure of the Chinese economy toward less energy-intensive activities. Despite improvements in efficiency and the relative decline of coal, China's CO2 emissions are expected to grow by 4.0 percent a year, the most rapid in the world, and will exceed those projected for the United States by 2025.

The demand for electricity grows with increases in income, for it is relatively clean and convenient at the point of use. In 1997 China had 263 GW in installed electricity generating capacity, two-thirds coal-fired (74 percent of actual electricity generation), 23 percent hydro-electric, with the remaining ten percent relying on oil, nuclear, gas, and renewables, in that order (IEA, 2000, p.204). The International Energy Agency expected China to add 500 GW of capacity by 2020, raising capacity by nearly a factor of three over
existing capacity, two-thirds of which would be coal-fired, despite out-sized increases in
gas-fired, nuclear, and hydro-power. This compares with a total of new generating capacity
in the USA (Europe) of only 396 GW (477 GW, mostly gas) over the same period. China is
expected to invest over 2001-2030 a total of $795 billion in new power generation,
compared with $654 billion in the USA and Canada, $525 billion in the European Union,

China faces a basic dilemma in framing its future energy policy. It has abundant
coal resources, but has so far had difficulty finding abundant oil or gas. Coal accounts for
much of the air pollution -- 85 percent of sulfur dioxide (of which only 30 percent comes
from power plants), for instance, and much particulate matter. In addition, coal mines are
mainly located considerable distance from the main sources of demand for energy, requiring
extensive transportation. Switching to oil or gas, however, would involve extensive
investments in infrastructure, and will prospectively increase China's dependence on the rest
of the world for primary energy, something that makes Chinese leaders uncomfortable.
Their attempts to resolve this dilemma leads them to place heavy emphasis on hydro- and
nuclear-power; to explore intensively for oil and gas (but not to the point of inviting foreign
equity participation, as distinguished from production-sharing, in Chinese production); to
develop coal liquefaction; and to diversify their sources of imports, notably by considering
(expensive) oil- and gas-pipelines from Kazakhstan and from Siberia, in order to reduce
inevitable growing dependence on sea-borne oil (and, in the future, gas) from the Persian
Gulf.

China has extensive hydroelectric potential, 290 GW estimated to be economically
exploitable, of which only 60 GW was developed in 1997. The controversial Three Gorges
Dam will bring on an additional 18 GW by 2009. IEA assumes the total will rise to 171
China's first nuclear power plant came on line in 1991 and by 2000 China had 2.1 GW of capacity. By 2006 China had nine reactors in operation in two locations, two finished reactors in a third location, and four additional reactors approved for international bidding (WSJ, 3/22/06, p.A6). Official plans call optimistically for 40 GW by 2020 (CDF 2003, p.71), but because of cost, long lead times, and other difficulties China is likely to reach only 21 GW. (The capital costs of nuclear plants are about three times higher per kW than for new coal-fired plants in China.)

China has discovered the many attractions of gas-fired power plants, in cost, scale, and low pollution. China's problem is insufficient economical gas. It has approved two LNG terminals, both on the south coast, and has several more under consideration; it has contracted for Australian and Indonesian gas. Power plants will however have to compete with high priority residential and industrial uses of gas. The IEA nonetheless projects a 20-fold increase in gas-fired power plants between 1997 and 2020, from a low base (IEA, p.205).

The structure of the Chinese energy market is highly fragmented. While national policy is set in Beijing, actions by each province and municipality reflect local interests. End-use of energy, as in many countries particularly gas and electricity, is subject to local price control. This is partly to prevent exploitation of local monopoly in delivery, but also reflects residual habits created during central planning days in the energy sector, which is seen as critical to many industrial activities. Over 95 percent of China’s population has access to electricity, but there are no national or even extensive regional electricity grids in China, so most power plants distribute only within the vicinity of the plants. Long-distance gas pipelines are few, although a West-East pipeline to bring gas from the Tarim Basin in Xinjiang province to Shanghai and other eastern destinations was completed in 2004 and is now in operation. Thousands of small coal mines also serve mainly local needs, although vast amounts of coal are also shipped east and south by rail and coastal barge.
Furthermore, with few exceptions, energy is provided by state-owned enterprises (SOEs), many now owned by provinces or municipalities. Oil production and distribution has been concentrated in three large national SOEs, mostly non-competing. Electricity production is typically provided by provincial or municipal enterprises. China is having difficulty placing SOEs under tight budget constraints; they have historically had ready access to bank credit, and while banks (themselves SOEs) are under instruction to make loans only on a commercial basis, local politics continues to play an important role in credit allocation, especially (I suspect) to energy firms.

China is notably inefficient in its use of energy. China’s energy efficiency is expected to improve over the projection period to 2025, at 1.9 percent a year, compared with 1.7 percent for the United States and 1.0 percent in Japan. This assumed rate of improvement seems too modest, given the scope for improvement and the concerns of Chinese leaders about growing dependence on imported energy.

According to the IEA, China’s coal-fired generating plants operated at only 28 percent efficiency, 26 percent below the 38 percent average of the OECD countries in the late 1990s (IEA, p.204), despite more extensive pollution controls on the OECD plants. Generating plants in China were much smaller, coal consistency was uneven, and plants were down more often. New plants in China are typically much larger than average, over 300MW, but remain behind world best practice.

China's authorities are well aware of their energy needs, problems, and constraints. They acknowledge that energy should not simply serve the requirements of growth, but should also take into account cost, environmental factors, and security. They also acknowledge the need to separate more sharply policy formulation from regulation and supervision (at all levels of government), and the need to move to price-incentives based competitive markets subject to regulation to protect consumers from natural monopolies, particularly in final distribution, and taking into account environmental externalities (see statements by Qingtai Chen and Jiange Li of the Development Research Center at the China
As is often the case in China, the difficult task is in translating coherent principles into actual practice.

One part of China's strategy seems to be to back out coal as rapidly as investment in gas, nuclear, and hydro permit, and to charge consumers of electricity what is necessary to finance the required investment.

Growing dependence on critical imported materials, including food and feed grains, creates new vulnerabilities for China. The clearest and most notable concerns oil. On the US Department of Energy’s baseline projection, China will consume 14.2 mbd of oil in 2025, up 4.5 percent a year from the 4.9 mbd consumed in 2001. China was a small net exporter of oil in the early 1990s; by 2025 it will import nearly 11 mbd. China also desires to increase its consumption of natural gas, including liquified natural gas (LNG), for environmental reasons – to replace coal in the home and workplace, and even to generate electricity in places close to the coast (or gas pipelines) and far from coal mines.

China’s oil industry was re-organized in 1998 mainly into three large, vertically integrated oil firms, somewhat in emulation of the international oil majors: the China National Petroleum Corporation (CNPC), the China Petrochemical Corporation (Sinopec) and, for offshore development, the China National Offshore Oil Corporation (CNOOC). All are and are intended to remain state-owned firms, but each has floated minority shares in the international market and has as minority shareholders one or more of the major international oil companies, BP, Shell, and ExxonMobile. Regulatory oversight is by the State Energy Administration, created in 2003.

About a quarter of China’s domestic oil production of 3.6 mbd is accounted for by a single field at Daqing in Manchuria, now in decline. About 15 percent of domestic production is offshore, mainly in the Bohai Sea east of Tianjin. Offshore exploration
and development are occurring there and elsewhere, with the technical help and financing of a number of US firms such as ChevronTexaco, ConocoPhillips, and Kerr-McGee, as well as Husky Oil of Canada.

New discoveries in China have been disappointing, imports have risen sharply, and Chinese firms have been not only buying in the market but also seeking oil development and production abroad. CNPC has acquired concessions in Azerbaijan, Canada, Indonesia, Iraq, Iran, Kazakhstan, Sudan, and Venezuela. Sinopec is directly involved in developing Iran’s Yadavaran field, and has purchased 40 percent of Canada’s Northern Lights oil sands project. Sinopec also has acquired offshore exploration rights in the Bight of Biafra, in territory jointly leased by Nigeria and Sao Tome. CNOOC has purchased a stake in an Indonesia field, and made an abortive effort in 2005 to purchase the US firm Unocal, whose oil reserves reside in southeast Asia. “Street gossip” suggests that China has been paying a significant 10-20 percent premium for equity oil, although CNOOC’s late bid for Unocal was only about four percent higher than the winning bid. Moreover, the unexpected rise in oil prices during 2004, if they persist, suggest that such premia might have been warranted.

The largest foreign project is CNPC’s 60 percent stake in a Kazakh oil firm, with a promise to invest in development over the next 20 years. A pipeline has been constructed from Kazakhstan to western China which will initially supply three Chinese refineries with about 200,000 barrels a day. Chinese officials talk about eventually acquiring about half of imported oil “through the market” and about half through China’s overseas investments in equity oil (conversation with Zheng Bijian). China’s overseas ventures produced less than ten percent of China’s imported oil in 2005, however. This ratio may rise slightly with the opening of the Kazakh pipeline. About half of China’s imported oil originates in the Middle East, with Saudi Arabia being the major supplier. China may discover, as the oil majors did in the 1970s, that “owning” the oil provides no security of supply when oil supplies are tight; the oil-producing countries are capable of
taxing away the higher earnings, or even nationalizing the foreign-owned reserves and
operations.

China has been holding conversations with Russia about constructing an oil
pipeline carrying as much as one million barrels a day from central Siberia to Daqing,
where it would tie into China’s pipeline system. An alternative eastbound pipeline route
would skirt China and end up in the Russian port Nakhodka on the Sea of Japan, whence
oil could be shipped to Japan, Korea, and China. Russia has so far been unable to decide
which route to adopt, leaving China with growing reliance on sea-borne oil. In March
2006 Russia’s President Putin suggested that a branch could be built to China from a
Nakhodka-bound pipeline, but specialists questioned whether there would be sufficient
oil to serve both pipelines.

China has discovered the advantages of natural gas, and has been working hard to
develop its indigenous natural gas resources, mainly in Xinjiang in western China and in
the Ordos basin in Inner Mongolia, and to build the infrastructure – pipelines and
distribution systems – to make use of the gas. Hitherto China’s modest gas use was
mainly for feedstocks to the chemical industry, especially fertilizer, but it is increasingly
being used as a fuel, including for electricity generation, where most of the significant
incremental demand over the next two decades is expected to go.

China’s potential demand for gas is much greater than prospective domestic
supply, so China has been seeking foreign sources. One is the large gas resources of
central Siberia, and letters of intent were signed with Russia (along with South Korea,
another potential customer) in late 2003, to build a pipeline capable of transporting 2.9
billion cubic feet of gas per day, of which China would take 1.9 Bcf. Unresolved
conflicts within Russia have so far prevented this $12 billion project from getting started.
A summit meeting between President Putin and President Hu in March 2006 reaffirmed
their joint commitment to this pipeline, but the price Russia wants to charge for gas
(linked to oil prices, as in Russia’s gas sales in Europe) is probably unacceptably high for
Another potential source is liquefied natural gas (LNG) imported by specialized ship. China is building two LNG terminals in south China (near Guangdong and Zhangzhou) and has contracted for liquified gas from Australia and from Indonesia. It is contemplating at least six additional LNG terminals along the east coast, and has begun to construct LNG carriers in China’s shipyards. Guangdong province has contracted to build six gas-fired power plants, and to convert 1.8 GW of oil-fired generating capacity to gas.

As noted in Table 3, China’s gas consumption is projected to rise at 7.8 percent annually over the next two decades. Even so, however, China’s share of world gas consumption in 2025 will have risen to less than three percent of world consumption, so pressure on world gas supplies will be considerably less than in the case of oil.

(According to some experts, by 2025 LNG will have become “commoditized,” selling on the spot market as oil does today. That prognostication remains to be seen; it will require extensive investments in the total supply train – condensation, shipping, and re-gasification, all capital-intensive processes – without full commitment to long-term supply and demand contracts.)

**Other Raw Materials**

Chinese demand for imports has grown rapidly, if erratically, for a number of non-fuel primary products as well. Table 4 shows China’s import quantities and values for 1985-2004. It is noteworthy that China is a physically large and highly diverse economy and it produces many primary products. Imports reflect the difference between demand and domestic supply. There has been an extraordinary growth in imports of inputs into China’s steel industry, whose output is now the largest in the world and continues to grow rapidly: iron ore, steel scrap, and nickel. Imports of non-ferrous metals have also grown significantly, but much less dramatically (especially for aluminum) from 1985, since imports of both copper and aluminum fell between 1985 and 1990. China’s
inventories and stockpiling policy are not known, so it is possible that China from time to time has done some anticipatory buying, followed by inventory liquidation, making single year comparisons problematic.

Table 4 also reports significant but by comparison with metals less dramatic increases in import demand for agricultural raw materials, and again there are intervening years in which imports for selected products fell. Imports of foodstuffs, both wheat and maize, while large in 2004 were both lower than they were in 1990.

Did growing demand from China strain world supply of non-fuel raw materials? If so, it would show up inter alia in unabated price pressures. Prices did indeed rise significantly (by more than 20 percent) in 2002-2004 for iron ore, nickel, copper, aluminum, cotton, and rubber, among the items shown in Table 4, as well as for petroleum and other fuels. A number of other primary products, such as vegetable oils and lead, also experienced significant price increases. But for many products these price increases represented a recovery from the depressed prices of the late 1990s, and indeed the 2004 prices of aluminum, copper, cotton, rubber, and timber were still below their levels of 1995 (Table 5). Prices of metallic minerals (except nickel) continued to rise sharply through 2005, along with petroleum and rubber; prices of agricultural products were essentially unchanged or even declined.

China’s share of world imports of primary products in 2004, a boom year in China, remained under ten percent for most categories, the exceptions being agricultural raw materials (14 percent) and mineral ores (23 percent). For non-ferrous metals, iron and steel, industrial chemicals, and textiles, the share was between five and ten percent (calculated from WTO 2005b, pp.212, 231). Of course these shares will grow over time if China’s growth continues to exceed the world average and China’s industrial structure does not change significantly.

Nonetheless, rapid growth from a low base can leave modest shares of world trade even after a few decades. Thanks to Boeing, we have forward projections of world
demand for air freight to 2023. Intra-Chinese carriage is expected to grow by 8.1 percent a year from 2003, highest in the world except for within the Persian Gulf region and much higher than the 5.2 percent growth in worldwide air freight. By 2023, China’s share will be 5.0 percent of world air freight, up from 2.9 percent in 2003 (WTO 2005a, p.263-64).

**Conclusion**

Chinese leaders are of course aware of their growing dependence on imported oil and other raw materials and of the vulnerabilities it creates, both to physical and to market disruption. China has aggressively pursued oil exploration around the world, with a strong emphasis where possible on equity oil. In addition, China’s leaders have launched a charm offensive throughout the developing world – in southeast Asia, Latin America, Africa, even India – focused on cultivating trading partners, especially those that have resources necessary for China’s development, including especially oil but not limited to oil. China also plans to create a strategic stockpile of oil. It would like to develop the hydro-carbons of the South China Sea cooperatively, without necessarily resolving the territorial disputes.

At the end of the day, practical considerations of high dependence on imports of critical materials, especially but not only oil, combined with a navy of limited capacity and no naval tradition since the 15th century, are likely to shape Chinese behavior in the international arena in a peaceful and even strongly cooperative spirit. Concretely, China has the same interest as Japan and the United States in a stable Persian Gulf region, from which most of the world’s incremental oil must come over the next 20 years.

An alternative scenario is possible but implausible. Like Germany before 1914 and in 1941 (with the invasion of the Soviet Union), and Japan in the 1930s, China’s sense of vulnerability regarding critical materials might lead to an aggressive policy of gaining control over such materials. In China’s case, that points mainly to East Siberia, lightly populated and defended by Russia; or to acquisition through sponsored political
coup in southeast Asia, leading to governments that are in effect satellites of Beijing – although absent significant new discoveries the latter course would not by itself assure sufficient oil for China’s needs. In the long run, China might attempt to build a blue water navy (and collateral air support) capable of challenging the US Navy, not only in the western Pacific but also in the Indian Ocean, as Japan did with brief but transitory success in the 1930s. But that would require several decades of construction and naval training.

China is more likely to consider these alternatives, the more hostile is the political environment in which it must operate. Those who see China as a “threat” and act accordingly may well be making a self-fulfilling prophecy.

<table>
<thead>
<tr>
<th></th>
<th>GDP (trillion 2005 dollars)</th>
<th>Population (millions)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2000</td>
<td>2025</td>
</tr>
<tr>
<td>China</td>
<td>1.3</td>
<td>7.4</td>
</tr>
<tr>
<td>India</td>
<td>0.57</td>
<td>2.75</td>
</tr>
<tr>
<td>Japan</td>
<td>5.09</td>
<td>7.61</td>
</tr>
<tr>
<td>USA</td>
<td>10.87</td>
<td>21.9</td>
</tr>
</tbody>
</table>


* Normal units of measurement have been converted into quadrillion British thermal units (quads) at the following rates:
  * petroleum: 1 million barrels a day = 2.03 quads per year
  * coal: 1 million short tons = 0.0184 quads
  * gas: 1 trillion cubic feet = 1.034 quads
  * nuclear power: 1 billion kwh = 0.0105 quads
References


### Table 2

#### Demand for Primary Energy and for Oil, 2001 and 2025

<table>
<thead>
<tr>
<th></th>
<th>Primary Energy (quads)</th>
<th>Oil (million barrels per day)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2001</td>
<td>2025</td>
</tr>
<tr>
<td>China</td>
<td>40.9</td>
<td>109.2</td>
</tr>
<tr>
<td>India</td>
<td>13.8</td>
<td>29.3</td>
</tr>
<tr>
<td>USA</td>
<td>96.3</td>
<td>132.4</td>
</tr>
<tr>
<td>Japan</td>
<td>21.9</td>
<td>24.7</td>
</tr>
<tr>
<td>World</td>
<td>403.9</td>
<td>644.6</td>
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</table>


### Table 3

#### Chinese Primary Energy Consumption

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Coal</td>
<td>20.7</td>
<td>25</td>
<td>42.4</td>
<td>55.9</td>
<td>59.7</td>
<td>3.6</td>
</tr>
<tr>
<td>Oil</td>
<td>4.7</td>
<td>9.9</td>
<td>18.7</td>
<td>25</td>
<td>28.8</td>
<td>4.5</td>
</tr>
<tr>
<td>Gas</td>
<td>0.5</td>
<td>1.1</td>
<td>2.7</td>
<td>4.3</td>
<td>6.7</td>
<td>7.8</td>
</tr>
<tr>
<td>Nuclear</td>
<td>0.2</td>
<td>0.8</td>
<td>1.7</td>
<td>2.1</td>
<td>9.8</td>
<td></td>
</tr>
<tr>
<td>Hydro</td>
<td>1.3</td>
<td>2.6</td>
<td>5.2</td>
<td>6.2</td>
<td>6.7</td>
<td>3.4</td>
</tr>
</tbody>
</table>

Total: 27, 40.9, 73.1, 97.7, 109.2, 4.1

Source: EIA (2005), App. A

### Table 5

#### Commodity Prices, 1990-2004

<table>
<thead>
<tr>
<th></th>
<th>1995</th>
<th>2000</th>
<th>2004</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iron ore</td>
<td>87.7</td>
<td>88.9</td>
<td>117</td>
</tr>
<tr>
<td>Steel scrap</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nickel</td>
<td>92.8</td>
<td>97.3</td>
<td>155.9</td>
</tr>
<tr>
<td>Aluminum</td>
<td>110.1</td>
<td>94.7</td>
<td>104.4</td>
</tr>
<tr>
<td>Copper</td>
<td>110.2</td>
<td>68.2</td>
<td>107.6</td>
</tr>
<tr>
<td>Rubber</td>
<td>182.8</td>
<td>79.9</td>
<td>156</td>
</tr>
<tr>
<td>Cotton</td>
<td>119.1</td>
<td>71.6</td>
<td>75.2</td>
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<tr>
<td>Wool (Aust. 48)</td>
<td>114.3</td>
<td>87.9</td>
<td>172.9</td>
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<tr>
<td>Timber (Malaysian Sawn)</td>
<td>143.1</td>
<td>115.8</td>
<td>112.6</td>
</tr>
<tr>
<td>Wheat</td>
<td>130.6</td>
<td>84.1</td>
<td>115.7</td>
</tr>
<tr>
<td>Maize</td>
<td>113</td>
<td>80.8</td>
<td>102.4</td>
</tr>
<tr>
<td>Soybeans</td>
<td>139.7</td>
<td>113.9</td>
<td>172.3</td>
</tr>
<tr>
<td>Petroleum (WTI)</td>
<td>74.9</td>
<td>123.2</td>
<td>168.4</td>
</tr>
</tbody>
</table>

Source: IMF, International Financial Statistics
### Table 4a
China’s Imports of Selected Primary Products

<table>
<thead>
<tr>
<th></th>
<th>Quantities (net)</th>
<th>Value ($billion)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iron ore (mi.)</td>
<td>10</td>
<td>14.2</td>
</tr>
<tr>
<td>Steel scrap (mil.)</td>
<td>-</td>
<td>0.1</td>
</tr>
<tr>
<td>Nickel ('000)</td>
<td>0.03</td>
<td>0.16</td>
</tr>
<tr>
<td>Aluminum ('000)</td>
<td>483</td>
<td>61</td>
</tr>
<tr>
<td>Copper ('000)</td>
<td>346</td>
<td>37</td>
</tr>
<tr>
<td>Rubber ('000)</td>
<td>228</td>
<td>333</td>
</tr>
<tr>
<td>Cotton ('000)</td>
<td>0.4</td>
<td>559</td>
</tr>
<tr>
<td>Wool ('000)</td>
<td>105</td>
<td>44</td>
</tr>
<tr>
<td>Timber (m³)</td>
<td>10.7</td>
<td>3.8</td>
</tr>
<tr>
<td>Wheat (mil.)</td>
<td>5.63</td>
<td>12.33</td>
</tr>
<tr>
<td>Maize (mil.)</td>
<td>6.17</td>
<td>13.56</td>
</tr>
<tr>
<td>Soybeans (mil.)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Petroleum *(mil.)</td>
<td>0.72</td>
<td>-</td>
</tr>
</tbody>
</table>

*including products

Source: China Statistical Yearbook, various issues