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**Challenges to China's Energy Security**

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## **ABBREVIATIONS AND ACRONYMS**

gw	gigawatts, equivalent to $1 \times 10^6$ kilowatts
kwh	kilowatt hour
mtoe	million tonne oil equivalent
tcm	trillion cubic metres
toe	tonne oil equivalent

ABARE	Australian Bureau of Agricultural and Resource Economics
ADB	Asian Development Bank
APEC	Asian Pacific Economic Cooperation
BDWS	Blake Dawson Waldron Solicitors
CASS	Chinese Academy of Social Sciences
CSID	China Statistics Information Daily
IEA	International Energy Agency
IPP	Independent Power Producer
MFN	Most Favoured Nation
SSB	State Statistical Bureau
WTO	World Trade Organisation

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**Abstract**

Energy security is of increasing concern to China. This arises from the rapid growth and non-substitutability of China's energy demand, the perceptible downturn in China's energy production, and competition for energy imports from neighbouring East Asian economies. This paper explores some of the processes and factors that affect energy demand and supply in China and considers their implications for China's trade in energy and for the energy policies of both China and its trade partners. The analysis shows that China will increasingly depend on the rest of the world as both an export market and a source of raw materials such as energy. Further economic reforms and the development of a liberal and transparent policy environment that allows fluid trade and investment in the Asia Pacific region are essential for energy security in China and in the region.

## **Introduction**

China has been one of the fastest growing economies in the world for nearly two decades. From 1978 to 1995, China's real GDP increased at 9.8 per cent per annum (SSB 1996). Accompanying and fostering China's economic growth are its energy demand increases reflecting industrialisation, urbanisation, the rise in motorised transportation, and increased residential energy use to sustain a higher standard of living. Such increases in energy demand have emerged as severe strains for China's development.

In 1993, China switched from being an oil exporter to an oil importer. In fact, its net imports are not limited to energy and often now involve many other energy-intensive basic materials such as iron and steel. Imports are relied upon to cover important industrial needs. As the Chinese economy continues to grow, the issue of security of supplies of energy and key mineral products is becoming increasingly important to China, as well as to the world. With a population of over 1.2 billion, an economy of China's size can have a large influence on the world market. China is already the 11th largest trading nation in the world and it will become progressively more important if its economy continues to expand at or near recent rates of growth.

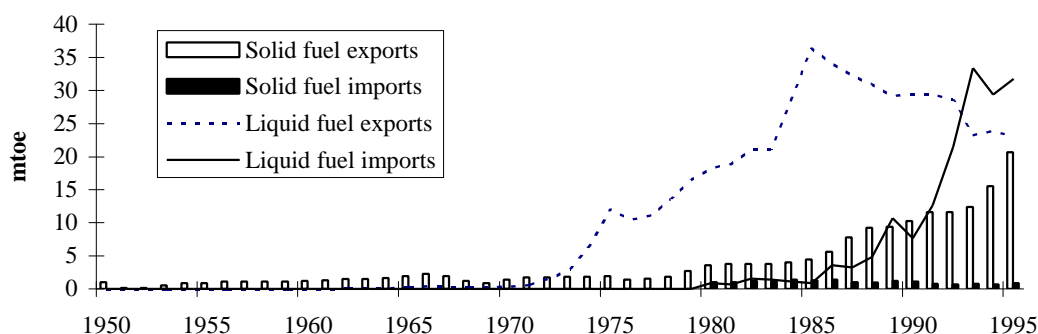
Following the oil price collapse in 1986, world demand for all forms of energy has accelerated. This trend is likely to continue, driven mainly by the growth of developing countries, particularly the dynamic economies of East Asia. The world is projected to consume 45 per cent more primary energy by year 2010 than it does currently, assuming current consumption trends continue. More than one third of this increase will be from East Asian economies (IEA 1995a). This emerging energy pattern has important regional implications. Currently, China accounts for about 65 percent of East Asia's energy consumption. It is likely that China and its Asian neighbours will be vigorously bidding for imports in energy markets. Equally likely is that uncertainties or shocks in supplies from countries exporting energy raw materials will have potentially disruptive impacts on the world economy.

Given the significance of energy security for China and its implications for the global economy, it is important to understand the processes which affect energy demand, supply and trade in China, and to assess appropriate policy responses. This paper explores some of the factors and processes that affect energy demand and supply in China, and considers their implications for China's trade in energy, and for the energy policies of both China and its trading partners.

### The Recent shift in China's energy trade position

In contrast to the current energy shortages in the Chinese economy, China had been an energy exporter from the inception of the People's Republic in 1949 until 1993. Figure 1 shows China's energy trade from 1950 to 1995, with the bars representing trade in solid fuels (coal and coke). The quantities involved in this trade were quite small by international standards, but the early trade in solid fuels established a network of trade contacts throughout the Asia-Pacific region that was available when China began considering energy exports on a larger scale following the oil price hikes in the 1970s. The dotted line shows China's liquid fuel exports (crude oil and petroleum products) which overtook solid fuel exports from 1973, peaked before the collapse of world oil prices in 1986, but have since declined precipitously. At the same time, China's oil imports have increased rapidly. By 1993, China became a net oil importer.

**Figure 1. China: Energy Trade 1950-1995**  
(million tonne oil equivalent)



Source: SSB, China Statistical Yearbook, various year issues.

The shift of China's energy trade position reflected a combination of China's growing domestic energy demand and the transformation of China's energy trade pattern closer to China's comparative advantage in an increasingly open and industrialising economy. At the early stage of development China's exports in the 1960s and 1970s relied heavily on resource-based products such as minerals and agricultural goods. As the economy grew, China's exports gradually changed from being dominated by agricultural products into labour intensive manufactures, as expected from comparative advantage theory (Anderson 1990). A similar decline in the importance of energy exports was, however, delayed by China's policy of setting low domestic energy prices for consumers. Large price gaps between domestic and border prices encouraged the government's state-owned producing and trading enterprises to restrict domestic sales and to generate higher export revenues.

Although coal is the major source of China's primary energy, China's energy trade has largely been dominated by oil. China switched from an oil-poor country to an oil self-sufficient country in the 1960s, following the discoveries of a number of substantial oilfields such as Daqing and Shengli. China started exporting oil in 1973 following the rise in world oil prices. By 1985 it became the largest oil exporter in Asia, overtaking other major oil exporters such as Indonesia. Domestic planned prices for crude oil were set at levels well below international oil prices. Planned quotas were used to control energy production and exports. Until recently oil exports accounted for over 80 percent of China's total energy export revenues and reached a quarter of China's total export revenues at the peak of the mid-1980s (Peng and Martin 1994). Oil exports were used as a way of gaining access to an increasing variety of foreign plant, equipment and technology.

Despite the substantial hard currency revenues generated by oil exports, the "oil exports for technology imports" formula imposes an increasing opportunity cost to the Chinese economy as excess demand for domestic energy grows and world oil prices decline. In recent years, China's consumption of oil has increased at a speed of over 7 million tonnes every year, but production has only managed to grow at about 2 million tonnes annually (SSB 1995). The need to close the gap required China increasingly to

open its domestic oil sector to market reforms, in particular to remove the distortions in energy trade.

Important steps have been taken in the 1990s to reform oil pricing and marketing. In 1992, the market shares of planned allocation of crude oil and petroleum products were reduced to 90 and 34 per cent, respectively. In some cities and provinces up to 80 per cent of the market for petroleum products was opened up (Lu Fuxin 1995, Xie Zhenglin 1994). Price ceilings imposed on market sales of oil products were abolished. These reforms created a market which was more responsive to demand. Domestic oil prices increased significantly by 50 to 100 per cent and the impacts on energy trade were dramatic. In 1993, imports for crude oil and petroleum products increased 38 and 127 per cent, while their exports decreased by 10 and 31 per cent, respectively (Lu Nan *et al.* 1995).

The jump in oil imports in 1993 made China a net oil importer which occurred two years earlier than China had anticipated (Zhou Fengqi 1995). The timing and the magnitude of the shift spurred policy changes intended to curtail oil imports through greater use of administrative controls and the withdrawal of some market initiatives. As will be discussed in detail later in the paper, the recentralised control over oil products allocation has failed to tame the oil market in an increasingly open economy. China's net oil imports have persisted since 1993 as oil allocation plans are penetrated by the market where the demand for oil products is growing rapidly.

In contrast to its worsening oil trade, China's net coal exports have increased steadily in recent years. Greater price and trade reforms have been introduced in the coal sector than in the oil sector. The prices of coal are opened to market forces and subsidies to state owned coal mines are removed. The opening up of the coal market has led to increases in coal prices. Collective and private coal mines increased their coal production, while output of state-owned coal mines has declined in the presence of increased competition. Total coal production has increased and coal supply has exceeded coal demand. This has put China in a position to increase its coal exports. From 1990 to 1995, China's coal exports grew at over 10 per cent yearly (SSB 1995).

However, it remains a question as to whether China will be able to sustain its growth in coal exports. China's coal exports are constrained by its inadequate rail and port infrastructures. Much of China's coal is produced in inner north regions and has to be transported east for exports or to south and southeast coastal regions for domestic consumption. Indeed, China's overburdened transport system has already forced the rapidly growing southern and eastern coastal provinces to import coal. The congestion and cost of transporting coal to the south and southeast suggest that coal imports will increase to meet a growing energy demand in the coastal provinces which will reduce China's net coal exports.

Related to energy trade is China's trade in energy-intensive products such as base metals and petrochemical products. China is now a major importer of aluminium, copper, iron and steel, and fertiliser. Measuring these imports by the energy required to produce them they represent substantial equivalent energy imports. These basic materials are of particular importance for industrialisation and agricultural development in China. As economic growth continues, the potential for China as a consumer of basic materials adds to the challenge of energy supply security.

### **Aggregate trend and sectoral patterns of energy demand growth in China**

The future of China's energy trade and its implications for the world economy depends critically on the growth of China's energy demand. Its aggregate trend and sectoral patterns are examined in this section to allow understanding of the driving forces of China's energy consumption in recent years and to suggest potential developments in the years ahead.

China is currently the third largest energy consuming country in the world behind the USA and Russia. On a per capita basis, however, China ranks substantially lower than industrialised countries and the East Asian newly industrialised economies. Table 1 shows that China's per capita energy consumption is less than a half of the world's average. Importantly, the table shows that per capita energy consumption increases from low income South Asian economies, through higher income East Asian economies, to industrialised countries in the region, revealing a clear relationship

between per capita energy consumption and per capita GDP. As China strives to raise its standard of living, its per capita energy consumption is expected to increase. The impact of the subsequent increases of China's aggregate energy consumption on the world energy market can be overwhelming.

**Table 1. China: Energy and Development in a Global Context, 1994**

	Energy use per capita (toe)	GDP per capita (\$)	Energy intensity (toe/\$1000)
China	0.65	440	1.48
South Asia	0.22	330	0.69
Bangladesh	0.07	220	0.29
India	0.24	320	0.76
Pakistan	0.26	410	0.62
Sri Lanka	0.11	650	0.17
East Asia developing	0.53	1350	0.39
Philippines	0.36	960	0.38
Indonesia	0.39	920	0.43
Thailand	0.77	2470	0.31
Malaysia	1.71	3530	0.48
East Asia newly industrialised	2.93	11010	0.27
Hong Kong	2.28	21980	0.10
Taiwan	2.44	11290	0.22
South Korea	3.00	8560	0.35
Singapore	6.56	22980	0.29
Asia Pacific industrialised	6.61	27980	0.24
Japan	3.83	36730	0.10
Australia	5.17	18440	0.28
Canada	7.80	18720	0.42
USA	7.91	25470	0.31
World	1.43	4500	0.32

note: Regional totals refer to the sum of identified economies.

Sources: Raw data from World Bank (1996) and SSB (1995).

The potential increases in China's aggregate energy consumption are, however, balanced by a trend of declining energy intensity in the Chinese economy. In the past

18 years of economic reforms, one of the impressive achievements of China's economic performance was China's fast economic growth with relatively modest growth in energy needs. Between 1978 and 1994, China's energy demand grew at under 5 per cent per annum (Table 2), significantly less than the GDP annual growth rate of nearly 10 per cent. Energy intensity effectively declined at around 5 per cent per year. If non-commercial energy such as biomass is included, the decline in intensity was even greater.

**Table 2. China: Energy Consumption, 1975 to 1994**

Year	Primary energy consumption		Proportion in primary energy consumption (%)			
	Amount (mtoe)	Period average growth rate (%)	Coal	Oil	Natural gas	Hydropower/a
1975	295		71.9	21.1	2.5	4.5
1976	311		69.9	23.0	2.8	4.3
1977	340		70.3	22.6	3.1	4.1
1978	372		70.7	22.7	3.2	3.4
1979	381		71.3	21.8	3.3	3.6
1980	392	5.8	71.8	21.1	3.1	4.0
1981	387		72.7	19.9	2.9	4.5
1982	404		73.9	18.7	2.6	4.9
1983	429		73.7	18.6	2.5	5.3
1984	461		75.1	17.7	2.3	4.9
1985	499	4.9	75.9	17.1	2.3	4.8
1986	526		75.8	17.2	2.3	4.7
1987	563		76.2	17.0	2.1	4.7
1988	605		76.2	17.0	2.1	4.7
1989	630		76.0	17.1	2.0	4.9
1990	642	5.2	76.2	16.6	2.1	5.1
1991	675		76.1	17.1	2.0	4.8
1992	710		77.7	18.7	1.9	1.7
1993	698		75.8	20.3	2.1	1.8
1994	768	4.6	78.0	18.1	2.0	1.9
1978-94	9142	4.6	75.3	18.4	2.3	4.0

/a. From 1992, electric power is converted into tonne oil equivalent (toe) at 10 kwh for 0.8 toe. Figures before 1992 adopt average electric power using up coal in the same year, and converted at 1 tonne coal equivalent for 0.65 toe.

Such a decline in energy intensity has been achieved through a number of factors, including the improvement in energy efficiency, imports of embodied energy in energy intensive basic materials, and a relatively developed infrastructure at the

beginning of the reform period and the subsequent shift of industrial structure toward labour intensive products (IEA 1994, Lin Xiannuan 1992). Despite its achievement of rapid industrialisation with declining energy demand growth, China still has an energy intensity significantly higher than those in peer developing countries. As shown in column 3 of Table 1, measuring energy consumption in tonnes of oil equivalent (toe) per US\$1000 of GDP, China has an intensity of about 1.5 compared with 0.7 and 0.4 for the South and East Asia developing country groups, respectively. If possible under estimation of China's GDP is considered, China's energy intensity is found to move closer to the experience of other countries, but still to remain around 30 per cent higher than that for the developing countries in the region (Drysdale 1994). There appears to be scope for further improvement in China's energy intensity.

A possible future outlook for China's energy demand growth to the year 2010 is presented in Table 3, based on integrated modeling projections by the International Energy Agency (IEA 1995a). Reflecting the trend of energy consumption in recent years, China's energy demand is projected to grow at slightly over 4 per cent per annum on average to the year 2010, assuming China remains to be the fastest growing economy in the world, with GDP growth averaging 8.1 per cent per annum from 1994 to 2000 and 7 per cent per annum from 2001 to 2010, and population growth at slightly over 1 per cent per annum on average throughout the period.

China's share in world total energy demand is projected to increase from under 9 per cent in 1992 to near 13 per cent in 2010. Together with energy demand growth in East Asia, China and Asia Pacific developing economies will account over 20 per cent of the world's total energy demand by 2010. The impact of these energy demand increases on the world energy market will be significant, and satisfying such growing energy demand in the region could become increasingly challenging.

**Table 3. China: Domestic Demand for Energy in 1992 and Projected for 2010**

1992		2010		Annual growth
Amount	Share/a	Amount	Share/a	

	(mtoe)	(%)	(mtoe)	(%)	(%)
<u>All Primary Energy</u>					
China	710	8.9	1460	12.7	4.1
Asia Pacific developing	392	4.9	904	7.9	4.8
Asia Pacific industrialised	2891	36.4	3665	31.9	1.3
Rest of world	3943	49.7	5461	47.5	1.8
World	7936	100	11490	100	2.1
<u>Energy Composition</u>					
China					
Solids	552	77.7	1018	69.7	3.5
Oil	133	18.7	325	22.3	5.1
Gas	14	1.9	57	3.9	8.1
Electricity	71	13.1	211	18.2	6.2
Asia Pacific developing/ <u>b</u>					
Solids	92	23.5	228	25.3	5.2
Oil	223	56.8	458	50.7	4.1
Gas	42	10.6	135	14.9	6.7
Electricity	37	13.4	107	17.0	6.1
Asia Pacific industrialised/ <u>c</u>					
Solids	718	47.1	878	46.5	1.1
Oil	1213	92.8	1482	85	1.1
Gas	622	35.7	867	41.4	1.9
Electricity	393	19.5	576	22.4	2.1
Rest of world					
Solids	939	26.5	1156	23.4	1.2
Oil	1540	43.4	2129	43.1	1.8
Gas	1067	30.1	1649	33.4	2.4
Electricity	547	20.0	853	22.1	2.5
World					
Solids	2301	29	3280	28.5	2
Oil	3109	39	4394	38.2	1.9
Gas	1745	22	2708	23.6	2.5
Electricity	1048	18.8	1747	21.3	2.9

/a. Shares for solids, oil and gas refer to primary energy shares, electricity is final energy share.

/b. East Asia, excluding China and Japan. /c. Australia, Canada, Japan, New Zealand, USA.

Source: IEA (1995a).

The projections presented in Table 3 assume rising world energy prices, reflecting the view that the present combination of low prices and high demand might not be sustainable over the period to 2010. Supply capacity might not be forthcoming at current prices, unless prices rise to dampen demand. In an alternative projection of no substantial real energy price increases, but faster energy demand growth, with annual GDP growth rate averaging 8.5 per cent and annual population growth averaging 1.3 per cent to year 2010, and a significant improvement in energy intensity (adjusted for possible GDP under estimation) to 0.5 toe per US\$1000 by 2010, China's share in world total energy demand for fossil fuels and electricity will reach as high as 19 per

cent, and East Asia developing economies (together with China) will lift up their share in world energy demand to 28 per cent by the year 2010 (Drysdale 1994).

China's energy consumption is coal based. As shown in Table 2, coal accounts for over 75 per cent of China's current primary energy consumption. This share is expected to decline to under 70 per cent by 2010 which is still extremely high by international standards, compared with 25 per cent for other developing economies in the region (Table 3). Use of coal in China differs from that in most other countries as substantially less coal is converted into electricity in China for final energy consumption. Electricity as a share in final energy use in China is 13 per cent compared with about 20 per cent for industrialised economies.

The difference in the degree of reprocessing coal into electricity has important implications for the patterns of China's energy demand growth. As China continues to be industrialised, there will be increasing penetration of electricity use in China's energy consumption, especially in the industrial and residential sectors.

The industrial sector currently accounts for over 60 per cent of China's total final energy consumption. Electricity is taking up an increasing share of industrial energy use due to strong growth in the production of machinery and equipment which are very electricity intensive, the shift of iron and steel making from blast furnace to more efficient electric arc furnace, and the growth of manufacturing process industries which favour the use of electricity over other fuels. Growth in power generation has not kept pace with electricity demand. According to the Asian Development Bank (1991), only 40 per cent of the potential demand for electricity is satisfied in township and village industries.

In the residential sector, as the urban population grows and rural electrification programs increasingly replace traditional fuels of biomass, the number of households with access to electricity supplies and the penetration of electrical appliances have grown dramatically since 1978. Associated with income growth, the number of fans and television sets have expanded 20 and 60 times respectively, and washing machines and refrigerator have grown to 97 and 30 million respectively from a base of

nearly zero in 1978 (SSB 1995). The wave of hot water heater and air-conditioner expansions are yet to come as they are currently almost non-existent in China's urban residential centres compared with other developing countries.

China's electricity demand growth is projected to account for around 20 per cent of the world's incremental electricity demand to the year 2010, increasing from 71 mtoe in 1992 to 211 mtoe at a speed of 6.2 per cent per annum (Table 3). This compares with an alternative scenario put forward by the APEC Energy Working Group which projected China's electricity consumption would grow at 8 per cent per annum between 1992 and 2010 (BDWS and ABARE 1995).

Increasing market penetration is also projected for oil and gas in China's energy demand growth, particularly for oil. Three powerful engines will propel rising demand for oil: an automotive boom, growth of an oil-intensive manufacturing industry, and soaring air travel.

Increasing production of goods and services, rising per capita incomes, and accelerating urbanisation have led to sharp increases in motorised transportation in China. Total passenger and freight transportation has grown at roughly the same rate as GDP since 1978 (SSB 1995). This still leaves China's per person transportation about 20 times lower than that in the USA. Conservative projection of overall energy demand growth for China's road transport is 7 per cent per year to 2010, equivalent to an increase of incremental oil demand of around 1.4 million barrels per day (IEA 1994). More recent estimates by the China Automobile Industry Corporation indicate that demand for automobiles is expected to rise rapidly at 12 per cent per annum between 1996 to 2000, and 9 per cent per annum between 2001 and 2010. The annual increases of automobiles reach 2.5 million by 2000, and 5.5 million by 2010 (Huang Wei 1995). The fuel demand implications for China's automobile boom is significant.

China's fastest transport growth has been in air travel which has increased at a speed of 20 per cent per annum since 1978. Despite this, the share of air travel in total transport is less than 7 per cent, very low for a country of China's vast size. Even a

significant moderation of the trend in air travel growth will generate a demand for aviation fuel at least double the rate of overall energy consumption.

The production of petrochemicals is also oil-intensive. China's demand for petrochemical products such as fertiliser, plastic and ethylene has grown at double digits in recent years. Fertiliser production dominates China's petrochemical industry. The use of fertiliser is expected to grow faster than agricultural output due to the increasing use of marginal land, land shortage and increasing requirements for higher agricultural production. Despite a strong demand growth for oil required to boost domestic petrochemical production, China is likely to remain a major importer of these products.

In sum, China's energy demand will increase rapidly in the coming years to sustain strong economic growth. Despite continuing improvement in energy intensity, the rise of per capita income and the size of the economy will increase China's share in world energy demand substantially by the year 2010. Two clear patterns emerge in China's energy demand growth. One is the surge of demand for oil and the other is the rapid penetration of electricity use relying on increasing conversion of coal into power. The way China meets the challenges of satisfying its increasing oil demand and rapid electricity penetration will affect how well China performs into the next century.

### **China's energy supply constraints and the trade implications**

China's growing energy demand poses a great challenge to its energy supply. The challenge is less of a constrained resource base but is likely to come from the speed of energy demand growth, and from the institutional distortions which impede energy production expansion.

China's energy resources are abundant. Table 4 presents a global view of fossil fuel reserves. China has over 11 per cent of the world's coal endowment. The bulk of China's coal reserves are located in the north of the country: Shanxi and Inner Mongolia contain about half of China's proven coal reserves. China is also moderately strong in oil and gas resources. A recent Chinese study completed in 1994 estimated

China's total oil and gas resources to be 89 billion tonnes and 40 trillion cubic metres, respectively (Lu Nan *et al.* 1995). The Tarim basin in west China is recognised as one of the most prospective in the world, with over 20 million tonnes oil potential. But the exploration and development of economically recoverable oil reserves in this remote region have been very slow. The South China Sea is believed to have deposits equivalent to 8 Daqing oilfields, although recent offshore discoveries have been modest. Not shown in Table 4 is China's rich hydropower resources which rank first in the world. Only around 10 per cent of China's hydropower potential has so far been developed (Yan Changle 1994).

China's large energy resource endowment is matched by an equally large population size. China has 22 per cent of the world's population but 8 per cent of the world fossil fuel reserves. To meet the demand for energy for over 1.2 billion people is a challenging task, although the resource base does not present a serious constraint in the medium term.

China has made considerable progress in increasing energy production by a series of market-based reforms. In the coal industry, for example, a large part of the coal market has been opened up, millions of small- and medium-sized coal mines in collective or private ownership mushroomed in China in recent years. Guided by market signals, they now supply nearly 60 per cent of Chinese coal. However, energy supply growth has not been able to match the surge of energy demand. Reforms of an incomplete

**Table 4. World Fossil Fuel Reserves by Country and Region, 1991 (mtoe)**

	Coal	% in world	Oil	% in world	Gas	% in world
Asia & Australasia	158200	30.38	5900	4.36	7600	6.82
China	58900	11.31	3278	2.42	900	0.81
Australia	45400	8.72	200	0.15	300	0.27
India	41000	7.87	800	0.59	600	0.54
Indonesia	11000	2.11	900	0.66	1600	1.44
Japan	1300	0.25	9	0.01	32	0.03
North America	122400	23.50	5300	3.91	6600	5.92
USA	118000	22.66	4300	3.18	4300	3.86
Canada	4400	0.84	1000	0.74	2300	2.06
Latin America	6100	1.17	16900	12.48	6100	5.48
Mexico	1000	0.19	7200	5.32	1800	1.62
Venezuela	300	0.06	8500	6.28	2800	2.51
OECD Europe	42600	8.18	1900	1.40	4600	4.13
Germany	34700	6.66	58	0.04	300	0.27
UK	2400	0.46	500	0.37	500	0.45
Non-OECD Europe	150400	28.88	8000	5.91	45000	40.39
Ex USSR	115000	22.08	7800	5.76	44500	39.95
Africa	41000	7.87	8000	5.91	7900	7.09
Middle East	100	0.02	89400	66.03	33600	30.16
World	520800	100	135400	100	111400	100

Sources: 1. Hargreaves, Eden-Green and Devaney (1994). 2. Yan Changle (1994).

nature have not been sufficient in lifting energy production, and the speed of energy demand growth outpaced infrastructure development needed to support capacity expansion in energy production. In fact, an important trend in China's energy production is the perceptible downturn in the growth rate since mid-1980s (Table 5).

Institutional distortions, among other factors, have impeded energy supply expansion. The well-known two-tier price system, when introduced to the energy system in the early 1980s, boosted energy production by providing market incentives to energy producers at the margin. However, as energy demand grew, but planned prices remained fixed for a substantial part of energy production, the gap between the planned and market prices became increasingly large. Towards the late 1980s and early 1990s, planned energy prices were often several times lower than market prices for over 60 percent of total energy production sales (CASS 1990). Such disproportionately large price gaps and high planned production quotas generate substantial income transfers, reduce the profit to energy producers, and erode their ability to increase energy production. While the energy market clears by the secondary market prices at the margin (Sicular 1988), the larger the gap between planned and market prices and the higher the planned allocation of energy products to consumers, the less effective is the two-tier price system for energy production expansion.

Reforms in the energy investment system also had unintended consequences. To some extent, the decentralisation of energy investment from a central budget allocation to local government and enterprise self financing has been successful in increasing the mobilisation of funds and diversifying the sources of finance. However, the underdeveloped financial market in China is unable to supply intermediate, long term and large scale investment funds which are characteristic to energy sector investment. There are still excessive government controls on interest rates, security issues, and the direction of credits. Related to price reforms, decentralisation of investment has made energy prices ever more critical for generating internal finance and attracting outside capital investment. However, the two-tier price system has failed to live up to

expectations, and has actually constrained investment growth as the excessively low planned prices worked against market incentives.

**Table 5. China: Energy Production, 1975 to 1995**

Year	Coal		Oil		Natural gas		Hydropower	
	Amount (mt)	Period average annual growth (%)	Amount (mt)	Period average annual growth (%)	Amount (bcm)	Period average annual growth (%)	Amount (b kwh)	Period average annual growth (%)
1975	482		77		9		48	
1976	483		87		10		46	
1977	550		94		12		48	
1978	618		104		14		45	
1979	635		106		15		50	
1980	620	5.2	106	6.6	14	10.0	58	4.1
1981	622		101		13		66	
1982	666		102		12		74	
1983	715		106		12		86	
1984	789		115		12		87	
1985	872	7.1	125	3.3	13	-2.0	92	9.7
1986	894		131		14		95	
1987	920		134		14		100	
1988	980		137		14		109	
1989	1054		137		15		118	
1990	1080	4.4	138	2.1	15	3.4	127	6.5
1991	1087		141		15		125	
1992	1116		142		16		131	
1993	1151		145		17		152	
1994	1240		146		18		167	
1995	1292	3.66	149	1.5	17.60	2.8	188	8.2

Source: SSB (1996).

These institutional constraints have caused considerable financial difficulties for the entire energy industry. In the oil industry, most oilfields have run into deficits since the late 1980s resulting from a combination of fixed low planned prices for a substantial portion of crude oil production and increases of extraction costs as prices of production inputs increase and oilfields are aging. An important consequence is the lack of sufficient funds for oil exploration. Although oil reserves are potentially large, the ratio of oil production to recoverable oil reserves declined from 1 to 15.2 in 1986 to 1 to 13.6 in 1992. On the other hand, low oil prices have encouraged the inefficient

use of oil. In the downstream oil refining industry, small scale and wasteful refineries prospered at low oil prices and significantly impeded the development of an internationally competitive refining industry. At the end use stage, around 20 to 30 per cent of annual oil output is burnt as fuel. All of these added to the shortages of oil supply (Lu Nan *et al.* 1995).

In the power sector, despite considerable progress made in increasing power tariffs to reflect costs, power enterprises are unable to generate sufficient internal capital for reinvestment, and access to outside sources is limited by the underdeveloped financial market. The power industry's difficult financial position in turn impacts on the coal industry as coal supplies to power plants cannot be fully opened up to the market.

Inadequate infrastructure also constrains energy production growth, particularly in the coal industry. Coal consumption is concentrated in the rapidly growing southern and eastern coastal provinces. As the bulk of China's coal reserves are located in the north and west of China, the inadequate rail transport network which connects the coal production and consumption sites presents a severe bottleneck on coal production expansion. In China's major coal producing provinces such as Shanxi and Inner Mongolia substantial quantities of coal are being stockpiled at the pithead.

The institutional, financial and infrastructure constraints to China's energy supply have important implications for China's energy trade. Given the speed of energy demand growth in the years ahead, China will increasingly rely on energy trade to meet its domestic energy needs.

### *Oil*

Oil represents the single most important fuel in managing China's future energy trade. The prospect of China's oil production rests on the pace of development of oil basins in the west and northeast, and to a lesser extent, the offshore resource base. While holding great potential, the cost of exploration is significant. Depending on the degree of opening up to foreign participation, it is uncertain that China's prospective oil basins such as Tarim can be fully developed before 2010.

China currently produces over 140 million tonnes of oil annually, translating to about 3 million barrels a day. In the case where accelerated oil investment is justified if world energy prices are to increase to sustain growing world energy demand, the International Energy Agency projects China to increase oil production to 4.5 million barrels a day by 2010. Given China's rapidly growing oil needs as shown in Table 3 (translating to about 6.5 million barrels a day by 2010), this still leaves China with a significant oil import gap of about 2 million barrels a day by 2010.

An important trend in China's oil imports in recent years has been the rapid increase of refined petroleum products. While this reflects rapid demand growth and inadequate refining capacity, the mix of petroleum product imports also exposes price control distortions over petroleum products. The price of gasoline has been set substantially high relative to other oil products. This has led to the orientation of refineries towards the production of gasoline rather than other fuels, including diesel which is used widely in transport, industry and power generation. Domestic production of diesel relative to gasoline declined from 1.8 to 1 in 1979 to 1.12 to 1 in 1993. Diesel has dominated a share of over 75 per cent in China's refined petroleum imports in recent years (Lu Nan *et al.* 1995).

Increases of petroleum products imports also reflect regional barriers. Most refined oil imports have been absorbed in southern provinces where all main fuel categories are in shortage as refineries are located in the northeast and eastern provinces. With a shortage of oil products, local governments put restrictions on the outflow of refined oil. The costs of transporting oil products from the north to the south, overcoming all barriers, are high. Wholesale prices plus transport costs amount to the price ceilings imposed on retail prices by the government. As a result, imports of refined oil have risen significantly in recent years to meet rising demand in southern provinces. Remaining to be addressed in the transition of China's oil refining industry, the inadequate refining capacity and regional imbalances may lead to further expansion of international trade.

### *Coal*

Transporting coal from north to south is a key issue in determining the importance of coal imports in China. China's coal demand growth will continue to be concentrated in coastal southern and eastern regions. Given the congestion and cost of north/south coal transportation, coal imports into southern China are expected to continue to rise. On the other hand, coal exports from north China are likely to increase through rail and port infrastructure development currently under way.

Although the potential for increased coal exports exists, China will continue to rely on coal as the major source of domestic energy consumption. Coal-fired power stations are the predominant source of electricity generation in China. With policy emphasis on locating power plants near coal mines and transporting electricity rather than coal, an increasing amount of China's coal will be used to meet its growing electricity needs.

There are significant uncertainties in China's net coal export outlook. The IEA suggests China is likely to be a relatively small net coal exporter (Table 6). This compares with China's National Coal Industry Import and Export Corporation's statement that coal exports are expected to increase substantially to 50 million tonnes by year 2000 (Millsted, Stuart and Kicic 1996), while a study by Japan completed in 1994 points to China becoming a net coal importer by year 2000 (IEA 1995b, p.202). Indeed, given China's huge coal production and consumption capacities, small changes on supply or demand can have a major impact on world coal trade.

### *Power*

China's continuing reliance on coal, in particular its increasing conversion of coal into electricity, is met with challenges to build new power capacity with ongoing significant implications for power generation equipment imports and formidable capital

**Table 6. China: Energy Balance, 1992, 2000 and 2010**

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	1992	2000	2010
<b>Oil (million barrels per day)</b>			
Demand	3.0	4.1	6.5
Supply	2.9	3.2	4.5
Imports	0.1	0.9	2
Self-sufficiency (%)	97	78	69
<b>Coal (million tonnes)</b>			
Demand	1119	1495	2090
Supply	1138	1515	2100
Exports	20	30	60
Imports	1	10	50
Self-sufficiency (%)	102	101	100
<b>Electricity</b>			
Installed capacity (gw)/ <u>a</u>	167	359	600
Equipment imports (gw)	11	11	11
Capital imports (m\$)	375	5000	8000

/a. Installed capacity for 2000 is a linear extrapolation between 1992 and 2010.

Sources: Raw data from IEA (1995a, 1995b), BDWS and ABARE (1995).

requirements. The power market in China is the largest in the world. China's electricity generating capacity is projected to increase from 166.5 gigawatts in 1992 to more than 600 gigawatts by 2010 (Table 6), translating to an increase of around 24 gigawatts annually which is equivalent to an average annual addition of more than the total capacity for Indonesia and Thailand or an addition of coal-fired plant capacity which doubles that for all East Asian economies as a whole by year 2010 (BDWS and ABARE 1995).

Currently, China has a capacity for producing power generation equipment for about 13 gigawatts annually (Zhou Fengqi 1995). A shortage of about 11 GW in equipment will be met through imports or joint ventures for the production of power generation equipment. The capital cost for new electricity capacity building in China is estimated at \$15-20 billion per year to the year 2000 and more thereafter (World Bank 1994). While domestically sourced finance needs to be raised through further reforms of the power sector and the financial market, China will have to rely increasingly on foreign capital imports given the scale of investment requirements.

Foreign capital flow to China's power sector has been limited and accounted for about 6 per cent in total power sector investment in 1993, mainly from concessionary sources of international lending agencies and bilateral aid agencies (World Bank

1994). To meet the capacity expansion requirement, China is seeking 20 to 25 per cent of power sector investment from foreign financing. An increasing proportion of foreign capital will have to come from private business finance raised on the international capital market. Estimates of investment cost in new generating capacity over the period to 2010 in APEC member economies show that China will require substantially more than half of 1 trillion capital finance. Approximately 20 per cent of this will have to rely increasingly on investment by independent power producers (BDWS and ABARE 1995).

### **Trade liberalisation and regional cooperation**

China's increasing reliance on energy trade to meet domestic energy needs implies that the degree to which the international energy market is stable and highly contested is critical to China's energy security, and the extent to which the development of a liberal and transparent policy environment that allows for free flow of trade and investment is essential to ensuring China's access to the international market.

Most of China's energy trade has been in the Asia Pacific region. Table 7 shows China's bilateral energy and overall trade in 1994. Japan, Hong Kong, South Korea, Singapore, Indonesia and USA are the major partners in China's energy trade. Significant quantities of coal and crude oil have been exported to Japan, with much of it based on long term contracts. In 1994, Japan accounted for over 30 and 60 per cent of China's coal and crude oil exports, respectively, followed by South Korea as the second largest energy export customer. Hong Kong and the USA were also important energy export markets. On energy imports, a number of countries in the region have been the sources of China's imports for crude oil (Indonesia, Papua New Guinea, and Vietnam) and petroleum products (Singapore), with the Middle East supplying an increasingly large share in crude oil imports. Coal imports have been dominated by North Korea, Australia and Canada.

**Table 7. China: Bilateral Energy and Overall Trade, 1994**

Energy Exports	Energy Imports/a
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Major trade partners	Values (m\$)	Shares (%)	Major trade partners	Values (m\$)	Shares (%)
<b>Coal</b>					
Japan	229	32	North Korea	27	65
South Korea	150	21	Australia	8	19
Hong Kong	85	12	Canada	5	11
World	723	100	World	42	100
<b>Crude oil</b>					
Japan	1336	64	Indonesia	602	38
USA	272	13	Middle East	598	38
South Korea	171	8	PNG	115	7
Indonesia	82	4	Vietnam	76	5
World	2081	100	World	1573	100
<b>Petroleum products</b>					
Singapore	331	38	Singapore	1140	58
South Korea	98	11	South Korea	201	10
Japan	36	4	Russia	172	9
Hong Kong	23	3	USA	159	8
World	876	100	World	1958	100
<hr/>					
	Exports (m\$)	Shares (%)	Imports (m\$)	Shares (%)	Net trade (m\$)
<hr/>					
Total energy trade	3680	3	3573	3	107
All merchandise trade					
Japan	21573	18	26321	23	-4748
Hong Kong	32365	27	9457	8	22908
USA	21461	18	13970	12	7491
South Korea	4402	4	7318	6	-2916
Singapore	2558	2	2482	2	76
Australia	1488	1	2452	2	-964
Indonesia	1052	1	1588	1	-537
Middle East	2564	2	1242	1	1322
World	121038	100	115669	100	5369

/a. Figures for coal imports are 1991 estimates based on Dorian (1994).

Source: China's Ministry of Foreign Economic Relations and Trade (1995).

Most of these countries are also major partners in China's overall trade, in part owing to the significance of energy in their trade with China. As shown in the lower panel of Table 7, Japan, Hong Kong, USA, and South Korea accounted for about 60 per cent of China's overall trade in 1994, with large differences in their trade balances with China. The shares of total energy exports and imports in China's overall trade in 1994 were relatively small, but the aggregation hides the significance of energy in bilateral trade. The expected increases of China's energy trade are likely to contribute to the

expansion of China's bilateral trade with countries in the region, and have a sizeable impact on China's overall balance of payment in the coming years.

As one of the lowest-cost producers of coal in the region China's potential to increase coal exports is promising, given the region's dynamic economic development and expected strong growth of demand for coal and power. Subject to the constraints of domestic demand and infrastructure development, China's proximity to Japan and South Korea, two of the largest coal importers in the region, puts China in a position to increase coal exports from its northern ports and to improve bilateral trade with Japan and South Korea.

The growth of China's coal exports is, however, likely to be outweighed in value by oil import increases. In 1994, China's oil trade ran a deficit of over 570 million dollars, although total energy trade had a surplus of 107 million dollars owing to coal exports (Table 7). In 1995 the oil deficit jumped to over 1390 million dollars, while net coal exports increased to 940 million dollars (CSID 1996). This turned China's total energy trade to a deficit of 450 million dollars in 1995. The dramatic turn around of China's energy trade balance in 1995 illustrated the speed of oil import growth and its potentially large impact on China's overall balance of payments.

China's bilateral trade with oil import source countries such as Indonesia and the Middle East is expected to increase sharply, with major implications for bilateral trade balances. Similarly, coal imports into south China are expected to increase China's bilateral trade with countries such as Australia which has been a growing important energy and mineral import source for China in the region.

Such increases in energy imports require China to expand exports of other products such as labour intensive manufactures to maintain a balanced overall trade. Indeed, in 1995, China's balance of payment increased by more than 11 billion dollars over 1994's figures (SSB 1996) despite its energy trade deficit in the order of half a billion. The shift of China's trade pattern reflects China's changing comparative advantages in the process of industrialisation as resource based agriculture and mining sectors

continue to decline. The outcome is China's increased dependence on the rest of the world as both an export market and a source of raw materials.

Given the size of the Chinese economy, the greater reliance of China on international markets has significant strategic implications for energy security. In the case of a world supply disruption, not only the degree of dependence on energy imports could affect China's ability to sustain its economic growth, most of China's neighbours would also be affected as they likewise rely on the world for their energy needs. Japan, South Korea, Singapore, Hong Kong and Taiwan are all major energy importers with negligible domestic energy resources. Oil remains the single most important fuel among energy sources for the region. The International Energy Agency projects that the dynamic economies of East Asia (together with China) will account for a greater increase in annual oil demand than the whole of the OECD (IEA 1995a). Currently, ASEAN countries such as Indonesia and Vietnam are the major source of oil supplies within the region. Although oil production is expected to expand in Vietnam, subsidised energy prices and inadequate incentives for exploration and production in Indonesia are accelerating the trend of the region becoming a net oil importer.

China and neighbouring East Asian economies will increasingly be competing contenders for energy imports and rely more on energy sources outside the region. For oil imports, one likely supply source is the Middle East. The geopolitical impacts of a tighter Asia and Middle East link and, within the region, the conflicting offshore claims in South China Sea (Calder 1996) are beyond the scope of this paper. However, these issues highlight the need for increasing regional cooperation among the Asia Pacific economies to address their common concern of energy security.

The key economic factor is that, as bidding intensifies, prices will go up and the potential supply of energy, even outside the Middle East, can become relatively large. A liberal and open policy environment that encourages trade and investment in energy and maximises access to energy market worldwide, together with stable development of oil reserves in the region are critical to achieve energy security for all countries in the region.

The fact that the development of energy resources is constrained in countries such as China and Indonesia in the region means that these countries have much to gain by further liberalising its energy trade and opening up the development of the energy sector to foreign participation with improved foreign investment incentives. The benefits to China of such an open approach would include reduced reliance on oil imports, acceleration of power capacity building, and fostering China's coal exporter position.

Industrialised countries in the region have important roles to play with capital and technological assistance. In particular, energy cooperation between China, Japan and US could be enormously important. The benefits to the three economic powers in the region are beyond energy security concerns as the pursuit of a common energy security interest could serve to break the escalation of trade friction among the three economic giants. Sino-US joint energy projects, for example, could help to improve bilateral trade as illustrated by the encouraging precedents of US involvement in build-operate-transfer power plants in Asia which have led to substantial US exports of electric equipment.

A cooperative approach in the region requires countries to act in an accommodating manner to lower the barriers for trade and investment. China has made significant progress in liberalising trade and freeing up capital flows. The adoption of the Foreign Trade Law in July 1994 and the announcement by Jiang Zemin at the Osaka APEC meeting in November 1995 to reduce tariffs on a wide range of commodities are indications of China's commitment to a greater degree of openness. The custom tariff rates as effective from April 1996 show that China's energy import tariff rates are now insignificant (Table 8), and capital flows from the region into China are growing strongly (Table 9). However, there are still substantial non-tariff barriers in China's energy trade, and the share of foreign investment in the energy sector in China's total foreign investment is limited. Further trade liberalisation is needed in a number of important areas.

Domestic prices for many energy products remain distorted and do not reflect economic costs. The centralised control of oil prices reinstated in 1994, following the

jump of oil imports in 1993, has failed to reflect demand and supply in the market. As shown in Table 10, planned crude oil prices remain substantially lower than international oil prices. Since the bulk of crude oil production is subject to planned pricing, this severely discourages crude oil production. On the other hand, prices for petroleum products are considerably higher than international prices, inducing substantial refined oil imports. Such price distortions result in inefficient resource allocation, and increase dependence on imports. In addition, the current planned oil pricing system does not, and indeed cannot, competently consider regional, seasonal and qualitative variations, and the relative prices of crude oil to coal, and kerosene to gasoline are lower than international comparisons on an energy content basis, leading to wasteful burning of crude oil and shortages of kerosene (Lu Nan *et al.* 1995). All these provide the wrong signals when a greater effort of energy conservation is needed. Reforms of oil pricing based on market mechanisms and linking domestic and international oil prices will be key steps toward oil security. Such price reforms will provide incentives to the development of domestic oil reserves, promote energy savings, and increase access to the world oil market.

Considerable progress has been made in coal and electricity pricing. However, efforts should be made to consolidate and continue the reforms, particularly in power tariffs which to a certain extent have constrained the further opening up of coal prices in relation to coal supply for electricity generation. The key to reform is to increase power tariffs to reflect costs of supply. This will not only induce a more efficient use of present resources, but also attract new investment in the power sector. As China will rely increasingly on international capital markets to finance its power capacity expansion plans, commercially viable power investment is critical to encourage the participation of independent power producers (IPP). The role of IPP in China's power sector has been insignificant so far, due to a lack of appropriate policy framework, market mechanisms and institutional arrangements conducive to private sector involvement (World Bank 1994). In addition to ensuring that consumers pay enough to cover the costs of new investment, there is a need for China to develop a basic framework that is transparent and competitive to deal with IPP's risk concerns. The more transparent and predictable the regulatory outcome is, the more responsive IPP

bids should be. Similar reforms towards a transparent and competitive bidding system for foreign participation in developing coal and oil resources are needed.

Energy cooperation also requires the removal of non-tariff trade barriers. These include the channelling of energy imports through government controlled trading corporations, quotas and licensing for exports of coal and oil and imports of petroleum products, registration requirement for crude oil imports, and approval of foreign exchange for imports as enterprises no longer retain foreign exchange from their exports. Some of these barriers are designed as safeguard measures and their restrictions on trade are not immediately obvious. For example, registrations for oil imports are automatic for import agents who are lined up with import end users instead of re-selling imports on domestic markets, and applications for foreign exchange for imports are usually granted provided enterprises have the *renminbi* backing. However, such administrative mechanisms increase the cost of imports, and the rights can be taken away from enterprises and import agents if the authorities deem it necessary (Dickson 1996). The latter point draws attention to the need and importance of the consistency and continuation of China's trade reforms. Given the large size of the Chinese economy, fluctuations and instability in China's trade behaviour can have powerful negative impacts on trading partners, especially to economies in the region who have a big stake in trade with China. Adverse reactions will be particularly harmful to China's energy security, as the world is less likely to supply China in the face of uncertainty.

One concern of a greater reliance on the world for a big country such as China is the costs of terms of trade moving against the big trader. The perception of such costs depends, however, on the responsiveness of the rest of the world to China's trade

**Table 8. China: Energy Import Tariffs, 1992 and 1996**

	1992 (%)	1996 (%)
Coal		
Black coal	15	6
Brown coal	15	3

Coke	6	6
Crude oil	3	1.5
Petroleum products		
Gasoline	9	9
Kerosene	9	9
Diesel	6	6
Fuel oil	15	12
Natural gas	15	6
Electricity	3	3

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Sources: China's Customs Administration Authority (1995, 1996).

reform. Anticipation of China's impact on the world market and adjustment on the part of the rest of the world to accommodate China's opening up are likely to reduce costs and reduce China's sense of strategic risk. The key issue is therefore one of "interdependency" and not "dependency" (Findlay and Watson 1996).

The careful management of China's trade interdependency is a major issue both for China and for the rest of the world. Apart from the strategic concerns, it is important for China's trading partners to build a stable trading framework. Restrictions on China's exports, the proceeds from which are used to pay for China's imports of such sensitive products as energy, for example, would limit China's involvement in a regional approach to energy security and damage economic prosperity for all countries. To this extent, the continuing rejection of China's bid to enter the World Trade Organisation (WTO) and annual difficulty of the Most Favoured Nation (MFN) approval by the US Congress work against the interest of regional energy security.

China's participation in the WTO will consolidate its access to the international market, and will also commit China to a liberal trade regime at home. China's WTO

**Table 9. China: Sources of Foreign Direct Investment, 1984 to 1994**

Source Countries	1984 -1989		1990 -1994		1984 -1994	
	Amount (\$)	Shares (%)	Amount (\$)	Shares (%)	Amount (\$)	Shares (%)
East Asia newly industrialised	896146	61.7	6153108	76.8	7049254	74.5
Hong Kong	872436	60.1	4876413	60.8	5748849	60.7

Macao	7856	0.5	138129	1.7	145985	1.5
Taiwan	0	0.0	826894	10.3	826894	8.7
Singapore	15854	1.1	190060	2.4	205914	2.2
South Korea	0	0.0	121612	1.5	121612	1.3
Asia Pacific industrialised	381547	26.3	1182295	14.8	1563842	16.5
Japan	189357	13.0	514510	6.4	703867	7.4
USA	172264	11.9	584416	7.3	756680	8.0
Australia	14707	1.0	37303	0.5	52010	0.5
Canada	4514	0.3	42997	0.5	47511	0.5
New Zealand	705	0.05	3069	0.04	3774	0.04
Rest of World/a	174158	12	678838	8.5	852996	9
Other East Asia developing	7316	0.5	145782	1.8	153098	1.6
South Asia	3	0.0	1355	0.02	1358	0.01
Middle East	532	0.04	30137	0.4	30669	0.3
Europe	99069	6.8	316450	3.9	415519	4.4
Latin America	1137	0.1	25816	0.3	26953	0.3
Africa	355	0.02	5533	0.1	5888	0.1
Others	65746	4.5	153765	1.9	219511	2.3
<b>Total</b>	<b>1451851</b>	<b>100</b>	<b>8014241</b>	<b>100</b>	<b>9466092</b>	<b>100</b>

/a. Regional sums are calculated only for countries identified in the original Chinese data.  
Source: Chen Chunlai (1996).

**Table 10. China: Domestic and Border Prices of Oil and Petroleum (yuan/t)  
1985 to 1995**

	Crude oil				Petroleum product			
	Plan		Market	Border/a	Plan		Market	Border
	Basic	High			Basic	High		
1985	100	555		627	580		880	870
1990	167	555		979	617			
1991	201	589		813	717		1675	
1992	201	589		908	680		1618	
1993	205	535	1100	975	1250	2400	2917	
1994		700	1232	1151	2400		2400/b	1600
1995		700	1250	1190	2400		2400/b	

/a. International trade weighted average prices, converted to yuan using market exchange rates.

/b. Price ceilings.

Sources: ABARE (1994, 1996), Bi Jingquan (1994).

membership is therefore an opportunity for China and the region to move toward greater regional cooperation, including energy cooperation.

## Conclusions

Energy security is of increasing concern to China. This concern arises from a number of sources. First is the rapid growth of China's energy demand to sustain strong economic growth. Despite continuing improvement in energy intensity, the rise of per capita income and the size of the economy will increase China's energy demand substantially. Second is the perceptible down turn in China's energy production since the mid-1980s. The speed of energy demand growth imposes a great challenge to China's energy production expansion which is impeded by institutional distortions and infrastructural constraints. Third is that China's increasing reliance on energy trade to meet its energy needs is met with competition from the dynamic East Asian economies in the region, most of whom are major energy importers with negligible domestic energy resources.

Two clear patterns emerge in China's energy demand growth. One is the surge of demand for oil and the other is the rapid penetration of electricity use relying on increasing conversion of coal into power. Their international trade implications are significant. Depending on the degree of opening up to foreign participation, it is uncertain whether China's prospective oil basins such as Tarim can be fully developed before 2010 given the institutional, financial and infrastructural constraints. An import gap as wide as 2 million barrels a day is projected by the year 2010. For electricity generation, formidable capital and electric equipment imports are expected in order to build power capacities at a rate of over 20 GW per year to 2010. A large proportion of foreign finance will have to come from independent power producers. Increasing amounts of China's coal will be used to produce power. China has managed to increase its coal exports considerably in recent years but increased domestic use of coal by coal-fired power stations and expected growth of coal imports in southern coastal provinces, due to the congestion and cost of transporting coal from the north to the south, will reduce China's net coal exports.

Given the size of the Chinese economy, the greater reliance of China on the international market to meet its energy needs has significant strategic implications for energy security. Not only could the degree of dependence on energy imports affect China's ability to sustain its economic growth, most of China's neighbours would also be affected as the region is becoming a net energy importer. Oil remains the single

most important fuel among energy sources for the region. A regional cooperation approach is required to achieve energy security. The degree to which that international energy market is stable, and the extent to which a liberal and transparent policy environment is developed to encourage trade and investment in energy and maximise access to the energy market worldwide are essential for energy security in China and neighbouring countries.

China has much to gain through further reforms at two levels: first, removal of policy distortions to increase energy efficiency, promote energy conservation, and bring about a more responsive energy supply system; second, further liberalisation of the energy trade and opening up the development of the energy sector to foreign participation with improved foreign investment incentives. Key reforms needed include changing oil price policy from controlled pricing to market-based pricing, increasing the power tariff to reflect economic cost, and removal of non-tariff barriers in energy trade. The benefits of such reforms would include reduced reliance on oil imports, acceleration of power capacity building, and fostering China's coal exporter position in the region.

A regional approach requires all countries in the region to lower trade and investment barriers in a cooperative manner. China's greater integration into the international market depends on the responsiveness of the rest of world. Careful management of trade interdependence is critical in building a stable trading framework. Restrictions on China's exports, the proceeds from which are used to pay for China's energy imports, would limit China's involvement in a regional approach to energy security and damage economic prosperity for all countries. Industrialised countries in the region have important roles to play. In particular, energy cooperation between China, Japan and US could be enormously important. The benefits to the three economic powers in the region are beyond energy security concerns as the pursuit of a common energy security interest in the region could serve to break the escalation of trade friction among the three economic giants.

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## Appendix

### **Country groups used in this paper**

#### East Asia

Brunei, China, Hong Kong, Indonesia, Japan, Kampuchea, Laos, Malaysia, Myanmar, North Korea, Papua New Guinea, Philippines, Singapore, South Korea, Taiwan, Thailand, Vietnam, Pacific Islands.

#### South Asia

Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, Sri Lanka

#### Asia Pacific developing

East Asia, excluding China and Japan.

#### Asia Pacific industrialised

Australia, Canada, Japan, New Zealand, USA.

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