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China:
Socialist Economic Development

(In Nine Volumes)

Annex E: The Energy Sector

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CURRENCY EQUIVALENTS

The Chinese currency is called Renminbi (RMB). It is denominated in yuan (Y). Each yuan is subdivided:

1 yuan = 10 jiao = 100 fen

Exchange rates used in this report are as follows:

1977	$1.00	=	Y 1.828
1978	$1.00	=	Y 1.661
1979	$1.00	=	Y 1.541

WEIGHTS AND MEASURES

Chinese statistics are usually in metric units; in addition, mu and jin are often used:

1 mu = 0.1647 acres = 0.0667 hectares (ha)

1 jin = 0.5 kg

FISCAL YEAR

January 1 - December 31

TRANSLITERATION

The Pinyin system is used in this report.

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CHINA: SOCIALIST ECONOMIC DEVELOPMENT

ANNEX E
THE ENERGY SECTOR

Table of Contents

Page No.

MAPS

LIST OF TABLES IN THE TEXT

Page No.

TABLES IN THE APPENDIX

Page No.

CHART

1. OVERVIEW

Energy Production and Consumption

1.01 China is the world's third largest consumer of commercial energy, following the USA and the USSR, and, at least at present, it produces more than it consumes. Production and consumption in 1979 are estimated at 649 million tons of coal equivalent (Mtce) and 621 Mtce, respectively. Consumption per capita, at about 644 kgce, was close to the average for developing countries in 1979 but it is high per dollar of estimated GNP (about 2.5 kgce); the corresponding averages for developing countries as defined in the World Bank's World Development Report, 1980 (WDR, 1980) are about 620 kgce/capita and 0.9 kgce/$. Industry /1 is the dominant energy consumer, accounting for 72% of the "commercial" total. Household and commercial uses consume about 14%, followed by agriculture /2 (6%) and transportation (5%).

1.02 Table 1.1 shows estimated commercial energy balances. Coal is the main source of energy: production in 1979 was about 635 million tons or 454 Mtce./3 Production of oil, the second largest source, was about 106 million tons or 155 Mtce. Natural gas production amounted to about 14.5 billion m^3 or 19 Mtce and hydroelectricity to 50 TWh (50 billion kWh) or 21 Mtce.

1.03 "Noncommercial" energy sources comprise mainly rice straw and other crop residues, firewood and animal wastes. Together they supplied 250 Mtce of energy (unofficial estimate), which is comparable on a per capita basis with estimates for other low-income, densely populated developing countries.

Importance in the Economy

1.04 The energy sector in China is important not only as a producer of essential products but also as a direct contributor to GNP, as a foreign exchange earner, and as a consumer of investment funds. The sector accounted for about 12% of the 1979 gross value of industrial output in

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/1 Including here mining, but excluding electricity generation, which is generally counted as part of industry in Chinese statistics.

/2 The data for agriculture include rural consumption of electricity in brigade industries, other sideline activities, and household and commercial uses; in oil, where agriculture is computed as a residual, they probably also include oil used in construction.

/3 Assuming, in the absence of an official estimate, that Chinese coal averages 5 million kcal per ton, compared with 7 million kcal per ton of "standard" coal or "coal equivalent."

Table 1.1: ENERGY BALANCES, 1979

	Coal	Oil	Natural gas	Electricity Hydro	Electricity Total	Total commercial energy	Noncommercial energy	Total
	(mn tons)		(bn m^3)	-- (TWh) --				
Primary Production	635	106	15	50	n.a.			
Net consumption	630	89	15	n.a.	282			
Power system	111	17	2	n.a.	43			
Industry	385	43	13	n.a.	184			
Transport	25	14	..	n.a.	1			
Agriculture and other	..	14	..	n.a.	38			
Domestic and commercial	109	1	..	n.a.	15			
Exports	5	17	..	n.a.	..			
	(Mtce)							
Primary production	454	155	19	21	n.a.	649	250	899
Net consumption	451	130	19	n.a.	119	621	250	871
Power system	71	25	2	n.a.	18	18	0	18
Industry	289	62	17	n.a.	78	446	n.a.	446
Transport	12	21	..	n.a.	1	34	n.a.	34
Agriculture and other	..	20	..	n.a.	16	36	n.a.	36
Domestic and commercial	79	2	..	n.a.	6	87	250	337
Exports	3	25	..	n.a.	..	28	-	28

Notes: Mtce defined as 7 million kcal. Calorific values assumed as follows:

Coal (overall)	5,000 kcal/kg
Coal (used in power plants)	4,476 kcal/kg
Coal (used in industry)	5,250 kcal/kg
Coal (used in railways)	3,370 kcal/kg
Coal (remaining)	5,090 kcal/kg
Crude oil and oil used in power plants and industry	10,200 kcal/kg
Oil used in other sectors & refined product exports	11,400 kcal/kg
Natural gas	9,310 kcal/m^3
Hydro and electricity	2,954 kcal/kWh

Double-counting of electricity and the primary energy forms from which it is produced has been avoided in arriving at totals. The power system's electricity consumption is composed of transmission losses (11 Mtce) and generating plant uses (7 Mtce). The contribution of thermal power plants with a capacity of under 6 MW (4.1 Mtce or 3.4% of total electric output) is assumed to be produced at the same heat rate as production from larger plants, using the same proportions of coal, oil, and natural gas.

Sources: Ministries of Coal Industry, Electric Power, Petroleum Industry, and Railways, and mission estimates.

1970 prices and invested an average of about $7-8 billion per year /1 in 1978/79, or nearly 3% of GNP. In other developing countries, investment in the energy sector is estimated to have averaged about 1.7% of GNP in 1980./2 The distribution of energy investments appears to differ from that of other developing countries, although the data may reflect differences in accounting practices as well as in substance. Electric power, for instance, absorbs only about 40-45% of sectoral investment,/3 in contrast with 75-80% in many other developing countries. Energy exports (virtually all oil exports) in 1980 appear to have been worth $4-5 billion (about 25% of total merchandise exports). Employment in the sector totals about 6 million workers, over 4 million of whom work in the coal industry.

Historic Growth Rates

1.05 From 1952 to 1975 energy production grew at about 10.5 % p.a., but in the last five years the growth rate has been only 5.6%. Total production actually declined by 1.3% in 1980 from the 1979 level (from about 649 to 641 Mtce). Output fell by 2.4% in coal, 0.2% in crude oil, and 1.7% in natural gas, while electricity output rose by 6.6%, with the help of a 16.1% increase in hydroelectric output./4 Table 1.2 shows key energy production growth rates for 1952-80.

/1 These numbers include petroleum refining. The investment figures are as reported by the ministries concerned and converted at Y 1.5 = $1.0. They may include more housing, social services and machine-supplying industrial investments, but less transportation infrastructure expenditure, than would be included in Western practice. Also, Chinese prices seem to exaggerate the value of industrial goods relative to GNP; but this might not be true on average in this case.

/2 Derived from World Bank, Energy in the Developing Countries, August 1980 estimate of investment and WDR, 1980 GNP estimates. The projections in these reports imply that energy investment in other developing countries will, however, need to be raised to 2.5%-3.0% of GNP by the late 1980s.

/3 Based on the total for electric power; petroleum exploration, development and refineries; and coal.

/4 See Annex D, "Challenges and Achievements in Industry," Table 1.2, and (for hydroelectric growth) this Annex, Tables A.1 and A.19.

Table 1.2 ENERGY PRODUCTION GROWTH RATES, 1952-80
(% p.a.)

Period	Electricity /a	Hydro	Coal	Oil /b	Natural gas	Total primary /c
1952-65	18.7	17.6	10.1	28.5	46.2	10.9
1965-70	11.4	14.5	8.8	22.1	20.9	10.6
1970-75	11.1	18.4	6.4	20.2	25.3	9.5
1975-80	8.9	4.1	5.2	6.6	10.0	5.6
1952-80	14.2	14.7	8.3	21.7	30.7	9.6

/a Hydro and thermal.
/b Includes shale oil.
/c Includes hydro but not thermal electricity.

Source: Table A.1

1.06 Coal production grew at an average annual rate of over 8% p.a. over the period, and yet fell in relative terms from over 97% of primary energy production in 1952 to 69% in 1980. Over the same period, oil production grew at an average rate of nearly 22% p.a. and moved from 1.3% to 24% of total primary production. Hydro and natural gas production also grew rapidly, but in 1980 these sources still contributed only 3.8% and 3%, respectively. Table 1.3 shows how the relative shares of the various sources of primary energy have evolved since 1952.

Table 1.3: COMPOSITION OF PRIMARY ENERGY PRODUCTION, 1952-80
(%)

	Coal	Oil	Natural gas	Hydro
1952	97.6	1.3	..	1.1
1957	95.7	2.2	0.1	2.0
1965	88.1	8.8	0.8	2.3
1970	81.6	14.4	1.2	2.8
1975	70.5	23.0	2.4	4.1
1980	69.1	24.1	3.0	3.8

Source: Table A.1.

Reserves

1.07 The known reserves of coal and hydroelectric potential are very large and should allow considerable expansion of production, while those for oil and gas development are quite limited in relation to current production rates. Coal and lignite reserves are estimated at about 600 billion tons (416,000 Mtce), while exploitable hydro potential is estimated at 1.9 trillion kWh/yr (81,000 Mtce). Our best but very uncertain estimates of known oil and gas reserves, based on the limited information available, are 1.8 billion tons (2,720 Mtce) and 130 billion m^3 (175 Mtce), respectively. Information on nuclear fuel reserves is not available. Table 1.4 shows the estimated distribution of coal, oil, gas and hydroelectric resources.

Table 1.4: REGIONAL DISTRIBUTION OF RESERVES
(Mtce)

Region	Recoverable coal and lignite	Exploitable hydro-electric	Recoverable oil	Recoverable gas	Total
Northeast	13,500	1,600	1,095	33	16,200
North	273,900	1,000	570	7	275,500
Subtotal	287,400	2,600	1,665	40	291,700
East	29,100	2,900	375	18	32,400
Central-South	15,600	12,600	120	3	28,300
Subtotal	44,700	15,500	495	21	60,700
Northwest	39,000	8,000	540	20	47,600
Southwest	45,000	55,100	20	94	100,200
Subtotal	84,000	63,100	560	114	147,800
Total	416,100	81,200	2,720	175	500,200

Notes: Coal is assumed to average 5 million kcal/ton and lignite 3.33 million kcal/ton. Hydro reservoir life is assumed as 100 years. Shale is not included.

Sources: Tables 2.1, 3.4 and A.24.

1.08 Geographical considerations inhibit the development of many of these resources. While coal resources are widespread, the largest and richest deposits are concentrated in the north. This results in a need to balance the higher cost of mining the lower grade coal generally found in the south against the transportation costs involved in supplying southern markets from northern mines. Some 70% of the hydroelectric potential is in the southwest region, principally Xizang (Tibet), 2,000 km from the major Chinese markets. In the petroleum subsector, about 75% of the proven reserves are in fields in the northeast or within about 200 km of the Bo Hai; these fields are linked to markets as far south as Nanjing by pipeline. Exploration for and development of reserves in the northwest has been much less thorough due to transportation and logistical problems. The current geographic distribution of coal and oil production is illustrated in the maps at the end of this Annex: IBRD 15627R and 15628R.

Technology

1.09 Oil production has decelerated in recent years, in part because of the out-of-date technology used and the modest rate of discovery. Use of equipment and techniques considered out of date in many other countries is also apparent in the coal and electricity subsectors; while this may increase costs, it does not appear to hold back production as much as in the oil industry.

1.10 In some areas, however, China has developed a technological lead. One is the extraction of oil from shale, for which a simple and effective technique is in use on a significant scale. Another is biogas, which has been developed on a scale unparalleled elsewhere - some 7 million digestors, each capable of meeting the cooking and lighting needs of a household of 5 people, were reported to have been built by 1979. Yet another may be small-scale hydroelectric power plants, which in rural areas have the advantages of faster construction, low demands on trained manpower, and modest transmission costs; some 90,000 (with an average capacity of about 80 kW) are estimated to be in operation, and the numbers and capacity are being rapidly expanded.

Institutions

1.11 Fragmentation of responsibilities may impede the development and implementation of coherent policies in the sector. The institutions primarily concerned with commercial energy are the Ministries of Coal Industry, Petroleum Industry and Electric Power, and the Energy Commission recently created to coordinate their activities./1 Except for this new commission,

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/1 Energy ministries have been alternately consolidated and fragmented throughout the last 30 years. Coal and petroleum were under the same ministry as recently as 1975. The most recent changes have been the separation of the Ministry of Chemical Industry from that of Petroleum Industry (1978), and of Water Conservancy from that of Electric Power (1979), and the creation of the Energy Commission (1980).

their activities are generally confined to energy supply. Allocation and pricing of energy are the responsibilities of state and lower level economic commissions, materials distribution bureaus, and pricing bureaus.

1.12 The respective roles of the central ministries vis-a-vis provincial and local authorities vary among the three principal subsectors. Petroleum is the most centralized, with all onshore oil and gas fields controlled from Beijing by the Ministry of Petroleum Industry. By contrast, roughly 40% of coal is produced by small mines controlled at or below the provincial level, and even large mines report both to the Ministry of Coal Industry and the provincial government. For electric power, five regional grids come under the direct supervision of the Ministry of Electric Power, while other systems are under the dual control of the provincial government and the Ministry.

1.13 Other ministries also play important roles in the sector. The Ministry of Railways handles about two thirds of the coal and most of the refined petroleum production; conversely, coal and oil together account for over 40% of the total tonnage carried by rail. Large volumes of coal and oil are also moved via coastal and inland waterways by ships operated by the Ministry of Communications. The Ministry of Chemical Industry operates a number of refineries, which produce a considerable volume of fuels as well as petrochemical feedstocks. The Ministry of Water Conservancy has a role in water management and, thus, hydro development. The Ministry of Geology is active in the surveying of mineral resources, and some of its activities seem to overlap or compete with those of the Ministries of Coal and Petroleum Industry. While the three energy producing ministries manufacture much of their own equipment, some equipment is also bought from the Ministries of Machine Building or imported via the Ministry of Foreign Trade, which also handles oil and coal exports.

Investment Planning

1.14 The investment planning system and project design and evaluation criteria used in the energy sector appear to vary somewhat among ministries and provinces. The task of obtaining information on planning procedures and criteria was further complicated by the present process of reform, which has so far affected some aspects more than others. The description below attempts to summarize the situation in 1980, but may be oversimplified; further changes are likely as economic reforms are instituted.

1.15 The main focus of investment planning in the coal and oil industries is the annual plan. Some longer term plans, covering 5-10 year periods, are used in formulating the annual plans and others are being prepared, but they seem to be the exception. The basic administrative unit in the planning system is the bureau or administration responsible for an individual coal mine or oil field or, in some cases, for a group of mines or fields located near one another and managed as a unit. Proposals for projects are prepared at this level and, if they exceed a specified size, submitted to a higher authority (provincial coal bureau or the Ministry of Petroleum Industry) in the fall of the year preceding proposed implementation. A geological report and preliminary project design would generally (in the case of coal) or sometimes (in the case of petroleum) have been approved earlier, so processing of the annual plan is concerned primarily with allocations of budgetary resources and key construction materials.

1.16 In the electric power industry, five-year plans are in general use. They cover individual grids and are developed by the respective regional and provincial power bureaus. Major projects are subject to approval by the Ministry of Electric Power and the State Planning Commission (SPC). The process is a two-stage one, with an initial approval required for detailed design work and a second approval required to implement a project. Project selection is based on "payback" periods rather than present worth analysis. Also, the concept of the least-cost sequence of projects for developing the entire system over a period of time is not applied.

1.17 The function of "balancing" resource availability against project proposals is carried out within the three energy supply industries by the respective ministries, and across sectors by the State Planning and Capital Construction Commissions./1 Only a few months (in some cases, a few weeks) are allowed for this process, and as the Energy Bureau of the SPC has only about 30 professional staff, it seems unlikely that detailed analysis can be made of a large number of alternatives.

1.18 With such a planning system, problems are likely to arise from the limited time horizon, the few alternatives considered, and the limited geographic and jurisdictional scope of most planning work. Focusing attention primarily on annual planning can produce two kinds of problems. First, it may result in use of short-term expedients, such as neglect of tunnelling and other development work in coal mines and excessively rapid depletion of oil reserves. This appears to have happened to a certain extent. Second, in investment programs, the preoccupation with current output may lead to a focus on current investment levels, but little concern about channeling investment into projects that will yield benefits earlier rather than later. This seems to be reflected in long construction periods and in the very long production lives planned for many mines.

1.19 The isolation of planning within ministries, the limited number of alternative studies and the short time allowed central authorities to determine the best combination of investment projects must often result in failure to study adequately solutions to problems that cross the lines of geographical or ministerial jurisdictions. The creation of the Energy Commission can be expected to improve this situation in some respects, e.g. coordination of coal and electric power planning. Other closely related sectors, such as railways and chemical industries, however, do not come under this commission, and analytical methods that link sectoral plans across jurisdictional lines do not seem to be in general use. It would, of course, be useful to link

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/1 The Energy Commission will presumably become an intermediate step.

railway planning with the planning for coal and for highways, and to link chemical industry planning with petroleum and agricultural planning, but without putting all these sectors under the same commission. Shadow prices, i.e. estimates of the value to the economy of key commodities such as capital, foreign exchange, and fuel that are used to provide a consistent basis for planning in all sectors (but not in financial accounting), could be used to provide the needed intersectoral links in planning.

1.20 The choices among projects and of technical design and operating standards for projects would also seem to offer scope for raising outputs and lowering costs. The mission visited, for example, a number of installations with what appeared to be an excessive amount of underutilized and stand-by equipment. Improving performance in this area may require less fundamental changes than those required to implement comprehensive sector planning. Aspects of project selection and design that may merit attention include:

(a) generation of an inventory of investigated projects and project design alternatives that is sufficiently large to allow selection of the most economically attractive alternatives;

(b) the computation of economic indices (such as net present value, benefit-cost ratio, or internal rate of return) that can assist in the allocation of scarce resources to their most productive use;

(c) comparison of costs and benefits under a variety of project design alternatives and equipment types; and

(d) the balance made by project designers between operating reliability and return per unit of invested resources.

Pricing

1.21 Despite recent (1979) rises in natural gas and coal prices to non-household users (25% for gas, 29% for coal), the prices of several forms of energy - including fuel oil, coal, crude oil and industrial electricity - are at the official exchange rate still well below international prices (Table 1.5). Equally important, the current relative prices of different forms of energy are inappropriate - for example, encouraging the use of heavy oil rather than coal for fuel. However, prices of a few energy produces - gasoline, kerosene and electricity for household lighting - are now above international trade prices.

Table 1.5: PRICE COMPARISONS

	Unit	Average Chinese price	Price in international trade
Coal (7,000 kcal/kg)	$/ton	19-33/a	41/a
Crude oil	$/ton	90	250
Gasoline, 70 oct.	$/ton	533	310/b
Kerosene	$/ton	453	360/b
Diesel fuel	$/ton	280	320/b
Heavy fuel oil	$/ton	37	220
Electricity	¢/kWh	4.3	5.2/c
Average household lighting	¢/kWh	10-13	5.2/c
Average heavy industry	¢/kWh	4.0	5.2/c

/a The Chinese price is ex-mine, while the international price is f.o.b. Australia.
/b Retail prices in many countries are much higher than this due primarily to excise taxes.
/c Estimated cost of electricity from large, coal-fired plants with 1980 investment and fuel costs. Tariffs in many countries are considerably lower than this.

Note: Average prices were only available for the principal petroleum products and for electricity; from indirect indications, crude oil is priced at Y 135/ton and coal at Y 35/ton (raw, equivalent to Y 49/ton of standard coal, at the mine mouth). Chinese prices were converted at Y 1.5 = $1.0.

Sources: Ministries of Petroleum Industry and Electric Power, and mission estimates.

1.22 The extent to which these prices affect the level or composition of energy supply and demand is not clear, however, as fuels and electricity are distributed through a system of administrative allocation. The general use of low-octane gasoline rather than diesel in trucks apparently reflects the availability of these fuels and of trucks with the two types of engines rather than the relative fuel prices. Similarly, the substantial use of crude oil as a fuel goes against a price disadvantage of more than 2:1 in favor of fuel oil. Nor is the low rate of refinery utilization (about 82%) directly explainable by the oil price structure; in spite of the low fuel oil price, refining operations appear highly profitable (Y 1.0 of crude oil is refined into about Y 2.6 of products)./1

1.23 The setting of prices appears to be separated from annual economic plan management or investment planning. While no explicit statement of price-setting principles was given, the history and structure of prices indicate that price stability is given a high priority; that the accounting cost of domestic production is given greater weight in price setting than the opportunity cost in overseas markets; that wide profit margins are built into prices of products for use outside of the industrial sector, while this is less true for the intermediate products consumed primarily by industry; and that some effort is made to achieve geographic uniformity of prices.

1.24 Energy pricing appears to be used in China primarily to generate and distribute revenues rather than to influence supply and demand. Data are not directly available on the value of energy producton and conversion in current prices, but in 1970 prices, gross output in 1979 was as follows:/2

Production:	Coal	Y 11.6 bln
	Oil & gas	2.8
	Hydroelectricity	3.2
	Subtotal	24.6
Conversion:	Oil refining	15.2
	Thermal elec. generation	14.5
	Subtotal	29.7

Based on the prices shown on Table 1.5, revenues from coal, oil and gas would now be considerably higher, while those from electricity would be slightly lower than this, for an overall total in the order of Y 60 billion. Little is known about the distribution of these revenues. The sector's annual wage bill appears to fall somewhat short of Y 5 billion. Investment from the state capital construction budget averaged about Y 11 billion p.a. in 1978 and 1979. Some fraction of the remainder pays for material current inputs to operations, but the bulk is presumably remitted as taxes and profits to the provincial and national governments.

/1 There may be an indirect link, however; the profitability of refineries may have prompted the construction of much capacity in locations where it cannot now be used because of transport bottlenecks. Alternatively, the Ministry of Foreign Trade may prefer exporting crude oil, which is much cheaper internally than externally, though it also exports gasoline and middle distillates, which it buys at prices well above their export values.

/2 Based on Annex D, Table 1.4, with electricity divided in proportion to 1979 production (17.8% hydro and 82.2% thermal).

Energy Consumption in Relation to GNP

1.25 China's per capita consumption of commercial energy is about 3-1/2 times the average of other low-income developing countries, one third short of the middle-income average, or 25-30% above the average of all developing countries. This level of consumption of commercial energy is very high in relation to economic activity: about 2.5 times as much per unit of GNP as the average for other developing countries (Table 1.6) or for industrialized market economies, and about 1-1/2 times the average for other centrally planned economies.

Table 1.6: ENERGY INTENSITY OF MAJOR DEVELOPING COUNTRY ECONOMIES, 1978
(Kgce commercial energy consumption per $ GNP)

China (1979)/a	2.5
Bangladesh	0.5
Ethiopia	0.2
Burma	0.5
Viet Nam	0.7
India	1.1
Pakistan	0.9
Indonesia	1.2
All low-income countries /b	(1.0)
Egypt	1.4
Thailand	0.8
Philippines	0.7
Nigeria	0.2
Korea, Rep. of	1.3
Turkey	0.7
Mexico	1.1
Brazil	0.6
Spain	0.8
All middle-income countries /b	(0.9)
All developing countries except China /b	(1.0)

/a Based on 1979 estimates of 621 Mtce, $260/capita and 965 million people at mid-year; 1978 ratio was probably slightly higher.

/b Country groups as defined in World Bank, WDR, 1980.

Note: The countries listed have a population of 30 million or more. The listing of countries other than China is in ascending order by estimated GNP per capita.

Sources: Energy consumption data from World Bank, Economic Analysis and Projections Department Data Base. Population and per capita GNP data from World Bank, World Economic and Social Indicators, October 1980.

1.26 Our present knowledge allows only a tentative analysis of the apparently very high rate of energy consumption to GNP. The low share of liquid fuels and electricity and the high share of coal may force consumers to use coal-fired technologies, which often have a low energy efficiency. It may be noted, for instance, that the energy-intensive East European economies also rely heavily on coal. The example of India, however, which approaches China in dependence on coal (60% of consumption, as compared with China's 72%), suggests that this is not an important part of the explanation, inasmuch as India's energy consumption is about 1.0 kgce per $ of GNP (1979), while China's is about 2.5 kgce/$ (or 2.2 kgce/$ if coal used in households is excluded to adjust for the generally harsher climate). China's per capita consumption of motor fuels and electricity combined is almost double that of Indonesia or India,/1 so the Chinese economy does not seem to be short of premium energy forms relative to other countries at its income level.

1.27 Since industry (particularly heavy industry) is generally more energy intensive than other sectors, part of the reason for China's higher energy consumption is probably the higher shares of industry in total output and of heavy industry (which accounts for four fifths of all industrial electricity consumption) in industrial output. But when allowance is made for the unusual internal price structure in China, the share of industry in GDP, though about 10 percentage points above the average for other low-income countries, is probably close to the average for middle-income countries. A comparison with India shows that while China's industrial sector is about roughly three to four times larger (in tons of steel, basic chemicals and cement, as well as in its contribution to GDP),/2 it consumes about six times as much energy. Similarly, China's energy-to-GDP ratio is well above that of middle-income countries with large heavy industry sectors such as the Republic of Korea (1.1 kgce/$ in 1979) and Turkey (0.6 kgce/$), despite lower urbanization and less energy-intensive agriculture.

1.28 Thus, the macroeconomic data (buttressed by a variety of microeconomic evidence) suggest that China uses energy - especially in industry - a good deal less efficiently than other developing countries. One underlying reason has been inadequate access to foreign equipment (and know-how), which embodies the substantial progress made in fuel-saving techniques over the past three or four decades. More important, however, has been the lack of incentives to economize on energy: as with other materials, enterprise managers until very recently have had little reason to limit the energy use of their equipment, or to demand new and more fuel-efficient models from their suppliers - who in turn have been under little pressure to undertake appropriate

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/1 Comparison refers to combined consumption of motor diesel, gasoline, and electricity, with electricity counted at 270 g/kWh.

/2 See Annex D, Tables 1.5 and 1.6.

research and innovations. This situation is now changing; and major energy savings were recorded in 1979 and 1980./1

Prospects

1.29 Official projections are not available for most of the variables involved in estimating future energy production-consumption balances. However, the information available indicates that China may well be a net importer of oil by 1990, and that slow-growing energy supplies will be the most serious constraint on China's growth rate in the 1980s. This situation (discussed in its broader context in Chapter 6 of the Main Report) can be better understood with the help of quantitative estimates designed to indicate the magnitude of the potential problem and its sensitivity to alternative policies and conditions. In the paragraphs that follow, four alternative cases or sets of assumptions are presented, one for each of the possible combinations of two alternative sets of estimates of economic growth rates and of coefficients measuring the effectiveness of energy conservation efforts. At least one of these cases implies coal and oil imports at levels beyond the capacity of the ports and other infrastructure involved and total imports at unaffordable levels. While not plausible as predictions, these cases nonetheless illustrate that certain combinations of planning targets, which may be reasonable taken individually, may be unworkable. More generally, the scenarios help to show the potential contribution of energy saving to China's growth and trade prospects in the 1980s.

1.30 Depending on the scenario chosen, the balance of trade in energy deteriorates from net exports valued at about $4.7 billion in 1980 to, in the best case from the point of view of minimizing energy consumption, exports of about $4 billion in 1985 and $2.3 billion in 1990 (in 1980 dollars). Two other cases have net imports of $3.7-4.7 billion in 1990, while the worst case has net imports already in 1985 and impossible import levels in 1990./2 Table 1.7 summarizes the results of the four cases in terms of the 1985 and 1990 energy trade balance, while Table 1.8 shows much of the detail. The assumptions and methodology used are described below.

1.31 The prospect of a deterioration in the energy trade balance is largely the result of declining oil production and continued growth of demand. The oil production level of 104-106 million tons p.a. reached in 1978 and maintained through 1979 and 1980 appears to represent at least a temporary peak. In the projections, production is assumed to drop to 100 million tons by 1985 and 95 million tons in 1990. The latter level, especially, is very uncertain (paras. 3.12-3.15).

/1 See Annex D, para. 3.13.

/2 Figures are in 1980 dollars, but with prices adjusted for expected real price increases.

Table 1.7: ALTERNATIVE ESTIMATES OF 1985 AND 1990 OIL AND COAL BALANCES

	Moderate growth scenarios				Faster growth scenarios			
	Mod. savings		High savings		Mod. savings		High savings	
	1985	1990	1985	1990	1985	1990	1985	1990
Quantity (million tons)								
Coal	20/a	16	20/a	40/a	(21)	(108)/b	20/a	19
Oil	1.3	(16.9)	11.3	1.1	(3.8)	(32.1)/b	6.5	(13.9)
Value ($ billion)/c								
Coal	0.8	0.8	0.8	1.9	(0.8)	(5.1)/b	0.8	0.9
Oil	0.4	(5.5)	3.2	0.4	(1.1)	(10.5)	1.8	(4.6)
Total	1.2	(4.7)	4.0	2.3	(1.9)	(15.6)	2.6	(3.7)

* Negative balances in parentheses.

/a Assumed to be constrained by port facilities.

/b Believed to be infeasible due to foreign exchange and transport bottlenecks.

/c Average "real" prices in 1980 dollars assumed to be: $280/ton and $328/ton for oil, and $40/ton and $47/ton for coal, in 1985 and 1990, respectively.

Sources: Table 1.8 and staff estimates.

Table 1.8: CONSTRUCTION OF 1985 AND 1990 OIL AND COAL BALANCE ESTIMATES

	Base year	Moderate growth scenarios				Faster growth scenarios			
		Moderate savings		High savings		Moderate savings		High savings	
	1980	1985	1990	1985	1990	1985	1990	1985	1990
Oil Balance (mln tons)									
Power generation	16.5	12.5	8.5	10.5	4.5	12.5	8.5	10.5	4.5
Other heavy industry	27.5	27.7	32.3	24.5	26.9	29.5	36.0	26.2	30.9
Light industry	8.0	10.7	14.3	10.1	12.7	11.2	16.4	10.6	14.7
Transportation	14.0	19.5	28.0	19.2	26.8	21.2	34.2	20.8	33.1
Agriculture and construction	15.0	18.5	22.6	18.3	22.0	19.1	24.4	18.9	23.6
Interfuel substitution outside power	0.0	0.0	-4.0	-2.0	-6.0	0.0	-4.0	-2.0	-6.0
Refining losses	8.0	9.8	10.2	8.1	7.0	10.3	11.6	8.5	8.1
Total consumption	89.0	98.7	111.9	88.7	93.9	103.8	127.1	93.5	108.9
Production	106.0	100.0	95.0	100.0	95.0	100.0	95.0	100.0	95.0
Net exports (imports)	17.0	1.3	(16.9)	11.3	1.1	(3.8)	(32.1)/a	6.5	(13.9)
Coal Balance (mln tons)									
Power generation	117	157	220	154	209	171	256	162	233
Other heavy industry	305	307	358	272	299	327	408	290	342
Light industry	65	87	116	82	104	91	133	86	119
Transportation	25	29	33	28	32	29	36	29	35
Household and commercial	107	124	146	117	122	130	164	123	137
Interfuel substitution outside power	0	3/b	11/b	7/b	15/b	3/b	11/b	7/b	15/b
Total consumption	619/c	707	884	660	781	750	1,008	697	881
Production	606	727/d	900	680/d	821/d	730	900	717/d	900
Net exports (imports)	6	20/d	16	20/d	40/d	(20)	(108)/a	20/d	19
Electricity Consumption (bln kWh)									
Electric power system	45.0	53.4	67.2	50.0	59.4	56.2	75.5	51.6	64.4
Other heavy industry	160.0	181.0	231.0	174.7	213.3	194.7	266.8	184.3	238.9
Light industry	48.0	73.1	105.2	69.3	95.1	77.3	124.5	72.8	110.4
Agriculture	27.0	34.7	45.8	33.9	43.6	36.1	49.7	35.1	47.0
Services and households	20.6	26.2	35.0	25.2	32.2	26.9	37.9	25.7	34.3
Total consumption	300.6	368.4	484.2	353.1	443.6	391.2/e	554.4	369.5	495.0
Hydro production	58.2	75.0	104.0	75.0	93.9	75.0	115.8	75.0	106.4
Natural Gas Production/Consumption (bln cu m)	14.3	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0
Overall Balance (Mtce)									
Primary energy production	640.9	712.6	841.0	677.5	779.6	714.8	846.1	705.5	842.2
Consumption	615.4	696.4	854.3	646.7	750.3	735.3	970.0	681.7	848.8
Net exports (imports)	25.5/c	16.2	(13.3)	30.8	29.3	(20.5)	(123.9)/a	23.8	(6.6)

/a Believed infeasible due to constraints on foreign exchange and transport facilities.

/b Includes 3 million tons as replacement for natural gas.

/c Assumed to include 5 million tons (2.9 Mtce) taken from stocks.

/d Assumed to be constrained by available port facilities.

/e Probably infeasible due to constraints on electrical generation, transmission, and distribution facilities.

1.32 The energy demand projections are derived from estimates of the growth rates of the principal energy-consuming sectors of the economy and coefficients representing energy consumption per unit of output in each sector. In some cases, different coefficients are applied to "base" levels of output (equal to 1980 levels) and to incremental output in the 1980-85 and 1985-90 periods. In the two industrial sectors (heavy and light), the same coefficients are applied to oil and coal consumption; interfuel (coal for oil) substitution is estimated separately. Estimates of electric power system fuel consumption and refining losses are derived after estimating final demand for electricity and refined petroleum products.

1.33 The selection of "sectors" among which total demand is divided varies somewhat according to the energy form. Thus transportation is treated as a separate sector for estimating coal and oil demand, but not for electricity demand./1

1.34 The two sets of economic growth projections are labelled "moderate" and "faster." Under the moderate growth scenarios, GDP grows at 4% p.a. from 1980 to 1985 and 5% p.a. from 1985 to 1990. GDP growth under the faster growth scenarios is 5% in 1980-85 and 6% in 1985-90. Growth rates over the two five-year periods by sector are shown in the following page.

/1 The sectoral division used is as follows:

Oil demand	Coal demand	Electricity demand
Heavy industry /a	Heavy industry /a	Heavy industry /a
Light industry	Light industry	Light industry
Transportation	Transportation	Agriculture
Agriculture and construction	Household and commercial	Services and households
Power generation	Power generation	Power system use and losses
Refining losses		

/a Exclusive of electricity generation and (in oil) petroleum refining.

The 1980 energy balances, compared to those for 1979 on Table 1.1, transfer some of the agricultural demand for electricity to industrial or household uses. Guesswork is used for other changes from 1979 to 1980. The results are merely intended to illustrate the orders of magnitude involved.

	Moderate growth		Faster growth	
	1980-85	1985-90	1980-85	1985-90
	------ Growth rates (% p.a.) --------			
Heavy industry	2.5	5.0	4.0	6.5
Light industry	7.0	6.0	8.0	8.0
Agriculture	3.0	3.0	3.5	3.5
Services and other	4.5	5.5	5.0	6.5
Total GDP /a	4.0	5.0	5.0	6.0

/a Rounded to nearest 0.5.

1.35 In most sectors the underlying demand (adjusting for efficiency improvements) is assumed to grow at the same rate as the corresponding component of GDP. In some sectors, however, different growth rates are used. Thus, the underlying demand for oil in agriculture and construction is assumed to grow at 1.5 times the annual rate of agricultural output. The underlying demands for oil and coal in transportation are assumed to grow at 1.8 and 0.7 times the GDP growth rate, respectively. These coefficients represent increased mechanization and use of irrigation in agriculture and increasing use of trucks and diesel railway locomotives. The underlying demand for coal for household and commercial use is assumed to grow at the same rate as GDP. (However, the electricity demand of the services and household sector is assumed to grow at the same rate as the "services and other" component of GDP.) Where they differ from sectoral growth rates, these derived growth rates are as follows:

	Slow growth		Faster growth	
	1980-85	1985-90	1980-85	1985-90
	------ Growth rates (% p.a.) --------			
Oil/agriculture and construction	4.50	4.50	5.25	5.25
Oil/transportation	7.20	9.00	9.00	10.80
Coal/transportation	2.80	3.50	3.50	4.20
Coal/household and commercial	4.00	5.00	5.00	6.00

1.36 Conservation of oil and coal in the final demand sectors (refinery and power system requirements are handled separately) is reflected in coefficients relating demand for each fuel per unit of output in each sector to "base" (1980 level) output and to the increments added to annual output over the 1980-85 and 1985-90 periods. The coefficients assumed for unit fuel consumption on "base" output reflect improvements in existing plant and the shifting of production from less efficient to more efficient plants and are as follows:

	Moderate savings		High savings	
	1985	1990	1985	1990
Heavy industry	0.90	0.85	0.80	0.70
Light industry	0.95	0.95	0.90	0.85
Household and commercial	0.95	0.90	0.90	0.75
Others	1.00	1.00	1.00	1.00

1.37 The coefficients for unit fuel consumption on incremental output are generally lower (i.e. energy savings are greater at the margin), reflecting the assumption that greater efficiency can be more easily achieved by introducing new equipment (or expanding output from selected existing equipment) than by upgrading the energy efficiency of existing equipment. In light industry and in the household and commercial sector, however, the coefficients shown above for base year output are also applied in 1985 and 1990 to all output, including increments between 1980 and 1985. In other cases, the amount of energy use associated with the 1980-85 increment in output remains the same in 1990 and in 1985. The coefficients used are as follows:

	Moderate savings		High savings	
	1980-85	1985-90	1980-85	1985-90
Heavy industry	0.80	0.70	0.70	0.60
Transportation	0.95	0.90	0.90	0.80
Agriculture and construction	0.95	0.90	0.90	0.80

1.38 In electric power demand, the assumptions used imply few major savings possibilities, except in power transmission and possibly in other heavy industry (where metallurgy and chemicals are the principal users). Elsewhere, modernization of China's economy is expected to result in gradually higher ratios of electricity consumption per unit of output, despite efforts to economize. This is consistent with 1977-79 experience. The coefficient of electricity usage per unit of "base" output is 1.00 in all sectors./1 The coefficients on incremental output are as follows:

	Moderate savings		High savings	
	1980-85	1985-90	1980-85	1985-90
Power system losses	0.9	0.8	0.6	0.7
Heavy industry	1.0	1.0	0.7	0.8
Light industry	1.3	1.3	1.1	1.1
Agriculture	1.8	2.0	1.6	1.8
Services and households	1.1	1.1	0.9	0.9

1.39 Interfuel substitution outside of the power sector is accounted for separately./2 In all scenarios, and in both 1985 and 1990, we assume that 3 million tons of coal will be needed to make up for a decline in production of natural gas. Additional coal will be used to substitute for oil; we assume the amounts involved (in millions of tons p.a.) are as follows:

	Oil consumption		Coal consumption	
Scenario	1985	1990	1985	1990
Moderate savings	0	-4	0	+8
High savings	-2	-6	+4	+12

/1 However, once the 1985 demand for electricity has been computed for each sector and scenario, these figures become the new base for computing demand in 1990. To illustrate this method of calculation, if a sector uses 200 units of electricity in 1980, its output grows by 50% in 1980-85, and its incremental coefficient is 1.2, its incremental output in 1980-85 will require 120 units of electricity (50% of 200 = 100 x 1.2); thus it will require a total of 320 units in 1985. If its output then grows by another 50% from 1985-90 while its incremental coefficient rises to 1.5, its demand for electricity will grow by 240 units (50% of 320 = 160 x 1.5), to 560 units in 1990. The growth of demand in the power system, used in computing incremental power system losses, is calculated based on electricity demand growth in the other (user) sectors combined.

/2 See para. 1.41 regarding substitution in the power sector.

1.40 Energy consumption in the final demand sectors, computed according to the assumptions discussed above, is used for projecting consumption in the energy transformation industries, oil refining and electric power. Oil refining losses are estimated as a fraction of the final demand for oil after refining. In the moderate energy savings scenario, the figures used are 11% in 1985 and 10% in 1990. In the high savings scenarios, they are 10% in 1985 and 8% in 1990. By comparison, the equivalent ratio for oil actually refined in 1979 is assumed (Table 3.1) to have been about 11.8%./1

1.41 In estimating fuel consumption in electric power production, it is assumed that the use of oil-fired plants will be reduced, as follows:

	Base	Moderate savings		High savings	
	1980	1985	1990	1985	1990
Net change (mln tons)	n.a.	-4.0	-8.0	-6.0	-12.0
Oil used (mln tons)	16.5	12.5	8.5	10.5	4.5
Electricity produced (Twh)	57.0	43.1	29.3	36.2	15.6

1.42 Hydroelectric power is assumed to supply 25% of incremental demand for electricity in each five-year period after 1980, except that an upper limit of 75 Twh (billion kWh) is assumed for hydroelectric capacity that can be built by 1985; i.e., a 16.8 Twh increase from 1980-85.

1.43 In all scenarios, all other incremental demand for electricity after 1985, both to substitute for oil and to supplement hydro output, is assumed to be met by additional use of coal, with 0.62 tons of coal required for each Twh. This represents roughly a 10% energy saving at the margin, compared to the 1979 ratio of about .68-.69 tons required per Twh.

1.44 As an alternative method of presentation, Table 1.9 summarizes the energy savings and switching assumptions applying to coal and oil. Here the energy conservation effects in most sectors are expressed as percentage savings compared to base year ratios of energy consumption.

/1 The actual ratio of refining losses to consumption in 1979 is estimated (Tables 1.1 and 3.1) at about 10%; but the projected rates imply improvements in refining efficiency, because in 1980 China burned a great deal of unrefined crude oil. Note also that the projected demand for oil in sectors that consume primarily light products (transportation, agriculture, and construction) is rising faster than the demand for heavy fuel oil, implying a need for more cracking and refining per ton in the future.

Table 1.9: SUMMARY TABLE OF ENERGY SAVING AND SWITCHING ASSUMPTIONS FOR OIL AND COAL IN THE MODERATE AND HIGH ENERGY SAVINGS SCENARIOS /a

	Moderate savings scenarios		High savings scenario	
	1985	1990	1985	1990
Base year power generation switched from oil to coal (million tons)	4	8	6	12
Other fuel use switched from oil to coal (million tons, net of switches to feedstock use)	0	4	2	6
Energy savings on 1980 base output in heavy industry	10%	15%	20%	30%
Energy savings on incremental output in heavy industry /b	20%	30%	30%	40%
Energy savings on base and incremental output in light industry	5%	5%	10%	15%
Energy savings (in coal) on base and incremental household and commercial demand /c	5%	10%	10%	25%
Energy savings on incremental demand in transportation, agriculture and construction /d	5%	10%	10%	20%
Refining loss as a percentage of oil consumption after refining	11%	10%	10%	8%

/a Not shown is the requirement for coal in power generation, which is assumed in all cases to be 0.62 million tons of coal for each billion kWh of added power based on coal.

/b Percentage reductions compared to 1980 ratios of energy use per unit of output, applied to the increment of the last five years. As an example, in projecting energy demand in heavy industry in 1990, in the moderate savings case, the ratio needed to produce the base amount is reduced by 15%, the ratio to produce the 1980-85 increment is reduced by 20% (with no further reduction after 1985), and the ratio to produce the 1985-90 increment is reduced by 30%, compared to the base ratio.

/c This demand is assumed to grow at the same rate as GDP.

/d Incremental demand projected as in heavy industry but with no reductions in the requirement to produce the 1980 base output. Demand for oil in transportation is assumed to grow at 1.8 times the rate (in % p.a.) of GDP growth (so that 5% GDP growth requires 9% transport growth using oil); demand for oil in agriculture and construction is assumed to grow at 1.5 times the rate (in % p.a.) of agricultural growth; demand for coal in transportation is assumed to grow at 0.7 times the rate (in % p.a.) of GDP growth.

1.45 In the four scenarios considered (Table 1.8), the total consumption of energy, including natural gas and hydroelectricity, would rise from the 1980 level of 615 Mtce to between 677 and 735 Mtce in 1985. One scenario (moderate savings combined with faster growth) would require a physically unattainable 970 Mtce in 1990, implying net imports of 124 Mtce; while requirements in 1990 in the other scenarios would range from 750 to 853 Mtce.

1.46 The stringency of the conservation effort required to satisfy demand levels of the high savings cases is apparent from the implied growth rates of energy demand, compared to growth of GDP (Table 1.10). For the decade as a whole, energy consumption would grow at rates 2.2% to 2.4% p.a. less than GDP, and energy use per unit of final output would be required to fall by about 20% (i.e. at an average rate of 2.2% to 2.3% p.a.). Even larger reductions would be required in the use of oil per unit of final output - by about 30% over the decade (at rates averaging 3.4% to 3.8% p.a.). Thus the share of oil in total energy consumption would be reduced from 21.1% in 1980 to roughly 18.5% in 1990.

1.47 These numbers, though only illustrative, indicate that providing the energy needed to sustain even a 4-5% p.a. economic growth rate over the coming decade will require a coordinated program of investments involving energy consumers and transportation infrastructure, as well as energy production./1 Oil production prospects, especially at Daqing, the largest field, can be improved by investment in reservoir engineering and the equipment and training needed to implement it effectively. Investment in coal and electricity generation, as well as in related transportation and transmission facilities, will need to be accelerated if energy is to be available in the quantities and forms needed as alternatives to oil. Energy consumption in general and oil consumption in particular need to be restrained. To obtain the required level of conservation in the time required, control through the central allocation of investment resources and fuels may need to be supplemented by adjusting the incentives facing provincial, local, and enterprise officials and workers.

/1 How to do this is discussed in detail in Annex D, paras. 5.05-5.14, and in Chapter 6 of the Main Report.

Table 1.10: LEVELS OF CONSERVATION IMPLIED IN DEMAND PROJECTIONS

		Moderate growth scenarios		Faster growth scenarios	
		Moderate savings	High savings	Moderate savings	High savings
Energy consumption (Mtce)	1980	615.4	615.4	615.4	615.4
	1985	696.4	646.7	735.3	681.7
	1990	854.3	750.3	970.0	848.8
Growth rate of energy consumption (% p.a.)	1980-85	2.5	1.0	3.6	2.1
	1985-90	4.2	3.0	5.7	4.5
	1980-90	3.3	2.0	4.7	3.3
Difference between GDP and energy consumption growth rates (% p.a.)/a	1980-85	1.5	3.0	1.3	2.8
	1985-90	0.6	1.8	0.3	1.5
	1980-90	1.1	2.4	0.8	2.2
Elasticity with respect to GDP /a	1980-85	0.63	0.25	0.73	0.43
	1985-90	0.88	0.63	0.95	0.75
	1980-90	0.75	0.45	0.85	0.60
Energy savings (%)/a,/b	1985	7.0	13.6	5.9	13.2
	1990	9.8	20.7	7.7	19.3
Average savings (%) p.a.	1980-90	1.0	2.3	0.8	2.2
Energy savings in oil (%)/a,/b	1985	8.8	21.3	8.6	17.7
	1990	18.3	31.4	16.4	28.4
Average savings (%) p.a.	1980-90	2.0	3.8	1.8	3.4
Oil as proportion of total energy consumption (%)	1980	21.1	21.1	21.1	21.1
	1985	20.7	20.0	20.6	20.0
	1990	19.1	18.3	19.1	18.7

/a To avoid biasing these ratios, the precise weighted growth rates of GDP are used here in place of the rates rounded to the nearest 0.5; thus in the moderate growth case the rates per annum are 4.0% for 1980-85, 4.8% for 1985-90 and 4.4% for 1980-90, while in the faster growth case they are 4.9% for 1980-85, 6.0% for 1985-90, and 5.5% for 1980-90.

/b Percentage by which projected energy consumption is below the level that would be reached if it grew at the same rate as GDP from 1980 base.

Sources: Table 1.8 and assumptions explained in text and Table 1.9.

2. COAL

Introduction

2.01 Coal is China's largest indigenous energy resource and at present meets nearly 70% of demand for commercial energy. In view of the very large quantity of proven reserves relative to those of oil and gas, coal can be expected to remain the dominant fuel in the foreseeable future./1 Coal reserves in China are comparable in quantity and grade to those of the USA and USSR. The known resource base is adequate to meet the present consumption rate for around 1,000 years, and since exploration of the remoter deposits is still proceeding, the total of proven reserves is likely to increase still further. Table 2.1 shows proven reserves by geographical region.

Table 2.1: RECOVERABLE RESERVES OF COAL
(billions of tons)

Regions	Coal and Lignite
Northeast	20.0
North	411.3
East	41.8
Central-South	23.7
Northwest	77.1
Southwest	68.6
Total	642.5

Source: Ministry of Coal Industry.

2.02 Although substantial coal deposits occur in all regions, the north has by far the largest proportion. In general, the coal deposits in southern China are of a lower grade than those in the north, but some attempt is now being made to exploit these lower grade reserves for power generation at the mine site and to reduce the strain on the transport system.

Organization

2.03 All coal reserves in China are the property of the state, but responsibility for their development is divided between the central government, represented by the Ministry of Coal Industry and the provinces. In general,

/1 Reserve estimates appear to be based on extensive drilling and geophysical surveying, so a high proportion can be regarded as "proven."

the larger mines are operated by the Ministry, and the smaller ones by provincial, county and commune authorities. The same division of responsibility applies to the allocation of coal. The Ministry of Coal Industry is also responsible for many other functions: for instance it runs several educational facilities offering specialized training for graduate-level students and workers. It also operates research institutes and facilities for manufacturing mining equipment (although some equipment is also manufactured by the Ministry of Machine Building). The Ministry of Coal Industry has a number of separate departments responsible for, inter alia, labor, finance, mechanization, local mining (provincial mines), mine safety and transportation/sales (the latter department allocates coal from the centrally controlled mines).

2.04 On a geographical basis, the Ministry has 84 coal mining bureaus responsible to it, 11 of which produce 10 million tons of coal a year or more. Districts apparently report through the local provincial government. Each district has a mine bureau and each province its own coal administration bureau. The separation of centrally organized mines and the smaller mines operated by provinces, administrative areas, counties and communes seems to be fairly complete at the working level, since the latter rely on the provincial coal administration bureaus for materials allocation, technical assistance, and other matters. Local mines seem to be less well equipped and less well organized than the centrally managed mines, and their workers are more poorly paid. Their productivity and the quality of coal produced also appear to be lower.

Employment Conditions

2.05 Miners' pay in state-owned mines seems to be about Y 100 per month, including allowances, with miners working on mechanized mine faces paid 20% more than ordinary miners. The general level of pay is set by the Ministry, but the provincial bureaus have some discretionary power to adjust the rate for local conditions. Pay systems vary, with some mines paying on a straight monthly basis, others on a straight tonnage basis, and others using a combination of salary and bonuses. There is some evidence that determining pay systems and rates is a sensitive issue on which ideological and practical considerations have had to be balanced. Mine workers are paid considerably more than agricultural laborers, and they have far better housing and benefits, so recruitment is not a major problem (although some labor bureaus have found that unemployed urban youth do not want jobs as miners).

Production

2.06 Coal production increased from 90 million tons in 1955 to 635 million tons in 1979, before falling to 620 million tons in 1980 (Table 2.2). The reason for the drop in production between 1979 and 1980 appears to be that in previous years production was expanded at the expense of tunnelling and other development work needed to sustain production. The Government has stated that coal production will drop again in 1981. The Government nevertheless expects to increase production to over 700 million tons by 1985.

Table 2.2: COAL PRODUCTION, 1955-80
(million tons)

	Lignite	Anthracite	Bituminous /a	Total
1955	2.1	13.6	74.0	89.7
1960	8.5	68.2	318.3	397.2
1965	8.8	39.6	183.4	231.8
1970	13.0	56.1	284.9	354.0
1975	20.3	97.1	364.8	482.2
1976	20.6	99.6	363.3	483.5
1977	23.3	115.5	411.9	550.7
1978	24.9	126.2	466.8	617.9
1979	25.3	125.8	484.4	635.5
1980	24.3.	128.9	466.9	620.1

/a Includes coking coal. In 1979 this amounted to 327.4 million tons, much of it used as fuel.

Note: Statistics on coal production must be treated with considerable caution, since the coal appears to be measured by filling railway coal cars and river barges to a given level, not by weighing it. The quantities of coal produced by county and commune mines are probably subject to even greater errors, and some production may not be recorded.

Sources: Tables A.6, A.7 and A.8.

2.07 About 95% of coal production comes from underground mines, most of which are only partly mechanized. The few large underground mines equipped with coal cutting machinery provide about a third of deep-mined coal and partly mechanized mines another third. The number of underground coal mines in operation is shown in Table 2.3.

Table 2.3: UNDERGROUND COAL MINES IN OPERATION, 1976-79

	Large mines over 600,000 t/y		Medium mines 100,000-600,000 t/y		Small mines Less than 100,000 t/y	
	Number	Production (million t/y)	Number	Production (million t/y)	Number	Production (million t/y)
1976	187	149	988	205	944/a	114
1977	203	174	1,015	228	999/a	134
1978	201	203	1,141	256	921/a	142
1979	213	213	1,040	255	1,007/a	151

/a These figures are inconsistent with reports that 20,000 county and commune mines produce 25-40% of total output. The 1,007 small mines may refer only to those under the control of the Ministry of Coal Industry, but the production shown for small mines must include that for the small mines controlled at the county and commune levels.

Source: Ministry of Coal Industry.

2.08 Future plans call for increased mechanization of working faces in both old and new mines, with the former having priority, and for domestic manufacture of underground mining equipment. For mechanized mines, longwall mining is preferred to the room and pillar system because it achieves a higher recovery of coal. The resulting surface subsidence is not regarded as a problem, although it prevents mining under inhabited areas and major civil works. Underground mining equipment has been purchased from the Federal Republic of Germany, the UK, Poland and Japan. However, the equipment has been introduced with mixed success, partly due to inadequate training of the operators and maintenance staff.

2.09 There are long lead times to open new underground mines, generally 5-10 years depending on the size of the mine. Part of this time is required for project approvals, but construction of new shafts and tunnelling for haulage ways and underground development are extremely time consuming due to a lack of modern equipment. These are critical areas for the expansion of future coal production.

2.10 Open-pit mines produce only a small proportion of the coal (12% and 2.4%, respectively, for bituminous coal and lignite in 1979) because geological conditions often lead to high stripping ratios and because the equipment is very small by modern standards. For example, the Chinese use 8-ton dump trucks whereas 85-ton trucks are used in India and trucks as large as 175 tons are used in the USA./1 The use of such small equipment

/1 Major open-pit mines such as that at Fushun use railways, however.

greatly reduces the economic efficiency of the present Chinese open-pit operations. The Coal Ministry places high priority on developing open-pit mines and wishes to import modern, large-scale dump trucks, power shovels of 30-40 ton capacity, and draglines. Owing to the hardness of the overburden, bucket wheels are not usually suitable.

2.11 Since open-pit mines can generally be developed more quickly and usually have lower unit investment and operating costs than underground mines, the development of open-pit mining is a matter of highest priority for the industry. Joint ventures with the Ministry of Electric Power would permit the development of mine-mouth power plant complexes.

Coal Quality

2.12 The quality of coal delivered to the consumer is generally poor. The power sector reports an average calorific value of only 4,480 kcal/kg. Analyses of raw coal (which appear to represent the better grades) are shown in Table 2.4.

Table 2.4: RAW COAL ANALYSES

	Liaoning Province	Shandong Province	
	Santaizi Mine	Nantun Mine No. 3 seam	Xinglongzhuang field
Ash content %	21.6	9.87	9.41
Volatiles %	43.5	33.1	32-49
Calorific value kcal/kg	5353	6821	7060
Sulphur	1.99	0.49	0.5
Phosphorus	0.038	n.a.	n.a.
Moisture %	10	6.3	2.89

Source: Liaoning and Yanzhou Coal Bureaus.

2.13 Most coal could be improved by washing. Only about 100 million tons are washed at present, but it is planned to double coal washing capacity by 1985 and the purchase of needed equipment has high priority. Washeries produce three grades of coal: large lump (50%), middlings (20%) and fines (15%), with dirt and losses accounting for the remaining 15%. Where geological conditions are complex, washing produces a disproportionately high percentage of fines, which are difficult to dewater. It is planned to utilize middlings and fines as fuel in power plants at the mine mouth, and also to improve the quality of fines and make them suitable for industrial use by flotation processes. At present, lump coal is reserved for coking, middlings for power generation, and fines for domestic use (including the manual production of compressed coal balls).

2.14 Coal mines purchase power from coal-fired thermal plants run by the Ministry of Electric Power. At present, energy is wasted as the coal is transported, often over long distances, from the mine to the plant and the power sent back to the mine. It seems that, in future, more power plants will be constructed (as joint ventures between the Ministry of Coal Industry and the Ministry of Electric Power) at the mouth of open-pit mines and underground mining complexes with coal washeries.

Transportation /1

2.15 Coal is transported principally by rail. The 413 million tons year transported in 1979 accounted for 38% of total rail freight; an additional 220 million tons/year are moved by inland waterways and coastal shipping. Coal ports handled 82 million tons of coastal shipments and exports last year. Transport bottlenecks have occurred in the past but are reported to have eased, possibly as a result of the decline in coal production, but also as a result of double-tracking and electrification of parts of the railroad system, which is nevertheless still reported to be running at capacity in many segments. While in some cases the Ministry of Coal Industry builds rail spurs to coal mines and owns coal cars, in general the Ministry of Railways takes delivery of the coal, and assumes responsibility for it, at the mine. Transportation is at present the principal bottleneck to expanding coal production in several provinces, including Shanxi, Shaanxi, Ningxia, Guizhou and others.

Table 2.5: COAL CONSUMPTION BY SECTOR, 1976-78
(%)

	1976	1977	1978
Power	16.6	17.5	20.1
Railways	4.9	4.8	4.7
Metallurgical	9.3	9.7	10.5
Other industries	50.2	49.3	48.9
Household and commercial	19.0	18.7	17.8

Source: Ministry of Coal Industry.

/1 For greater detail, See Annex F, "The Transport Sector."

Consumption

2.16 In the consumption of coal, industrial demand is dominant, especially as industry also consumes roughly four-fifths of electrical power. The metallurgical sector comprised only 10.5% of coal consumption in 1978, but this does not include coke ovens (classified under chemicals) which consumed about 10% according to one source./1 Industrial and power sectors must use large quantities of coking grade coal for thermal purposes; coking grade coals reportedly account for 51% of total coal produced.

Export Prospects

2.17 Exports of coal have been rising rapidly from a small base, and reached 4.63 million tons in 1979. A further rise is expected to perhaps 20 million tons in 1985. Given the enormous resource base and the acceptable quality of the better grades of Chinese coal, exports could continue to rise thereafter. However, there are problems to be overcome: (a) increasing mine output to meet expanding domestic demand while also conserving energy to free coal for export; (b) improving the capacity of the railroads that link mines with ports; and (c) improving the number and capacity of coal loading ports (both loading rate and size of vessels). At present only two specialized ports can load coal in northern China, Lianyungang and Qinhuangdao; the capacity of the latter is being increased from 10 to 40 million tons/year by 1985. A new coal port is being built at Shijiusuo to handle 15 million tons/year by 1985, with an ultimate capacity of 30 million tons; a 240 km double-track electrified railway is being constructed to bring coal to the port. Increasing exports are also anticipated though general cargo ports such as Qingdao and Dalian. Not only northern ports but also southern ones such as Huangpu could be usefully improved, along with transport links to the interior, to handle coal for export.

Productivity

2.18 Comparisons with other countries are difficult, because in China each coal mining enterprise provides a range of social services that in other countries are provided by the Government. Thus, many persons whose activities have no direct relation to coal mining are included in the mine work force. Employment in the coal industry is shown in Table 2.6.

/1 R.P. Greene and J.M. Gallagher, editors, World Coal Study, Vol. I, Future Coal Prospects, Cambridge, Massachusetts: Ballinger, 1980, p. 100, based on data for 1977 allegedly supplied by the Ministry of Coal Industry.

Table 2.6: COAL INDUSTRY EMPLOYMENT, 1975-79
('000)

	1975	1976	1977	1978	1979
Total employed	3,626	3,814	3,939	4,068	4,104
Miners in centrally controlled mines	836.7	859.2	924.0	921.1	929.8
Of which:					
Underground	809.6	833.7	897.4	895.1	903.6
Open-pit	27.1	25.5	26.6	26.0	26.2

Source: Ministry of Coal Industry.

2.19 The data indicate an average production of about 0.5 tons per man-day in underground mines and about 2.0 tons per man-day in open-pit mines. The small number of modern open-pit mines and the overall low degree of mechanization in underground mines result in lower productivity than is common in industrialized Western countries. Mechanized underground mines planned for the northeast would have capacities of 1.2 and 1.8 million tons/year; their output would be 1.6 tons per man-shift, compared with 2 tons in India, an average 3-4 tons/per man-day in Western European underground mines and 10.75 tons in the USA. Even greater output, of the order of 10-20 tons/per man-day, could be obtained from modern open-pit mines with large-scale equipment.

Prospects and Recommendations

2.20 Any estimates of future coal production must be treated with caution. The mission was told that "more than 700" million tons would be produced in 1985./1 Even if high priority is given to the coal industry in response to the recent change in expectations of oil output, total coal production is not likely to exceed 750 million tons by 1985; taking transport problems into account, production of around 730 million tons seems more likely. Such an increase in production would come from the development of a number of major new projects (Table 2.7) and from various small projects. This increase appears achievable based on past performance, since the production data for 1965-80 indicate an increase of about 125 million tons of production capacity every 5 years for the past 15 years.

/1 Other visitors have reportedly been told that 1985 production would be 720 or (more recently) 730 million tons.

2.21 However, judging by the limited information available, this expansion will not be easy. Data on major new projects (Table 2.7) show an approximate increase in capacity of 50-60 million tons/year by 1987. But much of this production will come onstream after 1985 and some allowance must be made for slippage in construction schedules. Several of the identified projects are joint ventures with foreign companies, while others involve contractual arrangements, whereby the import and installation of foreign equipment is paid for by coal exports. Negotiation of these projects is proving difficult. Furthermore, any major expansion of open-pit coal mining will depend on satisfactory arrangements being concluded for the procurement, operation and maintenance of foreign equipment, since large-scale equipment is not manufactured domestically. In the next decade at least, most new production capacity is expected to be from underground mines, which require several years to construct. Thus, much will depend on the success of continuing efforts, such as are now being made, to modernize and transform the tehnology of medium-sized and small-mines so as to prolong and expand their output.

2.22 The potential for expanding coal output up to 1990 will be constrained both by the possibilities for opening up new mines and by the difficulties of expanding transportation on the scale required. Since the mid-1960s, China has increased its coal output by 120-130 million tons every five years, and a similar increase seems entirely possible during 1980-85. By extension, output might be expected to rise further to about 870 million tons in 1990; a strenuous effort to accelerate the pace of mine development, coupled with heavier investment, could possibly raise the level to 900 million tons or a little more. However, coal production on this scale would encounter transport difficulties requiring substantial further investments in railroad facilities. Making effective use in 1990 of a 280 million ton increase in coal output might well require, in addition, construction on a large scale of mine-mouth thermal power plants, together with long-distance transmission lines, and a major investment in coal washing and processing facilities, which would reduce bulk before transporting and so economize on transport requirements. Improvements now projected in inland waterways - particularly the Huai He, Grand Canal, and Xi Jiang - will also ease the coal transport problem.

Capital Requirements

2.23 A final area of importance for coal production prospects is financing. No information was available on the industry's financial position, its sources of funds or its future capital expenditure plans. Capital requirements for the coal industry in China are difficult to assess since investment costs and expansion plans are not known. However, they are undoubtedly very large, on the order of Y 10 billion more for 1981-84. Investment during the past five years is shown in Table 2.8. Investment in 1981 is expected to be roughly the same as in 1980, about Y 2.5 billion.

Table 2.7: MAJOR COAL MINE PROJECTS

Province	Mining administration	Project
Nei Monggol	Huolinhe	Open-pit lignite mine under construction. Planned output 3-5 million tons/year by 1985.
Hebei	Kailuan	Following rehabilitation of earthquake damage, two new mines are under construction - Qianjiaying and Donghuantuo - with capacities of 4 million tons/year each.
Shandong	Yanzhou	Mines producing steam coal for export under construction - production 8-10 million tons/year by 1987.
Anhui	Huainan & Huaibei	Increase production of coal to supply Shanghai with 20-30 million tons/year by 1987. Five to six new mines with outputs of 1.5-2.0 million tons/year each are being developed.
Shanxi	Datong	Open-pit mine to be constructed at Shuoxian to produce 10-15 million tons/year by 1987.
Henan	Pingdingshan	Increase production of coking coal from 10 to 13 million tons/year by 1987.
Jiangsu	Xuzhou	Increase production of bituminous coal from 13 to 15 million tons/year by 1987.

Source: Ministry of Coal Industry.

Table 2.8: INVESTMENT IN THE COAL INDUSTRY, 1976-80
(Y million)

1976	1977	1978	1979	1980 (est.)
1,866	2,166	3,138	3,248	2,447

Source: Table A.12.

2.24 Foreign exchange will be required to purchase mining equipment and to develop a Chinese capability to manufacture a wider range of modern types of equipment. There are now over 100 large plants making machinery for the coal industry,and they have growing capabilities. But along with open-pit mining equipment, there is still a need to import coal washing equipment and various other items, notably in the area of precision hydraulic equipment.

3. PETROLEUM

Sector Development

3.01 Until the establishment of the People's Republic in 1949, the scale of oil exploration and discoveries had been modest, with production of only 70,000 tons p.a., plus 50,000 tons of shale oil. Extensive exploration was then undertaken with help from the USSR, but with only limited success and that in the remote northwest. The discovery in 1959 of the Daqing field, which was to become one of the world's major oilfields, shifted exploration to the northeast, north and east and led to the discovery of the Shengli, Dagang, Liaohe, Nanyang and Renqiu fields, and of offshore findings in the Bo Hai.

3.02 By 1979, production had reached 106 million tons of crude oil and 14.5 billion m^3 of natural gas, an outstanding and promising performance, particularly as it was achieved with China's own equipment. Production has, however, been essentially static for 2-1/2 years and is now declining slightly.

Organization

3.03 All exploration and production activities specifically concerned with oil and natural gas are the responsibility of the Ministry of Petroleum Industry in Beijing. The Ministry of Geology also carries out exploration work. Once production has been established, the Ministry of Petroleum

Industry organizes a production unit responsible for all petroleum activities, including exploration, in its area (this area corresponds to geological boundaries rather than to the regular administrative units). A separate unit is responsible for offshore operations.

3.04 Oil fields are made as self-sufficient as possible, with the exception of electric power generation. In addition to their normal functions, petroleum units manage agricultural production, schools, nurseries, hospitals, municipalities, and commercial activities catering to their employees. This explains in part the very high number of personnel employed in petroleum activities.

Exploration

3.05 Exploration is done by about 300 seismic crews and 500 drilling rigs (total staff about 100,000), which annually drill 2,000-3,000 wells, compared with a total of 395 for all oil-importing developing countries in 1978./1 Exploration activities are spread over an area of sedimentary formations with oil-bearing potential, totalling 4.2 million km^2 on land (about one third of the country) and over 1 million km^2 offshore. There is some evidence that the considerable amount of modern equipment recently purchased is not being effectively used.

3.06 The last major discovery was the Renqiu area in 1975. Although it appears that Chinese practice is to report as a new "discovery" the finding of production in an area remote from existing production (rather than reporting each individual oilfield as a discovery), the rate of discoveries seems very low in relation to the area explored and to the number of exploratory wells. Indonesia, for example, which is comparable to China in terms of sedimentary areas and current oil production level, finished 133 exploratory wells in 1979, of which 34 produced oil and 9 natural gas.

3.07 Offshore exploration is still at an early stage, and despite periodic reports of "significant" discoveries, oil production does not appear to be imminent from any of them, especially since large-scale development is likely to require the expertise of foreign oil companies. Agreements have been signed with French and Japanese groups for offshore development in the Bo Hai, but the geology of the region makes it unlikely that production can do more than offset the decline of production from older onshore fields. Proposals for further exploration work are being sought from international oil companies that have participated in seismic surveys of the continental shelf off the southeastearn and southern regions of China. Major offshore production is unlikely before 1985 or, possibly, 1990.

/1 Differing definitions of "exploration" drilling may bias this comparison.

3.08 Onshore, according to Chinese estimates, only about 13% of the potential oil-bearing wells have been well explored and over 60% have hardly been explored at all; while almost no drilling has been done anywhere to depths of over 3,000 meters. Promising sedimentary areas still have to be explored, particularly in the northwest. Though prospects for large discoveries exist here, their development would entail severe logistical problems, in particular transportation over very long distances to consuming areas. The prospect is therefore for further discoveries of relatively small oil-fields close to the existing producing areas, which might tend to offset the decline of production from existing fields.

3.09 Over the long term, China will need to raise the productivity of the exploration effort through improved technology, personnel deployment and training if it is to reverse the present production decline.

Production

3.10 After peaking in 1979 at 106.1 million tons - including 300,000 tons of shale oil - production has started to decline. Almost 90% of production is concentrated in the north, the east and particularly the northeast, where the Daqing field supplies about half of China's oil (Table 3.1).

Table 3.1: CRUDE OIL PRODUCTION BY REGION AND MAJOR FIELDS, 1977-80
(million tons)

	1977	1978	1979	1980
Northeast	54.875	56.039	57.363	58.59
Daqing	50.314	50.375	50.753	51.50
Liaohe & others	4.561	5.664	6.610	7.09
North	15.554	20.399	20.404	19.11
Renqiu	12.298	17.230	17.331	16.03
Dagang	3.150	3.000	2.901	2.91
Others	0.106	0.169	0.172	0.17
East	17.660	19.743	19.206	17.92
Shengli	17.520	19.468	18.880	17.59
Others	0.140	0.275	0.326	0.33
Central-South	1.261	2.832	3.385	4.16
Northwest	4.207	4.942	5.687	6.06
Southwest	0.081	0.094	0.104	0.10
Total	93.638	104.049	106.149	105.94

Sources: Ministry of Petroleum Industry.

3.11 Daqing is located in a geological unit known as the Songliao Basin, which lies mainly in Heilongjiang, and produces over 50 million tons of crude oil annually. Other fields in the basin produce about 1 million tons of crude oil annually. The Daqing field measures some 140 km in a north-south direction and 20-40 km in an east-west direction. From information on the historical development of the field and its geological characteristics, the original oil in place in the reservoir can be estimated at around 3,000 million tons, of which about 30% or 900 million tons is likely to be recovered by the existing production techniques. Of this amount, some 515 million tons appear to have been recovered between 1960 when production began and the end of 1979. Crude oil production from the field has apparently peaked and is beginning to decline.

3.12 The production method used at Daqing throughout its 20-year production history has involved injecting water into the oil reservoirs in order to flush oil towards the producing wells. The injection pattern is apparently based on a Soviet model; it gives a neat and orderly spacing of wells at the surface, but a very poor geometrical distribution of wells among the individual oil reservoirs. This system yields relatively high production rates in the early years of development, but results in a lowered ultimate total recovery of oil and a relatively rapid production decline as injected water breaks through the oil and reaches the production wells. This point has been reached at Daqing, where daily oil production per well is declining while the quantity of water injected is increasing very rapidly. Since there is a physical limit to the total amount of fluid that can be handled by the wells and surface facilities, the future prospect is for ever-increasing recovery of water combined with declining oil production. Output from existing wells in the field is expected to fall in the 1980s by 2-3 million tons on the average each year, but officials suggest that this will be partially offset by drilling new wells and tapping new layer around those now in production.

3.13 The production decline rate at Daqing is likely to be the key factor in any forecast of oil production in China during the next ten years. In the other producing areas, which consist of groups of smaller oilfields, new discoveries will tend to offset the decline of production of fields developed earlier. The overall decline in production in the next five years from these grouped fields (such as Liaohe, Dagang, and Shengli) is therefore likely to be much less marked than at Daqing. These fields are grouped around the Bo Hai, and the extension of the producing areas offshore will also tend to offset production declines in the older onshore fields. None of the anticipated new pool developments, however, seems important enough to offset the likely decline in production from Daqing in the next five years.

3.14 Earlier expectations of future production levels from the continental shelf seem to be overoptimistic in the light of the results of the geophysical surveys made in the last two years. Much of the northern continental shelf and the Bo Hai appears to be underlain by a continuation of the onshore geology, so that production characteristics of any oilfields are likely to resemble those of the existing onshore fields. Production from all of these existing fields has been based on extensive use of water to flood the oil reservoirs; this would be an extremely expensive operation offshore, with corresponding long lead times for installation of production facilities. The geology of the southern part of the continental shelf appears to be more like a conventional oil producing area, and reports of oil discoveries in the Xi Jiang estuary and off Hainan Island are encouraging. Nevertheless, these discoveries will have to be confirmed by appraisal wells before production platforms can be designed and installed. It is therefore unlikely that offshore oil production can commence before 1985, and offshore production on a scale sufficient to materially affect the overall petroleum situation is unlikely much before 1990.

3.15 A tentative forecast is for China's oil production to fall to 100 million tons in 1985; indeed, production is being cut back toward that level in 1981 and at the same time efforts being made to adjust methods to get better long-run results. Trends in the second half of the 1980s are more uncertain, since they depend on the magnitude of new discoveries and the speed with which they can be developed. Output in 1990 is likely to amount to 80-105 million tons, but on balance, even if improved techniques are applied and some new fields begin to be developed, a further small decline seems likely, perhaps to 95 million tons.

Quality of Crude Oil

3.16 A large part of Chinese crude oil has a high wax content, a low proportion of light fractions, and a melting point so high that it is a solid at ambient temperatures most of the year in most of China. These characteristics lead to severe problems in transportation and refining, as described later.

Equipment and Methods

3.17 Most of the drilling equipment is manufactured in China and based on outdated models from the USSR. The quality is lower in the oldest fields like Daqing and better in the new fields like Renqiu and offshore fields, where imported equipment is used. The two drilling rigs visited by the mission were poorly maintained and dangerous. Stationary equipment such as pump stations and tanks was much better maintained. No information was obtained on the rate of accidents but it is likely to be high, with no blow out preventers on drilling sites, little use of protective clothing, breached dikes around tanks, lack of efficient fire extinguishers, open electric knife switches in pump houses, etc.

3.18 Drilling methods and production technology are also backward, although they too are better in the new fields. Work overs on wells, rendered difficult by the type of equipment used, seem to be infrequent. Many wells are not producing, for example, up to 20% of those at Shengli. Poor cementation of well casing prevents proper control of oil production and water injection in many wells. In Daqing, the pattern of water flooding used results in much recoverable oil being left in the reservoir, but the more recently developed Shengli and Renqiu fields use more efficient patterns of water injection. The measurement of oil, water and gas is imprecise, particularly for individual wells, which has serious implications for field and reservoir management. There seems to be poor training of field personnel and a lack of supervision by qualified staff, due to a shortage of trained personnel and a lack of transport for supervisors to make frequent visits to scattered work locations. With these constraints it is doubtful whether advanced methods of enhanced recovery can be effectively implemented. The productivity of the work teams and their equipment appears to be low; at Daqing, for example, 20 teams drill 50 exploratory wells per year at an average depth of 2,000 m. The total depth per team is one eighth to one fifth of what trained crews using modern equipment could achieve. In Daqing, Shengli and Renqiu, the excess capacity of capital equipment such as pumps and machine tools was evident and must have added significantly to the investment costs for these oilfields.

3.19 In the last five years, China has imported a considerable amount of modern oilfield equipment, particularly seismic survey and drilling equipment, but it appears that much of this is not yet being effectively used in the field. The greater part of this equipment seems to have been purchased in 1978, when investment for petroleum exploration is reported to have more than doubled (to $1.4 billion) from the previous year. Among the items imported at this time are land seismic survey equipment from the USA, heavy onshore drilling equipment from the USA and Romania, seismic data processing centers and an offshore seismic survey vessel from France, and offshore drilling equipment from Singapore, Japan and Norway. Field staff seem to have been inadequately trained to use this equipment, however. (This situation is clearly described in reports concerning the loss of the Bo Hai II offshore drilling rig.)

Consumption

3.20 Table 3.2 shows the estimated balances of the principal categories of oil for 1979.

Table 3.2: OIL BALANCES, 1979
(million tons)

	Gasoline	Kerosene	Diesel oil	Fuel oil & crude	Other	Total
Primary production	n.a.	n.a.	n.a.	106	n.a.	106
Refining						
Input	n.a.	n.a.	n.a.	-76	n.a.	-76
Output	11	4	19	28	6	68
Net	11	4	19	-48	6	-8
Exports	2	..	2	13	..	17
Net domestic availability	9	4	17	45	6	80
Consumption	9	4	17	45	6	81
Electric power system	..	..	..	17	..	17
Heavy industry	..	..	1	23	3	27
Light industry	..	..	1	5	2	8
Transportation	7)	..	7	..	..	14
Agriculture & other	2)	3	8	..	1	14
Domestic & commercial	..	1	..	..	..	1

Notes: Distribution of refined product exports and consumption is conjectural. The figures shown for total consumption by sector are consistent with the percentage breakdown obtained from the Ministry of Petroleum Industry, assuming (a) "Agriculture and Other" accounts for otherwise unaccounted for consumption, and (b) refining losses are included in industrial consumption.

Sources: Ministry of Petroleum Industry and mission estimates.

Natural Gas

3.21 In 1980, the 14.27 billion m^3 of natural gas produced was 1.7% below production in 1979; the mission estimates that production will further decline, perhaps to as little as 12.0 billion m^3 in 1985. Production is almost equally divided between nonassociated gas, produced mainly in Sichuan, and associated gas dissolved in the oil and produced with it. Associated gas is now almost fully utilized as fuel in the oil fields or as feedstock for fertilizer and petrochemical plants. Total natural gas consumption in 1979 is estimated at 4.1 billion m^3 (28%) for fertilizers, 1.3 billion m^3 (9%) for petrochemicals and synthetic fibers, and 9.1 billion m^3 (63%) for fuel, of which 1.7 billion m^3 (12%) were used in thermal power plants. The regional breakdown of gas production is shown in Table 3.3. Many of the fertilizer and petrochemical plants are located near old oilfields and thus depend on associated gas obtained from declining production of oil. The supply of gas may therefore fall below requirements in the near future, which would make the development of nonassociated gas supplies in the oil producing areas an urgent priority. To do this would require deeper drilling and improved equipment.

Table 3.3: NATURAL GAS PRODUCTION
(billion m^3)

	1977	1978	1979	1980
Northeast	4.62	5.00	5.17	5.27
Daqing	3.00	3.20	3.31	3.39
Others	1.62	1.80	1.86	1.88
North	0.78	0.82	0.93	0.80
Renqiu	-	-	-	-
Dagang	0.78	0.82	0.93	0.80
Others	-	-	-	-
East	1.18	1.44	1.55	1.44
Shengli	1.2	1.4	1.5	1.42
Others	-	-	-	0.02
Central-South	0.02	0.02	0.02	0.05
Northwest	0.26	0.30	0.33	0.39
Southwest	5.26	6.15	6.52	6.33
Total	12.12	13.73	14.52	14.27

Note: The table was compiled from two sets of data, one rounded to tens of millions of m^3 and the other to hundreds of millions of m^3.

Source: Ministry of Petroleum Industry.

Oil and Gas Reserves

3.22 The extent of oil and gas reserves is not widely publicized inside China and is a matter for considerable speculation outside the country. Even in the oil fields visited - which accounted for 80% of petroleum production - the data available did not permit the calculation of a reliable estimate. Table 3.4 shows tentative estimates of oil and gas reserves based on available information.

Table 3.4: TENTATIVE ESTIMATES OF OIL AND NATURAL GAS RESERVES

Region	Original recoverable oil	Oil produced to date	Remaining recoverable reserves of oil	Associated gas	Non-assoc. gas	Total natural gas
	(million tons)			(billion m^3)		
Northeast	1320	590	730	25.0	..	25.0
North	460	80	380	5.0	..	5.0
East	410	161	249	10.0	3.5	13.5
Central-south	90	10	80	2.5	..	2.5
Northwest	400	40	360	15.0	..	15.0
Southwest	13	1	12	0.5	70.0	70.5
Total	2693	882	1811	58.0	73.5	131.5

Source: Mission estimates.

Pipelines and Refineries

3.23 Pipelines and some refineries are under the control of the Ministry of Petroleum Industry. Refineries combined with petrochemical plants come under the Ministry of Chemical Industry.

3.24 Eighty percent of crude oil production is moved by pipeline and the remainder by rail, which also carries most of the refined products, or a total of 80-90 million tons per year. The 6,800 km network of oil pipelines is not extensive in relation to China's size and the distribution of production and markets. The high pour point of most of the crude oil, fuel oil and the heaviest grades of diesel fuel complicates their transport, and all pipelines, railroad tank wagons and oil tankers must have heating equipment.

3.25 Refinery capacity is about 93 million tons p.a., with a throughput of perhaps 76 million tons in 1980. There are 46 refineries, most of which are small by international standards. Only 31 have capacities of 500,000 tons p.a. or more, and even the largest refineries visited by the mission (at Daqing, Fushun, Shanghai, and Yanshan, about 40 km from Beijing) are not particularly large by world standards. Given the economies of scale in petroleum refining, many of the smaller refineries may be uneconomic.

3.26 Refineries produce a wide range of products, together with petrochemical feedstocks and industrial solvents. The output of the principal products is shown in Table 3.5. Because of the low proportion of light fractions in the crude oil, secondary refining or cracking plants are required in most refineries.

Table 3.5: OUTPUT OF PRINCIPAL REFINED PETROLEUM PRODUCTS
('000 tons per year)

Product /a	1978	1979	% of total /b
Gasoline	9,913.9	10,698.6	16.0
Kerosene	3,560.4	4,093.2	6.0
Diesel oil	18,256.6	18,728.2	27.0
Lubricating oil	1,806.2	1,914.8	3.0
Fuel oil	28,142.9	28,161.2	41.0
Benzene /c	340.3	322.9	0.5
Other /d	n.a.	n.a.	6.5

/a Product specifications are not available in all cases and some designations may, in translation, vary from international usage. It appears, for example, that heavy marine diesel is classified as fuel oil.

/b As reported by the Ministry of Petroleum Industry.

/c May refer to industrial solvents.

/d Includes LPG, wax, coke, aviation fuel, asphalt, petrochemical feedstocks, greases.

Source: Ministry of Petroleum Industry.

3.27 The quality of most products appears to be below international standards, with, for example, automotive gasoline octane ratings of only 66-70. No quality index is used for diesel fuel, which has a high pour point. Lubricating oils are of variable quality and complaints have been voiced by users.

3.28 The refinery equipment seen was mostly produced in China, with the exception of specialized components such as wax purification and packing plant and major reactor vessels in some of the larger refineries.

3.29 The efficiency of refineries cannot be estimated with much accuracy since statistics do not distinguish between refinery fuel consumption and petrochemical feedstocks. In the refineries visited, the standard of cleanliness was high, but instrument maintenance was poor and fire fighting provisions insufficient.

3.30 Refineries, like other petroleum installations, are handicapped by the lack of domestic production of seamless steel pipes larger than 25 cm in diameter. Most pipelines and refinery pipework of larger diameter use spiral-weld pipe, which has a much lower pressure rating. Pipe elbows and swages in these larger diameters are not forged, but built up in segments from spiral-weld line pipe. Not only is the manufacture of this pipe laborious and time consuming, but the pipe also reduces the operating pressure and/or the safety factor of the installation.

Oil Shale

3.31 Reserves of oil shale in China are reported unofficially to be of the order of 400 billion tons and may be much larger, since the geological environment is favorable for their formation in many of the sedimentary basins. Deposits of 100 billion tons or more, containing 5-10 billion tons of oil, are reported in Heilongjiang and Hebei. The grade of most oil shales is fairly low (less than 10%) but a few deposits have 10-20% of oil by weight.

3.32 Before 1958, shale oil accounted for almost half of Chinese oil production, but the proportion declined rapidly as normal crude oil production increased after the discovery of the Daqing oilfield. Recent production figures are shown in Table 3.6 for two producing fields at Fushun (Liaoning) and Maoming (Guangdong).

3.33 At the Fushun plant (visited by the mission) raw shale comes from the Fushun open-pit coal mine, where it overlays the coal. The rate of shale extraction is therefore geared to coal production. The shale oil plant has a capacity of 3 million tons/year of shale and produces 100,000 tons/year of heavy black viscous oil, which is burned as fuel oil. The oil content of the shale is about 6% by weight, but oil extraction is only about 3%. The technology, which is simple and works, should be applicable in other developing countries, after some upgrading to improve its efficiency.

Table 3.6: SHALE OIL PRODUCTION
('000 tons)

	1970	1975	1977	1978	1979
Liaoning	385	363	238	262	233
Guangdong	122	151	114	101	81
Total	507	514	352	363	314

Source: Ministry of Petroleum Industry.

3.34 Although there appear to be no plans to expand the extraction of oil from shale, this development might be useful if conventional oil production continues to decline, since the reserve base is large and the plants can be built entirely with Chinese resources. There is apparently a cooperative project with Romania for direct burning of oil shale as fuel in a power plant.

Recommendations

3.35 Despite great achievements since 1949, the petroleum sector has certain weaknesses that need to be remedied.

3.36 In exploration, improved technology and field practices, (particularly seismic surveying, well logging and drilling), together with equipment for deeper drilling, are essential to improve the discovery rate.

3.37 In production, fields have been made to produce too rapidly, which has led to quick declines after production peaks and to a reduction in the amount of oil ultimately recovered. Oil production peaked in 1979 and existing fields now face a long period of decline, which cannot be offset by production from the few new fields being developed. Some increases can be expected from offshore developments but many of the earlier estimates seem exaggerated. Offshore development will depend on agreements with foreign oil companies, but even major discoveries in the near future would still require five to ten years to be developed. It is therefore unlikely that an overall decline can be arrested before 1985-90. Immediate steps should be taken to implement enhanced oil recovery programs and to improve reservoir engineering, particularly at Daqing. Drilling equipment and performance, and the cementing of well casings should also be improved. Specialized well logging tools are also needed to monitor the advance of water in the oil reservoirs.

3.38 While refineries represent a significant achievement in process engineering and manufacturing, they may require considerable investment in the near future, if improvement of the quality of products becomes an important factor in programs to increase the efficiency with which petroleum is used. This is particularly important for automotive fuels and lubricants needed for a new generation of fuel-efficient trucks, automobiles and agricultural equipment. A program of vigorous energy conservation measures is also likely to have a high rate of return when it is evaluated in current international prices; this has proved true in refineries in various other countries, where programs are now underway.

3.39 In all sectors of the industry, better measuring techniques and instruments are needed and more attention should be paid to safety practices, if only to protect investments in equipment and training. The industry needs better and larger seamless steel pipe and fittings.

Investment Requirements

3.40 Capital investments for the petroleum sector averaged about \$1.8 billion annually in 1977-79 (Table 3.8). Capital requirements in the next decade should exceed \$2 billion p.a., with 10-20% in foreign exchange.

Table 3.7: INVESTMENT FOR EXPLORATION, DEVELOPMENT AND REFINERIES (Y million)

	Exploration	Development Crude	Development Gas	Refinery	Total
1977	967	479	30	493	1,969
1978	2,093	1,009	44	646	3,792
1979	1,286	888	80	470	2,724
		Average for period		:	2,828

Source: Ministry of Petroleum Industry.

4. ELECTRICITY

Sector Development

4.01 China's achievements in the field of electric power are indeed impressive. From 1,964 MW of generating capacity in 1952, the country had developed a capacity of 63,016 MW by the end of 1979 - an average growth rate of 13.7% p.a., which compares favorably with the rates in India (9% p.a.), Indonesia (8% p.a.) and all developing countries (10% p.a.). The total electricity production increased even faster (14.7% p.a.) to 300.6 billion kWh in 1980. Electricity generation was 13 kWh per capita in 1952 and 308 kWh per capita in 1980.

4.02 Almost all equipment needed for power generation, transmission and distribution is manufactured within the country; indeed substantial surplus capacity exists for the making of power generation equipment. Foreign technology and equipment are used only in exceptional cases, of which high tension transmission lines of 500 kV or over are the most important, although China has begun test-manufacturing its own 500 kV equipment. Technology for manufacturing, system planning, research and other areas has, however, lagged somewhat behind world standards./1

4.03 Electrification had reached a substantial proportion of the country in 1979, with 87% of communes and 63% of brigades having access to electricity. Figures for electrification at the household level are not available, but are presumably much lower inasmuch as the per capita consumption of electricity in the household and commercial sector is about equal to household consumption in Indonesia, where only 6% of the population have electricity in the home.

Organization

4.04 The Ministry of Electric Power has overall responsibility for policy direction, plan coordination, and technical guidance in the sector. It has 15 departments and bureaus in Beijing. Also under its control are the 2 power construction administration offices, 8 scientific research institutes, 14 colleges and schools, 11 manufacturing and repair plants, 7 supplies departments, 1 construction company and 1 international engineering consultant company. Operation of the five principal regional grids is coordinated by regional electric power administrations responsible to the Ministry. The provincial grids and isolated installations, as well as transmission and distribution below 110 kV, are under the management of the provincial governments with technical guidance from the Ministry. About 4.3% of the generating capacity is owned by Communes and brigades, and another 5.7% belongs to self-generating industries.

Consumption Pattern

4.05 Industry consumed 79.0% of electricity net of power losses in 1979 and agriculture defined to include brigade industry - 15.8%. Residential, commercial and municipal consumption amounted to 4.8% and transportation to only 0.6%. A large part of the industrial consumption was accounted for by heavy industries (64% of the total). For comparison, industrial consumption in India was about 62% and in Indonesia about 39%. A range of 40-60% is more common in Asian developing countries such as Thailand, Malaysia, Korea and the Philippines. Transmission and distribution losses (energy sent out less energy sold) amounted to 9.24%, compared to about 13% in Indonesia, 10% in Thailand, 17% in Brazil and 7% in the Philippines. One reason for the rather

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/1 Recent contracts for designs and technical assistance from foreign firms will help to overcome these problems; for example, the big generation plants in Harbin and Shanghai have contracted with Westinghouse for assistance in producing international-quality thermal turbogenerators of 300 and 600 MW.

low losses in China is the large proportion of high voltage consumers and small volume of sales of electricity to the low voltage sector (domestic and commercial uses). Residential and commercial use per capita in 1979 amounted to less than 12 kWh/year - about the same as India's and Indonesia's consumption levels in domestic uses alone.

System Description

4.06 The 63,000 MW capacity consisted in 1979 of a large number of systems but with three fourths of generation concentrated in 12 large grids, of which the 5 largest account for 47% of total capacity (Table 4.1). The many small power grids throughout the country lack the interconnections necessary to improve the efficiency of operations.

Table 4.1: MAJOR ELECTRICAL GRIDS, 1979

Grids	Area covered	Installed capacity (MW)	Peak demand (MW)	Energy generation (GWh)
Regional Grids				
Northeast China	Liaoning and the major part of Heilongjiang and Jilin	7,759	6,020	42,350
East China	Jiangsu, Anhui and Zhejiang, and Shanghai municipality	7,455	5,810	42,390
Central China	Henan and Hubei	5,529	3,500	24,810
North China	Beijing and Tianjin municipalities and the northern part of Hebei	4,989	3,553	25,890
Northwest China	Shaanxi, Gansu and the major part of Qinghai	3,832	2,628	17,490
Subtotal		29,564		152,930
Seven large provincial grids		14,204		68,170
Total		43,768		221,100
% of national total		69.5%		78%

Source: Ministry of Electric Power.

4.07 Generally, the development of transmission and distribution has lagged behind that of generation. China has a shortage of about 10,000 km of transmission circuits of voltages above 110 kV. Similar shortages exist in substation capacity. These shortages limit the flexibility with which the available supply of electricity can be distributed among consumers. The transmission voltages in the country are 110 kV (62,000 km of lines), 220 kV (26,000 km) and 330 kV (801 km). Development of higher voltage lines is needed to permit significant power transfers over long distances. About 1,000 km of 500 kV transmission lines are under construction in central China and the northeast, while others in the north and the east are at the design stage. In the course of the 1980s, a high priority will be given to high transmission lines west to east, bringing power from energy-rich regions to industries near the coast.

4.08 A large part of the total generating capacity consists of small machines, which are inherently less efficient in power generation than larger units (unit sizes under 50 MW account for 47% and units of 50-100 MW another 20%). There are about 90,000 small hydro stations accounting for 7,000 MW, or 11% of total capacity; the average one thus had less than 80 kW of capacity. These scattered small units have proved to be very successful in serving rural needs, since they economize on transmission line costs. They are now being expanded by nearly 400 MW per year, while the average size has been trending upward. Thermal generating capacity was 69.7% (43,904 MW) of the total and accounted for 82.2% of the total production in 1979 and 80.6% in 1980. Coal-fired thermal capacity was 32,955 MW (52.3%) and produced 57.3% of the electrical energy in 1979; oil-fired thermal capacity was 10,762 MW (17.1%) and produced 19.7% of the energy, while natural gasfired thermal units produced 1.9% of the energy. The hydroelectric capacity of 30.3% (19,110 MW) produced 17.8% of the electrical energy. The rise of over 16% in hydroelectric power output in 1980 over 1979, accounting for 43% of the increment in power output in the one year, lifted hydro's share to 19.4%. Though this result may have been helped by unusually high water levels in many reservoirs, it is also indicative of a determination to expand hydroelectric capacity rapidly in the 1980s, while giving increased emphasis to medium-sized units (50-500 MW) which can often be built in as little as 4-6 years.

Fuel Consumption

4.09 The average fuel consumption rate for thermal power stations /1 was 2,954 kcal/kWh in 1979. The corresponding figures in 1977 and 1978 were 3,122 kcal/kWh and 3,038 kcal/kWh, respectively, which show a steady improve ment. This average fuel consumption rate compares favorably with 3,220 kcal kWh in Indonesia but is considerably higher than the 2,520 kcal/kWh in the USA. Substituting coal for oil in power generation and further improving

/1 Excluding those smaller than 6 MW capacity, which accounted for 3.4% of the total electric energy supply.

conversion efficiency are important policy objectives in thermal power development because of the tight energy supply situation and the need to free oil for higher priority uses. Both objectives will involve substantial capital investments, particularly because small and old units must be replaced (further reductions in their fuel consumption are not possible), and boiler design limitations will allow conversion of only a fraction of the oil-fired thermal station capacity to coal.

Capacity Utilization

4.10 The average running hours for all thermal units in the country was 6,018 hours in 1978 and 5,956 hours in 1979. The energy production from thermal units amounted to about 5,280 kWh/kW of installed capacity in 1979, and is said to have risen further to about 5,500 kWh/kW by 1980, which compares with about 3,900 kWh/kW in India and about the same in the USA. These figures show a high degree of maintainability and reliability of Chinese-designed machines in this size and indicate adequate operation and maintenance. Total capacity utilization, including hydro as well as thermal stations, was 4,474 kWh/kW in 1979, the equivalent of over 12 hours per day of operation at full capacity.

Demand Management

4.11 Despite considerable growth in generating capacity, the supply capability has lagged behind demand and shortages exist, particularly in the northeast, north and east grids. It was not possible to obtain a precise assessment of the magnitude of the shortage and its effect on industrial production, but a figure of 20% loss in industrial production was quoted in three regions./1 The northwest grid and the province of Shanxi have not experienced power shortages. Demand management and allocation of shortages are apparently well organized with hardly any *ad hoc* load shedding and no blackouts. A remarkable performance in redirecting electricity supplies toward new priorities including exports appear to have made possible the swift rise in production of light industry (by 18.4% in 1980) and other sharp recent changes in the composition of industrial output. Several industrial plants visited with large exports were guaranteed electric power supplies. But like all rationing schemes, this system almost certainly results in some nonoptimal distribution and disguised costs. Spreading demand evenly over the hours of the day and days of the week requires work shifts to be staggered and production to be curtailed. These changes are associated with social and financial costs that need to be considered in expanding energy suppliers.

Prospects and Recommendations

4.12 No official development program for the electricity industry is available, or expected to become available, until the next five-year plan

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/1 The extent to which these estimates take other constraints into account is not clear.

is prepared and released. A ten-year national development plan for power is being formulated by the Government and a draft is expected before the end of 1981. Quantitative information on future capacity is thus limited to works already underway. About 10,000 MW of hydroelectric and 12,000 MW of thermal generating capacity installations were in various stages of construction as of 1980; about 16,000 MW of this capacity could be expected to be commissioned by the end of 1985. In addition, about 400 MW of capacity is expected to be commissioned each year in the form of small hydroelectrical schemes, thus making a total capacity addition in the order of 18,000 MW by 1985. This is expected to be able to sustain a growth rate in electrical energy supply of 4-5% p.a. in the 1980-85 period. Because of the new emphasis on medium-sized hydroelectric projects and the high priority now being given to the sector in investment programs, this growth rate is expected to rise to 6-7% p.a. in the second half of the 1980s.

4.13 Long-Range Plans. The formulation of long-range (10-15 year) development plans for each region and for the country as a whole, including identification of the least cost sequence of projects for meeting expected demand, would represent an important advance. The present planning process does not use sophisticated economic analysis to compare alternative development strategies and select the least cost solution. Because of the large magnitude of investments envisaged, each percentage point reduction in the cost would amount to a saving far in excess of the cost of carrying out the analysis. We strongly recommend strengthening the planning agencies to perform this task and using external assistance in the initial period.

4.14 More emphasis needs to be given to planning interconnections between generating facilities within a province, between provinces to form regional grids, and between regional grids. Such interconnections would permit savings in capital investments (by reducing the reserve margins required and by permitting larger unit sizes and stations) and on fuel costs (by permitting efficient loading of thermal plants and optimum utilization of hydro capacity). Regional design and research institutes should pool their expertise and supplement it from outside, if necessary, to formulate long-range grid development plans, into which short-term actions would ultimately fit. Industrial and transport plans need to be well integrated with electric power development. Some of the most energy-intensive industries can usefully be shifted increasingly into regions where electricity costs are low. Changes in electricity pricing to reflect costs of supply appear to be needed to help promote such a shift.

4.15 Hydro and Mine-Month Thermal Development. The least cost development plan is likely to include numerous hydroelectric projects, which would increase the proportion of hydroelectric generation. However, large projects now under implementation will not increase hydro's share in total generation significantly. As most large hydro projects have an implementation period of about 8-10 years, and medium projects require at least 4-6 years, a vast and near-term effort both in terms of preparing projects and in terms of committing large capital resources for their implementation within the context of a long-term plan - will be needed. The high priority now being given to small- and medium projects with shorter construction periods appears appropriate. Attention is also rightly being given to mine-month coal-fired thermal plants, together with long-distance transmission lines to link these and other sources of cheap power to user grids.

4.16 Financial Requirements. Accelerating the growth of electric power production in the second half of the decade, so that it surpasses the 4.5% p.a. that appears possible for 1980-85, would of course require an increase in investment, which in 1979 amounted to about $3.2 billion. Currently this investment level is being maintained as a leading exception to the sharp cutback in State capital construction in 1981.

4.17 Institutional Problems. Some weaknesses evident in the sector may reflect institutional problems:

(a) the provincial governments have, by and large, not been able to discharge their responsibility of adequately developing the subtransmission and distribution systems, possibly for lack of resources;

(b) small thermal generating stations have proliferated at the provincial and county levels as a matter of expediency rather than as a part of a long-range plan;

(c) tariffs are generally uniform throughout the country, while cost structures vary;

(d) there is overstaffing with low skilled personnel;

(e) the construction of facilities within a province is normally entrusted to the provincial construction companies, which may or may not have the requisite expertise;

(f) there is virtually no mobility of manpower; and

(g) construction times have been generally longer than in many other countries, particularly for hydro projects, due to a lack of expertise, equipment and building materials or to organizational constraints; but this problem now promises to be overcome.

4.18 Introduction of Modern Technology and Training of Personnel. An acute shortage of manpower is felt in the "high skill" areas. To carry out its expansion program, China will have to develop and implement a large-scale training program for staff at various levels. Several measures can be taken to improve training of manpower and to introduce modern methods, inter alia:

(a) providing computer centers for power system studies;

(b) creating training centers, with full scale digital simulation of the large thermal plants now proposed, for operators;

(c) establishing management training centers for technical, administrative and financial staff;

(d) training of the staff in utilities and organizations outside China on design, construction, operation and maintenance of power facilities; and

(e) strengthening the power research institutes by the addition of equipment and trained personnel.

5. OTHER SOURCES OF ENERGY

Geothermal

5.01 Geothermal resources are widely distributed since the whole of China seems to have a relatively high geothermal gradient. Most occurrences seem to be relatively low temperature groundwater suitable for space heating; high temperature manifestations suitable for power generation seem to be more frequent in the mountainous western parts of the country such as Yunnan and Xizang. Geothermal exploration in China is the responsibility of the Ministry of Geology, which has its own drilling equipment and crews and operates through provincial bureaus. Two projects have been identified so far: a geothermal power generation project at Yangbajian, 50 km northwest of Lhasa, and a district heating project in the southeast part of Beijing. There are reported to be other small projects in the pipeline, including one at Tianjin thought to be another district heating project.

5.02 Geothermal energy has not been developed to a significant extent in China. Its role is likely to be limited to some urban heating systems in the colder regions of the country - particularly Beijing, which has a high temperature gradient - and to power generation in regions like Xizang, which lack other energy sources.

Noncommercial Energy

5.03 Unofficial estimates put fuels extracted from the agricultural system and from forestry at roughly 250 Mtce, or less than 30% of the total, for about 800 million users. Average per capita use on this basis would be about 0.6 m^3 firewood equivalent annually. Rice straw appears to be the most important traditional fuel, as firewood is not available in many areas. Traditional fuels thus play an important role in the Chinese energy sector, but a much smaller one than in most other countries at similar per capita income levels. This reflects a low per capita use of traditional fuels, necessitated by a high population density and low availability of forest resources, and the very high industrial fuel demand. In forested areas, as in many other developing countries, however, the cutting that does take place is believed to be having a cumulative negative effects on the nation's limited forest resources, which are badly needed for industrial materials such as timber and wood pulp,/1 so that steps may be needed to reduce forest cutting while substituting other energy sources.

5.04 A number of approaches have been used to alleviate rural household energy shortages. Mass afforestation campaigns have been undertaken. Coal dust is collected in mining areas, made into balls, and distributed. Biogas is reportedly used on a scale unprecedented in other countries; some 7 million digesters were said to have been built by mid-1979. The standard size unit apparently meets the cooking and lighting needs of a household of five persons, so the fraction of the rural population in households equipped with digestors may not exceed 5%. Kerosene and other petroleum fuels do not appear to be in general use in rural areas. Rural electrification does not seem to include household connections in most cases, so rural household lighting may be an area of large potential energy demand.

/1 One of the negative comments on national economic performance in 1980, in the (April 29, 1981) Xinhua communique on fulfillment of the year's plan, was that "trees were felled at random in many areas."

Table A.1: GROWTH OF ENERGY PRODUCTION, 1952-80

	Electricity		Hydro		Coal		Oil		Natural gas		Total primary	
	(GWh)	(% p.a.)	(GWh)	(% p.a.)	(mln tons)	(% p.a.)	(mln tons)	(% p.a.)	(Bln cu m)	(% p.a.)	(Mtce)	(% p.a.)
1952	7,260		1,260		66.49		0.436		0.008		48.7	
1952-57		21.6		30.8		14.5		27.3		54.3		14.9
1957	19,340		4,820		130.73		1.458		0.070		97.6	
1957-65		16.9		10.1		7.4		29.2		41.3		8.5
1965	67,600		10,410		231.80		11.31		1.112		187.0	
1965-70		11.4		14.5		8.8		22.1		20.9		10.6
1970	115,860		20,460		353.99		30.65		2.870		310.0	
1970-75		11.1		18.4		6.4		20.2		25.3		9.5
1975	195,840		47,630		482.24		77.06		8.850		488.6	
1975-80		8.9		4.1		5.2		6.6		10.0		5.6
1980	300,627		58,211		620.13		105.95		14.270		640.9	
1952-80		14.2		14.7		8.3		21.7		30.7		9.6

Notes: (1) Mtce (million tons of coal equivalent) coefficients based on tce of 7 million kcal, with calorific values assued as follows: coal 5,000 kcal/kg; oil 10,200 kcal/kg, natural gas 9,310 kcal/m^3; hydroelectric power 2,954 kcal/kg.
(2) Oil production includes shale oil.

Source: Ministries of Electric Power, Coal Industry and Petroleum Industry.

Table A.2: ENERGY SECTOR INVESTMENTS, 1977-79
(Y million)

	1977	1978	1979
Petroleum	1,969	3,792	2,724
Power	3,306	4,933	4,784
Coal	2,166	3,318	3,248
Total	7,441	12,043	10,756
(%) Petroleum	26	31	26
Power	44	41	44
Coal	29	28	30
National total	36,441	47,955	49,988
Energy as %	20.4	25.1	21.5

Note: Official figures on state capital construction supplied to the United Nations Statistical Office, shown in Annex D, Table 3.2, are a little different in every case, no doubt because of different definitions and coverage.

Source: Tables 3.8, A.12 and A.22

Table A.3: OIL EXPORTS, 1975-80
(Thousand tons)

Year	Crude oil	Products	Total
1975	9,878	2,217	12,095
1976	8,496	2,145	10,641
1977	9,107	2,169	11,276
1978	11,313	2,417	13,731
1979	13,450	3,400	16,850
1980 (planned)	13,400	4,060	17,460

Source: Ministry of Petroleum Industry.

Table A.4: NUMBER OF UNDERGROUND COAL MINES IN OPERATION, 1975-79

	1975	1976	1977	1978	1979
Large Mines /a					
Southwest	19	20	22	22	22
Northwest	19	20	25	23	27
Central-South	17	26	27	27	28
East	28	29	31	31	33
North	59	62	66	66	68
Northeast	27	30	32	32	34
Total	169	187	203	201	212
Medium Mines /b					
Southwest	120	120	126	220	145
Northwest	105	90	83	102	89
Central-South	210	197	211	225	215
East	160	173	182	192	192
North	211	207	213	203	204
Northeast	208	201	200	199	195
Total	1,014	988	1,015	1,141	1,040
Small Mines /c					
Southwest	221	223	238	137	208
Northwest	95	126	133	117	131
Central-South	200	239	248	269	266
East	101	94	111	124	121
North	159	163	158	159	163
Northeast	96	98	111	115	118
Total	872	944	999	921	1,007

/a Large mines - production greater than 600,000 tons per year.

/b Medium mines - production 100,000 to 600,000 tons per year.

/c Small mines - production less than 100,000 tons per year.

Source: Ministry of Coal Industry.

Table A.5: COAL PRODUCTION BY TYPE AND SIZE OF MINE, 1970-80
(Thousand tons)

Year	Total	Open-pit mines	Underground mines: Over 0.6 mln tons per year production	Underground mines: From 0.1 mln to 0.6 mln tons per year production	Underground mines: Under 0.1 mln tons per year produciton
1970	353,988/a	1,9717	114,256	150,321	77,440/a
1971	392,288/a	12,138	134,504	157,418	88,228/a
1972	410,470/a	11,623	135,388	171,144	92,315/a
1973	416,969	13,548	134,703	174,339	94,379
1974	413,170	14,442	131,728	171,224	95,776
1975	482,240	15,711	172,599	181,777	112,153
1976	483,450	15,680	149,265	204,608	113,897
1977	550,680	14,990	173,717	227,611	134,362
1978	617,860	16,977	203,150	256,036	141,697
1979	635,540	16,557	212,811	254,946	151,226
1980	620,130	n.a.	n.a.	n.a.	n.a.

/a Estimate.

Source: Ministry of Coal Industry.

Table A.6: LIGNITE PRODUCTION BY PROVINCE, 1955-79
(Thousand tons)

	1955	1960	1965	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	Estimated cumulative 1955-79
Total	2,090	8,466	8,831	12,996	13,979	15,641	17,392	18,020	20,346	20,550	23,313	24,856	25,252	302,560
Southwest														
Sichuan	-	-	-	-	37	45	33	12	6	6	11	9	10	-
Guizhou	-	-	-	-	1	9	-	2	2	4	6	5	7	-
Yunnan	-	-	-	3,514	4,129	4,206	4,462	4,461	4,906	4,295	6,034	5,746	5,484	-
Xizang	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Northwest														
Shaanxi	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gansu	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Qinghai	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ningxia	-	-	-	-	-	-	12	-	-	-	-	-	-	-
Xiniang	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Center-South														
Henan	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hubei	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hunan	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Guangxi	-	-	-	694	950	1,030	1,091	1,309	1,433	1,644	1,830	1,839	1,778	-
Guangdong	-	-	-	387	429	398	402	428	473	538	590	557	428	-
East														
Shanghai	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Jiangsu	-	-	-	-	5	-	-	-	-	-	-	-	-	-
Zhejiang	-	-	-	121	74	43	44	25	22	18	35	33	22	-
Anhui	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fujian	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Jianxi	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Shandong	-	-	-	-	39	43	34	71	343	369	464	504	558	-
North														
Beijing	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tianjin	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hebei	-	-	-	115	84	58	90	272	285	325	290	155	98	-
Shanxi	-	-	-	-	-	-	-	-	-	-	-	-	4	-
Nei Monggol	-	-	-	1,034	899	1,056	1,228	1,024	1,048	1,060	1,154	1,604	1,686	-
Northeast														
Liaoning	-	-	-	3,266	3,300	3,948	4,459	4,713	5,033	5,061	5,207	6,118	6,513	-
Jilin	-	-	-	2,124	2,516	2,703	2,917	3,160	3,908	4,079	4,586	4,903	5,231	-
Heilongjiang	-	-	-	1,741	1,516	2,099	2,620	2,545	2,889	3,151	3,106	3,385	3,813	-

Source: Ministry of Coal Industry.

Table A.7: ANTHRACITE COAL PRODUCTION BY PROVINCE, 1955-79
(Thousand tons)

	1955	1960	1965	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	Estimated cumulative 1955-79
Total	13,576	68,179	39,586	56,124	71,922	81,363	83,256	85,638	97,092	99,592	115,467	126,218	125,838	1,547,494
Southwest														
Sichuan	347	4,060	-	1,216	3,848	4,179	3,716	3,645	4,745	4,655	6,566	6,297	6,138	-
Guizhou	177	2,326	-	2,199	2,617	4,717	2,635	3,270	4,143	3,902	4,639	5,339	5,011	-
Yunnan	107	1,240	-	1,062	2,148	1,127	1,214	1,237	1,481	1,450	935	1,654	1,439	-
Xizang	-	-	-	1	-	22	30	33	47	43	24	60	33	-
Northwest														
Shaanxi	180	71	-	-	43	-	47	35	45	59	59	116	66	-
Gansu	-	914	-	304	408	508	547	947	843	822	1,220	587	1,066	-
Qinghai	-	56	-	-	-	-	-	33	-	-	-	-	-	-
Ningxia	-	915	-	529	754	1,050	1,394	1,576	2,197	1,757	2,189	2,654	2,299	-
Xinjiang	27	-	-	100	883	472	499	482	611	513	809	661	549	-
Center-South														
Henan	3,474	13,517	-	11,329	12,444	14,091	14,880	14,962	13,888	12,338	17,595	19,185	18,133	-
Hubei	410	1,510	-	1,886	2,315	2,142	2,135	2,180	2,821	2,986	3,767	4,326	3,087	-
Hunan	878	5,771	-	3,801	7,177	7,979	7,934	7,678	9,247	9,323	8,889	9,079	8,572	-
Guangxi	5	580	-	96	625	600	479	800	1,308	1,817	1,760	1,798	1,934	-
Guangdong	285	3,414	-	4,322	6,240	5,400	5,136	5,201	6,569	7,579	8,661	8,924	7,974	-
East														
Shanghai	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Jiangsu	35	124	-	76	72	313	390	522	773	678	714	846	691	-
Zhejiang	-	165	-	1,250	579	306	256	243	233	214	322	448	455	-
Anhui	35	1,283	-	901	1,055	884	1,118	1,145	1,487	1,422	1,482	2,045	1,916	-
Fujian	21	935	-	892	1,340	1,773	2,137	2,239	2,574	2,736	3,262	4,008	4,559	-
Jianxi	179	2,727	-	1,650	1,586	1,969	2,388	2,669	2,794	3,082	3,681	4,717	4,679	-
Shandong	18	1,082	-	597	833	1,035	1,208	862	1,367	1,866	2,427	2,838	2,978	-
North														
Beijing	1,522	8,360	-	6,238	6,793	6,918	7,083	7,345	7,491	7,461	7,808	8,191	8,133	-
Tianjin	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hebei	582	3,082	-	3,066	3,451	3,439	3,988	4,582	5,029	5,431	6,746	7,820	8,106	-
Shanxi	3,911	11,898	-	11,934	14,232	19,470	20,871	20,996	24,425	25,988	28,245	30,625	33,652	-
Nei Monggol	82	421	-	7	20	29	22	27	43	55	53	57	38	-
Northeast														
Liaoning	1,013	2,879	-	2,166	2,115	2,437	2,619	2,785	2,693	2,849	2,933	3,302	3,312	-
Jilin	288	514	-	502	328	366	400	144	160	511	598	565	793	-
Heilongjiang	-	335	-	-	16	137	130	-	78	55	83	76	225	-

Source: Ministry of Coal Industry.

Table A.8: BITUMINOUS STEAM COAL PRODUCTION BY PROVINCE, 1952-79
(Thousand tons)

	1952	1955	1960	1965	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	Estimated cumulative 1952-79
Total	46,166	74,017	318,304	183,384	284,868	306,397	313,467	316,321	309,512	364,799	363,308	411,900	466,787	484,449	6,994,405
Southwest															
Sichuan	-	-	-	-	18,295	21,332	23,109	21,817	20,740	26,112	24,284	36,200	31,633	32,232	-
Guizhou	-	-	-	-	3,745	5,405	4,527	4,237	4,709	6,905	6,612	9,320	11,343	11,341	-
Yunnan	-	-	-	-	4,353	4,083	5,610	5,710	6,066	6,528	5,483	6,532	7,440	6,614	-
Xizang	-	-	-	-	8	13	3	13	17	16	27	53	27	26	-
Northwest															
Shaanxi	-	-	-	-	6,739	8,173	9,491	10,768	10,681	11,363	11,626	14,725	16,540	17,746	-
Gansu	-	-	-	-	4,496	5,707	5,667	5,937	6,370	1,539	8,105	8,426	9,226	7,684	-
Qinghai	-	-	-	-	1,118	1,183	1,340	1,529	1,584	1,827	2,024	2,277	2,497	2,158	-
Ningxia	-	-	-	-	4,199	4,767	5,033	5,494	4,457	5,482	6,436	6,916	7,577	8,197	-
Xingiang	-	-	-	-	5,488	5,444	5,053	5,066	5,652	6,551	7,404	9,046	10,132	9,712	-
Center-South															
Henan	-	-	-	-	17,800	19,556	22,429	21,365	24,068	29,339	24,426	36,114	39,260	40,246	-
Hubei	-	-	-	-	745	1,190	1,410	1,190	1,216	1,539	1,578	1,876	2,109	1,502	-
Hunan	-	-	-	-	7,237	6,755	8,017	8,726	7,247	9,178	9,529	11,207	12,924	17,302	-
Guangxi	-	-	-	-	1,938	2,352	2,300	2,563	3,053	3,314	3,582	3,909	4,648	3,512	-
Guangdong	-	-	-	-	478	451	460	555	641	783	831	971	1,054	941	-
East															
Shanghai	-	-	-	-	-	-	-	-	-	-	42	230	874	1,067	-
Jiangsu	-	-	-	-	6,916	9,710	10,622	11,438	8,361	10,664	12,431	13,370	16,224	16,566	-
Zhesiang	-	-	-	-	846	1,066	998	732	192	238	453	736	1,112	1,210	-
Anhui	-	-	-	-	14,541	16,131	16,763	17,043	13,444	17,772	19,398	20,742	22,488	22,863	-
Fujian	-	-	-	-	208	301	323	311	250	232	200	202	223	231	-
Jianxi	-	-	-	-	7,325	8,693	7,054	7,892	6,855	7,583	7,904	9,181	11,236	10,941	-
Shandong	-	-	-	-	23,457	25,564	26,829	24,461	13,372	26,801	31,125	35,300	38,659	40,845	-
North															
Beijing	-	-	-	-	12	19	20	22	26	22	22	-	-	-	-
Tianjin	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hebei	-	-	-	-	32,529	35,207	36,451	38,458	41,438	46,654	37,988	38,144	49,447	50,206	-
Shanxi	-	-	-	-	41,046	41,383	40,467	43,104	46,959	50,986	51,215	59,291	67,624	75,279	-
Nei Monggol	-	-	-	-	6,446	7,381	7,064	6,694	6,526	8,562	8,874	10,380	11,358	10,887	-
Northeast															
Liaoning	-	-	-	-	36,954	36,994	36,099	34,237	36,526	36,496	36,996	35,755	38,754	37,346	-
Jilin	-	-	-	-	11,487	12,459	12,392	12,366	12,803	13,137	13,415	14,068	15,269	15,363	-
Heilongjiang	-	-	-	-	26,462	25,078	23,936	24,593	26,259	29,175	31,298	32,929	37,109	42,432	-

Source: Ministry of Coal Industry.

Table A.9: COKING COAL PRODUCTION BY PROVINCE, 1955-79
(Thousand tons)

	1955	1960	1965	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	Estimated cumulative 1955-79
Total	44,409	197,402	134,878	179,323	207,835	216,610	208,037	193,763	238,490	235,105	267,020	317,616	327,408	3,832,123
Southwest														
Sichuan	2,466	24,680	-	7,105	14,527	19,599	17,316	15,900	19,587	19,230	23,102	25,593	27,159	-
Guizhou	33	3,017	-	2,147	3,456	4,033	2,590	2,366	3,975	3,786	6,851	9,002	9,727	-
Yunnan	181	3,234	-	3,343	2,576	4,654	4,777	4,321	5,924	5,179	6,424	7,374	6,339	-
Xizang	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Northwest														
Shaanxi	184	1,940	-	3,275	3,167	4,872	5,611	5,066	5,243	5,105	6,877	7,770	9,180	-
Gansu	-	1,326	-	47	615	1,108	597	883	905	1,135	1,039	906	558	-
Qinghai	11	670	-	76	88	57	49	23	105	157	211	185	109	-
Ningxia	-	1,961	-	3,817	4,380	4,573	5,063	3,882	4,859	5,778	6,063	6,852	7,144	-
Xiniang	89	1,991	-	536	672	657	708	742	645	1,266	1,839	1,916	1,542	-
Center-South														
Henan	193	10,919	-	15,151	16,622	17,554	16,443	17,703	21,217	16,854	24,352	26,435	26,824	-
Hubei	12	430	-	258	499	614	899	556	1,072	1,067	1,309	790	799	-
Hunan	567	4,964	-	4,281	5,543	6,642	4,297	2,718	3,575	5,241	3,933	4,716	4,801	-
Guangxi	-	3,361	-	150	-	-	-	205	256	268	403	398	353	-
Guangdong	-	711	-	479	240	460	364	427	488	519	572	625	606	-
East														
Shanghai	-	-	-	-	-	-	-	-	-	-	-	874	1,067	-
Jiangsu	1,578	1,844	-	5,016	9,344	9,894	10,239	7,131	9,699	11,267	12,386	14,881	14,947	-
Zhejiang	-	333	-	846	1,065	941	698	162	212	423	698	1,040	1,184	-
Anhui	3,249	10,976	-	14,497	16,131	16,628	17,043	13,444	17,623	19,200	20,445	21,956	22,344	-
Fujian	-	270	-	209	301	-	-	-	-	-	-	-	-	-
Jianxi	935	3,916	-	7,043	7,087	6,443	5,619	4,870	5,509	5,694	6,778	8,159	8,332	-
Shandong	3,356	19,845	-	20,828	21,877	23,080	19,967	11,103	22,077	26,410	29,820	33,196	35,157	-
North														
Beijing	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tianjin	-	-	-	-	-	-	-	-	-		-	-	-	-
Hebei	11,388	35,160	-	29,238	33,845	32,871	35,311	38,594	44,026	35,847	36,170	46,179	46,677	-
Shanxi	1,566	14,508	-	8,852	18,849	18,753	17,281	18,630	19,438	17,669	22,442	38,496	31,530	-
Nei Monggol	62	6,072	-	4,171	4,305	4,287	4,322	4,501	6,594	6,997	8,256	8,514	8,540	-
Northeast														
Liaoning	8,750	14,703	-	18,574	14,714	13,988	12,794	13,328	13,173	12,629	12,497	12,999	12,694	-
Jilin	1,139	3,656	-	6,830	3,685	3,683	4,029	4,277	7,913	7,503	7,770	8,309	8,604	-
Heilongjiang	8,650	29,940	-	22,554	24,247	21,239	22,021	22,931	24,376	25,881	26,783	30,453	41,194	-

Source: Ministry of Coal Industry.

Table A.10: EMPLOYMENT IN COAL MINING, 1970-79

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
Total Personnel										
Southwest	267,912	311,980	316,645	423,194	438,463	451,614	459,615	464,855	465,127	467,441
Northwest	242,256	290,167	306,766	269,956	296,015	324,169	342,168	353,003	364,530	363,395
Central-South	446,597	514,229	526,948	587,264	616,239	640,337	687,233	706,050	718,212	720,367
East	491,399	557,369	626,698	654,330	668,029	730,638	790,931	816,427	887,941	869,615
North	486,362	558,955	578,645	630,495	692,545	752,636	784,611	827,383	824,308	858,573
Northeast	550,127	584,660	609,906	686,357	690,683	726,648	749,925	771,352	808,531	824,601
Total	2,484,653	2,817,360	2,965,608	3,251,596	3,401,974	3,626,042	3,814,483	3,939,070	4,068,649	4,103,992
Miners in Nationally Allocated Mines										
Underground	649,234	698,082	711,606	747,730	763,117	809,565	833,730	897,375	895,085	903,579
Open pit	19,371	20,200	20,645	21,637	25,698	27,173	25,532	26,685	26,022	26,218
Total	668,605	718,282	732,251	769,367	788,815	836,738	859,262	924,060	921,107	929,797

Source: Ministry of Coal Industry.

Table A.11: COAL EXPLORATION EFFORT, 1970-79

Region	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
Seismic Set-Months										
Southwest	-	-	-	7.70	5.62	18.05	18.67	24.33	18.30	20.46
Northwest	-	-	-	48.04	29.06	42.84	67.49	50.25	49.33	51.61
Central-South	-	-	-	47.43	58.83	75.03	78.39	66.15	71.24	69.44
East	-	-	-	119.84	131.43	108.32	122.81	134.16	149.05	139.27
North	-	-	-	28.18	36.52	34.41	43.45	57.57	68.90	82.26
Northeast	-	-	-	49.12	35.64	47.27	42.19	43.67	37.23	44.62
Total	-	-	-	300.31	297.10	325.92	373.00	376.13	394.05	407.66
Drilling Rig-Months										
Southwest	462.54	537.44	641.63	550.15	533.43	557.56	570.23	575.53	742.50	748.63
Northwest	375.30	518.49	572.34	518.67	554.60	600.46	679.17	718.52	790.44	776.38
Central-South	1,157.84	1,388.45	1,465.50	1,505.03	1,551.47	1,663.67	1,788.80	1,900.54	2,022.94	2,015.31
East	1,299.66	1,755.84	1,875.28	1,934.09	1,732.28	1,645.67	1,793.01	1,940.98	1,998.50	2,153.04
North	256.88	355.20	441.43	510.60	749.52	831.14	903.31	1,027.85	1,249.49	1,409.44
Northeast	786.82	974.47	1,031.37	1,011.53	1,054.96	1,045.49	1,115.83	1,131.24	1,240.59	1,408.09
Total	4,339.04	5,629.89	6,027.55	6,030.07	6,176.26	6,313.99	6,847.35	7,294.66	8,044.46	8,510.89
Number of Wells Completed										
Southwest	475	923	872	640	484	534	713	850	903	1,038
Northwest	417	579	559	545	497	628	712	866	753	725
Central-South	1,210	1,485	1,617	1,385	1,218	1,406	1,266	1,499	1,365	1,336
East	1,542	2,180	2,082	1,717	1,353	1,680	2,114	2,267	1,871	1,741
North	350	451	528	582	824	948	878	1,020	1,330	1,155
Northeast	774	712	1,294	1,779	953	1,346	1,560	1,560	1,771	1,494
Total	4,768	6,330	6,953	6,648	5,329	6,542	7,243	8,062	7,993	7,489
Meters Drilled										
Southwest	141,917	230,011	215,955	178,214	163,670	187,690	230,832	287,422	342,344	345,377
Northwest	157,536	184,219	204,807	194,108	197,524	237,371	276,529	328,119	314,944	318,088
Central-South	438,663	476,331	487,629	456,714	426,125	472,066	514,535	575,958	596,749	586,864
East	679,417	835,630	805,680	766,712	559,858	700,568	887,119	1,001,016	973,796	974,144
North	163,067	223,488	226,176	272,671	396,111	484,428	439,152	509,562	609,014	637,955
Northeast	364,741	401,754	411,508	572,775	539,988	660,408	658,338	662,311	678,873	657,989
Total	1,945,341	2,351,433	2,351,755	2,441,194	2,393,276	2,742,531	3,006,505	3,364,388	3,515,720	3,520,417

Source: Ministry of Coal Industry.

Table A.12: COAL INVESTMENT BY REGION, 1970-80e
(Y Million)

Region	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980 (est.)
Southwest	368.66	383.46	326.90	258.81	223.82	221.52	147.26	152.66	221.58	199.95	139.45
Northwest	217.10	238.96	231.76	230.85	258.58	266.25	204.43	217.74	312.33	293.86	183.49
Central-South	475.92	429.84	447.88	412.74	406.27	381.11	308.62	367.31	513.12	457.51	325.38
East	321.67	461.09	450.12	434.88	426.06	405.74	462.02	560.82	897.45	929.93	751.08
North	147.99	163.86	216.16	304.92	409.46	491.23	399.92	465.26	758.05	751.10	667.89
Northeast	122.86	143.18	207.41	255.34	272.79	308.91	344.01	402.28	615.13	615.93	379.21
Total	1,654.20	1,820.39	1,880.23	1,897.54	1,996.98	2,074.76	1,866.26	2,166.07	3,317.66	3,248.28	2,446.50

Source: Ministry of Coal Industry.

Table A.13: MAJOR POWER STATIONS IN CHINA, 1979

No.	Name of power station	Power grid	Installed capacity (MW)
1.	Harbin Thermal Power Station	Northeast China	300.0
2.	Xinhua Thermal Power Station	Northeast China	500.0
3.	Qianqi Thermal Power Station	Northeast China	299.0
4.	Jilin Heat and Thermal Power Station	Northeast China	450.0
5.	Fengman Hydro Power Station	Northeast China	553.7
6.	Qinghe Thermal Power Station	Northeast China	1,100.0
7.	Hunjiang Thermal Power Station	Northeast China	150.0
8.	Liaoning Thermal Power Station	Northeast China	682.0
9.	Fushun Thermal Power Station	Northeast China	245.0
10.	Yunfeng Hydro Power Station	Northeast China	200.0
11.	Huanren Hydro Power Station	Northeast China	294.5
12.	Shuifeng Hydro Power Station	Northeast China	315.0
13.	Anshan Thermal Power Station	Northeast China	220.0
14.	Fuxin Thermal Power Station	Northeast China	550.0
15.	Yuanbaoshan Thermal Power Station	Northeast China	300.0
16.	Chaoyang Thermal Power Station	Northeast China	400.0
17.	Jixi Thermal Power Station	Northeast China	192.0
18.	Jingbohu Hydro Power Station	Northeast China	96.0
19.	Douhe Thermal Power Station	North China	750.0
20.	Tangshan Thermal Power Station	North China	305.0
21.	Tianjin No. 3 Thermal Power Station	North China	375.0
22.	Dagang Thermal Power Station	North China	640.0
23.	Beijing No. 1 Heat and Thermal Power Station	North China	340.0
24.	Jingsi Thermal Power Station	North China	200.0
25.	Shijingshan Thermal Power Station	North China	735.0
26.	Shentou Thermal Power Station	North China	350.0
27.	Taiyuan No. 2 Thermal Power Station	North China	250.0
28.	Niangziguan Thermal Power Station	North China	200.0
29.	Huoxian Thermal Power Station	North China	400.0
30.	Matou Thermal Power Station	North China	650.0
31.	Zhanhua Thermal Power Station	Shandong Province	250.0
32.	Xindian Thermal Power Station	Shandong Province	600.0
33.	Laiwu Thermal Power Station	Shandong Province	375.0
34.	Shiheng Thermal Power Station	Shandong Province	150.0
35.	Jining Thermal Power Station	Shandong Province	300.0
36.	Xuzhou Thermal Power Station	East China	500.0
37.	Huaibei Thermal Power Station	East China	350.0
38.	Huainan Thermal Power Station	East China	600.0
39.	Nanjing Heat and Thermal Power Station	East China	385.0
40.	Tianshenggang Thermal Power Station	East China	250.0
41.	Jianbi Thermal Power Station	East China	500.0

No.	Name of power station	Power grid	Installed capacity (MW)
42.	Wangting Thermal Power Station	East China	800.0
43.	Zhabei Thermal Power Station	East China	464.6
44.	Wujing Thermal Power Station	East China	380.0
45.	Minxing Thermal Power Station	East China	473.0
46.	Jinshan Thermal Power Station	East China	250.0
47.	Zhenhai Thermal Power Station	East China	250.0
48.	Fuchunjiang Hydro Power Station	East China	297.0
49.	Xinanjiang Hydro Power Station	East China	662.5
50.	Hunanzhen Hydro Power Station	East China	85.0
51.	Gutianxi Hydro Power Station	Fujian Province	259.0
52.	Yongan Thermal Power Station	Fujian Province	100.0
53.	Anyang Thermal Power Station	Central China	352.0
54.	Jiaozuo Thermal Power Station	Central China	448.0
55.	Sanmenxia Hydro Power Station	Central China	250.0
56.	Luoyang Heat and Thermal Power Station	Central China	285.0
57.	Kaifeng Thermal Power Station	Central China	330.0
58.	Yaomeng Thermal Power Station	Central China	300.0
59.	Danjiang Hydro Power Station	Central China	900.0
60.	Jingmen Heat and Thermal Power Station	Central China	225.0
61.	Qingshan Heat and Thermal Power Station	Central China	662.0
62.	Huangshi Thermal Power Station	Central China	270.0
63.	Zhelin Hydro Power Station	Jiangxi Province	180.0
64.	Fenyi Thermal Power Station	Jiangxi Province	220.0
65.	Fengtan Hydro Power Station	Hunan Province	400.0
66.	Zhexi Hydro Power Station	Hunan Province	447.5
67.	Jinzhushan Thermal Power Station	Hunan Province	350.0
68.	Shaoguan Thermal Power Station	Guangdong Province	224.0
69.	Fengshuba Hydro Power Station	Guangdong Province	150.0
70.	Xinfengjiang Hydro Power Station	Guangdong Province	292.5
71.	Huangpu Thermal Power Station	Guangdong Province	250.0
72.	Maoming Heat and Thermal Power Station	Guangdong Province	250.0
73.	Heshan Thermal Power Station	Guangxi Province	325.0
74.	Xijin Hydro Power Station	Guangxi Province	234.4
75.	Wulashan Thermal Power Station	Ningxia Province	100.0
76.	Baotou No. 1 and No. 2 Thermal Stations	Ningxia Province	412.0
77.	Hancheng Thermal Power Station	Northwest China	402.5
78.	Qinling Thermal Power Station	Northwest China	250.0
79.	Shiquan Hydro Power Station	Northwest China	135.0
80.	Qingtongsia Hydro Power Station	Northwest China	272.0
81.	Xigu Heat and Thermal Power Station	Northwest China	300.0
82.	Liujiaxia Hydro Power Station	Northwest China	1,225.0
83.	Yanguoxia Hydro Power Station	Northwest China	352.0
84.	Bikou Hydro Power Station	Sichuan Province	300.0

No.	Name of power station	Power grid	Installed capacity (MW)
85.	Yingxiuwan Hydro Power Station	Sichuan Province	135.0
86.	Yuzixi Hydro Power Station	Sichuan Province	160.0
87.	Gongju Hydro Power Station	Sichuan Province	707.5
88.	Douba Thermal Power Station	Sichuan Province	300.0
89.	Zhongqing Thermal Power Station	Sichuan Province	296.0
90.	Huayingshan Power Station	Sichuan Province	150.0
91.	Wujiangdu Hydro Power Station	Guizhou Province	210.0
92.	Qingzhen Thermal Power Station	Guizhou Province	278.0
94.	Yilihe Hydro Power Station	Yunnan Province	321.5
95.	Weihuliang Thermal Power Station	Xinjiang Province	59.0
96.	Hongyanchi Thermal Power Station	Xinjiang Province	100.0
97.	Tiemenguan Hydro Power Station	Xinjiang Province	47.4
98.	Lhasa Thermal Power Station	Xizang	12.0
99.	Najin Hydro Power Station	Xizang	10.76

Source: Ministry of Electric Power.

Table A.14: ELECTRICITY GENERATION AND INSTALLED GENERATING CAPACITY, 1949-79

Year	Total generation (GWh)	Installed capacity (MW)
1949	4,310	1,848.6
1952	7,260	1,964.0
1957	19,340	4,635.0
1962	45,800	13,037.2
1965	67,600	15,076.3
1970	115,860	23,770.0
1971	138,360	26,282.0
1972	152,450	29,501.0
1973	166,760	33,925.0
1974	168,850	38,108.0
1975	195,840	43,406.0
1976	203,130	47,147.4
1977	223,400	51,450.5
1978	256,550	57,122.1
1979	281,950	63,015.9

Source: Ministry of Electric Power.

Table A.15: HYDRO AND THERMAL ELECTRICITY GENERATION BY REGION, 1970-79
(GWh)

Year	N.E.	North	N.W.	East	Central South	S.W.	Total
1970							
Hydro	3,350	680	2,670	4,320	6,950	2,480	20,460
Thermal	25,470	20,190	5,670	25,390	11,410	7,290	95,400
Subtotal	28,820	20,870	8,340	29,710	18,360	9,770	115,860
1971							
Hydro	5,180	530	3,560	4,310	7,940	3,540	25,060
Thermal	27,200	23,720	7,160	31,170	14,250	9,800	113,300
Subtotal	32,380	24,250	10,720	35,480	22,190	13,340	138,360
1972							
Hydro	6,480	410	4,010	4,380	8,780	4,760	28,820
Thermal	28,800	25,840	7,800	35,150	16,480	9,560	123,630
Subtotal	35,280	26,250	11,810	39,530	25,260	14,320	152,450
1973							
Hydro	7,390	410	5,700	7,010	12,180	6,210	38,900
Thermal	29,480	27,910	7,460	37,440	16,830	8,740	127,860
Subtotal	36,870	28,320	13,160	44,450	29,010	14,950	166,760
1974							
Hydro	6,020	720	6,960	7,080	13,120	7,540	41,440
Thermal	32,630	30,090	7,520	33,930	16,210	7,030	127,410
Subtotal	38,650	30,810	14,480	41,010	29,330	14,570	168,850
1975							
Hydro	5,350	710	8,580	7,920	17,020	8,050	47,630
Thermal	35,810	34,240	8,430	41,570	18,390	9,770	148,210
Subtotal	41,160	34,950	17,010	49,490	35,410	17,820	195,840
1976							
Hydro	3,560	560	10,060	7,150	17,170	7,140	45,640
Thermal	39,460	34,920	8,600	47,520	17,830	9,160	157,490
Subtotal	43,020	35,480	18,660	54,670	35,000	16,300	203,130
1977							
Hydro	3,850	800	10,440	7,900	16,030	8,650	47,650
Thermal	39,760	37,840	10,350	52,960	23,900	10,930	175,750
Subtotal	43,610	38,640	20,790	60,860	39,930	19,580	223,400
1978							
Hydro	2,690	970	9,750	6,450	15,630	9,150	44,630
Thermal	45,830	44,860	12,710	63,690	30,520	14,300	211,920
Subtotal	48,520	45,830	22,460	70,140	46,150	23,450	256,550
1979							
Hydro	4,746	1,376	10,416	5,996	17,178	10,408	50,120
Thermal	46,834	49,183	13,512	71,539	35,356	15,406	231,830
Subtotal	51,580	50,559	23,928	77,535	52,534	25,814	281,950

Source: Ministry of Electric Power.

Table A.16: HYDRO AND THERMAL INSTALLED CAPACITY BY REGION, 1970-79
(MW)

Year	Type	North East	North	North West	East	Central South	Southwest	Total
1970	Hydro	1,308	254	912	1,328	1,764	669	6,235
	Thermal	3,820	3,373	1,509	4,304	2,406	2,085	17,535
	Total	5,128	3,627	2,421	5,632	4,170	2,754	23,770
1971	Hydro	1,324	288	981	1,591	2,250	1,370	7,804
	Thermal	3,986	3,489	1,625	4,748	2,473	2,151	18,478
	Total	5,310	3,777	2,606	6,339	4,723	3,521	26,282
1972	Hydro	1,335	272	1,231	1,718	2,640	1,499	8,700
	Thermal	4,328	3,836	1,726	5,580	3,016	2,296	20,801
	Total	5,663	4,113	2,957	7,298	5,656	3,795	29,501
1973	Hydro	1,407	308	1,621	1,893	3,243	1,827	10,299
	Thermal	4,611	4,621	1,928	6,655	3,363	2,431	23,626
	Total	6,018	4,929	3,549	8,548	6,606	4,258	33,925
1974	Hydro	1,456	339	1,964	2,198	3,872	1,988	11,817
	Thermal	5,113	5,310	2,120	7,577	3,560	2,583	26,291
	Total	6,569	5,649	4,084	9,775	7,432	4,571	38,108
1975	Hydro	1,564	397	2,290	2,681	4,315	2,181	13,428
	Thermal	6,036	6,026	2,274	8,516	4,484	2,608	29,978
	Total	7,600	6,423	4,564	11,197	8,799	4,789	43,406
1976	Hydro	1,574	428	2,543	2,846	4,787	2,477	14,655
	Thermal	6,676	6,252	2,434	9,438	4,950	2,720	32,492
	Total	8,251	6,680	4,977	12,284	9,737	5,197	47,147
1977	Hydro	1,619	517	2,666	3,097	5,071	2,795	15,765
	Thermal	7,253	7,182	2,504	10,327	5,560	2,848	35,686
	Total	8,872	7,699	5,170	13,424	10,631	5,644	51,451
1978	Hydro	1,658	573	2,833	3,341	5,841	3,032	17,277
	Thermal	8,008	8,123	2,596	11,299	6,735	3,038	39,845
	Total	9,666	8,696	5,428	14,640	12,576	6,070	57,122
1979	Hydro	1,713	597	2,933	3,784	6,528	3,556	19,110
	Thermal	7,919	9,582	2,936	12,688	7,517	3,210	43,906
	Total	9,632	10,179	5,869	16,472	14,045	6,766	63,016

Source: Ministry of Electric Power.

Table A.17: GENERATING CAPACITY BY SIZE OF UNIT, 1979

Unit size (MW)	Installed capacity (MW)	Percentage (%)
>250	2,890	4.6
200-250	3,885	6.2
100-200	13,745	21.8
50-100	12,599.1	20.0
6-50	18,564.2	29.5
0.5-6	6,086.4	9.6
<0.5	5,246.3	8.3
Total	63,015.2	100.0

Source: Ministry of Electric Power.

Table A.18: POWER STATION FUEL CONSUMPTION AND EFFICIENCY, 1979

Region	Fuel consumption: Coal (10^6 ton)	Fuel consumption: Oil (10^6 ton)	Fuel consumption: Natural gas (10^6 m^3)	Total /a (10^6 ton)	Energy generation /b (GWh)	Unit (kg/ kWh)	Consumption (kcal/ kWh)	Efficiency (%)
(a) Northeast China	16.4	6.1	665.2	18.4	45,977	0.401	2,807	30.6
(b) North China	23.5	2.1	7.2	19.4	47,522	0.408	2,856	30.1
(c) Northwest	7.6	0.1	80.6	5.5	12,799	0.426	2,982	28.8
(d) East China	29.4	6.1	610.2	28.9	68,745	0.420	2,940	29.3
(e) Central-South China	18.7	2.0	0.6	14.8	32,728	0.453	3,170	27.1
(f) Southwest China	11.1	..	305.7	7.0	14,590	0.479	3,353	25.6
National overall	106.7	16.4	1,668.9	94.0	222,352	0.422	2,954	29.2

/a Converted to standard coal equivalent of 7,000 kcal/kg. Heat rates used in conversion:

Coal	4,415 kcal/kg
Oil	10,200 kcal/kg
Natural gas	9,310 kcal/m^3.

/b From thermal stations greater than 6 MW only. Including 9,616 GWh produced in smaller plants, thermal generation by fuel was as follows:

Coal	161,502 GWh
Oil	55,590 GWh
Natural gas	5,260 GWh

Source: Ministry of Electric Power.

Table A.19: ELECTRICITY SALES BY CONSUMER CATEGORY, 1949-79

Year	Energy sales (GWh) /a (% figures in parentheses)					
	Residential & commercial /b	Industrial /c	Agricultural /d	Transportation	Others	Total
1949	490(14.2)	2,390(69.0)	20 (0.6)	20 (0.6)	540(15.6)	3,460(100)
1952	817(13.1)	4,981(80.0)	43 (0.7)	59 (0.9)	327 (5.2)	6,227(100)
1957	1,975(11.9)	13,605(82.9)	108 (0.7)	70 (0.4)	649 (4.0)	16,407(100)
1965	3,839 (6.8)	47,723(84.0)	3,710 (6.5)	332 (0.6)	1,198 (2.1)	56,802(100)
1970	- -	- -	- -	- -	- -	- -
1971	4,558 (4.5)	84,203(83.2)	10,433(10.3)	452 (0.4)	1,628 (1.6)	101,274(100)
1972	5,305 (4.3)	101,784(82.3)	12,989(10.5)	707 (0.6)	2,815 (2.3)	123,600(100)
1973	5,830 (4.3)	110,194(81.6)	15,823(11.7)	1,126 (0.8)	2,133 (1.6)	135,106(100)
1974	6,453 (4.7)	107,860(79.5)	17,982(13.3)	1,171 (0.9)	2,242 (1.6)	135,708(100)
1975	7,150 (4.6)	124,782(79.5)	20,877(13.3)	1,435 (0.9)	2,725 (1.7)	156,969(100)
1976	7,721 (4.7)	128,966(78.3)	23,154(14.1)	1,846 (1.1)	3,011 (1.8)	164,698(100)
1977	8,498 (4.7)	142,691(78.5)	24,834(13.7)	2,104 (1.2)	3,564 (1.9)	181,691(100)
1978	8,967 (4.3)	166,087(79.0)	28,742(13.5)	2,280 (1.2)	4,163 (2.0)	210,239(100)
1979	11,252 (4.8)	184,636(79.0)/e	32,493(13.9)	1,323 (0.6)	3,873 (1.7)	233,577(100)

/a Excludes self-generation by industries and mini-hydro owned by communes and brigades.

/b Urban areas only.

/c For details of industrial electricity use, see Table 7.4.

/d Includes rural residential and commercial use.

/e Of which: 35,057 GWh to light industries and 149,579 GWh to heavy industries.

Source: Ministry of Electric Power.

Table A.20: ELECTRIFICATION OF COMMUNES AND BRIGADES BY REGION, 1979

Region		% of communes electrified	% of brigades electrified
(a)	Northeast China	98.2	94.5
(b)	North China	88.0	78.3
(c)	Northwest China	70.0	47.8
(d)	East China	90.2	60.7
(e)	Central and South China	93.3	64.1
(f)	Southwest China	82.6	46.9
	National overall	87.1	62.6

Source: Ministry of Electric Power.

Table A.21: ELECTRICITY TARIFFS, 1980 (FEN /a PER kWh)

Category of consumers	Northeast China	Other areas	Average tariff
Lighting	9.0	15.0-20.0	16.0
Commercial and small industries	7.0	8.5	7.9
Large industries			
Demand charge (Yuan /a per month)			
on maximum demand	5.0	6.0	6.2/b
on KVA installed	3.5	4.0	
Energy charge	3.5	5.8	
Agriculture			
Low tension	-	5.5-6.0	5.4
High tension at bulk supply	-	3.5	
National average	-	-	6.47

/a US$1 = Yuan 1.5, US¢1 = Fen 1.5.

/b With demand charge prorated over KWh used.

Source: Ministry of Electric Power.

Table A.22: ELECTRICITY INVESTMENT, 1975-79
(Y Million)

	1975		1976		1977		1978		1979	
	Amt.	(%)	Amt.	(%)	Amt.	(%)	Amt.	(%)	Amt.	(%)
Generation	2,286	(79.7)	2,651	(82.3)	2,701	(81.7)	3,994	(81.0)	3,746	(78.3)
Transmission & substation facilities	455	(15.9)	450	(14.0)	484	(14.6)	693	(14.0)	815	(17.0)
Others (including design & research)	127	(4.4)	119	(3.7)	121	(3.7)	246	(5.0)	223	(4.7)
Total	2,868	(100.0)	3,220	(100.0)	3,306	(100.0)	4,933	(100.0)	4,784	100.0)

Source: Ministry of Electric Power.

Table A.23: ELECTRICITY INDUSTRY STAFF, 1979

	Number	Percentage
Technical staff	59,000	6.3
Administrative staff	113,000	12.1
Service staff	100,000	10.7
Labor	554,000	59.2
Apprentices	87,000	9.3
Others	23,000	2.4
Total	936,000	100.0

Source: Ministry of Electric Power.

Table A.24: THEORETICAL, EXPLOITABLE, AND INVESTIGATED HYDRO POTENTIAL BY REGION

Region	Theoretical Capacity (MW)		Theoretical Annual energy (GWh)	Exploitable Capacity (MW)	Exploitable Annual energy (GWh)	Investigated /a (MW)
Northeast	12,126.6	(1.8%)	106,230	11,994.5	38,391	6,354.5
North	12,299.3	(1.8%)	107,740	6,919.8	23,225	3,622.5
Northwest	84,176.9	(12.5%)	737,390	41,936.7	190,493	7,919.0
East	30,048.8	(4.4%)	263,230	17,902.2	68,794	5,824.6
South-Central	64,083.7	(9.5%)	561,380	67,434.9	297,365	42,415.8
Southwest	473,311.8	(70.0%)	4,146,210	232,343.3	1,305,036	61,678.1
Total	676,047.1	(100.0%)	5,922,180	378,532.4	1,923,304	127,714.5

/a Not included are those which have already been developed and are being constructed.

Source: Ministry of Electric Power.

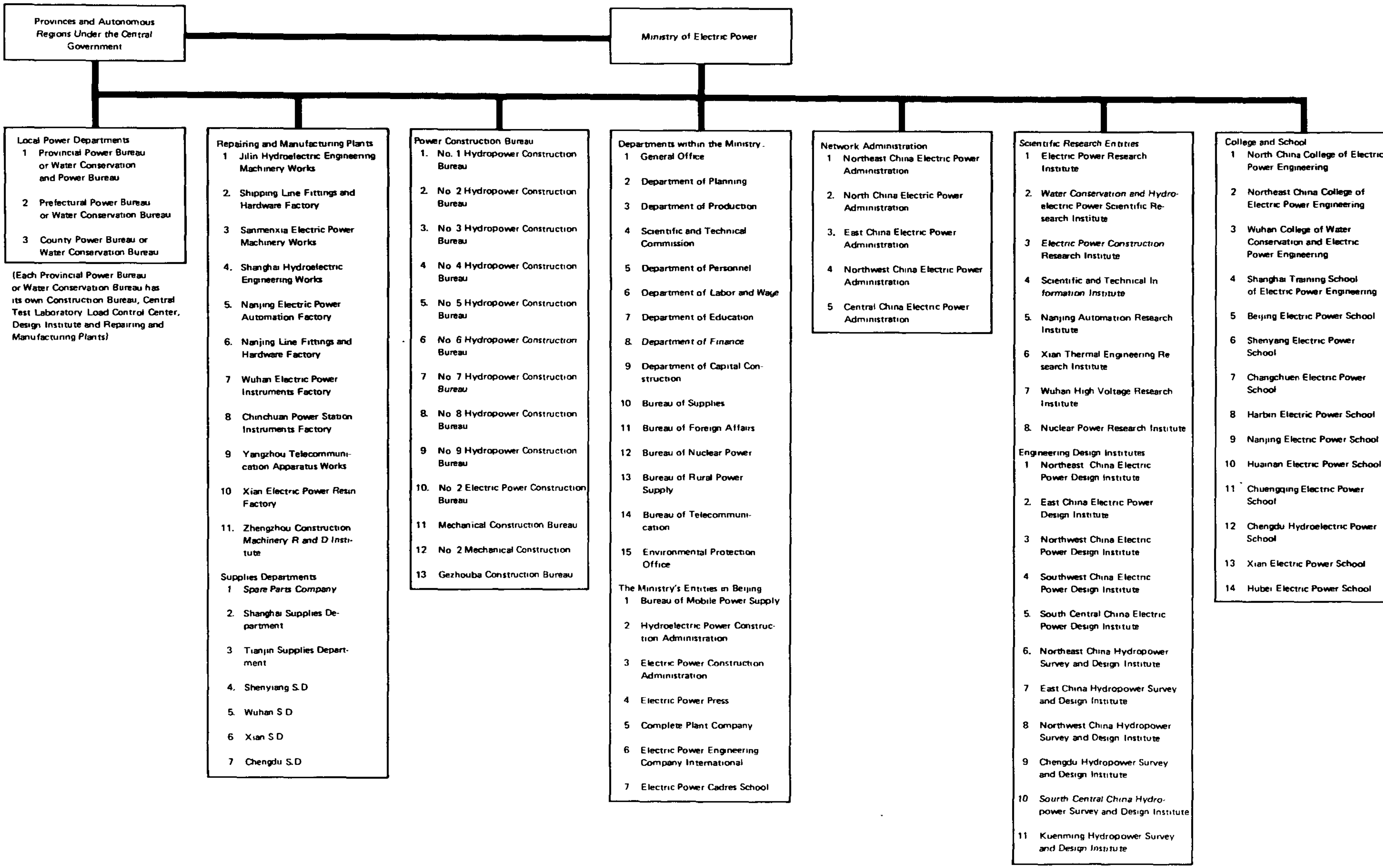
Table A.25: ADDITIONS TO GENERATING CAPACITY ANTICIPATED BEFORE 1985, BY REGION /a

Region	New capacity Hydro	Thermal	Total	Retirement	Net additions
Northeast China	900 (Baishan)	2,200	3,100	-	3,100
North China	-	2,200	2,200	-	2,200
East China	350	4,175	4,525	1,020	3,505
Central and South China	2,300 (Gezhouba & Dahua)	1,955	4,255	-	4,255
Northwest China	1,500 (Longyangxia)	-	1,500	-	1,500
Southwest China	420 (Wujiangtu)	-	420	-	420
Total	5,470	10,530	16,000	1,020	14,980

/a As of November 1980. Excludes small-scale projects.

Source: Ministry of Electric Power.

MINISTRY OF ELECTRIC POWER
ORGANIZATION CHART



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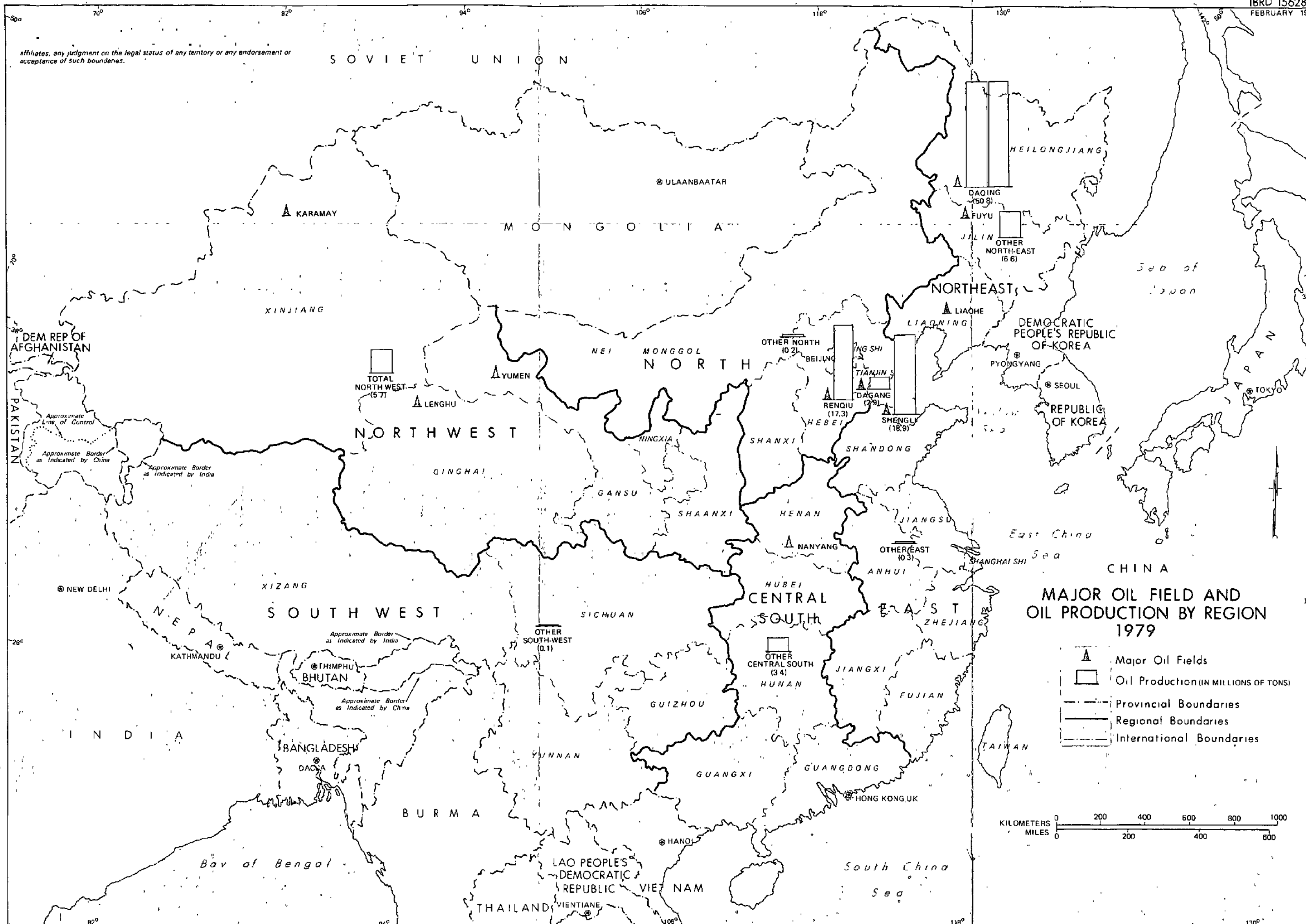

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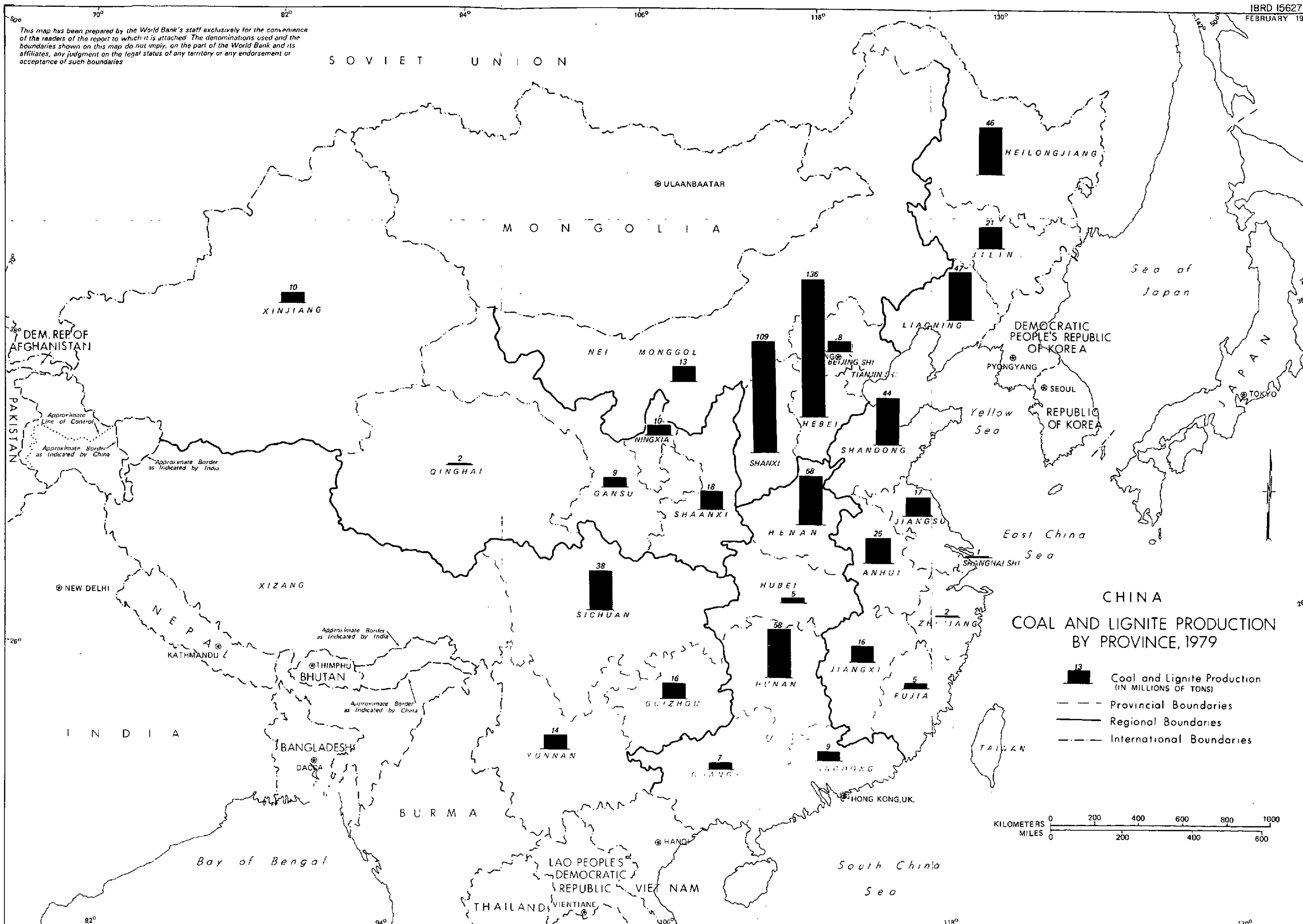
FEBRUARY 1982
affiliates, any judgment on the legal status of any territory or any endorsement or acceptance of such boundaries.
SOVIET UNION
MONGOLIA
ULAANBAATAR
KARAMAY
XINJIANG
DEM REP OF AFGHANISTAN
PAKISTAN
Approximate Line of Control
Approximate Border as Indicated by China
Approximate Border as Indicated by India
TOTAL NORTH WEST (5.7)
YUMEN
LENGHU
NORTHWEST
QINGHAI
NEI MONGGOL
NORTH
NINGXIA
GANSU
SHAANXI
SHANXI
OTHER NORTH (0.2)
BEIJING
TIANJIN
RENQIU (17.3)
DAGANG (2.9)
SHENGLI (18.9)
HEBEI
SHANDONG
HEILONGJIANG
DAQING (50.6)
FUYU
JILIN
OTHER NORTH-EAST (6.6)
NORTHEAST
LIAOHE
LIAONING
DEMOCRATIC PEOPLE'S REPUBLIC OF KOREA
PYONGYANG
SEOUL
REPUBLIC OF KOREA
JAPAN
TOKYO
Sea of Japan
HENAN
NANYANG
JIANGSU
OTHER EAST (0.3)
SHANGHAI SHI
ANHUI
HUBEI
CENTRAL SOUTH
EAST
ZHEJIANG
East China Sea
CHINA
MAJOR OIL FIELD AND OIL PRODUCTION BY REGION 1979
Major Oil Fields
Oil Production (IN MILLIONS OF TONS)
Provincial Boundaries
Regional Boundaries
International Boundaries
XIZANG
SOUTH WEST
NEW DELHI
NEPAL
KATHMANDU
THIMPHU
BHUTAN
SICHUAN
OTHER SOUTH-WEST (0.1)
OTHER CENTRAL SOUTH (3.4)
HUNAN
JIANGXI
FUJIAN
GUIZHOU
INDIA
BANGLADESH
DACCA
YUNNAN
GUANGXI
GUANGDONG
TAIWAN
HONG KONG,UK
BURMA
HANOI
Bay of Bengal
LAO PEOPLE'S DEMOCRATIC REPUBLIC
VIENTIANE
VIET NAM
THAILAND
South China Sea
KILOMETERS 0 200 400 600 800 1000
MILES 0 200 400 600



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CHINA
COAL AND LIGNITE PRODUCTION BY PROVINCE, 1979
Coal and Lignite Production (IN MILLIONS OF TONS)
Provincial Boundaries
Regional Boundaries
International Boundaries
KILOMETERS 0 200 400 600 800 1000
MILES 0 200 400 600
SOVIET UNION
MONGOLIA
ULAANBAATAR
46 HEILONGJIANG
21 JILIN
47 LIAONING
136 HEBEI
8 BEIJING SHI
TIANJIN SHI
109 SHANXI
13 NEI MONGGOL
10 NINGXIA
10 XINJIANG
2 QINGHAI
9 GANSU
18 SHAANXI
44 SHANDONG
58 HENAN
17 JIANGSU
25 ANHUI
1 SHANGHAI SHI
XIZANG
38 SICHUAN
HUBEI 5
58 HUNAN
16 JIANGXI
2 ZHEJIANG
5 FUJIAN
16 GUIZHOU
14 YUNNAN
7
9
HONG KONG, UK.
TAIWAN
DEMOCRATIC PEOPLE'S REPUBLIC OF KOREA
PYONGYANG
SEOUL
REPUBLIC OF KOREA
JAPAN
TOKYO
Sea of Japan
Yellow Sea
East China Sea
South China Sea
DEM. REP. OF AFGHANISTAN
PAKISTAN
Approximate Line of Control
Approximate Border as Indicated by China
Approximate Border as Indicated by India
NEW DELHI
NEPAL
KATHMANDU
THIMPHU
BHUTAN
INDIA
BANGLADESH
DACCA
BURMA
Bay of Bengal
HANOI
LAO PEOPLE'S DEMOCRATIC REPUBLIC
VIET NAM
THAILAND
VIENTIANE

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