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China: The Electric Power Problem

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An Intelligence Assessment

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An Intelligence Assessment

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China: The Electric Power Problem

Key Judgments

Information available as of 1 July 1984 was used in this report.

Chinese officials have repeatedly cited electric power shortages as the leading constraint on China's economic growth and development. Chronic power shortages in China grew increasingly serious in 1983 as economic policies encouraging accelerated industrial production and the creation of new power consumers coincided with a slowdown of power capacity growth. In large measure, the slowdown in added capacity was the result of ill-conceived Chinese decisions to cut back investment in the early 1980s.

China has nevertheless been able to achieve high industrial growth rates in the 1980s despite much slower growth in generating capacity. More efficient use of electricity by consumers and higher utilization rates of existing power plants have eased the power constraint somewhat. Many of these are one-time improvements, however, and we believe gains in hydroplant utilization are particularly vulnerable, possibly reversible. We expect China's industrial growth rates, now at 11 percent, eventually will be forced downward, nearer the expected 5- to 8-percent growth rate of electricity supplies through 1990.

Although electric power capacity grew only 5.9 percent in 1983, the additions were still the largest since 1979. Power capacity will grow even more slowly through 1984-85. China's planners increased investment in electric power last year, but this will not begin to pay off until 1986-87. Capacity growth in 1988 and beyond will depend on whether China continues to increase investment in the power sector in 1984-85 and in the Seventh Five-Year Plan (1986-90).

Delays in the construction of hydro and nuclear plants are likely. China is just beginning its first two nuclear plants and has suffered incredible slowdowns in constructing large hydropower projects. Further postponements in these projects will lead to increased emphasis on coal-fired power plants in the late 1980s. Use of larger thermal generators and the construction of mine-mouth power plants will mitigate the continuing strains on the coal and transport sectors.

Improvements in China's power transmission include first steps to link regional grids into a national network and emphasis on a greater but off-grid role for small rural hydrostations, whose sporadic power supplies create more problems for grids than they solve. Gains from these policies may be partially offset by problems in getting regional grids to cooperate in power-sharing situations.

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China's more rational approaches to power supply problems in this decade have not been complemented with policies to deal with runaway demand. Without consistent, nationwide rationing policies, power shortages will worsen and cause more serious disruptions. We have seen no evidence to date that such policies are under consideration above the local level, where practices vary widely.

The United States and other foreign suppliers of technology are only now beginning to play a significant role in China's power development plans:

- China is now building high-power thermal generators using purchased US technology, is training its power grid technicians in the United States, and is buying US computers and control equipment for grid operations.
- Negotiations are under way with foreign suppliers for both nuclear power plants and high-voltage powerline equipment and technology.

However, we believe these infusions of foreign technology will not have great impact on China's electric power problem until late in this decade.

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Table 1
Selected Countries: Electric Power Production and Capacity, 1982

	Production (*billion kilowatt-hours*)	Capacity [a] (*thousand megawatts*)
United States	2,386.7	634.8
USSR	1,367.1	276.7
Japan	581.1	143.7
Canada	384.5	83.8
West Germany	366.9	84.9
China	**327.7**	**69.3**
United Kingdom	272.1	71.7
France	262.2	70.8
Italy	183.7	47.3
Poland	117.6	25.5

[a] 1981 end-of-year capacity.

Table 2
Selected Countries: Per Capita Production of Electricity, 1983

Kilowatt-hours

Canada	16,585
United States	10,455
USSR	5,204
Japan	4,896
Singapore	3,179
Brazil	1,140
South Korea	1,024
Mexico	825
Nicaragua	425
Philippines	368
China	**325**
India	189
Zaire	150
Nigeria	80

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Table 3
China: Generating Capacity by Unit Size, 1983

Size (*megawatts*)	Number of Units [a]	Installed Capacity (*megawatts*)	Share of Capacity (*percent*)
Over 250	15	3,800	5.0
201-250	30 to 35	7,100	9.3
101-200	100	15,300	20.0
51-100	200	16,400	21.4
6-50	800 to 2,000	20,400	26.6
Under 6	4,500 to 9,000	13,700	17.9

[a] Estimated.

Table 4
China: Electric Power Capacity and Production by Source, 1983

	Capacity		Production	
	Megawatts	Percent	Billion kilowatt-hours	Percent
Total	**76,661**	**100.0**	**351.4**	**100.0**
Thermal	52,475	68.5	265.0	75.4
Hydro	24,186	31.5	86.4	24.6

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China: The Electric Power Problem

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Background

China is one of the world's leading producers of electric power. As of 1982 it ranked eighth in the world in generating capacity and sixth in electricity production (see table 1). By 1990 China could become the fourth-largest producer of electricity, behind the United States, the USSR, and Japan. On a per capita basis, however, China's power output ranks far below developed countries (table 2). Moreover, because much of its generating capacity lies in inefficient, small-scale plants, the electric power sector is far less modern than those of the developed world.

Almost two-thirds of China's electricity is provided by generators of 100 megawatts (MW) or less (table 3). Furthermore, electricity supplies depend critically on China's overburdened transportation systems. About 60 percent of China's overall power capacity relies on railroad or boat shipments of coal from mines that may be hundreds of kilometers away. In recent years, coal shipment delays and coal quality problems have reduced operating hours at many thermal power plants, which provide three-fourths of China's electricity (table 4).

China also does not yet have a national power grid. To date, the 12 major grids that supply 70 percent of China's electricity have had little capability to tap each other for power. Line voltage and capacities have been chronically inadequate, both in linking grids and within the grids themselves. The typical voltage on long-distance transmission lines within the grids is 220 kilovolts (330 kV in the northwest). Only now, 500-kV lines are coming into use in China.

The Shortage Situation

China produced a record 351 billion kilowatt-hours (kWh) of electric power in 1983, but official statements indicate that the year probably was the worst in over a decade for chronic power shortages, outages, and rationing:

- In Heilongjiang, power shortages forced over 600 factories in Qiqihar to shut down for three months.
- In Sichuan, what had been local seasonal power shortages became year-round, provincewide concerns and repeatedly idled the only factory in China producing certain models of amphibious tanks and artillery tractors.
- In Qingdao, shortages became so acute that a railcar factory could not find out until the beginning of each workday whether it would be supplied with electricity; the factory often ran at 15-percent capacity or sat idle.
- Hunan Province's electricity output in the dry season fell to 54 percent of overall requirements.
- In Jiangxi, a new, large Japanese-built copper smelter was unable to obtain allocations of electricity and sat idle.
- Yunnan Province cut power to machine-building, fertilizer, and textile factories to ensure power and water for irrigated farmland.

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Reasons for Shortages

China's power shortages in 1983 were the result of both demand and supply factors. Economic policies promoting growth and diversification of Chinese industry led to greater electric power needs just at a time when earlier cutbacks in power investment and in equipment production were slowing power supply growth.

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Table 5
China: Selected Economic Growth Rates, 1976-84

	1976	1977	1978	1979	1980	1981	1982	1983	1984[a]
Light industry	2.4	14.3	10.8	9.6	18.4	14.1	5.7	8.4	11.5
Heavy industry	0.6	14.3	15.6	7.7	1.5	−4.7	9.8	12.1	11.7
Electricity production	3.7	10.0	14.8	9.9	6.6	2.9	6.0	7.2	7.3
Generating capacity	8.6	9.1	11.0	10.3	4.5	5.2	4.4	5.9	4.2[b]

[a] January-June.
[b] Estimated.

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Demand Factors. Changes in economic policy in the post-Mao era caused overall demand for electric power to grow unexpectedly fast in 1982-83. Readjustment policies put in place after 1978 deemphasized heavy industry; Chinese planners felt too much of heavy industry's output was either surplus or obsolete, while needs for light industrial output, especially consumer goods, went unfilled. Slowdowns in heavy industry, China's largest consumer of electricity, eased pressure on power supplies in the early 1980s. At the same time, the new emphasis on developing light industry and reform efforts that spurred production in collective enterprises created a new set of power consumers who suddenly had easier access to electricity.

Light industry grew 35 percent in 1980-81, while output in heavy industry dropped 3.3 percent. The cutbacks in heavy industry, however, severely depressed the flow of revenues from industry into the national budget. Successive large deficits in 1980 and 1981 led Beijing to reemphasize the importance of heavy industry to China's economic well-being.

In 1982 a new campaign to again promote heavy industrial production quickly restored output in that sector to previous levels, and in 1983 it continued to rise. Heavy industry grew 12.1 percent in 1983, more than triple the 3.9-percent target set by the annual economic plan. Light industry grew 8.4 percent in 1983, well above its target of 4.1 percent (see table 5).

The competition for electric power between a resurging heavy industry sector and new light industrial and residential consumers caused the extreme shortages. The rapid rise of heavy industrial output was the main factor. The Chinese estimate that heavy industry on average uses six times as much electricity as light industry to produce output of equal value. The *excess* of heavy industrial production above its targeted output in 1983 consumed power equal to about half of the electricity consumed by *all* of light industry.

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Supply Factors. The readjustment policies that led to growth in demand for electricity also slowed the growth of electricity supplies. In the early 1980s, Chinese investment in electric power projects leveled out and Beijing stopped producing the generating equipment needed to add to electric power capacity.

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Table 6 shows the effects of readjustment policies on electric power investment. In the initial years of the readjustment policies (1979 and 1980), the amount spent on capital construction in electric power held steady slightly below the 1978 peak allocation of 4.9 billion yuan, as Beijing struggled to reduce both budgeted and off-budget investment.[1] In 1981, however, efforts to rein in capital construction were more successful, and overall investment dropped 21 percent.

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[1] Off-budget investment refers to provincial or local investment that is not included in the annual national budget accounts.

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Table 6
China: Investment in Electric Power, 1975-83

Billion yuan

	1975	1976	1977	1978	1979	1980	1981	1982	1983[a]
Total [b]	**2.87**	**3.22**	**3.31**	**4.93**	**4.78**	**4.81**	**4.01**	**4.62**	**5.4**
Generation	2.29	2.65	2.70	3.99	3.75	3.71	2.80	3.36	NA
Thermal	NA	NA	NA	NA	NA	1.91	1.46	1.82	NA
Hydro	NA	NA	NA	NA	NA	1.80	1.35	1.54	NA
Distribution [c]	0.58	0.57	0.61	0.94	1.04	1.10	1.21	1.27	NA

[a] Plan.
[b] Totals may differ due to rounding.
[c] Amounts of investment in distribution for the years 1975-79 were derived by subtracting investment in generation from total investment; amounts for the years 1980-82 were supplied by the Chinese.

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Although priority sectors suffered proportionally smaller cuts, the 17-percent reduction in electric power investment came entirely from allocations to power plant construction, which fell 25 percent from 1980.

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The cutbacks in heavy industry helped eliminate production of useless goods like low-grade machine tools and metal products, but production of badly needed items also fell. Despite a professed need to develop energy and transport, heavy industry's output of items required by these sectors dropped sharply. The production of trucks, tires, tractors, and locomotives declined, as did the production mining equipment, motors and transformers. Power generation equipment fell particularly sharply, dropping from 6,212 MW in 1979 to 1,395 MW in 1981 (see figure 1).[2]

The results of cutbacks in investment and heavy industrial production earlier in the decade are now affecting China's electric power supplies. Additions to electric power capacity in the 1980s have slowed in both absolute and percentage terms compared with 1977-79 (see table 7). As demand for electricity rose at ever faster rates, China's additions to electric power capacity fell to and stayed at their lowest levels in 10 years.

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Power Rationing Schemes in 1983

The shortages of 1983 confronted local and regional grid authorities with unattractive choices. Without rationing, complete shutdowns of local grids were likely. Cutting power to light industry meant meager power savings for the grid and greater reductions in industrial output value for the local economy. Cutting power to state-owned enterprises had more serious effects on budget revenues and was harder to sell politically. Cutting household power consumption provided only marginal relief, and power for on-site factory housing often was not easily separated from power used for production.

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In Shanghai in 1983, power officials faced with rationing gave priority to central city, state-owned heavy industry and cut supplies to collective industry and towns in the surrounding countryside.

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[2] The fall in production of these necessary heavy industrial goods was in part responsible for the subsequent reemphasis on heavy industry output in 1982 and 1983. Production of power generation equipment rose to 2,740 MW in 1983, but was still less than half of the 1979 output.

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Figure 1
China: Production of Electric Power Equipment

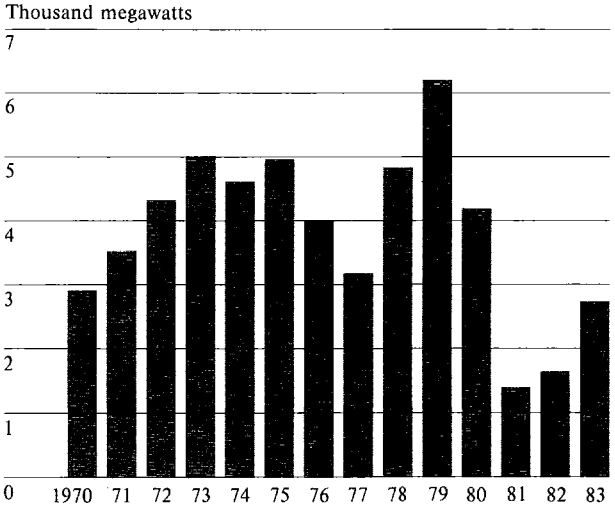

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Table 7
China: Growth of New Capacity

Megawatts (except where noted)

	New Capacity Brought On Line	Total Capacity at Yearend	Percent Increase
1971	2,512	26,282	10.6
1972	3,219	27,501	12.2
1973	4,424	33,925	15.0
1974	4,183	38,108	12.3
1975	5,298	43,406	13.9
1976	3,741	47,147	8.6
1977	4,303	51,450	9.1
1978	5,672	57,122	11.0
1979	5,894	63,016	10.3
1980	2,854	65,870	4.5
1981	3,420	69,290	5.2
1982	3,070	72,360	4.4
1983	4,301	76,661	5.9
1984 [a]	3,200	79,861	4.2

[a] Planned 2,800 MW additions to capacity plus estimated 400 MW growth in small hydrostations.

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In Yunnan and Jilin Provinces, factories were assigned limits for electric power consumption and faced shutoffs if the limits were exceeded. Other provinces rotated power among factories, reduced shifts for industrial consumers from three to two, had daily "nonenergy" days for different areas in their jurisdiction, or suspended factory production targets for days or weeks at a time.

Jiangxi Province in 1983 began to allocate power based on the economic performance of provincial factories. Enterprises were classified according to their levels of profit remittances to the state. The uppermost tier received absolute priority for uninterrupted supplies of electricity. A second group of plants also received special consideration. Other industrial consumers, including coal mines and defense plants, had to register with the government in order to receive power allocations, and most faced substantial cuts.

Table 8 lists power shortage situations observed in a number of Chinese provinces in 1983, major factors contributing to the situation, and remedial actions taken by local power authorities. China may be forced to evolve a national allocations policy in the mid-1980s to deal with shortages, conceivably based on the experiences of these provinces in implementing power rationing policies.

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The Problem in 1984

China's double-digit growth rates in light and heavy industry in 1983 and 1984 tend to mask the problems caused by electric power shortages. By straining electricity supplies, above-target industrial growth contributes to several serious problems.

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First, because of unplanned growth, China's ability to meet future power needs is threatened. Power projects under construction are forced to compete with off-plan projects for construction materials and equipment, as well as for electricity for their own needs.

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Table 8
China: 1983 Power Shortages

Province	Cause of Shortage	Policy Response
Hunan	Drop in hydro output for irrigation needs	Increased power output by thermal plants
Yunnan	Drought	Shutoffs for above quota users. Two shift factories down to five to nine hours per day. Rotational nightly blackouts of different areas of Kunming. Cuts in urban and rural, domestic use. Renovation/maintenance of idle capacity.
Jiangxi	Coal shortage, coal quality problems, grid connections behind schedule, floods (power used to drain fields)	Power allocated to high-profit firms.
Shenxi	Poor coal supplies, low water levels at Liujiaxia	Heavy industry on three-day week. Plant shutdowns. Daily rotating outages.
Heilongjiang	Thermal plant construction behind schedule	600 factories idled three months until power plant completion.
Guangdong	Dry season	Factory shutdowns. Production assignments for April-August only.
Shanghai	Rapid industrial growth	Power cutoffs to collective light industry.
Jilin	Drought	Fixed power rations.
Hebei	Drought	Free off-peak (night) power to spread demand.
Liaoning	Drought	Increased thermal production.
Shandong	Low coal supply, above quota or excess consumption by users	Consumption restrictions. Daily announcements of power availability.
Shenxi	Coal shortage	Three-day week for steel plants. Industrial plant operations at half capacity. Rotating rest periods.

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China's overall economic plans for the 1980s had deliberately specified moderate growth, in large measure to give the energy and transport sectors time to support more rapid economic growth in the 1990s. Instead, above-plan industrial output and off-budget capital construction have drained resources away from energy and transport development.

Second, above-plan growth in both light and heavy industry is disrupting planned output of industrial goods, including defense items. Factories operating under profit incentives are less willing to observe power quotas, and their excess demands have reportedly shut local grids down entirely. Shortages make state control of industrial output more difficult and reduce the likelihood of an optimal mix of goods.

Third, planners realize that the present output of electric power is not necessarily sustainable. Even with new coal-fired and hydropower generators scheduled to come on line in the 1980s, lengthy droughts in hydropower areas could make power shortages worse than they already are. Despite substantial additions to capacity, low water levels cut hydropower output twice in the 1970s, by 4.2 percent in 1976 and 6.3 percent in 1978. In 1982, drought in Jilin Province cut hydropower production by over 50 percent from 1981. Thermal plants were able to offset only about one-third of the decline, and overall provincial electricity generation fell almost 9 percent.

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Table 9
China: Additions to Generating Capacity, by Five-Year Plan, 1976-87

Megawatts

Fifth Five-Year Plan	22,464
1976	3,741
1977	4,303
1978	5,672
1979	5,894
1980	2,854
Sixth Five-Year Plan	18,016
1981	3,420
1982	3,070
1983	4,301 [a]
1984	3,200 [a]
1985	4,025 [a]
Seventh Five-Year Plan	NA
1986	6,035 [a]
1987	6,600 [a]

[a] Estimated.

Table 10
China: Hydroplant Utilization Rates, 1976-83

	Capacity [a] (*megawatts*)	Production (*billion kilowatt-hours*)	Average Hours per Year in Operation
1976	13,428	45.6	3,396
1977	14,655	47.6	3,248
1978	15,765	44.6	2,829
1979	17,277	50.1	2,900
1980	19,110	58.2	3,046
1981	20,510	65.6	3,198
1982	21,890	74.4	3,399
1983	22,960	86.4	3,763

[a] Yearend capacity, from previous year.

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Prospects in the Short Run

New power plants and improvements in shipping coal by rail have allowed the Chinese to maintain 7-percent growth in electric power output in the first half of 1984, and reported shortages have dropped significantly. Nevertheless, we believe a decline in capacity growth in 1984 and 1985, together with the economy's surging demand for electricity, will make any respite short lived. Barring unexpected improvements in output from existing plants, we feel capacity additions in 1984 and 1985 will allow electric power supplies to grow only 5 to 6 percent annually in 1984-86.

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Supply Factors

Prospects for power supply growth in the mid-1980s are not good. Capacity growth in 1984 and 1985 will be even slower than in 1980-83, and increasing output from existing power plants will not be easy. Thermal plants can do little to speed rail deliveries of coal. Hydropower plants probably are being operated near their limits, and we suspect that present output is extremely vulnerable to any decrease in rainfall.

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Capacity Growth. New power plants coming on line in 1984 and 1985 will not provide much relief. Capacity will continue to grow slowly, reflecting funding and construction cutbacks in energy projects during the early 1980s. Capacity growth in 1984-85 will average 4.6 percent, down from 5.2 percent in 1981-83. As a result, total capacity additions in the Sixth Five-Year Plan (1981-85) will come to only about 18,000 MW, down from over 22,000 MW added during the Fifth Five-Year Plan (1976-80), as shown in table 9.

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Hydropower. Beijing claims that both abundant rainfall and improved management were responsible for China's ability to increase hydropower output 48 percent in 1981-83 with only a 20-percent increase in generation capacity. We believe the former to be more responsible for these increases than the latter. Tables 10 and 11 show the utilization rates of China's hydroprojects since 1976. Increases in 1977-82 made up for earlier declines, but large and medium-size hydroplants achieved an unprecedented 14-percent increase in hours of utilization in 1983.

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Table 11
China: Hydroplant Utilization Rates, by Size, 1982-83

	1982	1983	Percent Change
Large and medium-sized hydroelectric projects			
Capacity (*megawatts*)	14,250	14,880	4.4
Production (*billion kilowatt-hours*)	58.1	69.2	19.1
Utilization rates (*average hours per year*)	4,077	4,651	14.1
Small hydrostations			
Capacity (*megawatts*)	7,640	8,080	5.8
Production (*billion kilowatt-hours*)	16.3	17.2	5.5
Utilization rates (*average hours per year*)	2,134	2,129	−0.2

Table 12
China: Thermal Plant Utilization Rates, 1976-83

	Production (*megawatts*)	Capacity [a] (*billion kilowatt hours*)	Average Hours per Year of Operation
1976	157.5	29,978	5,254
1977	175.8	32,492	5,411
1978	212.0	35,686	5,941
1979	231.9	39,845	5,820
1980	242.4	43,906	5,521
1981	243.8	45,360	5,375
1982	253.3	47,400	5,343
1983	265.0	49,400	5,364

[a] Previous year's end-of-year capacity.

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Utilization rates theoretically might be further improved, but maintaining even present rates in dry years seems unlikely. A reduction in the above-normal rainfall of the last three years in central or southwest China could cut sharply into electricity available for industry. Supplies could be further reduced if dry conditions force power authorities to divert water for irrigation and to allocate electricity to agricultural pumping equipment. Even if rainfall patterns remain favorable, we expect existing hydroprojects to add only marginally to growth in electricity production.

Thermal Plants. The intensive use of hydropower plants described above offset a drop in thermal plant utilization (see table 12). Output of thermal power in 1981-83 rose only 9 percent, even though capacity increased by 13 percent. China's thermal plants are run inordinately hard by Western standards, but in recent years problems with coal shipments have cut into thermal utilization rates. The Chinese credit timely coal deliveries to thermal plants for the electric power growth made so far in 1984, but it is too early to tell how permanent the supply improvements are.

Demand Factors

We have seen no falloff in demand for electricity supplies in any sector of the economy through the first six months of 1984. Light industry's 11.5-percent annual growth rate is keeping pace with 11.7-percent growth in heavy industry. Industrial expansion in 1984 exceeds power supply growth by an even greater margin than in 1983, leading us to expect similar shortages to emerge. However, no clear-cut, nationwide policy identifies priority considerations for electricity distribution in shortage situations. Yang Bo, the Minister of Light Industry, said recently that light industry still received priority for electric power supplies, but in provincial power allocation schemes we have observed since 1982, the priorities are much less clear.

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Long-Run Improvements in Power Supplies

Stepped-up investment in electric power begun last year will lead to faster growth in capacity additions after 1985, helping to ease the electric power constraints facing China in the late 1980s. China's

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Table 13
China: Planned Capacity Growth, 1983-2000

	1983		1990		2000	
	Thousand Megawatts	Percent	Thousand Megawatts	Percent	Thousand Megawatts	Percent
Total [a]	**76.7**	**100.0**	**110-120**	**100**	**240-260**	**100**
Thermal capacity	52.5	68.5	76-86	69-72	177-197	74-76
Hydro capacity	24.2	31.6	34	28-31	63	24-26
Large and medium-sized capacity	15.7	20.5	22	18-20	45	17-19
Small capacity	8.5	11.1	12	10-11	18	7-8

[a] Totals may not add due to rounding.

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planners have evolved a more rational set of long-run development plans that will allow for faster growth in electricity supplies. We believe these plans will begin to bear fruit late in the 1980s, though most benefits will be realized much later.

Investment Growth

China's planners in 1983 gave the lion's share of increases in energy investment to the power industry, raising its allocation to 5.4 billion yuan, up from 4.6 billion in 1982 and 4 billion in 1981. Planners have apparently increased planned investment in electric power for the Sixth Five-Year Plan (1981-85); funding was scheduled to drop to 20.7 billion yuan, in comparison with outlays of 21.0 billion yuan in the Fifth Five-Year Plan (1976-80). Funding through 1983 totals over 14 billion yuan, however, and reductions from 1983's 5.4 billion yuan are unlikely in the last two years of the plan. We expect China's total investment in electric power in 1981-85 to exceed 25 billion yuan.

Capacity Expansion

As in other industries, China's modernization plans for the electric power industry through the end of the century call for moderate growth in the 1980s and more rapid growth in the 1990s. Additions to capacity are expected to grow at a 6.75-percent annual rate by 1990, rising to 9.6 percent by the year 2000. If attained, these growth rates will provide the Chinese with about four times their 1980 capacity by the year 2000. Table 13 gives a detailed breakdown of China's plans for capacity growth and additions to thermal and hydro capacity.

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Targets for the year 2000 appear overblown, but China probably can achieve its 1990 goal for overall electric power capacity of 110,000 to 120,000 MW. The most likely problem is that construction problems will delay planned additions to hydropower capacity. If slowdowns become obvious, China could expand or accelerate thermal plant production as late as 1987 and still reasonably expect to achieve the lower 1990 target (110,000 MW) for overall capacity.

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Our estimates of capacity additions through 1987 are shown in table 14. These projections are based on power plants now under construction and do not run beyond 1987, because construction of new thermal plants that begins in 1984-85 can still bring new capacity on line as early as 1988. If plants now under construction are completed on schedule, meeting the lower 1990 target will require capacity growth of about 13,500 MW in 1988-90, which should be well within Chinese capabilities if adequate investment funds are forthcoming.

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Table 14
China: Planned Capacity Growth

	Capacity (*megawatts*)		Growth Rates (*percent*)		
	Expected, 1987	Additions Needed, 1988-90	Observed 1980-83	Expected 1984-87	Required 1988-90
Total	**96,521**	**13,479-23,479**	**5.0**	**5.9**	**4.5-7.5**
Thermal	68,005	7,995-17,995	4.6	6.7	3.8-8.1
Hydro	28,516	5,484	6.1	4.2	6.0
Large	18,416	3,584	5.1	4.1	6.1
Small	10,100	1,900	7.9	4.4	5.9

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Plans for Thermal Power Plants

China's plans for thermal power for 1984-90 call for capacity additions of 24,000 to 34,000 MW. Despite increased priority given to hydropower, the thermal plant share of overall capacity will rise from 68 percent to 72 percent.

In carrying out this expansion, the Chinese are pursuing several measures that may reduce many of the difficulties presently associated with China's thermal power plant operations.

Larger Generators. China claims that a fourth of its coal-fired capacity consists of small boilers and generators of 50 MW or less, with an average of 12 MW. These small, inefficient facilities reportedly consume almost half of the coal delivered to the electric power industry. Most of China's planned additions to thermal capacity through the 1980s consist of generators in the 100- to 300-MW range. Given current known construction, electric power generators of 200 MW and above installed in the 1980s, including domestically built 300- and 600-MW generators of US design, will double their share of China's overall electric power capacity.

Because of the greater efficiency of the new large generators, China's planned increase of 54 percent in coal-fired capacity by 1990 may increase the power industry's coal consumption by only 40 percent. If the 12,000 MW of small coal-fired plants also were replaced with larger units, planned growth would require only 13 percent more coal than the electric power industry now uses. Given present low-production levels and stated intentions not to increase equipment imports, we feel the Chinese will be hard pressed simply to meet the equipment requirements of planned expansion and will not be able to devote sizable resources to replacing existing small generators.

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Mine-Mouth Power Plants. Higher-voltage power transmission lines have made it more practical for China to build large power plants near coal mines and run powerlines to the cities. This diminishes the need to use railroads to haul coal to smaller urban plants that would add to China's severe pollution problems. Mine-mouth power plants at present account for only 6,881 MW, or 13 percent of China's thermal power capacity. By 1990 the capacity of mine-mouth plants on line could more than triple. In 1984-86 over half of expected thermal power plant capacity additions—5,650 of 9,930 MW—will be mine-mouth power plants, a proportion we expect to continue through this decade.

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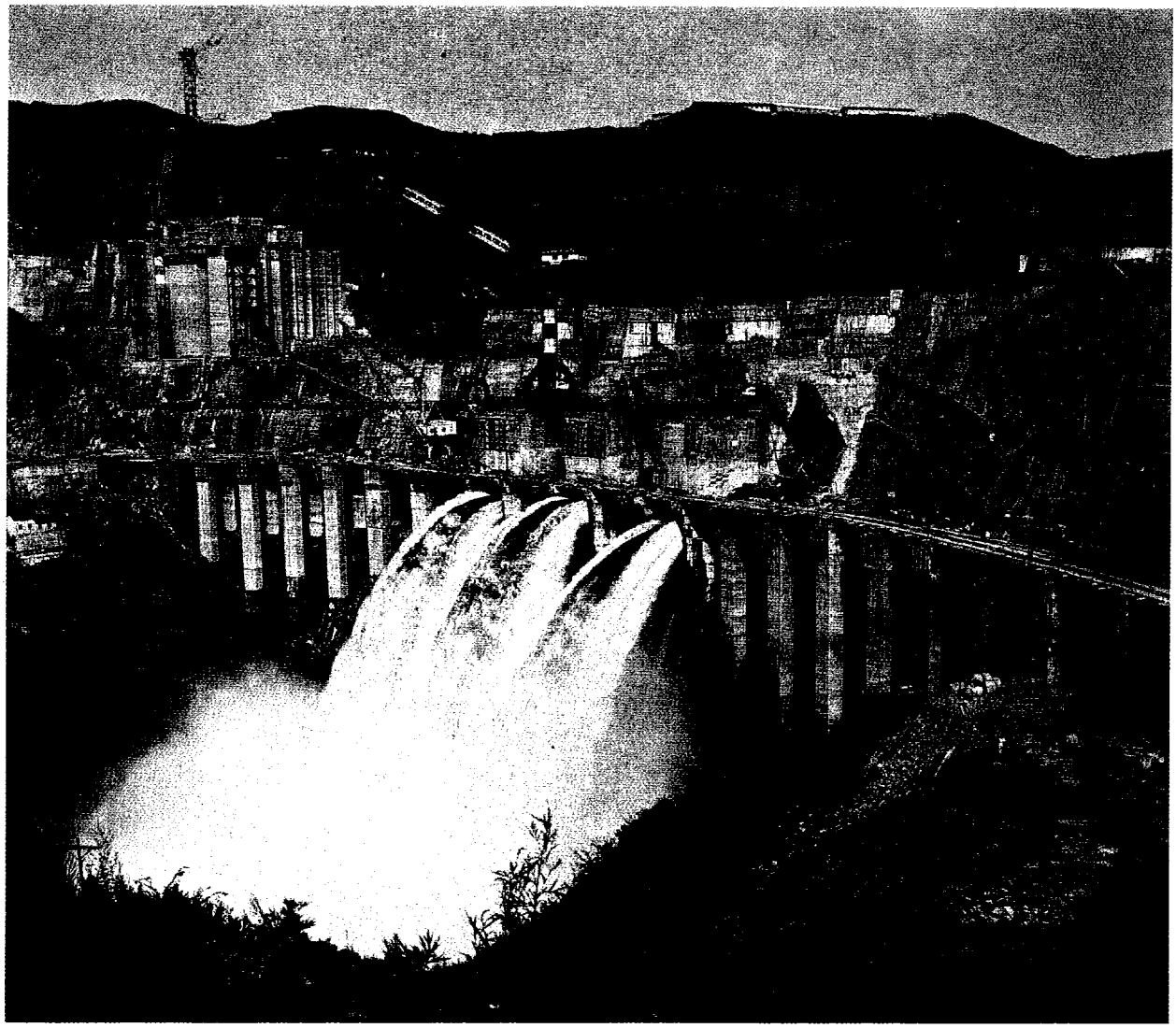

Baishan Hydropower Station, Jilin Province

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We estimate that mine-mouth plants equipped with generators in the 100- to 300-MW range could allow China to achieve its planned 54-percent increase in thermal plant capacity by 1990 with only a 23-percent increase in railroad shipments of coal. Rail shipments could actually *drop* by 5 percent over this period if larger generators were installed at inefficient small plants, which are largely rail-served.

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Plans for Hydropower Plants

China's efforts to exploit its potential hydropower are likely to take longer, cost more, and deliver less than is now planned. Past efforts in hydropower development, especially in the 1970s, suffered repeated engineering and construction bottlenecks that forced the Chinese to constantly reevaluate plans and change priorities for funding and resources. Four of eight major projects whose funding began in the late 1970s were shelved for two years or more; two have yet to begin construction.

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The Role of Small Hydropower Stations

A tremendous benefit to China's grid improvements has been the redefinition of the role of small hydropower stations—stations with a capacity of 12 MW or less, often 1 or 2 MW—that typically furnish about enough power to run a large factory or supply electricity to a town of 10,000 to 20,000 people.

China's small hydro efforts began as a means of providing communes in remote areas with token amounts of electric power for lighting and irrigation. After 1966 when the Cultural Revolution stressed the role of hydropower, funding shifted to medium- and small-scale installations linked to local power grids. As late as 1981, small hydrostations still enjoyed funding priority, and grids were required to purchase surplus power from small hydrostations.

As a result, more than a third of China's small hydrostations linked up with local and regional grids, but they soon became a net burden. Because they were usually built in regions also possessing larger hydroprojects, they added power at times when the grids had as much as they could handle. Large projects were sometimes idled while grids were forced to buy power from small hydrostations at greater cost. Localities with small hydro often tapped the grids for electricity themselves, as their power needs exceeded their own output. 25X1

By 1983 the Ministry of Water Resources and Electric Power (MWREP) had redefined the role of small hydrostations, confining them to supply primarily rural users with an off-grid, self-generated source of supply. Some small hydrostations were removed from grids and placed under local control. Grids were at least partially relieved of their obligations to buy power from small hydrostations. 25X1

In recent policy moves allowing local financing and operation of off-grid small hydro, Beijing is hoping to use rural savings rather than state funds to advance rural electrification. China hopes to add 4,000 MW of small hydrocapacity by 1990, and 6,000 MW more by the year 2000. Small hydrocapacity additions have slowed in recent years, but may accelerate above planned growth if rural consumers prove eager to buy their own power facilities. 25X1

China plans to add about 10,000 MW of hydropower capacity by 1990; 6,300 MW in larger projects. Past Chinese experience with hydroconstruction leads us to believe that these projects will be late in coming on line. Figure 2 shows those hydropower plants with capacity additions scheduled for the 1980s.

Other factors threaten hydroelectric output regardless of capacity completions. Chronic shortfalls of water flow in 1965-81 kept hydroelectric power output 10 percent below expectations for China's 46 large and medium hydroprojects. Silting is also a major problem, reducing the water storage capacity of reservoirs behind many of China's major dams and cutting into their ability to generate electricity in dry seasons. Chinese power officials estimate that silting has already taken up 10 billion cubic meters of volume out of the 37 billion cubic meters of capacity built into China's 11 largest reservoirs. Reservoirs are now nearly useless at Yanguoxia, Qingtongxia, and Yilihe; these projects are largely restricted to generating power from existing flow. 25X1

Electric Power Grids 25X1

China's power networks present one of the more promising areas for rapid improvements in ability to meet power needs. New high-voltage transmission lines will enable China to make efficient use of both mine-mouth thermal plants and remote hydropower resources. Developing a national grid will relieve the present regional grids of some peak load demands by sharing surplus power. 25X1

Figure 2
Hydropower Projects and Capacity Additions Planned for the 1980s

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Figure 3 shows China's power grids in black as they existed in 1979, with five major regional grids and seven large provincial grids. The highest line voltage was 330 kV found only in the northwest. These grids supplied 70 percent of China's electricity.

Major grid improvements since 1979 are shown in red. China has constructed 20,000 kilometers of transmission lines of 110 kV and above. The Sichuan and Guizhou grids have been linked to form China's sixth regional grid (the Southwest grid), soon to include Yunnan Province; Shanxi and Hebei have been tied into the North China grid; Hunan has been linked into the Central grid, where China's first 500-kV lines are in operation, supplying the Wuhan area with electricity from the partially complete Gezhouba hydropower plant.

Additional lines will be built as more power comes on line at Gezhouba. Other 500-kV lines, using domestically manufactured equipment, are now in operation in the north and northeast grids, supplying coastal cities with power from mine-mouth thermal plants. China's major power grids now distribute three-fourths of electricity, up from 70 percent four years ago.

China's progress to date making new lines operational suggests that it probably will meet its goals for the Seventh Five-Year Plan. Beijing has increased funding for powerlines dramatically through the early 1980s, has brought lines into operation on schedule, and has succeeded in producing 500-kV AC equipment domestically.

The emergence of a national grid in China will provide two new problems for China, one technological and one bureaucratic. First, power sharing at a national level, even with planned use of DC transmission lines, will require more sophisticated methods of monitoring and distributing electric power supplies. China has already begun importing computers from the United States and sending electric power technicians to study at US grid operations centers. In April of this year, China began the construction of a computerized control center for the northeast power grid in Shenyang. This center will use imported equipment and is scheduled for completion in 1986.

China's ability to absorb the skills and equipment necessary for such operations will be a key in determining whether it can take full advantage of new grid improvements. 25X1

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Secondly, plans to link regional grids into a national system also imply a centralization of authority and need for intergrid cooperation that may be more difficult than the Chinese realize. While nominally under the Ministry of Water Resources and Electric Power, the regional grid authorities have been powers unto themselves in many aspects of their operations. It may prove difficult for the central government to enforce power-sharing arrangements when all participants are experiencing shortages, or to induce regional authorities to tailor local improvements to national directives. 25X1

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Nuclear Power Plans

By the year 2000 China hopes to build or start a total of 10 nuclear power plants incorporating 20 reactors. The Chinese do not see nuclear power as a major factor in generating electricity in this century, nor do we. These power plants would only supply 10,000 MW—less than 5 percent of China's planned electric power generation capacity for the year 2000—and would be far more expensive than thermal or hydro plants. Still, the Chinese hope to acquire the technology to build plants themselves to serve heavily polluted urban centers that are far from hydroprojects and generally derive their electricity from rail-delivered coal. 25X1

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At present, the Guangdong Project and the Qinshan Nuclear Plant (sometimes called the 728 Project) are the only two nuclear plants to receive investment funds from the state budget. Site preparation has begun at both plants, and China's optimistic projections call for both to be operational before 1990. Planning officials have indicated that two more plants probably will begin construction during the Seventh Five-Year Plan, in east China and Liaoning Province.

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Figure 3
Major Electric Power Grids

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Outlook

We expect relatively slow growth in electric power supplies through the 1980s, as capacity growth rises from 4 or 5 percent annually in 1984-85 to 7 percent annually in 1986-87. Capacity growth in 1987 and beyond will be determined by investment funding for electric power after 1984. The Chinese increased funding for electric power in 1983, but must continue to do so to achieve faster capacity growth targets set for the last part of the decade.

Given our projections for electric power growth through 1987, we expect industrial growth eventually will be forced down from its present double-digit growth rates to expansion at a rate more closely in line with growth in power supplies. We cannot predict the onset or the duration of an industrial slowdown, or even the severity of its impact. All of these elements depend on Chinese reaction to what we expect to be an increasingly restrictive power constraint.

The combination of slow electricity growth and unchecked demand for electric power could create serious problems for the leadership. The most likely scenario is a continuation of the ongoing, chronic shortages that limit rapid growth and wastefully idle production capacity. However, unregulated competition for power supplies or poorly coordinated electricity rationing schemes could create more serious power shortfalls later in the 1980s that threaten state production targets. A falloff in hydropower production, a strong possibility at some point in this decade, could produce extreme power shortages that force a difficult recentralization of production decisions. This would seriously undercut the present reform policies, which provide factories with profit incentives but also charge them with responsibilities for losses.

We expect problems would exist in enforcing either national or local rationing schemes. The leadership would have to rein in local power grid authorities long used to autonomy. Many grids lacking more sophisticated distribution equipment would have to rely on factories to remain on their honor to "throw the big switch" when their power supply is supposed to be cut.

The key question for China will be whether or not planners accept the likelihood of a pause in China's present high rates of growth and take an active role in determining which sectors of the economy bear the brunt of the slowdown. A concerted effort to allocate power to priority industrial sectors or priority enterprises within industries would minimize the adverse impact of power constraints. 25X1

Foreign technology will not play a major role in China's electric power sector until later in the decade. 25X1
Furthermore, most of the impact will derive from smaller scale purchases and technology transfers, rather than large projects and "big-ticket" items. China continues to negotiate for nuclear technology and foreign funding and equipment for large hydroprojects, but the main benefits China gains from abroad in the 1980s will stem from purchases of US technology for thermal generators, and US grid equipment and grid management training, which will all contribute substantially to improving and increasing China's electricity supplies in the late 1980s. 25X1 25X1

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