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North Korea: Energy Scene



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July 1987

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A Research Paper

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North Korea: Energy Scene



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Summary

Information available as of 16 June 1987 was used in this report.

North Korea's energy picture offers a striking contrast between abundant resources—mainly coal and sources of water power—and chronic energy shortfalls that have created bottlenecks throughout the economy and have even affected the all-important military sector. P'yongyang has tried short-term fixes to deal with energy-related difficulties, but for the most part these have either exacerbated existing problems or created new ones:

- P'yongyang has exhorted energy producers to increase output, but such orders have strained equipment and reduced time for maintenance and repair.
- The North has tried alternative fuels, but use of lower octane gasoline or methane in motor vehicle engines, for example, reduces efficiency and can cause damage.

North Korea's efforts to go beyond these stopgap measures focus on expanding electric power capacity and coal-mining operations, as well as increasing oil imports and domestic exploration. In our view, the goals P'yongyang has set are overly ambitious and unlikely to be met, given the North's shortages of manpower, machinery, and materials; its inability to pay for imports of equipment; and its inadequate infrastructure:

- During the current Seven-Year Plan (1987-93) P'yongyang wants to double coal output, but we doubt it can increase production much faster than the 7.5-percent annual rate achieved in recent years.
- Even if the North completes the electric power plants under construction, it will be 7 to 8 million kilowatts short of the capacity needed to meet its goal of tripling output by 1993.
- P'yongyang is already behind on payments to its three major oil suppliers, who are unlikely to extend new credits the North would need to step up imports, and domestic exploration has met with little success.

As a result, energy shortages will continue to hinder the North Korean economy. Only a change in priorities could boost the energy sector. P'yongyang would have to divert substantial investment from new production facilities in areas such as steel and machinery to even come close to realizing its energy goals. A less centralized leadership that relied on expert advice in planning could also give the energy sector a nudge. But wide-ranging reforms in decisionmaking and incentives that would enable the energy sector, as well as the rest of the economy, to take off are unlikely to occur soon, in our judgment.



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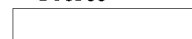
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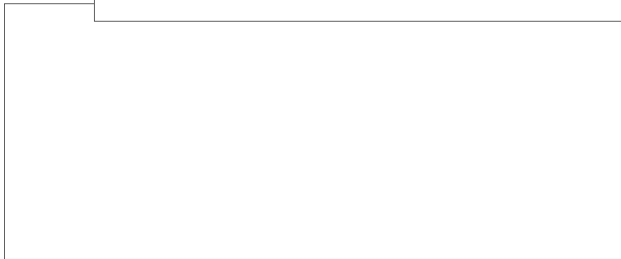
North Korea: Energy Scene 


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**The North Korean Energy Picture:
Potential and Reality**

By most measures, North Korea should not have faced the energy shortages that have crippled its economy. The North has ample reserves of coal and sources of waterpower. Its relatively small population and low stage and pace of industrialization should have kept demand at manageable levels, especially compared with South Korea, which has nearly twice as many people and a booming economy to support, but fewer domestic energy resources. North Korea also derives substantial benefits from its ties to the USSR and China, which have provided much of the equipment and technology for its power plants and oil refineries and most of its oil. Moscow, in fact, donated equipment immediately after the Korean war, and both the USSR and China later sold North Korea equipment on credit. In addition, Beijing and, until recently, Moscow have granted large price subsidies on their exports of oil to the North. 

Despite what would appear to be a satisfactory energy base, North Korea is unable to meet even the modest demands of its primary energy user, the industrial sector.¹ 



¹ North Korea allocates nearly all of its energy to the productive sector—where the high share of heavy industry results in high energy use—with very little going to other consumers. In contrast, the South allocates about one-third of its energy for residential and commercial uses. 

Preview of North Korea's Energy Sources

North Korea's fuel and power industries are based mainly on its large resources of coal and water power, with coal estimated to account for more than 70 percent of the energy available from primary sources, hydroelectric power for about 20 percent, oil for about 5 to 6 percent, and fuelwood for the remainder:

- *Coal.* North Korea's major deposits of coal—we estimate reserves at 8 to 12 billion metric tons—are anthracite and are used mostly for electric power generation. All high-quality coking coal for the metallurgical industry must be imported.
- *Electric power.* The electric power industry, equally divided between hydropower and coal, had an installed capacity of about 6.5 million kilowatts at the end of 1986. P'yongyang has relied heavily on imports, largely from the Soviet Union, for equipment for its power plants.
- *Petroleum.* North Korea depends on imports to supply its two oil refineries, one built by the Soviets in the early 1970s and the other by the Chinese later in the decade. Imports from China have remained steadier over time than have those from the USSR and Iran, the North's other two major suppliers.

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See appendix for further details on the North's energy sources.



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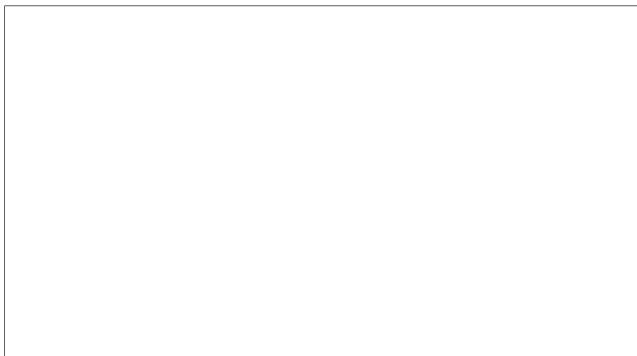
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In our view, North Korea's inability to meet its energy needs is rooted in systemic and technical problems that afflict the economy as a whole.

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- P'yongyang also has consistently called on energy producers to increase output. [Redacted]

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Like other parts of the economy, the energy sector is constrained by technical limitations. The coal industry's inability to fully exploit the North's abundant reserves illustrates this problem. North Korea's coal-mining technology remains far below international standards. For example, the North lacks the know-how, as well as the machinery and managerial skills, for rapid exploitation of deeper seams as the easier deposits are worked out. Coal mines are also constantly short of pit props, explosives, detonators, oil, and spare parts. The lack of railway spurs and loading facilities, roads, living quarters, and medical facilities has delayed the opening of new minesites. Similar problems have impeded the exploitation of the North's hydroelectric power potential. [Redacted]

- Another short-term fix has been to use alternate fuels. But using lower octane gasoline or methane in motor vehicle engines reduces efficiency and could damage them.

- P'yongyang has called for reduction in energy use. Cutbacks, however, have led to frequent black-outs—which are costly because workers are idle and equipment must be shut down—and to power brownouts, which can seriously damage equipment.

[Redacted]

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Longer Term Solutions

North Korea has gone beyond these stopgap measures to identify long-range objectives for solving energy problems. In fact, energy figures prominently among 10 goals for economic development the North originally selected for completion in the 1980s but now has pushed into the early 1990s. According to the North Korean press, the Third Seven-Year Plan (1987-93) calls for expanded electric power capacity and enlarged and modernized coal-mining operations. It also has placed a priority on exploring for both offshore and onshore oil reserves, and on increasing oil imports. Many of the projects would require at least some imported equipment and technology, placing pressure on North Korea to boost exports to fund such purchases as well as additional oil imports. [Redacted]

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The oil industry has similar infrastructure problems, as well as the financial limitations that trouble all parts of the energy industry. North Korea cannot afford to import all the oil it needs to keep its refineries operating. And the North has not yet begun to make large-scale use of nuclear power, for which it must rely completely on foreign equipment. [Redacted]

Short-Term Solutions

P'yongyang clearly recognizes the difficulties confronting the energy sector, but in many cases its quick fixes only exacerbate those problems or create others:

[Redacted]

Coal. In our judgment, all of the North's goals for the energy sector are ambitious. There is some chance of success in the area of hard and bituminous coal production, [Redacted]

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The North already has stressed the importance of progress in this area. An editorial in the Korean Workers Party daily, *Nodong Sinmun*, last September, for example, dealt at length with the need to

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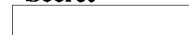
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boost coal output, citing Kim Il-song's teaching that "coal is the food for our country's *chuche* (self-reliant) industry." P'yongyang also has announced plans to improve mine safety, particularly in providing protection from flooding. Damage to mines in the wake of Typhoon Vera last summer highlighted the need for such steps. Moreover, North Korea has succeeded in lining up foreign help for the industry. According to the Polish press, Warsaw has agreed to provide equipment and technical help for a coal mine in the Anju area; and the North is probably counting on Japan and the USSR as continued sources of equipment. 

We do not know if P'yongyang will match its planning with action in the form of funding or resources. If it does give more attention to the coal industry, the North should be able at least to equal the 7.5-percent average annual growth rate in hard coal output realized during the last Seven-Year Plan, which covered 1978-84. But we doubt it can meet the new plan target of 10.5-percent growth in production per year. We expect that continued shortages of manpower, materials, and machinery will prevent significant

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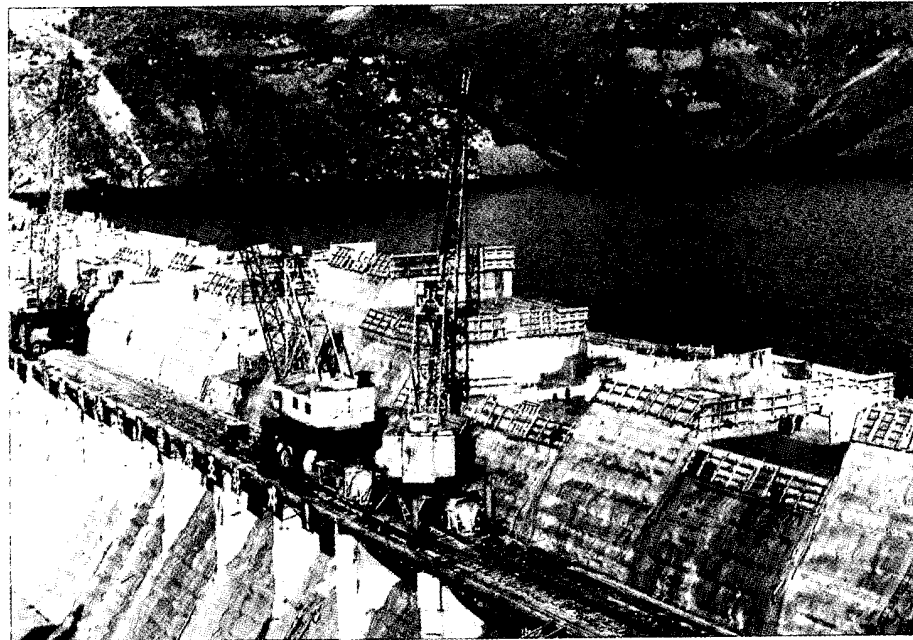
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Figure 1. North Korea: The T'aech'on hydroelectric project under construction. [Redacted]



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progress. Moreover, foreign exchange problems will limit the amount of equipment North Korea can import. [Redacted]

Electric Power. The North's plans for electric power are even more ambitious than those for the coal industry. P'yongyang hopes to triple electric power output to 100 billion kilowatt-hours by 1993. The North Korean press has headlined construction at two major hydroelectric power projects, and P'yongyang claims it has released thousands of soldiers to work at the sites:

- Construction on the T'aech'on hydroelectric power project in the northwestern part of the country began in 1981 (see figure 1). According to the North Korean press, the project will consist of five separate power stations, two of which are nearing completion. The North Korean press also reports that the project will use 125,000-kilowatt generators, which the North has recently begun to produce at the Taean Heavy Machinery Complex (see figure 2).
- Last year the North broke ground for construction of the Kumgangsan hydropower project in the southeast. P'yongyang says the plant, which will be the largest in the country, will have a capacity of

810,000 kilowatts. P'yongyang plans to create four reservoirs—at Innam, Chongok, Changan, and Naepyong—that will provide water to power the plant, 20 kilometers south of Wonsan near Sinhwa Ri. [Redacted]

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The North has commitments for foreign assistance in expanding its electric power base:

- [Redacted] China will assist in construction of the Kumgangsan project. In addition, the council of the China-Korea Hydraulic Corporation—which operates joint hydroelectric projects between the two countries—adopted a proposal last July for joint construction of a new power plant on the Yalu River.

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- Since early 1984, North Korea has conducted negotiations with Poland, Switzerland, and Austria for construction of a thermal power station at Anju to consist of four 250,000-kilowatt units [Redacted]

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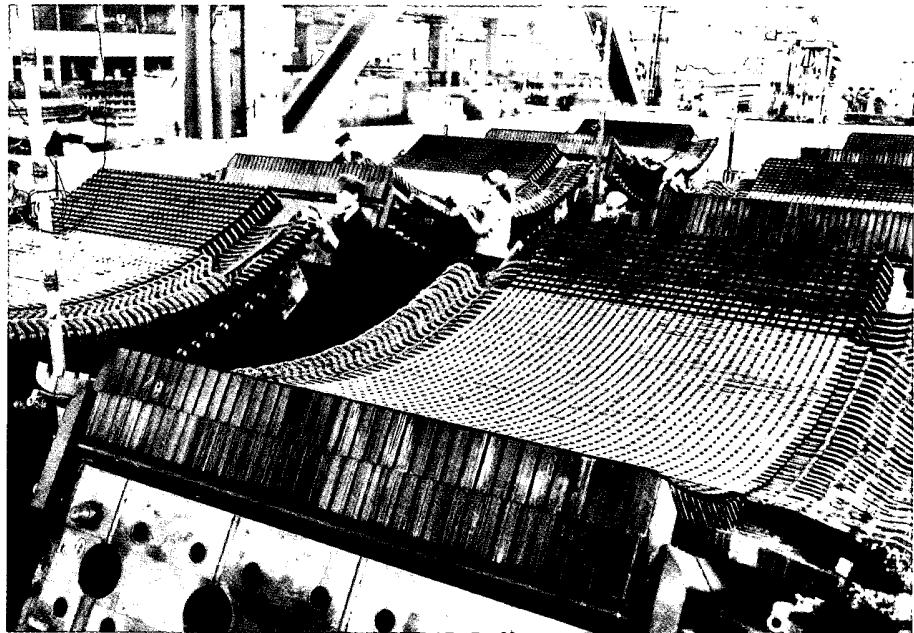
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Figure 2. North Korea: A 125,000-kilowatt generator being built at the Taean Heavy Machinery Complex.



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[redacted], the USSR has agreed to help build a 200,000-kilowatt thermal power plant in east P'yongyang. [redacted]

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Nevertheless, we believe the Soviets could drag their feet in getting the project off the ground. Moscow was apparently reluctant to provide P'yongyang a nuclear reactor in the first place: negotiations for Soviet nuclear power reactors were reported as long ago as 1978.

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In December 1985, the Soviets also agreed to help the North build its first nuclear power plant, which reportedly will have a capacity of about 1.4 million kilowatts. In a February 1986 interview with the US publication *Nucleonics Week*, the chairman of the USSR State Committee for the Utilization of Atomic Energy stated that Soviet-designed VVER-440 reactors would be built in North Korea. The project would be a boon to the North because it would allow for diversification of energy sources and provide relatively stable supplies. The project appeared to be in trouble in the spring of 1986, however, following the Chernobyl' accident.

[redacted]

Although construction or planning of new power plants is already under way and the North has promises of foreign assistance, we believe P'yongyang will fall far short of its goals for the electric power industry under the new Seven-Year Plan. The nuclear power plant may not be completed until well after the plan ends in 1993. Given its troubles in the coal industry, P'yongyang probably will not have enough coal to fuel the thermal electric power plants it is

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constructing. Even if all the power plants that we know are under construction were completed and operating, the North would still be 7 to 8 million kilowatts short of the capacity we believe necessary to meet its production goal. In sum, P'yongyang may be able to increase electric power production 8 to 10 percent a year, faster than the 5-percent rate achieved since 1975, but we believe it will remain below the 16-percent annual rate implicit in the Seven-Year Plan and well below the needs of the economy. [redacted]

Petroleum. The North is least likely to make substantial progress toward solving its energy problems in the petroleum sector. P'yongyang is in arrears on its debts to all three of its major suppliers—and none is likely to extend new credit:

- The USSR agreed in early 1986 to supply the North with 20,000 b/d of crude oil for its east coast refinery [redacted]

The volume is about the same as that stipulated in North Korean-Soviet trade protocols of the past several years, but Soviet trade data indicate actual deliveries in 1981-85 did not reach that total (see table 1). Moreover, in view of the North's poor record for increasing exports to cover oil and other imports, the requirement for advance payment clearly limits the agreement.

- The Chinese probably also will continue to press for balanced trade. Beijing's increased emphasis on earning hard currencies in the international market may make it reluctant to provide all the oil P'yongyang wants for its west coast oil refinery and to continue to subsidize prices.
- North Korea has paid for Iranian oil with arms, but even this arrangement is not a sure bet for increasing or even maintaining import levels. With a rise in Chinese arms sales, Tehran may be less willing to purchase poorer quality North Korean arms. Nor are the Iranians likely to extend new credits or to accept other North Korean goods—most of which are of poor quality—in exchange for oil.

As a result, we believe that North Korea can expect little increase in oil imports during the next few years. [redacted]

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Table 1 *Thousand barrels per day*
North Korea: Estimated Oil Imports^a

	USSR ^b	China ^b	Iran	Total
1970-73 average	13	2	0	15
1974-77 average	20	13	0	33
1978-80 average	24	18	0	42
1980	25	16	5	46
1981	16	14	10	40
1982	19	17	15	51
1983	13	18	15	46
1984	12	19	12	43
1985	14	18	10	42
1981-85 average	15	17	12	44

^a Includes imports of petroleum products, which we estimate have averaged less than one-fifth of the total in the 1980s.

^b We have estimated the volume of imports from the USSR and China, which these countries report only in value terms. In the case of the Soviet Union, we have used the calculated CEMA price for each year to determine the volume. In the case of China, we have used a midpoint, assuming the Chinese discount their oil to North Korea by 20 to 40 percent of the world market price.

Finally, domestic production of oil offers little hope for relieving North Korea's petroleum problems. P'yongyang's efforts to find onshore and offshore oil appear to have met with little success, although exploration continues with Soviet participation. And the North is still looking in the West for oil exploration and exploitation equipment—so far without much success. Even if P'yongyang discovered sizable oil deposits, full exploitation would be many years away. [redacted]

Outlook

We believe energy shortages will continue to be the norm for North Korea. The leadership could give the energy sector, as well as other parts of the economy, a nudge by allowing experts a greater role in decision-making, increasing incentives to managers and workers, and reducing redtape. [redacted]

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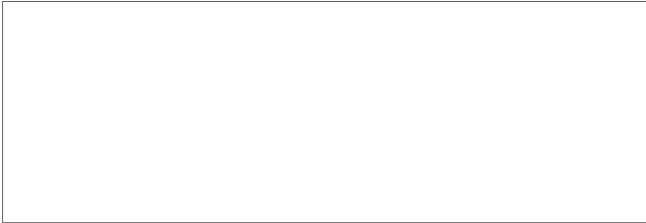
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If P'yongyang diverted investment resources to energy as well as to transportation and other infrastructure projects, progress could be possible. Such a move would mean a cutback in new productive facilities—factories that produce steel and machinery, for example—but would ease the many bottlenecks that prevent existing plants from operating even close to full capacity. Nonetheless, we see no signs that changes of this scope are even being considered in P'yongyang. Indeed, like other areas of the economy, the North's problems with energy reflect the consequences of its priorities on the defense industry, an almost 40-year-long commitment to autarky, and an unwieldy centralized and personalized top-down management system. We do not expect P'yongyang to come to grips with its difficulties in developing and managing this sector any more quickly than it has in dealing with its problems in others. 

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Figure 3
Major Energy Facilities



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Appendix

Details on Energy Availability



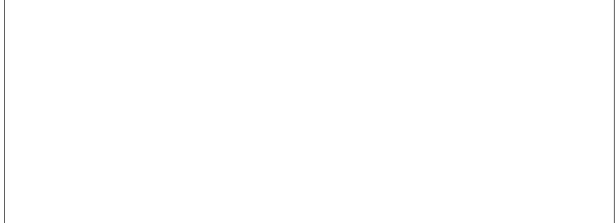
P'yongyang pays for coking coal from China with an equal value of anthracite. The North's metallurgical plants consume nearly all the coking coal it purchases.

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Electric Power

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North Korea's electric power industry—now equally divided between hydropower and coal—had an installed capacity at the end of 1986 of approximately 6.5 million kilowatts, more than twice the 1970 level but far short of the approximately 12 million kilowatts needed to fulfill the 1978-84 plan for output.



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Coal

North Korea's major coal deposits are primarily in the central and northeastern regions, with the Anju area producing roughly two-fifths of coal output (see figure 3). Reserves are an estimated 8 to 12 billion tons, which is adequate for more than 100 years at the present rate of use. Anthracite accounts for about two-thirds of coal reserves, and lignite and bituminous coal for the remainder. Although production of hard and bituminous coal rose from an estimated 22 million tons in 1970 to 52 million tons in 1984, it fell short of the Seven-Year Plan (1978-84) target by roughly one-third (see table 2).

North Korea failed to reach the 1978-84 Seven-Year-Plan target of 50 to 60 billion kilowatt-hours by 1984 (table 3 presents a list of major electric power plants in North Korea).

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About two-thirds of the North's domestic coal supplies generate electric power, with the remainder being used by coal-burning locomotives, factories that rely on coal-based chemicals to produce rayon and vinylon, and small users and households. In addition, P'yongyang has commitments for exports of about 2 million tons of coal annually to China, although it often falls short because of domestic demands.

Because P'yongyang is stressing the construction of thermal power plants, the share of hydroelectric plants in total output has fallen from more than four-fifths in 1970 to roughly one-half in 1986. Hydroelectric power plants do not produce uniformly throughout the year because reservoir levels vary both with fluctuations in precipitation and use of the water for irrigation. The fact that hydroelectric plants take longer to build than thermal plants and require larger capital investment is probably also behind the shift.

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The North has no known deposits of high-quality coking coal and, thus, must rely on imports. In 1984 it imported more than 2 million tons from China—by far the largest supplier—the USSR, and Poland.

P'yongyang has had to rely heavily on imports—largely from the USSR—for equipment for its power plants. Most North Korean hydroelectric power

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Table 2
North Korea: Estimated Energy Production, 1970-93

	1970	1975	1977	1980	1981	1982	1983	1984	Planned for 1978-84 ^a	1985	Planned for 1987-93 ^b
Total coal (million metric tons)	28	35	41	56	58	60	61	63	NA	64	NA
Hard coal ^c	22	27	32	46	47	49	50	52	70-80	53	120
Electric power ^d (billion kilowatt- hours)	14	18	20	23	24	25	26	27	50-60	30	100

^a The Second Seven-Year Plan.

^b The Third Seven-Year Plan.

^c Includes bituminous coal.

^d Includes output from thermal (mainly coal powered) as well as from hydroelectric power plants.

plants were built by the Japanese and refurbished and expanded with Soviet and Czechoslovak assistance after the Korean war. The Soviet press has reported that nearly two-thirds of the North's electric power output comes from Soviet-built plants and that plants constructed with Soviet assistance in the 1970s ensured a 40-percent increase in electric power. We have no evidence to dispute the Soviet claim. The USSR has been involved in the construction of three thermal power plants that account for nearly all of the country's thermal capacity—the Pukch'ang, P'yongyang, and Ch'ongjin (see figure 4). The North Koreans also have received assistance from the Chinese in the construction of power plants—the Sup'ung-ho and Yunfeng hydroelectric plants on the Yalu River, with output shared between the two countries (see figure 5).

Petroleum

North Korea does not produce crude oil or natural gas, and before construction in the early 1970s of the first of two oil refineries—the Sungni Chemical Plant, which was built by the USSR in Unggi (see figure 6)—P'yongyang imported all of its petroleum products. The Chinese built the North's second refinery in

Paengma-ri, which came onstream in 1978. Chinese oil is heavier than the other oil North Korea imports and is suitable only for this refinery; the lighter Soviet and OPEC oil can be used in either refinery. We estimate that the crude oil charge capacity of the Sungni refinery is about 40,000 b/d and of the Paengma-ri about 34,000 b/d. Most of the North's oil imports now consist of crude, which the USSR delivers mainly by rail and China primarily by a pipeline from the Dandong area of China. In 1985 the USSR provided about 33 percent of North Korea's oil imports, China about 43 percent, and Iran the remainder.

The North's main oil consumers are the military, transportation, agricultural, and fishing sectors. Oil is also used in the manufacture of petrochemicals—notably at a petroleum-based urea plant imported from Austria and at an acrylonitrile plant purchased from France.

Availability of oil has not—on average—increased in recent years, although demand presumably is growing. Imports have fluctuated with North Korea's

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Table 3
North Korea: Major Electric Power Plants ^a

	Capacity (kilowatts)	Remarks
Pukch'ang TPP	1,600,000	Built with Soviet assistance. All 16 generators were operating as of June 1985.
P'yongyang HTPP	500,000	Built with Soviet assistance.
Anju HTPP	300,000	North Korea is seeking equipment and technical assistance from Poland, Switzerland, and Austria for another power plant (consisting of four 250,000-kilowatt units) at Anju.
Unggi TPP	200,000	Only North Korean thermal power plant that uses oil rather than coal.
Ch'o'ngjin TPP	100,000	Built with Soviet assistance. Two generators were operating as of June 1985 and a third generator reportedly was completed in December 1986.
Sodu Su HPP	450,000	Also known as Ch'o'ngin HPP; consists of three plants.
Hochon 1-4	348,000	Consists of four plants: Honggum Ni HPP, Hochon Up HPP, Sangnong Nodongjagu HPP, and Pinaechon HPP.
Sinhung HPP Pujon 1-4	200,000	Consists of four plants.
Hagaru Ri HPP	334,000	Consists of four plants; also known as Changjin 1-4.
Kanggye HPP 1-3	221,000	Consists of three plants.
Sup'ung-ho HPP	630,000	Joint Chinese-North Korean project built on the North Korean side of the Yalu River. This project is known as the Shuifeng Power Station in China. The project is being expanded by about 150,000 kw on the Chinese side. Half of the output goes to China.
Yunfeng HPP	400,000	Joint Chinese-North Korean project built on the Chinese side of the Yalu River; also known as Huludao HPP Unbong. Output is shared by the two countries.
Taipingwan HPP	190,000	Built by China on its side of the Yalu River. Power plant is a joint venture between China and North Korea. Two generating units were in operation as of December 1986. The other two were scheduled to be completed in 1987. Capacity will then total 190,000 kilowatts. Output is to be shared by North Korea and China.
Wiwon HPP	240,000 ^b	A joint Chinese-North Korean project under construction.
Kumgangsan HPP	810,000 ^b	Under construction. To be powered by water tunneled from four reservoirs.
T'aech'on HPP	625,000 ^b	Under construction. Scheduled to consist of five separate power stations.

^a Note: TPP=thermal power plant; HTPP=heat and thermal power plant; HPP=hydropower plant.

^b Projected.

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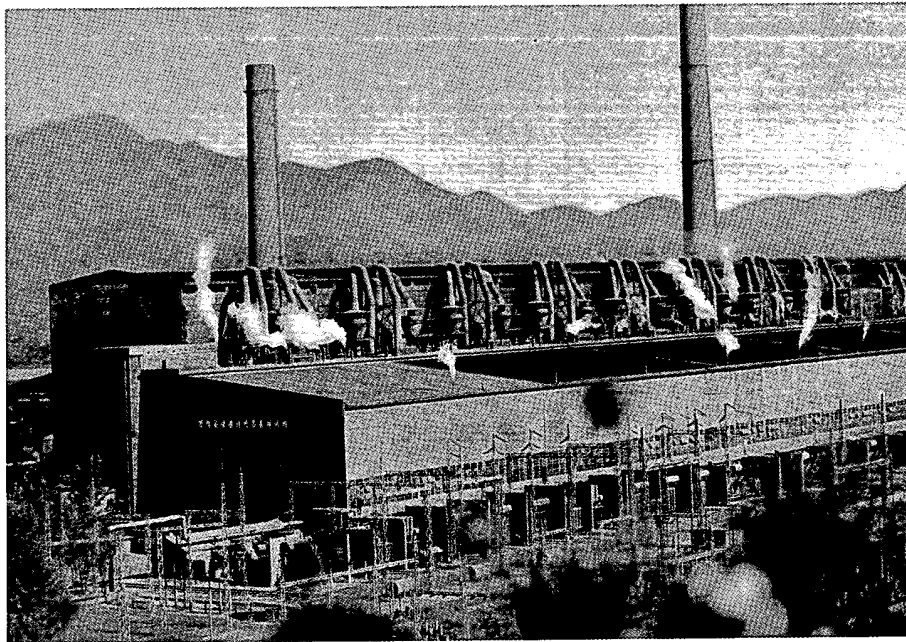
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Figure 4. North Korea: The Pukch'ang Thermal Power Plant.

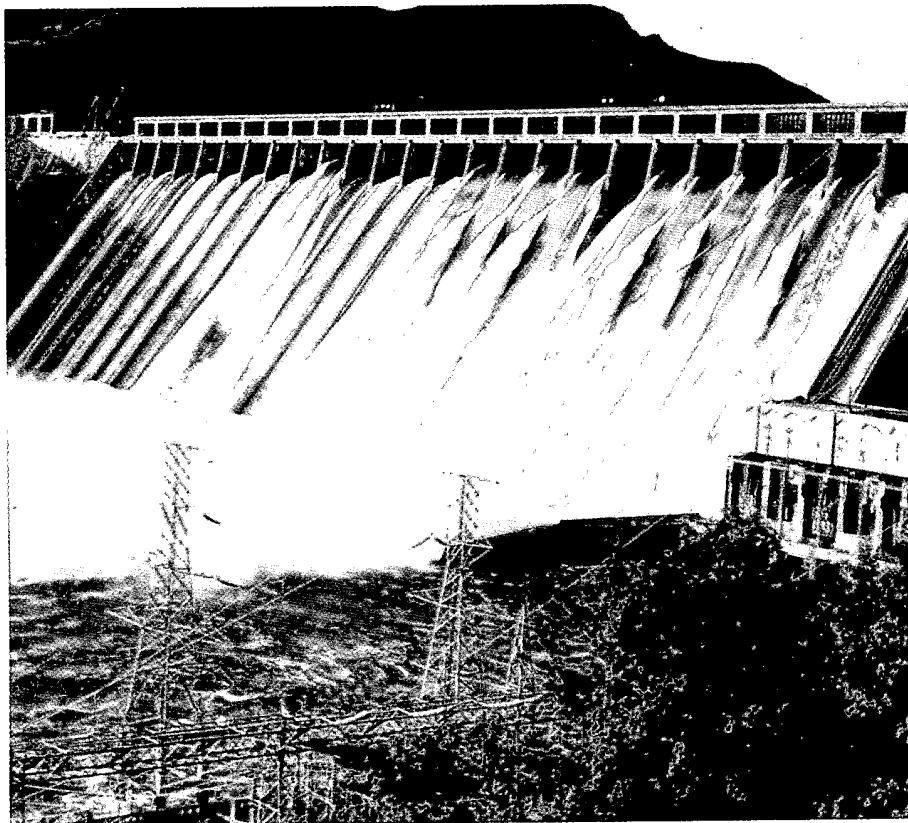
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Figure 5. North Korea-China: The Joint Sup'ung hydroelectric project on the Yalu River.

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Figure 6. North Korea: The Sungni Chemical Plant, one of the country's two petroleum refineries. [Redacted]

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ability to pay [Redacted] since the mid-1970s Moscow has insisted that P'yongyang not only pay cash for its imports but also that it make at least some payments on its more than \$600 million in debt to the USSR.⁴ This has increased the strain on North Korea's limited export capacity and resulted in numerous shortfalls in Soviet oil deliveries. We estimate that imports of Soviet crude oil and petroleum products fell from an average of 24,000 b/d in the period 1978-80 to 17,500 b/d in 1981-82 and to only 13,000 b/d in 1983-85. [Redacted]

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Imports of oil from China appear to have remained steadier over time than those from the USSR. [Redacted]

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[Redacted] we believe—on the basis of Chinese value data and assuming a 20- to 40-percent price discount—imports averaged between 15,000 b/d and 21,000 b/d during 1978-85. [Redacted]

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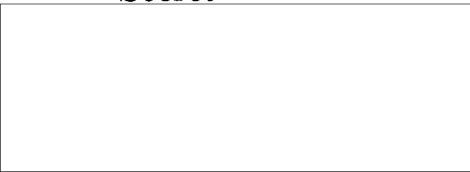
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