China

Tianjin No.3 Gas Works Project

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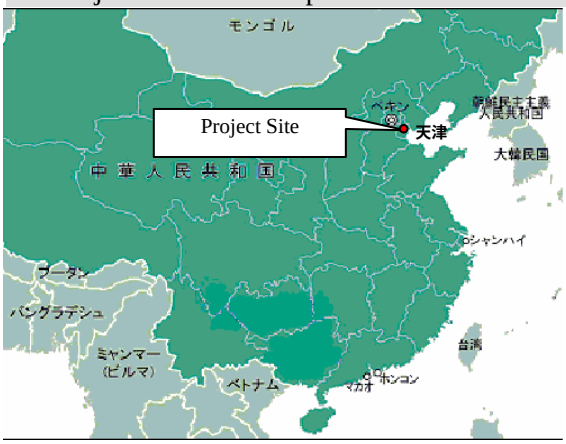
Field Survey: September 2004

1. Project Profile and Japan's ODA Loan



Project site location map

Coke oven at No.3 Gas Plant

1.1 Background

Tianjin is one of the largest cities in China next to Shanghai and Beijing with a population of nearly 10 million and an area of approximately 11,000 km^2, which is almost the same as that of Akita Prefecture, located an hour's drive by expressway from Beijing, the capital of China. As a "coastal open city" designated under the reform and open policy of the government, Tianjin has been attracting many foreign companies[1] in recent years and achieving remarkable economic growth.

At the time of appraisal in 1994, the gas demand in Tianjin was 3.24 million m^3/day and the gas supply was 2.07 million m^3/day, causing a huge supply-demand gap. The gas supply coverage as of 1993 was 80.9% (supply of gas for household use in the urban area), which indicates that gas service was not available to some citizens. The gas demand was predicted to increase to 4.43 million m^3/day by 2000 to keep pace with the increase in industrial production, and therefore the supply-demand gap was feared to expand. Also, gas was considered as an alternative energy source to coal and heavy oil, and the improvement of energy efficiency and environmental load reduction effects were expected of gas.

1.2 Objective

This project's objective was to stabilize gas supply in the city as a substitute for coal and heavy oil by constructing a coal gasification plant with a production capacity of 1 million

[1] Including major companies such as GM and Motorola of US and Daihatsu, YAMAHA, and Toyota of Japan, etc.

m^3/day in Tianjin, and thereby contribute to eliminating the gas supply-demand gap, enhancing gas supply coverage and improving the natural environment.

1.3 Borrower/Executing Agency

Ministry of Finance/Ministry of Construction of the People's Republic of China

1.4 Outline of Loan Agreement

Loan Amount / Loan Disbursed Amount	5,722million yen / 5,720 million yen
Exchange of Notes / Loan Agreement	January 1995 / January 1995
Terms and Conditions -Interest Rate -Repayment Period (Grace Period) -Procurement	 2.6% 30 years (10 years) General untied
Final Disbursement Date	February 2000
Main Agreement	Local companies
Consultant Agreement	—
Feasibility Study (F/S), etc.	1991 Chinese Government

2. Results and Evaluation

2.1 Relevance

At the time of appraisal, the supply-demand gap of gas was expected to widen with rapid economic growth. This project was implemented based on the Eighth 5-Year Plan of China (1991-95), which mentioned the expansion of gas supply in urban areas as one of its goals, as well as the Eighth 5-Year Plan of Tianjin City, which set forth the objective of improving the imbalance in gas supply and demand in Tianjin. Also, the project was intended to replace coal used by households and heavy oil used by industries with coal gas, which places less burden on the environment. Therefore, the project was relevant at the time of appraisal.

At the time of ex-post evaluation, development of natural gas was promoted under the Ninth 5-Year Plan (1996-2000), while coal was regarded as the basic energy source. In the Tenth 5-Year Plan (2001-05), the Chinese Government set the target of promoting diversification of energy sources as is seen in the "West-East Gas Pipeline" project[2] by reducing consumption of coal and increasing the share of natural gas[3]. However, the share of natural gas among primary

[2] A project to construct a 4,200 km gas pipeline between Xinjiang Lunnan and Shanghai to transport natural gas resources from the Tarim basin in the Xinjian Uygur autonomous region to the eastern region, which was completed in 2004

[3] Although natural gas is more expensive than coal gas in terms of unit price, it is environmental friendly with no sulfur oxides or soot emitted and is more energy efficient.

energy sources remains low[4] and coal gas continues to play an important role in supplying energy on a stable basis to help develop economy and improve the standard of living. Particularly in Tianjin where the demand for reasonable coal gas remains strong mainly in the steel industry zone, this project is indispensable to balancing supply and demand. Also considering that high-quality coke, which is in great demand at home and abroad, is produced as a byproduct, this project has economic significance. Therefore, the project maintains its relevance to date.

2.2 Efficiency

2.2.1 Output

This project was planned to construct a coal gasification plant in Dongli District, Tianjin City and supply gas via pipelines. The ODA Loan covered the entire foreign currency portion of the project cost to construct the following facilities.

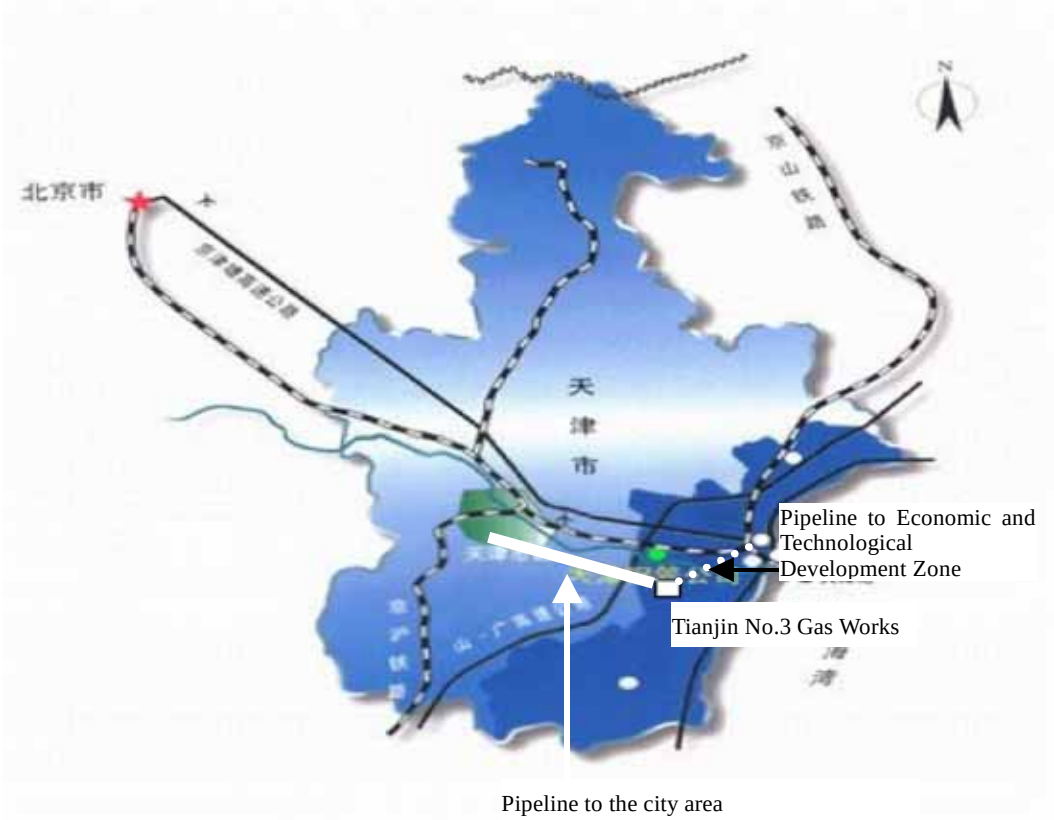
(1) Coal gasification plant (production capacity: 1 million^3/day)
(2) Related facilities (road, waterworks, power transmission line, track)
(3) Gas transport facilities (pipelines)

In the project, the coal gasification plant and related facilities other than gas transport facilities (pipelines) were constructed almost as planned. The original plan was to transport gas produced at No.3 Gas Works to the city area of Tianjin by a 18.5 km pipeline, and to the Economic and Technological Development Zone around the Haihe river mouth by a 16.0 km pipeline. However, the construction of the pipeline to the Economic and Technological Development Zone was cancelled because it was decided in the Ninth 5-Year Plan of Tianjin City to deliver natural gas to industrial development zones including the Economic and Technological Development Zone and newly developed industrial areas.

Gas produced under the project is supplied to two factories in the Haihe Lower Reaches Steel Industry Zone, in addition to the Tianjin city area, via the pipeline constructed with its own fund.

[4] 3.58% in 2000, 3.54% in 2001, and 3.33% in 2002 (China Energy Statistical Yearbook).

Figure 1　Tianjin No.3 Gas Works and Pipelines



2.2.2 Project Period

The project took 79 months from December 1994 to June 2001, 110% longer than the planned period of 37 months from December 1994 to December 1997. The extension was mainly due to the shortage of local currency attributable to the difficulty in obtaining financing from banks under the belt-tightening policy. Other factors include: companies did not make contributions to the Gas Use Promotion Fund[5] due to the sluggish economy and deterioration of business performance; there were only a few contractors interested in bidding for the contracts in yen because of yen's depreciation, and it took time to explain the project to contractors; the cost for relocation of residents and land acquisition increased.

2.2.3 Project Cost

The actual project cost was 13.48 billion yen (ODA Loan: 5.722 billion yen), up 3.87 billion yen (28.7%) from the planned cost of 17.35 billion yen (ODA Loan: 5.72 billion yen). The increase in the project cost was caused by the inflation that began in 1992 following the abolition of the dual-price structure, depreciation of yen after 1995, and the extension of the

[5] The fund was planned for the purpose of eliminating gas supply shortage and making up for the shortage of investment funds by collecting 600 yuan per ton of future gas demand from companies.

project period.

2.3 Effectiveness

2.3.1 Gas Production

The planned gas production was approximately 1 million m^3/day (365 million m^3/year). The actual production increased steadily from 0.218 million m^3/day (46.95 million m^3/year) in 2001 when the project was completed to 0.792 million m^3/day (289 million m^3/year) in 2002 and to 0.937 million m^3/day (342 million m^3/year) in 2003, almost achieving the target (Table 1).

The ratio of gas supply for private and other use to that for industrial use was initially planned to be 6 : 4. However, as the supply of natural gas increased, general households have come to use natural gas, and a larger portion of low-price coal gas is supplied for industrial use. As a result, the actual ratio of gas supply for private and other use to that for industrial use is 2.5 : 7.5 (Table 1).

Assuming the annual gas consumption per household is 240 m^3, the number of beneficiaries of this project is estimated at about 350,000 households. Beneficiaries of gas supply for industrial use are Tianjin Pipe Corporation and Tianjin Steel Plant. Tianjin Pipe Corporation started operation in 1996 and manufactures 1 million tons of seamless steel pipes[6] annually. Tianjin Steel Plant started operation in 2004 and manufactures 3 million tons of iron annually.

Table 1 Gas Supply from No.3 Gas Works

(Unit: ten thousand m^3/day)

	Plan		Actual					
			2001		2002		2003	
Private and other use	60.3	60%	15.0	69%	19.8	25%	23.4	25%
Industrial use	40.2	40%	6.8	31%	59.4	75%	70.3	75%
Total	100.5	100%	21.8	100%	79.2	100%	93.7	100%

Source: Tianjin Tianti Coking and Chemical Co., Ltd.

2.3.2 Substitution of Coal and Heavy Oil

The gas produced in this project is considered as an alternative energy source to coal (briquette for kitchen use) and heavy oil (industrial fuel) and was expected to improve energy efficiency and reduce environmental load. Coal is more energy efficient and emits less soot when used as gas after gasified at a coal gasification plant compared to when used as coal in general households. In this project, a tightly sealed blast furnace and an integrated desulfurization and deammonification system were introduced in the coal gasification process as

[6] Unlike welded steel pipes, seamless pipes have no seams and are used mainly for oil and gas development as oil well tubes.

measures to enhance energy efficiency and reduce emission of sulfur dioxide from coal combustion.

2.3.3 Production of Byproducts

In this project, China's first large-scale chamber-type coke oven was installed and produces high-quality coke, benzene, tar, and sulfur as byproducts in the process of roasting coal in the blast furnace. The production of coke, in particular, exceeded the planned 0.86 million tons/year and reached 1 million tons/year in 2003, generating a large part of the business income. Because of the high demand for steel, high-quality coke is in great demand. Every year, 0.2 million tons of coke produced under this project is exported to Japan, and the rest is sold in China. Considering that it has become more difficult to satisfy the demand for coke in the Japanese steel industry in recent years, it is highly valued that a certain volume of coke is provided to Japanese companies through the project.

2.3.4 Economic Analysis

①Financial Internal Rate of Return (FIRR)

The Financial Internal Rate of Return (FIRR) calculated at appraisal time was 8.1%, and recalculation for ex-post evaluation resulted in 17.8%. One of the causes that lead to the increase in FIRR is the active demand for steel that boosted sale prices of coke[7]. The assumptions for the calculation of FIRR at the time of appraisal are as follows:

(Assumptions for calculation)

- Project life: 30 years
- Benefits: business income from the sale of gas and by products
- Costs: project cost, maintenance cost

②Economic Internal Rate of Return (EIRR)

In addition to FIRR, which was calculated at the time of appraisal, the Economic Internal Rate of Return (EIRR) was calculated for ex-post evaluation and resulted in 29.6%. The assumptions for the calculation of EIRR are as follows:

(Assumptions for calculation)

- Project life: 30 years
- Benefits: Increase in gas production, export of coke and production of other byproducts, reduction in sulfur dioxide emission, and land opportunity cost of the project site

[7] The price of coke for the domestic market increased from the appraisal time to 2004 by 100% and that for export increased by 367%.

・ Costs: project cost, maintenance cost (excluding taxes)

2.4 Impact

2.4.1 Stabilization of gas supply in Tianjin

The gas demand in Tianjin steadily increased to reach 5.18 million m^3/day in 2003, marking a 60% increase from 1994. The gas supply also increased, pushed up by the increase in the supply of natural gas as a result of the energy policy of Tianjin City and China's Great Western Development Policy, which realized the transport of natural gas from Shaanxi Province to Beijing. The supply-demand gap was temporally eliminated in 2001 when the gas supply peaked at 5.03 million m^3/day. After that, despite the increase in the supply of coal gas, the total gas supply decreased to 4.71 million m^3/day in 2002 and to 3.99 million m^3/day in 2003, whereas gas demand increased to 4.92 million m^3/day in 2002 and to 5.18 million m^3/day in 2003, regenerating supply-demand gap. This supply-demand gap is attributable to the following two causes: supply of liquefied petroleum gas has decreased with the increase in the supply of natural gas; and demand for gas for industrial use is increasing supported by economic development.

Although the volume of gas produced under this project accounts for only 5% of total gas supply in Tianjin, the fact that the ratio of households receiving gas supply increased from 80.9% in 1993 to 94.8% in 2001, 95.1% in 2002, and 97.1% in 2003 indicates that the project played a certain role in stabilizing energy supply. However, as already mentioned in 2.3.1, the ratio of gas supply for household use in this project has decreased from the planned 60% to 25%.

Table 3 Gas Supply in Tianjin by Type and Gas Supply Coverage

（Unit: ten thousand m^3/day）

Type of Gas	1994		2001		2002		2003	
	Supply	Share	Supply	Share	Supply	Share	Supply	Share
Liquefied Petroleum Gas	100	49%	376	75%	316	67%	218	54%
Natural Gas	49	23%	89	18%	97	21%	114	29%
Coal Gas	58	28%	37	7%	58	12%	66	17%
No.1 Gas Works	13.1		—		—		—	
No.2 Gas Works	45.3		22		38.2		42.6	
No.3 Gas Works	—		15		19.8		23.4	
Total Supply	207	100%	503	100%	471	100%	399	100%
Demand*	324		467		492		518	
Demand-Supply Gap	△117		36		△21		△119	
Gas Supply Coverage (%)	80.9**	-	94.8	-	95.1	-	97.1	-

Source: Tianjin Statistical Yearbook, JBIC data

*The figures for 2001 and after are calculated based on the demand estimate at appraisal time (average annual demand growth rate: 5.4%)

**Data for 1993

2.4.2 Industrial Development in Tianjin

As shown in Table 4, iron production in Tianjin in 2002, or the year following the completion of the project, was 4,825,800 tons, up 22% from 2001. Considering that part of gas produced in this project is supplied for industrial use at Tianjin Pipe Corporation and Tianjin Steel Plan, the project contributes greatly to the development of the steel industry of Tainjin by providing a stable energy source.

Table 4 Iron Production in Tianjin

(Unit: ten thousand tons)

	1994	1995	1996	1997	1998	1999	2000	2001	2002
Iron Production	188.55	171.57	200.99	236.79	255.27	317.69	356.76	395.3	482.58
Growth Rate		-9%	17%	18%	8%	24%	12%	11%	22%

Source: Tianjin Statistical Information Network

2.4.3 Relief of housework burden through the use of gas (beneficiary survey)

In order to assess the effect of the shift of kitchen fuel from briquette (coal) to coal gas in terms of reduction of housework, we conducted a beneficiary survey of 102 residents in the city area of Tianjin (valid responses: 90). According to the result, 60% of the respondents say “housework hours have been reduced by 1-2 hours,” and 37% say “housework hours have been reduced by less than 1 hour”. Most of the saved time is used for the care of children and the elderly and hobbies. The survey also shows that the use of coal gas solved the problem of soot and dust that used to annoy the residents when they used briquette, and their living environment has improved.[8]

2.4.4 Environmental Impact

As a measure to reduce load on the environment, the project introduced a completely sealed-off large scale chamber-type coke oven and installed a device to prevent scattering of soot at the coal storage. Also, additional desulferization equipment was set at the boiler, and integrated desulfurization and deammonification technology was employed to purify gas. As a result, emission of sulfur dioxide from coal combustion has been successfully reduced. The gas works obtained an ISO certificate and conducts monitoring of air, water, and noise at 5 monitoring points within the plant every year. The monitoring results all meet the national standards. Since No.3 Gas Works constructed under this project imposes less impact on the environment than other coal gas plants, all the production of coal gas is planned to be

[8] About 64% of the respondents had completed the shift to coal gas before the completion of the project. In addition, there is another gas supply source (No.2 Gas Works). Therefore, the housework reduction effect and living environment improvement effect are not entirely attributable to the project.

concentrated in this plant in the future.[9]

Although the concentrations of air pollutants in Tianjin are below the national standards, concentrations of sulfur dioxide (SO_2) and nitrogen dioxide (NO_2) have been increasing. Various measures taken by Tianjin City, such as the "switch from small-size coal-fired boilers to large-size boilers", "installation of desulfurization equipment", and "shift from coal to natural gas or electricity", do not keep up with the increase in pollutants caused by industrial development. Increase in exhaust gas as a result of the increase in the number of registered automobiles is considered to be another factor behind the increased concentration of SO_2 and NO_2.

Table 5 Concentrations of Air Pollutants in Tianjin

(Unit: mg/m^3)

	1992	2000	2001	2002	2003
SO2	0.036	0.056	0.054	0.069	0.073
Standard	0.15（Japanese Standard: 0.04）				
NO2	0.035	0.053	0.048	0.046	0.051
Standard	0.08（Japanese Standard: 0.06）				
TSP	0.260	0.305	0.283	—	—
Standard	0.30（Japanese Standard: 0.10）				

Source: Tianjin Environmental Protection Bureau

2.4.5 Relocation of Residents

In this project, a land area of 7,821 m^3 was expropriated, and 46 households were relocated. According to the executing agency, the government's land administration officials and the representative of the neighborhood association visited each household, and the process from assessment, examination, and evaluation to agreement was carried out without any problem pursuant to the Land Administration Law (2nd amendment 1986). It was confirmed in the interview with the relocated residents that their living standards have improved through the improvement of housing environment and employment opportunities at No.3 Gas Works and that they are mostly satisfied with their living conditions since relocation[10].

2.5 Sustainability

2.5.1 Executing Agency

2.5.1.1 Technical Capacity

The technical staff of the plant are classified into "technical employee", "quasi-engineer", "middle engineer" and "senior engineer" according to the result of the technical examination,

[9] No.1 Gas Works was closed down due to concern that its decrepit facilities may have considerable impact on the environment and is now used as a natural gas storage tank. No.2 Gas Works is also scheduled to be closed in several years.

[10] In this survey, 4 persons were interviewed.

academic background, technical skills, length of employment, and specialty. Among the technical staff of the operation and maintenance division, 88% are middle engineers and 12% are senior engineers. Various classroom training and on-the-job training courses are provided for the maintenance and improvement of the technical level. Before the completion of each training course, trainees are required to pass an examination (those who fail must take the same training course again). Thus, they have a system to ensure the technical level required for the operation and maintenance of the plant such as the training system, and the staff is allocated based on the evaluation results. Therefore, no problem is found in terms of technical capacity.

2.5.1.2 Operation and Maintenance System

The executing agency of this project is the Ministry of Construction, and the implementing body is No.3 Gas Works (municipal plant of Tianjin), which is under the control of the Ministry of Construction. After the start of production in 2001, No.3 Gas Works was incorporated as Tianjin Tianti Coking and Chemical Co., Ltd. and affiliated by Tianjin Tiantie Metallurgical Group Co. Ltd., a state-run enterprise.

As of September 2004, Tianjin Tianti Coking and Chemical Co., Ltd. is composed of 11 major divisions, 5 plants (water and electricity, thermal power, chemical substances retrieval, gas, and coke), Quality Inspection Center, Transport Division, and Automation Division. Operation and maintenance activities are performed by the machinery power department, one of the 11 major divisions.

2.5.1.3 Financial Status

Until 2002 shortly after the completion of the project, Tianjin Tianti Coking and Chemical Co., Ltd. recorded deficits both in operating income and current net profit due to the low capacity utilization rate. However, in 2003 when full-scale production started, the sales almost doubled from 2002, and the company went into the black for the first time both in operating income and net profit. Although the surplus fund is negative because of the continued deficits since the establishment, it is expected to turn positive if steady production continues. Therefore, there is no problem with financial sustainability of the project.

Profit and Loss Statement

(Unit: thousand yuan)

Item	**2002**	**2003**
Sales	531,647	1,025,962
Operating Income	△10,004	75,169
Net Profit	△17,738	50,508

Balance Sheet

(Unit: thousand yuan)

Item	2002	2003
Assets		
Current Assets	265,304	435,672
Fixed Assets	1,519,974	1,305,671
Other Assets	103,147	192,816
Total Assets	1,888,426	1,934,160
Liabilities		
Current Liabilities	293,526	336,264
Fixed Liabilities	911,328	854,104
Total Liabilities	1,204,855	1,190,369
Shareholders' Equity		
Capital Stock	658,278	698,278
Legal Reserve for Retained Earnings	81,000	50,711
Surplus	(55,707)	(5,198)
Total Shareholders' Equity	683,571	743,791
Total Liabilities and Shareholders' Equity	1,888,426	1,934,160

2.5.2 Operation and Maintenance Status

For the operation and maintenance of facilities, there are 35 kinds of operation and maintenance systems and procedure manuals covering quality control, environmental management, safety management, accident prevention structure, emergency control structure, etc. In the field survey, it was confirmed by specialists that the coal gas refining process and environmental management measures are of high standard and that major equipment and facilities such as the coke oven, gas refining facilities, and sewage treatment facilities are for the most part properly operated and maintained.

3. Feedback

3.1 Lessons Learned

N.A.

3.2 Recommendations

N.A.

Comparison of Original and Actual Scope

Item	Plan	Actual
①Project Scope		
1. Coal gasification plant	Preprocessing facilities (including coal storage) Coke production facilities Gas refining facilities Gas production facilities Power generation facilities Gas storage and in-plant transport facilities Ancillary facilities In-plant infrastructure Facilities for employees Others	Preprocessing facilities (including coal storage) Coke production facilities Gas refining facilities Gas production facilities Power generation facilities Gas storage and in-plant transport facilities Ancillary facilities In-plant infrastructure Facilities for employees Others
2. Related Facilities	Road: approach 4.1km Waterworks: pipeline 2.5km Power transmission equipment: transmission line 2.8km Track: sidetrack 8.9km	Road: approach 2.72km Waterworks: pipeline 3.5km Power transmission equipment: transmission line 14.2km Track: 23.53km (14km(outside the plant) +6km (in the plant), 3.53km (sidetrack))
3. Gas Transport facilities	Pipeline: Gas plant-Tianjin city area: 18.5km Gas plant-Haihe River Mouth Industrial Area: 16.0km	Pipeline: Gas plant-Tianjin city area: 18.5km Gas plant-Haihe River Mouth Industrial Area: cancelled
②Project Period	Dec. 1994 - Dec. 1997 (37 months)	Dec. 1994 - Jun. 2001 (79 months)
Detailed designing	Jan. 1994 -Dec. 1994	Jan. 1994 - Dec. 1995
Bidding evaluation	Nov. 1994 - Dec. 1996	Mar. 1995 - Dec. 1999
Coal gasification plant	Nov. 1994 -Dec. 1997	Jul. 1996 - May 2001
Related facilities		
Gas transport facilities	Nov.1994 - Dec. 1997 Dec. 1994 - Dec. 1997	Jan. 1998 - Oct. 2000 Jan. 1998 - Oct. 2000
③Project Cost		
Foreign Currency	5,722 million yen	5,720 million yen
Local Currency	7,759 million yen (Local currency: yuan)	11,633 million yen (Local currency: yuan)
Total	13,481million yen	17,353 million yen
ODA Loan Portion	5,722 million yen	5,720 million yen
Exchange Rate	1 yuan ＝ 11.9 yen	1 yuan＝11.9 yen