People's Republic of China

Ex-Post Evaluation of Japanese ODA Loan Project

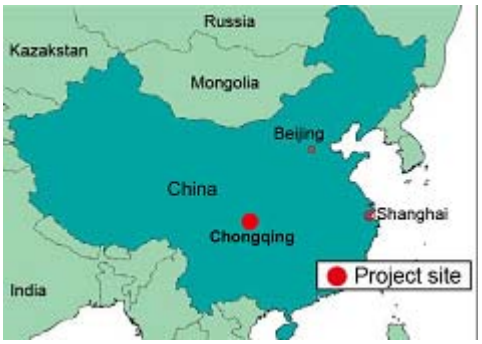
"Chongqing Environment Model City Project (1) (2)"

External Evaluator: Junko Miura, Global Link Management, Inc.

0. Summary

Environment Model City Projects were implemented in Chongqing, Dalian and Guiyang in order to improve environment by carrying out air pollution control intensively and by building environmental monitoring system, under the "Environment Model City Framework[1]", which was aiming to replicating the good practices of the projects in other cities in China. As Chongqing City's energy structure depends on coal, the City was facing serious air pollution along with recent rapid industrialization and increase of vehicles. Thus, it was urgently needed to take actions in air pollution control and in building an environmental monitoring system. As a result of the implementation of this project, the following indicators have been achieved: reduction in air pollutants emission amount, desulfurization efficiency of Flue-Gas Desulfurization (FGD) and operating hours of the monitoring system, thus, it can be said that expected effects have been observed almost as planned. In addition, these effects have contributed to the improvement of the living environment by betterment of air quality and to the enhancement of the environmental management capacity. Therefore, effectiveness and impact of this project is high. Although the project cost was within the plan, the project period exceeded the plan, therefore efficiency of the project is fair. No major problems have been observed in the operation and maintenance system, technical level, and operation and maintenance status of the implementing agencies of each sub-project. Financial situations are also stable. Therefore, sustainability of the project effect is high. In light of the above, this project is evaluated to be highly satisfactory.

1. Project Description



Project Location

Toutong Natural Gas Station

[1] The framework was proposed at the Japan-China Summit in 1997.

1.1 Background

In China, along with steady economic growth since 1980's, environmental pollution had been worsened due to industrialization and population growth. Particularly, emission of Sulfur Dioxide[2] (SO_2), Total Suspended Particular[3] (TSP) and Nitrogen Oxide[4] (NOx) was serious due to the burning of coals as industrial materials, power generation and heating materials. As a result, density of SO_2 and TSP of the major cities in China was too high to meet the national environment standards. The target area of this project, the urban areas in Chongqing City, also faced serious air pollution problems along with industrialization and the increase of the number of automobiles. Due to the energy structure, which depends on coals, and the industrial structure, which mainly consists of heavy chemical industry, air pollution was worsened by gas emission from coal burning. SO_2 density exceeded the National Environment Ambient Air Quality Standards Grade II[5] (hereinafter refers as the National Standards Grade II) considerably. Under this circumstance, Chongqing City was selected as one of the model cities of "Environment Model City Framework", then this project was implemented.

1.2 Project Outline

The objective of this project is to improve the air quality in Chongqing City[6], by following five sub-projects: 1) Chongqing Natural Gas Transmission and Distribution Extension Project (hereinafter refers as the natural gas supply sub-project); 2) Natural Gas Filling Stations Project; 3) Major Pollutant Sources Monitoring and Control Project (hereinafter refers as the major pollutant sources monitoring system sub-project)[7]; and 4) Chongqing Jiulong West Power Plant Desulfurization Project; thereby contributing to the improvement of the environment of Chongqing City. The location of the project site is shown in Figure 1[8].

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[2] SO_2 is one of the major air pollutants. It is generated by burning the fuels including sulfur such as coal or oil. SO_2 is one of the causes of acid rain.

[3] TSP is particulate matter which is less than 100 micron in diameter. Smoke dust is one of the smokes. It is solid particulate matter such as soot and burned embers.

[4] Nitrogen Oxide is one of the pollutants which are generated by burning of coals or traveling of vehicles. It is one of the causes of photochemical smog.

[5] These current standards were raB3095-1996). The standards were divided into three grades and Grade I is the stricter standards. Grade I standards are applied for natural conservation area. Grade II standards are applied for commercial, residential and agricultural and general industrial areas. Grade III standards are applied for special industrial area.

[6] It was recorded that the central area in Chongqing City was the "model area" in the JICA appraisal documents. However, some parts of the major pollution sources monitoring and control project are located in the suburbs. Since the JICA appraisal documents and the Minutes of Discussion also set "Chongqing City" as the target area, this study also follows this definition.

[7] The monitoring sites include the main pollution sources such as chemical factory, power plants and wastewater treatment plants. The system consists of monitoring centers and monitoring facilities for waste air and waste water. For more details, see the section of "Efficiency".

[8] As the major pollution sources monitoring system sub-project covers the whole model area, its location are not shown in the map. The natural gas supply sub-project also covers the whole model area, but its gas storage

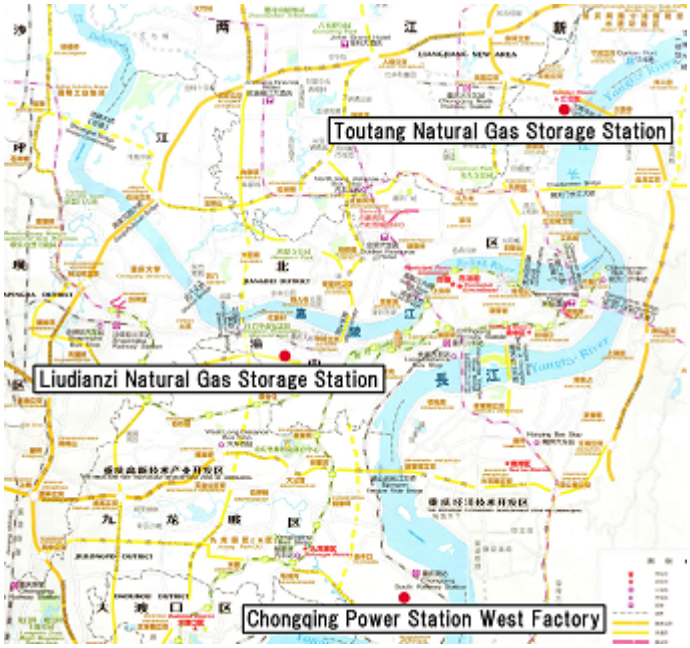


Figure 1 Location of Project Site

Approved Amount / Disbursed Amount	(I) 4,412million yen / 4,257million yen (II) 3,289million yen / 876 million yen
Exchange of Notes Date / Loan Agreement Signing Date	(I) March 2000 / March 2000 (II) March 2001 / March 2001
Terms and Conditions	Interest Rate: 0.75%; Repayment Period: 40years (Grace Period: 10 years); Conditions for Procurement: Bilateral Tied
Borrower / Executing Agency	The Government of the People's Republic of China / Chongqing Municipal People's Government
Final Disbursement Date	(I) December 2009, (II) April 2007
Main Contractor (Over 1 billion yen)	China National Precision Machinery Import and Export Corp.
Main Consultant (Over 100 million yen)	NA
Feasibility Studies, etc.	Feasibility Studies were conducted as follows. Natural Gas Filling Stations: Chongqing Steel Design Institute, April 2000. Chongqing Power Station FGD: West South Power Design Institute, November 1999. Monitoring System: Chongqing Architecture University Architecture Design Institute, August 1999 Natural Gas (Station): China Municipal Central North Design Research Institute, 2000-2001. Natural Gas (Pipes): Zhongxing Group, International Engineering Group and Chongqing Design Institute. Natural Gas (Automatic control): Chongqing Automatic Institute, 2000-2001. SAPROF was conducted for the monitoring system in March 2000.

stations only are shown in the map. As the natural gas filling stations sub-project was cancelled, its location is not shown in the map.

Related Projects	Osaka City has carried out technical cooperation regarding the high level of natural gas with Chongqing City, and this project was implemented based on the above cooperation. In addition, in responding to the needs of Chongqing City, Osaka City also conducted joint study on the gas supply technology such as automatic supply, industrial combustion technology such as boilers and detection technology for gas leakage.

2. Outline of the Evaluation Study

2.1 External Evaluator

Junko Miura, Global Link Management

2.2 Duration of Evaluation Study

Duration of the Study: August, 2011 to September, 2012

Duration of the Field Study: November, 13th to 26th, 2011 and March 5th to 15th, 2012

2.3 Constraints during the Evaluation Study

Among the sub-projects, the natural gas supply sub-project aimed at reducing air pollutants emission by promoting the project of converting small and medium-sized boilers in the urban areas to natural gas[9]. However, the conversion project was out of scope of this project, and it has passed long time since the completion of the conversion project. Thus, it was not possible to confirm by reports the actual figures of small and medium-sized boilers which had been converted, and the precise date of the project completion. Therefore, the sub-project was evaluated by confirming JICA internal documents and interviewing with the responsible person in Chongqing Environmental Protection Bureau (CEPB).

3. Results of the Evaluation (Overall Rating: A[10])

3.1 Relevance (Rating: ③[11])

3.1.1 Relevance with the Development Policy of China

3.1.1.1 Development Policy at the time of appraisal

At the time of appraisal (2000), China's 9th Five-Year Environmental Protection Plan (1996-2000) set the following specific objectives: decrease in the major pollutants emission to the level of 1995; and achieve the emission standards at industrial pollution sources. The Government of China introduced the concept of "SO_2 pollution control area" and "acid rain

[9] At the time of planning, it was also considered to include the conversion project into the scope of this project, but the conversion project was deleted from this project for the following reasons: as medium-small boilers are scattered in wide range, it takes long time; as the owners of medium-small boilers are small enterprises, the conversion project does not match with the loan project. Source: JICA appraisal documents.

[10] A: Highly satisfactory, B: Satisfactory, C: Partially satisfactory, and D: Unsatisfactory.

[11] ③: High, ②: Fair, and ①:Low.

control area" [12] by the revision of air pollution control regulations in 1995[13], and took intensive actions by designating those areas in 1998. In order to take further actions for the improvement of environment, the current 10th Five-Year Environmental Protection Plan (2001-2005) targeted reducing the emission of major pollutants by 10% compared with the year of 2000; and decreasing the total SO_2 emission amount in the above two pollution control areas by 20% compared with the year of 2000.

The Chongqing's 9th Five-Year Environmental Protection Plan (1996-2000) and the Long-term Plan towards 2010 targeted the achievement of the National Standards Grade II by 2005 regarding the annual average air pollution density. The target values are as shown below.

Table 1 Target of annual average of air pollution density in Chongqing City

Unit: mg/m^3

Pollutants	National Standards II	Year 2000	Year 2005	Year 2010
SO_2	0.06	0.15	0.06	0.06
TSP	0.20	0.25	0.20	0.20
NOx	0.05	0.07	0.05	0.05

Source: JICA appraisal documents

In order to achieve the above targets, the following specific directions were announced: 1) enhancement of the clean combustion technology and combustion facilities; 2) promotion of natural gas usage as domestic fuel; and 3) promotion of the FGD projects.

3.1.1.2 Development Policy at the time of ex-post evaluation

The 11th Five-Year National Environmental Protection Plan (2006-2010) targeted reducing SO_2 emission by 10%. The current 12th[t] Five-Year National Environmental Protection Plan (2011-2015) set the goal of reducing SO_2 emission by 8% as a binding objective[14]. While the national target of reducing SO_2 emission by 10% in the 11th Five Year Plan was equivalent to 22.94 million tons, the national target of reducing SO_2 emission by 8% in the 12th Five Year Plan was equivalent to 20.86 million tons. For example, in order to achieve those targets,

[12] SO_2 pollution control area is the area of serious contamination of SO_2. Acid rain control area is the area where acid rain occurs or where there is a possibility that acid rain will occur in the future.

[13] The basic framework of air pollution control in China is regulated by Air Pollution Action Law. It was enacted in 1987, and it was revised in 1995 and 2000. The basic principle of controlling air pollutants emission is regulating the density of air pollutants at pollution sources. The State Council established the national environmental air quality standards and established national emission standards accordingly in order to achieve the air quality standards. The local government has a right to establish local standards for the parameters which the state government has not established and to establish local standards which are stricter than the state government.

[14] Binding objectives have legal effects unlike predictive objectives. The 11th Five Year Plan introduced the concept of biding objectives for the first time.

specific targets were set for each province. In Chongqing City, the following objectives were set: reducing from 837,000 to 737,000 (by 11.9%) in the former plan and reducing from 609,000 to 566,000 (by 7.1%) in the latter plan.

Chongqing's 11th Five-Year Environmental Protection Plan (2006-2010) set the following objectives: 290 days per year in achieving the National Standards Grade II; reducing the emission of SO_2, smoke and dust; and strengthening the control of gas emission from automobiles. With respect to natural gas supply, the following specific goals were set: increasing the annual usage from 3.6 billion m^3 in 2005 to 7.8 billion by 2010; and increasing the natural gas consumption ratio in all the energy consumption from 14.2% to 20%. The current Chongqing's 12th Environmental Protection Plan (2011-2015) further strengthened environmental policies and set the following targets: achieving the National Standards Grade II in terms of the annual average air pollution density of major pollutants; 311 days per year in achieving the National Standards Grade II; and keeping the acid rain frequency per year within 45%.

3.1.2 Relevance with the Development Needs of China

At the time of appraisal, the central areas in Chongqing City faced serious air pollution problems along with industrialization and the increase of the number of automobiles. Due to the heavy dependency on coals as energy sources and the industrial structure in which heavy chemical industry is dominant, air pollution by waste gas from coal burning became serious, thus SO_2 density exceeded the National Standards Grade II significantly. As the urban areas[15] and some counties of Chongqing City were designated as acid rain control areas in 1998, CPMG reinforced its pollution control actions. Prior to this, CMPG enacted the "law of SO_2 pollution control along with coal burning in Chongqing City" in 1997. By this law, it became compulsory for the power plant, which uses coals with more than one percent of sulfur, to reduce SO_2 by installing FGD facility or by other means. In particular, the Chongqing Jiulong Power West Plant under this project was next to the residential areas, thus it was desired to reduce SO_2 and TSP.

Meanwhile, Chongqing City is rich in natural gas resources. At the time of appraisal, the annual natural gas production amount by China National Petroleum Corporation was 3.654 billion m^3. Among them, a total of 2 billion m^3 (1.4 billion for industrial large consumer and 0.6 billion for the urban domestic gas) was supplied to Chongqing City, and a total of 1.654 billion m^3 was supplied to Sichuan and Yunnan Provinces. Although the 9th

[15] The districts such as Yuzhong, Zhanbei, Shapingba, Nan'an, Jiulongpo, Dadukou, and Yubei.

Chongqing Five Year Plan aimed promoting gas for domestic use, the gas supply capacity in the urban areas was merely 0.6 billion m^3 per year, thus it needed to expand its supply capacity. Moreover, CMPG enacted Clean Auto Action Article 13 of the Science Technology Commission, which made it compulsory for all the buses and taxies in the urban area of Chongqing City to be natural gas vehicles by the end of 2001. Therefore, it became an urgent issue to build efficient storage and supply system of natural gas.

At the same time with implementing air pollution control actions intensively, strengthening environmental management capacity was also urgently needed. In 2003, disposal fee collection, use and management ordinance (State Council Order 369) was introduced. In order to calculate the disposal fee properly and swiftly, it became more necessary to measure pollutant emission amount properly and rapidly by building major pollutant sources monitoring system and others.

Even after the appraisal, due to urbanization and economic development, the demands for air pollution control actions have been increased. Online monitoring systems, which were not obligatory at the time of appraisal, are obligatory in each province/city at present.

3.1.3 Relevance with Japan's ODA Policy

At the time of appraisal, the Operational Policy for the Overseas Economic Cooperation of the Japan International Cooperation Agency (JICA, former JBIC) set environmental issues as one of the priority areas for loan projects for China. In addition, the Operational Policy of JBIC for China also regarded the environmental issues in China as global issues, thus announced its policy of focusing on lending support to China through air pollution control actions. The Economic Cooperation Policy of the Government of Japan towards China (2001) gave priorities to environment issues, poverty reduction and social development in inland areas, human resource development, legal system, and technical transfer. Among them, assistance cooperation for responding to global issues such as environmental issues was one of the top priorities.

Moreover, this project was implemented based on the "Environment Model City Framework" which was launched at the Japan-China Summit between then-Prime Minister Ryutaro Hashimoto and then-Prime Minister Li Peng in 1997. Thus, this project was highly consistent with the Japan's ODA policy. In the selection process of the model cities, serious air pollution situations (Chongqing City and Guiyang City) and past experiences of cooperation between Japan and China (Dalian City) were taken into account.

This project has been highly relevant with China's development plans, development needs, as well as Japan's ODA policies; therefore, its relevance is high.

3.2 Effectiveness (Rating:③)

3.2.1 Quantitative Effects

3.2.1.1 Operation and Effect Indicators

(1) Air pollutants emission and reduction amount

[Chongqing Natural Gas Supply Project]

This natural gas supply sub-project aimed at reducing air pollutants emission by promoting the project of converting small and medium-sized boilers in the urban areas to natural gas (the latter is out of the scope of this project). Therefore, this study reviewed whether this project and the conversion project were carried out as planned. Table 2 shows the plan and actual of emission amount of air pollutants. Table 3 shows coal consumption amount by each energy source before and after the boiler conversion projects and the emission amount of SO_2, TSP and NOx, which are the breakdowns of Table 2.

Table 2 Emission amount of air pollutants from small-medium boilers in the urban areas in Chongqing City (Baseline/Plan/Actual)

Unit: ton/year

Indicators	Baseline	Plan after the project completion	Actual after the project completion
	Year 2000	Year 2003	Year 2001
SO_2	274,000	194,980 (-79,020)	194,980
TSP	43,000	29,830 (-13,170)	29,830
NOx	32,100	27,470 (-4,630)	27,470

Source: Baseline and plan are from JICA appraisal documents.Actuals are from interview with CEPB.
Note: The figures in ( ) shows the estimated reduction amount to be achieved through the small-medium boilers conversion project, which are promoted by this sub-project.

Table 3 Coal consumption amount by each energy source before and after the boiler conversion projects and the emission amount of SO_2, TSP and NOx in the urban areas in Chongqing City

Unit: ton/year (excluding the numbers of boilers)

Project		Large scale boiler conversion project	Small-medium boiler conversion project				
Item		>10t/h Boiler	Boiler with less than10t/h	Tea boilers	Cooking boilers	Households	Total
Numbers		30	1,153	1,500	18,500	180,000	
Coal consumption amount	Before Project	3,013,000	867,000	197,000	179,000	144,000	4,400,000
	After Project	0	0	0	0	36,900	36,900
	Reduced Amount	3,013,000	867,000	197,000	179,000	107,100	4,363,100
SO2	Before Project	191,000	49,000	13,100	11,600	9,300	274,000
	After Project	0	270	40	1,210	2,460	3,980
	Reduced Amount	191,000	48,730	13,060	10,390	6,840	270,020
TSP	Before Project	28,900	7,500	2,500	2,300	1,800	43,000
	After Project	0	120	20	260	530	930
	Reduced Amount	28,900	7,380	2,480	2,040	1,270	42,070
NOx	Before Project	25,700	5,300	600	260	240	32,100
	After Project	0	1,460	190	40	80	1,770
	Reduced Amount	25,700	3,840	410	220	160	30,330

Source: Compiled based on the JICA appraisal documents.

As this sub-project was completed as planned (see the outputs in the section of efficiency) and the small-medium boiler conversion project was completed in June 2001[16], it can be judged that the targets have been achieved. However, as noted in the section of "Constraints during the Evaluation Study", it was not possible to verify by reports the actual figures of small and medium-sized boilers which had been converted and the precise date of the project completion. Therefore, this sub-project was evaluated by reviewing JICA internal documents and by interviewing with the responsible person in CEPB. At the time of appraisal, this project incorporated the effects of the small-medium boilers (10t/h and less than 10t/h) conversion project only in its assumption. However, beyond the assumption, the large scale boilers (more than 10t/h) conversion project was also completed by 2006[17], and the number of natural gas served households increased from 560,000 to 2,600,000. This suggests that air pollutants have been reduced more than the original targets of this project.

[Chongqing Jiulong West Power Plant Desulfurization Project]

Baseline, plan and actual of the SO_2 emission amount are shown in Table 4. Power generation amount, which affects SO_2 emission amount, is also indicated in the same table for reference.

Table 4 Power generation amount and SO_2 emission amount (Baseline/Plan/Actual)

Unit : GWh for power generation amount and ton/year for SO_2

Indicators	Baseline (Note 1)	Plan after project completion (Note2)	Actual						
			2005	2006	2007	2008	2009	2010	2011
Power generation amount (Reference only)	1,163	1,000～1,200	1,152	1,224	1,049	814	975	1,060	1,203
SO2 emission amount	40,000	2,000(-38,000)	23,064	8,052	4,129	4,055	4,242	3,709	2,921

Source: Baseline and planned figures are from JICA appraisal documents. Actual figures are from the Questionnaire answer of Chongqing Jiulong Power Corporation.

Note 1: Annual power generation amount is the actual in 1997. SO_2 emission amount is the actual in 2000.

Note 2: Power generation amount is the demand forecast. The figures of SO_2 in ( ) shows the reduced amount, which was calculated based on the assumption that limestone-plaster FGD.

Power generation amount was almost as planned except that the demand was decreased in 2008 and 2009. The reason why the SO_2 emission amount was high in 2005 and 2006 was because the FGD facility was in a test operation and adjustment. The SO_2 emission amount remained at the level of approximately 4,000 tons/year between 2007 (two years after the project completion) and 2010. Although it did not reach the target of 2,000 tons/year, the reduction amount from the baseline was 36,000 tons/year, which

[16] Source: JICA internal documents.

[17] Source: interview with CEPB.

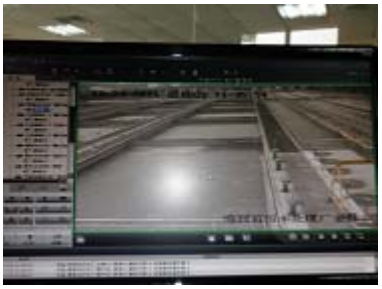
was equivalent to 95% of the plan (36,000 tons/year divided by 38,000 tons/year). Furthermore, the SO_2 emission at the time of ex-post evaluation in 2011 was 2,921 tons/year and its reduction amount from the baseline was 37,079 tons/year, which was equivalent to 97% of the plan (36,000 tons/year divided by 38,000 tons/year). In light of the above, the target has almost been achieved[18]. Meanwhile, compared with the time of appraisal, SO_2 emission standards became stricter. While the emission standards in 2001 were 8,250 tons/year, the standards in 2011 were 4,000 tons/year. The SO_2 emission amount in 2011 met the current standards, thus it can be said that there is no concern.

(2) Operating hours of the major pollutant sources monitoring system

The major pollutant sources monitoring system has been operating as planned for 24 hours throughout the year, in total of 8,760 hours/year, except the outage time due to maintenance[19]. The responsible agency of the system is CEPB. Operation and maintenance of the monitoring system (O&M of network and transmission facilities and data collection) has been managed by the Chongqing City Environmental Protection Intelligence Center (sub-ordinate of CEPB). Daily check, cleaning, calibration and repair of the monitoring equipment of each major pollutant source are outsourced to Chongqing Jiaxing Environmental Engineering Co. Ltd. (for details of the outputs, see the section of efficiency).

Central Monitoring Center

Major pollutant sources and monitoring items



Real-time picture of camera at Jiguanshi Wastewater Treatment Plant

[18] Initially, TSP emission reduction amount was also established as an effective indicator of this project. However, it was confirmed from the JICA appraisal documents and the interview with Jiulong Power Corporation that the dust removers, which are the pre-conditions for TSP reduction, were included neither in local portion nor in foreign portion of this project. Therefore, this study did not include the TSP emission reduction amount into the scope of evaluation.

[19] Source: Questionnaire answer from CEPB.

(3) Efficiency of FGD at the Chongqing Jiulong West Power Plant

Table 5 shows the baseline and planned figures of FGD efficiency at the Chongqing Jiulong West Power Plant. The FGD efficiency was between 89.5% and 94.5% between the project completion in 2005 and the ex-post evaluation in 2011. It was slightly below the target (95% or above). However, since 2005, the Plant has kept more than 90% of the target consecutively. The FGD efficiency in 2011 was also 96% (91.4% divided by 95%). Hence, it can be judged that the target has been almost achieved.

Table 5 FGD efficiency (Plan and Actual)

Unit: %

Indicator	Plan after project completion	Actual						
		2005	2006	2007	2008	2009	2010	2011
FGD efficiency	95.0% or above	94.5	91.9	91.4	92.0	89.5	91.3	91.4

Source: Questionnaire answer from Chongqing Jiulong Power Corporation.

Chongqing Jiulong Power Plant West Plant

FGD facility

Central control room

3.2.2 Qualitative effects

3.2.2.1 Increase of natural gas supply and number of service population

It was confirmed that the supply amount of natural gas and the number of households receiving natural gas from Chongqing Gas Group Co., Ltd. (former Chongqing Gas Co., Ltd.) were increased by this project and others, although these were not established as effective indicators of this project. The planned and actual supply amount and the number of service households are shown in Table 6 and 7. The supply amount was increased by 3.3 times between 2001 and 2010. The number of households receiving natural gas was increased by 4.9 times, and the number of public facilities and factories receiving natural gas was increased by 9.2 times in the same period.

Table 6 Natural gas supply amount (Baseline/Plan/Actual)

Unit: m^3 /year

	Baseline (2001)	Plan (Project Completion)	Actual (2010)
Supply amount	About 583 million	About 1,554 million	About 2 billion

Source: Baseline is from JICA appraisal documents. Actual is from the data provided by Chongqing Gas Group.

Table 7 Households/facilities which receive natural gas (Baseline/Actual)

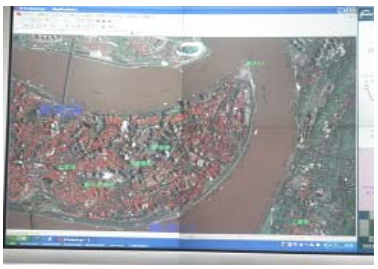
Unit: number

	Households		Public facility, commercial facilities & factories	
	Baseline (2001)	Actual (2010)	Baseline (2001)	Actual (2010)
Number of households	About 530,000	About 2,600,000	6,505	About 60,000

Source: JICA appraisal documents for the plan. Data provided by Chongqing Gas Group for the actual.

In addition, Chongqing Gas Group has also provided some service stations with natural gas. At the time of appraisal, there were only nine service stations in Chongqing City. Since it became compulsory for taxis and buses to use natural gas in 2001, there are more than 70 gas service stations in Chongqing City at the time of ex-post evaluation[20].

Filtration machine at Toutong Gas Storage Station



Natural gas supply status shown in the Supervisory Control And Data Acquisition (SCADA) system[21] (supplied areas are shown in red)

Fixed route bus run by natural gas in Chongqing City (Out of the scope of this project)

3.3 Impact

3.3.1 Intended impacts

3.3.1.1 Improvement of air quality in Chongqing City

According to the National Standards Grade II which has been applied since 1996 to the present, the limit value of average density of pollutants such as SO_2, TSP and NOx, which were set as the effect indicators for this project at the time of appraisal, is regulated. Not only these parameters, but also the limit value of the average density of Particulate Matter less than 10 micron[22] (PM10) and Nitrogen Dioxide (NO_2) is also regulated by the National Standards Grade II. Similar to other cities in China, the CPMG monitors mainly PM10 and NO_2 instead of TSP and NOx. The data obtained during this study was that of SO_2, PM10 and NO_2. Table 8 illustrates the baseline, plan and actual of SO_2, TSP, PM10,

[20] Source: Interviews with Chongqing Gas Group. Gas service stations have been operated by a few companies such as China Petro, China Petro Chemicals and Chongqing Gas Group/ Chongqing City Public Transportation Group.

[21] A centralized monitoring and control system for geographically distributed systems such as natural gas pipeline system.

[22] PM10 is the particulate whose trapping efficiency becomes 50% in the ten micron of aerodynamic diameter. It is the definition is generally used worldwide.

NOx and NO_2.

As shown in Table 8, the annual average density of air pollution in 1999 was recorded as the baseline data in the JICA appraisal documents. However, it is unknown whether the baseline data was that of the whole Chongqing City or that of the urban areas of the City. At the time of ex-post evaluation, the data obtained from the CEPB is the annual average air pollution density of the urban areas of the City. Thus, it is not possible to compare simply. Considering these, this study compares the plan (National Standards Grade II) and the actual data of SO_2, PM10 and NO_2 in the urban areas of the City.

Table 8 Annual average density of air pollution in the urban areas of Chongqing City (Baseline/Plan/Actual)

Unit: mg/ m^3

Indicators	Chongqing City (Baseline)	Plan (National Standards Grade II)	Urban areas in Chongqing City (Actual)			
	1999	2005/2010	2005	2009	2010	2011
SO2	0.171	0.060	0.073	0.053	0.048	0.038
TSP	0.204	0.200	NA	NA	NA	NA
PM10	NA	0.100	0.120	0.105	0.102	0.093
NO_X	0.062	0.050	NA	NA	NA	NA
NO2	NA	0.040	0.048	0.037	0.039	0.032

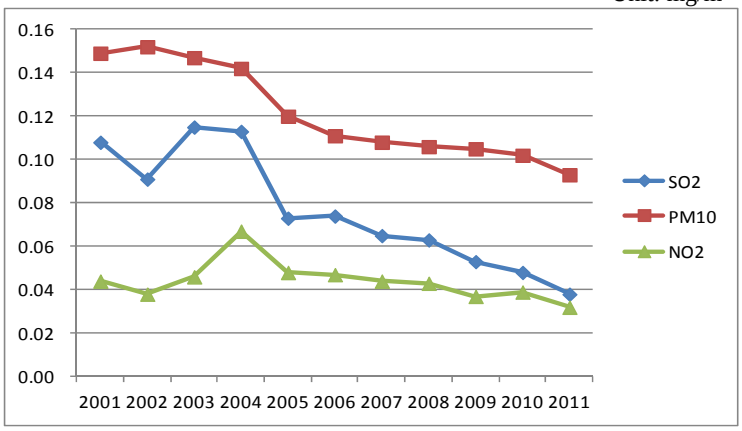
Source: Baseline and plan are from the JICA appraisal documents. Actuals are from Chongqing Municipality State of the Environment and the data provided by CEPB.

Note: The figures for the plan are those of the target in the 9th Five-Year Chongqing Environmental Conservation Plan (1996-2000) and the Long-term Plan for 2010.

The 9th Five-Year Chongqing Environmental Protection Plan (1996-2000) and the Long-term Plan for 2010 aimed at the achievement of the National Standards Grade II by 2005 through the environmental improvement actions including this project. As Table 8 shows, as of 2005, all the parameters of SO_2, PM10 and NO_2 did not achieve their targets. However, in 2009 when the project was completed, SO_2 and NO_2 reached their targets. In 2011, two years after the project was completed, PM 10 also reached its target.

Figure 2 shows the changes of annual average air pollution density between 2001 and 2011. As the Figure shows, the density of SO_2 and NO_2 was increasing between 2002 and 2004, but since 2005, it has been decreasing. The density of PM10 remained on the same level between 2001 and 2004, but it has been decreasing since 2005.

Unit: mg/m^3



Source: Chongqing Municipality State of the Environment and the data provided by CEPB.

Figure 2 Annul average density of air pollution in the urban areas of Chongqing City (Actual)

The number of days per year in which the National Standards Grade II was achieved is shown in the table below, although this was not established as an indicator for this project. The Chongqing's 11th Five Year Plan (2006-2010) set a goal of achieving 290 days per year, and it has been met every year since 2008. The target of the 12th Five Year Plan (2011-2015) was 311 days per year, and it was met in 2011.

Table 9 Number of days in which the National Standards Grade II were achieved

Unit: days

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Number of days	207	221	238	243	266	287	289	296	303	311	324

Source: Chongqing Municipality State of the Environment and the data provided by CEPB.

In light of the above, it can be judged that the air quality in the urban areas in Chongqing City has been improved. However, as this project includes only two sub-projects for reducing air pollutants in the urban areas, this project's direct quantitative contribution to the air quality improvement is considered to be limited. Regarding the degree of contribution of this project to the improvement of air quality, "Survey regarding the contribution evaluation of environmental loan projects for China- Assistance for improvement of environment in China (air and water) (2005)" conducted by Kyoto University Graduate School entrusted by JICA (former JBIC), it was estimated that the reduction amount of SO_2 by this project (approximately 114,000 tons) accounted for 10.8 % of the total SO_2 emission amount (approximately 1,050,000 tons) in Chongqing City in 2003. However, each sub-project made an important role which cannot be measured quantitatively. Chongqing Jiulong Power West Plant is a small-scale plant, but in light of

the significance of air quality improvement in the urban area, FGD was installed at this plant for the first time except one among the 30 plants in Chongqing City, thereby contributing to the reduction of SO_2 particularly in the urban area. Similarly, it is assumed that the natural gas supply sub-project has contributed to reducing SO_2 and TSP not only through the medium-small boilers conversion project, but also through providing natural gas steadily for taxi and buses, which have been obliged to utilize natural gas since 2001.

3.3.1.2 Perception of air quality improvement by residents in Chongqing City

Beneficiary surveys were conducted for 100 people [23]: 50 residents in Huangjiaoping Area in Jiulongpo District near the Chongqing Jiulong Power Plant West Plant and 50 residents and taxi drivers in Shapingba District.

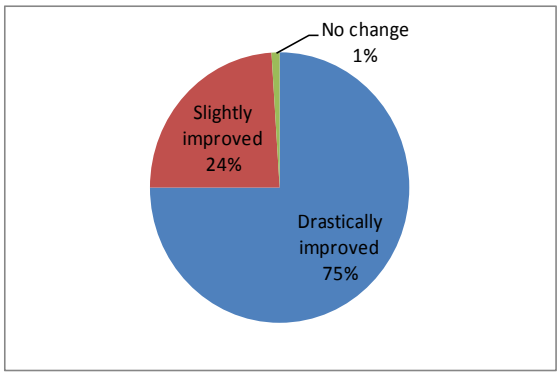


Figure 3 Perception of citizens about the improvement of air quality (N=100)

According to the survey, 75% of the respondents answered that the air quality has improved significantly; 24% answered that the quality improved slightly; and 1% answered there was no change. There was no respondent who answered "aggravated". Regarding the perception of the timing of improvement, 27% of the respondents answered that the air quality has started to improve in 2005; 51% in 2006 and 11% in 2007. To summarize, about 90% of the respondents answered that the air quality had started to improve between 2005 and 2007. This period coincides with the timing when the annual average air pollution density in Chongqing City fell down.

The following reasons for air quality improvement were identified by the beneficiary respondents (multiple answers allowed): decrease in the utilization of coals at households (63%), relocation of factories to the suburbs (60%); decrease in the utilization of coals at factories (42%); government's regulations on factories for pollutant emissions (35%); control of pollutant emissions by advanced technology (32%); control on the gas emission from automobiles (7%). The reason why 63% of the respondents identified the decrease in the utilization of coals at households as one of the reasons for air quality improvement is because natural gas has been widely used by now.

[23] 21 respondents own gasoline-vehicles, 14 respondents own natural-gas vehicles, 65 respondents do not own vehicles. There was nobody who owns hybrid vehicles. The natural-gas vehicles owners are drivers of taxis and buses.

3.3.1.3 Enhancement of the living environment by improving air quality

The followings were raised as effects of air quality improvement (multiple answers allowed): dirt on clothing by dust has decreased (61%); dry clothing outside became possible (45%); sore eyes and coughing has decreased (10%); and use masks and sunglasses for protecting from dust less than before (1%).

3.3.1.4 Enhancement of the environment management capacity of the administration

Based on the regulation for the disposal fee collection, usage and management in 2003, CMPG issued the Chongqing Environment Protection Regulation in 2007, which decided to impose penalties on a daily basis based on the monitoring data when enterprises discharge pollutants beyond the emission standards. This project has contributed to the advancement of the environmental monitoring capacity by building the automatic monitoring system of major pollutant sources. At the same time, it has also made possible to utilize the real-time objectively monitored data for collecting disposal fees and to utilize emission data for environment administration. Before introducing the above system, monitoring staff used to visit each major pollutant source regularly for collecting and recording the data by using simple equipment. As the previous system did not contain a function of transmitting data online to the monitoring center, there was no sufficient evidence to demonstrate the relationship between the pollutants emission data and the conduct of discharging. Thus, when imposing penalties on enterprises, some troubles used to occur. At present, the emission data has been widely utilized for issuing disposal permission, collection of disposal fees and penalties, allocation of subsidies, environmental administration such as total volume control and decision making. Upon the project completion, the platform of the monitoring system and the 30 major pollution sources developed under this project were connected by local funds with seven sub-monitoring centers and 400 pollution sources of 300 enterprises. It became a primary management tool for the environmental administration in Chongqing City.

Column

The role of the major pollution sources automatic monitoring system in implementing the disposal fee collection system

China's disposal fee collection system was regulated by the environmental law in 1979 using the German system as a model, and the current system was developed based on the disposal fee collection, usage and management regulation in 2003. In the system before 2003, discharge fees for wastewater, waste gas and solid waste were to be paid only for the exceeded portion from the standard emission amount. However, in the system after 2003, disposal fees are to be paid for the total emission amount. Furthermore, in the case of discharging beyond the standards, penalties are to be paid. The number of regulated pollutants was increased from one to three. Disposal fees are to be calculated after adding together the equivalent weights for each pollutant type. The intended uses of the disposal fees are the following four: 1) prevention and processing of major pollutant sources; 2) prevention and processing of regional pollution; 3) development of new technology for preventing and processing pollution, and dissemination and application of the technology; and 4) prevention and processing of pollution which the State Council decides.

In the current system, even if observing the standards, the payment amount for disposal fees increases in proportion to the increase of total emission amount. This put more burdens on enterprises than before. It is therefore more important to measure emission amounts objectively by the automatic monitoring system in order to obtain the support by enterprises. Regarding penalties, after the automatic monitoring system was introduced, it became possible for each enterprise to check its emission amount precisely and in real time, and to take counter-measures in advance. It was pointed out that the above situation has minimized penalties and brought economic benefits for enterprises. For example, the system of the monitoring center in Chongqing City can detect automatically when the emission amounts of some plants exceed its standards, and the center sends notices to the concerned plants immediately. The concerned plants have three hours to take counter-measures, and only when the situations are not rectified in three hours, penalties are imposed.

Emission data is an essential part of the disposal fee collection system. If the emission amount is not monitored properly and in real time, the disposal fee collection system is also difficult to function properly. In this sense, it can be said that this project has made certain contribution to the implementation of the disposal fee collection system, as this project assisted CMPG in building automatic monitoring system, particularly in its infrastructure.

Reference: "Survey regarding the contribution evaluation of environmental loan projects for China- Assistance for improvement of environment in China (air and water) (2005)" conducted by Kyoto University Graduate School entrusted by JICA (former JBIC) and the questionnaire response from CEPB.

3.3.2 Other impacts

3.3.2.1 Impacts on the natural environment

Under the natural gas supply sub-project, sound-proof facility was installed during the construction in order to minimize the noise of compressors. In addition, dust, noise and soil drain by the construction were minimized through implementing the construction management control strictly[24]. Under the sub-project for the monitoring system of major pollutant sources, a large scale construction was not conducted, and no major problems have been pointed out. At the Chongqing Jiulong West Power Plant, automatic monitoring station for waste air was installed under the monitoring sub-project, thus environment monitoring has been conducted properly. According to the beneficiary survey, all the respondents in Jiulongpo District, where the West Power Plant is located, answered that no major problems have been observed regarding noise and vibration during the installation of the FGD facility. Processing of disposals from the FGD facility (plaster, wastewater, etc) has been entrusted to Chongqing Power Plant, and it has been processed properly. A total of approximately 130,000 ton of plaster has been discharged annually, and it has been reused as solidified material by Chongqing Jieyu Plaster Comprehensive Use Co. Ltd.[25].

No other negative impact on the natural environment has been observed as far as known from the questionnaire answers by the implementing agencies and beneficiary survey result.

3.3.2.2 Land acquisition and Resettlement

The planned and actual resettlement and land acquisition under the natural gas supply sub-project is shown in Table 10. Land acquisition was completed as planned. Regarding resettlement, while the planned number of relocation was 100 persons, the actual was 80 persons. The reasons why it decreased may be partly because Wutaishan Gas Storage, which was expected to be constructed at the time of appraisal, was canceled and partly because the site acquired for the Liudianzi Gas Storage was slightly different from the originally planned location, but details are unknown. According to the implementing agency, the procedure of resettlement was carried out by the Land Resource Bureau of CMPG, and its compensations were paid appropriately in accordance with the land law[26]. According to the beneficiary survey, no particular problem was pointed out. Under other sub-projects, there was no resettlement and land acquisition.

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[24] Source: Questionnaire answer from Chongqing Gas Company.
[25] Source: Questionnaire answer from Chongqing Jiulong Power Plant.
[26] Source: Questionnaire answer and interview with Chongqing Gas Company

Table 10 Resettlement and land acquisition (Baseline and Actual)

Households		Public facility, commercial facilities, factories	
Baseline (2001)	Actual (2010)	Baseline (2001)	Actual (2010)
100 persons	80 persons	Approximately 6ha	6.03ha

Source: Plan from JICA appraisal documents. Actual from the questionnaire answer of Chongqing Gas Company.

3.3.2.3 Unintended Positive/Negative Impact

Through this project, CEPB introduced a major pollutant sources monitoring system, a new management tool, prior to other provinces and cities in China, and succeeded in making it compulsory to operate the system[27]. This made possible for CEPB to provide its knowledge and experiences regarding the management know-how of the system and the specification of the facilities, which CEPB has accumulated as a pioneer, for the State Environment Protection Agency. As a result, it has contributed to the wide use of the system throughout China. A number of the Environmental Protection Bureaus in other provinces such as Sichuan, Guangxi and Shanxi inspected the system of Chongqing City as a model in building their own systems.

According to CEPB, since the 24-hour automatic monitoring began, enterprises started to make efforts from their own initiatives in reducing their pollutants emission, thereby contributing to the betterment of air and water quality, and to the ecological conservation of the Three Gorge Reservoir. CEPB has also a view that the real-time monitoring brought not only economic effects for enterprises, but also economic and social effects by reducing the risks of environmental disasters such as the discharge of wastewater[28].

In the labor safety aspect, a positive impact by installing the automatic monitoring system was observed. Before the project completion, the staff needed to climb 200 meter or higher chimneys frequently in order to take samples of smoke from power plants for regular monitoring and inspection of equipment. Thus, the occurrence of accidents did not stop as the staff fell down from chimneys. After the automatic monitoring system was installed on the ground by this project, the number of accidents decreased partly because the staff's monitoring of emission amount at chimneys by hand became limited only for comparison tests every three months and partly because regular check of the equipment can be done on the ground. Moreover, it was also heard that the staff has less chances in touching wastewater and waste smoke directly, thereby contributing to the reduction in health hazards.

[27] CEPB has also operated an automatic monitoring system for general air quality parameters in five stations since 1994.

[28] Source: Questionnaire answer from CEPB.

In light of the above, this project has largely achieved its objectives, therefore its effectiveness and impact is high.

3.4 Efficiency (Rating:②)

3.4.1 Project Outputs

The planned and actual outputs and reasons of change are summarized in Table 11. Among the four sub-projects, there were changes in two sub-projects and one sub-project was cancelled. However, the change and addition of the natural gas system sub-project and the monitoring system sub-project is reasonable in terms of the project purposes. Regarding the natural gas service stations sub-project, the cancelation of the project is considered to be reasonable because the both Japanese and Chinese parties have undertaken possible measures accordingly under the changing environment of the project.

Table 11 Output (Plan and Actual)

Sub-projects	Plan	Actual
1) Chongqing Natural Gas Supply	Eight gas storage tanks (10,000 m^3 x 6 tanks, 5,000 m^3 x1 tank, 1,000 m^3 x1 tank, 66,000 m^3 in total). SCADA system. A total length of 262 km of pipelines. Technical guidance.	Gas storage tanks: As planned except one tank of 1,000 m^3. SCADA system: As planned. Pipes: Increased to approximately 371km. The reason for the increase was that the areas which need the installation of gas pipes were increased due to the adjustment of the city planning.
2) Natural Gas Filling Stations	30 gas service stations.	Cancelled as a sub-project. The reasons for the cancelation are the followings. Financial situations of the implementing agency were aggravated. Its parent company also decided to withdraw because it was difficult to acquire the land for a set of 30 gas stations at once and because there are only few available sites for construction. CMPG called for other candidates, but there was application only from private companies, not from national companies. Finally, the sub-project was cancelled due to the following reasons: it was difficult to go through procedures to change the implementing agency to a private company; and there was time constraint in terms of loan disbursement deadline.
3) Major Pollution Sources Monitoring System	1 central monitoring center, 1 sub-monitoring center, 18 waste air monitoring facilities and 18 wastewater monitoring facilities.	Central and sub-monitoring centers: As planned. Waste air monitoring facilities: 11. Wastewater monitoring facilities: 19. The reason for the changes is that it took two to three years from the appraisal to the implementation and that the target factories and the number of target sites were changed as the structural adjustment of chemical industry and power sector occurred and as the relocation of factories occurred. The followings were additional items and the reasons for the addition. 1) Video camera of 21 sites: For strengthening supervision capacity.

Sub-projects	Plan	Actual
		2) Online remote control system: At the time of appraisal, regulations and technical standards for environmental monitoring was not established. However, since the disposal fee collection, use and management regulations were enacted in July 2003, it was judged that remote control system is required for observing the emission standards strictly and for comprehensive environmental management. 3) Anti-thunder system: To prevent damage of the monitoring equipment by thunder.
4) Chongqing Jiulong West Power Plant Desulfurization	Installation of FGD at the existing power generation unit (200MW).	As planned.

Source: Plans are from JICA appraisal documents. Actuals are from PCR and questionnaire answers.

3.4.2 Project Inputs

3.4.2.1 Project Cost

While the total project cost estimated at appraisal was 18,971 million yen (of which the Japanese ODA loan amount was 7,701 million yen), the actual total project cost was 13,327 million yen (of which the Japanese ODA loan amount was 5,133 million yen), thus the actual was within the plan. The actual total cost was 82% of the planned amount excluding the portion of the cancelled sub-project, which was 16,316 million yen. The actual project cost of the natural gas supply sub-project was 78% of the plan; that of the monitoring system sub-project was 102% of the plan; and that of the power plant sub-project was 91% of the plan.

Regarding the natural gas supply sub-project, the actual cost was as low as 78% of the plan for the following reasons: 1) cancelation of a gas storage tank; 2) it became possible to purchase reasonable domestic gas storage tanks for the four tanks to be procured during the latter half of the implementation period; and 3) efficient placement of order by competitive bidding.

For the Chongqing Power West Plant sub-project, the actual cost remained at 91% of the plan because the project utilized foreign currency only for the consulting services related to the purchase and installation of FGD, which was imported from Japan, and utilized local currency for procuring other facility and equipment, following the CMPG’s decision after the signing of the Loan Agreement.

As per the major pollutant sources monitoring system, foreign currency was increased for adding GPS equipment, but local currency was decreased due to the efficient placement of order by competitive bidding. Thus, the actual cost was 102% of the plan.

3.4.2.2 Project Period

Regarding the natural gas supply project, the project period was 169% of the plan. For the major pollution sources monitoring project, it was 167% of the plan. For the Chongqing Power West Plant, it was 98% of the plan. The reasons for the delay are as described below.

Table 12 Project Period (Plan and Actual)

Sub-project	Plan	Actual
Chongqing Natural Gas Supply	March 2000- December 2005 (70 months)	March 2000- December 2009 (118 months, 169% of the plan) The reasons for delay are the followings: 1) at the preparation stage, the location of the Liudianzi gas storage station was changed due to the fire-fighting safety, thus it was necessary to review overall design and procurement materials (15 month delay); 2) procurement procedures such as the preparation of bidding documents were delayed due to the prevalence of SARS (6 months delay); 3) as the surroundings of the Liudianzi Station was ameliorated, the original plan was revived. It took time for review and procedures (18 months delay); and 4) due to the adjustment of the city planning, the areas which need the installation of gas pipes were increased. As the installation work of pipes was done in line with the construction work of new roads, a delay was caused.
Major Pollution Sources Monitoring System	March 2001- March 2005 (49 months)	March 2001- December 2007 (82 months, 167% of the plan) The reason of the delay is due to the addition of the on-line monitoring control system and the anti-thunder system.
Chongqing Jiulong West Power Plant Desulfurization	March 2001- December 2004 (46 months)	March 2001- November 2004 (47 months, 98% of the plan)

Source: JICA appraisal documents for the plan. PCR, Questionnaire answer and JICA internal documents for the actual.

3.4.3 Results of Calculations of Internal Rate of Return (IRR)

At the time of appraisal, neither Financial Internal Rate of Return (FIRR) nor Economic Internal Rate of Return (EIRR) was calculated. The assumptions such as expenses, benefits and projects life are also unknown. Therefore, those were not recalculated at the ex-post evaluation.

In light of the above, the project cost was within the plan, although the project period was within the plan in one sub-project, it significantly exceeded the plan in the two sub-projects, therefore efficiency of the project is fair.

3.5 Sustainability (Rating: ③)

3.5.1 Structural Aspects of Operation and Maintenance (O&M)

The O&M system of the implementing agencies of the three sub-projects are stable. The O&M system of each organization is summarized in Table 13.

Table 13 O&M system

Sub-project	Implementing agency	O&M system
Chongqing Natural Gas Supply	Chongqing Gas Group	One of the five biggest companies in China for supplying natural gas in the urban areas. Chongqing Gas Group is responsible for O&M for natural gas storage tanks. A total of 65 staff works at Toutong and Liudianzi stations. Maintenance of pipelines is outsourced to Pipeline Maintenance Company (150 staff). Maintenance of automatic control system is outsourced to Information Center (70 staff). A chain of command for accidents is also very clear.
Major Pollution Sources Monitoring System	CEPB	The responsible agency of the system is CEPB. Operation and maintenance of the monitoring system (O&M of network and transmission facilities and data collection) is managed by Chongqing City Environmental Protection Intelligence Center (sub-ordinate of CEPB). Daily check, cleaning, calibration and repair of the monitoring equipment of each major pollutant source are outsourced to Chongqing Jiaxing Environmental Engineering Co. Ltd. Regarding the Information Center, one manager and two technicians have been involved in the O&M of this monitoring system. For Jiaxing Company, one manager and eight technicians have worked for O&M of the system. According to CEPB, the number of staff is sufficient.
Chongqing Jiulong West Power Plant Desulfurization	Chongqing Jiulong Electric Power Co. Ltd.	In 1994, it became independent from Chongqing Electric Power Co. Ltd. East Plant and the Third Plant are managed by Chongqing Electric Power Co. Ltd, and the West Plant is managed by Chongqing Jiulong Electric Power Co. Ltd. The number of O&M staff is 15. A group of three persons work in four shifts a day.

Source: JICA appraisal document, responses to the questionnaire and interviews.

3.5.2 Technical Aspects of Operation and Maintenance

Technical level and training system of the implementing agencies and the companies which are entrusted for operation and maintenance is summarized as below.

Table 14 O&M technical capacity

Sub-project	O&M technical capacity
Chongqing Natural Gas Supply	Among 65 staff of Tongtong and Liudianzi gas stations, 25 persons are university graduates, 40 persons are technical college graduates. Among 150 O&M staff for pipes, 50 persons are university graduates and 100 persons are technical college graduates. All the 70 O&M staff for automatic control system is university graduates. There are many staff who has been working more than three years. In addition to the training course for new staff, technical training has been carried out two to three times a year. As a part of this project, technical guidance was provided by experts from Tokyo and Osaka Gas Companies. In addition, a joint study on the gas supply technology and gas leak detection technology was conducted in cooperation with Osaka Municipal Government.

Sub-project	O&M technical capacity
	Toutong Gas Station holds fire-fighting training by using fire-distinguishers once a year. This station is the biggest gas storage stations in Western China and is one of the biggest stations in China. It is also designated as Chongqing City Gas Industry Practical Training Base as well as National Occupation Competency Evaluation Office. Various companies and agencies visit the station from all over the country.
Major Pollution Sources Monitoring System	For the staff in the central monitoring center, training is conducted by inviting trainers from the State Environmental Protection Agency four times a year. For the staff in the sub-monitoring centers, the staff of the central monitoring center conducts training twice a year. According to the CEPB, the skill level of the staff of the Environmental Protection Intelligence Center and Jiaxing Company is sufficient.
Chongqing Jiulong West Power Plant Desulfurization	No technical problem has been observed because the FGD of this project is the same specification as the FGD at the Chongqing Power Plant Third Plant by the loan from Germany. Many O&M staff is technical college graduates. It is obligatory for the staff to pass the exam in safe production and technology every year.

Source: JICA appraisal document and responses to the questionnaire

Required number of staff is allocated and technical guidance has been conducted properly at all the implementing agencies. In particular, regarding the major pollution source monitoring system, it can be said that technical sustainability is high given the fact that the system is connected with more than 400 monitoring points as of 2012, as mentioned in the section of “impact”. As there was no precedent for the major pollutant automatic monitoring system in China at the time of appraisal, CEPB has accumulated the knowledge and experiences regarding the design and specifications of the system, temperature control, etc. by trial and error. Although it took longer than planned, it is worth to mention that CEPB has continuously developed the system by itself after the project completion and that it became possible for CEPB to share the know-how with other cities.

3.5.3 Financial Aspects of Operation and Maintenance

[Chongqing Gas Group Co., Ltd.] (Former Chongqing Gas Co., Ltd.)

Although financial statement was not obtained, it can be assumed that the financial foundation of Chongqing Gas Group is stable as the Group will list its stocks in 2012. According to the Group, listing of its stocks will not affect its credits and debts. The Group has not experienced deficit in the past, and its maintenance cost has been secured every year[29]. Maintenance and repair cost was two million RMB in 2009[30]. The gas tariff is as shown below.

[29] Source: Questionnaire answer from Chongqing Gas Group.

[30] Source: PCR.

Table 15 Tariff of Gas

unit: yuan /m^3

Category	At the time of appraisal	At the time of ex-post evaluation
Households	1.06	1.72
Public facilities	1.70	2.29(Note)
Commerce	2.00	2.24
Industry	0.753	2.29

Data source: JICA appraisal documents for the figure of appraisal. Questionnaire Answer from Chongqing Gas Group for the figure of ex-post evaluation.

Note: Gas tariff of school kitchens is same as that of households.

In the case of natural gas, material costs are relatively low and the heat supply amount by unit is large, thus operation costs are relatively low. As shown in Table 16, based on the costing in 2005, the tariff of Chongqing Gas Group for domestic use was 1.1 RMB/m^3 while the O&M cost was 1.06 RMB/m^3. This shows that the company could recover the O&M costs even the gas tariff is below the gas charge of other cities.

Table 16 O&M cost of gas supply and tariff of gas for households in 2005

unit: yuan /m^3

Gas companies	O&M cost	Gas tariff for households
Baotou Coal Gas	0.65	0.8
Hohhot Coal Gas	1.24	0.8-1.4
Liujiu LPG Gas	9.00	4.0
Changsha LPG Gas	4.90	3.8
Chongqing Natural Gas	1.06	1.1

Data source: JICA Study, 2005

[Chongqing Environmental Protection Bureau]

Required budget for operating and maintaining the monitoring system (management fee, personnel, patrolling vehicles, etc) is allocated by the CMPG every year. The actual O&M cost between 2006 and 2008 is shown in the table below. The actual amount was between 94% and 104% of the budget. Since the project completion in December 2007, the number of monitoring points of the major pollutant sources was significantly increased by using local funds. Thus, after 2008, the O&M cost increased accordingly. The annual O&M cost after 2009 is eight million RMB[31]. As described earlier, some portions of disposal fee, which have been collected, are funding sources for processing major pollutant sources.

Table 17 O&M cost of the major pollutant sources monitoring system (actual)

unit: 00,000 RMB

Year	system management	O&M of monitoring points	Total
2006	37	15	52
2007	45	23	68
2008	51	191	242

Data source: PCR.

[31] Source: Interview with the CEPB.

[Chongqing Jiulong Power Corporation]

As planned at the time of appraisal, Chongqing Jiulong Power Corporation listed its stocks on the Shanghai Stock Exchange in 2000. As the government still holds 67% of the stocks even after the listing, the financial situation of the company is stable[32]. Since the project completion in 2006, approximately 40 million RMB has been secured for operation and maintenance cost of the output of this project[33].

3.5.4 Current Status of Operation and Maintenance

As far as known from the O&M status of each facility and equipment, O&M plan, operation record, procurement and replacement status of spare-parts, which were confirmed during field inspection, no major problem has been observed.

Operation manual
Toutong Natural Gas Station

Natural gas supply flowchart
at Toutong Station

Staff inspecting the equipment
at Toutong Station

It was confirmed that the environment monitoring system was operating properly, although it cannot be generalized from the inspection of the following three facilities: the central monitoring center, the waste air monitoring facility at the Chongqing Power Plant and the wastewater monitoring equipment at the Second Plant of Xinan (West South) Synthetic Pharmaceutical Company. The frequency of the inspection, washing and replacement of the monitoring equipment (weekly, monthly, annually, etc) is fixed depending on the type of equipment. Based on the plan, inspection, washing and replacement have been conducted accordingly[34]. This was also verified by the regular check sheet. As the lifetime of some equipment such as chemical analyzers is seven to eight years, it has been replaced as needed. Some monitoring equipment made by a different manufacturer from the original manufacturer has been installed, but no major trouble has occurred so far. According to the CEPB, spare-parts can be purchased easily as there are the agents for the manufacturers in Chongqing City.

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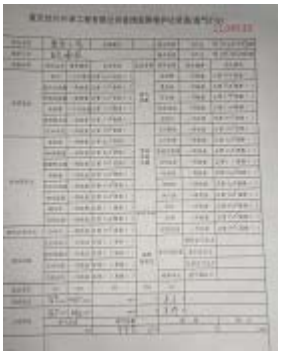
32 Source: Interview with Chongqing Jiulong Power Corporation.
33 Source: PCR and questionnaire answer from Chongqing Jiulong Power Corporation.
34 Source: PCR and questionnaire answer from CEPB.

Wastewater monitoring equipment in Xinan Synthetic Pharmaceutical Factory

Waste air monitoring equipment at Chongqing Power Plant



O&M record of the equipment as shown left

In light of the above, no major problems have been observed in the operation and maintenance system, therefore sustainability of the project effect is high.

4. Conclusion, Lessons Learned and Recommendations

4.1 Conclusion

Environment Model City Projects were implemented in Chongqing, Dalian and Guiyang in order to improve environment by carrying out air pollution control intensively and by building environmental monitoring system, under the “Environment Model City Framework”, which was aiming to replicating the good practices of the projects in other cities in China. As Chongqing City’s energy structure depends on coal, it was facing serious air pollution along with recent rapid industrialization and increase of vehicles. Thus, it was urgently needed to take actions in air pollution control and in building an environmental monitoring system. As a result of the implementation of this project, the following indicators have been achieved: reduction in air pollutants emission, desulfurization efficiency of Flue-Gas Desulfurization (FGD) and operating hours of the monitoring system. Thus, it can be said that expected effects have been observed almost as planned. In addition, these effects have contributed to the improvement of the living environment by betterment of air pollution and to the enhancement of the environmental management capacity. Therefore, effectiveness and impact of this project is high. Although the project cost was within the plan, the project period exceeded the plan, therefore efficiency of the project is fair. No major problems have been observed in the operation and maintenance system, technical level, and operation and maintenance status of the implementing agencies of each sub-project. Financial situations are also stable. Therefore, sustainability of the project effect is high. In light of the above, this project is evaluated to be highly satisfactory.

4.2 Recommendations

4.2.1 Recommendation to the Executing Agency

None.

4.2.2 Recommendation to JICA

None.

4.3 Lessons Learned

4.3.1 Lessons learned for collection of data required for evaluation

This project established the reduction amount of pollutants emission by relevant project as effective indicators. Although the progress of the relevant project was verified in this study, it was difficult to collect the actual data as it has passed for ten years since its completion. In case of setting an indicator to be achieved jointly by the target project and relevant project as effective indicator, it is recommended for concerned departments to collect the actual data of a relevant project in advance.

4.3.2 Combination of approaches (good practice)

While installing FGD facilities for reducing air pollutants from major pollution sources partially, this project took an approach of establishing a major pollution sources online monitoring system as a core component of the project as early as in 2000, which is thought to have brought bigger effects than expected. As mentioned in the sections of impact and column, the above system has continuously developed since the project completion and is an indispensable management tool for the environmental administration in Chongqing City now. The real-time and objective data obtained by the system has been widely used not only for collecting disposal fees but also for environmental administration such as total volume control.

Therefore, in the case of a project which implements environmental protection measures comprehensively, it is recommended to consider incorporating some components for strengthening environmental management capacities such as the establishment of online monitoring system together with air and water pollution control components.

In addition, dealing flexibly with the ever-changing situations and needs such as the enactment of environmental ordinances and making the use of online system mandatory, for example by adding outputs, may bring broader effects.

Comparison of the Original and Actual Scope of the Project

Item	Original	Actual
1. Output		
1) Chongqing Natural Gas Transmission and Distribution Extension Project	8 gas storage tanks. SCADA system. A total length of 262 km of pipelines. Technical guidance, etc.	Gas storage tanks: As planned except the cancellation of one tank of 1,000 m^3. SCADA system: As planned. Pipes: Increased to approximately 371km.
2) Natural Gas Filling Stations Project	30 gas service stations.	Cancelled.
3) Main pollution sources monitoring and control Project	1 central monitoring center, 1 sub-monitoring center, 18 waste air monitoring facilities and 18 wastewater monitoring facilities.	Central monitoring center and sub-monitoring center: As planned. Waste air monitoring facilities:11. Wastewater monitoring facilities:19. Video camera of 21 sites, online remote control system and anti-thunder system were added.
4) Chongqing Jiulong West Power Plant Desulfurization Project	Installation of FGD at the existing power generation unit (200MW).	As planned.
2. Project Period	(I) March 2000~December 2005 (70 months) (II) March 2001~March 2005 (49 months)	(I) March 2000~December 2009 (118 months) (II) March 2001~December 2007 (82 months)
3. Project Cost	(I)	(I)
Foreign currency	4,412 million yen	4,257million yen
Local currency	8,265.75 million yen (551.05 million RMB)	5,694.91million yen (401.05million RMB)
Total	12,678million yen	9,952million yen
Japanese ODA loan	4,412million yen	4,257million yen
Exchange rate	1yuan=15 Japanese Yen (As of November 1999)	1yuan=14.2yen (Average between March 2000 and December 2009)
	(II)	(II)
Foreign currency	3,289 million yen	876million yen
Local currency	3,003.78 million yen (231.06 million RMB)	2.499.63million yen (176.03million RMB)
Total	6,293 million yen	3,375million yen
Japanese ODA loan	3,289 million yen	876 million yen
Exchange rate	1yuan=13 Japanese Yen (the time of exchange: unknown)	1yuan=14.2yen (Average between March 2001 and April 2007)