People's Republic of China

FY 2017 Ex-post Evaluation Report of Japanese ODA Loan Project
"Inner Mongolia Autonomous Region Hohhot City Atmospheric Environmental Improvement Project (I) (II)"

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0. Summary

This project was implemented under the objective to mitigate the burden of air pollution through reduction in small-scale sources of pollutants in Hohhot City, the Inner Mongolia Autonomous Region (IMAR), People's Republic of China, by developing energy-efficient intensive heat supply facilities with lower pollution load, thereby contributing to the improvement of the living environment and stable heat supply in the city. This project was fully consistent with the development, environmental protection, heat supply plans, and the development needs of China, IMAR, and Hohhot City at the time of the appraisal and the ex-post evaluation[1] as well as Japan's ODA policy at the time of the appraisal; therefore, the relevance of the project is high. The outputs of the project underwent substantial review from the time of the appraisal. However, after the review, in both Phases 1 and 2, it was carried out as planned. The efficiency of the project is high because its total cost and period were as planned. The outcome expected as the primary effect of the project was to "mitigate the air pollution burden through reduction in small-scale sources of pollutants," and the impact was the "improvement of the living environment and stable heat supply in Hohhot City." Regarding outcome, in both phases, the project was highly effective because it achieved the goal of reducing emissions of sulfur dioxide (SO_2), nitrogen dioxide (NO_2), and total suspended particulate (TSP) matter, its three major indicators, and all auxiliary indicators showed a tendency toward improvement. Therefore, the effectiveness of the project is high. With regard to impact, the project contributed to improvement of residents' living environment by prompting all small coal-burning stoves and small boilers to shift to intensive heat supply. Necessary land acquisition was implemented appropriately, forcing no resettlement of residents. Regarding impact on the natural environment during the construction and at the time of the ex-post evaluation, appropriate measures were taken, and monitoring was conducted properly, and results indicated that there was no negative impact. Based on the above, the effectiveness and impact of the project is high because the envisioned project results were achieved. The systems, technology, finance, and maintenance management at Hohhot Chengfa Development & Management Co., Ltd. and Hohhot Futai Heating Supply Co., Ltd., both of which were responsible for operation and maintenance management under the project, were generally favorable, and the sustainability of effects brought by the project is high.

In light of the above, this project is evaluated to be highly satisfactory.

1. Project Description

Project Location

Boiler at Xinjiaying Power Plant B
(Hohhot Chengfa Development & Management Co., Ltd)

[1] The content of this project underwent substantial changes (For details refer to Section 3.1.4 "Appropriateness of the Project Plan and Approach"), and reappraisals were conducted in 2008 and 2012. In this ex-post evaluation, the content of the project after review was viewed as "the plan", and the project was evaluated by comparing the plan with results.

1.1 Background[2]

In early 2005, because it depended on coal for about 69% of energy consumed in the country, China was suffering from serious air pollution caused by sulfur oxides (SOx), smut, and other pollutants. In particular, SOx, which causes acid rain, had grave effects on the health of residents and the ecosystem. Taking these circumstances into account, the Chinese government set a goal of reducing emissions of principal pollutants, prohibited construction of new coal-burning thermal power plants in cities, and promoted construction of new co-generation equipment and intensive heat supply facilities.

In the IMAR covered by the project, energy consumption rose sharply as the economy grew rapidly, and the Region's dependence on coal for about 96% of its resources made it one of the country's districts where air pollution was particularly serious and improving the air environment was becoming an urgent issue to address. Especially in winter, most of the houses and public facilities used distributed, old small coal-burning boilers for district heating. However, because these boilers had low energy efficiency and lacked in equipment such as dust collectors and desulfurizers, they were a major source of air pollutants. As the city developed rapidly, it was feared that if this problem was left unsolved, small coal-burning boilers, which were installed in large numbers each year, would further aggravate air pollution in addition to pollution by existing ones. Taking this situation into consideration, the IMAR's government intended to improve the urban air environment by promoting intensive heat supply. To achieve this goal, it pushed forward with three policies: spreading intensive heat supply further, prohibiting installation of new small coal-burning boilers, and removing existing small coal-burning boilers. This project, which aimed at introducing intensive heat supply equipment to replace small coal-burning boilers, was expected to reduce emissions of SOx and other air pollutants.

1.2 Project Outline

The objective of this project is to mitigate the burden of air pollution through reduction in small-scale sources of pollutants in Hohhot City, IMAR, People's Republic of China, by developing energy-efficient intensive heat supply facilities that with lower pollution load, thereby contributing to the improvement of the living environment and stable heat supply in the city.

Loan Approved Amount / Disbursed Amount	Phase 1: 7,400 million yen / 7,375 million yen Phase 2: 6,300 million yen / 6,281 million yen	
Exchange of Notes Date / Loan Agreement Signing Date	Phase 1: June 2006 / June 2006 Phase 2: March 2007 / March 2007	
Terms and Conditions (Same terms and conditions for Phases 1 and 2)	Interest rate	0.75%
	Repayment period (Grace Period)	40 years (10 years)
	Conditions of Procurement	Phases 1 and 2: General untied
Borrower / Executing Agency	People's Republic of China/People's government of Inner Mongolia Autonomous Region (Finance Agency)	
Project Completion	September 2015	

[2] This section is based on materials provided by JICA and the ex-ante evaluation table.

Main Contractors	Shanghai Electric (Group) Corporation (People's Republic of China) and China National Precision Machinery Import & Export Corp. (People's Republic of China)
Main Consultants	—
Related Studies (Feasibility Studies, etc.)	Phase 1: North China Municipal Engineering Design & Research Institute, conducted in November 2004 and approved in June 2006/change in the scope of the project in 2008: conducted in November 2007, North China Municipal Engineering Design & Research Institute, conducted in November 2007 and approved in January 2006 Phase 2: North China Municipal Engineering Design & Research Institute, implemented March 2005 and approved in June 2007/change in the scope of the project in 2012: implemented in 2011; North China Municipal Engineering Design & Research Institute, implemented in 2011 and approved in April 2012
Related projects	Japanese ODA Loans: "Hohhot/Baotou Environmental Improvement Project" (December 1996) and "Hohhot/Baotou Environmental Improvement Project (2)" (September 1997) Other donors: Inner Mongolia Autonomous Region Renewable Energy-Related Project (World Bank, 2006–2011) and Hohhot City Local Low-Carbon Heat Supply Project (Asian Development Bank, 2013–2016)

2. Outline of the Evaluation Study

2.1 External Evaluator

Hiromi Suzuki S., IC Net Limited

2.2 Duration of Evaluation Study

This ex-post evaluation was conducted with the following schedule.

Duration of the Study: August 2017 to November 2018

Duration of the Field Studies: November 19-29, 2017 and June 10-18, 2018

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

3.1 Relevance (Rating: ③[4])

3.1.1 Consistency with the Development Plan of China[5]

A) Development plans

The national development plan being implemented at the time of the appraisal for the project was the *Eleventh Five-Year Plan (2006-2010)*. This plan, which continued to view taking actions such as stepping up environmental protection and protecting and repairing the natural ecosystem as its priority areas, set five major goals to achieve by 2010, including reducing new sources of environmental pollution and improving the environment in places designated as priority environmental protection regions and cities. In particular, the goal for the air environment was to reduce emissions of major pollutants by 10% compared to the results of the Tenth Five-Year Plan; to achieve the goal, the Chinese government announced that it would prohibit construction of new coal-burning thermal power plants in cities and promote efforts to build new co-generation equipment and intensive heat supply facilities. At the time

[3] A: Highly satisfactory, B: Satisfactory, C: Partially satisfactory, D: Unsatisfactory

[4] ③: High, ②: Fair, ①: Low

[5] The evaluation was based on appraisal materials and the ex-ante evaluation at the time of the appraisal and on the 13th Five-Year Plan (2016-2020) at the time of the ex-post evaluation.

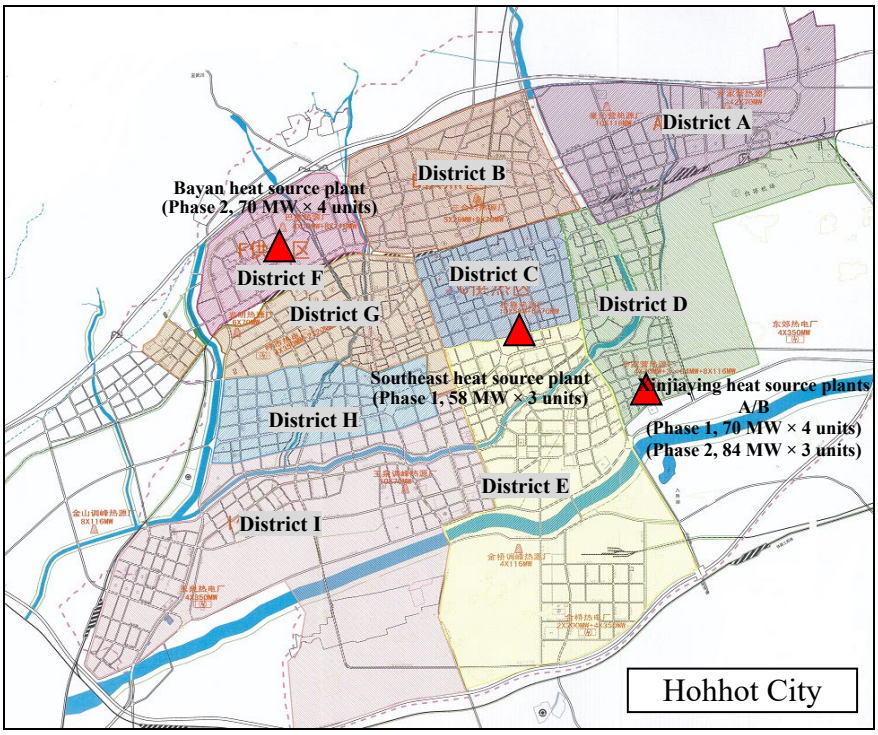
of the ex-post evaluation, the national development plan was the *Thirteenth Five-Year Plan (2016-2020)*. The plan set five goals to realize a moderately prosperous society, and two of them were related to this project: improving the overall quality of the environment and ecosystems and making the standards of living and quality of national life universally better. It clearly stated that environmental protection was an essential condition to ensure sustainable development and achieve high-quality national life and that the government would strive to save resources and protect the environment. The government established specific targets, including reducing energy consumption per unit of GDP by 15% by 2020 and cutting back emissions of carbon dioxide per unit of GDP by 18% by the same year. In terms of city planning, it aimed at building comfortable cities in harmony with the environment and considered it necessary to continue stepping up efforts to construct urban infrastructure facilities, including intensive heat supply; to achieve this goal, it announced its plan to build modern urban infrastructure systems. At the time of both the appraisal and the ex-post evaluation, this project was highly consistent with China's development plans.

At the time of the appraisal, the development plan for the IMAR was the *Eleventh Five-Year Plan for the Inner Mongolia Autonomous Region (2006-2010)*, and in this Plan, the regional government announced that it would improve the urban air environment by promoting intensive heat supply. The Region's development plan at the time of the ex-post evaluation was the *Thirteenth Five-Year Plan for the Inner Mongolia Autonomous Region (2016-2020)*. In this Plan, the government aimed at increasing the overall capacity to supply heat in the autonomous region, announcing that, to achieve this goal, each city government should step up efforts to build heat supply infrastructure facilities. As described above, at the time of both the appraisal and the ex-post evaluation, this project was consistent with the regional government's development plan.

B) Environmental protection plans

The national environmental protection plan at the time of the appraisal was the *Eleventh Five-Year Environmental Protection Plan (2006-2010)*, which announced five major goals that should be achieved by 2010. In particular, this project was in accord with three of the goals set in the plan: reducing new sources of environmental pollution, suppressing destruction of the environment and ecosystems, and improving the environment in places designated as priority environmental protection regions and cities. At the time of the ex-post evaluation, the environmental protection plan was the *Thirteenth Five-Year Environmental Protection Plan (2016-2020).* This plan set major environmental protection goals, and this project was in agreement with two of them: establishing an ecological civilization construction model which combined the protection of ecosystems and urbanization and improving it continuously, and formulating guidelines to develop ecological civilization construction model districts and environmental protection model cities and guiding each region in building an ecological civilization model.

At the time of the appraisal, Hohhot City's environmental protection plan was the *Hohhot City Eleventh Five-Year Environmental Protection Plan (2006-2010)*. In this Plan, the city government announced that it would reduce the average annual concentration of SO_2 by spreading intensive heat supply facilities, prohibiting construction of new small coal-burning boilers, and promoting removal of existing small boilers. The city's environmental protection plan at the time of the ex-post evaluation was the *Hohhot City Thirteenth Five-Year Environmental Protection Plan (2016-2020)*. In this plan, in accordance with the principle of shifting from distributed heat use to intensive heat supply in phases, the government was adjusting the heat supply structure in urban areas, and its goal was to build a heat supply model with clean energy added to it by promoting cogeneration in city centers and shifting from small coal-burning boilers to intensive heat supply completely.



Source: Documents provided by the executing agency.

Figure 1. Map of Hohhot City's Heat Supply Districts and the Project's Undertakings

In addition to the environmental protection plan, the city government formulated the *Hohhot City Heat Supply Plan (2005–2020)*. This is a master plan for heat supply in the city, which sets targets for the area of heat supply and heat loads that should be achieved by 2020 by developing intensive heat supply facilities in a total of nine districts that constitute the city. This project is included in the facility development plan for three districts under the master plan (See Figure 1).

As described above, this project was consistent with goals at the time of the appraisal and the ex-post evaluation to reduce and improve air and environmental pollution, spread intensive heat supply, and develop urban heat supply infrastructure under (1) China and Inner Mongolia Autonomous Region's Five-Year Plan, (2) China and Hohhot City's Five-Year Environmental Protection Plan, and (3) Hohhot City's heat supply plan.

3.1.2 Consistency with the Development Needs of China

In 2005, environmental pollution in China remained serious, although efforts to step up environmental protection policy in the 1990s brought certain results. Hohhot, the project site, was a city of medium standing with a population of 1.1 million, an area of 2,100 km^2, and a heat supply capacity of 2,888 MW and ranked 36th among the country's 113 worst air-polluted cities designated as national priority environmental protection districts. Thus, improving the air pollution was becoming an urgent issue to address. In the project area, less energy-efficient small coal-burning boilers were used for heating in winter; because they lacked in dust collectors and desulfurizers, they were a major source of air pollution. As a result, the city failed to meet Grade 2 of the national air environment standards for SO_2, NO_2, and TSP, which should be satisfied in residential areas (See Table 1)[6].

[6] This is based on materials provided by JICA.

Table 1. Concentration of Air Pollutants in Hohhot City at the Time of Appraisal and Ex-post Evaluation

(Unit: μg/m^3)

At the Time of Appraisal						
	SO_2		NO_2		TSP	
	Yearly average	Winter maximum	Yearly average	Winter maximum	Yearly average	Winter maximum
2004	27	*182*	44	80	*353*	*763*
2005	53	*170*	40	*144*	92	*644*
2006	56	*380*	49	*187*	100	*1,713*
Grade 2 of the national air environment standards (1996) *	Yearly average	Daily average	Yearly average	Daily average	Yearly average	Daily average
	60 or less	150 or less	80 or less	120 or less	200 or less	300 or less

At the Time of Ex-post Evaluation								
	SO_2		NO_2		PM10		PM2.5	
	Yearly average	Winter maximum	Yearly average	Winter maximum	Yearly average	Winter maximum	Yearly average	Winter maximum
2015	34	*196*	39	*104*	*103*	*255*	*43*	*255*
2016	28	119	*42*	*94*	*95*	*318***	*41*	*296*
2017	29	141	*45*	*91*	*99*	*278***	*44*	*297*
Grade 2 of the national air environment standards (2012) *	Yearly average	Daily average	Yearly average	Daily average	Yearly average	Daily average	Yearly average	Daily average
	60 or less	150 or less	40 or less	84 or less	70 or less	150 or less	35 or less	75 or less

Source: Data for the period from 2004 to 2006 are based on materials provided by JICA. Those for 2015 and thereafter are based on materials provided by the executing agency.

Figures in italics indicate that they exceeded Grade 2 of the national air environment standards.

*: The National Air Environment Standards revised in 2012 (GB3095-2012), which applied at the time of the ex-post evaluation, were stricter than the standards applicable at the time of the appraisal (GB3095-1996) in terms of NO_2 emissions. In addition, instead of TSP, the revised standards required monitoring of PM2.5, fine inhalable particles with diameters that are generally 2.5 micrometers or less, and PM10, ones with diameters that are generally ten micrometers or less.

**: Excluding sandy-dust (yellow sand) weather

According to the latest information (2016) available at the time of the ex-post evaluation, the urban districts of Hohhot City had achieved remarkable growth; its population had increased to 3.09 million, and its land area had grown to 129,110,000 km^2. In 2017, the city had a capacity to supply 11,157 MW of heat (of which 986 MW of heat were provided by this project) with heat supply factories in operation at eleven locations. The overall number of small coal-burning boilers in the city decreased significantly, and the intensive heat supply penetration rate rose to 83%. As shown in Table 1, however, the city failed to achieve Grade 2 of the national air environment standards which should be satisfied in residential areas; in March 2017, it ranked 42nd among the country's 74 worst air-polluted cities designated as national priority environmental protection districts. Thus, Hohhot City's development needs for air environmental improvement continued to be high.

As described above, at the time of both the appraisal and the ex-post evaluation, there was a strong need to raise the intensive heat supply penetration rate, thereby reducing air pollution.

3.1.3 Consistency with Japan's ODA Policy

Japan's ODA policy at the time of the appraisal consisted of the *Economic Cooperation Plan for China (2001-2006)* as well as JICA's *Implementation Policy for Overseas Economic Cooperation Operations (2005-2007)* and the *FY2006 Implementation Policy for Operations*

by Country. The goal set by the *Economic Cooperation Plan for China (2001-2006)*[7] was to emphasize areas centered on protecting the environment and ecosystems as pollution and destruction became serious, improving the lives of people in inland areas and developing their societies, developing human resources, establishing systems, and transferring technology, and six priority areas were listed. In particular, in the priority area of cooperation to cope with environmental and other global problems, the plan clearly stated that Japan would support China's efforts to introduce new types of renewable energy and conserve energy consumption, and this was highly consistent with this project. The *Implementation Policy for Overseas Economic Cooperation Operations (2005-2007)* considered support for poverty reduction, infrastructure development for sustained growth, support for solving global issues and peace building, and support for human resource development as its four priority areas. In particular, it stated that Japan would actively use its technology to address global issues, cope effectively with environmental problems in developing countries, assist in improving the lives of people, and contribute actively to solution of problems such as global warming, and this was also highly consistent with this project. The *FY 2006 Medium-Term Strategy for Overseas Economic Cooperation*[8], which stressed environmental protection, stated that JICA would place emphasis on public projects such as supporting air pollution measures in which the government was required to play a part and provide intangible support such as improving environmental administration abilities. It also stated that JICA would work more closely with local governments in Japan to transfer their know-how in the environmental area. The goals set for the atmospheric sector were to install stack gas desulfurization systems in existing thermal power plants, develop intensive heat supply facilities, promote natural gas projects, introduce air environment monitoring equipment, and step up support in the intangible aspects of these undertakings. This was highly consistent with the project.

3.1.4 Appropriateness of the Project Plan and Approach

The scope of this project underwent changes in both Phase 1 and Phase 2. In Phase 1, in early 2008, because of low yen value and rises in the price of items such as construction materials, the upper limit to Japanese ODA loan made it difficult to build a northeast heat source plant, heat supply piping, and heat exchange stations as planned for Phase 1. Therefore, the executing agency decided to complete the heat source plant using its own funds and use the Japanese ODA loan to construct Xinjiaying heat source plant A, heat supply piping, and heat exchange stations in the eastern district, which was growing remarkably (See Table 2). In 2008, when JICA conducted intermediate supervision, it became clear that part of the construction work for the northeast heat source plant had already begun using domestic capital, and the cost and period of the project and its effects were reviewed through consultations with the executing agency (approved by JICA on January 23, 2008). As for Phase 2, in 2012, it was revealed that the Guangming heat source plant had already been completed using China's own capital and was currently in operation. On the other hand, an administrative, commercial, and financial center was built in the eastern district of Hohhot City on a full scale, and since this sharply increased heat supply demand in the district, it was decided that the Xinjiaying heat source plant B, heat supply piping, and heat exchange stations should be constructed using the Japanese ODA loan to meet the district's growing heat demand (approved by JICA on December 4, 2012). After the project was reviewed, there was no major difference between its plan and results, and the logic to lead the project to the achievement of its objectives was also reasonable. These changes were attributed to changes in external factors during the early stage of appraisal (such as rising commodity prices, low yen value, and the acceleration of urban development) and considered appropriate. However, because there was no project supervision such as strict control regarding the submission of progress reports among others, changes took place two years after starting the project, and another four years after that as well, thus

[7] Ministry of Foreign Affairs' *Economic Cooperation Plan for China (2001-2006)*.
[8] This is based on materials provided by JICA.

attention needs to be paid to this point.

Based on the above, the implementation of the project was in full accord with the development policy and development needs of China, Inner Mongolia Autonomous Region, and Hohhot City as well as Japan's ODA policy, and its relevance is high.

3.2 Efficiency (Rating: ③)

3.2.1 Project Outputs

As mentioned earlier, the scope of this project was reviewed in 2008 for Phase 1 and in 2012 for Phase 2. The project was carried out as planned as shown in Table 2, and there was no difference in facility development and equipment procurement between the reviewed project and the project's results.

Table 2. Project Outputs (Facility Development and Equipment Procurement*)

Item	Description		
	At the time of the appraisal (2006; for reference)	After review (2008 and 2012)	Results
1. Heat supply equipment (boiler)	[Phase 1] a. Southeast heat source plant: 58 MW × 5 units b. Northeast heat source plant: 64 MW × 4 units, 29 MW × 1 unit c. Jinqiao heat source plant (new urban district): 64 MW × 4 units, 20 t/h × 2 units d. Non-planned	[Phases 1] a. 58 MW × 3 units b. Cancelled c. Cancelled d. Xinjiaying heat source plant A: 70 MW × 4 units	As planned
	[Phase 2] e. Bayan heat source plant: 70 MW × 4 units f. Guangming heat source plant: 70 MW × 4 units g. Non-planned	[Phase 2] e. 70 MW × 4 units f. Implemented using China's own fund g. Xinjiaying heat source plant B: 84 MW × 3 units	As planned
2. Heat supply piping	[Phase 1] a. Southeast heat source plant: 25.5 km b. Northeast heat source plant: 17.9 km c. Jinqiao heat source plant (new urban district): 17.4 km d. Non-planned	[Phase 1] a. 19.8 km b. Cancelled c. Cancelled d. Jinqiao heat source plant A (new urban district): 18.5 km	As planned
	[Phase 2] e. Bayan heat source plant: 19.26 km f. Guangming heat source plant: 18.25 km g. Non-planned	[Phase 2] e. 23.30 km f. Implemented using China's own fund g. Xinjiaying heat source plant B: 22.0 km	As planned
3. Steam piping	[Phase 1] a. Jinqiao plant (new urban district): 1.9 km	[Phase 1] a. Cancelled	As planned
4. Heat exchange stations	[Phase 1] a. Southeast heat source plant: 39 units b. Northeast heat source plant: 37 units c. Jinqiao heat source plant (new urban	[Phase 1] a. 29 units b. Cancelled c. Cancelled	As planned

	district): 31 units d. Non-planned Total: 107 locations	d. Xinjiaying heat source plant A: 31 units Total: 60 units	
	[Phase 2] e. Bayan heat source plant: 27 units f. Guangming heat source plant: 27 units g. Non-planned Total: 54 units	[Phase 2] e. Bayan heat source plant: 27 units f. Implemented using China's own fund g. Xinjiaying heat source plant B: 29 units Total: 56 units	As planned
5. Other	• Comprehensive dust usage plant • Automated control center	• Cancelled • Automated control center	As planned

Source: At the time of the appraisal and the review, materials were provided by JICA. For results, materials were provided by the executing agency.
*: The names of the heat source plants are all current ones: the Bayan Plant (former North Plant), Guangming Plant (former South Plant), Xinjiaying Plant A (former Jinqiao Plant, East District), and Xinjiaying Plant B (former Xinjiaying Plant).

A training program for the executing agency in Japan, which concerned measures to cope with air pollution, including comprehensive use of ashes, was planned but cancelled because the Chinese regulations for public officials leaving China became strict.[9]

3.2.2 Project Inputs

3.2.2.1 Project Cost[10]

A comparison of the planned and actual total project costs after the review of the project scope for Phase 1 indicates that the actual cost was 94% of the planned one, remaining within the range of the initial plan. Specifically, while the planned cost was 9,664 million yen (foreign currency: 7,872 million yen; domestic currency: 1,792 million yen; and the cost covered by Japanese ODA: 7,400 million yen), the actual one was 9,060 million yen (foreign currency: 7,368 million yen; domestic currency: 1,692 million yen; and the cost covered by Japanese ODA: 7,368 million yen) (please refer to Table 3).

Table 3. Project Cost (Phase 1)

(Unit: million yen)

Item	Planned cost (2008; after the review)			Actual cost			Planned/actual ratio
	Foreign currency (including ODA)	Domestic currency	Total	Foreign currency (including ODA)	Domestic currency	Total	
Intensive heat supply materials and equipment	6,325 (6,325)	0	6,325	7,368 (7,368)	0	7,368	116%
Civil engineering and installation	0	758	758	0	643	643	85%
Tax	0	226	226	0	0	0	0
Administrative expenses,	0	303	303	0	194	194	64%

[9] Among the project implementation units, Hohhot Futai Heating Supply Co., Ltd. sent personnel to the five-day training and field visits in Japan in March 2018. The participants consisted of four people at managerial positions, and all expenses were paid by the company.

[10] Reference information: The project cost at the time of the appraisal in 2006 was as described below. The total project cost for Phase 1 was 13,700 million yen (foreign currency: 7,931 million yen; domestic currency: 5,769 million; and the cost covered by Japanese ODA: 7,400 million yen (foreign currency only)), and that for Phase 2 was 10,094 million yen (foreign currency: 6,790 million yen; domestic currency: 3,304 million yen; and the cost covered by Japanese ODA: 6,300 million yen (foreign currency only)) (Source: Both are based on materials provided by JICA)

etc.							
Price escalation	431 (431)	0	431	0	0	0	0
Physical reserve funds	955 (955)	38	993	0	0	0	0
Training expenses	25 (25)	0	25	0	0	0	0
Interest during construction	136 (0)	210	346	0	450	450	130%
Land acquisition expenses*	0	257	257	0	405	405	158%
Total	7,872 (7,400)	1,792	9,664	7,368 (7,368)	1,692	9,060	94%

Source: For the review, materials were provided by JICA. For the results, materials were provided from the project information management sheet and by the executing agency.
* The land acquisition expenses for Phase 1 include those for Phase 2.
(Note 1) <After the review> Exchange rates: US$ 1.00 = 112 yen; US$ 1.00 = 7.52 yuan; 1 yuan = 14.90 yen
Price escalation rate: 2.4% for foreign currency and 0.0% for domestic currency
Reserve fund rate: 5.0%
Base time for cost calculation: January 2008 (The total project cost was reduced, and the cost covered by Japanese ODA was also reduced, and the difference is reported as part of the reserve fund)
<Actual> Exchange rate: 1 yuan = 13.30 yen (Based on the ex-post evaluation reference, IMF's average annual exchange rate for the period from 2008 to 2012 is used)
(Note 2) Because figures are rounded off, their sum does not necessarily correspond with the total at the bottom of the table.

In Phase 1, because of rising commodity prices, procurement expenses for intensive heat supply materials and equipment increased by 16% compared to the time of the appraisal. In addition, because loan interest in China went above that at the time of the appraisal, the interest rate during the construction grew by 30% compared to the initial plan. Owing to rising land prices, land acquisition expenses were 58% higher than initially planned. These increases in project cost were covered by physical reserve funds. On the other hand, administrative expenses were kept at 64% of the planned level because of cost management such as reduction in personnel expenses at the executing agency and the project implementation units, and this allowed the project cost to remain within the initially planned range.

In Phase 2, while, after the review of the project scope, the total project cost was 5,256 million yen (foreign currency: 2,868 million yen; domestic currency: 2,388 million yen; and the cost covered by Japanese ODA loan: 2,840 million yen), the actual one was 5,985 million yen (foreign currency: 2,814 million yen; domestic currency: 3,171 million yen; and the cost covered by Japanese ODA loan: 2,814 million yen). This was higher than planned, at 114% of the initially planned level (See Table 4).

Table 4. Project Cost (Phase 2)

(Unit: million yen)

Item	Planned cost (2012; after the review)			Actual cost			Planned/actual ratio
	Foreign currency (including ODA loan)	Domestic currency	Total	Foreign currency (including ODA loan)	Domestic currency	Total	
Intensive heat supply materials and equipment	2,637 (2,637)	0	2,637	2,814 (2,814)	0	2,814	107%
Civil engineering and installation	0	1,788	1,788	0	3,045	3,045	170%
Training expenses	19	0	19	0	0	0	0

	(19)						
Price escalation	50 (50)	158	208	0	0	0	0
Physical reserve funds	135 (135)	97	233	0	0	0	0
Interest during construction	28 (0)	296	324	0	0	0	0
Land acquisition expenses	0	0	0	0	3	3	—
Administrative expenses, etc.	0	49	49	0	123	123	251%
Total	2,868 (2,840)	2,338	5,256	2,814 (2,814)	3,171	5,985	114%

Source: For the planned cost, materials were provided by JICA, and for the actual cost, materials were provided by the executing agency.
(Note 1) <After the review> Exchange rates: US$ 1.00 = 77.50 yen; US$ 1.00 = 6.97 yuan; and 1 yuan = 12.20 yen
Price escalation rate: 1.64% for foreign currency and 6.0% for domestic currency
Base time for cost calculation: December 2011
<Actual> Exchange rate: 1 yuan = 17.40 yen (Based on the ex-post evaluation reference, IMF's average annual exchange rate for the period from 2013 to 2015 is used)
(Note 2) Because figures are rounded off, their sum does not necessarily correspond with the total at the bottom of the table.

In Phase 2, partly because of the effects of rising commodity prices and low yen value, civil engineering and installation expenses grew by 70% compared to the initial plan, and because of growing personnel expenses, administrative expenses were 251% of the initially planned level. In addition, tracts of land unexpectedly had to be expropriated in association with the laying of some parts of the heat pipe network. Both were covered by physical reserve funds.

As described above, the reason the project cost grew in both phases was that commodity prices and loan interest rates rose in China. In Phase 1, the project cost remained within the initially planned range through cost management, but in Phase 2, it slightly exceeded the planned cost because of low yen value and other effects. To derive a sub-rating for the total project cost for the two phases combined, a weighted average was used taking the percentage of the project cost for each phase to the actual total project cost into account in order to avoid bias. As a result, the total project cost remained within the initially planned range.[11]

3.2.2.2 Project Period[12]

For both Phase 1 and Phase 2, the planned period from the signing of the loan agreement to the completion of the project after the review of the project scope (defined as the completion of the compensation period) was compared with the actual one. As a result, the planned period for Phase 1 was from June 2006, when the loan agreement was signed, to October 2012, when the project was completed (77 months, or six years and five months), and the actual one was as planned. The planned period for Phase 2 was from March 2007, when the loan agreement was signed, to September 2015, when the project was completed (103 months, or eight years and eleven months), and the actual one was as planned. In both

[11] The percentage of the project cost for Phase 1 to the total project cost was 60% and that for Phase 2 was 40%. The sub-rating for Phase 1 was (3), and that for Phase 2 was (2), and therefore, the overall sub-rating (3) was derived taking the percentage of the project cost for each phase to the total project cost into account ((3) × 60% ＋ (2) × 40% ＝ 2.6; The sub-rating is (3) if the result is rounded off).

[12] For reference information, the completion of the project was defined as the "completion of receipt of equipment and installation work after inspection" at the time of the appraisal in 2006. The project period was as specified below. Phase 1 was planned to be from June 2006 (signing of the loan agreement) to the end of January 2011 (56 months, or four years and eight months), and Phase 2 from March 2007 (signing of the loan agreement) to October 2011 (56 months, or four years and eight months).

phases, appraisals leading up to bidding and planning were accelerated; in addition, the construction period was strictly controlled, and these efforts enabled the project to be completed within the planned project period.

As described above, project periods of both Phases 1 and 2 were 100% compared to plan, exactly as planned.

3.2.3 Results of Calculations for Internal Rates of Return (Reference Only)[13]

The Financial Internal Rate of Return (FIRR) for this project at the time of the appraisal was 5.38% for Phase 1 and 6.56% for Phase 2. At the time of the ex-post evaluation, FIRR was calculated by considering the two phases combined as a single project because available information on expenses and benefits was one that combined Phases 1 and 2. As a result, FIRR at the time of the ex-post evaluation was favorable, at 9.32%.

The project was implemented as planned because there was no difference between the planned outputs of the project after it was reviewed and actual ones. In Phase 1, the project cost remained within the initially planned range, but in Phase 2, it slightly exceeded the planned cost. In calculating the sub-rating for the total project cost in the two phases combined, the percentage of the project cost for each phase to the total project cost for the two phases combined was taken into consideration; as a result, the sub-rating for the project cost was as planned. In terms of project period, the project was carried out in both phases as planned.

Based on the above, the project was implemented as planned in terms of both project cost and project period. Therefore, the efficiency of the project is high.

3.3 Effectiveness and Impacts[14] (Rating: ③)

3.3.1 Effectiveness

3.3.1.1 Quantitative Effect (Operation and Effect Indicators)

The outcome of this project is to "mitigate air pollution through reduction in small-scale sources of pollutants" and is evaluated by using main indicators (such as (1) SO_2 emission reduction, (2) NO_X emission reduction, (3) TSP emission reduction) and auxiliary indicators (such as (4) reduction rate of compact coal boiler in the project target area, (5) penetration rate of centralized heat supply in the object area of the project, (6) number of beneficiaries, (7) number of heat supply households and (8) heat supply area.) With regard to the indicators (6) to (8), only the total value of Phase 1 and Phase 2 was available. Therefore, evaluation was conducted based on the total value.

[Main indicators]

During Phase 1, achievement of main indicators other than SO_2 emission reduction was 100% or more. SO_2 emission reduction achieved 90% or more in 2014 (2 years after completion.) During Phase 2, achievement of main indicators other than NO_X emission reduction was 100% or more. NO_X emission reduction achieved 90% and more in 2017 (2 years after completion.) It is recognized that both phases contributed to "mitigate the burden of air pollution" (See Table 5.)

[13] At the time of the appraisal, FIRR was calculated on the assumptions listed below. Costs consisted of the project costs and operation/maintenance management expenses, and benefits comprised fee incomes and subsidies. The project life was 30 years. The same assumptions were used at the time of the ex-post evaluation. However, because available data could not be divided into those for Phase 1 and Phase 2, FIRR for the two phases combined was calculated.

[14] Sub-rating for Effectiveness is to be put with consideration of Impacts.

Table 5. Operation Effect Indicators: Main Indicators

(A) Phase 1

Indicator name	Baseline 2007	Target 2 years after completion Note	Actual Achievement of targets are in parentheses				
			2013 1 year after completion	2014 2 years after completion	2015 3 years after completion	2016 4 years after completion	2017 5 years after completion
(1) SO_2 emission reduction (t/year)	0	3,100	2,505 (81%)	2,781 (90%)	3,359 (108%)	3,339 (108%)	3,233 (104%)
(2) NO_X emission reduction (t/year)	0	1,800	1,774 (97%)	1,930 (107%)	2,064 (115%)	2,062 (115%)	1,959 (109%)
(3) TSP emission reduction (t/year)	0	7,900	7,868 (99%)	8,599 (109%)	9,078 (115%)	9,070 (115%)	9,010 (114%)

(B) Phase 2

Indicator name	Baseline 2006	Target 2 years after completion Note	Actual (Achievement of targets are in parentheses)		
			2015 A year of completion	2016 1 year after completion	2017 2 years after completion
(1) SO_2 emission reduction (t/year)	0	2,094	1,628	1,736	2,270 (108%)
(2) NO_X emission reduction (t/year)	0	2,243	1,784	1,852	2,101 (94%)
(3) TSP emission reduction (t/year)	0	5,713	4,320	4,769	6,627 (116%)

Source: Baselines and targets are indicated in documents provided by JICA. Actual figures are indicated in documents provided by the executing agency

Note: The base year at the beginning of appraisal was 2005 for both Phase 1 and Phase 2, and the target was set to 1 year after completion. However, the base year for Phase 1 was changed to 2007 because of changes made to the 2008 project scope and the target was changed to 2 years after completion. Likewise, the base year for Phase 2 was changed to 2007 because of changes made to the 2012 project scope and the target was changed to 2 years after completion.

[Auxiliary indicators]

For both Phase 1 and Phase 2, all compact coal boilers were removed that were in the target area for the project and the penetration rate of centralized heat supply achieved 100%. In addition, as the economy of Hohhot City grows, the number of beneficiaries and beneficiary households tend to increase every year. The supply area also increases; in 2017, it achieved 126% compared to the plan (See Table 6).

Table 6: Operation Effect Indicator: Auxiliary Indicators (Total of Phase 1 and Phase 2)

Indicator name	Target at the time of completion	Actual (Achievement of targets are in parentheses)				
		2013	2014	2015	2016	2017
(4) Reduction rate of compact coal boilers in project target area (%)	100%	100%	100% (100%)	100%	100%	100%
(5) Penetration rate of centralized model of heat supply in project target area (%)	100%	100%	100% (100%)	100%	100%	100%
(6) Number of beneficiaries (1000 households)	—	430	460	580	660	720 (Upward trend)

(7) Number of beneficiary households (1000 households)	—	140	150	200	230	230 (Upward trend)
(8) Supply area (10,000 m^2)	1,844	1,425	1,526	1,991	2,278	2,327 (126 %)

Source: Targets are indicated in the document provided by JICA and actual figures were indicated in the document provided by the executing agency.

As stated above, the outcome of this project to "mitigate air pollution through reduction in small-scale sources of pollutants" achieved the target emission reduction of SO_2, NOx and TSP for both Phase 1 and Phase 2. In addition, all compact coal boilers in the target area were removed and the penetration rate of centralized heat supply achieved 100%. The number of beneficiaries and households, and the supply area increase steadily every year, which indicates that this project is effective.

3.3.1.2 Qualitative Effects (Other effects)

Qualitative effects of this project have been considered as "Improvement of the living environment of Hohhot residents and stable heat supply." As this can be understood as an effect at the impact level of this project, it is evaluated based on "3.3.2.1. Intended Impacts."

3.3.2 Impacts

3.3.2.1 Intended Impacts

The impact of this project is "to contribute to improving the living environment in Hohhot City and to ensure a stable heat supply." To grasp this impact, the External Evaluator conducted group interviews with beneficiaries to check (1) their level of satisfaction with the current heat supply service and (2) how life and people's health changed before and after the project because of the improvement of centralized heat supply capacity and service.[15] As shown in Table 7, satisfaction of residents regarding (1) is very high in all categories such as supply time, service stop time and number of days, customer correspondence and charge setting. With regard to (2), problems of soot and ash, etc. have been eliminated. The living environment is improved and temperature is always kept stable. Anxiety about the health of children and elderly people in particular has been greatly reduced, the risk of carbon monoxide poisoning is gone and it was confirmed that the "quality of life" has improved.

Table 7. Project Impact: Main Results Obtained from Group Interviews

[Satisfaction of current heat supply service]

- Project satisfaction: All categories such as supply time, service stop time and number of days, customer correspondence and charge setting are "highly satisfactory (30 people)" and "satisfactory to some extent (2 people)." The main reason for the latter is "temperature is slightly unstable" and "it is dusty because it gets dry."
- Heat supply service stop/customer correspondence: There is no interruption in the heat supply service due to incomplete management and maintenance. The heat supply service was scheduled to stop due to a blackout and suspension of water supply, etc. It is always notified beforehand. Any pipe clogging or damage in the building is notified to the hotlines of the heat supply company and heat exchange station. Companies handle the situation within 2 hours. Generally, the heat supply company provides good

[15] An overview of the group interviews is as follows. The executing agency called research target people from the project target area (3 areas), 12 people (8 men and 4 women), 10 people (3 men and 7 women) and 10 people (6 men and 4 women), 32 people in total (17 men and 15 women.) The age of targets ranged from 20s to 60s. As for resident status and heat supply method before the project, some residents lived in a one-story house and used a compact coal stove (19 people) and other residents lived in a multi-family dwelling house and use a compact coal boiler (13 people.) The executing agency made contact with resident committees and real estate owners in the target area, telling them the date of the group interview and asking residents to participate. The group interviews were held on November 22, 23 and 24, 2017, a total of 3 days.

facility management and service. There was a request to change the heat supply period according to the weather of that year as occasion may demand.

- Supply time and charge setting: Charge has been fixed to 22.08 yuan/m^2/year since the project started. Fuel expenses consume more of the income of households but it does not have influence on their life because income increases as well. When considering the living environment before the project, the charge is reasonable. Payment can be made conveniently through various methods such as bank, charge collection office and mobile phone, etc.

[Changes in lifestyle before and after the project because of the improvement of centralized heat supply capacity/service]

1. Changes in the usage situation of compact coal boiler, changes in lifestyle after shifting to centralized heat supply:

- As there is no need to burn coal, people were able to spend their time on other activities such as sleep, housekeeping, child care, work, pleasure and exercise, etc. (It took about 30 minutes to crush coal and burn, which was repeated several times in a day to maintain the temperature.)
- Living environment was improved. Centralized heat supply does not generate ash and smoke, which made the inside of the room clean. As the temperature is kept stable, health problems (such as sensitivity to the cold and joint pain of elderly people and colds, etc. that elderly people and children catch) caused by coldness was reduced, and people live a pleasant life. Therefore, people have peace of mind.
- The atmospheric environment in Hohhot City has improved. Before the project, as the emission standard of small-scale boilers that were used during winter was low, Hohhot City was generally dusty and the air quality was significantly worse. Since the project, the atmospheric environment has improved throughout the year.

2. Opinions on diseases caused by air pollution

- Many residents aged from 20 to 49 answered "there was no big problem in the first place." Before the project, children and elderly people often had a fit of coughing. Phlegm and nasal mucus were black and they felt unwell. After the project, these symptoms were significantly alleviated.
- Residents who were using a compact coal stove in a one-story building needed to turn off the stove when they slept. There was always a problem of carbon monoxide poisoning; however, this risk was completely cleared and people were able to spend time safely and securely.

Source: The External Evaluator summarized the results of the group interview.

Generally, positive opinions were collected related to the project "to contribute to improving the quality of life in Hohhot City and ensure a stable heat supply," and results that back up the certain effects of this project were obtained.

Southeast heat source plant: Chimney for dust collection and desulfurization
(Hohhot Chengfa Development & Management Co., Ltd)

3.3.2.2 Other Positive and Negative Impacts

(1) Impacts on the Natural Environment[16]

An Environmental Impact Assessment (EIA) of Phase 1 of this project was approved by the Inner Mongolia Autonomous Region Environmental Protection Agency in January 2006. This EIA includes Xinjiaying heat source plant B that was the object of this project after revision. With regard to Phase 2, EIA after revision was created in March 2007 after revision and was approved in April 2012. It was confirmed that records and hearing investigations related to exhaust gas, dust, waste treatment, muddy water and noise proved that measures were made. Moreover, in this project, a chimney 120m high was constructed in Phase 1 and a

[16] In this project, as a quantitative impact of relief of the atmospheric pollution burden in phase 1, it was estimated to reduce 150,000 tons of carbon dioxide emission by controlling small-scale pollutant emission sources. However, after the national atmospheric environmental standard was revised in 2012, it was heard from the executing agency that it does not have data because carbon dioxide is not monitored. Therefore, this impact was excluded from the ex-post evaluation.

chimney 100m high was constructed in Phase 2 for measures against exhaust gas and dust, and for dust collection and desulfurization due to coal combustion. The central government's environmental protection agency and Hohhot City environmental protection agency monitor pollutant emissions in real time and the emission standard of national atmospheric pollutants is strictly maintained. Environmental measures were properly implemented during construction and at the time of the ex-post evaluation, and negative impacts on the environment are not found.[17]

(2) Resettlement and Land Acquisition

Both Phase 1 and Phase 2 own the right to use the land where construction was conducted before the project started and it was planned not to acquire land or ask residents to relocate. It was actually necessary to acquire the right to use a total of 754 hectares of land to construct Xinjiaying factories A and B. The target land was owned by the government. The executing agency followed a procedure based on the "Urban real estate management act," paid the fee after appraisal by the Hohhot municipal government and acquired smoothly the right to use the land. In addition, it was necessary to relocate the poultry farm in Hohhot Agriculture University to another location in the university in order to construct a heat exchange station. Relocation expenses were paid to the university to relocate the poultry farm and there was no influence on lectures and exercises, etc. As described in "3.2.2.1 Efficiency: Project Cost," land necessary for Phase 2 was acquired during Phase 1 in advance. However, it was necessary to acquire the right to use the land temporarily in the process of laying additional piping in Phase 2. As this land was waste land which did not require relocating residents, the proper procedure was followed according to the preceding act and there was no particular problem.

(3) Unintended Positive/Negative Impacts

Before the project was reviewed, it was estimated that heat demand in the southeast area of Hohhot City increased by an amount equivalent to one boiler of heat supply capacity of 58 MW in winter, 2008. However, because of the changes in the project, heat supply was delayed one year and started in winter 2009. As a result, this project did not handle the increase in heat demand in winter 2008 and purchased the heat temporarily from a thermal power plant in the Jinqiao New Urban District to cover the shortfall amount. With regard to heat demand of 788,000 m^2 in 2008, it was handled by purchasing 360,100 Gigajoule temporarily from the thermal power plant as scheduled and there was no influence on residents.

With regard to the outcome of this project to "mitigate air pollution through reduction in small-scale sources of pollutants," reduction in emissions atmospheric pollutants, a major indicator, was achieved. All compact boilers were removed from the target area and the penetration rate of centralized heat supply achieved 100%. The beneficiary population, number of households and heat supply area increase every year and effectiveness is generally high. With regard to the impact "to contribute to improving the living environment in Hohhot City and to ensure a stable heat supply," compact coal stoves and small-scale boilers were replaced with centralized heat supply according to interviews with residents, and it was confirmed that the living environment was significantly improved and stable heat supply was secured. Land was obtained smoothly in accordance with the law and residents did not need to relocate. As for environmental measures and monitoring during the project and environmental monitoring

[17] As for the project target area of both phases at appraisal, it was assumed that the area did not cover regions such as national parks that may be influenced or surrounding areas, and undesirable influences on the natural environment should be minimal. When local observation was made for the ex-post evaluation, it was confirmed that the estimation made at the beginning of the plan was correct and that the estimation was maintained at the time of the ex-post evaluation. With regard to the group interview of residents, it was confirmed that this project did not have a negative influence during construction and operation.

after the operation started, the national environmental protection agency carries out strict management and negative impacts on the environment were not recognized.

This project has largely achieved its objectives. Therefore, effectiveness and impacts of the project are high.

3.4 Sustainability (Rating: ③)

3.4.1 Institutional / Organizational Aspects of Operation and Maintenance

The department in charge of operating and managing infrastructure facilities provided in this project (hereinafter referred to as "Project executing department") is Hohhot Chengfa Development & Management Co., Ltd. and Hohhot Futai Heating Supply Co., Ltd[18]. At the time of the ex-post evaluation, the preceding company covered approximately 30% of the heat supply area and in this project, and the company is in charge of operation and maintenance of the Southeast heat source plant (Phase 1) and Xinjiaying heat source plant A (Phase 1) and B (Phase 2). Likewise, the latter company covered approximately 17% of the heat supply area in Hohhot City and in this project, and the company is in charge of operation and maintenance of the Bayan heat source plant (Phase 2). Details of the institutional/organizational aspects of operation and maintenance of each executing department are as follows.

- Southeast Supply subsidiary of Hohhot Chengfa Development & Management Co., Ltd. This is one of four subsidiary companies of Hohhot Chengfa Development & Management Co., Ltd. The company is in charge of Southeast heat source plant and operation and maintenance of the pipeline and heat exchange station in the heat supply area of this plant. The company consists of 16 sections in total such as electricity, equipment, safety management, water examination, financial affairs, pipeline and heat exchange station of the heat source plant under the president and vice president. It has 791 employees in total.
- Xinjiaying supply subsidiary of Hohhot Chengfa Development & Management Co., Ltd: One of four subsidiary companies of Hohhot Chengfa Development & Management Co., Ltd. The company is in charge of operation and maintenance of Xinjiaying power plants A and B in Phase 1 and Phase 2 and operation and management of the pipeline and heat exchange station in the heat supply area. The company consists of 13 sections in total such as electricity, equipment, safety management, water examination, pipeline and heat exchange station of the heat source plant under the president and the vice president. It has 330 employees in total.
- Bayan subsidiary of Hohhot Futai Heating Supply Co., Ltd.: One of two companies affiliated to Hohhot Futai Heating Supply Co., Ltd. The company is in charge of operation and maintenance of the Bayan heat source plant in Phase 2 and operation and maintenance of the pipeline and heat exchange station in the target area. The company consists of 11 sections in total such as electricity, equipment, safety management, water examination, financial affairs, pipeline and heat exchange station of the heat source plant under the president and the vice president. It has 160 employees in total.

Bayan heat source plant: Boiler maintenance
(Hohhot Futai Heating Supply Co., Ltd.)

[18] Hohhot Chengfa Development & Management Co., Ltd is a state-owned enterprise into which Hohhot City invests 100%. Hohhot Futai Heating Supply Co., Ltd. is also a state-owned enterprise but 85% of stock is owned by the Hohhot City National Property Management Committee, 12% is owned by employees and 3% is owned by state-owned corporations at the time of the ex-post evaluation. Hohhot Chengfa Development & Management Co., Ltd has supervision of the Hohhot City National Property Management Committee.

Every project executing department has a clear organization chart, sufficient scale necessary for operation and management and a fully functional system of decision making/instruction system, guidance provision/supervision, etc. This system is sufficient to secure sustainability of this project.

3.4.2 Technical Aspect of Operation and Maintenance

Technical aspects of operation and maintenance of the department executing this project are evaluated based on the familiarity of technology adopted by the facility developed by this project, especially the number of people who acquire national certificates, maintenance of the training system, operation and maintenance manuals and usage situation.

Heat exchange station
(Hohhot Futai Heating Supply Co., Ltd.)

Training for personnel responsible for charge collection
(Hohhot Chengfa Development & Management Co.. Ltd)

With regard to technical standards and the training system of operation and maintenance personnel, if an occupation specifically requires the acquisition of a national certificate, each project executing department conducts a strict management, at the same time it actively advances the acquisition of national certification and secures sufficient human resources (See Table 8). The following occupations require national certification: boiler operator, chemical analysis worker, machine part repair/assembly worker, electric welding worker, thermal dynamics worker and plumbing worker. Occupations are classified as beginner, intermediate, advanced-level and special engineer according to years of experience and a written exam. In these occupations, training is mainly conducted at an outside training organization, but technical training is conducted inside the company on a regular basis by inviting instructors from outside. As for occupations that do not require national certification, there is a human resource development system and every project executing department grasps human resource needs of all personnel every year and creates and conducts a training plan for the next fiscal year. Training is intensively conducted during summer because the heat source plant is not in operation and all of the personnel get trained in some way to continually update their knowledge.[19] In addition, experienced engineers and young members always make teams to pass on techniques and know-how at workplaces. Turnover rates are low. Even if an employee leaves a job, he/she is likely to move and change to another heat supply company, so knowledge and experience are kept in the heat supply sector.

[19] Examples of training that Hohhot Chengfa Development & Management Co., Ltd conducted in 2017 are: “Theory and practice for boiler operators,” “Theory and practice of water treatment,” “Training of theory and practice of dust collection and desulfurization,” “Theory and practice of external network operation,” “Training of inspection theory and practice,” and “Training for personnel collecting charges,” etc. and 189 people including operation/inspection workers and collectors and personnel supervising collection were trained in total.

Table 8. Number of People Acquiring National Certification Related to Operation and Maintenance of the Project Executing Department in This Project

Institution/facility	Hohhot Chengfa Development & Management Co., Ltd		Hohhot Futai Heating Supply Co., Ltd. Bayan subsidiary
	Southeast supply subsidiary	Xinjiaying supply subsidiary	
Heat source plant	98	38	21
Heat supply piping/ Heat exchange station	49	38	23
Dust integration use plant	5	4	5
Automatic control center	9	21	9

Source: Documents provided by the executing agency.

As for improvement and use of operation and maintenance manuals, in addition to confirmation by local observation on manual and operation and maintenance records, a survey was conducted on operators in charge of operation and maintenance of heat supply factories/heat exchange stations and maintenance of heat supply piping. It was confirmed that these were sufficiently maintained and used, and a manual of emergency measures was prepared. Moreover, important points in the manual related to each piece of equipment were summarized in a poster and installed on the wall of each facility, which enables personnel to always check it. During the heat supply period, personnel visit each house once a month, check equipment to confirm that the proper temperature is maintained, and give advice on maintenance if necessary.

Overall, employees in charge of operation and maintenance in every project executing department have a sufficient level of technical skill. The training system is well organized, the company always works on maintaining and improving technical proficiency, and the technology for sustainability of this project is secured.[20]

3.4.3 Financial Aspect of Operation and Maintenance

In this project, it was assumed at the time of the appraisal that operation and maintenance expenses would be covered by income from heat supply charges. The heat supply charge is calculated based on the site area of the user and users are required to pay the charge by November 15 every year. The charge at the time of the ex-post evaluation is 22.08 yuan/m^2/year for residents and 30.18 yuan/m^2/year for public facilities[21]. The collection rate of both Hohhot Chengfa Development & Management Co., Ltd. and Hohhot Futai Heating Supply Co., Ltd. in the past three years from 2015 to 2017 is high at around 91% to 95%. However, the operating profit is in the red, which means that operation and maintenance expenses cannot be covered only by the charge income of heat supply (See Table 9). According to the executing agency, price and labor costs are increasing in China, so it is planned to revise the charge in the near future. The Chinese government is taking measures to enforce privatization. However, regarding companies related to foundation infrastructure including heat supply etc., it is defined by law that these companies are subject to receive preferential treatment (such as subsidy, tax exemption, loan, etc.) from the government, autonomous region

[20] In this project, it was not possible to conduct training in Japan, but activities to develop human resources in China are making progress. Therefore, operation and management have no problem.

[21] As for heat supply charges in Hohhot City, the committee of Hohhot City development and reorganization has a right to decide on a revision. In response to a request from the project executing department, it is stipulated that the committee holds a public hearing to reflect opinions from users and decides whether to revise the charge. Charges have not been revised since 2008.

and Hohhot City.[22] For that reason, government subsidy is invested in Hohhot Chengfa Development & Management Co., Ltd, which is why the company could make a profit for three years from 2015 to 2017. On the other hand, Hohhot Futai Heating Supply Co., Ltd. is in the red because of delays in investment of the government subsidy. However, according to the company, the preceding law has been applied to improve the situation in one or two years.

Table 9. Profit and Loss Statement of Project Executing Department

(Unit: million yuan)

	Hohhot Chengfa Development & Management Co., Ltd			Hohhot Futai Heating Supply Co., Ltd.		
	2015	2016	2017*	2015	2016	2017*
Sales (rate income)	711,9	774,8	826.7	344.3	382.1	414.1
General administrative expenses/selling expenses etc. including operation and maintenance expenses	845,6	896,2	947.1	402.2	446.4	473.5
Operating profit	***-133,6***	***-121,4***	***-120.4***	***-57.9***	***-64.3***	***-59.4***
Non-operating income	144,1	141,8	143.3	42.1	51.4	33.3
Government subsidy	*143,7*	*141,8*	*140.3*	*NA*	*42.4*	*34.1*
Non-operating expense	1.4	0.4	1.2	0.9	1.6	0.2
Ordinary profit	**9.0**	**20.1**	**21.7**	**-16.7**	***-14.9***	***-26.3***

Source: Documents provided by executing agency.
*: Based on the pre-audit profit and loss statement.

As mentioned above, because the two companies are unable to cover operation and maintenance with income from charges, a revision of the charges is desirable. However, as the government has committed to continuously investing in various subsidies, financial sustainability is secured.

3.4.4 Status of Operation and Maintenance

It was confirmed through local observation that operation and maintenance statuses of facilities constructed by this project and the installed equipment were appropriate. As there is an agency of a manufacturer that manufactures spare parts in China, problems such as delays in delivering parts do not occur. The operators manage to partially expand facilities and to make operation work effectively and also upgrades equipment necessary for environment conservation such as desulfurization and collecting dust.[23] Control centers in each heat source plant can grasp all processes of heat supply in real time. In addition, detailed information about the weather that is indispensable for a proper heat supply service is also sent from a weather bureau in real time and the load on boilers is decided based on this information. Furthermore, the central government's environmental protection agency and municipal government conduct strict management of atmospheric pollutant

Maintenance of a heat exchange station
(Hohhot Chengfa Development & Management Co., Ltd)

[22] Based on "Request to conduct marketing operation of centralized heat supply facility in east area of Hohhot City" (National Property Document [2006] No. 75 issued by Hohhot City), General office of Hohhot City People's Government issued on September 6, 2006, "Notification related to preferential treatment of tax increase in heat supply company, real estate tax and urban city land use tax" (Property and tax [2016] No. 94) and Inner Mongolia Autonomous Region Government Finance National Tax Bureau issued on August 24, 2016.

[23] At the time of the ex-post evaluation, installation of a more effective desulfurization device is under consideration with financing from Denmark.

emissions. A heat exchange station is operated and maintained to keep the water temperature sent to each household around 38 to 41 degrees, and temperature and pressure are properly adjusted according to the number of stories and type of heating. Daily maintenance is conducted three times a day. Five senses are used to check the smell in a heat exchange station, the sound of the motor and circular pump and water leakage and temperature, and numerical values of temperature and pressure are checked on a control panel and recorded. Simple water examination is also conducted. As mentioned above, operation and maintenance of facilities constructed in this project and installed equipment are conducted properly and sustainability of this project is guaranteed.

In light of the above, there have been no major problems observed in the institutional, technical and financial aspects or the current status of the operation and maintenance system. Therefore, sustainability of the project effects is high.

4 Conclusion, Lessons Learned and Recommendations

4.1 Conclusion

This project was implemented under the objective to mitigate the burden of air pollution through reduction in small-scale sources of pollutants in Hohhot City, Inner Mongolia Autonomous Region, People's Republic of China, by developing energy-efficient intensive heat supply facilities with less environmental load, thereby contributing to the improvement of the living environment and stable heat supply in the city. This project was fully consistent with the development, environmental protection, heat supply plans, and the development needs of China, the Inner Mongolia Autonomous Region, and Hohhot City at the time of the appraisal and the ex-post evaluation as well as Japan's ODA policy at the time of the appraisal; therefore, the relevance of the project is high. The outputs of the project underwent substantial review from the time of the appraisal. However, after the review, in both Phases 1 and 2, it was carried out as planned. The efficiency of the project is high because its total cost and period were as planned. The outcome expected as the primary effect of the project was to "mitigate the air pollution burden through reduction in small-scale sources of pollutants," and the impact was the "improvement of the living environment and stable heat supply in Hohhot City." Regarding outcome, in both phases, the project was highly effective because it achieved the goal of reducing emissions of SO_2, NO_2 and TSP, its three major indicators, and all auxiliary indicators showed a tendency toward improvement. Therefore, the effectiveness of the project is high. With regard to impact, the project contributed to improvement of residents' living environment by prompting all small coal-burning stoves and small boilers to shift to intensive heat supply. Necessary land acquisition was implemented appropriately, forcing no resettlement of residents. Regarding impact on the natural environment during the construction and at the time of the ex-post evaluation, appropriate measures were taken, and monitoring was conducted properly, and results indicated that there was no negative impact. Based on the above, the effectiveness and impact of the project is high because the envisioned project results were achieved. The systems, technology, finance, and maintenance management at Hohhot Chengfa Development & Management Co., Ltd and Hohhot Futai Heating Supply Co., Ltd., both of which were responsible for operation and maintenance management under the project, were generally favorable, and the sustainability of effects brought by the project is high.
In light of the above, this project is evaluated to be highly satisfactory.

4.2 Recommendation

4.2.1 Recommendations to the Executing Agency

None.

4.2.2 Recommendations to JICA

None.

4.3 Lessons Learned

Enforcement of appropriate project management by local office (Completeness of submitting progress reports, etc. described in the Loan Agreement)

This project was significantly revised in both Phase 1 and Phase 2. Contents of the project after being revised were conducted as planned and the project effect has been realized. However, as the executing agency and project executing department do not have sufficient experience in Japanese ODA loans, etc., enforcement of mid-term supervision has been reported since the appraisal in 2006 and supervision including project monitoring was considered important. However, it was in 2008, the second year since the project started, that the mid-term supervision made clear that the contents of the project need to be reviewed. This mid-term supervision proved that a part of the project scope subject to Japanese ODA loans had already started work with domestic funding. On this occasion, the project was appraised again, including a revision of project scope that matched the project objective, funding and project period and resetting of operation/effect indicator targets. Consequently, there is no problem, but the executing agency is supposed to submit a project progress report every time a loan contract is agreed, and JICA needs to be thorough in having the executing agency submit such reports. If the executing agency and the project executing department do not have sufficient experience in Japanese ODA loans and if domestic sources of funds diversify because of sudden economic growth and external factors, submission of progress reports, etc. needs to be thorough and project management reinforced more than usual so that prevention of significant changes in the contents of the project would become possible.

END

Comparison of the Original and Actual Scope of the Project

Item	Plan (after revision)	Actual
1. Project Output [Facility / procurement device] (1) Heat supply equipment (boiler) (2) Heat supply piping (3) Heat exchange station (4) Other (1) Heat supply equipment (boiler) (2) Heat supply piping (3) Heat exchange station (4) Other [Training]	[Phase 1] Southeast heat source plant: 58 MW x 3 units Xinjiaying heat source plant A: 70 MW x 4 units Southeast heat source plant: 19.8 km Xinjiaying heat source plant A: 18.5 km Southeast heat source plant: 29 units Xinjiaying heat source plant A: 31 units Automatic control center [Phase 2] Bayan heat source plant: 70 MW x 4 units Xinjiaying heat source plant B: 84 MW x 3 units Bayan heat source plant: 23.3 km Xinjiaying heat source plant B: 22.0 km Bayan heat source plant: 27 units Xinjiaying heat source plant B: 29 units Automatic control center [Phase 1, Phase 2] Training in Japan related to atmospheric pollution measures including ash integration use	[Phase 1] As planned As planned As planned As planned As planned As planned As planned [Phase 2] As planned As planned As planned As planned As planned As planned As planned As planned [Phase 1, Phase 2] Cancel
2. Project Period	[Phase 1] June 2006–October 2012 (77 months, 6 years and 5 months) [Phase 2] March 2007–September 2015 (103 months, 8 years and 11 months)	[Phase 1] As planned [Phase 2] As planned
3. Project Cost Amount Paid in Foreign Currency Amount Paid in Local Currency Total ODA Loan Portion Exchange Rate Amount Paid in Foreign Currency Amount Paid in Local Currency Total ODA Loan Portion Exchange rate	[Phase 1] 7,872 million yen 1,792 million yen (120 million yuan) 9,664 million yen 7,400 million yen 1 yuan = 14.9 yen (As of January 2008) [Phase 2] 2,868 million yen 2,388 million yen (196 million yuan) 5,256 million yen 2,840 million yen 1 yuan = 12.2 yen (As of December 2011)	[Phase 1] 7,368 million yen 1,692 million yen (127 million yen) 9,060 million yen 7,368 million yen 1 yuan = 13.3 yen (Average between January 2008 and December 2012) [Phase 2] 2,814 million yen 3,171 million yen (182 million yuan) 5,985 million yen 2,814 million yen 1 yuan = 17.4 yen (Average between January 2013 and December 2015)
4. Final Disbursement	[Phase 1] October 2013 / [Phase 2] September 2015	