



Completion Report

Project Number: 36362
Loan Number: 2112
September 2012

People's Republic of China: Liaoning Environmental Improvement Project

Asian Development Bank

CURRENCY EQUIVALENTS

Currency Unit – yuan (CNY)

		At Appraisal (15 September 2004)	At Project Completion (31 December 2011)
CNY1.00	=	\$0.1208	\$0.1587
\$1.00	=	CNY8.2767	CNY6.3009

ABBREVIATIONS

ADB	–	Asian Development Bank
CBM	–	coal-bed methane
CDM	–	clean development mechanism
CER	–	certified emission reduction
CMM	–	coal mine methane
CO ₂	–	carbon dioxide
EIRR	–	economic internal rate of return
EMO	–	environmental management offices
EMP	–	environmental management plan
EMR	–	environmental monitoring report
FIRR	–	financial internal rate of return
GLP	–	government of Liaoning province
HES	–	heat exchange station
LPEPB	–	Liaoning Provincial Environmental Protection Bureau
LUCPUAB	–	Liaoyang Urban Construction and Public Utility Administrative Bureau
NO _x	–	nitrogen oxide
O&M	–	operation and maintenance
PIA	–	project implementing agency
PIO	–	project implementation office
PMO	–	project management office
PRC	–	People's Republic of China
SO ₂	–	sulfur dioxide
SPRSS	–	summary poverty reduction and social strategy
TSP	–	total suspended particulates
VAT	–	value-added tax
WACC	–	weighted average cost of capital

WEIGHTS AND MEASURES

km	–	kilometer
m	–	meter
m ²	–	square meter
m ³	–	cubic meter
mu	–	666.67 square meters
MW	–	megawatt
ton	–	1,000 kg
1 MW	–	3.6 gigajoules/hour = 1.42 tons (of steam)/hour

NOTES

- (i) The fiscal year (FY) of the government ends on 31 December.
- (ii) In this report, "\$" refers to US dollars.

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BASIC DATA

A. Loan Identification

1.	Country	People's Republic of China
2.	Loan Number	2112
3.	Project Title	Liaoning Environmental Improvement Project
4.	Borrower	People's Republic of China
5.	Executing Agency	Government of Liaoning Province
6.	Amount of Loan	\$70.00 million
7.	Project Completion Report	PCR: PRC 1336

B. Loan Data

1.	Fact-Finding	
	– Date Started	3 November 2003
	– Date Completed	20 November 2003
2.	Appraisal	
	– Date Started	12 April 2004
	– Date Completed	27 April 2004
3.	Loan Negotiations	
	– Date Started	20 October 2004
	– Date Completed	22 October 2004
4.	Date of Board Approval	25 November 2004
5.	Date of Loan Agreement	26 May 2005
6.	Date of Loan Effectiveness	
	– In Loan Agreement	26 August 2005
	– Actual	16 November 2005
	– Number of Extensions	1
7.	Closing Date	
	– In Loan Agreement	30 September 2009
	– Actual	30 December 2011
	– Number of Extensions	1
8.	Terms of Loan	
	– Interest Rate	London interbank offered rate (LIBOR)-based
	– Maturity	25 years
	– Grace Period	5 years
9.	Terms of Relending (if any)	
	– Interest Rate	LIBOR-based
	– Maturity	25 years
	– Grace Period	5 years
	– Second-Step Borrower	Government of Liaoning Province

10. Disbursements

a. Dates

Initial Disbursement	Final Disbursement	Time Interval
30 May 2006	30 December 2011	66 months
Effective Date	Original Closing Date	Time Interval
25 November 2005	30 September 2009	46 months

b. Amount (\$)

Category	Original Allocation	Allocation after Major Change	Net Amount Available	Amount Disbursed^a
Civil Works	3,560,000.00	759,589.00	759,589.00	759,589.56
Equipment and Material	57,030,000.00	50,969,879.00	50,969,879.00	50,778,864.21
Consulting Service and Training	1,780,000.00	958,487.00	958,487.00	882,798.45
Interests and Commitment Fee	4,010,000.00	4,010,000.00	4,010,000.00	4,010,000.00
Unallocated	3,620,000.00	0.00	0.00	0.00
Total	70,000,000.00	56,697,955.00	56,697,955.00	56,431,252.22

^a \$266,702.78 was cancelled on 30 December 2011.

11. Local Costs (Financed): None

C. Project Data

1. Project Cost (\$ million)

Cost	At Appraisal	At Major Change	Actual
Foreign Exchange Cost	76.00	75.19	56.43
Local Currency Cost	85.00	95.75	143.92
Total	161.00	170.94	200.35

2. Financing Plan (\$ million)

Source	At Appraisal				At Major Change				Actual			
	Foreign	Local	Total	%	Foreign	Local	Total	%	Foreign	Local	Total	%
Equity												
Fuxin CBM/CMM Development and Utilization Company	1.53	7.79	9.32	5.8	1.41	8.70	10.11	5.91	0.00	30.96	30.96	15.45
Fushun Gas General Company	0.16	0.72	0.88	0.5		Cancelled				Cancelled		
Benxi Gas General Company	0.27	1.54	1.81	1.1	0.23	1.16	1.39	0.8	0.00	4.15	4.15	2.07
Benxi General Heating Company	0.53	2.16	2.69	1.7	0.45	7.22	7.67	4.5	0.00	13.36	13.36	6.67
Liaoyang Real Estate Heating Company	1.36	11.23	12.59	7.8	1.10	20.17	21.27	12.4	0.00	29.14	29.14	14.54
Yingkou Heating Company	1.23	25.49	26.72	16.6	1.08	22.57	23.65	13.8	0.00	24.12	24.12	12.04
Fuxin Heating Company		New subproject			0.45	6.01	6.46	3.8	0.00	7.12	7.12	3.55
Benxi Huaxing Heating Company		New subproject			0.47	9.92	10.39	6.1	0.00	7.64	7.64	3.81
Anshan General Heating Company	0.92	5.33	6.25	3.9		Cancelled				Cancelled		
Subtotal	6.00	54.26	60.26	37.4	5.19	75.75	80.94	47.3	0.00	116.49	116.49	58.14
Loans												
Asian Development Bank	70.00	0.00	70.00	43.5	70.00	0.00	70.00	41.0	56.43 ^a	0.00	56.43	28.17
Local Banks	0.00	30.74	30.74	19.1	0.00	20.00	20.00	11.7	0.00	27.44	27.44	13.70
Subtotal	70.00	30.74	100.74	62.6	70.00	20.00	90.00	52.7	56.43	27.44	83.87	41.86
Total	76.00	85.00	161.00	100.0	75.19	95.75	170.94	100.0	56.43	143.92	200.35	100.00

^a The loan amount was reduced to \$56.7 million on 30 July 2010 due to the cancellation of \$13.3 million originally allocated to the Fuxin CBM and CMM Development subproject from ADB financing. The loan actually closed on 30 December 2011 following the final disbursement and cancellation of undisbursed loan balance of \$266,702.78.

3. Cost Breakdown by Project Component (\$ million)

Component	Appraisal Estimate			Major Change			Actual		
	Foreign Exchange	Local Currency	Total Cost	Foreign Exchange	Local Currency	Total Cost	Foreign Exchange	Local Currency	Total Cost
Part A: CBM and CMM Development	15.78	10.89	26.67	16.2	7.87	24.07	0.00	30.96	30.96
A1 Fuxin CBM and CMM Development									
(i) Civil Works (incl. vertical wells)				3.75	5.36	9.11	0.00	9.29	9.29
(ii) Equipment for Power Plants				6.11	0.00	6.11	0.00	5.16	5.16
(iii) Equipment for CBM and CMM Drainage and Transmission				6.34	0.00	6.34	0.00	13.42	13.42
(iv) Other Costs (land acquisition, site preparation, etc.)				0.00	2.51	2.51	0.00	3.10	3.10
Subtotal A1	15.78	10.89	26.67	16.20	7.87	24.07	0.00	30.96	30.96
Part B: Gas Distribution Improvements	4.45	3.33	7.78	2.64	3.46	6.10	2.20	3.90	6.10
B1 Fushun Gas Distribution Improvements				Cancelled			Cancelled		
(i) Gas Pipelines and Pressure Regulating Stations	0.98	0.00	0.98						
(ii) Civil Works and Pipeline Installations	0.67	0.73	1.40						
(iii) Implementation Supervision Consultants and Training	0.05	0.00	0.05						
Subtotal B1	1.70	0.73	2.43						
B2^a Benxi Gas Distribution Improvements									
(i) Gas Pipelines and Pressure Regulating Sections				2.64	0.00	2.64	2.20	0.00	2.20
(ii) Civil Works and Pipeline Installations				0.00	3.46	3.46	0.00	4.15	4.15
Subtotal B2	2.75	2.60	5.35	2.64	3.46	6.10	2.20	4.15	6.35
	41.61	58.62	100.22	42.44	80.15	122.59	49.34	103.70	153.03

Component	Appraisal Estimate			Major Change			Actual		
	Foreign Exchange	Local Currency	Total Cost	Foreign Exchange	Local Currency	Total Cost	Foreign Exchange	Local Currency	Total Cost
Part C: City Central Heating Supply									
C1 Anshan Central Heating Supply				Cancelled			Cancelled		
(i) Heat Transmission and Distribution Pipes	8.54	0.20	8.74						
(ii) Civil Works	0.68	0.97	1.65						
(iii) Consumer Connection Modernization	0.00	3.87	3.87						
(iv) Implementation Supervision Consultants and Training	0.22	0.00	0.22						
Subtotal C1	9.44	5.04	14.47						
C2^b Liaoyang Central Heating Supply									
(i) Heat Source (boilers and auxiliaries)				8.05	2.51	10.09	12.42	3.87	16.29
(ii) Heating Transmission and Distribution Pipeline				4.70	13.68	18.52	0.00	22.36	22.36
(iii) Civil Works				1.01	6.89	8.22	0.76	5.18	5.94
(iv) Other Costs (land acquisition, site preparation, etc.)				0.00	4.92	4.92	0.00	5.82	5.82
Subtotal C2	14.02	22.05	36.06	13.76	28.00	41.76	13.18	37.23	50.41
C3^c Yingkou Central Heating Supply									
(i) Heat Source (boilers) and Steam Turbine-Generator				2.65	1.19	10.09	2.41	1.38	3.80
(ii) Supplementary System (thermoelectricity plant)				5.30	0.44	18.27	5.32	0.51	5.84
(iii) Steam Pipelines and Control Systems				4.87	8.89	8.22	4.89	10.33	15.22
(iv) Civil Works and Preconstruction Works				0.00	15.61	0.00	0.00	18.25	18.25
Subtotal C3	12.70	26.18	38.89	12.82	26.13	38.95	12.63	30.47	43.10

Component	Appraisal Estimate			Major Change			Actual		
	Foreign Exchange	Local Currency	Total Cost	Foreign Exchange	Local Currency	Total Cost	Foreign Exchange	Local Currency	Total Cost
C4^a Benxi Hengze Central Heating Supply									
(i) Heat Source (boilers and auxiliaries)				3.61	2.30	5.91	5.15	3.28	8.44
(ii) Heating Transmission and Distribution Pipeline				2.40	2.89	5.29	0.00	3.31	3.31
(iii) Civil Works				0.00	3.31	3.31	0.00	8.27	8.27
(iv) Other Costs (land acquisition, site preparation, etc.)				0.00	1.90	1.90	0.00	1.68	1.68
Subtotal C4	5.45	5.35	10.80	6.01	10.4	16.41	5.15	16.53	21.86
C4 Fuxin Central Heating Supply	New subproject added at major change								
(i) Heating Transmission and Distribution Pipeline				3.80	5.33	9.13	11.04	3.17	14.22
(ii) Heat Monitoring and Control System				1.10	0.00	1.10	1.49	0.00	1.49
(iii) Civil Works				0.00	0.06	0.06	0.00	7.62	7.62
(iv) Other Costs (land acquisition, site preparation, etc.)				0.00	1.04	1.04	0.00	1.03	1.03
Subtotal C4				4.90	6.43	11.33	12.53	11.82	24.35
C5 Benxi Huaxing Central Heating Supply	New subproject added at major change								
(i) Heat Source (boilers and auxiliaries)				2.85	1.98	4.78	3.49	0.61	4.10
(ii) Heating Transmission and Distribution Pipelines				2.10	1.54	3.69	2.36	0.71	3.06
(iii) Civil Works				0.00	3.49	3.49	0.00	4.80	4.80
(iv) Other Costs (land acquisition, site preparation, etc.)				0.00	2.18	2.18	0.00	1.53	1.53
Subtotal C5				4.95	9.19	14.14	5.85	7.64	13.49

Component	Appraisal Estimate			Major Change			Actual		
	Foreign Exchange	Local Currency	Total Cost	Foreign Exchange	Local Currency	Total Cost	Foreign Exchange	Local Currency	Total Cost
Part D: Institutional Strengthening and Consulting Services	0.60	0.00	0.60	1.05	0.00	1.05	0.82	0.05	0.87
Subtotal Base Cost for Items A–D	62.44	72.84	135.28	62.33	91.48	153.81	52.36	107.89	191.76
Contingency									
Physical	3.80	4.83	8.64	5.70	2.19	7.89	0.00	0.00	0.00
Price	2.48	4.06	6.54	2.05	1.28	3.33	0.00	0.00	0.00
Interest during Construction	7.28	3.26	10.54	5.11	0.80	5.91	3.52	5.06	8.58
Commitment Fee ^e	0.00	0.00	0.00	0.00	0.00	0.00	0.55	0.00	0.55
Total Project Cost	76.00	85.00	161.00	75.19	95.75	170.94	56.43	112.96	200.35

CBM = coal bed methane, CMM = coal mine methane.

^a B2 was recategorized as B1 at major change in scope.

^b C2 was recategorized as C1 at major change in scope.

^c C3 was recategorized as C2 at major change in scope.

^d C4 was recategorized as C3 at major change in scope.

^e Commitment fee used by Anshan subproject.

Source: Asian Development Bank.

4. Project Schedule

Item	Appraisal Estimate	Actual
Date of Contract with Consultants	January 2005	June 2005
Completion of Engineering Designs	September 2004	March 2005
Civil Works Contract		
Contract Award	January 2005	April 2006
Completion of Work	June 2008	October 2007
Equipment and Supplies		
First Procurement	February 2005	September 2005
Last Procurement	April 2008	November 2010
Completion of Equipment Installation	October 2008	March 2011
Start of Operations		
Completion of Tests and Commissioning	March 2009	March 2011
Beginning of Start-Up	March 2009	March 2011

5. Project Performance Report Ratings

Implementation Period	Ratings	
	Development Objectives	Implementation Progress
From 1 January 2006 to 31 December 2006	Satisfactory	Satisfactory
From 1 January 2007 to 31 December 2007	Satisfactory	Satisfactory
From 1 January 2008 to 31 December 2008	Satisfactory	Satisfactory
From 1 January 2009 to 31 December 2009	Satisfactory	Satisfactory
From 1 January 2010 to 31 December 2010	Satisfactory	Satisfactory
From 1 January 2011 to 31 December 2011	Green	Green

Note: "Green" indicates project is on track.

D. Data on Asian Development Bank Missions

Name of Mission	Date	No. of Persons	No. of Person-Days	Specialization of Members
Fact-Finding Mission	3–20 November 2003	6	62	a, b, c, d, e,
Appraisal Mission	12–27 April 2004	6	62	a, b, c, d, f, g
CDM Consultation Mission	25–28 April 2005	2	8	g, h
Inception Mission	21–28 July 2005	2	16	a, i
Review Mission	19–23 December 2005	4	16	a, i, j, k
Review Mission	4–14 December 2006	6	31	l, m, n, o
Special Loan Review Mission	14–17 May 2007	3	12	m, o, p
Review Mission	10–18 December 2007	2	18	p, q
Midterm Review Mission	2–9 December 2008	4	14	k, m, n, p
Review Mission	7–11 December 2009	2	10	p, q
Review Mission	6–10 December 2010	2	10	p, q
Project Completion Review	26 March–1 April 2012	3	15	p, q, r

CDM = clean development mechanism.

Note: a = project economist (energy), b = financial analyst, c = energy specialist, d = environment specialist, e = resettlement specialist, f = counsel, g = CDM expert or staff consultant, h = CDM specialist, i = project officer, j = senior project officer, k = resettlement officer, l = head of portfolio management unit, m = finance officer, n = project officer (environment), o = senior project assistant, p = project officer (energy), q = associate project analyst, r = staff consultant (environment).

I. PROJECT DESCRIPTION

1. The Liaoning Environmental Improvement Project¹ was implemented in Liaoning Province in the north of the People's Republic of China (PRC). With a heavy industrial base, Liaoning Province is one of the country's major coal-producing and coal-consuming provinces. The province has severe air pollution problems because of its heavy reliance on coal as the primary fuel for its many heavy industries and small coal-fired heating boilers. In 2003, only seven of the 14 major cities in Liaoning met the national air quality standards. The project is a major part of the effort of the government of Liaoning province (GLP) to improve the air quality in all major cities to meet the national air quality standards.

2. The project's theme was classified as environmental sustainability, and the subthemes were global and regional transboundary environmental concerns and issues, clean production, and control of industrial pollution. The long-term goal of the project was to support environmental improvement in Liaoning Province. The main outputs of the project were envisaged to be: (i) improvement in the efficiency and reliability of gas and central heating supply and closure of small coal-fired boilers, and (ii) production and commercial utilization of coal-bed methane (CBM) and coal mine methane (CMM). The project originally included the following components: (i) Part A: CBM and CMM development in Fuxin City; (ii) Part B: gas distribution improvement in Fushun and Benxi cities; (iii) Part C: city central heating supply in Anshan, Benxi, and Yingkou cities; and (iv) Part D: institutional reforms and corporate governance improvement for all project implementing agencies.

3. At the request of the borrower,² on 3 September 2007 the Asian Development Bank (ADB) approved the following major changes to the scope and implementation arrangements of the project: (i) the scope of subproject A: Fuxin CBM and CMM Development was changed to include four mini CBM and CMM-fired power plants with a total capacity of 22 megawatts (MW);³ (ii) subproject C1: Anshan City Central Heating Supply and subproject B1: Fushun Gas Distribution Improvements were cancelled;⁴ and (iii) two new subprojects—Fuxin Central Heating Supply and Benxi Huaxing Central Heating Supply—were added. As requested by the borrower, on 30 July 2010 ADB approved another change in project scope for expansion of the Fuxin Heating Supply subproject and cancellation of the Fuxin CBM and CMM Development subproject from ADB financing.⁵

¹ ADB. 2004. *Report and Recommendation of the President to the Board of Directors on a Proposed Loan to the People's Republic of China for the Liaoning Environmental Improvement Project*. Manila.

² The borrower refers to PRC acting through the Ministry of Finance (MOF).

³ The changes under the Fuxin CBM/CMM Development subproject were mainly triggered by an unresolved purchase agreement with the original purchaser of methane gas, and the need for optimization of technical design. At project appraisal it was envisaged that about 50% of the CBM/CMM produced would be sold to a local glass factory for industrial use and the rest would be for domestic use. At the preliminary design stage, the project implementing agency (PIA) found that the gas price offered was unrealistically low and an agreement with the factory could not be reached. To utilize the CBM/CMM efficiently, the PIA revised the design to construct four mini CBM/CMM-fired power plants. Technical design was adjusted to increase CBM/CMM production by about 37% compared with the original design. The four power plants would utilize about 56% of the CBM/CMM produced, and the rest would be distributed to households in the local and neighboring cities as an economical source of clean fuel for domestic use.

⁴ The Anshan Central Heating Supply subproject and Fushun Gas Distribution Improvements subproject were cancelled because the PIAs concerned had been transformed into joint-venture companies from state-owned enterprises. Considering the privatization and the difficulty of onlending the ADB loan, the GLP decided to implement these two subprojects using its own resources.

⁵ For the Fuxin CBM/CMM Development subproject, most of the works—including the vertical wells, the CMM-fired power plants, and the 5,000 cubic meter (m³) above-ground methane gas storage tank—were completed by the Fuxin CBM/CMM Development and Utilization Company (the PIA) in collaboration with the domestic partners using domestic funds, mainly due to stringent coal mine safety requirements as the government had increasingly

4. ADB approved a loan of \$70 million from its ordinary capital resources to finance the project on 25 November 2004. The loan was signed in May 2005 and became effective in November 2005. The original loan closing date was 30 September 2009. At the borrower's request, the loan was extended by 2 years, with a revised closing date of 30 September 2011.⁶ The loan amount was reduced to \$56.7 million on 30 July 2010 due to the cancellation of \$13.3 million originally allocated to the Fuxin CBM and CMM Development subproject from ADB financing. The loan actually closed on 30 December 2011 following the final disbursement and cancellation of undisbursed loan balance of \$266,702.78. The net ADB loan was \$56,431,252.22. Appendix 1 shows the project framework at appraisal, at major change in scope, and the achievements at completion. The chronology of major events is in Appendix 2.

II. EVALUATION OF DESIGN AND IMPLEMENTATION

A. Relevance of Design and Formulation

5. Heavy dependence on coal as an energy source causes substantial harm to the environment. Recognizing that fossil-fuel dominance is neither environmentally sustainable nor economically desirable, the Government of the PRC is strongly committed to improving energy efficiency, developing renewable sources to diversify the country's energy supply mix, reducing emissions, and lessening the adverse effects of global warming and climate change. It has set mandatory targets and incentive-based policies to achieve these objectives.

6. The energy sector has been a priority area for ADB since it started operations in the PRC in 1986. ADB's energy sector operations have evolved from capacity addition in traditional power generation and transmission projects to innovative projects with large demonstration effects. In its long-term strategic framework for 2008–2020,⁷ ADB identified the energy sector as a core operational sector and environmental sustainability as a key strategic priority. ADB has introduced new initiatives to augment its assistance to developing member countries for acquiring low-carbon technologies and implementing energy efficiency projects. Further, ADB's country partnership strategy 2008–2010 emphasized clean and efficient technologies to promote the utilization of renewable energy and help reduce greenhouse gas emissions in the PRC.⁸ There has been a strong and clear consistency between the strategic priorities of ADB and of the PRC in the energy sector.

7. The project was consistent with the government's strategy of developing clean energy and restructuring the energy sector. It was also in harmony with the government's plan to speed up economic development in Liaoning Province by providing a reliable supply of heat and gas to local residents, and to improve the availability and reliability of heat and gas supply. Heat and gas development and utilization have increased supply capacities, made supply more efficient and reliable, and improved environmental quality, and thereby have directly and indirectly contributed to economic growth and reducing poverty. With the incorporation of the poverty

recognized the importance and urgency of CBM/CMM production and utilization. The GLP decided to implement the remaining scope using its own resources at that time.

⁶ At that time, the remaining project activities were expected to complete by March 2011, about two years behind the appraisal schedule, mainly due to the change of the project scope and prolonged implementation of Fuxin CBM and CMM Development subproject. On 30 June 2009, ADB approved the extension of the loan closing date from 30 September 2009 to 30 September 2011 to enable completion of the remaining project activities.

⁷ ADB. 2008. *Strategy 2020: The Long-Term Strategic Framework of the Asian Development Bank, 2008–2020*. Manila.

⁸ ADB. 2008. *Country Partnership Strategy: People's Republic of China, 2008–2010*. Manila.

reduction and social strategy into the project design and implementation, the project has demonstrated direct and substantial impacts on poverty reduction and social development.

8. The project design was generally sound. It was formulated through project preparatory technical assistance (TA)⁹ and included support for project management and implementation through consultants' inputs, including national, internal, and on-the-job training. The changes in project scope accommodated the design changes in the Fuxin CBM and CMM Development subproject and the inclusion of two new central heating subprojects, with the project objectives as envisaged during appraisal remaining unchanged. The quality of the project preparatory TA was satisfactory, and the overall design of the project was highly relevant.

B. Project Outputs

9. A summary of anticipated outputs at appraisal is listed in para. 2. Apart from some changes listed in para. 3, the outputs for the project were achieved as anticipated. The project finally consisted of seven subprojects, of which six were completed partially through ADB financing and one—the Fuxin CBM and CMM Development subproject—was constructed using only local funds. Expectations at appraisal, at major change in scope, and actual implementation are reflected in the project framework in Appendix 1, and described in paras. 10–18.

1. Part A: CBM/CMM Development Component

10. The scope of the Fuxin CBM/CMM Development subproject originally included (i) 22 CMM vertical wells; (ii) 3 above ground methane storage tanks each with a capacity of 54,000 m³, 10,000 m³, one 5,000 m³, respectively; and (iii) three CBM extraction stations. As the major change in scope of the project was approved by ADB in September 2007, the scope of the Fuxin CBM AND CMM Development subproject was revised to include four CBM/CMM-fired power generation plants, and extraction, storage, transmission, and distribution facilities for greater CBM and CMM production. The change in scope of the component, triggered by failure to reach agreement on the sale price of CBM/CMM, enabled augmentation of CBM and CMM production and utilization as a clean fuel, which led to greater environmental improvement compared with the original scope (see footnote 2).

11. ADB approved the borrower's request to cancel this component from ADB-financing on 30 July 2010¹⁰, as the Fuxin CBM/CMM Development and Utilization Company (the project implementing agency [PIA]) had implemented the subproject in collaboration with domestic partners using local funds (footnote 4). The subproject has achieved efficient extraction and utilization of CBM and CMM for improving coal mine safety, providing sources of clean energy, and reducing pollution to the natural and ecological environment.¹¹ The subproject was fully completed in 2012, with the construction of 22 vertical CMM wells, above-ground methane storage tanks with a capacity of 20,000 m³ and 5,000 m³ respectively, one compressed natural gas (CNG) station, and five CBM and CMM-fired power plants with total capacity of 24.6 MW,

⁹ ADB. 2002. *Technical Assistance to the People's Republic of China for Preparing the Liaoning Environmental Improvement Project*. Manila (TA3919-PRC, approved on 18 September for \$500,000).

¹⁰ The borrower requested cancellation of Fuxin CBM and CMM Development subproject from ADB financing on 15 July 2010.

¹¹ Coal mines in the PRC have very high methane levels. Traditionally methane is extracted from coal mines or coal beds and released into the atmospheres. This creates a global problem because methane is a greenhouse gas, which is 21 times more potent than carbon dioxide (CO₂). Underground methane is also a major cause of mine accidents.

and upgrade of the existing compression system. The subproject was successfully registered with the United Nations Clean Development Mechanism Board on 9 January 2009 as a clean development mechanism (CDM) project¹² with support from ADB's CDM Facility, and implementation of the subproject contributed significantly to greenhouse gas emission reductions with about 1,270,000 certified emission reductions (CERs)¹³ for the period from 9 January 2009 to 31 July 2011, with carbon revenue of about CNY88 million.

2. Part B: Gas Distribution Component

12. Construction of the Benxi Gas Distribution Improvement subproject was completed in October 2008 with the replacement of 43 kilometers (km) of gas pipelines and construction of 5 km of new gas pipeline, including a set of gas desulphurization facilities.

3. Part C: City Central Heating Supply Component

13. **Benxi Hengze Central Heating Supply subproject.** The subproject was completed in June 2006 with installation of two 58 MW circulated fluidized-bed hot water boilers, two sets of electronic-static precipitators, 18 heat exchange stations, and 17 km of heat supply pipelines, and demolition of 63 small boilers. Trial operation started in the 2006–2007 heating season to provide heating to an area of 3.2 million m². Boilers financed by the ADB loan have been operating normally.

14. **Liaoyang Central Heating Supply subproject.** Construction of the subproject was completed in October 2007. Two heating plants were constructed, ten 58 MW chain-grate stoker hot water boilers and auxiliaries were erected (of which eight were financed by ADB loan), 42 km of heat distribution pipelines were installed, 63 heating exchange stations (HESs) were constructed (of which 55 were financed by ADB loan), and 174 small and inefficient boilers were closed. The total heating area upon completion covered 8.2 million m².

15. **Yingkou Central Heating Supply subproject.** The subproject was completed in February 2009. A combined heat and power plant was constructed with three 58 MW circulated fluidized-bed boilers (two of which were financed by local funds), two 12 MW steam turbine power generators (one of which was financed by local funds), two 40-ton peak shaving boilers, 12 HESs, and 40 km of heat distribution pipelines. The total heating supply area was increased from 1.5 million m² to 2.17 million m² and 177 small obsolete boilers were demolished.

16. **Fuxin Central Heating Supply subproject with extension.** The construction scope of the original Fuxin Central Heating Supply subproject comprised renovation and construction of 20.9 km of heat distribution pipelines (16.4 km of trunk pipelines and 4.5 km of branch pipelines), construction of 14 new valve stations and renovation of 12 existing valve stations, and an automatic heating monitoring and control system. Construction and installation of the equipment and pipelines started in April 2009, and were completed in October 2009. The central heating facilities started providing heating services to local users in November 2009. The added Fuxin Central Heating Supply subproject extension includes 12 HESs, 6.6 km of main heating pipelines and 1.8 km of secondary heating pipelines, and associated automatic control systems. The subproject extension was completed in March 2011. The heating service capacity was increased from 2 million m² to 6 million m² upon completion of the subproject.

¹² CDM Board registration number: CN-1926.

¹³ 1 certified emission reduction (CER) = 1 ton of CO₂ equivalent.

17. **Benxi Huaxing Central Heating Supply subproject.** The subproject consisted of construction of three 58 MW hot water boilers and auxiliaries, construction or renovation of 20 km of heat distribution network pipelines (diameters of 20–70 centimeters), construction or renovation of 16 heat exchange stations (seven of which were to be newly constructed), and closure of 28 small boilers. The installation and commissioning of three boilers and their auxiliary facilities financed by ADB were completed in December 2009, and 28 small boilers located in 18 small boiler houses were decommissioned. The heating facilities met all design requirements with good operational outputs.

4. Part D: Institutional Strengthening

18. The institutional strengthening included improving corporate management, enterprise reform, private sector participation, financial management, heating tariff reform, and domestic and overseas study tours and trainings. Corporate management, enterprise reform, and financial management for most of the PIAs have been significantly strengthened with the assistance of the loan implementation consultants. The institutional strengthening specialists visited each PIA, interviewed the senior management of the involved PIAs and discussed reform plans and management issues with them. The institutional strengthening specialists also developed questionnaires and distributed them to the PIAs. The feedback was used to identify the areas for improvement, and corresponding recommendations were proposed. Some enterprise reforms were achieved during the implementation period, and the PIAs for the Benxi Gas Distribution Improvement subproject and the Benxi Hengze Central Heating Supply subproject underwent the most significant reorganization. A two-part heating tariff mechanism was developed and piloted in some cities in Liaoning Province beginning in 2009. A series of domestic and overseas study tours, workshops, seminars, and trainings was organized to introduce modern concepts and best practices relating to corporate governance and management for capacity building and knowledge transfer during 2006–2011. The consultants also delivered on-the-job training to the project management office (PMO) and PIA staff.

C. Project Costs

19. The project cost at appraisal was \$161.00 million, and updated project cost at the major change in scope in 2007 was \$170.94 million. The actual project cost was \$200.35 million, an increase of 17.2% compared with the estimate at major change in scope and a 24.4% increase from the appraisal estimate. The increase was mainly due to the appreciation of the yuan¹⁴ and the changes in project scope. In local currency terms, the project cost at appraisal was CNY1,332.55 million, and at major change in scope it was CNY1,256.41 million, compared with the actual cost of CNY1,262.23 million. The actual ADB financing was \$56.43 million and the counterpart funds mobilized from stockholders and local banks was \$143.92 million. These funds were provided in a timely manner and ensured smooth project implementation.

20. There was no significant discrepancy between the financing plan at appraisal, at major change in scope, and actual financing in regard to the ADB loan, domestic loan, or equity capital. The equity capital accounted for 58.1% of the total funding compared with the 37.4% estimated at appraisal, and the 47.3% estimated at major change in scope. The detailed project cost and summary financing plan is in Appendix 3.

¹⁴ The exchange rate used at appraisal was \$1 = CNY8.28, at major change in scope it was \$1 = CNY7.35, while at project completion it was \$1 = CNY6.30. The yuan appreciated by 31.4% between the date of appraisal in September 2004 and the date of major change in August 2007, and by 16.7% between the date of appraisal and the date of project completion in December 2011.

D. Disbursements

21. Loan proceeds were withdrawn according to ADB's standard disbursement procedures. The total disbursement of the ADB loan was \$56,431,252.22. An imprest account was opened with an initial disbursement of \$6 million from ADB in 2005 and was closed in December 2011. The average annual turnover ratio¹⁵ for the imprest account over the implementation period of the project was about 1.44. Four major types of disbursement were utilized effectively during project implementation. Direct payment and commitment methods were used mainly for equipment contracts, and reimbursement and imprest account methods were used for equipment procurement and civil works contracts. Overall, disbursement was consistent with the physical implementation schedule and annual disbursement projections. The actual contract awards and disbursements are in Appendix 4.

E. Project Schedule

22. ADB approved a \$70 million loan for the project from its ordinary capital resources on 5 December 2004, and the Loan Agreement was signed on 26 May 2005 and took effect on 16 November 2005. Preconstruction and construction activities—including detailed design, preparation of bidding documents, tendering and awarding of contracts—started in January 2004. The project was originally scheduled to be completed by 31 March 2009. However, the project completion date was extended to 31 March 2011 due to the major changes of the project scope with the addition of new subprojects. By 31 March 2011, the implementation of all the ADB-financed subprojects had been completed and the loan was closed on 30 December 2011 with a final disbursed loan amount of \$56.43 million, imprest account balance refunded to ADB, and cancellation of loan savings. Appendix 5 shows the planned and actual project implementation schedule.

F. Implementation Arrangements

23. The GLP was the executing agency for the project. The Foreign Funds Utilization Project Office under the Liaoning Provincial Development and Reform Commission acted as the project management office and was responsible for management, coordination, and supervision of project implementation. There were seven PIAs under the project—the Fuxin CBM/CMM Development and Utilization Company responsible for the Fuxin CBM and CMM Development subproject, the Benxi Ganghua Gas Company responsible for the Benxi Gas Distribution Improvement subproject, the Benxi Hengze Heating Company responsible for the Benxi Hengze Central Heating Supply subproject, the Benxi Huaxing Heating Company responsible for the Benxi Huaxin Central Heating Supply subproject, the Fuxin Heating Company responsible for the Fuxin Central Heating Supply subproject, the Liaoyang Real Estate Heating Company responsible for the Liaoyang Central Heating Supply subproject, and the Yingkou Heating Company responsible for the Yingkou Central Heating Supply subproject. The project organizational chart is in Appendix 6.

24. Each PIA established a project implementation office (PIO) with direct responsibility for the design, construction, and operation of the subprojects. During implementation of the project, construction supervision companies were hired by the PIAs to supervise the work of the contractors and conduct quality, cost, and time control. The PMO was responsible for engaging

¹⁵ The annualized imprest turnover ratio is computed as the ratio of total liquidation over the time-weighted average fund balance for 12 months.

the project implementation consultant. International and domestic consultants were mobilized on 26 June 2006 for project construction supervision and institutional strengthening over the entire implementation period.

25. The implementation arrangements were satisfactory and effective, and consistent with the design envisaged at project appraisal. With changes in the project scope during the course of the project, separate PIAs were identified for newly added subprojects. The project management, financial management, and performance management capacity of the PIAs were strengthened through domestic training, overseas study tours, and consulting services.

G. Conditions and Covenants

26. The loan covenants concerning implementation arrangements, reporting, environmental protection, social and resettlement, and economic and financial aspects were all complied with. The financial covenants for the PIAs were the exception. The sharp price increases of coal and other raw materials had an adverse impact on financial performance. Local governments are in the process of adjusting the heating tariff to ensure full cost recovery by PIAs. Compliance with the financial covenants is expected during 2012–2016.¹⁶ Project reporting was adequate. In general, the required monitoring and evaluation reports, including audited project accounts and audited financial statements, were submitted on time and were of good quality. Appendix 7 presents the status of compliance with the loan covenants.

H. Consultant Recruitment and Procurement

27. An international consulting firm was selected by the GLP through the quality- and cost-based selection procedure. The contract for the consulting services was signed between the PMO and the consultant on 1 June 2006. In view of the urgency of the project, the consultant quickly mobilized in Liaoning at the end of June 2006. Originally, the consulting services were supposed to be provided until September 2009, when the project was originally proposed to be completed. However, the consulting services contract was extended to the end of September 2011 to match the extension of the project implementation. The consulting team consisted of six international and eight national specialists. About 20 person-months of international and 100 person-months of national consulting services were provided.

28. Twenty-two contract packages financed by ADB including two for civil works, 19 for equipment, and one for consulting services were procured according to ADB's Procurement Guidelines and Guidelines on the Use of Consultants that were in effect at the time of such procurement. The PMO hired the China International Technology Tendering Company as its tendering agent for international and national competitive bidding. The PIAs procured all ADB-financed components for the project in a timely manner with the assistance of the tendering company. There was no major issue in procurement. A summary of procurement undertaken is in Appendix 8.

¹⁶ The Benxi Hengze Heating Company will meet all the financial covenants starting from 2016; Benxi Huaxing Heating Company will meet all the financial covenants starting from 2012; Fuxin Heating Company will meet all the financial covenants starting from 2013; Yingkou Heating Company will meet all the financial covenants from 2012; and Benxi Ganghua Gas Company will meet all the financial covenants from 2013 (Appendix 9).

I. Performance of Consultants, Contractors, and Suppliers

29. The performance of the consultants, contractors, and suppliers was satisfactory. The international consulting firm for the project worked closely with the PMO and satisfactorily completed the tasks as specified in its terms of reference, including organizing a series of training workshops covering construction supervision, contract management, environmental monitoring, specification preparation, financial management, and project management, as well as overseas studies for staff.¹⁷ The consultant also reviewed all bidding documents and provided comments and improvements, and assisted the PMO and PIAs in preparing and submitting quarterly progress reports, annual reports, semiannual environmental monitoring reports, annual social and economic impact and poverty reduction reports, and other associated reports based on site visits and information collected from PIAs, which strengthened project implementation. Civil works constructed by national contractors were completed satisfactorily in accordance with contract specifications and quality requirements. The suppliers of equipment also performed satisfactorily. The equipment and facilities were delivered and installed on schedule and are operating satisfactorily with no major problems.

J. Performance of the Borrower and the Executing Agency

30. The borrower, and the GLP, provided full support for project implementation throughout the entire implementation period. The performance of the borrower, the executing agency, and the PIAs was satisfactory. They all met their responsibilities and obligations during project implementation. The schedule, quality, and cost of construction were generally controlled well. The PIAs had enough experienced staff and managed their subprojects efficiently. Adequate counterpart funds were provided on time. However, an extension was necessary due to the changes in project scope (para. 3).

K. Performance of the Asian Development Bank

31. ADB's performance in monitoring the project was satisfactory. Regular project review missions as well as frequent consultations and briefings with the Ministry of Finance demonstrated ADB's efforts in monitoring the progress of project implementation. ADB delegated project administration to the PRC Resident Mission in December 2005. ADB fielded 12 missions¹⁸ involving 274 person-days, and ADB staff spent adequate time reviewing physical progress and resolving issues with staff of the PMO and PIAs during implementation. ADB promptly approved the contracts it financed as well as the necessary disbursements of funds. Further, ADB approved in a timely manner the requested changes in project scope and the reallocation of loan proceeds. The GLP and the PIAs have expressed appreciation for the timely action of ADB in resolving project implementation issues.

32. Four ADB project officers were responsible for project implementation. Despite the frequent changes in staff assigned to the project, effective communication was maintained and issues addressed in a timely manner during project implementation.

¹⁷ The objective of overseas training for local managers and government officials was to provide them with first-hand experience of (i) current advanced technologies and international practices of developed countries in heating supply, improvement of the energy structure, and decreasing environmental pollution; (ii) improvement of gas distribution systems and the efficiency and reliability of gas supply; and (iii) institutional strengthening, tariff reform, price/tariff regulations, and financial management. Three international study tours, to the United States and Canada, Finland and Sweden, and Germany and Switzerland, were organized by the consultant.

¹⁸ The missions comprised fact-finding, appraisal, CDM consultation, inception, special review, midterm review, project completion review, and five reviews.

III. EVALUATION OF PERFORMANCE

A. Relevance

33. The project was highly relevant to the government's long-term strategic objectives as well as those of the ADB country partnership strategy. The project was consistent with the priorities of the government and ADB at the time of appraisal and completion, and helped to improve the environment in Liaoning Province. Many cities in the province had experienced serious air pollution problems during the winter heating season, which highlighted the need to address environmental concerns in urban areas. The completion of the project has substantially reduced air pollution and significantly improved energy efficiency in the subproject cities of Liaoning Province with annual emission reductions of 6,218 tons of SO₂, 68,891 tons of TSP, and 6,722 tons of NO_x, and annual savings of 286,627 tons of coal achieved. In addition, the Fuxin CBM and CMM Development subproject has substantially reduced greenhouse gas emissions and was successfully registered as a CDM project. It received 1,270,000 CERs for the period from 9 January 2009 to 31 July 2011, with carbon revenue of about CNY88 million (see para. 41). The project is therefore rated *highly relevant*.

34. The GLP's plan is to continue to improve the environment of the province. The provincial and local governments have lined up programs and projects to reduce pollution.¹⁹ ADB is supporting environmental improvement activities in the energy sector in the PRC. Since 1992, ADB has approved 15 loans worth \$2 billion designed to improve environmental conditions in the PRC energy sector.

B. Effectiveness in Achieving Outcome

35. Implementation of the project followed the arrangements envisaged at appraisal and achieved the targeted outputs. The project (i) improved the efficiency and reliability of gas and central heating supply in Benxi, Fuxin, Liaoyang, and Yingkou through desirable and environmentally friendly investments and practices; (ii) improved the air quality in the subproject cities with 442 small and inefficient boilers closed; (iii) produced and utilized clean fuel (CBM and CMM) for residential, commercial, and industrial purposes; and (iv) demonstrated its direct and substantial impacts on poverty reduction and social development with the incorporation of a poverty reduction and social strategy into the project design and implementation. Detailed information on these achievements/results is presented in paras. 41-55. The project has achieved its expected outcomes despite some delays due to changes in project scope which resulted in the extension of loan closing. The project also helped establish a more conducive environment for sustainable economic growth. Overall, the project is rated *effective*.

C. Efficiency in Achieving Outcome and Outputs

1. Efficiency of Investments

36. The project's financial internal rate of return (FIRR) was reevaluated on the basis of the final cost estimates and financing plan, operation and maintenance (O&M) costs, and tariffs. The recalculated FIRR is 6.1% for the whole project, which is lower than the appraisal estimate

¹⁹ The World Bank is currently implementing the Liaoning Third Medium Cities Infrastructure Project. The objective of the project is to improve energy efficiency and environmental performance of heating and gas services in selected areas of participating cities in Liaoning Province.

of 8.7%. At subproject level, the Benxi Hengze Central Heating Supply subproject, Liaoyang and Yingkou Central Heating Supply subprojects, and the Benxi Gas Distribution Improvement subproject all reported lower FIRR than the appraisal estimates. The lower FIRRs were mainly due to the significantly higher coal cost which is the major operating cost of heating plants. The Benxi Huaxing Central Heating Supply and Fuxin Central Heating Supply subprojects were added to the project scope in 2007, and their FIRRs were higher than the estimates at major change approval stage because of (i) the lower capital cost in the case of the Benxi Huaxing subproject, and (ii) the low operation cost achieved by utilizing hot effluent water from the neighboring power plant in the case of the Fuxin heating subproject. The after-tax weighted average cost of capital (WACC) was calculated based on the actual financing mix and the relative costs. The WACC was recalculated as 3.40%. The project's FIRR is higher than the WACC and the project is considered financially viable. Appendix 9 provides a detailed financial evaluation. The project is rated financially *efficient*.

37. The economic internal rate of return (EIRR) for the project was recalculated at project completion. The EIRRs ranged from 19.0% to 36.2% without the local environmental benefits for the six ADB-financed subprojects and 22.6% to 41.7% with the local environmental benefits. For the whole project, the cumulative EIRR without environmental benefits was 23.1% compared with 13.6% at appraisal; the EIRR with the local environmental benefits was 29.0% compared with 26.3% at appraisal. The EIRR results demonstrated the significance of environmental benefits of the project, which is consistent with its objectives. The scope changes have not affected the economic viability of the project as a whole. The project is rated economically *efficient*. A detailed economic evaluation is presented in Appendix 10.

2. Efficiency of Process

38. ADB's internal processing and support during project implementation was efficient and satisfactory. The organization and management of the executing agencies and the PIAs were generally effective and timely. All the subprojects were implemented without major cost overruns. Project facilities were constructed, installed, and commissioned without major problems. The scope changes made during implementation allowed for a wider coverage and more beneficiaries to be served by the project. Counterpart funds were adequate and were provided in a timely manner. Based on these results, the project is rated *efficient*.

D. Preliminary Assessment of Sustainability

39. The project has significantly increased heat and gas supply capacity in subproject cities of Liaoning Province and guaranteed a stable heat and gas supply to local residents. Despite the concern about the adequacy of heating and gas tariffs, projected net revenue flows for each subproject are positive, and the recalculated FIRR and EIRR of the project meet the criteria set by ADB. The revenues for all the subprojects can cover their operating costs during the operational period. Based on the current assumptions and forecast, the financial situation will get better in the long term. In addition, the project facilities were constructed according to the required standards and specifications and are considered to be of sufficient quality to ensure that project benefits are continuously achieved in the long term. The project is therefore rated *likely to be sustainable*.

E. Impact

1. Environmental Impact

40. The project was classified as environment category B. As envisaged at appraisal, the project produced positive environmental impacts and benefits. The project has improved and expanded clean energy supplies; improved energy efficiency; improved ambient and indoor air quality; and reduced the explosion risks associated with methane gas production, transmission, and distribution. Global environmental benefits were realized via expanded CMM production, capture and utilization of vented methane, and improved energy efficiency, which will result in reduced methane and CO₂ emissions.

41. The Fuxin CBM and CMM Development subproject is a significant success as a CDM project, reducing greenhouse gas emissions from the use of CBM and CMM. It was registered with the United Nations Clean Development Mechanism Board as a CDM project on 9 January 2009, and subproject implementation has resulted in 212,531 CERs during the verification period from 9 January 2009 to 30 June 2009, and 697,463 CERs during the verification period from 1 July 2009 to 30 November 2010, with actual revenue of about CNY68 million. About 360,000 CERs generated from 1 December 2010 to 31 July 2011 is under verification, with expected revenue of about CNY20 million.

42. A total of 442 small and inefficient coal-fired boilers were closed as a result of the completion of the central heating subprojects. The indoor air quality during the winter heating season and ambient air quality in general in the subproject cities have significantly improved. The project has achieved annual emission reductions of 68,891 tons of total suspended particulates (TSP), 6,218 tons of sulfur dioxide (SO₂), 6,722 tons of nitrogen oxide (NO_x), and 1,304,689 tons of CO₂ equivalent.

43. During construction the contractors effectively implemented the environmental management plan (EMP) mitigation and monitoring measures. The adverse effects of the project construction on the surrounding environment were minimized. The necessary environmental management approaches were integrated into operations. Eight semiannual environmental monitoring reports (EMRs) prepared by the Liaoning PMO have been submitted to ADB and uploaded to the ADB website in line with ADB's public communication policies. Appendix 11 provides a summary assessment of the impact of the project on the environment.

2. Resettlement

44. The resettlement plan was approved by ADB in September 2004 during project preparation. According to the plan, land acquisition and resettlement impacts were considered minor. Only the Fuxin CBM and CMM Development subproject were expected to acquire village collective land; 6 *mu*²⁰ of farmland to be permanently acquired, and 111 *mu* of farmland to be temporarily used during construction of the gas transmission pipeline. According to the detailed design, 43.75 *mu* of farmland was permanently acquired under the project, with an increase of 37.75 *mu* from the resettlement plan. The main reason for the increase was that 26.16 *mu* of permanent land acquired for the Liujianan Gas Storage and Distribution Station was not included in the original plan. Subsequently, the resettlement plan was updated and submitted to ADB for approval in early 2007. During implementation, the PIA decided to use its own land for the well sites, so only the gas storage station had an impact on farmers. Only three households

²⁰ The *mu* is a Chinese unit of measurement (1 *mu* = 666.67 square meters).

with 11 persons were affected by permanent land acquisition. No houses were demolished by the project. The PIA and local government took measures to ensure income restoration and livelihood improvement for the affected persons.

45. Land acquisition and resettlement were implemented based on the updated resettlement plan, the 2004 Land Administration Law, and specific land acquisition and resettlement policy for the project issued by the GLP. The compensation rates in the original resettlement plan were estimated by the local Land Management Bureau. During the preparation of the updated resettlement plan, the Fuxin CBM/CMM Development and Utilization Company negotiated with the two villages on compensation rates, and reached an initial agreement. For permanent land acquisition the compensation rate was CNY55,000/mu, and for temporary land use the compensation rate was CNY10,500/mu. During implementation, the Fuxin CBM/CMM Development and Utilization Company signed a formal compensation agreement with Shangwang village on 11 January 2008, where the compensation rate was CNY60,000/mu, which was higher than the estimate in the updated resettlement plan.

46. Affected people were consulted during project preparation and implementation, and the increase in compensation rates resulted from initial planning, updated planning, and further consultation during implementation. During the preparation stage, from 2003 to 2006, numerous surveys and discussions with village leaders and representatives of affected households were conducted. As indicated in the updated resettlement plan, the initial resettlement booklet was distributed to affected people in November 2003, and updated resettlement booklets were distributed in January 2007. During implementation, detailed consultations with the three affected households were conducted to address the affected people's concerns over resettlement policies, compensation rates, distribution of land compensation funds, and other entitlements such as subsidies, social insurance, and fertilizer, as well as farmland adjustment. Consequently, an agreement on land acquisition was signed between the Fuxin CBM/CMM Development and Utilization Company and the Shangwang Village Committee in January 2008.

47. In general, land acquisition and resettlement were well implemented. The Liaoning Academy of Social Science was engaged in external monitoring and evaluation of the implementation of land acquisition and resettlement. Land acquisition and resettlement was implemented transparently, and the affected households were satisfied. Direct communications between the PIA and the affected village and households were sound and efficient. Compensation funds were delivered in a timely manner. Details of land acquisition and resettlement are in Appendix 12.

3. Social Impact

48. Social and poverty analysis was an integral part of the project design, and a summary poverty reduction and social strategy (SPRSS) was developed to identify the key issues and formulate measures as part of project design. In 2007, the SPRSS was updated because of a change in project scope. The poverty reduction measures and social actions include (i) providing efficient and environmentally compatible gas and central heating supplies to the poor, (ii) creating jobs for the poor during project construction and operation, (iii) reducing environmental impacts on the poor, (iv) improving occupational safety of miners, (v) enhancing quality of life for the poor, (vi) implementing gas and heating assistance programs for the poor, and (vii) reemploying workers affected by the closure of 442 small boilers. In addition, the project city governments and PIAs would establish necessary mechanisms to ensure successful implementation of gas and heating assistance programs for the poor, which covers gas and heating connections and tariff discounts.

49. According to the updated SPRSS in 2007, the project would directly benefit a total urban population of about 2.48 million in the seven project beneficiary areas of Benxi, Fuxin, Liaoyang, and Yingkou, in which about 183,934 persons (7.4%) are poor. According to the poverty and social economic impact monitoring and evaluation report prepared by the PMO and the consultant in 2011 upon project completion, the number of actual project beneficiaries was 2.64 million people, a 6.5% increase on the 2.48 million originally estimated. Of the total beneficiaries, about 1.84 million urban residents benefit from gas supply and 0.80 million benefit from central heating supply. About 239,000 people, or about 9.1% of the total beneficiaries, were poor. The ethnic minorities in the project area, including Mongol and Hui peoples, also benefited from the project through measures including the gas and/or heating assistance program and employment opportunities.

50. The project created 4,928 person-years of employment opportunities with an annual income value of about CNY39 million during the construction period, and approximately 786 full-time jobs with a combined annual value of CNY14 million during the operation period. Among these, nearly 30% of the temporary employment opportunities during construction and 200 full-time employment opportunities during operation were for the poor, women, and ethnic minorities.

51. A comprehensive reemployment plan for affected employees was prepared during project preparation. A total of 442 small and inefficient boilers were closed upon completion of the central heating subprojects, and as a result the air quality in the subproject cities has significantly improved. In the three project cities of Benxi, Fuxin and Yingkou, the total days with air quality better than grade II (the PRC National Standard) increased from 916 days in 2006 to 1002 days in 2010. Particularly, the project also achieved coal savings of 286,627 tons per year. By improving gas and central heating supplies to local residents, especially the poor, the project has significantly improved the overall quality of life for people in the project areas through cleaner and more convenient working and living conditions, less housework related to heating for women, and reduced health costs.

52. The construction of the Fuxin CBM and CMM Development subproject and implementation of the coal mining safety enhancement program directly improved the safety of 16,000 miners in the subproject area. There has been a reduction from 13 accidents, 266 deaths, and 5 serious injuries in 2005 to 3 accidents, 3 deaths, and 1 serious injury in 2011. As a result, the target of a greater than 20% improvement in coal mine safety has been achieved. Improved safety has helped to prevent miners' households from becoming poor and vulnerable.

53. The affordability of heating and gas has been a major concern of the beneficiaries, particularly the poor. During project preparation, the project cities and PIAs agreed to two specific programs to help the poor to pay for gas supply and winter heating. From 2006 to 2010, all seven PIAs cumulatively assisted 208,539 poor households in heating and gas supply service with total waived tariff and connection fees of CNY363 million. Various local governments have also taken measures to subsidize the heating needs of poor households.

54. The closure of 442 small boilers affected 1,740 workers, all of whom have been reemployed by the subprojects or other enterprises or units. Before the affected workers were assigned new positions under the project, they received technical and on-the-job training organized by various PIAs. Training included operation of large heating boilers, panel control, maintenance and repair, stoking, electrical work, and welding. A total of 2,311 person-months of training were conducted during the project construction and operation periods. For some workers who were not willing to be reemployed by PIAs, the local Human Resource and Social

Security Bureau, together with government agencies, provided skill trainings for them, such as electric welding and electrical appliance repair.

55. The project supported gender development. The improvement of gas and heating supply has significantly improved the quality of life of urban residents, especially women. They have access to a cleaner, convenient, and reliable heating or gas supply, which brings better indoor air quality and reduces their workload. As a result, women's health conditions and quality of life have improved. In addition, about 847 (17%) out of 4,928 person-year employment opportunities were provided to women with a combined income of about CNY6.8 million per year during the project construction and 157 (20%) out of 786 full-time employment opportunities with an annual income value of CNY2.8 million have gone to women since project operation.

56. Overall, the project demonstrated direct and substantial positive impacts on poverty reduction and social development in the project beneficiary areas. A summary of poverty reduction and social impacts in the project area is in Appendix 13.

IV. OVERALL ASSESSMENT AND RECOMMENDATIONS

A. Overall Assessment

57. The project is highly relevant to the government's development strategy and ADB's energy sector policy for the PRC. The project was successfully implemented and its objectives were achieved. The social safeguards issues were managed satisfactorily. The environmental impact of the project is substantially positive, and all necessary mitigation measures were undertaken. Overall, social impacts were very positive and will continue to benefit the local people.

58. Through the joint efforts of project owners, the construction companies, the supervision agents, the PMO, and financial institutions including ADB, the project was successfully completed. Project implementation was in line with the PRC's rules and regulations as well as ADB's requirements and loan covenants. Project facilities have been operating well, and heat and gas supply capacities in the subproject cities have increased and reliability of the services has improved. The project implementation has greatly strengthened the institutional capacity of PIAs and the managerial and operational competence of their managers and staff. The financial and economic viability of the project has been confirmed. The expected direct benefits of the project have been realized and are likely to be sustainable in the long run.

59. The strong and positive environmental and social impact of the project has been recognized by the government, which in turn has increased its own expenditure and sought ADB and World Bank financing for additional heating projects in Liaoning and other provinces. Overall, the project is rated *successful* (Appendix 14). It is *highly relevant*, *effective*, and *efficient*, and is *likely to be sustainable*. The anticipated outputs were fully achieved, and the budget was well controlled.

B. Lessons

60. Major changes in scope were undertaken during implementation. The CBM/CMM subproject was revised, two subprojects cancelled, and another two subprojects added, although these did not affect the project outcome. While minor changes in scope and implementation arrangements are inevitable during project implementation, major changes in

project scope involve additional inputs and resources from both the government and ADB in undertaking due diligence. Prudent prescreening of subprojects is thus essential during loan processing, especially where the subproject (like the CBM/CMM Development Component) depends on contractual agreement with a third party.

61. **Project management.** Deviations between the final project costs and the appraisal estimates were small. The results were achieved through coordinated efforts made by all parties involved in project implementation. Properly administered bidding processes were vital in obtaining advantageous bid offers. Proactive project management, both in equipment procurement and construction, enabled capital cost savings and ensured the quality of construction and equipment supply. The effectively adopted external supervision mechanism also played an important role in improving the quality of the project. The selection and hiring of competent international and national consultants ensured that the quality standards required for projects were met.

C. Recommendations

1. Project Related

62. The loan covenants were complied with in all areas except for the financial ratios of the PIAs. The key reasons for partial compliance include the price increase in coal and other raw materials in recent years, and the heating tariff not being increased adequately, which had a significant impact on subproject financial performance. A tariff that allows full cost recovery should be established to improve the sustainability of the subprojects. Meanwhile, some of the companies have excessive staffing levels when compared with similar companies in a similar city. It is recommended that the organizational structure of these companies be streamlined and managerial staff reduced. Clear and well-structured work flows and procedures need to be established to improve operational efficiency.

63. All the project facilities are fully operational. ADB could undertake a project performance evaluation review in 2013, after 1 year of operation.

2. General

64. A clean environment is essential for sustainable economic growth in the PRC. The PRC's recent economic growth will be hampered if urban pollution is not abated. The transformation of the environment sector in the PRC entails short- and long-term adjustments. With the continuing toll of industrialization, population growth, and growth in the number of vehicles, adequate environmental protection measures need to be in place. The project has been the centerpiece of the environmental plan of Liaoning Province, and its success can be replicated in similar undertakings elsewhere.

65. Heating services are provided in provinces such as Liaoning from November each year. Thus, construction activities must be completed in October. The short construction season presented challenges during project implementation. It is therefore crucial that, during project preparation, subprojects are carefully screened and a realistic project implementation schedule is developed. It is recommended that ADB loan processing missions help to set a realistic project implementation schedule for future district heating projects, and adequate training should be provided to potential PIAs to facilitate project preparation and implementation.

PROJECT FRAMEWORK

Design Summary	Performance Indicators and Targets			Monitoring Mechanisms	Assumptions and Risks
	Original	Updated	Actual		
A. Impact					
Environmental Improvement in Liaoning Province	Annual emission reduction of 840,900 tons of CO ₂ equivalent, 2,600 tons of SO ₂ , 18,800 tons of TSP, and 1,700 tons of NO _x , and annual savings of 217,500 tons of coal	Annual emission reduction of 1,197,614 tons of CO ₂ equivalent, 3,396 tons of SO ₂ , 24,545 tons of TSP, and 2,218 tons of NO _x , and annual savings of 285,281 tons of coal	The project has achieved annual emission reductions of 1,304,689 tons of CO ₂ equivalent, 6,218 tons of SO ₂ , 68,891 tons of TSP, and 6,722 tons of NO _x , and annual savings of 286,627 tons of coal	Implementation and impact monitoring by GLP and ADB	
B. Outcomes					
1. Improvement in efficiency and reliability of gas and central heating supply to the poor and closure of small coal-fired boilers	1.1. Reduce line loss from 10% to 4% for Fushun project, and from 17% to 13% in Benxi 1.2. Average 20% efficiency improvement in heating supply in project areas 1.3. Closure of 412 small, inefficient, coal-fired boilers 1.4. Gas and heating services to 2.7 million urban population, including 199,800 urban poor	1.1. Reduce line loss from 17% to 13% in Benxi, while Fushun project was cancelled 1.2. Average 20% efficiency improvement in heating supply in project areas 1.3. Closure of 440 small, inefficient, coal-fired boilers 1.4. Gas and heating services to 2.48 million urban population, including 183,934 urban poor	1.1. Line loss was reduced from 17% to 10% in Benxi, while Fushun project was cancelled 1.2. Average 33% efficiency improvement in heating supply in project areas 1.3. 442 small, inefficient, coal-fired boilers were closed 1.4. Gas services to 2.63 million urban population, including 239,000 urban poor	PPMS and PCR Liaoning province and project cities statistical yearbooks Reports and information provided by PMO and PIAs Implementation and impact monitoring by GLP and ADB Ex-post monitoring by GLP	Assumptions GLP continues enforcing environmental standards Continued importance of coal industry for the supply of primary energy Risk Delay in loan effectiveness and procurement
2. Utilization of clean fuel	2.1. Production of 46 million m ³ /year of CBM and CMM and utilization of methane for residential, commercial, and industrial purposes	2.1. Production of 63 million m ³ /year of CBM and CMM and utilization of methane for residential, commercial, and industrial purposes	2.1. Production of 166 million m ³ /year of CBM and CMM and utilization of methane for residential, commercial, and industrial purposes		Assumption Complementary social services to the poor are in place.

Design Summary	Performance Indicators and Targets			Monitoring Mechanisms	Assumptions and Risks
	Original	Updated	Actual		
C. Outputs	By End of Project				
1. Increased CBM and CMM production and utilization	<p>1.1. In Fuxin, construction of 22 vertical CMM wells; one 54,000 m³, one 10,000 m³, and one 5,000 m³ above-ground methane gas storage tanks; and three CBM extraction stations</p> <p>1.2. 20% improvement in mine safety index in Fuxin coal mining areas after project is commissioned in 2009</p>	<p>1.1. In Fuxin, construction of 22 vertical CMM wells; one 20,000 m³ and one 5,000 m³ above-ground methane gas storage tanks; one CNG station; four CBM and CMM-fired power plants with total capacity of 22 MW, and upgrading existing compression system</p> <p>1.2. 20% improvement in mine safety index in Fuxin coal mining areas after project is commissioned in 2009</p>	<p>1.1. In Fuxin, construction of 22 vertical CMM wells; one 20,000 m³ and one 5,000 m³ above-ground methane gas storage tanks; one CNG station; five CBM and CMM-fired power plants with total capacity of 24.6 MW; and upgrading existing compression system</p> <p>1.2. 50% improvement in mine safety index in Fuxin coal mining areas since project was completed</p>	<p>Quarterly progress reports, PAMs, PPMS, and PCR</p> <p>Annual financial, operation, and performance reports of project companies</p> <p>Social and poverty monitoring report by implementation consultants</p> <p>Implementation and impact monitoring by GLP and ADB</p> <p>Compliance with ADB covenants</p>	<p>Risks Delay in loan effectiveness and procurement</p> <p>Inadequate project management</p> <p>Assumptions Cost savings from efficiency improvements are passed on to consumers</p> <p>Complementary social services to the poor are in place</p>
2. Rehabilitated and expanded gas distribution systems	<p>2.1. In Fushun, replacement of 15.5 km of aging gas pipelines, and improvement of 45 pressure regulation stations</p> <p>2.2. In Benxi, replacement of 43 km of aging gas pipelines, and installation of 5 km of new gas pipeline</p>	<p>Subproject cancelled</p> <p>2.1. In Benxi, construction of one sulfur remove station, replacement of 43 km of aging gas pipelines, and installation of 5 km of new gas pipeline</p>	<p>2.1 In Benxi, construction of one sulfur remove station, replacement of 43 km of aging gas pipelines, and installation of 5 km of new gas pipeline</p>	<p>Ex-post monitoring by GLP</p>	<p>Assumptions MOC, NDRC, and city price bureaus continue to implement urban gas and heating sector reforms</p>

Design Summary	Performance Indicators and Targets			Monitoring Mechanisms	Assumptions and Risks
	Original	Updated	Actual		
3. Augmented central heating systems to facilitate closure of small, inefficient coal-fired boilers	3.1. In Anshan, recovery of the waste heat from the Anshan Steel No. 1 new blast furnace and the No. 2 thermal power plant, and construction of household heat supply control system	Subproject cancelled			
	3.2. In Benxi, construction of two 209 GJ/hour circulating fluidized bed hot water boilers and auxiliaries, 7 km of heat supply pipeline, and 18 heat exchange stations, to close 63 small boilers	3.1. In Benxi, (i) Benxi Hengze Central Heating Supply: construction of two 209 GJ/hour circulating fluidized bed hot water boilers and auxiliaries, 17 km of heat supply pipeline, and 18 new heat exchange stations, and upgrade of two existing heating exchange stations, to close 63 small boilers; and (ii) Benxi Huaxing Central Heating Supply: construction of one 174 MW heating plant, three 58 MW boilers, 20.83 km of heat supply and distribution network, and seven new heating exchange stations, and renovate nine existing heating exchange stations, to close 28 small boilers	3.1. In Benxi, (i) Benxi Hengze Heating Supply: two 58 MW circulating fluidized bed hot water boilers and auxiliaries, 17 km of heat supply pipelines and 18 new heat exchange stations were completed, 63 small boilers were closed; and (ii) Benxi Huaxing Central Heating Supply: three 58 MW boilers and auxiliaries and 20.83 km of heat supply pipelines were completed, seven new heat exchange stations were built, and nine existing heat exchange stations were renovated; 28 small boilers were closed		
	3.3. In Liaoyang, construction of eight 208 GJ/hour hot water boilers and auxiliary facilities, 42 km of heat distribution network, and	3.2. In Liaoyang, construction of eight 208 GJ/hour hot water boilers and auxiliary facilities, 42 km of heat distribution network, and	3.2. In Liaoyang, construction of 10 208 GJ/hour hot water boilers (eight financed by ADB and two financed by local		

Design Summary	Performance Indicators and Targets			Monitoring Mechanisms	Assumptions and Risks
	Original	Updated	Actual		
	55 heat exchange stations, to facilitate the closure of 174 small boilers	55 heat exchange stations, to facilitate the closure of 174 small boilers	funds) and auxiliary facilities, 42 km of heat distribution network, and 55 heat exchange stations, to facilitate the closure of 174 small boilers		
	3.4. In Yingkou, construction of one (2 x 12 MW) combined heat and power generation plant and auxiliaries, three 104 GJ/hour hot water boilers, 40 km of heat supply and distribution network, and 12 heat exchange stations, and closure of 175 small boilers	3.3 In Yingkou, construction of one (2 x 12 MW) combined heat and power generation plant and auxiliaries, two 104 GJ/hour hot water boilers, 41.6 km of heat supply and distribution network, and 12 new heating exchange stations, and closure of 175 small boilers	3.3. In Yingkou, three 58 MW circulated fluidized-bed boilers (two financed by local funds and one by ADB funds), two 12 MW steam turbine power generators (one financed by local funds and one by ADB loan), two 29 MW peak shaving boilers, 12 HESSs, and 42 km of heat distribution pipelines were completed		
		3.4 In Fuxin, construction and renovation of 20.92 km of heat distribution pipelines, 14 new heating exchange stations, 12 existing exchange stations, and one autonomic heating monitoring and control system	3.4. In Fuxin, 23.0 km (phase I 16.4 and phase II 6.6) of primary pipelines and 22.7 km (phase I 20.9 and phase II 1.8) of distribution pipelines, 14 new valve chambers and 12 upgraded valve chambers were completed, construction area increased from 2 million m ² to 6 million m ²		
	3.5. Reemployment of 1,874 affected workers	3.5 Reemployment of 1,959 affected workers	3.5. 1,740 affected employees were reemployed		

Design Summary	Performance Indicators and Targets			Monitoring Mechanisms	Assumptions and Risks
	Original	Updated	Actual		
4. Developed institutional and financial tariff reform action plan, and privatization plan	4.1. Implementation plan developed by 2005 and implemented by 2006, and 95% billing collection of PIAs achieved by 2008 4.2. PIAs are profitable and return on net fixed assets increasing gradually to at least 6.0% and 1.4 times debt service ratio 4.3. A privatization plan for PIAs under parts B and C by June 2007	4.1. Implementation plan developed by 2006 and implemented by 2007, and 95% billing collection of PIAs achieved by 2008 4.2. PIAs are profitable and return on net fixed assets increasing gradually to at least 6.0% and 1.4 times debt service ratio 4.3. A privatization plan for PIAs under parts B and C by June 2007	4.1. The average billing collection rate has increased to over 95% 4.2. Price increases of coal and other raw materials have had a significant impact on the financial performance of PIAs; local governments should adjust the tariff to ensure cost recovery of these PIAs 4.3. A privatization plan for PIAs was submitted to ADB in 2007		
5. Implemented assistance programs for poor households	5.1. PIAs to provide discounts on connection fees and bills to pass on the 20% efficiency improvement of the project to the poor 5.2. Establishment of heating assistance fund to provide discounts to 90,870 poor households	5.1. PIAs to provide discounts on connection fees and bills to pass on the 20% efficiency improvement of the project to the poor 5.2. Gas and heat assistance program to provide discounts to 39,481 poor households	5.1. PIAs to provide discounts on connection fees and bills to pass on the 20% efficiency improvement of the project to the poor 5.2. Gas and heat assistance program to provide discounts to 41,701 poor households		
D. Activities					
1. CBM and CMM production, and utilization in Fuxin 1.1. Procurement of equipment and goods	1.1. Start: Oct 2004 Complete: Dec 2005 Responsible: PIA and PMO	1.1. Start: Aug 2007 Complete: Aug 2008 Responsible: PIA and PMO	1.1. Start: Nov 2008 Complete: Sep 2011 Responsible: PIA and PMO	Quarterly progress reports, PAMs, PPMS, and PCR	Assumptions Sufficient gas and heating demand Implementation of

Design Summary	Performance Indicators and Targets			Monitoring Mechanisms	Assumptions and Risks
	Original	Updated	Actual		
1.2. Installation and construction of project facilities	1.2. Start: Sep 2005 Complete: June 2008 Responsible: PIA	1.2. Start: Oct 2007 Complete: Feb 2009 Responsible: PIA	1.2. Start: Apr 2010 Complete: Jun 2012 Responsible: PIA and PMO	Consultants' reports Implementation and impact monitoring by GLP and ADB Ex-post monitoring by GLP	consulting services, training of appropriate staff, and agreement and adoption of recommendations made On-time consultant recruitment and availability of local funds Adequately staffed PMO and PIOs
1.3. Training	1.3. Start: Jun 2006 Complete: Jun 2008 Responsible: PIA and PMO	1.3. Start: Jun 2006 Complete: Jun 2008 Responsible: PIA and PMO	1.3. Start: Jun 2006 Complete: Jun 2011 Responsible: PIA and PMO		
2. Rehabilitation of gas distribution systems in Benxi					
2.1 Procurement of equipment and goods	2.1. Start: Oct 2004 Complete: Jun 2006 Responsible: PIA and PMO	2.1. Start: May 2006 Complete: Sep 2006 Responsible: PIA and PMO	2.1. Start: June 2006 Complete: Sep 2006 Responsible: PIA and PMO		
2.2 Installation and construction of project facilities	2.2. Start: Mar 2005 Complete: Jun 2007 Responsible: PIA	2.2. Start: Apr 2007 Complete: Dec 2008 Responsible: PIA	2.2. Start: Apr 2007 Complete: Oct 2008 Responsible: PIA		
2.3 Training	2.3. Start: Jun 2006 Complete: Jun 2008 Responsible: PIA and PMO	2.3. Start: Jun 2006 Complete: Jun 2008 Responsible: PIA and PMO	2.3. Start: Jun 2006 Complete: Jun 2011 Responsible: PIA and PMO		
3. Augmentation of central heating systems in Benxi, Fuxin, Liaoyang, and Yingkou					
3.1 Procurement of equipment and goods	3.1. Start: Oct 2004 Complete: Jun 2006 Responsible: PIAs and PMO	3.1. Start: Apr 2005 Complete: Dec 2007 Responsible: PIAs and PMO	3.1. Start: Apr 2005 Complete: Nov 2010 Responsible: PIAs and PMO		
3.2 Installation and construction of	3.2. Start: Mar 2005 Complete: Mar 2009 Responsible: PIAs	3.2. Start: May 2005 Complete: Oct 2008 Responsible: PIAs	3.2. Start: May 2005 Complete: Mar 2011 Responsible: PIAs		

Design Summary	Performance Indicators and Targets			Monitoring Mechanisms	Assumptions and Risks
	Original	Updated	Actual		
project facilities 3.3 Training	3.3. Start: Jun 2006 Complete: Jun 2008 Responsible: PIAs and PMO	3.3. Start: Jun 2006 Complete: Jun 2008 Responsible: PIAs and PMO	3.3. Start: Jun 2006 Complete: Jun 2011 Responsible: PIAs and PMO		
4. Closure of small coal-fired boilers					
4.1 Closure of small coal-fired boilers	4.1. Start: Feb 2005 Complete: Jun 2006 Responsible: PIAs	4.1. Start: Feb 2005 Complete: Dec 2008 Responsible: PIAs	4.1. Start: Feb 2005 Complete: Dec 2010 Responsible: PIAs		
4.2 Reemployment of affected workers	4.2. Start: May 2005 Complete: Jun 2008 Responsible: PIAs	4.2. Start: May 2005 Complete: Jun 2008 Responsible: PIAs	4.2. Start: May 2005 Complete: Jun 2009 Responsible: PIAs		
5. Institutional strengthening and capacity building					
5.1 Consulting services	5.1. Start: Apr 2005 Complete: Apr 2006 Responsible: PMO	5.1. Start: Sep 2005 Complete: Jun 2009 Responsible: PMO	5.1. Start: Jun 2006 Complete: Jun 2011 Responsible: PMO		
5.2 Workshops	5.2. Start: Sep 2005 Complete: Feb 2006 Responsible: PMO	5.2. Start: Aug 2006 Complete: Dec 2008 Responsible: PMO	5.2. Start: Aug 2006 Complete: Dec 2010 Responsible: PMO		
5.3 Dissemination of information	5.3. Start: Mar 2006 Complete: Apr 2006 Responsible: PMO	5.3. Start: Jan 2007 Complete: Dec 2008 Responsible: PMO	5.3. Start: Jan 2007 Complete: Dec 2008 Responsible: PMO		
6. Support pro-poor measures	6. Start: 2005 Complete: 2009 Responsible: GLP	6. Start: 2005 Complete: 2009 Responsible: GLP	6. Start: 2005 Complete: 2009 Responsible: GLP		
E. Inputs					
Civil Works	Project cost \$161.00 million	Project cost \$170.94 million	Project cost \$200.35 million	Quarterly progress reports, PAMs, MTR, PCR, and consultant reports	Assumptions Sufficient counterpart funds
Equipment	Funding sources: ADB loan \$70.00 million	Funding sources: ADB loan \$70.00 million	Funding sources: ADB loan \$56.43 million		
Land acquisition and	Domestic equity: \$60.30	Domestic equity: \$80.94	Domestic equity: \$116.49		

Design Summary	Performance Indicators and Targets			Monitoring Mechanisms	Assumptions and Risks
	Original	Updated	Actual		
resettlement Consulting services and training	million Domestic borrowing: \$30.70 million	million Domestic borrowing: \$20.00 million	million Domestic borrowing: \$27.44 million	Procurement documents Project accounts	Affected persons are compensated and resettled in a timely manner

ADB = Asian Development Bank, CBM = coal-bed methane, CNG= compressed natural gas, CMM = coal mine methane, CO₂ = carbon dioxide, GJ = gigajoule (1,000,000,000 joules), GLP = government of Liaoning Province, HES = heat exchange station, PIA = project implementing agency, km = kilometer, m³ = cubic meter, MW = megawatt (1,000,000 watts), MOC = Ministry of Construction, MTR = midterm review, MW = megawatt, NDRC = National Development and Reform Commission, NO_x = nitrogen oxide, PAM = project administration mission, PCR = project completion report, PIA = project implementation agency, PIO = project implementation office, PMO = project management office, PPMS = project performance management system, PRC = People's Republic of China, SO₂ = sulfur dioxide, t = ton, TSP = total suspended particulates.

CHRONOLOGY OF MAJOR EVENTS

Date	Project Events
3–20 November 2003	ADB loan fact-finding mission
12–27 April 2004	ADB loan appraisal mission
25 November 2004	ADB loan approval
1 December 2004	Project implementation units established in all PIAs
25–28 April 2005	ADB CDM consultation mission
26 May 2005	Loan signing
2 May 2005	ADB approved award of three ICB packages for (i) boiler body, electric dust removal system, installation; (ii) blower, air dust removal system, electric equipment of heating source, auto equipment of heat network; and (iii) plate-type heating exchange set, nodal tube heating exchange, incubation tube, electric equipment, and auto equipment of heat network for Benxi Hengze Central Heating subproject
21–28 July 2005	ADB loan inception mission
14 September 2005	Three contracts for (i) boiler body, electric dust removal system, installation; (ii) blower, air dust removal system, electric equipment of heating source, auto equipment of heat network; and (iii) plate-type heating exchange set, nodal tube heating exchange, incubation tube, electric equipment, and auto equipment of heat network for Benxi Hengze Central Heating subproject signed
14 December 2005	Three contracts for (i) boiler body, electric dust removal system, installation; (ii) blower, air dust removal system, electric equipment of heating source, auto equipment of heat network; and (iii) plate-type heating exchange set, nodal tube heating exchange, incubation tube, electric equipment, and auto equipment of heat network for Benxi Hengze Central Heating subproject completed
16 November 2005	Loan became effective
15 December 2005	Loan administration delegated to PRC Resident Mission
19–23 December 2005	ADB loan review mission
25 January 2006	ADB approved award of one ICB package for supplementary system of thermoelectricity plant for Yingkou Central Heating subproject
14 February 2006	Contract for supplementary system of thermoelectricity plant for Yingkou Central Heating subproject signed
16 February 2006	ADB approved award of two ICB packages for 58 MW boiler unit and heat net prefabricated thermal insulation pipe for Liaoyang Central Heating subproject
28 February 2006	Two contracts for 58 MW boiler unit and heat net prefabricated thermal insulation pipe for Liaoyang Central Heating subproject signed
3 April 2006	ADB approved award of two NCB packages for Liaoyang civil works of Beicaoku and Doushuangshu heat source factories

Date	Project Events
14 April 2006	Contract for supplementary system of thermoelectricity plant for Yingkou Central Heating subproject completed
15 April 2006	Contract for Doushuangshu heat source factory for Liaoyang signed
2 May 2006	Contract for Beicaoku heat source factory for Liaoyang signed
1 June 2006	ADB approved award of two QCBS packages for institutional strengthening and consulting services and the two contracts were signed
10 June 2006	Completion of Benxi Hengze Central Heating subproject
26 June 2006	Consultants commenced services
3 August 2006	PMO submitted a request on scope change to ADB
14 August 2006	ADB approved award of four ICB packages for (i) pipes and fittings, (ii) valves, (iii) equipment (dry type 25 desulphurization facility/agent, gas detectors, user gas meters, etc.) and (iv) material (cement, hot rolled round bar, steel plate, etc.) for Benxi gas distribution improvement subproject.
15 September 2006	ADB approved award of two ICB package for 58 MW CFB boilers, steam turbine power generator and desulphurization tower equipment, heat exchange station equipment, materials for network, steam pipe system, and electrical system equipment for Yingkou Central Heating subproject.
18 September 2006	Four contracts for pipes and fittings, valves, equipment (dry type desulphurization facility/agent, gas detectors, user gas meters, etc.) and material (cement, hot rolled round bar, steel plate, etc.) for Benxi gas distribution improvement subproject signed
25 September 2006	Contract for 58 MW CFB boilers and steam turbine power generator for Yingkou Central Heating subproject signed
26 September 2006	Contract for desulphurization tower equipment, heat exchange station equipment, materials for network, steam pipe system, and electrical system equipment for Yingkou Central Heating subproject signed
4–14 December 2006	ADB loan review mission
14–17 May 2007	ADB loan review mission
3 September 2007	ADB approved the following major changes to the scope and implementation arrangements of the project without changing the project objectives: (i) the scope of subproject A: Fuxin CBM and CMM Development would be changed to include four mini CBM and CMM-fired power plants with total capacity of 22 MW; (ii) subproject C2: Anshan City Central Heating Supply and subproject B1: Fushun Gas Distribution Improvement would be cancelled; and (iii) two new subprojects—Fuxin Central Heating Supply and Benxi Huaxing Central Heating Supply—would be added
31 October 2007	Two contracts for 58 MW boiler unit and heat net prefabricated thermal insulation pipe for Liaoyang Central Heating subproject finished. Completion of Liaoyang Central Heating subproject
23 November 2007	Loan and project agreements amended to reflect the changes of scope and implementation arrangements and forwarded to Ministry of Finance
30 November 2007	Two contracts for Liaoyang civil works of Beicaoku and Doushuangshu heat source factories and a contract for 58 MW CFB boilers and steam turbine power generator for Yingkou Central Heating subproject finished

Date	Project Events
10–18 December 2007	ADB loan review mission
18 August 2008	Land acquisition application for Fuxin CBM and CMM Development subproject approved by GLP
15 October 2008	Completion of Benxi gas distribution improvement subproject
27 October 2008	Four contracts for (i) pipes and fittings, (ii) valves, (iii) equipment (dry type desulphurization facility/agent, gas detectors, user gas meters, etc.), and (iv) material (cement, hot rolled round bar, steel plate, etc.) for Benxi gas distribution improvement subproject finished
4 November 2008	Four contracts for (i) pipes and fittings, (ii) valves, (iii) equipment (dry type desulphurization facility/agent, gas detector, user gas meter, etc.), and (iv) material (cement, hot rolled round bar, steel plate, etc.) for Benxi gas distribution improvement subproject finished
15 November 2008	Two contracts for (i) pipelines and valves, and (ii) automatic monitoring control system for Fuxin Central Heating subproject; three contracts for (i) boilers and auxiliaries; (ii) electricity distribution equipment and heating control system; (iii) pipelines, valves, and equipment for heat exchange station for Benxi Huaxing Central Heating subproject were signed
2–9 December 2008	ADB loan midterm review mission
9 January 2009	By contracting CERs generated mainly from the established CMM-fired power plants financed by domestic funds, the CDM project was successfully registered with United Nations CDM Board
8 February 2009	Completion of Yingkou Central Heating subproject
30 June 2009	ADB approved the request from the executing agency for extension of the loan closing date from 30 September 2009 to 30 September 2011 to enable completion of remaining project activities
30 September 2009	Original loan closing date
25 October 2009	Completion of Fuxin Central Heating subproject
7–11 December 2009	ADB loan review mission
31 December 2009	Benxi Huaxing Central Heating subproject completed
15 July 2010	The borrower requested the change in the project scope of inclusion of Fuxin Heating Supply subproject extension, and cancellation of Fuxin CBM and CMM Development subproject from ADB financing
30 July 2010	ADB approved the request for minor change in scope
23 November 2010	ADB approved two contracts for (i) pipes and accessory materials, (ii) electricity system and decentralized control system for Fuxin Central Heating subproject
24 November 2010	The last two contracts for Fuxin Central Heating subproject extension signed
6–10 December 2010	ADB loan review mission
31 March 2011	Two contracts for (i) pipes and accessory materials, and (ii) electricity system and decentralized control system for Fuxin Central Heating subproject finished
31 March 2011	Completion of Fuxin Central Heating subproject extension
30 September 2011	Loan closing date

Date	Project Events
30 December 2011	Final liquidation, loan cancelling, and loan account closing
26 March–1 April 2012	ADB project completion review mission

ADB = Asian Development Bank, CBM = coal bed methane, CDM = clean development mechanism, CER = certified emission reduction, CFB = Circulating Fluidized Bed, CMM = coal mine methane, ICB = international competitive bidding, MW = megawatt, NCB = national competitive bidding, PIA = project implementation agency, PMO = project management office, PRC = People's Republic of China, QCBS = quality and cost based selection.

Source: Asian Development Bank.

PROJECT COST AND FINANCING PLAN

Table A3.1: Detailed Project Cost
(\$ million)

Component	Appraisal Estimate			Major Change			Actual		
	Foreign Exchange	Local Currency	Total Cost	Foreign Exchange	Local Currency	Total Cost	Foreign Exchange	Local Currency	Total Cost
Part A: CBM and CMM Development	15.78	10.89	26.67	16.2	7.87	24.07	0.00	30.96	30.96
A1 Fuxin CBM and CMM Development									
(i) Civil Works (incl. vertical wells)				3.75	5.36	9.11	0.00	9.29	9.29
(ii) Equipment for Power Plants				6.11	0.00	6.11	0.00	5.16	5.16
(iii) Equipment for CBM and CMM Drainage and Transmission				6.34	0.00	6.34	0.00	13.42	13.42
(iv) Other Costs (land acquisition, site preparation, etc.)				0.00	2.51	2.51	0.00	3.10	3.10
Subtotal A1	15.78	10.89	26.67	16.20	7.87	24.07	0.00	30.96	30.96
Part B: Gas Distribution Improvements	4.45	3.33	7.78	2.64	3.46	6.10	2.20	3.90	6.10
B1 Fushun Gas Distribution Improvements				Cancelled			Cancelled		
(i) Gas Pipelines and Pressure Regulating Stations	0.98	0.00	0.98						
(ii) Civil Works and Pipeline Installations	0.67	0.73	1.40						
(iii) Implementation Supervision Consultants and Training	0.05	0.00	0.05						
Subtotal B1	1.70	0.73	2.43						
B2^a Benxi Gas Distribution Improvements									
(i) Gas Pipelines and Pressure Regulating Sections				2.64	0.00	2.64	2.20	0.00	2.20
(ii) Civil Works and Pipeline Installations				0.00	3.46	3.46	0.00	4.15	4.15
Subtotal B2	2.75	2.60	5.35	2.64	3.46	6.10	2.20	4.15	6.35
Part C: City Central Heating Supply	41.61	58.62	100.22	42.44	80.15	122.59	49.34	103.70	153.03
C1 Anshan Central Heating Supply				Cancelled			Cancelled		

Component	Appraisal Estimate			Major Change			Actual		
	Foreign Exchange	Local Currency	Total Cost	Foreign Exchange	Local Currency	Total Cost	Foreign Exchange	Local Currency	Total Cost
(i) Heat Transmission and Distribution Pipes	8.54	0.20	8.74						
(ii) Civil Works	0.68	0.97	1.65						
(iii) Consumer Connection Modernization	0.00	3.87	3.87						
(iv) Implementation Supervision Consultants and Training	0.22	0.00	0.22						
Subtotal C1	9.44	5.04	14.47						
C2^b Liaoyang Central Heating Supply									
(i) Heat Source (boilers and auxiliaries)				8.05	2.51	10.09	12.42	3.87	16.29
(ii) Heating Transmission and Distribution Pipeline				4.70	13.68	18.52	0.00	22.36	22.36
(iii) Civil Works				1.01	6.89	8.22	0.76	5.18	5.94
(iv) Other Costs (land acquisition, site preparation, etc.)				0.00	4.92	4.92	0.00	5.82	5.82
Subtotal C2	14.02	22.05	36.06	13.76	28.00	41.76	13.18	37.23	50.41
C3^c Yingkou Central Heating Supply									
(i) Heat Source (boilers) and Steam Turbine-Generator				2.65	1.19	10.09	2.41	1.38	3.80
(ii) Supplementary System (thermoelectricity plant)				5.30	0.44	18.27	5.32	0.51	5.84
(iii) Steam Pipelines and Control Systems				4.87	8.89	8.22	4.89	10.33	15.22
(iv) Civil Works and Preconstruction Works				0.00	15.61	0.00	0.00	18.25	18.25
Subtotal C3	12.70	26.18	38.89	12.82	26.13	38.95	12.63	30.47	43.10
C4^d Benxi Hengze Central Heating Supply									
(i) Heat Source (boilers and auxiliaries)				3.61	2.30	5.91	5.15	3.28	8.44
(ii) Heating Transmission and Distribution Pipeline				2.40	2.89	5.29	0.00	3.31	3.31

Component	Appraisal Estimate			Major Change			Actual		
	Foreign Exchange	Local Currency	Total Cost	Foreign Exchange	Local Currency	Total Cost	Foreign Exchange	Local Currency	Total Cost
(iii) Civil Works				0.00	3.31	3.31	0.00	8.27	8.27
(iv) Other Costs (land acquisition, site preparation, etc.)				0.00	1.90	1.90	0.00	1.68	1.68
Subtotal C4	5.45	5.35	10.80	6.01	10.4	16.41	5.15	16.53	21.86
C4 Fuxin Central Heating Supply	New subproject added at major change								
(i) Heating Transmission and Distribution Pipeline				3.80	5.33	9.13	11.04	3.17	14.22
(ii) Heat Monitoring and Control System				1.10	0.00	1.10	1.49	0.00	1.49
(iii) Civil Works				0.00	0.06	0.06	0.00	7.62	7.62
(iv) Other Costs (land acquisition, site preparation, etc.)				0.00	1.04	1.04	0.00	1.03	1.03
Subtotal C4				4.90	6.43	11.33	12.53	11.82	24.35
C5 Benxi Huaxing Central Heating Supply	New subproject added at major change								
(i) Heat Source (boilers and auxiliaries)				2.85	1.98	4.78	3.49	0.61	4.10
(ii) Heating Transmission and Distribution Pipelines				2.10	1.54	3.69	2.36	0.71	3.06
(iii) Civil Works				0.00	3.49	3.49	0.00	4.80	4.80
(iv) Other Costs (land acquisition, site preparation, etc.)				0.00	2.18	2.18	0.00	1.53	1.53
Subtotal C5				4.95	9.19	14.14	5.85	7.64	13.49
Part D: Institutional Strengthening and Consulting Services	0.60	0.00	0.60	1.05	0.00	1.05	0.82	0.05	0.87
Subtotal Base Cost for Items A–D	62.44	72.84	135.28	62.33	91.48	153.81	52.36	107.89	191.76
Contingency									
Physical	3.80	4.83	8.64	5.70	2.19	7.89	0.00	0.00	0.00
Price	2.48	4.06	6.54	2.05	1.28	3.33	0.00	0.00	0.00

Component	Appraisal Estimate			Major Change			Actual		
	Foreign Exchange	Local Currency	Total Cost	Foreign Exchange	Local Currency	Total Cost	Foreign Exchange	Local Currency	Total Cost
Interest during Construction	7.28	3.26	10.54	5.11	0.80	5.91	3.52	5.06	8.58
Commitment Fee ^e	0.00	0.00	0.00	0.00	0.00	0.00	0.55	0.00	0.55
Total Project Cost	76.00	85.00	161.00	75.19	95.75	170.94	56.43	112.96	200.35

CBM = coal bed methane, CMM = coal mine methane.

^a B2 was recategorized as B1 at change in scope.

^b C2 was recategorized as C1 at change in scope.

^c C3 was recategorized as C2 at change in scope.

^d C4 was recategorized as C3 at change in scope.

^e Commitment fee used by Anshan subproject.

Sources: Asian Development Bank.

Table A3.2: Summary Financing Plan
(\$ million)

Source	At Appraisal				At Major Change				Actual			
	Foreign	Local	Total	%	Foreign	Local	Total	%	Foreign	Local	Total	%
Equity												
Fuxin CBM/CMM Development and Utilization Company	1.53	7.79	9.32	5.8	1.41	8.70	10.11	5.91	0.00	30.96	30.96	15.45
Fushun Gas General Company	0.16	0.72	0.88	0.5		Cancelled				Cancelled		
Benxi Gas General Company	0.27	1.54	1.81	1.1	0.23	1.16	1.39	0.8	0.00	4.15	4.15	2.07
Benxi General Heating Company	0.53	2.16	2.69	1.7	0.45	7.22	7.67	4.5	0.00	13.36	13.36	6.67
Liaoyang Real Estate Heating Company	1.36	11.23	12.59	7.8	1.10	20.17	21.27	12.4	0.00	29.14	29.14	14.54
Yingkou Heating Company	1.23	25.49	26.72	16.6	1.08	22.57	23.65	13.8	0.00	24.12	24.12	12.04
Fuxin Heating Company		New subproject			0.45	6.01	6.46	3.8	0.00	7.12	7.12	3.55
Benxi Huaxing Heating Company		New subproject			0.47	9.92	10.39	6.1	0.00	7.64	7.64	3.81
Anshan General Heating Company	0.92	5.33	6.25	3.9		Cancelled				Cancelled		
Subtotal	6.00	54.26	60.26	37.4	5.19	75.75	80.94	47.3	0.00	116.49	116.49	58.14
Loans												
Asian Development Bank	70.00	0.00	70.00	43.5	70.00	0.00	70.00	41.0	56.43	0.00	56.43	28.17
Local Banks	0.00	30.74	30.74	19.1	0.00	20.00	20.00	11.7	0.00	27.44	27.44	13.70
Subtotal	70.00	30.74	100.74	62.6	70.00	20.00	90.00	52.7	56.43	27.44	83.87	41.86
Total	76.00	85.00	161.00	100.0	75.19	95.75	170.94	100.0	56.43	143.92	200.35	100.00

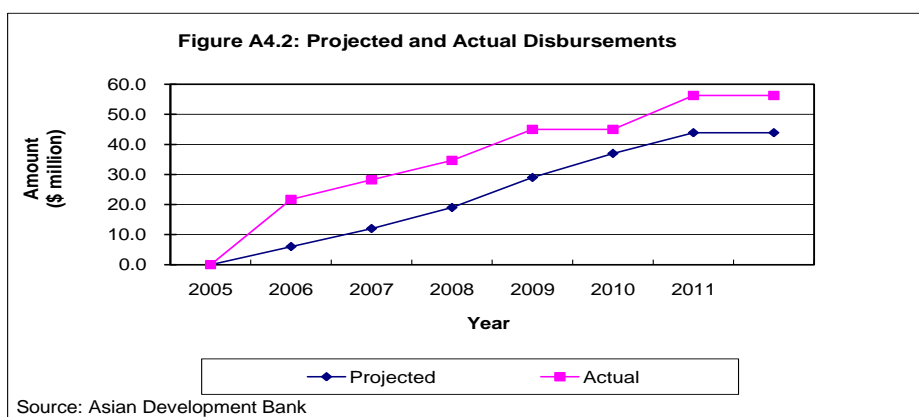
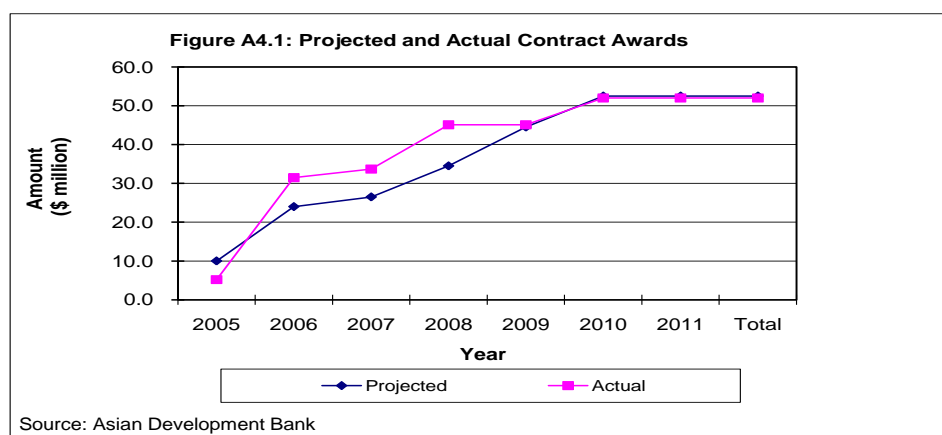
Sources: Asian Development Bank.

PROJECTED AND ACTUAL CONTRACT AWARDS AND DISBURSEMENTS

Table A4: Cumulative Contract Awards and Disbursements
(\$ million)

Year	Contract Awards		Disbursement	
	Projected ^a	Actual	Projected ^a	Actual
2005	10.0	5.2	0.0	0.0
2006	14.0	26.7	6.0	21.7
2007	2.5	2.2	6.0	6.5
2008	8.0	11.4	7.0	6.5
2009	10.0	0.0	10.0	10.3
2010	8.0	6.9	8.0	0.0
2011	0.0	0.0	6.9	11.3
Total	52.5	52.4	43.9	56.3

^a Figures shown are cumulative.
Source: Asian Development Bank.



PLANNED AND ACTUAL IMPLEMENTATION SCHEDULE

	ACTIVITY	2003			2004			2005			2006			2007			2008			2009			2010			2011			2012		
		O	N	D	F	A	J	A	J	A	O	D	F	A	J	A	J	A	O	D	F	A	J	A	J	A	O	D	F	A	J
Liaoning Environmental Improvement Project																															
Project Preparation Activities																															
1. ADB Fact-Finding Mission																															
2. ADB Project Processing																															
3. Approval of Advanced Procurement Action																															
4. Feasibility Reports Approval																															
5. EIA Approval																															
6. Recruitment of Tendering Company																															
7. Loan Effective Date																															
Preconstruction Activities																															
1. Construction Power Arrangement																															
2. Communication Facilities																															
3. Initial Civil Works and Site Preparation																															
Procurement Activities																															
1. Tender Document Preparation																															
2. Bidding																															
3. Bid Evaluation																															
Project Implementation																															
Fuxin CMM and CBM Development																															
Benxi Gas Distribution Improvement																															
1. Contract Award																															
2. Delivery of Plant and Equipment																															
3. Construction/Installation																															
Liaoyang Central Heating																															
1. Contract Award																															
2. Delivery of Plant and Equipment																															
3. Construction/Installation																															
Yingkou Central Heating																															
1. Contract Award																															
2. Delivery of Plant and Equipment																															
3. Construction/Installation																															
Benxi Hengze Central Heating																															
1. Contract Award																															
2. Delivery of Plant and Equipment																															
3. Construction/Installation																															
Fuxin Central Heating with Extension																															
1. Contract Award																															
2. Delivery of Plant and Equipment																															
3. Construction/Installation																															
Benxi Huaxing Central Heating																															
1. Contract Award																															
2. Delivery of Plant and Equipment																															
3. Construction/Installation																															
Source: Liaoning Provincial Project Management Office																															
		Planned									Actual																				

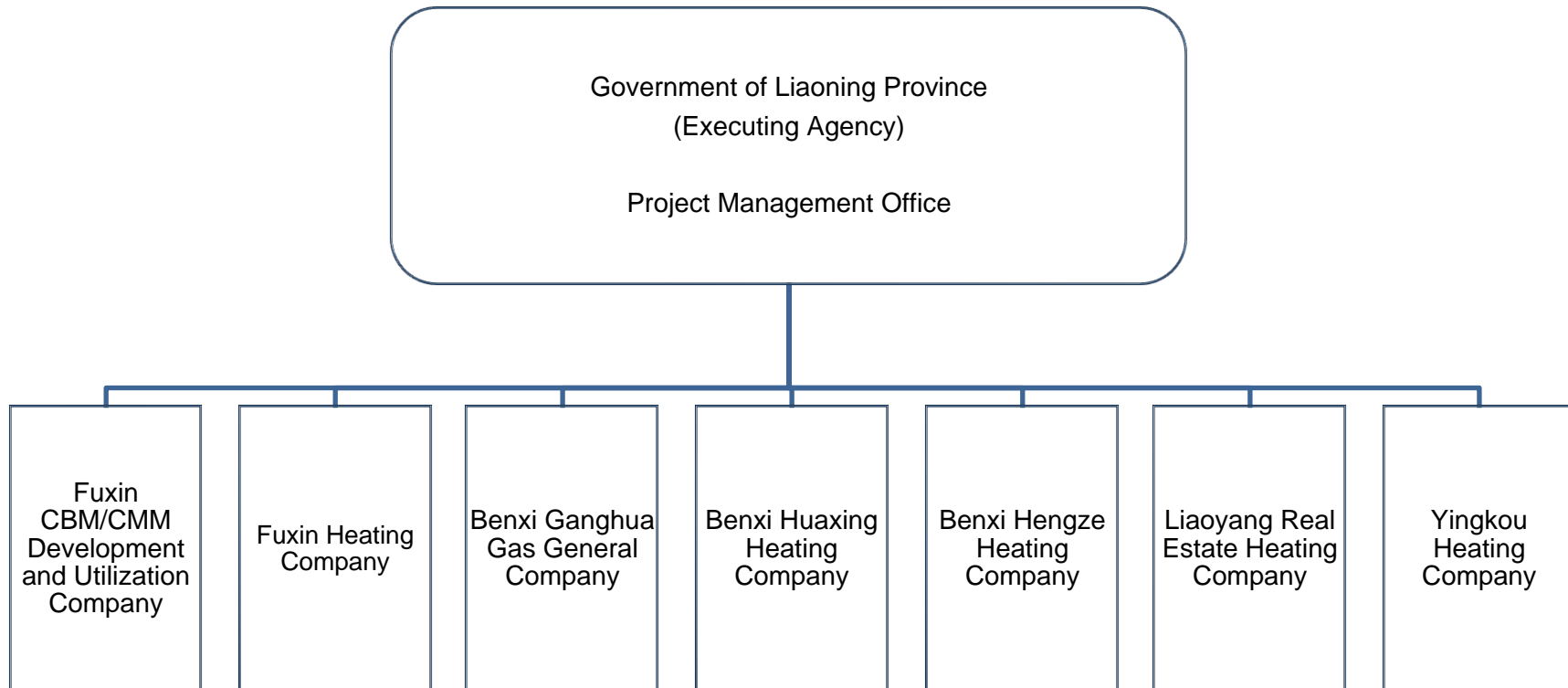
Source: Liaoning Provincial Project Management Office

Planned

Actual

CBM = coal bed methane, CMM = coal mine methane.

PROJECT ORGANIZATIONAL CHART



Source: Asian Development Bank

STATUS OF COMPLIANCE WITH LOAN COVENANTS

Covenant		Reference in Loan and Project Agreement	Status of Compliance
Environment			
1.	GLP and each PIA shall ensure that (i) the project be constructed and operated in accordance with national and local environmental procedures and guidelines, ADB's Environmental Policy (2002) and EIA, (ii) any adverse environmental impacts arising from the construction and operation of the project facilities be minimized by implementing the mitigation measures, environmental monitoring program and other recommendations presented in EIA, and (iii) implementation of the environmental management plan (including mitigating measures, copies of permits, licenses, and clearances) and any violation of safety or environmental standards, if any (and the actions taken to remedy such violations), be regularly reported to ADB in accordance with the specifications set forth in EIA. During Project implementation and the first two years of operations, GLP and each PIA shall submit to the ADB two times a year the reports on mitigation measures undertaken and on the results of the environmental monitoring program.	PA, Schedule, para. 19	Complied with. During construction and operation, all the contractors fulfilled their obligation to protect the environment and to implement mitigation measures in their construction schemes. Eight semiannual EMRs prepared by the PMO have been submitted to ADB in accordance with ADB requirements.
Social			
2.	GLP and each PIA shall (i) implement the resettlement plan in accordance with its terms; (ii) ensure that all land and rights-of-way required by the project be made available in a timely manner; (iii) ensure that the provisions of the RP, including compensation and entitlements for affected persons (APs), be implemented in accordance with all applicable laws and regulations of the Borrower and ADB's Policy on Involuntary Resettlement (1995); (iv) ensure compensation and resettlement assistance be given to the APs prior to dispossession and displacement; (v) ensure that the counterpart funds for land acquisition and resettlement activities be timely provided; (vi) meet any obligations in excess of the RP budget estimate; and (vii) ensure that the APs will be at least as well off as they would have been in the absence of the project.	PA, Schedule, para. 20	Complied with. Land acquisition and resettlement were implemented based on the updated resettlement plan, the 2004 Land Administration Law, and a specific land acquisition and resettlement policy for the project issued by the GLP. Compensation funds were delivered to affected persons in a timely manner.
3.	GLP and each PIA shall ensure that (i) adequate staff and resources be committed to supervising and monitoring the implementation of the RP and to providing quarterly reports on such implementation to ADB, (ii) an independent agency acceptable to ADB be contracted to carry out monitoring and evaluation, and forward reports to ADB as specified in the RP, including, among others, a resettlement completion report and annual reports for two years after resettlement completion, (iii) monitoring data be disaggregated by gender and monitoring focus on gender impacts and vulnerable groups, (iv) a summary of	PA, Schedule, para. 21	Complied with. Land acquisition and resettlement was implemented in a transparent manner to the satisfaction of affected households. Direct communications between the PIA and affected village and

Covenant		Reference in Loan and Project Agreement	Status of Compliance
	government audits of resettlement disbursements and expenditures be provided to ADB, and (v) local resettlement offices keep records of consultation and grievances and make such records available to ADB on request.		affected households were sound and efficient. An external monitor was engaged to confirm that the resettlement plan was implemented properly.
4.	GLP and each PIA shall update the RP (a) upon the completion of the detailed measurement survey as described in the RP and prior to the commencement of civil works, submit any such modifications to ADB for its concurrence and (b) as necessary to reflect any significant material changes in the project scope or other causes, and submit any such changes to ADB for its approval. GLP and each PIA shall ensure that civil works contract specifications include requirements to comply with the RP and entitlements for permanent and temporary impacts to APs, and shall supervise the contractors to ensure compliance with requirements of the RP, applicable law, and ADB policy.	PA, Schedule, para. 22	Complied with. The revised resettlement plan was approved and uploaded to ADB website for public disclosure in March 2007.
5.	GLP and each PIA, during implementation of the project, take all necessary actions to encourage women living in the project area to participate in planning and implementing Project activities. GLP and each PIA shall monitor Project effects on women during Project implementation in consultation with the Liaoning Provincial Women's Federation.	PA, Schedule, para. 23	Complied with. Employment opportunities of 847 person-years have been provided to women during the project construction and 157 full-time employment opportunities have gone to women since project operation.
6.	GLP and each PIA, shall, in coordination with the appropriate agencies identified by GLP, cause the contractors to disseminate information on the risks of socially and sexually transmitted diseases, including HIV/AIDS, to their employees during Project implementation.	PA, Schedule, para. 24	Complied with.
7.	GLP and each PIA shall ensure that all civil works contractors engaged under the project (i) provide timely payment of wages and safe working conditions to all workers including male and female workers (with such requirements being included in civil works contract and monitored by construction supervision consultant); (ii) provide women's employment, where appropriate, and pay equal wages to the women employees for the equivalent work; (iii) not employ child labor in Project activities in accordance with the relevant laws and	PA, Schedule, para. 25	Complied with.

Covenant		Reference in Loan and Project Agreement	Status of Compliance
	regulations of the Borrower.		
8.	GLP and the concerned PIAs shall ensure that the PIAs implement the pro-poor programs that provide gas and heating connection fee discounts and tariff discounts to the poor based on the cost savings from the efficiency improvement under this project, and ensure that the project cities will establish the government-funded Heating Assistance Funds to assist the poor with income at or below the poverty levels in meeting their gas and heating needs.	PA, Schedule, para. 10	Complied with. All seven PIAs have provided assistance to households on heating/gas supply service, and local governments have taken measures to subsidize heating for poor households.
Financial			
9.	Each PIA shall furnish to ADB, promptly after their preparation but in any event not later than six (6) months after the close of the fiscal year to which they relate, certified copies of such audited accounts and financial statements and the report of the auditors relating thereto (including the auditor's opinion on the use of Loan proceeds and compliance with the covenants of the Loan Agreement), all in the English language.	PA, Section 2.09 (iii)	Complied with. Audited accounts and financial statements and the report of the auditors were submitted and accepted by ADB as scheduled.
10.	GLP and each PIA shall provide, (i) through cash injections and local financial institutions' loans, counterpart funding, and (ii) in case of any shortfall for funds or cost overruns, any additional funding for the project as agreed by ADB, necessary for completion of the project. GLP, together with PIAs, shall provide sufficient foreign exchange, as needed, according to the percentage of its commitment to make equity investment to the project to finance the project construction in case the total foreign exchange cost of the project exceeds \$70,000,000.	PA, Schedule, para. 4	Complied with. Counterpart funding of \$143.92 million was provided by the GLP and PIA in a timely manner.
11.	For each fiscal year commencing from fiscal year 2005, each PIA shall implement the recommendations in the financial reform action plans.	PA, Schedule, para. 12	Complied with. Recommendations were implemented by PIAs.
12.	(a) Except as ADB shall otherwise agree, no PIA may incur any debt unless reasonable forecast of the revenues and expenditures of the PIA shows that the estimated net revenues of the PIA for each fiscal year commencing from fiscal year 2005 during the term of the debt to be incurred shall be at least 1.4 times the estimated debt service requirements of the PIA in such year on all debt of the PIA including the debt to be incurred and no event has occurred since the date of the forecast which has, or may reasonably be expected in the future to have, a material adverse effect on the financial condition of future operating results of the PIA.	PA, Schedule, para. 13	Partly complied with. Full compliance with the debt service coverage ratio requirement for all PIAs is expected during 2012–2016.

Covenant		Reference in Loan and Project Agreement	Status of Compliance
13.	(a) Except as ADB shall otherwise agree, each PIA shall earn, for each of its fiscal years after its fiscal year ending on 31 December 2008, an annual return of not less than 6.0 percent of the average current net value of the PIA's fixed assets in operation. (b) Before 1 January in each of its fiscal years, each PIA shall, on the basis of forecasts prepared by the PIA and satisfactory to ADB, review whether it would meet the requirements set forth in paragraph (a) above in respect of such year and the next following fiscal year and shall furnish to ADB the results of such review upon its completion. (c) If any such review shows that the PIA would not meet the requirements set forth in paragraph (a) above for its fiscal years covered by such review, the PIA shall promptly take all necessary measures in order to meet such requirements.	PA, Schedule, para. 14	Partly complied with. Full compliance with the requirement on return on net fixed assets for all PIAs is expected during 2012–2016.
14.	(a) Except as ADB shall otherwise agree, no PIA may incur any debt, if after incurrence of such debt, the ratio of debt to equity shall be greater than 70:30.	PA, para. 15	Partly complied with. Full compliance with the requirement for all PIAs is expected during 2008–2016.
15.	Each PIA shall, commencing from fiscal year 2009, maintain an account receivable level not to exceed the equivalent to three months' sales.	PA, para. 16	Partly complied with. Full compliance with the requirement is expected during 2008–2016.
Others			
16.	GLP shall be the Executing Agency for the project. A project management office (PMO) shall be established in GLP to be responsible for managing, coordinating and supervising implementation of all project subcomponents. GLP shall ensure that the PMO have sufficient staff and budget according to the agreement between GLP and ADB.	PA, Schedule, para. 1	Complied with.
17.	GLP and the concerned PIAs shall complete the closure of 412 small coal-fired heat boilers in the project cities in Liaoning Province not later than 31 December 2008 and ensure that the demolishing of boilers shall be carried out in accordance with all applicable environmental and safety standards of the Borrower.	PA, Schedule, para. 6	Complied with. 442 small boilers were demolished at project completion.
18.	In accordance with ADB's <i>Social Protection Strategy</i> , GLP and the concerned PIAs shall implement the reemployment action plan to ensure that all workers affected by the closure of the small coal-fired heat boilers under the project are reemployed in a timely manner so that they will be at least as well off as they would have been in the absence of the project.	PA, Schedule, para. 7	Complied with. All 1,740 affected workers have been reemployed by subprojects or other enterprises or units.

Covenant		Reference in Loan and Project Agreement	Status of Compliance
19.	GLP and Fuxin CMB/CMM Development and Utilization Company shall implement the strengthened coal mine safety programs agreed by ADB at the CBM and CMM extraction and utilization facilities to improve coal mine safety not later than 31 December 2008.	PA, Schedule, para. 8	Complied with. The implementation of the coal mining safety enhancement program has directly improved the safety of 16,000 miners in the subproject area, and the target of over 20% improvement in coal mine safety has been achieved.
20.	GLP and the PIAs for the Subcomponents involving heat supply shall implement at the city level the key heating tariff reforms formulated with the assistance of the consultants engaged under Part D of the project: Institutional Reforms and Corporate Governance Improvement Component.	PA, Schedule, para. 9	Complied with. Local governments increased the heating tariff in 2009, and heating tariff will be reviewed every 5 years based on the cost-recovery principles. A two-part heating tariff mechanism was proposed and piloted in some cities in Liaoning Province beginning in 2009.
21.	The PIAs shall execute, before the commercial operation of the project facilities, long-term purchase agreements for, where applicable, CBM and CMM, gas or heating, with large prospective customers to ensure the demand of energy, gas or heating supply services.	PA, Schedule, para. 11	Complied with.
22.	Each PIA shall implement, in accordance with the implementation plan agreed upon between GLP and ADB, the agreed upon recommendations for institutional strengthening made by the consultants under Part D of the project: Institutional Reforms and Corporate Governance Improvement Component, in particular with regard to improving cost accounting and financial management and reporting, corporate governance, budgeting, management administration, and staff incentive schemes.	PA, Schedule, para. 17	Complied with. The institutional strengthening activities were undertaken.
23.	Based on recommendations of the international consultants engaged under Part D of the project, each PIA in the gas or heat supply area shall prepare a privatization plan and submit it to ADB for review by 30 June 2007. Following the consultation with ADB, the concerned PIAs shall prepare specific measures for privatization, seek approval of the concerned authorities, and inform ADB of the results.	PA, Schedule, para. 18	Complied with. A privatization plan for PIAs was submitted to ADB in 2007.

Covenant		Reference in Loan and Project Agreement	Status of Compliance
24.	EA must seek ADB's approval for substantial variations in the contracts (i.e., above \$100,000) before they are issued.	LA, Schedule 4	Complied with.
25.	In the event that (i) any change in the ownership of the project facilities or any PIA, or (ii) any sale, transfer, or assignment of GLP's interest in any PIA is anticipated, the Borrower shall consult ADB at least six months before implementation of such change. The Borrower shall ensure that any proposed change in the ownership of the project facilities and sale, transfer, or assignment of GLP's interest in any PIA be carried out in a legal and transparent manner.	LA, Schedule 6, para. 5	Complied with.

ADB = Asian Development Bank, CBM = coal bed methane, CMM = coal mine methane, EIA = environmental impact assessment, EMR = environmental monitoring report, GLP = government of Liaoning Province, PMO = project management office, PIA = project implementation agency, PRC = People's Republic of China.

Source: Asian Development Bank.

SUMMARY OF CONTRACT PACKAGES

PCSS No.	Item	Mode of Procurement	Date of Contract	Name of Contractor	Currency	Contract Amount	ADB Financing Amount
0001	Boiler body, electric dust removal system, installation	ICB	14-Sep-05	China National Construction and Agricultural Machinery Import & Export Company	US \$	2,047,869.25	2,047,869.25
0002	Blower, air dust removal system, electric equipment of heating source, heat network auto equipment	ICB	14-Sep-05	Liaoning Huiming International Trade Company	US \$	1,607,709.82	1,607,709.82
0003	Plate-type heating exchange set, nodal tube heating exchange, incubation tube, heat network electric equipment, heat network auto equipment	ICB	14-Sep-05	Tsinghua Tongfang	US \$	2,356,503.00	2,356,503.00
0004	Supplementary system of thermoelectricity plant	ICB	14-Feb-06	Liaoning Huiming International Trade Company	US \$	5,324,142.04	5,324,142.04
0005	Boilers, dust removal systems, electrical systems etc.	ICB	28-Feb-06	Liaoning Instrument Company	CNY	65,295,000.00	65,295,000.00
0006	Heat net prefabricated thermal insulation pipe	ICB	28-Feb-06	Liaoning Instrument Company	CNY	37,399,779.80	37,399,779.80
0007	Beicaoku Heat Source Factory	NCB	5-Apr-06	Liaoning Construction Group	CNY	9,836,278.00	2,950,883.40
0008	Doushuangshu Heat Source Factory	NCB	5-Apr-06	Liaoning Construction Group	CNY	16,568,953.00	4,970,685.90

PCSS No.	Item	Mode of Procurement	Date of Contract	Name of Contractor	Currency	Contract Amount	ADB Financing Amount
0009	Institutional strengthening and consulting services	QCBS	1-Jun-06	H&J, Inc., USA	US \$	1,049,600.00	1,049,600.00
0010	Boiler and generator	ICB	25-Sep-06	Liaoning Mec Group Company	CNY	21,000,000.00	21,000,000.00
0011	Peak shaving boiler house equipment, heat exchange station equipment, materials for network, steam pipe system, electrical system equipment	ICB	26-Sep-06	China Dalian International Cooperation (Group) Holding	US \$	4,888,617.00	4,888,617.00
0012	Pipes and fittings	ICB	18-Sep-06	Shanghai Wallong Import and Export Corporation	CNY	13,218,879.00	11,127,420.94
0013	Valves	ICB	18-Sep-06	Shanghai Wallong Import and Export Corporation	CNY	1,984,147.00	1,664,138.46
0014	Equipment (dry type desulphurization facility/agent, gas detectors, user gas meters, etc.)	ICB	18-Sep-06	Shanghai Wallong Import and Export Corporation	CNY	4,369,559.00	3,706,596.33
0015	Material (cement, hot rolled round bar, steel plate, etc.)	ICB	18-Sep-06	Shanghai Wallong Import and Export Corporation	CNY	261,146.00	208,356.84
0016	Boilers and auxiliaries	ICB	4-Nov-08	Liaoning Huiming International Company	CNY	26,880,101.00	16,831,233.00
0017	Electricity distribution equipment and heating control system	ICB	4-Nov-08	Liaoning Huiming International Company	CNY	7,425,233.00	7,425,233.00
0018	Pipelines, valves, and equipment for heat exchange station	ICB	4-Nov-08	Liaoning Huiming International Company	CNY	9,534,709.00	9,534,709.00

PCSS No.	Item	Mode of Procurement	Date of Contract	Name of Contractor	Currency	Contract Amount	ADB Financing Amount
0019	Pipelines and valves	ICB	4-Nov-08	Heilongjiang Machinery and Equipment Import and Export Corporation	CNY	32,884,267.00	24,080,984.00
0020	Automatic monitoring control system	ICB	4-Nov-08	Heilongjiang Machinery and Equipment Import and Export Corporation	CNY	9,371,919.00	9,358,888.00
0021	Pipes and accessories	ICB	23-Nov-10	Heilongjiang Huacheng Environment and Energy Engineering Company	CNY	38,498,978	38,498,978
0022	Electricity system and decentralized control system	ICB	23-Nov-10	Heilongjiang Huacheng Environment and Energy Engineering Company	CNY	11,221,558	11,221,558

ADB = Asian Development Bank, ICB = international competitive bidding, MW = megawatt, NCB = national competitive bidding, QCBS = quality- and cost-based selection.

Source: Asian Development Bank.

FINANCIAL REEVALUATION

A. Basic Assumptions

1. The financial internal rate of return (FIRR) was calculated for the completed subprojects under the project, which included five central heating subprojects and one gas distribution subproject located in Benxi, Fuxin, Liaoyang, and Yingkou in Liaoning Province. The reevaluation followed the appraisal methodology and was based on the financial and operational information obtained from the project implementing agencies, and several revenue and cost assumptions. Capital costs included all incremental capital expenditures but excluded price contingencies and interest during construction. Major repair is assumed to be undertaken after 10 years of operation and the costs were estimated to be 5% of the capital costs. Operating and maintenance costs include annual incremental expenses incurred in operating the subprojects but exclude depreciation. No residual value was considered. All revenues and expenses were expressed in constant 2011 prices. The calculation period covered the construction phase and 20 years of operation.

2. Operating and maintenance costs, including the cost of maintaining the pipelines, were based on the actual performance of the respective project implementing agencies (PIAs). Revenues were calculated based on the volume of heat and gas sales and the prevailing tariffs. The volume of heat and gas sales were projected based on the expected growth in consumption and the design capacity of those plants. The income tax rate was 25% for all heating and gas companies. The value-added tax (VAT) was 13%, the city construction tax was levied at 7% of the VAT, and the education surcharge was levied at 4% of the VAT.

3. Heating tariffs are based on the flat rate per square meter (m²) per heating season in Liaoning Province. Due to sharp price increases of coal and others raw materials, the local municipal governments increased the heating tariff in 2009 to mitigate the losses encountered by the heating companies. Tariffs will be reviewed every 5 years based on cost-recovery principles. The tariff increases will help the PIAs offset some of the cost increases from coal prices, and improve their financial performance. Measures to enable users to pay based on actual consumption would encourage heat conservation. New apartments in the province are required to install meters to allow heat control, however retrofitting of old apartments was difficult due to inappropriate pipe configurations. In May 2007, the province issued the Comments on Energy Efficient Buildings Process, which required the installation of heating meters in targeted areas and piloting of consumption-based heating tariffs. At present, piloting programs are ongoing in a number of urban areas in the province, including Benxi, Liaoyang. The heating tariffs currently applied in each subproject and the projected levels are provided in Table A9.1.

Table A9.1: Heating Tariff in Subprojects
(CNY/m² of floor area)

Period	Yingkou		Benxi		Liaoyang		Fuxin	
	Resident	Non-resident	Resident	Non-resident	Resident	Non-resident	Resident	Non-resident
2005–2008	22	25.0	24	24	22.0	27.0	21.5	23.5
2009–2011	27	30.0	28	32	24.0	32.0	26.0	32.0
2012–2015	31	34.5	32	37	26.4	35.2	27.3	33.6
2016–2019	35	39.7	32	37	29.0	38.7	30.0	35.0
2020–2029	41	45.6	32	37	30.5	40.7	32.0	36.0

m² = square meter.

Sources: PIAs.

4. Since the “one apartment, one heat valve” measures were introduced in Liaoning, the heat collection rate has steadily increased. For example, the heat collection ratio of the Liaoyang PIA increased from 85.0% in 2005 to 95.0% in 2008 and 99.2% in 2011. The average heat billing collection rate for the project was 97.4% in 2011. The heat bill collection ratio for each PIA for 2005–2011 is provided in Table A9.2.

Table A9.2: Heating Bill Collection Ratio
(%)

PIA	2005	2006	2007	2008	2009	2010	2011
Yingkou Heating	97.4	98.7	98.2	98.5	98.6	98.7	99.7
Benxi Huaxing Heating	75.0	83.0	85.0	88.0	91.0	95.0	98.0
Benxi Hengze Heating	85.0	86.0	87.0	87.4	88.2	89.5	92.5
Liaoyang Heating	85.0	88.0	94.5	95.0	96.0	97.0	99.2
Average	85.6	88.9	91.2	92.2	93.5	95.1	97.4

Source: PIAs.

B. Financial Internal Rate of Return

5. The recalculated FIRR is 6.1% for the whole project, which is lower than the appraisal estimate of 8.7%. The Benxi Hengze Central Heating Supply subproject, Liaoyang and Yingkou central heating supply subprojects, and the gas distribution improvement subproject in Benxi all reported lower FIRRs than the appraisal estimates. The lower project FIRRs were mainly due to the significantly higher coal cost, which constitutes the major heating plant operational cost. The Benxi Huaxing and Fuxin central heating supply subprojects were added to the project scope in 2007, and their FIRRs were higher than the estimates at the major change approval stage because of (i) the lower capital cost (in the case of the Benxi Huaxing subproject), and (ii) low operation cost (by utilizing the hot effluent water from the neighboring power plant) in the case of the Fuxin heating subproject. The after-tax weighted average cost of capital (WACC) was calculated based on the actual financing mix and cost of these various sources. The project's

FIRR was recalculated as 6.1%, higher than the WACC of 3.4%, and the project is considered financially viable. Sensitivity analysis indicated that the FIRR would be reduced to 3.7% if the revenues were 10% lower, and 4.4% if the operation and maintenance costs were 10% higher. The results of the recalculated FIRRs are shown in Tables A9.3–A9.4.

Table A9.3: Summary of Financial Rate of Return

(%)			
Subproject	At Appraisal	At Major Change	At Completion
Benxi Hengze CHS	8.9		5.2
Benxi Huaxing CHS		8.1	11.2
Fuxin CHS		9.2	12.5
Liaoyang CHS	8.6		5.3
Yingkou CHS	8.9		3.8
Benxi GDI	8.5		8.0
Whole Project	8.7	8.5	6.1

CHS = central heating supply, GDI = gas distribution improvement.

Source: ADB estimates.

Table A9.4 Recalculation of Financial Rate of Return

(CNY million)

Year	Capital Costs	O&M Costs	Total Costs	Income Taxes	Revenue	After Tax Net Cash Flow
2006	613.96	39.27	653.23	1.07	40.03	(614.27)
2007	78.69	154.16	232.85	3.30	164.93	(71.23)
2008	104.21	186.16	290.38	0.00	196.94	(93.43)
2009	148.49	245.73	394.22	0.63	276.45	(118.40)
2010	58.37	287.38	345.74	1.08	311.52	(35.31)
2011	44.69	312.12	356.82	5.23	377.55	15.50
2012	0.00	343.43	343.43	9.93	423.90	70.54
2013	0.00	365.26	365.26	10.76	454.45	78.43
2014	0.00	490.85	490.85	20.59	619.46	108.02
2015	0.00	491.57	491.57	20.48	619.46	107.41
2016	0.00	493.75	493.75	26.60	645.83	125.48
2017	0.00	495.21	495.21	26.31	645.83	124.31
2018	0.00	495.94	495.94	26.07	645.31	123.29
2019	0.00	496.73	496.73	25.95	645.31	122.63
2020	0.00	498.03	498.03	28.53	656.62	130.06
2021	104.84	498.03	602.87	28.60	656.62	25.14
2022	0.00	498.03	498.03	28.68	656.62	129.91
2023	0.00	498.03	498.03	28.75	656.62	129.84
2024	0.00	498.03	498.03	28.82	656.62	129.76
2025	0.00	498.03	498.03	28.90	656.62	129.69
2026	0.00	498.03	498.03	28.98	656.62	129.61
2027	0.00	498.03	498.03	29.06	656.62	129.53
2028	0.00	498.03	498.03	29.14	656.62	129.45
2029	0.00	498.03	498.03	31.39	656.62	127.20
FIRR						6.10%

FIRR = financial internal rate of return.

Source: ADB estimates.

C. Financial Performances of Project Implementing Agencies

6. In the Project Agreement, four financial performance ratios were covenanted on the PIAs: (i) debt service coverage ratio of at least 1.4 commencing from 2005, (ii) return on net fixed assets of not less than 6% after 2008, (iii) debt–equity ratio of less than 70:30, and (iv) account receivable level not higher than the equivalent of 3 months of sales. The financial performance of the PIAs is summarized in paras. 7–13.

1. Benxi Hengze Heating Company

7. The Benxi General Heating Company was the original PIA for the Benxi Hengze Central Heating Supply subproject. It was a state-owned enterprise under the Benxi Commonwealth Company controlled by the Benxi municipal government. The company had a negative operating profit from 2004 until 2006 and owed about CNY90 million for coal to the Benxi Hengze Coal Mining Trading Company, the company's biggest coal supplier. Due to financial difficulties, Benxi General Heating Company was taken over by the Benxi Hengze Coal Mining Trading Company under the approval of the Benxi municipal government, and the Benxi Hengze Heating Company was formally established on 23 August 2006. The Benxi Hengze Coal Mining Trading Company has a 75% ownership stake and the Benxi Commonwealth Company maintains the remaining proportion. The Benxi Hengze Heating Company, with registered capital of CNY8 million, became the new PIA for the Benxi Central Heating Supply subproject. According to the actual financial performance and financial projection, the Benxi Hengze Heating Company will meet all the financial covenants starting from 2016.

2. Benxi Huaxing Heating Company

8. The Benxi Huaxing Heating Company, the PIA for the Benxi Huaxing Heating subproject, is a privately owned heating enterprise. It provided heating supply services as well as maintenance and installation of heating pipelines. The company was established in 2002 with registered capital of CNY12 million. In 2010 it had 135 staff members. As a private company, it bears sole responsibility for its profit or loss but does not operate and manage in accordance with the Company Law with a modern management system established. Compared with many heating companies that suffered losses for many years, the Benxi Huaxing Heating Company has been making meager profits due to good management. Total net profit was CNY3.94 million in 2009, –CNY0.36 million in 2010, and CNY2.59 million in 2011. The reason for the operational loss in 2010 was that from that year the company started to charge depreciation (about CNY8.31 million) on assets developed under the ADB-financed subproject. With the projected increase in heating area, the company will meet all the financial covenants starting from 2012.

3. Fuxin Heating Company

9. The Fuxin Heating Company, the PIA for the Fuxin heating subproject, is a state-owned heating enterprise. It was established in 1981 with registered capital of CNY134 million. After nearly 30 years of development, it has grown into a group enterprise focused on urban heating supply supported by multiple businesses including engineering design, development, construction, heat product manufacturing, processing, sale, house development, agriculture, forestry, and animal husbandry. The company ranks first among the 18 heating companies in Fuxin area in terms of the heating service capacity and coverage. It has 976 staff, including 104 senior and middle-level technical staff. Annual heating revenue is about CNY150 million, and total assets are CNY360 million. The company provides heating services to an area of over 9 million m² and services more than 75,000 residential households and 500 commercial users.

Because the heating tariff is still not sufficient to cover the costs, the company is facing an operational loss of about CNY10 million in 2008-2011. It will meet all the financial covenants starting from 2013.

4. Liaoyang Real Estate Heating Company

10. The Liaoyang Real Estate Heating Company, the PIA of the Liaoyang Central Heating Supply subproject, is a stated-owned heating company established in 2004 and one of the three major heating supply companies in Liaoyang City. With the increase in the price of coal, water, and electricity, these heating companies have recently become less profitable. At the same time, heating pipelines in urban areas were old and in poor condition, and needed to be replaced. However, the heating companies had no funds to improve the pipelines. To solve this problem, in June 2010 the Liaoyang municipal government transferred the operation of three local heating companies—the Liaoyang Real Estate Heating Company and the No. 1 and No. 2 Combined Heating and Power Plants—to the Shenyang Coal Mining Corporation. The Liaoyang Urban Construction and Public Utility Administrative Bureau (LUCPUAB), on behalf of the PIA, signed the Agreement on Commission Operation of Liaoyang Heating Supply with the Liaoyang Hongyang Heating Company, a subsidiary totally controlled by the Shenyang Coal Mining Corporation. Since 2010 the heating service of Liaoyang City has been provided by the Liaoyang Hongyang Heating Company. According to the operation agreement, the company has the right to manage and operate the heating source plants and pipeline network of the three heating companies during the commissioning and operating period from 10 June 2010 to 9 June 2030. By the end of the agreement period, all heating facilities and assets shall be returned to the LUCPUAB. The Liaoyang Hongyang Heating Company has no responsibility for repayment of the debts of the three heating companies. The Liaoyang Real Estate Heating Company as an independent enterprise still existed in 2010, and its enterprise property and the relationship with its employees were not changed. The main work of the Liaoyang Real Estate Heating Company was to resettle the remaining employees who were not working in the Liaoyang Hongyang Heating Company. As the PIA for the Liaoyang heating subproject the Liaoyang Real Estate Heating Company is responsible for the work and debt repayment related to the subproject. Considering the above, the financial covenants are no longer relevant for this PIA.

5. Yingkou Heating Company

11. The Yingkou Heating Company, the PIA of the Yingkou heating subproject, is a state-owned enterprise under the direct control of the Yingkou Public Utility and Real Estate Bureau. It mainly conducts heating supply services, as well as maintenance and installation of heating pipelines. The company was established in 1993 with registered capital of CNY22.17 million. The company has 564 employees. It operates and manages in accordance with the modern corporation system, and bears sole responsibility for its profits or losses; the government does not subsidize the company. The Yingkou Binhai Heating and Power Company is its subsidiary company and provide heating supply, steam supply, and electricity generation services; and is responsible for operating and managing the heating subproject. According to the actual financial performance and financial projection of the Yingkou Binhai Heating and Power Company, from 2008 it has met the covenants of a debt–equity ratio of 70:30 and accounts receivable not higher than the equivalent to 3 months' sales. It will meet the financial covenants from 2012.

6. Benxi Ganghua Gas Company

12. The original PIA for the Benxi Gas Distribution Improvement subproject was the Benxi General Gas Company, a stated-owned enterprise established in 1974 and managed as a

stated-owned enterprise for many years. Due to its poor financial performance it underwent a change in ownership. In August 2005, an announcement was posted for transfer of state-owned property and to solicit strategic investors. Benxi Panva Gas Holdings (Panva Gas) was the only potential investor to express an interest in the strategic investor partnership. Benxi Commonwealth State-Owned Property Operation Company (Commonweal Company), which was a stated-owned enterprise and the sole shareholder of the Benxi General Gas Company and Benxi Hua Qiang Gas Company (Hua Qiang) signed the property rights transfer agreement with Panva Gas on 4 November 2004. On the same date, the Benxi General Gas Company and Panva Gas also signed the joint-venture agreement to form the Benxi Panva Gas Company as the new PIA for the Benxi Gas Distribution Improvement subproject. According to the contract, the registered capital of the Benxi Panva Gas Company is CNY97.82 million, which consisted of CNY19.57 million (20% of the total capital) contributed by Commonweal Company and CNY78.26 million (80% of the total capital) contributed by Panva Gas. Both parties will share the risks and receive profits according to agreed capital shares. The name of the PIA was later changed to the Benxi Ganghua Gas Company Towngas Group on 14 April 2008. The company will meet the financial covenants from 2013.

D. Conclusion and Lessons

13. Price increases of coal and other raw materials have a significant impact on the financial performance of heating companies. Local governments should adjust the heating tariff to ensure the full cost recovery for these companies. Meanwhile, many of these companies have excessive staffing levels when compared with similar companies in a similar city. It is therefore suggested that the organizational structure be streamlined and the number of managerial staff reduced. Clearer and better structured work flows and procedures need to be established to improve the operational efficiency of these companies.

ECONOMIC REEVALUATION

A. Scope and Methodology

1. The economic reevaluation recalculated the economic internal rate of return (EIRR) of the project and compared the results with the appraisal and major change period estimates. The final project scope includes five city central heating subprojects and one gas distribution subproject. Project costs and benefits were reassessed on the basis of information provided by the respective subprojects implementing agencies. The economic costs and benefits were valued using the domestic numeraire and expressed in constant 2011 prices. The financial costs of traded goods were adjusted to their respective economic values using a shadow exchange rate factor of 0.987. All other cost items were valued at domestic prices less taxes and financing charges. The shadow wage rate for unskilled labor was estimated at 0.67 of the prevailing wage rate, and the conversion factors for skilled labor, other costs, and benefits were estimated to be 1.0. The EIRR was calculated for each subproject and for the whole project. The EIRR was compared with the economic opportunity cost of capital, which is assumed to be 12%. Sensitivity analysis was undertaken to assess the robustness of the EIRR calculation.

B. Costs

2. The project costs consist of capital and operation and maintenance (O&M) costs. The actual capital costs were converted to economic values by deducting taxes, duties, interest, and financial charges, and applying relevant conversion factors. Actual O&M costs in past years were applied and were assumed to remain constant in real terms during the evaluation period. Major repair is expected after 10 years of operation and the costs were estimated as 5% of the capital costs.

C. Benefits

3. Economic benefits are valued on the basis of the benefits of incremental heat and gas supply and the cost savings of the alternative heat and energy supply and efficiency improvement with and without the subprojects. The benefits of incremental heat and gas supply were calculated based on the willingness to pay. The cost savings were valued by comparing the fuel consumption of traditional small boilers with that of the central heating supply system, and by comparing the option of using coal with using gas by households for the gas subproject. In addition, the central heating supply and gas distribution subprojects generate substantial local environmental benefits to human health and welfare through avoidance of air pollution from alternative energy sources. For evaluation of the environmental benefit to human health and welfare, the benefit transfer method is used, as adopted in the *Economic Evaluation of Environmental Impacts: A Workbook* (1996)¹.

D. Economic Internal Rate of Return

4. This approach yields EIRRs ranging from 19.0% to 36.2% without the environmental benefits and 22.6% to 41.7% with the environmental benefits for the subprojects. For the overall project, the EIRR was recalculated to be 23.1% without local environmental benefits and 29.0% with local environmental benefits. The economic reevaluation results are presented in Tables A10.1–A10.2.

¹ADB, 1996. *Economic Evaluation of Environmental Impacts: A Workbook of the Asian Development Bank*.

Table A10.1: Summary of Economic Internal Rate of Return
(%)

Subproject	At Appraisal		At Major Change		At Completion	
	Without Environmental Benefits	With Environmental Benefits	Without Environ- mental Benefits	With Environ- mental Benefits	Without Environ- mental Benefits	With Environ- mental Benefits
Benxi Hengze CHS	10.8	25.5			21.8	27.1
Benxi Huaxing CHS			12.5	14.4	36.2	41.7
Fuxin CHS			14.4	17.0	30.0	35.6
Liaoyang CHS	13.9	43.8			22.4	30.5
Yingkou CHS	10.4	18.1			19.0	22.6
Benxi GDI	12.4	17.3			22.3	24.2
Whole Project	13.6	26.3	12.9	28.2	23.1	29.0

CHS = central heating supply, GDI = gas distribution improvement.
Source: ADB estimates.

Table A10.2 : Economic Internal Rate of Return Calculation For the Whole Project
(CNY million)

Year	Benefits					Costs			Net Benefits	Net Benefits without Environmental Benefits
	Heating Supply	Coal Saving	Incremental Electricity	Environmental Benefits	Total	Capital Costs	O&M	Total		
2006	45.75	10.46	0.00	5.3	61.5	543.4	37.1	580.6	(519.1)	(524.3)
2007	186.09	52.48	0.00	29.7	268.2	66.9	147.6	214.5	53.7	24.1
2008	212.42	63.69	16.60	33.9	326.6	92.3	179.2	271.5	55.1	21.2
2009	271.06	81.44	26.37	39.6	418.5	138.4	233.6	372.0	46.5	6.9
2010	305.15	96.01	28.10	45.1	474.3	53.2	270.5	323.7	150.6	105.5
2011	350.17	121.16	32.82	54.7	558.8	42.7	296.3	338.9	219.9	165.2
2012	369.32	127.63	32.82	57.3	587.1	0.0	325.4	325.4	261.7	204.4
2013	397.71	134.21	32.82	59.9	624.6	0.0	345.1	345.1	279.6	219.7
2014	547.71	171.23	32.82	74.3	826.1	0.0	465.9	465.9	360.2	285.8
2015	547.71	171.23	32.82	74.3	826.1	0.0	466.5	466.5	359.6	285.3
2016	547.71	171.23	32.82	74.3	826.1	0.0	468.2	468.2	357.8	283.5
2017	547.71	171.23	32.82	74.3	826.1	0.0	469.4	469.4	356.6	282.3
2018	547.71	171.23	32.82	74.3	826.1	0.0	470.0	470.0	356.1	281.7
2019	547.71	171.23	32.82	74.3	826.1	0.0	470.6	470.6	355.4	281.1
2020	547.71	171.23	32.82	74.3	826.1	0.0	471.7	471.7	354.4	280.1
2021	547.71	171.23	32.82	74.3	826.1	93.7	471.7	565.4	260.7	186.4
2022	547.71	171.23	32.82	74.3	826.1	0.0	471.7	471.7	354.4	280.1
2023	547.71	171.23	32.82	74.3	826.1	0.0	471.7	471.7	354.4	280.1
2024	547.71	171.23	32.82	74.3	826.1	0.0	471.7	471.7	354.4	280.1
2025	547.71	171.23	32.82	74.3	826.1	0.0	471.7	471.7	354.4	280.1
2026	547.71	171.23	32.82	74.3	826.1	0.0	471.7	471.7	354.4	280.1
2027	547.71	171.23	32.82	74.3	826.1	0.0	471.7	471.7	354.4	280.1
2028	547.71	171.23	32.82	74.3	826.1	0.0	471.7	471.7	354.4	280.1
2029	547.71	171.23	32.82	74.3	826.1	0.0	471.7	471.7	354.4	280.1
NPV		at 12%							951.1	602.5
EIRR									29.0%	23.1%

() = negative, EIRR = economic internal rate of return, NPV = net present value, O&M = operation and maintenance.
Source: ADB estimates.

5. Sensitivity analysis was carried out to test the impacts of (i) an increase in O&M costs, (ii) a decrease in benefits, and (iii) a combination of these two scenarios. According to this analysis, the project would continue to be economically robust under any of these conditions. The project EIRR is more sensitive to changes in benefits than O&M costs. The results of the sensitivity analysis are provided in Table A10.3.

Table A10.3: Sensitivity Analysis for the Whole Project
(CNY million)

Case	EIRR	NPV at 12%
Base Case	29.0%	1,065.2
(i) Benefit reduced by 20%	22.7%	496.3
(ii) Operation and maintenance costs increased by 20%	25.8%	743.4
(iii) Combination of (i) and (ii)	17.1%	174.4

EIRR = economic internal rate of return, NPV = net present value.

Source: ADB estimates.

ENVIRONMENTAL IMPACT ANALYSIS

A. Introduction

1. The completed project construction activities consisted of seven subprojects in four cities of Liaoning Province:

- (i) the Fuxin CBM and CMM Development subproject (22 vertical coal mine methane [CMM] wells, one 20,000 cubic meter [m³] and one 5,000 m³ above-ground methane gas storage tanks, one compressed natural gas station, five coal-bed methane [CBM] and CMM-fired power plants with total capacity of 24.6 megawatts [MW], and upgrade of existing compression system),
- (ii) the Benxi Hengze Central Heating subproject (two 58 MW circulated fluidized-bed hot water boilers, 2 sets of electronic-static precipitators, 18 heat exchange stations (HESs), and 17 kilometers [km] of heat supply pipelines),
- (iii) the Liaoyang Central Heating Supply subproject (2 heating plants, 10 58 MW chain-grate stoker hot water boilers and auxiliaries, 42 km of heat distribution pipelines, and 63 HESs),
- (iv) the Benxi Gas Distribution Improvement subproject (replacement of 43 km of aging gas pipelines and construction of 5 km of new gas pipeline, and a set of gas desulphurization facilities),
- (v) the Yingkou Central Heating Supply subproject (three 58 MW circulated fluidized-bed boilers, two 12 MW steam turbine power generators, two 40-ton peak shaving boilers, 12 HESs, and 40 km of heat distribution pipelines),
- (vi) the Fuxin Central Heating Supply subproject with extension (phase I includes renovation and construction of 20.9 km of heat distribution pipelines and an automatic heating monitoring and control system; phase II includes 12 HESs, 6.6 km of main heating pipelines and 1.8 km of secondary heating pipelines, and associated automatic control systems), and
- (vii) the Benxi Huaxing Central Heating Supply subproject (three 58 MW hot water boilers and auxiliaries, 20 km of heat distribution network, and 16 HESs).

2. The project was classified environment category B, which the Asian Development Bank (ADB) approved in line with its Environment Policy (2002). The domestic environmental impact assessment reports were approved by the Liaoning Provincial Environmental Protection Bureau (LPEPB) in 2001. The summary initial environmental examination and its environmental management plan (EMP,) dated December 2004, complied with ADB requirements. According to the national laws and regulations, one subproject¹ underwent environment protection completion audit conducted by the LPEPB in 2008. Subsequent environment protection completion review for the other subprojects will be conducted by end 2012.

B. Institutional Setup and Environmental Management

3. The provincial project management office (PMO) designated a person with an environmental engineering background to serve as an environmental officer for this project. Environmental management offices (EMOs) for all the subprojects have been established. Individuals from local Environmental Protection Bureaus, project implementing agencies (PIAs), contractors, construction supervision companies, and the PMO became members of the EMOs. Each of the contractors, construction supervision companies, and the PIAs designated one staff

¹ The Liaoyang Central Heating Supply subproject passed through the required domestic completion review and acceptance for environmental protection, and significant environmental benefits have been identified.

from the site management team to be responsible for environmental management and supervision. The PMO also engaged H&J, Inc. to provide environmental consulting services to inspect and monitor the implementation of mitigation measures. The PMO, PIAs, and EMOs ensured that the EMP is included in all contract bidding documents and operating contracts.

4. During the construction and installation period, the construction supervision companies were responsible for preparing and submitting monthly environmental supervision reports; local environmental monitoring stations were engaged as external environmental monitoring agencies to be responsible for monitoring environmental parameters according to the EMP clauses and preparing environmental monitoring reports. During the operational stage, the PIAs were responsible for preparing and submitting monthly environmental supervision reports; the external environmental monitoring agencies, with the assistance of the PIAs, were responsible for environmental monitoring in accordance with the EMP clauses, and for preparing monthly monitoring reports. The provincial PMO, with assistance from the consultant, was responsible for compiling and submitting semiannual environmental monitoring reports. In total, 21 Environmental Monitoring Reports (EMRs) prepared by local EMOs have been submitted to the Liaoning PMO, while eight semiannual EMRs prepared by the Liaoning PMO have been submitted to ADB and uploaded to the ADB website in line with ADB's public communication policies. The PMO has prepared EMRs in accordance with ADB requirements.

C. Environmental Impacts and Mitigation

5. Measures have been taken to minimize the negative impacts to the local and regional environment during the construction and operational period of the subprojects. During construction, dust caused by traffic, excavation and earthmoving, and aggregate processing facilities was suppressed with routine measures (e.g., water sprays on construction sites and roads, tarpaulins to cover trucks hauling raw materials). Construction vehicles and stationary equipment for aggregate processing and concrete mixing met existing national emission and noise standards. Construction activities in urban areas and near sensitive receptors (schools, hospitals, etc.) were limited to daylight hours. During operation, to minimize the emission of pollutants such as dust and sulfur dioxide (SO₂), all boilers under the project were equipped with specially designed dust removing and desulphurization equipment, which have been put into operation to meet the national Atmospheric Pollutant Discharge Standard for Boilers (GB13271-2001).

6. Monitoring stations were set up around the heat source plants to monitor SO₂, nitrogen oxide (NO_x), total suspended particulates (TSP), and PM₁₀² during operation. Almost all monitoring results met national standards, with the only exception being the Yingkou subproject where some TSP and PM₁₀ values exceeded the standards. Subsequent regional air quality monitoring has been conducted to analyze the issue. The results show that the impact was not caused by the project intervention.

7. Emissions of TSP, SO₂, and NO_x from newly installed boilers were tested and the results were in compliance with the national standards. In addition, monitoring stations were set up in the outlet of the dust removal systems used for coal conveyor systems. The results showed that all monitoring data for TSP were in compliance with the standards. Monitoring locations were also set up around the plants and within the surrounding residential quarters if applicable. The measured noise levels during the day and at night were in compliance with the relevant standards. The continuous emission monitoring equipment was installed in the Yingkou

² Particulate Matter (PM10).

Combined Heat and Power Plant, the Benxi Huaxing Heating Plant, and the Benxi Hengze Heating Plant and became operational during the 2009–2010 heating season.

D. Environmental Benefits

8. The project has improved and expanded clean energy supplies; improved energy efficiency; improved ambient and indoor air quality; and reduced the explosion risks associated with methane gas production, transmission, and distribution. Global environmental benefits were realized via expanded coal mine methane (CMM) production, capture and utilization of vented methane, and improved energy efficiency, which will result in reduced methane and carbon dioxide (CO₂) emissions.

9. The Fuxin CBM and CMM Development subproject was registered with the United Nations Clean Development Mechanism Board on 9 January 2009 as a clean development mechanism (CDM) project with support from ADB's CDM Facility, and project implementation has resulted in 212,531 certified emission reductions (CERs) during the verification period from 9 January 2009 to 30 June 2009, and 697,463 CERs during the verification period from 1 July 2009 to 30 November 2010, with actual revenue of about CNY68 million. Approximately 360,000 CERs generated from 1 December 2010 to 31 July 2011 are under verification, with expected revenue of about CNY20 million.

10. A total of 442 small and inefficient coal-fired boilers have been closed as a result of the completion of the central heating subprojects. The indoor air quality during the winter heating season and ambient air quality in general in the subproject cities have been significantly improved. The project has achieved estimated annual emission reductions of 68,891 tons of TSP, 6,218 tons of SO₂, 6,722 tons of NO_x, and 1,304,689 tons of CO₂ equivalent.

E. Conclusion

11. During construction the contractors implemented EMP mitigation and monitoring measures well. The adverse effects of the project construction on the surrounding environment were minimized. The necessary environmental management approaches have been integrated into operations. Moreover, the project has improved and expanded clean energy supplies; improved energy efficiency; improved ambient and indoor air quality; and reduced the explosion risks associated with methane gas production, transmission, and distribution in the project cities in Liaoning Province.

LAND ACQUISITION AND RESETTLEMENT

A. Scope of Project Impact

1. The resettlement plan was approved by the Asian Development Bank (ADB) in September 2004 during project preparation. According to the resettlement plan, land acquisition and resettlement impacts were considered minor; only the Fuxin Coal-Bed Methane (CBM)/Coal Mine Methane (CMM) Development subproject would acquire village collective land. Under the Fuxin subproject, 6 *mu*¹ of farmland would be permanently acquired, and 111 *mu* of farmland would be temporarily used during implementation of the gas transmission pipeline. According to the detailed design, 43.75 *mu* of farmland would be permanently acquired by the project, an increase of 37.75 *mu* from the resettlement plan. The main reason for the significant change is that 26.16 *mu* of permanent land acquisition for the Liujianan Gas Storage and Distribution Station was not included in the original plan. The resettlement plan was updated and submitted to ADB and approved in early 2007.

2. Land acquisition for and resettlement implementation related to the Fuxin CBM and CMM Development subproject commenced in April 2008 and was mostly complete by September 2008. The actual amount of permanent land acquisition was reduced to 26.16 *mu* because all the vertical wells were installed on industrial land owned by the Fuxin CBM/CMM Development and Utilization Company. The improvements to the final resettlement plan implementation meant that only three households with 11 persons were affected by permanent land acquisition; no houses were relocated as a result of the project. The land acquisition and resettlement cost was CNY2.21 million, comprising CNY1.57 million for compensation and resettlement and CNY0.64 million for land taxes or fees. Table A12.1 presents the actual project permanent impacts versus those estimated in the original resettlement plan and updated resettlement plan.

Table A12.1: Permanent Land Acquisition

Item	Original RP (2004)	Updated RP (2007)	Actual
Land Acquisition Area (<i>mu</i>) ^a	10.40	43.75	26.16
Affected People (households/persons)	3/12	17/75	3/11
Affected Villages	1 (Xiwa)	2 (Xiwa and Shangwang)	1 (Shangwang)
Affected Town	Hanjiadian	Hanjiadian	Hanjiadian

a The *mu* is a Chinese unit of measurement (1 *mu* = 666.67 square meters).

Source: Resettlement plan (2004), updated resettlement plan (2007), project final report by project management office (2011).

3. Land was also used temporarily under the project for construction purposes, particularly for the installation of pipelines. The actual type and amount of temporary land use was similar to what was in the updated resettlement plan, except for the Fuxin CBM and CMM Development subproject. All vertical wells were installed on industrial land and so construction of the gas pipeline did not affect any farmland. The impacts induced by temporary land use during project implementation were not significant and land was rehabilitated upon completion of construction (Table A12.2).

¹ The *mu* is a Chinese unit of measurement (1 *mu* = 666.67 square meters).

Table A12.2: Temporary Land Use

Subproject	Land Type		Quantity (mu) ^a	
	Updated RP	Actual	Updated RP	Actual
Benxi GDI	Urban Road	Urban Road	1,090.50	1,080.00
Benxi Hengze CHS	Urban Road	Urban Road	60.00	63.75
Benxi Huaxing CHS	Urban Road	Urban Road	305.70	306.00
Fuxin CHS	Urban Road	Urban Road	54.15	13.05
Liaoyang CHS	Urban Road	Urban Road	60.00	53.40
Yingkou CHS	Urban Road	Urban Road	210.00	180.00
Fuxin CBM and CMM Development	Dry Land		239.40	0.00 ^b
Total			2,019.75	1,696.20

CHS = Central Heating Supply, GDI = gas distribution improvement, RP = resettlement plan.

a The *mu* is a Chinese unit of measurement (1 *mu* = 666.67 square meters).

b The Fuxin CBM/CMM Development and Utilization Company confirmed there was no temporary use of farmlands during construction.

Source: Updated resettlement plan (2007), project management office, and project implementing agencies.

B. Resettlement Policy and Compensation Rates

4. Land acquisition and resettlement were implemented based on the updated resettlement plan, the 2004 Land Administration Law, and a specific land acquisition and resettlement policy for the project issued by the government of Liaoning Province. The compensation rates in the original resettlement plan were estimated by the local Land Management Bureau. During preparation of the updated resettlement plan, the Fuxin CBM/CMM Development and Utilization Company negotiated with the two villages on compensation rates, and reached initial agreement on compensation. The compensation rate was CNY55,000/mu for permanent land acquisition and CNY10,500/mu for temporary land use. During implementation, on 11 January 2008 the Fuxin CBM/CMM Development and Utilization Company signed a formal compensation agreement with Shangwang village, in which the compensation standard was CNY60,000/mu, higher than that in the updated resettlement plan (Table A12.3).

Table A12.3: Land Compensation Rates

Item	Unit	Original RP (2004)	Updated RP (2007)	Actual Rate
Permanent land acquisition				
Land compensation and resettlement subsidies (dry land)	CNY/mu ^a	21,000	55,000	60,000
Temporary land use	CNY/mu	7,667	10,500	
Compensation for crops loss	CNY/mu	1,000	3,000	
Land recovery fee	CNY/mu	6,667	7,500	

RP = resettlement plan.

a The *mu* is a Chinese unit of measurement (1 *mu* = 666.67 square meters).

Source: Resettlement plan (2004), updated resettlement plan (2007), project final report by project management office (2011).

C. Resettlement Measures and Income Restoration

5. On the basis of initial consultation, the updated resettlement plan provided two options for compensation and resettlement—cash compensation and land for land. Cash compensation means that part of the land acquisition compensation (around CNY30,000/mu) would be given to households and they would not receive replacement land through adjusting land within the village. The remaining land acquisition compensation (CNY25,000/mu) would be used

collectively for the village. Land for land means that all land acquisition compensation would be kept in villages and households would get the same area of replacement land from the village. During the preparation of the updated resettlement plan, all 17 households preferred cash compensation.

6. During implementation, further consultations were conducted among villagers, including those directly affected by the project. The scope of land affected was reduced and only three households in one village would be affected. The project implementing agency (PIA) reached consensus with the village and the three households on a package of compensation and resettlement which included (i) cash compensation at the rate of CNY20,000/mu, (ii) social insurance premium at CNY21,300/person for eligible family member,² (iii) fertilizer subsidy at CNY1,000 per household, and (iv) replacement land through land adjustment by the end of 30 years, which is due in 2026. The balance of land compensation funds were used for community facilities, including river dikes, wells, roads, and bridges. An external monitor interviewed the three affected households and found they were satisfied with the compensation and resettlement arrangement.

7. Zhang Junyou and his wife only had an annual net income of about CNY500/mu from farming land since the climate conditions were not favorable to farming in the region. His family mainly depended on his salary (CNY7,200 per year) as the secretary of the village committee. During land acquisition, the family received cash compensation of CNY20,000/mu for land compensation, and the couple also got CNY21,300/person in cash as a social insurance fee and CNY1,000 as subsidy for fertilizer. The family invested its compensation (around CNY209,600 in total) in a small-scale coal trade business later, and receives an annual income of around CNY70,000, which is 17 times the income from the 8.3 mu of land being acquired and seven times Zhang Junyou's current salary (around CNY10,000/year). Similarly, farming was not the main source of the household income before or after the project for the other two affected households (of Pei Runshan and Yang Xianlin). There are three able-bodied laborers in the two affected families who are engaged in migrant work in Fuxin city with a daily wage of CNY200 for 6–7 months a year, which can bring an annual income of CNY60,000 to each household.

D. Participation and Information Disclosure

8. The participation of and consultation with affected people occurred during project preparation and implementation, which resulted in compensation rates increasing from the original planning stage to the updated planning stage and to the implementation stage. During the preparation stage, numerous surveys and discussions with village leaders and representatives of affected households were conducted from 2003 to 2006. As indicated in the updated resettlement plan, resettlement booklets were distributed to affected people in November 2003 and updated resettlement booklets were distributed to affected people in January 2007. During implementation, detailed consultations with the three affected households were conducted to address the affected people's concerns over resettlement policies; compensation rates; distribution of land compensation funds; and other entitlements such as subsidies, social insurance, and fertilizer, as well as farmland adjustment. Consequently, the Fuxin CBM/CMM Development and Utilization Company and Shangwang Village Committee signed agreement on land acquisition in January 2008.

² Six eligible affected persons and one unmarried daughter received the social insurance premium.

E. Monitoring and Evaluation

9. The Liaoning Academy of Social Science was engaged for the external monitoring and evaluation (M&E) of the implementation of land acquisition and resettlement. The M&E contents included compensation policy and standards, compensation fund payments, public consultation and participation, grievance mechanism, institutional arrangements, and livelihood rehabilitation. In March 2009, ADB received the monitoring report which indicated that affected households were satisfied and their incomes had been increased.

F. Conclusions and Lessons

10. Land acquisition and resettlement was implemented transparently to the satisfaction of affected households. Direct communications between the PIA and the affected village and affected households were sound and efficient. Compensation funds were delivered in a timely manner. Since there may be some uncertainties on land readjustment in 2027, as requested by ADB the local government and Shangwang Village Committee have made commitment on land redistribution for the three affected households to eliminate the concerns of affected people. Temporary land use impacts were also monitored and reported by the PIAs, which indicated that there were no significant economic losses as the pipelines were constructed under urban roads.

POVERTY REDUCTION AND SOCIAL IMPACTS

A. Background

1. Social and poverty analysis was conducted and treated as an integral part of project design during loan processing. A summary poverty reduction and social strategy (SPRSS) was developed to identify the key issues and formulate measures as part of project implementation. In 2007, the SPRSS was updated because of a change in project scope. The poverty reduction measures and social actions included

- (i) providing efficient and environmentally compatible gas and central heating supplies to the poor,
- (ii) creating jobs for the poor during project construction and operation,
- (iii) reducing environmental impacts on the poor,
- (iv) improving occupational safety of miners,
- (v) enhancing quality of life for the poor,
- (vi) implementing gas and heating assistance programs for the poor, and
- (vii) reemploying affected workers.

2. In addition, the subproject city governments and project implementing agencies (PIAs) would establish necessary mechanisms to ensure successful implementation of gas and heating assistance programs for the poor, which covers gas and heating connections and tariff discounts.

B. Providing Efficient and Compatible Gas and Central Heating Supplies to the Poor

3. The SPRSS indicates that the project would directly benefit a total urban population of about 2.7 million in the six project beneficiary areas of Fushun, Fuxin, Benxi, Anshan, Liaoyang, and Yingkou. About 199,800 people, or about 7.4% of the total beneficiaries, are poor as measured by the various city poverty lines. According to the updated SPRSS in 2007, the project would directly benefit a total urban population of about 2.48 million people in the seven project beneficiary areas of Benxi, Fuxin, Liaoyang, and Yingkou, and about 183,934 poor people. According to the poverty and social economic impact monitoring and evaluation report prepared by the project management office (PMO) and the consultant H&J, Inc., in 2011 upon project completion, the actual number of project beneficiaries had reached 2.64 million, 6.5% higher than in the updated SPRSS. Of the total beneficiaries, about 1.84 million urban residents benefit from gas supply and 0.80 million people benefit from central heating supply. About 239,000 people, or about 9.1% of the total beneficiaries, were poor.

C. Creating Jobs During Project Construction and Operation

4. The project created 4,928 person-years of employment opportunities with total combined incomes of about CNY39 million per year during the construction period, and approximately 786 full-time jobs that provide combined annual incomes of CNY14 million during the operation period. Among these, nearly 30% of temporary jobs during the construction period and 200 full-time jobs in the operation period have been provided to the poor, women, and ethnic minorities (Table A13.1).

Table A13.1: Job Creation During Project Construction and Operation

Subproject	Jobs during Construction (Person-years)			Jobs during Operation (Persons)		
	Total	Female	Daily Wage (CNY)	Total	Female	Monthly Salary (CNY)
Benxi Hengze CHS	260	45	50	120	30	1,500
Benxi Huaxing CHS	209	37	50	103	26	1,500
Fuxin CHS	300	60	50	144	48	1,500
Liaoyang CHS	519	130	50	100	5	1,500
Yingkou CHS	520	60	50	166	32	1,500
Benxi GDI	120	15	50	32	6	1,500
Fuxin CBM and CMM Development	3,000	500	50	120	10	1,500
Total/Average	4,928	847	50	786	157	1,500

CHS = Central Heating Supply, GDI = Gas Distribution Improvement.

Source: Project management office and project implementing agencies.

D. Reducing Pollutions and Enhancing Life Quality for the Poor

5. A total of 442 small and inefficient boilers were closed upon completion of the central heating subprojects. As a result, the air quality in the subproject cities has been significantly improved. The total days in the three project cities with air quality better than grade II (People's Republic of China [PRC] National Standard) generally increased after project completion (Table 13.2).

Table 13.2: Days with Air Quality Better than Grade II, 2005–2010

Subproject City	(Days)					
	2005	2006	2007	2008	2009	2010
Yingkou	353	343	344	352	359	362
Benxi	291	303	312	319	343	345
Fuxin		270	300	305	314	295
Total	644	916	956	976	1,016	1,002

Source: Poverty and social economic impact monitoring and evaluation report (2011), PMO, and H&J, Inc.

6. Environmental conditions—particularly air quality—in the project cities have been significantly improved throughout project implementation. Under the project, the following annual emission reductions have been achieved: 68,891 tons of total suspended particulates, 6,218 tons of sulfur dioxide, 6,722 tons of nitrogen oxide, and 1,304,689 tons of carbon dioxide equivalent. The project also achieved coal savings of 286,627 tons per year. By improving gas and central heating supplies to local residents, especially the poor, the project has significantly improved the overall quality of life for people in the project areas through cleaner and more convenient working and living conditions, less housework for women, and decreased health problems and costs.

E. Improving Occupational Safety of Miners

7. The construction of the Fuxin Coal-Bed Methane (CBM)/Coal Mine Methane (CMM) Development subproject and implementation of the coal mining safety enhancement program has directly improved the safety of 16,000 miners in the subproject area. There has been a reduction from 13 accidents, 266 deaths, and 5 serious injuries in 2005 to 3 accidents, 3 deaths, and 1 serious injury in 2011. As a result, the target of greater than 20% improvement in coal mine safety has been achieved. Improved safety has prevented miners' households from becoming poor and vulnerable.

F. Implementing Heating and Gas Assistance Programs for the Poor

8. The affordability of heating and gas has been a major concern of the beneficiaries, particularly the poor. For a typical poor household living in a 40 square meter apartment unit in the project cities, the SPRSS indicated that 21%–27% of its total household expenditure is spent on heating. During project preparation, the project cities and PIAs agreed to two specific programs to help the poor to pay for gas supply and winter heating. As indicated in Table A13.3, from 2006 to 2010, all seven PIAs cumulatively provided assistance to 208,539 poor households on heating and/or gas supply service, with a total amount waived for tariff and/or connection fees of CNY363 million. In addition, various local governments took measures to subsidize poor households on heating (Table A13.4).

Table A13.3: Project Implementing Agency Assistance on Heating and Gas Supply Service

Subproject	PIA Key Actions	Total Benefitted Households (2006–2010)	Total Waived Tariff/Connection Fees (2006–2010) (CNY million)
Fuxin CHS	PIA offered free heating connection for all new consumers and waived 90% tariff for poor households (reduce 90% tariff for housing area less than 60 m ² and charge full price for the surplus housing area above 60 m ² per household, CNY5/m ² for poor households with an independent meter and house area less than 42 m ²)	24,891	19.63
Benxi Hengze CHS	PIA waived 90% of the heating tariff for poor households	67,517	75.40
Benxi Huaxing CHS	PIA offered free heating connection for all new consumers and reduced 55% tariff for poor households	7,413	13.10
Liaoyang CHS	PIA waived 80% of the heating tariff for poor households	19,087	22.68
Yingkou CHS	PIA waived 80% of the heating tariff for poor households	49,631	39.69
Benxi GDI	PIA offered a 50% discount for gas connection and 20% tariff discount for poor households	15,000	72.20
Fuxin CBM and CMM Development	PIA offered a 50% discount for gas connection and 20% tariff discount for poor households ^a	25,000	120.30
Total		208,539	363.00

CHS = central heating supply, GDI = gas distribution improvement, m² = square meter, PIA = project implementing agency.

^a A PIA has visited 20 poor households yearly with an annual cash donation of CNY10,000.

Source: Poverty and social economic impact monitoring and evaluation report (2011), PMO, and H&J, Inc.

Table A13.4: Government Heating Subsidy Programs

Subproject City	Key Government Programs	Fund Source
Benxi	(i) 90% heating subsidy to veterans and model workers in extremely difficult enterprises, (ii) 45% heating tariff subsidy provided to low-income families and regular employees of the extremely difficult enterprises, and (iii) 45% heating subsidy to marginal low-income households with incomes between CNY235 and CNY285 per person per month.	50% from the municipal fiscal budget 50% from the provincial government
Fuxin	(i) Heating tariff subsidy for households under the MLG for 14 m ² per person, counting three persons if household has less than three persons; (ii) 100% heating subsidy to households with three "nos" (no income source, no earning ability, and no legal living supporter) and retired cadres who once worked in difficult municipal enterprises; and (iii) CNY200 subsidy to each marginal low-income household with incomes between CNY180 and CNY220 per person per month.	100% from the provincial government
Liaoyang	(i) 100% subsidy up to 60 m ² for households with three "nos" (no income source, no earning ability, and no legal living supporter); this subsidy is provided by the municipal fiscal budget; (ii) 80% subsidy up to 60 m ² for households under the MLG; this subsidy is shared by the municipal fiscal budget, district fiscal budgets, and heating supply companies; and (iii) 85% subsidy for some special households including retired military soldiers and employees in bankrupted enterprises and extremely difficult enterprises.	100% from the municipal fiscal budget
Yingkou	(i) 100% heating subsidy to households with three "nos" (no income source, no earning ability, and no legal living supporter), (ii) 70% heating subsidy to households with chronically sick persons (chronicle kidney or liver problems, leukemia, cancerous tumors, etc.), (iii) 50% heating subsidy to extremely difficult households (e.g., single parent family, extremely low family income, etc.), and (iv) CNY500 subsidy to each self-heating-supply household.	CNY4.0 million–CNY4.5 million from provincial government; gap filled by municipal government

m² = square meter, MLG = minimum life guarantee.

Source: Poverty and social economic impact monitoring and evaluation report (2011), PMO, and H&J, Inc.

G. Closing Small Boilers and Reemploying Affected Workers

9. The closure of 442 small boilers affected 1,740 workers. All the affected workers have been reemployed by subprojects or other enterprises or units. Table A13.5 summarizes the closure of small boiler houses and the reemployment of affected boiler workers by subproject.

Table A13.5: Closure of Small Boiler Houses and Reemployment of Affected Workers

Subproject	Closure of Small Boiler		Reemployment		
	Houses	Labor Retrenchment	Total	By Project	By Others
Benxi Hengze	63	324	324	281	43
Benxi Huaxing	28	53	53	21	32
Liaoyang	174	944	944	380	564
Yingkou	177	419	419	339	80
Total	442	1,740	1,740	1,021	719

a No small boilers closed under the Fuxin Central Heating Supply subproject.

Source: consultations with PIAs in February 2012.

10. Before the affected small-boiler workers were assigned new positions by the project, they received technical and on-the-job training organized by various PIAs. Training contents included operation of large heating boilers, panel control, maintenance and repair, stoking, electrical work, and welding. As shown in Table A13.6, 2,311 person-times of training have been conducted during the project construction and operation period.

Table A13.6: Reemployment Training

Subproject	Person-times
Benxi Hengze	200
Benxi Huaxing	104
Liaoyang	900
Yingkou	1,107
Total	2,311

Source: Consultations with PIAs in February 2012.

11. For some workers who were not willing to be reemployed by PIAs, the local Human Resource and Social Security Bureau, together with relevant government agencies, provided skill trainings for them, such as in electric welding and electrical appliance repair.

G. Gender Development

12. The improved gas and heating supply has significantly improved living quality for urban residents, especially women. They now have access to cleaner, more convenient, and more reliable heating and/or gas supply systems which brings them better indoor air quality and smaller workload with regard to energy provision. Therefore, their health has improved and they have more time to enjoy life. In addition, about 847 out of 4,928 person-years of employment have gone to women, with a combined income of about CNY6.8 million per year during the project construction period, and 157 out of 786 full-time jobs provide women a combined annual income of CNY2.8 million since operation. Taking the Fuxin Central Heating Supply subproject as an example, 20% (60 out of 300) of construction jobs and 33% (48 out of 144) permanent positions were provided to females. Similarly, women accounted for 18% (37 out of 209) of the labor force during construction and 25% of the labor force (26 out of 103) during operation in the Benxi Huaxing Central Heating Supply subproject (Table A13.1).

H. Conclusion and Lessons

13. Given the incorporation of the poverty reduction and social strategy in the project design and implementation, the project has demonstrated direct and significant impacts on poverty reduction and social development in the project beneficiary areas, as follows:

- (i) A total of 2.64 million urban residents are benefitting from gas and central heating supply, of which about 239,000 people, or about 9.1% of the total beneficiaries, are poor.
- (ii) Among a total of 4,928 person-years of employment during construction and 786 full-time jobs during operation, around 30% to the poor, women, and minorities.
- (iii) The overall quality of life for people in the project areas was improved through cleaner and more convenient working and living conditions, less housework for women, and decreased health problems.
- (iv) Implementation of gas and heating assistance programs ensured that the project benefits could be enjoyed by the poor, which has cumulatively benefitted 208,539 poor households.
- (v) Implementation of the coal mining safety enhancement program has directly improved the work safety of 16,000 miners in the subproject area.
- (vi) Reemployment of affected workers induced by closing small boilers mitigated the adverse project impact and improved their working environment.

SUMMARY OF THE ASSESSMENT OF PROJECT PERFORMANCE

Criterion	Weight (%)	Assessment	Rating Value	Weighted Rating
Relevance	20	Highly Relevant	3	0.6
Effectiveness	30	Effective	2	0.6
Efficiency	30	Efficient	2	0.6
Sustainability	20	Likely	2	0.4
Impact		Substantial Positive		
Overall Rating		Successful	N/A	2.2

Source: Asian Development Bank.