



# Completion Report

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Project Number: 29629  
Loan Number: 1548  
September 2008

## Mongolia: Ulaanbaatar Heat Efficiency Project

## CURRENCY EQUIVALENTS

Currency Unit – togrog (MNT)

		<b>At Appraisal</b> (23 May 1997)	<b>At Project Completion</b> (31 December 2006)
MNT1.00	=	\$0.00125	\$0.00086
\$1.00	=	MNT798	MNT1,163

## ABBREVIATIONS

ADB	–	Asian Development Bank
CHP	–	combined heat and power plant
DHC	–	Ulaanbaatar District Heating Company
DHS	–	district heating system
EIRR	–	economic internal rate of return
ERA	–	Energy Regulatory Authority
FIRR	–	financial internal rate of return
HCSC	–	housing and communal services company
PIU	–	project implementation unit
PSC	–	project steering committee
SDR	–	special drawing rights
TA	–	technical assistance
TES	–	thermal energy station

## WEIGHTS AND MEASURES

kW	(kilowatt)	–	1,000 watts
MW	(megawatt)	–	1,000,000 watts
GW	(gigawatt)	–	1,000,000,000 watts
kWh	(kilowatt-hour)	–	1,000 watt-hours
GWh	(gigawatt-hour)	–	1,000,000 kWh
Gcal	(gigacalorie)	–	1,000,000 kilocalories
MVA	(megavolt-ampere)	–	1,000,000 volt-ampere
Tcal	(teracalorie)	–	1,000 gigacalories

## NOTE

In this report, "\$" refers to US dollars.

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## BASIC DATA

### A. Loan Identification

1.	Country	Mongolia
2.	Loan Number	1548
3.	Project Title	Ulaanbaatar Heat Efficiency Project
4.	Borrower	Mongolia
5.	Executing Agency	Ulaanbaatar District Heating Company
6.	Amount of Loan	SDR29.487 million (\$40 million) (\$600,000 [SDR407,409.42] canceled 21 Oct 2004; and \$103,509 [SDR68,950] canceled 1 Mar 2007)
7.	Project Completion Report Number	MON 1029

### B. Loan Data

1.	Appraisal	
	– Date Started	23 May 1997
	– Date Completed	6 June 1997
2.	Loan Negotiations	
	– Date Started	19 August 1997
	– Date Completed	20 August 1997
3.	Date of Board Approval	25 September 1997
4.	Date of Loan Agreement	9 December 1997
5.	Date of Loan Effectiveness	
	– In Loan Agreement	19 March 1998
	– Actual	24 November 1998
	– Number of Extensions	2
6.	Closing Date	
	– In Loan Agreement	30 June 2003
	– Actual	1 March 2007
	– Number of Extensions	3
7.	Terms of Loan	
	– Interest Rate	1% per annum
	– Maturity (number of years)	40 years
	– Grace Period (number of years)	10 years
8.	Terms of Relending (if any)	
	– Interest Rate	Variable rate of interest applicable to multicurrency loans from ADB's ordinary capital resources
	– Maturity (number of years)	25
	– Grace Period (number of years)	5
	– Second Step Borrower	Ulaanbaatar District Heating Company

## 9. Disbursements

## a. Dates

<b>Initial Disbursement</b>	<b>Final Disbursement</b>	<b>Time Interval</b>
20 January 1999	1 March 2007	98 months
<b>Effective Date</b>	<b>Original Closing Date</b>	<b>Time Interval</b>
24 November 1998	30 June 2003	56 months

## b. Amount (SDR million)

<b>Category</b>	<b>Original Allocation</b>	<b>Last Revised Allocation</b>	<b>Amount Canceled</b>	<b>Amount Disbursed</b>
Equipment: Power Station Improvements	7.12	5.85	0.07	5.85
Equipment: Control & Monitoring System	0.72	1.95		1.95
Equipment: Substation Improvements	3.66	3.72		3.72
Equipment: Ventilation Systems	0.34	0.36		0.36
Equipment: Separation of Direct Consumers	8.32	9.08		9.08
Equipment: Heat System Installations	1.45	1.97		1.97
Equipment: Bulk Heat & Hot Water Meters	0.85	1.79		1.79
Equipment: Individual Meters & Heat Control	0.67	1.40		1.40
Consulting Services	1.03	2.47		2.47
Service Charge	0.83	0.42	0.41	0.42
Unallocated	4.50			
<b>Total</b>	<b>29.49</b>	<b>29.01</b>	<b>0.48</b>	<b>29.01</b>

**C. Project Data**

## 1. Project Cost (\$ million)

<b>Cost</b>	<b>Appraisal Estimate</b>	<b>Actual</b>
	<b>\$</b>	<b>\$</b>
Foreign Exchange Cost	43.00	40.99
Local Currency Cost	12.70	7.12
<b>Total</b>	<b>55.70</b>	<b>48.12</b>

## 2. Financing Plan (\$ million)

<b>Cost</b>	<b>Appraisal Estimate</b>	<b>Actual</b>
	<b>\$</b>	<b>\$</b>
Implementation Costs		
ADB Financed	40.00	40.99 <sup>a</sup>
Borrower Financed	12.70	7.12
External Financing (Spain)	3.00	0.00
<b>Total</b>	<b>55.70</b>	<b>48.12</b>

<sup>a</sup> Equivalent to SDR29.01 million  
ADB = Asian Development Bank

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

<b>Component</b>	<b>Appraisal Estimate</b>	<b>Actual</b>
	<b>\$</b>	<b>\$</b>
1. District Heating System Conversion	32.17	31.66
2. Customer System Improvement	4.94	8.94
3. Steam System Rehabilitation	2.44	0.00
4. Consulting Services	1.93	3.63
<b>Total Base Cost</b>	<b>41.48</b>	<b>44.23</b>
5. Physical Contingency	4.94	0.00
6. Price Contingency	2.74	0.00
7. Interest During Construction	6.54	3.89
<b>Total Project Cost</b>	<b>55.70</b>	<b>48.12</b>

## 4. Project Schedule

<b>Item</b>	<b>Appraisal Estimate</b>	<b>Actual</b>
<b>Improvement at Power Plants</b>		
Bid Opening	Apr 1998	Aug 1998
Award of Contract	Aug 1998	Jun 2000
Completion of Design	Mar 1999	Jan 2001
Completion of Installations	Oct 2001	May 2006
<b>Improvement at Substations</b>		
Bid Opening	Jan 1998	
Lot A		Mar 2002
Lot B		Mar 2002
Lot C		Mar 2002
Award of Contract	Apr 1999	
Lot A		May 2004
Lot B		Dec 2002
Lot C		Dec 2002
Completion of Implementation	Oct 2002	
Lot A		Nov 2006
Lot B		Jun 2007
Lot C		Nov 2006
<b>Implementation Consultants</b>		
Selection	Oct 1997	Nov 1997
Date of Contract	Nov 1997	May 1998

## 5. Project Performance Report Ratings

<b>Implementation Period</b>	<b>Ratings</b>	
	<b>Development Objectives</b>	<b>Implementation Progress</b>
November 1998 to February 1999	Satisfactory	Satisfactory
March 1999 to May 2002	Satisfactory	Highly Satisfactory
June 2002	Satisfactory	Satisfactory
July 2002 to December 2002	Satisfactory	Highly Satisfactory
January 2003 to August 2004	Satisfactory	Satisfactory
September 2004 to December 2004	Satisfactory	Partly Satisfactory
January 2005 to September 2005	Satisfactory	Satisfactory
October 2005	Satisfactory	Partly Satisfactory
November 2005 to April 2006	Satisfactory	Satisfactory
May 2006	Satisfactory	Partly Satisfactory
June 2006 to September 2006	Satisfactory	Satisfactory
October 2006 to November 2006	Satisfactory	Partly Satisfactory
December 2006 to December 2007	Satisfactory	Satisfactory

**D. Data on Asian Development Bank Missions**

<b>Name of Mission</b>	<b>Date</b>	<b>No. of Persons</b>	<b>No. of Person-Days</b>	<b>Specialization of Members<sup>a</sup></b>
Fact-Finding	4–21 Mar 1997	5	90	a, b, d, k
Appraisal	23 May–6 Jun 1997	4	60	a, b, e, k
Review 1	3 Nov 1997	1	1	a
Review 2	26 Nov–4 Dec 1997	1	9	d
Review 3	7–20 Oct 1998	2	28	d, g
Review 4	17–30 May 1999	2	28	d, g
Review 5	4–16 Nov 1999	2	26	d, g
Review 6	20–31 Oct 2000	2	24	d, g
Review 7	13–26 Jun 2001	2	28	d, g
Review 8	24–30 Mar 2002	1	7	f
Review 9	20 Jun–3 Jul 2002	3	42	f, g, h
Review 10	21–29 Jul 2003	2	18	d, g
Review 11	6–15 Sep 2004	3	22	c, g, l
Review 12	23 May–3 Jun 2005	3	24	c, g, l
Review 13	24–31 May 2006	4	32	c, i, j, l
Project Completion Review	14–25 Apr 2008	4	10	c, g, h

<sup>a</sup> a - senior project economist, b - senior project engineer, c - senior financial specialist, d - project engineer, e - economist, f - energy specialist, g - assistant project analyst, h - staff consultant, i - director, j - social development specialist, k - young professional, l = senior economist

## I. PROJECT DESCRIPTION

1. The Ulaanbaatar Heat Efficiency Project was developed to address numerous deficiencies and shortcomings in the heat supply as identified in the late 1990s. The district heating system (DHS) suffered from insufficient heat supply in many areas, hydraulic imbalance, huge water losses, as well as lack of automatic controls and energy meters. The Ulaanbaatar DHS was initially constructed in 1959. It was based on supply of hot water produced at three combined heat and power plants (CHPs): Thermal Energy Station (TES) 2, TES 3, and TES 4. All three are coal-fired and generate electricity for the central electricity grid, steam for industrial purposes supplied through a separate pipe network, and hot water for the DHS. The main network of the DHS consists of about 125 kilometers (km) of double pipelines with diameters from 150 millimeters (mm) to 1,200 mm that feed the main substations and distribution points. About 36% of the pipelines in the main network are aboveground. The remaining 64% are underground pipelines placed in concrete ducts, mainly along roadways. Distribution networks are located beyond the substations or distribution points and total about 220 km of double pipelines with diameters from 20 mm to 200 mm. In operating the DHS, the Ulaanbaatar District Heating Company (DHC) acts as a heat wholesaler, buying heat from the power plants and selling it in bulk to large industrial, commercial, public, and institutional building operators; to the various housing and communal services companies (HCSCs) that belong to the Municipality of Ulaanbaatar and administer the majority of residential buildings; and to other, smaller housing companies in Ulaanbaatar. The steam system is administered by the power plants and covers parts of the city, generally in the vicinity of the power plants, where industries are located.

2. The Project's strategic objectives were to (i) meet the basic heating needs of the population, and (ii) improve sector efficiency. The direct objectives were to improve the district heating and steam system operations, encourage end-user efficiency, and thus ensure the reliability and adequacy of the heat and steam supply in Ulaanbaatar. The Project's target is to increase useful heat supply to consumers by more than half without installing additional capacity and to reduce electricity consumption for pumping by one third. The Project's scope included:

- (i) Conversion of the DHS to variable flow operation. This was planned to be achieved with the installation of about 22 variable speed pumps at the power plants, about 168 substation heat exchangers with control units, some 430 differential pressure controllers for heat ventilation systems, new distribution pipe work, approximately 1,412 heat exchanger installations in buildings, about 877 bulk heat meters, some 1,358 bulk hot water meters, a control and monitoring system together with modifications to the pressure holding system, hydraulic separation of the CHP plant internal heat systems, and about 300 cubic meters per hour of additional water treatment capacity.
- (ii) Consumer-end heat control and metering with pilot installation of meters, allocators, and valves for about 5,400 apartments plus the design and implementation of a new billing system.
- (iii) Rehabilitation of the steam system with the installation of about 2.2 km of replacement steam and condensate pipe, about 10.8 km of steam pipe insulation, 500 steam traps, and 57 steam meters.
- (iv) Project management and training, provided with consulting services for implementing supervision and training.



3. The Asian Development Bank (ADB) approved a loan of SDR29.487 million (\$40 million) for the Project on 25 September 1997 from its Asian Development Fund resources. The loan has a 40-year repayment term, including a 10-year grace period, and interest of 1% per annum. In October 2004, the Government agreed to cancellation of SDR407,409 (\$600,000) following a review of the project needs. Final loan savings at closing date of SDR68,950 (\$103,509) were cancelled, resulting in actual total loan utilization of SDR29,010,640 (\$40,993,348).

4. The loan agreement was signed on 9 December 1997 and became effective on 24 November 1998. The original Executing Agency was the Energy Authority, which was the national integrated energy supply utility. As part of the government's energy sector reform program, the former integrated entity was unbundled in 2001, and new corporate entities were created according to functional responsibilities. Prior to unbundling, the DHC was an administrative unit within the Energy Authority responsible for district heating distribution in Ulaanbaatar. After the restructuring, it became an independent state-owned company, and it was designated as the new Executing Agency for the Project. The original implementation period was planned for 5 years, but the Project took 9 years to complete. Appendix 1 lists the chronology of major events during loan implementation.

5. At the request of DHC, the original loan closing date of 30 June 2003 was extended three times to 31 December 2006 for a total of 3.5 years. The loan account was actually closed on 1 March 2007 following final disbursement. Loan repayment started on 15 October 2007, and SDR580,200 has been repaid as of 30 April 2008.

## II. EVALUATION OF DESIGN AND IMPLEMENTATION

### A. Relevance of Design and Formulation

6. Mongolia is one of the coldest countries in the world. Given its harsh climate, where temperatures can fall as low as minus 40°C, heat is a basic need. Deterioration in the piping and equipment of the DHS in Ulaanbaatar has limited the system's capacity to meet this basic need for nearly one million residents of the city and has prevented the connection of new industrial and commercial consumers to the DHS. That, in turn, has inhibited the city's growth. Subsequent migration from the rural areas to Ulaanbaatar also placed a heavy demand on heat supply. The Project has addressed these problems through redesign, rehabilitation, and modernization of the DHS to increase its inherent capacity and improve its reliability.

7. The Energy Authority and its successor, DHC, lacked adequate funds for rehabilitating and modernizing the DHS. The Project was part of a least-cost development program needed to improve the efficiency and reliability of heat supply in Ulaanbaatar and the electricity supply from the main grid. It was designed to complement the electricity and heat system rehabilitation measures being implemented at that time with assistance from ADB.<sup>1</sup> The Government put high priority on adequate and reliable supply of power and heat to support Mongolia's economic transformation and development. The Project was in line with ADB's operational strategy at the time for Mongolia's energy sector, which was focused on sector reforms, rehabilitation of existing facilities, tariff adjustments, energy conservation, and strengthening of sector institutions.

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<sup>1</sup> Loan 1334-MON (SF): *Power Rehabilitation Project*, for SDR27.142 million (\$40 million equivalent), approved on 24 November 1994; Loan 1492-MON (SF): *Energy Conservation Project*, for SDR6.944 million (\$10 million equivalent), approved on 26 November 1996.

## B. Project Outputs

8. **Conversion of the District Heating System to Variable Flow Operation.** The basic concept of the Project was to restructure the DHS in a such a way that the consumer installations designed for low pressure were hydraulically separated from the main transmission system. This hydraulic separation allowed the main transmission system to operate at a higher pressure level and accordingly increased the hydraulic capacity of the pipe system. The hydraulics in the Ulaanbaatar DHS were especially challenging due to the big elevation differences in the system. The installation of heat exchangers with automatic controls at selected locations enabled heat supply to secondary side installations to be adjusted automatically according to measured outdoor temperature. At the heat producers' end, i.e. the power plants, speed-controlled pumps with frequency converters were installed at TES 3 (5 pumps), and TES 4 (8 pumps), enabling the power plants to supply the required pressure and flow under variable flow conditions. Other improvements at the power plants, including TES 2, were replacement of hand operated valves with automatic control valves and new condensate control units for the heat exchanges, upgrading the pressure holding and water replenishment system, separation of internal heating systems, installation of water treatment equipment and de-aerator system, and installation of a control monitoring system to control the heat transferred to the distribution network. At the distribution and consumer end, 17 heating units were installed at 14 substations and 2 new substations; 417 units of heat exchangers were also installed at various selected distribution centers around the city, and about 9,000 meters (m) of underground and external pipes were connected to the heating units. The actual numbers and sizes of equipment installed differed from the estimates at appraisal due to design and scope changes. Following the rehabilitation, the DHS was able to supply reliable heating to more customers.

9. **Consumer-end Heat Control, Metering, and Billing Improvement.** A major part of this component was, in reality, closely tied to the distribution and consumer-end works described above. In addition to the heating units, hot water treatment systems were installed to improve water quality in the network, together with about 979 mixing loops and about 100 balancing valves for the ventilation system. Residential buildings were fitted with balancing valves, balancing risers, and energy meters. A pilot program was included in this component to install water meters, thermostatic valves and heat allocators on radiators in individual apartments so that consumers could individually control the heat supply and measure heat and hot water consumption. The actual installation included 5,822 thermostatic radiator valves; 510 strainers for risers; 3,850 allocators; and 2 monitoring systems. These were installed in 26 buildings. In connection with this, the pilot program included development of a new billing system that charged customers according to heat and hot water usage. Measured data from operation of the pilot project have been limited. The pilot program did not include an automatic data collection system, and PIU could not assign additional staff members to manually read the meters. The contractor tried to resolve this by setting up a data collection system based on modem connections to the energy meters at the various buildings. The system could not be put into operation, however, because of a lack of agreement on who would bear the cost of telephone charges for the dial-up modem. Additionally, difficulties were faced in making necessary adjustments to some of the installed equipment. Although billing is not based on consumption, the residents are able to control and shut off the heat supply when the weather is warm. As such, some measure of efficiency has been achieved in the utilization of the heat.

10. **Steam System Rehabilitation.** Although this component was to be financed by the Government of Spain, the Executing Agency renovated the steam system with its own resources. Consequently, the items were redefined to include reinforcement of the secondary

district heating pipe network and replacement of booster pumps at the pump stations with speed-controlled pumps. The changes were agreed with the Government of Spain, but the proposal was not ratified by the Mongolian parliament. DHC now intends to carry out these works with its own resources.

11. **Improved Management and Operation.** The Executing Agency's staff members were trained sufficiently by the consultants and contractors. Similarly, training and study tours provided under complementary technical assistance<sup>2</sup> were completed successfully.

### **C. Project Costs and Financing Plan**

12. At appraisal, the project cost, including interest during construction, was estimated at \$55.7 million equivalent, of which \$43.0 million (77% of total cost) was foreign exchange cost and \$12.7 million equivalent (23% of total cost) was local currency cost. On project completion, the actual cost was \$48.12 million, including interest during construction. Thus, the final cost was lower by \$7.58 million. The savings were due to the reduced interest during construction because of the slow rate of disbursement, non-implementation of the steam system network component, and unused contingencies of about \$5 million. At completion, 85% of the total cost was foreign exchange and 15% local currency.

13. The financing plan at appraisal consisted of ADB financing of \$40 million equivalent for the foreign exchange cost of the district heating components and related consulting services. The remaining \$3.0 million of the foreign exchange cost were to be financed by the Government of Spain for the steam rehabilitation system and related consulting services. As noted earlier, the Government withdrew the request for the loan from Spain and the project was carried out using local funds. Actual financing from ADB for the district heating components was \$40.99 million equivalent, or 85% of the total project cost. Comparison of the project costs estimated at appraisal with the actual is in Appendix 2.

### **D. Disbursements**

14. Disbursement of the ADB loan started in January 1999, two months after the loan was made effective. Disbursement was generally accomplished through reimbursement, commitment letters and direct payment. The rate of disbursement was slow initially as the first contract was awarded only in June 2000, followed by two other contracts in 2002. Disbursement accelerated in 2001, and subsequently increased steadily from 2002 to 2007 when project implementation was in full swing. The last disbursement was made in March 2007 with the final payment to the implementation consultants. When the loan account was closed on 1 March 2007, a total of \$40.99 million equivalent (SDR29.01 million) had been disbursed and the undisbursed balance of SDR68,950 (\$103,509 equivalent) was cancelled. Appendix 3 presents projected and actual disbursements.

### **E. Project Schedule**

15. The original implementation schedule was for the Project to be completed by December 2002, about 5 years from estimated loan effectiveness in March 1998. The deadline for loan effectiveness was extended twice because of the delay in meeting the conditions for loan effectiveness. Frequent changes in government during this period delayed decisions concerning

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<sup>2</sup> ADB. 1996. *Technical Assistance to the Government of Mongolia for Ulaanbaatar Heat Rehabilitation Project*. Manila (TA2610-MON approved on 18 July 1996 for \$450,000).

the loan. Loan effectiveness was declared on 24 November 1998 after ADB received official documentation supporting the automatic tariff adjustment mechanism. There were three extensions to the loan closing date up to 1 March 2007—a cumulative extension of 44 months. DHC continued to carry out the residual work in the summer of 2007. Thus, the physical completion of the Project took almost 9 years. Implementation of the ADB-financed portion of the Project was divided into two parts: improvements at power plants (tendered as package 1), and substations and consumer installations (tendered as package 2). There were considerable delays in the preparation and evaluation of bids for both procurement packages. Appendix 4 shows the project implementation schedule as originally planned and as actually executed.

16. **Improvement at Power Plants.** Bids for package 1 were issued in January 1998 and closed on 20 August 1998. During bid evaluation, it was found that the cost of the specified scope of work exceeded the funds available for the package. After much delay during bid evaluation and contract negotiations, the contract was finally signed in June 2000 for a reduced scope of work that did not compromise the project objectives. The original contract stipulated an implementation starting date of 1 June 2000 and completion date of 1 September 2002. However, implementation took significantly longer due to contractor's lack of international experience, and quality of goods and workmanship that did not meet contractual requirements. Actual completion took place in June 2006 when DHC issued the final acceptance certificate.

17. **Substations and Consumer Installations.** Package 2 also underwent a prolonged bidding period. Prequalification bid documents were approved by ADB in April 1998, but the bids were opened in May 2000 as a consequence of delays in the evaluation of package 1 and clarifications sought by bidders. Further, the bids significantly exceeded the available budget. The bidding documents had to be revised and the scope of work redefined; package 2 was subsequently retendered as three lots (A, B, and C). Contracts for lots B and C were signed in December 2002, whereas that for lot A could only be signed in May 2004. There were numerous design changes during implementation of the package 2 components. These were largely due to hydraulic conditions that had changed or were unknown at the time of design; there were also some fundamental changes, such as the location and capacity of heating substations and heat exchangers. Package 2 was originally expected to be completed in December 2005, but actual completion was in 2007.

## **F. Implementation Arrangements**

18. At the time of appraisal in 1997, the Energy Authority was designated as the Executing Agency responsible for supervising and implementing the Project. The Energy Authority was originally a department under what was then the Ministry of Infrastructure Development. DHC was initially an administrative department, and later became one of the subsidiary companies under the Energy Authority, functioning as the bulk distributor of heat from the power plants. In April 2001, however, in line with the energy sector restructuring, a new Energy Law was introduced that created three separate organizations: the Energy Authority, Energy Regulating Authority (ERA), and National Dispatching Center. All the subsidiary companies under the Energy Authority, including DHC, became independent, state-owned shareholding companies. To support development of the energy sector, the Ministry of Fuel and Energy was established in 2004 and the Energy Authority was subsequently dissolved. As a result, DHC was designated the Executing Agency for the Project and it was under the Ministry of Fuel and Energy. It took over both implementation and repayment responsibilities for the ADB loan. DHC's organizational structure is in Appendix 5. The project management structure included a project steering committee that had been established under previous ADB energy projects (footnote 1) and a project implementation unit (PIU) for day-to-day management of the Project. The steering

committee provided guidance to the PIU and met as necessary to (i) review all technical plans and designs; (ii) oversee and coordinate all activities, including liaison among the agencies involved; and (iii) serve as a forum for problem resolution. The majority of PIU staff were from the DHC and the HCSCs, and quite a number of staff changes took place during implementation of the Project. The HCSCs facilitated installation of heating units in buildings under their jurisdiction and participated in training on maintenance of the equipment. The Executing Agency relied heavily on the implementation consultant, who generally took the lead on design, preparation of bidding documents, bid evaluation, and negotiations with the winning bidders. After the construction contracts were awarded and the activities shifted to the field, the PIU took the lead in project execution and the services of the consultant were provided on an as-required basis.

## **G. Conditions and Covenants**

19. The loan covenants were generally complied with. Exceptions were the covenants for the establishment of a quarterly automatic heat and electricity tariff adjustment mechanism, individual metering of heat and hot water consumption, and those of a financial nature that were affected by insufficient heating tariff adjustments. The Government still subsidizes the operations of DHC, which continues to barely cover operating costs due to limited tariff adjustment. Full compliance with the loan covenants would require removing the subsidy and instituting a heating tariff that would allow full cost recovery. The Executing Agency kept separate project accounts, which were audited regularly. The status of loan covenant compliance is in Appendix 6.

## **H. Related Technical Assistance**

20. ADB approved technical assistance (footnote 2) in July 1996 to undertake a complete analysis of the DHS and to prepare a feasibility study for a suitable project. A comprehensive analysis of the DHS in Ulaanbaatar was undertaken, including an extensive computer analysis of the system with advanced software. It concluded that sufficient production capacity for adequate supply of heat already existed and that, after rehabilitation of the existing heat sources, there would be enough heat produced to meet the demand for at least 10 years. The technical assistance helped to identify the components that needed rehabilitation. The priority for rehabilitating and modernizing the DHS was confirmed by the findings of another technical assistance project,<sup>3</sup> which showed that rehabilitation was part of the least-cost development program to improve the efficiency and reliability of heat supply in Ulaanbaatar. The Project scope was determined through extensive discussions with government representatives and the Energy Authority.

## **I. Consultant Recruitment and Procurement**

21. As project work can only be carried out during the non-heating season (May–September) when weather conditions are favorable and the DHS is shut down, ADB approved advance action for recruiting implementation consultants and procurement activities. At appraisal, provision was made in the ADB loan proceeds to engage international consultants for 60 person-months and national consultants for about 108 person-months to support the PIU and assist DHC in such matters as tendering; review of engineering design; supervising the installation, testing and commissioning of equipment; and training for operations and

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<sup>3</sup> ADB. 1994. *Technical Assistance to the Government of Mongolia for Power System Master Plan Study*. Manila (TA2095-MON approved on 6 June 1994 for \$595,000).

maintenance. An international consulting firm was engaged in accordance with ADB's *Guidelines on the Use of Consultants*.

22. Procurement for the main project components was on a turnkey basis and was divided into three packages: package 1 (improvements at power plants), package 2 (substations and consumer installations), and package 3 (distribution network reinforcement). Package 3 was financed by DHC. Packages 1 and 2 were financed by ADB and procured in accordance with ADB's *Procurement Guidelines*. Contracts for ADB-financed packages were tendered using international competitive bidding procedures. Appendix 7 details the procurement packages financed by ADB. A small portion of domestic procurement funded by ADB was procured following shopping procedures.

## **J. Performance of Consultants, Contractors, and Suppliers**

23. As agreed with the PIU, the international consultant spent a considerable amount of time on basic engineering design and drawing up detailed technical specifications for equipment and works. The consultant also played a key role in the whole procurement process, including preparation of bidding documents, estimation of bid package prices, evaluation of bids, preparation of contracts, and negotiation with the winning bidders. As a result, supervision of the project field activities was relegated to the consultant on an as-needed basis.

24. It should be noted that the DHS is very complex in its design, installation, setup, and operation. Moreover, the original design was based on the neighborhoods as they existed during project preparation. By the start of project implementation, the social landscape of Ulaanbaatar had changed, and some of the locations originally identified had become irrelevant. The PIU had to identify new locations for installing the equipment, which necessitated the consultant to run numerous hydraulic model simulations for technical adjustments. This had to be done at the expense of implementation supervision. The consultant was diligent in assisting the PIU prepare and document the Project requirements, negotiating complex design and equipment changes with the contractors, was responsive to PIU's requests, was flexible in providing dedicated staff throughout the Project's duration, and remained committed to providing a high-quality heating system. Due to the protracted implementation period, the consultant's contract was extended seven times to 31 December 2006, and the actual input was 150 person-months for international consultants and 118 person-months of national consultants.

25. Implementation of package 1 (improvements at power plants) was hampered by delays in equipment delivery, insufficient labor force, and inadequate communication between the DHC, the consultant, and the contractor. The consultant reported that the contractor had problems in understanding the concept and nature of the project features and lacked a detailed plan for project execution. The contractor reportedly had difficulties in understanding Mongolian rules and regulations regarding customs procedures and import duties, resulting in delays in importing equipment and materials for the Project. Deviations were noted in respect of quality of goods and workmanship compared to the contractual requirements and to international standards. The contractor also had difficulties resolving problems with its subcontractor that supplied variable speed pumps that did not meet specifications. There was disagreement between the contractor and DHC how this problem should be rectified, and subcontractor attempted to resolve the issue directly with the DHC. The delay due to technical problems was further compounded by DHC's late payments for approved work. These issues had a serious impact on the implementation schedule. ADB's intervention was required to resolve differences amongst the involved parties; this fortunately made all parties more conscientious and package

1 was completed late but within budget. The late completion was thus caused by delays during all stages of implementation, starting from the bidding process through to final acceptance.

26. Although there were three separate contracts (lots A, B and C) under package 2 (substations and consumer installations), inasmuch as they all had the same contractor, in practice they were handled as one contract. In the first year of implementation, there were several misunderstandings regarding the requirements in the technical sections of the contract. It appeared that the contractor had not realized the complexity of the Project at the outset, and the challenges of working conditions in Mongolia. As with package 1, the contractor had to deal with Mongolian rules and regulations, including customs procedures and import duties, which consumed significant resources and time. Since the sites for installation of equipment were not final when the bids were submitted, the contractor had to repeatedly visit every site and make assumptions to prepare the overall system design and determine the capacity of heating units. The extent of the supply area and number of heating units to be installed were considerably larger than anticipated, and keeping sufficient qualified technicians throughout the implementation period became very challenging. On occasions, alternative solutions had to be investigated when the sites were found to be unsuitable. Because lots B and C involved works at a large number of sites, logistics, site preparation, installation works, follow-up actions, and administrative procedures became closely interrelated activities requiring good coordination between the contractor and PIU that was often lacking. DHC acknowledged, however, that the contractor had acted in a reasonable and flexible manner in addressing problems and rectifying errors, and was committed to delivering a quality output. Although there were numerous contract changes, all of package 2 was completed within budget.

27. Equipment suppliers were generally responsive and provided assistance readily. The supplier of the first-stage pumps at TES 4 did not deliver equipment according to contract specifications, thus causing prolonged disputes with the main contractor and DHC. The relationship between the contractor and supplier worsened when the supplier attempted to negotiate directly with DHC to arrive at a solution that was not acceptable to the contractor. ADB's intervention allowed the parties to come to an amicable settlement.

#### **K. Performance of the Borrower and the Executing Agency**

28. DHC was the Executing Agency for the Project and was responsible for project planning, management, supervision and coordination. With the assistance of the international consultant, DHC could follow ADB's *Procurement Guidelines* properly. Communications with ADB and reporting were adequate. The delayed availability of local funds sometimes made it difficult for DHC to communicate with the contractors and consultants as they could not fully comprehend the administrative encumbrances. The long wait for payment exceeding contractual provisions was a repeated subject of complaint.

29. Major problems and delays occurred in the installation of consumer-end components because the sites were not owned by DHC. This affected decisions on the size, quantity, and rating of the equipment to be installed and, in turn, affected the contractor's ability to design, order, and install the equipment in a timely manner. The short duration of the non-heating season intensified the delays in site selection.

30. Delays in implementation were attributed partly to the contractors, and partly to the Borrower and the Executing Agency for not facilitating the administrative procedures, such as importation of equipment and making funds available on time. Preparatory work in identifying the sites for the heating units could have been better planned. In spite of the challenges, the

Executing Agency completed the Project and put in operation a very effective DHS. Overall, the performance of the Borrower and DHC was considered satisfactory.

#### **L. Performance of the Asian Development Bank**

31. ADB got involved in procurement issues early on in the Project with the bidding for package 1. The Executing Agency and ADB disagreed over the selection of the winning bidder, and there were extensive communications between the involved parties. Bid evaluation for this package took about 16 months to settle before the winning bidder in ADB's assessment was invited for contract negotiations. ADB conducted 13 review missions between 1997 and 2006 to review the progress of Project activities, meet stakeholders, and help resolve implementation issues. ADB headquarters and the Mongolia Resident Mission provided guidance and support by formal and informal communication with the Executing Agency. The performance of ADB was satisfactory.

### **III. EVALUATION OF PERFORMANCE**

#### **A. Relevance**

32. The objective of the Project was to meet the basic heating needs of Ulaanbaatar and improve sector efficiency. Ulaanbaatar is the coldest capital city and heat is a basic need for the people. As the country has limited energy resources, it is necessary to encourage supply and end-user efficiency for ensuring the reliability and adequacy of Ulaanbaatar's heat supply. The Project has addressed this objective, and the Project is as relevant today as it was at the time of appraisal. The Project is rated as highly relevant.

#### **B. Effectiveness in Achieving Outcome**

33. Notwithstanding the problems encountered in implementing the Project, the main output was that a very effective DHS is in operation. With respect to the expected outcomes, the Project has improved the quality of life for the population of Ulaanbaatar, provided additional heat and hot water for new consumers, and achieved energy conservation through rehabilitating and modernizing the main and secondary heating systems. In quantitative terms, as of 2007, about 2,000 new customers have been supplied with adequate and reliable heat from the DHS in Ulaanbaatar, adding a load to the system of about 400 gigacalories (Gcal) per hour. Moreover, the approximately 6,000 customers that are connected to the DHS are more adequately served because of better temperature and heat flow controls provided through the Project.<sup>4</sup> The supply of heat via DHS increased significantly. Heat supplied from the three heat sources (TES 2, TES 3, and TES 4) was about 3,188 teracalories (Tcal) per year in 1995. By 2005, this had risen to 4,100 Tcal/year—an increase of 912 Tcal/year or 91% of the targeted increase by 2010. Available information about the Project's benefits are given in Appendix 8. The Project did not, however, succeed in introducing a new billing system based on heat consumption, nor the collection of data to monitor individual consumer's heat use. Nevertheless, the Project has delivered a very effective DHS, and is rated as effective in achieving outcome.

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<sup>4</sup> Customers include households, factories, retailers of heat in residential and commercial buildings, and public institutions. It is estimated that 75% of the non-*ger* households in Ulaanbaatar are connected to the DHS.



## **C. Efficiency in Achieving Outcome and Outputs**

34. The Project rehabilitated and modernized the DHS by converting to variable flow operation, providing end-user heat control facilities, and providing for metering of heat and hot water consumption on the main and secondary systems of most large consumers. The replacement of old distribution pumps has improved energy supply efficiencies. Between 2000 and 2005, power consumption for running these pumps at TES 3 was reduced by 49% while its heat supply to the distribution network increased by about 20% in the same period. Similar efficiencies were noted in TES 4, albeit at different rates. The ratio of power consumption versus heat distribution also improved from 21–10 kilowatt-hour (kWh) per Gcal in the old system to 12–9 kWh/Gcal in the new system. On the consumer end, at the start of the Project, the number of customers served was about 4,000 (footnote 4). This number grew by about 48% by 2007. Leakages in the system have also decreased. Project implementation was achieved within the original budget—but with constant review and modification of design. The procurement process took a long time. The modifications were incorporated without changes to the contract value, but required extensive consultation. Although the planned 5-year implementation period became 9 years, the project cost did not increase and the result was a better and more efficient DHS. In summary, the Project is rated as efficient.

### **1. Financial Performance**

35. The financial internal rate of return (FIRR) for the Project was reevaluated based on operational information obtained from DHC and the ERA and applying certain financial assumptions. Savings in power resulting from reduced power consumption of up to 24 gigawatt-hours per year were valued at the present average electricity tariff of \$0.045 per kWh. Revenues and expenses were assumed to increase at a nominal rate of 3% per year to 2025. The recalculated FIRR for the Project was 5% compared to the estimated FIRR at appraisal of 10%. The lower FIRR was because of net losses up to 2007, delays in project implementation that postponed benefits, and a lower incremental tariff for the Project. Appendix 9 summarizes the calculations.

36. DHC's financial performance continues to be weak. Revenues are insufficient to cover operating expenses, despite steady growth of heating sales. The company has not been able to meet the loan financial covenants. The ERA has indicated that the heating industry would become market-oriented, hence the average tariff for end users is estimated to increase by 20% in 2008 and 10% in subsequent years. It is assumed that the cost of purchasing heat from the power plants will continue to be subsidized because the fuel cost is linked to power generation and the waste heat is used for district heating. On this basis, projections of DHC's financial performance (Appendix 10) show adequate cash flows to sustain the business.

### **2. Economic Performance**

37. The economic evaluation was carried out in terms of the Project's economic internal rate of return (EIRR). The financial costs were adjusted to reflect the true economic opportunities realized on account of the Project. Incremental project costs and benefits were determined, net of taxes, import duties, and financial charges. Incremental consumer heat supply was valued on the basis of willingness to pay for heat estimated by considering the average heating costs for *gers* (traditional felt-covered nomadic homes) using coal and wood (the most widely used household heating in Ulaanbaatar). The recalculated EIRR was 32%, which exceeds the EIRR estimated at appraisal of 23.4%. The higher EIRR was due to greater revenues from higher

willingness-to-pay values that more than offset the net losses, and the delays in additional income generation because of delayed completion of the Project. A summary of the EIRR calculations is in Appendix 11.

## **D. Preliminary Assessment of Sustainability**

38. The Project is likely to be sustainable. Although the financial status of DHC, the principal owner of the assets, is weak, it is recognized that the Government has supported DHC through subsidies. In Ulaanbaatar's harsh climate, it is accepted that the Government will continue to support DHC to ensure a reliable heat supply. It is further noted that DHC management expects the heating tariff to rise gradually so it can operate with full cost recovery. DHC possesses the institutional capability and expertise to operate the facilities, and it has been given training under the Project to further develop its capacity.

## **E. Impact**

### **1. Environmental Impact**

39. The DHS was introduced in 1959, while the three CHPs were installed between 1961 and 1981. Due to their ages, they are not operating at optimal conditions with respect to energy production and environmental emissions. Most of the plant was rehabilitated in the late 1990s, although the CHPs still suffer from suboptimal boiler and turbine operations, as well as environmental emissions. Mongolia has environmental regulations for control of water, land, and air quality, and these are regularly monitored by the Ministry of Nature and Environment.

40. The Project has a positive environmental impact, because the alternative to rehabilitating the DHS would have been to construct new heat-only boilers or individual residential heating. That would have resulted in greater emissions than from the existing CHPs. Converting the DHS to variable flow has produced benefits for the power plants, such as reduced electricity consumption and greater energy supply to the distribution network; electricity consumption at TES 3 was 49% less in 2005 than in 2000, and heating supply in the same period increased by 20%. With a more efficient system, the quantity of coal use did not increase for the additional amount of electricity and heat from the CHPs.

### **2. Socioeconomic Impact**

41. The improvement in reliability and efficiency of the heat supply has benefited most of the population of Ulaanbaatar, regardless of income level. Many of the low-income apartment residents have been supplied with more efficient heating from the DHS. The Project involved no resettlement or temporary displacement of the population.<sup>5</sup> The construction work generated employment during the construction period, and the technical support through the consultant and the contractors served to upgrade the skills of DHC and the HCSCs. No negative socioeconomic impacts resulted from the Project, even as it has improved the comfort and well-being of over 6,000 customers (footnote 4) in Ulaanbaatar.

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<sup>5</sup> Cases were noted of complaints regarding substation locations. The Executing Agency informed ADB that great efforts were made to select sites acceptable to the Ulaanbaatar Municipal Government and limit the inconvenience to residents.

### **3. Asset Ownership**

42. The heating units and related equipment procured under the Project have been installed in various locations, including power plants, buildings belonging to the HCSCs, public institutions, and privately owned buildings. DHC, as the wholesale supplier, has easy access to the primary pipe network that is on public land, but not to the pumps installed in power plants or the heat exchangers and related equipment installed in the premises of the customers. It exercises operational control over all parts of the DHS for optimal efficiency and high reliability. At the same time, the supervision and maintenance of pumps and heat exchanges are best carried out by the owners of the premises. Therefore, DHC has initiated restructuring; its assets—including assets financed by the Project—are being transferred to owners of the property which house these assets. Accordingly, the financial responsibility to service the debt and tariff adjustment will also be carried out. The equipment installed in the power plants has been transferred and there is an agreement for them to repay the corresponding portion of the ADB loan. For capital assets related to heat distribution, DHC has made the following suggestions:

- (i) Replacement and new equipment equivalent to \$16 million was installed in residential buildings administered by 20 HCSCs belonging to the Municipality of Ulaanbaatar. With the backing of the municipality's citizens and a decree issued by the mayor, DHC entered into agreements with the HCSCs for turning the equipment over to their control. Corresponding onlending agreements were also made for the HCSCs to repay their portions of the ADB loan to DHC. However, none of the HCSCs have made any payment to DHC. DHC has nevertheless honored its debt obligation to the Ministry of Finance, repaying also the loan on behalf of the HCSCs. DHC now proposes that subsidiary agreements be made between the Ministry of Finance and the HCSCs, as the burden of loan repayment should rest with the owners of the equipment.
- (ii) Equipment totaling about \$10 million equivalent was installed in private organizations and enterprises for which DHC is also responsible to repay the ADB loan. DHC proposes to transfer the assets and the corresponding debt obligation to these private owners through onlending agreements. Such an arrangement will ensure that the owners take responsibility for maintaining and operating the equipment.

43. Taking into account efficiency and economy, ADB considers the above proposals to be reasonable and supports the divestment of assets to the parties that are in the best position to access and maintain the equipment.

## **IV. OVERALL ASSESSMENT AND RECOMMENDATIONS**

### **A. Overall Assessment**

44. Overall, the Project is rated successful. It is considered highly relevant, effective in achieving its outcome, efficient in achieving its outcome and outputs, and likely to be sustainable.

45. The Project has achieved its strategic objectives to (i) meet the basic heating needs of the population, and (ii) improve sector efficiency. The district heating system was converted to a

variable flow operation with installation of frequency-controlled speed pumps at the power plants, control units at substation heat exchangers, differential pressure controllers for heat ventilation systems, heat exchangers in buildings, bulk heat and hot water meters, control and monitoring systems with additional water treatment capacity, modifications to the pressure holding system, and hydraulic separation of the internal heat systems at the power plants. Rehabilitation of the steam system was carried out using the Executing Agency's own resources. However, the individual consumer metering and billing pilot project was not implemented although the meters have been installed and are ready for use. The DHC still confronts challenges in institutional capacity and would benefit from a tariff structure that enables full cost recovery and encourages energy conservation.

## **B. Lessons Learned**

46. Designing and implementing projects in countries and sectors that are undergoing major restructuring involves many uncertainties. These include policy and institutional uncertainties that are not fully apparent at appraisal. Hence, close consultation between ADB, the Government, the executing agency, and the implementation consultants during project implementation is crucial.

47. Projects in a sector that is undergoing reforms should be given some flexibility in loan covenants to ensure that these remain practical and relevant. This is especially true for the financial covenants with a company that is newly established and supplying a basic commodity to the population at a price that is determined administratively and not on market conditions.

48. Mongolia's severe winters and short summers present challenges for major construction activities, which makes advance planning and preparation crucial for smooth implementation. Before implementing complex projects like the DHS, the design must be complete or the variables identified (like location and size of substations) so that proper installation arrangements can be completed before construction is scheduled to begin.

49. The problems with contractors regarding work quality and delays reinforce the lesson that rigorous evaluation of contractors' technical qualifications must be undertaken before opening of the financial envelopes. This applies equally to construction, equipment, and consulting services contracts.

50. Since Mongolia is landlocked, logistics related to transport of equipment through the People's Republic of China and customs clearance pose challenges. These should be taken into account and planned appropriately so that equipment is available for installation at the start of the short summer season. Timely availability of required counterpart funds is another important factor that influences project execution.

## **C. Recommendations**

### **1. Project Related**

51. The Government and stakeholders should implement the metering function for the pilot project and demonstrate the capability of efficient end-user heat control and metering. Coordination with other donors will be sought when new assistance is provided for district heating in Ulaanbaatar.

52. The covenant on tariffs was not complied with. The priorities for assistance in this area are being reviewed during preparation of the Country Partnership Strategy (2009–2011). If agreement is reached on assistance for the DHS, suitable assurances on tariff-related issues should be discussed with the Government.

## 2. General

53. The benefits of improving the DHS have been proven with this Project. It solved many of the deficiencies in system capacity, and the heating needs of more people were met. The hydraulic analyses made at both the main system and secondary systems identified bottlenecks in the system, and these were rectified to improve efficient flow of heat. Such improvements helped provide an environmentally friendly way of supplying heat to the city, as well as reduced coal use. The Project's success should be replicated in other cities with inefficient DHSs.

54. The Borrower and DHC should carefully consider the issue of who should own the assets installed under the Project, and the final decision needs to be taken in consultation with ADB.

55. The management of the DHC is fully aware of the requirements and is in favor of (i) becoming a bona fide commercial company with independence on commercial matters, and (ii) being responsible for full cost recovery in its operations. However, the heating tariff reform has to be implemented by the Government and the ERA. It is generally estimated that the heating tariff needs to rise (in time) by over 50% to reach a level of full cost recovery and to encourage energy conservation.<sup>6</sup> Such a steep increase will have serious social implications because heating supply cannot be discontinued for commercial reasons in light of Ulaanbaatar's severe winter conditions. Because household incomes are still low, it will be difficult for households to seek a substitute without reverting to using coal (which raises serious environmental issues). The Government, ERA, and DHC recognize that heating tariff increases need to be gradual, but the challenge is to obtain a consensus among stakeholders—including legislators—on a suitable plan for raising heating tariffs.

56. In addition to gradually increasing heating tariffs, ERA should reform the tariff structure<sup>7</sup> to provide for metered heating tariffs in all consumer categories. Metering involves supplying and installing heat allocators and radiator valves in each apartment, balancing secondary water flow in apartment buildings, installing additional meters in some buildings, and adding electronic monitoring systems. About 3,600 of the 50,000 residential consumers in Ulaanbaatar were included in the pilot metering program. With adequate financial support, it would be technically possible for DHC to extend the metering facilities to all consumers in 4 years.

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<sup>6</sup> The heating tariff for residential housing in Ulaanbaatar is MNT191 (\$0.1642) per square meter (m<sup>2</sup>). By comparison, in Inner Mongolia Autonomous Region (IMAR), People's Republic of China, it is CNY2.95 (\$0.4214) per m<sup>2</sup> in Baotao city, which has a comparable population, and it is as high as CNY3.86 (\$0.5514) per m<sup>2</sup> in smaller cities. The Inner Mongolia heating tariff is estimated to be at a full cost recovery level. A direct comparison of costs would be inappropriate because the district heating in Ulaanbaatar is supplied from CHPs that recover waste heat from the steam cycle while a large part of the heating in Inner Mongolia is supplied by heat-only boilers. Still, it is difficult to explain a ratio of 2.5 to 3.5 between the retail heating tariffs.

<sup>7</sup> It would also be useful to disaggregate the heating tariff into its various components. These include supply of heat from CHPs, operation of the pipe network and substations (including financial charges), consumer services, and automatic adjustment for changes in exchange rate and inflation. Such transparency would enable DHC to pass on the cost of producing heat, exchange rate changes, and inflation while making it accountable for expenditures on its operations and customer services.

57. It is apparent that the Government has played a dominant role in DHC operations, and it has been involved in a manner that has limited DHC's ability to act as a commercial and independent company or to gain the financial strength to address known deficiencies. ADB recommends greater autonomy for DHC and the commercialization of its activities. Therefore, a commercialization action plan, agreed with the Government, is needed. Priorities and objectives for the commercialization action plan should include:

- (i) A long-term plan for tariffs with independently regulated cost recovery.
- (ii) A transparent, well-targeted subsidy mechanism to support socially vulnerable groups.
- (iii) Implementation of metering in the pilot project and a plan to extend metering to the complete DHS.
- (iv) Establishing a program for full commercial operation of DHC, including modernizing financial management, accounting policies and procedures, and billing and collection procedures.
- (v) At least achieving and sustaining the financial covenants of the loan, as outlined in Appendix 6.

## CHRONOLOGY OF MAJOR EVENTS

4 March 1997	Fact-Finding Mission fielded
2 May 1997	Management Review Meeting
23 May 1997	Appraisal Mission fielded
18 July 1997	Staff Review Committee Meeting
19 August 1997	Loan negotiations
25 September 1997	Asian Development Bank (ADB) approved loan of SDR 29.487 million (\$40 million equivalent) for the Ulaanbaatar Heat Efficiency Project (Loan 1548)
9 December 1997	Loan Agreement signed
13 May 1998	Contract signed with COWI-Fichtner JV as project implementation consultants
22 July 1998	Extension of loan effectiveness requested by Ministry of Finance
7 October 1998	Inception Mission fielded
24 November 1998	Loan became effective
20 January 1999	First disbursement
17 May 1999	Review Mission fielded
4 November 1999	Review Mission fielded
1 June 2000	Package 1 (District Heating System) contract awarded to BERIS (People's Republic of China)
20 October 2000	Review Mission fielded
13 June 2001	Review Mission fielded
24 March 2002	Review Mission fielded in conjunction with other Mongolia projects
20 June 2002	Review Mission fielded in conjunction with other Mongolia projects
25 October 2002	Contract awards for package 2 made: lot A to IMEPG (PRC), lots B and C to Samsung-KDHEC JV (South Korea)

18 December 2002	Contracts for package 2, lots B and C, signed with Samsung-KDHEC JV
30 June 2003	Original closing date
21 July 2003	Review Mission fielded
30 July 2003	Director of Energy Division approved extension of loan closing date by 2 years to 30 June 2005 (1st extension)
6 October 2003	Director of Energy Division approved minor change in implementation arrangements (change of executing agency from Energy Authority to Ulaanbaatar District Heating Company)
18 May 2004	Package 2 lot A (Customer Systems Improvement) was split into lots A, B, and C. Contracts for lots B and C awarded to Samsung-KDHEC JV when negotiations with IMEPG fell through
6 September 2004	Review Mission fielded
23 May 2005	Review Mission fielded
28 June 2005	Director General of East and Central Asia Department approved extension of loan closing date to 30 September 2006 (2nd extension)
24 May 2006	Review Mission fielded
6 October 2006	Director General of East Asia Department approved extension of loan closing date to 31 December 2006 (3rd extension)
9 October 2006	Director of Energy Division approved reallocation of loan proceeds
2 December 2006	Director General of East Asia Department approved keeping loan account open for disbursement purposes only and upgraded rating of Project from partly satisfactory to satisfactory
1 March 2007	Final disbursement
1 March 2007	Loan account closed
14 April 2008	Project Completion Review Mission fielded



**COMPARISON OF PROJECT COST AT APPRAISAL AND AT COMPLETION**  
(\$ million)

Appraisal Estimate				Actual			
Item	Foreign Currency	Local Costs	Total	Item/Contract Package	Foreign Currency	Local Costs	Total
<b>I. Base Costs</b>							
<b>1. District Heating System</b>							
Variable Speed Pumps	7.69	0.24	7.93				
Internal Heating Systems							
Separation	0.49	0.04	0.53				
Pressure Holding System	0.58	0.03	0.61				
Water Treatment Plant	0.90	0.10	1.00				
Control and Monitoring System	0.97	0.03	1.00				
<b>Subtotal</b>	<b>10.63</b>	<b>0.44</b>	<b>11.07</b>	<b>Package No. 1</b>	<b>11.34</b>	<b>0.95</b>	<b>12.29</b>
Improvements at Substations	4.96	1.17	6.13				
<b>Subtotal</b>	<b>4.96</b>	<b>1.17</b>	<b>6.13</b>	<b>Package No. 2 Lot A</b>	<b>5.50</b>	<b>0.00</b>	<b>5.50</b>
Ventilation System Improvements	0.46	0.02	0.48				
Separation of Direct Consumers	11.29	0.60	11.89				
Distribution Network Reinforcement	–	2.60	2.60				
<b>Subtotal</b>	<b>11.75</b>	<b>3.22</b>	<b>14.97</b>	<b>Package No. 2 Lot B</b>	<b>13.87</b>	<b>0.00</b>	<b>13.87</b>
<b>2. Customer Systems Improvement</b>							
Heating System Installations	1.96	0.22	2.18				
Bulk Heat and Hot Water Meters	1.16	0.60	1.76				
Individual Meters and Heat Control	0.91	0.09	1.00				
<b>Subtotal</b>	<b>4.03</b>	<b>0.91</b>	<b>4.94</b>	<b>Package No. 2 Lot C</b>	<b>5.89</b>	<b>0.00</b>	<b>5.89</b>
				Other items not in original cost estimate <sup>a</sup>	0.45	2.60	3.05
<b>3. Steam System Rehabilitation</b>							
	2.24	0.20	2.44	Cancelled			
<b>4. Consulting Services</b>							
	1.63	0.30	1.93	<b>Consulting Services</b>	3.34	0.29	3.63
<b>Total Base Cost</b>	<b>35.24</b>	<b>6.24</b>	<b>41.48</b>	<b>Total Base Cost</b>	<b>40.40</b>	<b>3.84</b>	<b>44.23</b>
<b>II. Contingencies</b>							
a. Physical Contingencies	4.20	0.74	4.94				
b. Price Contingencies	2.36	0.38	2.74				
<b>III. Interest During Construction</b>							
	1.20	5.34	6.54	<b>Interest During Construction</b>	0.59	3.30	3.89
<b>Total Project Cost</b>	<b>43.00</b>	<b>12.70</b>	<b>55.70</b>	<b>Total Project Cost</b>	<b>40.99</b>	<b>7.12</b>	<b>48.12</b>

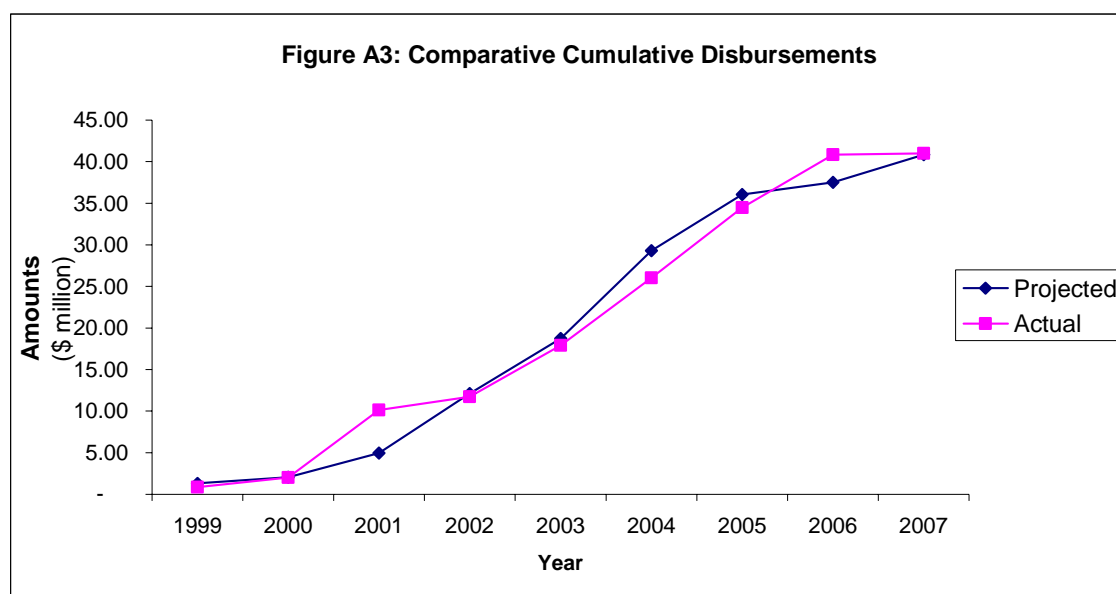
<sup>a</sup> Other items include water treatment chemicals, portable meter reading equipment, and secondary side piping.  
Source: Ulaanbaatar District Heating Company and Asian Development Bank.

## PROJECTED AND ACTUAL DISBURSEMENTS

**Table A3: Projected and Actual Disbursements 1999–2007**  
(\$ million)

Year	For the Year		Cumulative		% of Loan
	Projected	Actual	Projected	Actual	
1999	1.30	0.86	1.30	0.86	2.10
2000	1.20	1.15	2.06	2.01	4.89
2001	2.96	8.12	4.97	10.13	24.71
2002	2.00	1.60	12.13	11.73	28.61
2003	7.00	6.17	18.73	17.90	43.66
2004	11.41	8.13	29.31	26.03	63.49
2005	10.01	8.44	36.04	34.47	84.07
2006	3.04	6.38	37.51	40.85	99.65
2007	—	0.14	40.85	40.99	100.00

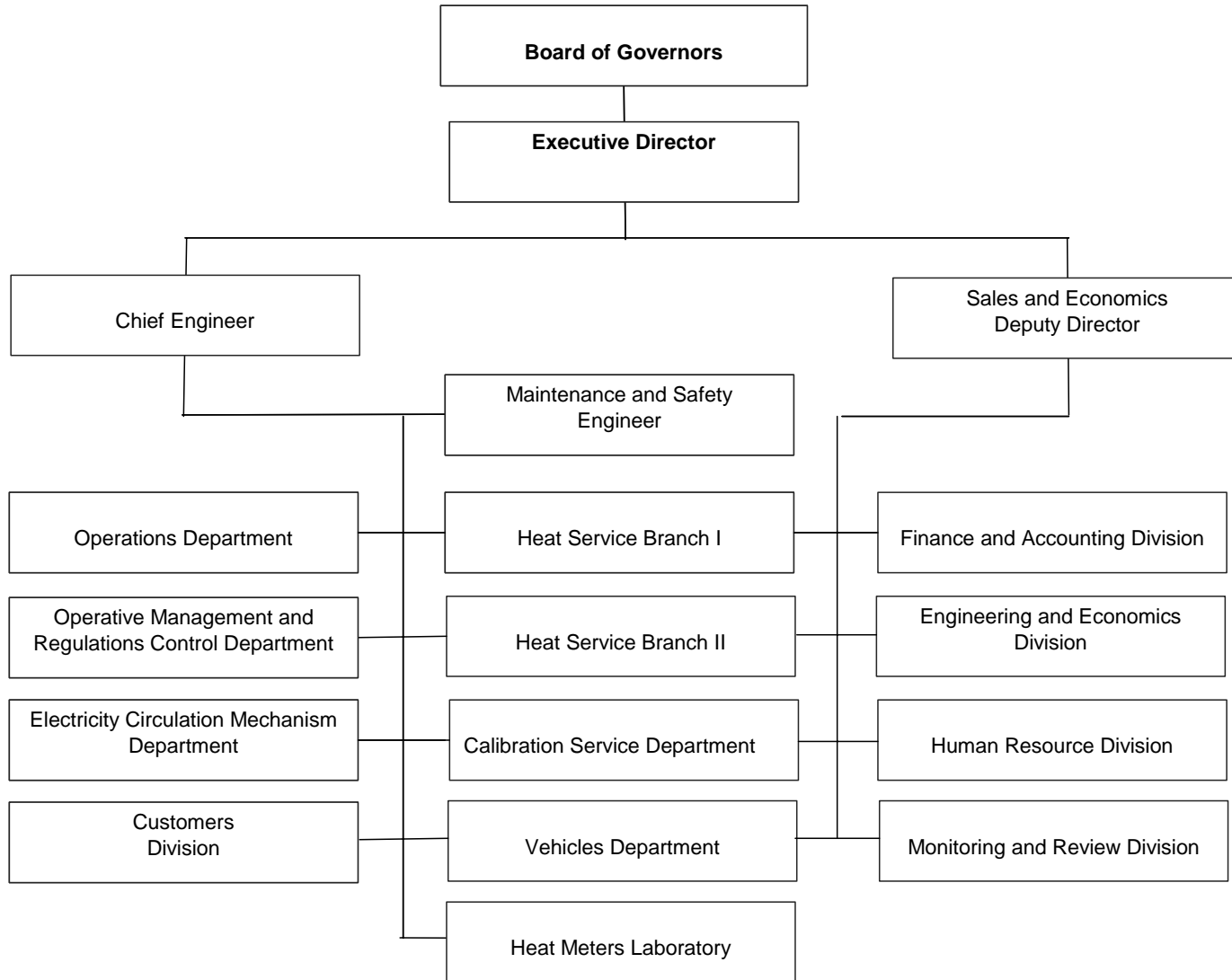
Sources: Asian Development Bank estimates and actual loan records.



Source: Asian Development Bank estimates.



**ORGANIZATIONAL CHART OF ULAANBAATAR DISTRICT HEATING COMPANY**



Source: Ulaanbaatar District Heating Company.

## STATUS OF COMPLIANCE WITH LOAN COVENANTS

Covenant	Reference in Loan Agreement	Status of Compliance
<b>Loan Effectiveness</b>		
1. The Loan Agreement will be approved by the State Council of the Borrower.	LA, Section 6.01	Complied with.
<b>Procurement</b>		
2. Procurement of goods and services will be in accordance with ADB's <i>Guidelines for Procurement</i> .	LA, Schedule 4, para. 2	Complied with.
<b>Execution of the Project</b>		
3. Energy Authority (EA) shall be responsible for overall supervision of the Project and coordination of Project implementation activities, with the support and assistance of the PIU and under the general guidance of PSC.	LA, Schedule 6, para. 1	Complied with. The ADB approved the change in executing agency in October 2003, from Energy Authority to Ulaanbaatar Heat District Company.
4. EA shall maintain the PIU at its head office to ensure cost-effective and timely Project implementation. The PIU shall be responsible, with the assistance of the implementation consultants referred to in Schedule 5 to this Loan Agreement, for day-to-day implementation of the Project, including preparation of tender documents, tendering and supervision of equipment installation, as well as liaison among the Borrower, EA, the Bank, and contractors and suppliers under the Project. The Borrower and EA shall ensure that the PIU is headed by a full-time Project Manager acceptable to the Bank; staffed by suitably qualified personnel from EA, DHC and HCSC; and assisted by the implementation consultants.	LA, Schedule 6, para 2.	Complied with.
5. The Borrower shall maintain throughout Project implementation the PSC to review all technical plans and designs for the Project; oversee and coordinate all Project activities including liaison among the departments and agencies of the Borrower involved; and serve as a forum for discussions on important Project issues. The PSC shall be chaired by the State Secretary of MID, and its members shall include representatives from EA, MID, and the Project Manager. The PSC shall meet as often as may be required, but in any event at least twice a year.	LA, Schedule 6, para. 3	Complied with.
6. Energy Authority shall make available, promptly as needed, the funds, facilities, services, equipment, land and other	PA, Section 2.02	Partly complied with.

Covenant	Reference in Loan Agreement	Status of Compliance
resources which are required, in addition to the proceeds of the Loan, for the carrying out of the Projects and the operation and maintenance of the Project facilities.		
<b>EA Commercialization Action Plan</b>		
7. The Borrower shall ensure the implementation and completion by EA of all actions under the A Commercialization Action Plan by their respective time deadlines. Commencing from 31 December 1997, the Borrower shall ensure that EA prepares and provides to the Bank a semi-annual status report on implementation of the EA Commercialization Action Plan during the preceding six-month period.	LA, Schedule 6, para. 4	Complied with.
<b>Public Awareness</b>		
8. The Borrower shall ensure the EA undertakes an ongoing public awareness program commencing before 31 December 1998 to encourage energy conservation measures and the adoption of individual metering and control, taking into account the results of the demonstration project on energy conservation at selected residential apartment buildings in Ulaanbaatar under Loan 1492-MON.	LA, Schedule 6, para. 6	Complied with. Consumers are generally satisfied with the heating services provided by DHC and the housing companies. DHC continues to carry out public information programs showing consumers and operators the methods of operation of the heating systems and energy conservation. This program is considered successful and ADB encourages its continuance.
<b>Heat and Hot Water Tariff System</b>		
9. In connection with the individual metering of heat and hot water consumption the Borrower, with the assistance of the consultants engaged under the Project, shall by 31 December 1999 formulate and commence implementation of a new tariff system acceptable to the Bank, so that consumers shall be charged based on their consumption of heat and hot water.	LA, Schedule 6, para. 7	Not complied with. The individual metering pilot project was not implemented, consequently, the billing system based on heat and hot water consumption also was not implemented. The Energy Regulating Authority has indicated plans to introduce a tariff category for small apartment residents based on consumption of heat and hot water, but has not committed to a time for implementation
<b>Quarterly Automatic Tariff Adjustment Mechanism</b>		
10. The Borrower shall ensure that from 1 October 1997, EA commences implementation of a quarterly automatic heat and electricity tariff adjustment mechanism acceptable to the Bank. Such mechanism	LA, Schedule 6, para. 8	Not complied with. The establishment of a quarterly automatic tariff adjustment was a condition for loan effectiveness. The Government had initially agreed to

Covenant	Reference in Loan Agreement	Status of Compliance
<p>shall require ascertaining and incorporating in the tariff adjustment formula, on a quarterly basis, changes in EA's operating costs (due to factors including changes in fuel costs, foreign exchange rates and the domestic inflation rate) to determine the necessary changes, if any, to the heat and electricity tariffs. The first adjustment to the heat and electricity tariffs shall be effective as of 1 January 1998, and shall be based on the period 1 October 1997 to 31 December 1997.</p>		<p>implement this starting November 1999. However, on 19 November 1999, the Prime Minister cancelled the proposed tariff increases, which is understood to be because most households cannot afford to pay the tariff needed for full cost recovery.</p>
<b>Environmental Matters</b>		
<p>11. The Borrower and EA shall take all necessary measures to ensure that all hazardous materials (including asbestos) associated with the Project are handled and disposed of in a safe and environmentally responsible manner in accordance with internationally accepted or equivalent Mongolian standards</p>	LA, Schedule 6, para. 10	Complied with.
<b>Financial Matters</b>		
<p>12. Except as the Bank may otherwise agree, EA shall maintain its net revenues at a level which, for each fiscal year, will produce internally generated funds equal to at least 1.3 times the maximum debt-service requirements.</p>	LA, Schedule 6, para. 13	<p>Not complied with as DHC's revenues were dependent on tariff increases set by the Energy Regulatory Authority (ERA).</p>
<p>13. Commencing with the fiscal year beginning on 1 January 1998, EA shall maintain a ratio of total working expenses to total operating revenue not higher than 60 percent</p>	LA, Schedule 6, para. 14	<p>Not complied with for reason stated above. The working ratio between 2003 and 2007 ranged from 86% to 98%.</p>
<p>14. EA shall earn for the fiscal year commencing from 1 January 1999, and annual rate of return on the average current net value of EA's fixed assets in operation of not less than three percent, and for each subsequent fiscal year, an annual rate of return of not less than five percent</p>	LA, Schedule 6, para. 15(a)	<p>Not complied with. See comment above.</p>
<p>15. If the EA will not be able to meet the rate of return requirements, the Borrower shall promptly take, and ensure that EA takes, all necessary measures, including without limitation, adjustments to the heating and electricity tariff structures of tariff rates, so that EA can meet such requirements</p>	LA, Schedule 6, para. 15(b).	<p>Partly complied with. Tariffs set by ERA tended to be based on customer affordability rather than cost recovery.</p>

Covenant	Reference in Loan Agreement	Status of Compliance
<b>Reports</b>		
16. EA shall furnish the Bank quarterly reports on management of the Project facilities. Such reports shall be submitted in such form and in such detail and within such a period as the Bank shall reasonably request, and shall indicate, among other things, progress made and problems, encountered during the quarter under review, steps taken or proposed to be taken to remedy these problems, and proposed program of activities and expected progress during the following quarter.	PA, Section 2.08(b)	Complied with.
17. Promptly after physical completion of the Project, but in any event not later than three (3) months thereafter or such later date as the Bank may agree for this purpose, EA shall prepare and furnish to the Bank a report, in such form and in such details as the Bank shall reasonably request, on the execution and initial operation of the Project, including its cost, the performance by EA of its obligations under this Project Agreement and the accomplishment of the purpose of the Loan.	PA, Section 2.08(c)	Complied with.
<b>Accounts</b>		
18. The EA shall (i) maintain separate accounts for the Project; (ii) have such accounts and related financial statements (balance sheet, statement of income and expenses, and related statements) audited annually, in accordance with appropriate auditing standards consistently applied, by independent auditors whose qualifications, experience and terms of reference are acceptable to the Bank; and (iii) furnish to the Bank, promptly after their preparation but in any event not later than six months after the close of the fiscal year to which they related, certified copies of such audited accounts and financial statements and the report of the auditors relating thereto, all in the English language. EA shall furnish to the Bank such further information concerning such accounts and financial statements and the audit thereof as the Bank shall from time to time reasonably request.	PA, Section 2.09(a)	Complied with.



**SUMMARY OF CONTRACT PACKAGES**

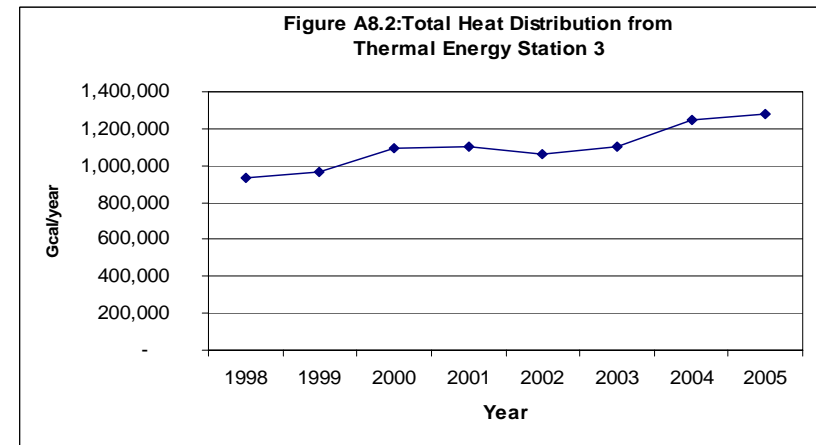
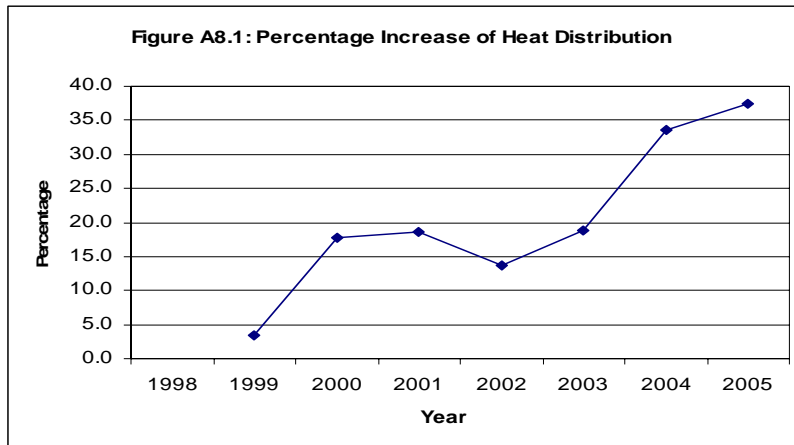
<b>PCSS No.</b>	<b>Item</b>	<b>Mode of Procurement</b>	<b>Date of Contract</b>	<b>Country of Contractor</b>	<b>Contract Amount (\$)</b>
0001	Project Implementation Consultant	ICB	13-May-98	Denmark	3,375,492.00
0002	Improvements at Power Plants	ICB	01-Jun-00	People's Republic of China	12,291,771.00
0003	Lot B-Heating Units and Related Works	ICB	18-Dec-02	Republic of Korea	13,871,000.00
0004	Lot C-Improvements to Consumer	ICB	18-Dec-02	Republic of Korea	5,890,000.00
0005	Substations & Consumer Installations	ICB	18-May-04	Republic of Korea	5,500,000.00
0006	P13: Installation of External Pipes Maternity House SS to SS No. 13 at 6 <sup>th</sup> Microdistrict	S	27-Jun-06	Mongolia	173,584.45
0007	P14: Installation of External Pipes Front of service center at 19 <sup>th</sup> Microdistrict	S	27-Jun-06	Mongolia	106,372.23
0008	P15: Installation of External Pipes Unit 15 to TK3 of Expansion Branch No. 2, Channel S167 of 19 <sup>th</sup> District	S	27-Jun-06	Mongolia	106,105.63
0009	P16: Installation of External Pipelines for Uguumur San Company	S	27-Jun-06	Mongolia	70,036.55

ICB = international competitive bidding, PCSS = procurement contract summary sheet; S = shopping.  
Sources: Executing agency and project files.

**Table A8.1 Heat Distribution from Thermal Energy Station 3  
(Gigacalories)**

Item	1998	1999	2000	2001	2002	2003	2004	2005
Heat distribution (low pressure)	554,003	353,914	424,794	443,213	450,092	468,576	499,591	642,378
Heat distribution (high pressure)	376,898	609,649	670,853	661,695	608,475	637,145	744,302	637,546
<b>Total heat distribution</b>	<b>930,901</b>	<b>963,563</b>	<b>1,095,647</b>	<b>1,104,908</b>	<b>1,058,567</b>	<b>1,105,721</b>	<b>1,243,893</b>	<b>1,279,924</b>
Increase in heat distribution (base year = 1998)		32,662	164,746	174,007	127,666	174,820	312,992	349,023
Increase (%)		3.5	17.7	18.7	13.7	18.8	33.6	37.5

Sources: Ulaanbaatar District Heating Company and Asian Development Bank.

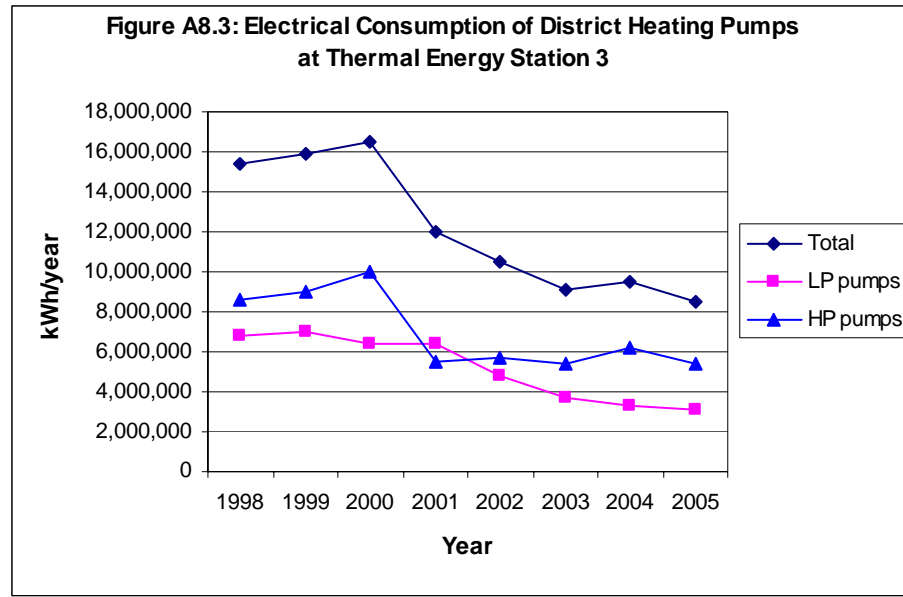


**Table A8.2 Electrical Consumption of District Heating Pumps at Thermal Energy Station 3  
(Kilowatt-hours)**

Item	1998	1999	2000	2001	2002	2003	2004	2005
Electrical consumption of LP district heating pumps	6,814,800	6,956,640	6,449,040	6,425,640	4,807,512	3,728,250	3,288,380	3,074,288
Electrical consumption of HP district heating pumps	8,617,200	8,955,660	10,012,120	5,531,677	5,683,680	5,396,640	6,172,744	5,400,000
Total	15,432,000	15,912,300	16,461,160	11,957,317	10,491,192	9,124,890	9,461,124	8,474,288
Decrease in consumption (%) (base year = 2000)				27.4	36.3	44.6	42.5	48.5

LP = low pressure, HP = high pressure.

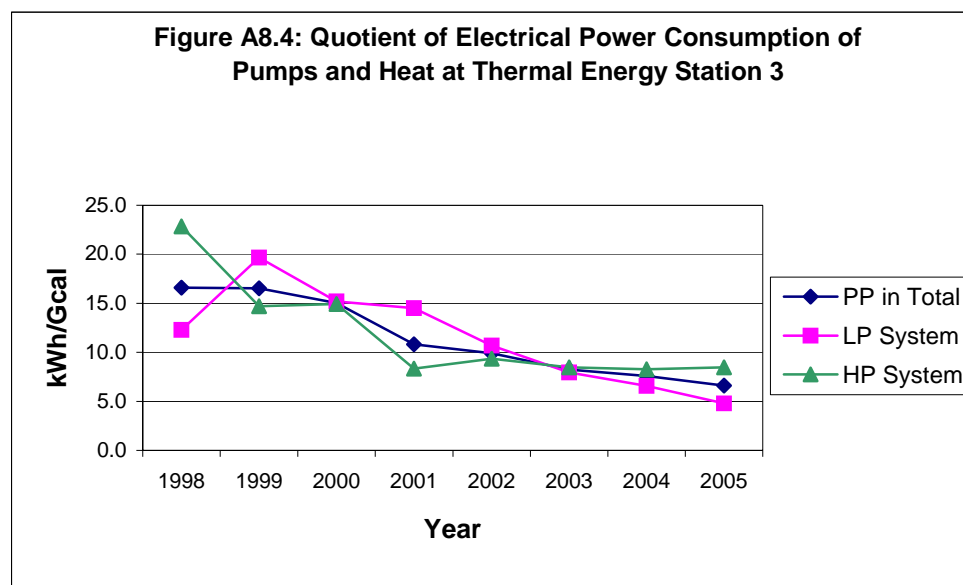
Sources: Ulaanbaatar District Heating Company and Asian Development Bank.



**Table A8.3 Quotient of Electrical Power Consumption of Pumps and Heat at Thermal Energy Station 3**

Item	1998	1999	2000	2001	2002	2003	2004	2005
Ratio of electrical consumption versus heat distribution (kWh/Gcal)								
power plant	16.6	16.5	15.0	10.8	9.9	8.3	7.6	6.6
low pressure	12.3	19.7	15.2	14.5	10.7	8.0	6.6	4.8
high pressure	22.9	14.7	14.9	8.4	9.3	8.5	8.3	8.5

Sources: Ulaanbaatar District Heating Company and Asian Development Bank.



HP = high pressure, LP = low pressure, PP = power plant.

## FINANCIAL EVALUATION

### A. General

1. The financial internal rate of return (FIRR) was evaluated based on financial and operational information obtained from the District Heating Company (DHC) and the Energy Regulatory Authority and applied with certain financial assumptions as outlined below. At the time of project appraisal, the Energy Authority was the designated Executing Agency. This was a large, complex organization responsible for distribution of both heat and electricity. The Energy Authority was unbundled during the Project, and DHC was designated as the Executing Agency. Accordingly, the FIRR has been evaluated as a project executed by the DHC.

### B. Assumptions

2. The financial results are based on the following facts and assumptions:
- (i) An average economic life of 20 years.
  - (ii) The cash streams were discounted to 1998, the first year of cash flow.
  - (iii) The evaluation was made for the period 1998–2025. The Project was implemented over a period of 9 years, with equipment installation starting in 2002 and final commissioning occurring in the early months of 2007, thus providing, on average, 20 years of operation and evaluation. The feasibility study<sup>1</sup> for the Project had indicated that the existing heating system (prior to implementing the Ulaanbaatar Heat Efficiency Project) would meet the system demand until 2001. Therefore, incremental benefits from the Project were considered to start in 2002.
  - (iv) The capital cost was spread as actually occurred (according to DHC accounts) over the 9 years from 1998 to 2007 and excludes depreciation and interest.
  - (v) Heating tariffs for end users are projected to increase by 20% at the start of the 2008 heating season and by 10% each year thereafter until 2018.
  - (vi) Reduced power consumption, ranging from 5 GWh in 2002 up to 24 GWh per year resulting from reduced pumping requirements in the power plants. Savings are valued at the present average electricity tariff of \$0.045 per kWh and adjusted for real tariff movements in future years as per the financial projections.
  - (vii) Payments by DHC to the power plants for heat production costs are projected to rise, starting at 10% in 2008 and 5% in 2009, then gradually increasing thereafter to 16% per year by 2018.
  - (viii) From 2018, heating revenues and production costs are assumed to increase at a nominal 3%.
  - (ix) Operation and maintenance costs are set at 2% of capital cost.
  - (x) Income taxes are based on corporate income taxes and charged to the Project according to the ratio of the Project's total revenue to DHC's total revenue.
3. The resulting financial analysis is presented in Table A9. Based on the above assumptions, the FIRR for the Project is estimated at 5%. The FIRR is lower than the 10% estimated at appraisal due to net losses up to 2007 and delays in project implementation that delayed benefits. Given the current inflationary conditions prevailing in Mongolia and the low interest rate for the ADB loan, the weighted average cost of project capital is estimated to be negative.

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<sup>1</sup> ADB. 1996. *Technical Assistance to Mongolia for Ulaanbaatar Heat Rehabilitation Project*. Manila.

**Table A9: Financial Internal Rate of Return**  
(\$ million)

Year	Incremental Costs			Incremental Income			Net Income
	Capital Costs	O&M	Heat Production	Income Tax	Increased Billable Heat Supply	Pumping Power Savings	
1998	0.07	0.00					(0.07)
1999	0.86	0.02					(0.88)
2000	1.14	0.04					(1.18)
2001	7.67	0.19					(7.86)
2002	2.04	0.24	0.33	0.00	0.38	0.23	(2.00)
2003	6.53	0.37	0.50	0.00	0.58	0.52	(6.30)
2004	8.49	0.54	0.71	0.00	0.80	0.59	(8.35)
2005	9.65	0.73	1.37	0.01	1.70	0.78	(9.28)
2006	7.81	0.89	1.34	0.02	1.77	0.82	(7.47)
2007	0.57	0.90	1.58	0.00	2.08	0.91	(0.06)
2008		0.90	2.20	0.00	3.01	0.99	0.90
2009		0.90	2.87	0.00	4.19	1.11	1.53
2010		0.90	3.59	0.00	5.41	1.20	2.12
2011		0.90	4.43	0.04	6.86	1.29	2.78
2012		0.90	5.43	0.11	8.58	1.38	3.52
2013		0.90	6.64	0.20	10.61	1.49	4.36
2014		0.90	7.79	0.32	12.46	1.58	5.03
2015		0.90	8.65	0.38	13.70	1.65	5.42
2016		0.90	9.72	0.45	15.07	1.73	5.73
2017		0.90	11.07	0.48	16.58	1.81	5.94
2018		0.90	12.79	0.44	18.24	1.89	6.00
2019		0.90	13.17	0.45	18.78	1.94	6.20
2020		0.90	13.57	0.46	19.35	2.00	6.42
2021		0.90	13.97	0.48	19.93	2.06	6.64
2022		0.90	14.39	0.49	20.53	2.12	6.87
2023		0.90	14.82	0.50	21.14	2.19	7.11
2024		0.90	15.27	0.52	21.78	2.25	7.34
2025		0.90	15.73	0.53	22.43	2.32	7.59
						<b>FIRR</b>	<b>5.00%</b>

( ) = negative, FIRR = financial internal rate of return, O&M = operation and maintenance.  
Source: Asian Development Bank estimates.

## FINANCIAL PERFORMANCE AND PROJECTIONS OF ULAANBAATAR DISTRICT HEATING COMPANY

1. Financial data for 2005–2007 from Ulaanbaatar District Heating Company (DHC) are used as the starting point of financial projections for the next 10 years.
2. The financial assurances under the loan were as follow:
  - (i) The Energy Authority shall maintain its net revenues at a level that, for each fiscal year, will produce internally generated funds equal to at least 1.3 times the maximum debt-service requirement for such fiscal year on all its debt.
  - (ii) Commencing with the fiscal year beginning on 1 January 1998, the Energy Authority shall maintain a ratio of total working expenses to total operating revenues not higher than 60%.
  - (iii) The Energy Authority shall earn for the fiscal year commencing from 1 January 1999 an annual rate of return on the average current net value of its fixed assets in operation of not less than 3%. For each subsequent fiscal year it shall earn an annual rate of return of not less than 5%.
3. These financial covenants were in the Loan Agreement with respect to the Energy Authority, which was the former Executing Agency. After it was unbundled, DHC, which had been an operating unit under the Energy Authority, became an independent entity and was designated as the Executing Agency for the Project. With this change, the financial performance relative to the assumptions in the report and recommendation of the President<sup>1</sup> is no longer applicable. DHC's financial performance shows weak rates of return on fixed assets, and the ratio of total working expenses to total operating revenues from 2005 to 2007 was around 80% to 90%.<sup>2</sup>
4. DHC has been operating with a subsidized rate for its heat supply purchased from the power plants. The actual value of the subsidy is not known at the time of this report but is generally said at DHC to be about half of the actual cost of production. Notwithstanding the subsidy, DHC's objective is to operate as a commercial entity with full cost recovery.
5. DHC expects heat consumption to grow by 2.9% annually over 2008 to 2018. The industry is in the process of becoming more market-oriented, and over the same period the average tariff for end users is expected to be increased by 20% in 2008 and 10% in the following years. As a result of the significant rise in tariffs, DHC should have a fairly strong operating cash inflow from 2009. DHC's performance will depend on the purchase price of heat from the power plants, including the subsidy. If the purchased heat price is increased at a lesser rate than the tariff for end users, then DHC can establish a sound financial base and evolve into a commercially viable entity. For projection purposes, the purchase price for heat has been assumed to increase by 10% in 2008, and thereafter gradually from 5% in 2009 to 16% in 2018.
6. Under this scenario, the net income would remain negative in 2008 and 2009 but would become positive in 2010 and thereafter. Similarly, the return on average net fixed assets in use is expected to be between 7% and 9% over the next 10 years. The debt service ratio will be over 2, and the working ratios are projected to be between 74% and 80%.
7. DHC's historical financial performance and financial projections are in Table A10.

<sup>1</sup> ADB. 1997. *Report and Recommendation of the President to the Board of Directors on a Proposed Loan to Mongolia for the Ulaanbaatar Heat Efficiency Project*. Manila.

<sup>2</sup> DHC accounts prior to 2007 did not provide data for determining the ratio of internally generated funds to maintain debt service.

**Table A10: Financial Performance of Ulaanbaatar District Heating Company**  
(MNT million)

Item	Actual			Projected					
	2005	2006	2007	2008	2009	2010	2011	2012	2013
<b>Income Statements</b>									
<b>Operating revenue</b>	<b>20,320</b>	<b>21,613</b>	<b>22,038</b>	<b>24,804</b>	<b>29,419</b>	<b>33,299</b>	<b>37,691</b>	<b>42,663</b>	<b>48,290</b>
Operating expenses									
Purchased heat	16,449	16,381	16,727	18,083	20,198	22,088	24,325	27,000	30,231
Repair and maintenance	2,165	3,143	2,895	4,826	5,007	5,267	5,581	5,967	6,455
Depreciation	1,910	1,973	2,507	5,755	5,873	6,109	5,959	6,374	6,884
<b>Total Operating Expenses</b>	<b>20,523</b>	<b>21,498</b>	<b>22,129</b>	<b>28,665</b>	<b>31,079</b>	<b>33,463</b>	<b>35,865</b>	<b>39,340</b>	<b>43,569</b>
<b>Net operating income</b>	<b>(203)</b>	<b>116</b>	<b>(90)</b>	<b>(3,861)</b>	<b>(1,660)</b>	<b>(164)</b>	<b>1,827</b>	<b>3,323</b>	<b>4,721</b>
Non-operating income (expenses)	1,086	1,129	253	525	551	578	607	638	670
Taxable income	882	1,244	162	(3,335)	(1,108)	415	2,434	3,961	5,391
Income tax	111	270	51				243	540	898
<b>Net income</b>	<b>771</b>	<b>975</b>	<b>112</b>	<b>(3,336)</b>	<b>(1,108)</b>	<b>415</b>	<b>2,191</b>	<b>3,421</b>	<b>4,493</b>
<b>Balance Sheets</b>									
Cash	91	82	338	246	716	806	1,080	1,251	1,448
Accounts receivable	1,635	1,566	1,166	2,067	2,452	2,775	3,141	3,555	4,024
Inventory	276	303	561	726	788	848	909	997	1,104
Other current assets	274	223	2,291	2,578	3,058	3,461	3,918	4,434	5,019
<b>Total Current Assets</b>	<b>2,275</b>	<b>2,174</b>	<b>4,355</b>	<b>5,618</b>	<b>7,013</b>	<b>7,890</b>	<b>9,048</b>	<b>10,237</b>	<b>11,597</b>
Long-term investment	20,228	19,546	37,470	37,470	37,470	37,470	37,470	37,470	37,470
Fixed assets									
Original value	56,596	57,646	50,366	51,026	52,846	56,466	61,806	68,726	77,226
Accumulated depreciation	6,860	8,777	11,238	16,993	22,866	28,974	34,933	41,308	48,192
<b>Net fixed assets</b>	<b>49,736</b>	<b>48,869</b>	<b>39,128</b>	<b>34,033</b>	<b>29,980</b>	<b>27,492</b>	<b>26,872</b>	<b>27,418</b>	<b>29,034</b>
Construction in progress	2,228	8,604		440	920	1,800	2,360	3,040	3,640
Other long-term assets	42	42	42	42	42	42	42	42	42
<b>Total assets</b>	<b>74,509</b>	<b>79,235</b>	<b>80,995</b>	<b>77,603</b>	<b>75,425</b>	<b>74,693</b>	<b>75,792</b>	<b>78,207</b>	<b>81,782</b>
<b>Current Liabilities</b>									
Accounts payable	4,341	2,211	2,145	2,296	2,561	2,798	3,079	3,415	3,821
Other payables	1,946	774	634	936	1,212	1,439	1,675	1,944	2,230
<b>Total Current Liabilities</b>	<b>6,288</b>	<b>2,985</b>	<b>2,779</b>	<b>3,232</b>	<b>3,773</b>	<b>4,237</b>	<b>4,754</b>	<b>5,359</b>	<b>6,051</b>
<b>Long-term loan</b>	<b>52,200</b>	<b>58,010</b>	<b>56,808</b>	<b>55,198</b>	<b>53,588</b>	<b>51,978</b>	<b>50,368</b>	<b>48,758</b>	<b>47,147</b>
<b>Total long term liabilities</b>	<b>52,200</b>	<b>58,010</b>	<b>56,808</b>	<b>55,198</b>	<b>53,588</b>	<b>51,978</b>	<b>50,368</b>	<b>48,758</b>	<b>47,147</b>
Paid in capital	19,065	19,065	22,413	23,513	23,513	23,513	23,513	23,513	23,513
Retained earnings	(3,044)	(825)	(1,005)	(4,340)	(5,449)	(5,034)	(2,843)	578	5,071
<b>Total equity</b>	<b>16,022</b>	<b>18,240</b>	<b>21,408</b>	<b>19,172</b>	<b>18,064</b>	<b>18,479</b>	<b>20,670</b>	<b>24,090</b>	<b>28,584</b>
<b>Total liabilities and equity</b>	<b>74,509</b>	<b>79,235</b>	<b>80,995</b>	<b>77,603</b>	<b>75,425</b>	<b>74,693</b>	<b>75,792</b>	<b>78,207</b>	<b>81,782</b>
<b>Cash Flow Statements</b>									
<b>Operating Cash Flows</b>									
Revenue and other receipts	22,630	24,225	25,241	24,428	29,586	33,555	37,933	42,887	48,491
Cash payments	22,957	24,703	25,890	21,785	24,112	26,294	29,121	32,510	36,619
<b>Net cash flow from operations</b>	<b>(327)</b>	<b>(478)</b>	<b>(649)</b>	<b>2,643</b>	<b>5,473</b>	<b>7,261</b>	<b>8,813</b>	<b>10,377</b>	<b>11,873</b>
<b>Net cash flow from investing</b>	<b>(6)</b>	<b>490</b>	<b>(1)</b>	<b>(1,100)</b>	<b>(2,300)</b>	<b>(4,500)</b>	<b>(5,900)</b>	<b>(7,600)</b>	<b>(9,100)</b>
Financing cash flows:									
Equity contributions			1,062	1,100					
Debt service and dividends		22	156	2,735	2,703	2,671	2,639	2,607	2,574
<b>Net cash flow from financing</b>		<b>22</b>	<b>907</b>	<b>(1,635)</b>	<b>(2,703)</b>	<b>(2,671)</b>	<b>(2,639)</b>	<b>(2,607)</b>	<b>(2,574)</b>
<b>Changes in cash</b>	<b>(333)</b>	<b>(9)</b>	<b>257</b>	<b>(92)</b>	<b>470</b>	<b>90</b>	<b>274</b>	<b>170</b>	<b>198</b>
Cash at beginning of year	423	91	82	338	246	716	806	1,080	1,251
Cash at end of year	91	82	338	246	716	806	1,080	1,250	1,449
<b>Financial Ratios</b>									
Working ratio (%)	98	90	86	87	88	82	79	77	75
Return on net fixed assets (%)	(3)	0	0	0	(4)	(2)	0	2	4
Debt service ratio				(1.41)	(0.61)	(0.06)	0.69	1.27	1.83

( ) = negative

Source: Ulaanbaatar District Heating Company and Asian Development Bank estimates.



## ECONOMIC EVALUATION

### A. General

1. The viability of the Project was analyzed from a broader national perspective in terms of its economic internal rate of return (EIRR). The financial costs were adjusted to reflect the true economic opportunities foregone and realized on account of the Project.

### B. Assumptions

2. The economic analysis was based on the following additional assumptions:
- (i) A standard conversion factor of unity. Although there are distortions in the market, these are small and have not been considered in the analysis.
  - (ii) An estimated total cost of \$37.31 million net of taxes and duties, which form about 16.67% of total cost.
  - (iii) Consumer useful heat supply is valued on a willingness-to-pay basis. This is estimated at \$30 per Gcal, based on an average heating cost for *gers* (traditional felt-covered nomadic homes) using coal and wood (the most costly but widely used residential heating in Ulaanbaatar). Considering losses in the system, this transforms to \$30 per Gcal for total heat supply.
  - (iv) Reduced pumping power consumption at the power plants is valued on a willingness-to-pay basis for electricity estimated at \$0.28 per kWh based on diesel generation at a 15% plant factor (as this is the only reasonable alternative to central power supply).

### C. Economic Internal Rate of Return

3. The EIRR for the Project (Table A11) is estimated at 32.0%, which markedly exceeds ADB's target of 12% as the economic opportunity cost of capital for Mongolia. It also exceeds the EIRR of 23% estimated at appraisal. The high EIRR is due to the higher revenues from the higher willingness-to-pay values than at the time of appraisal, which more than offset the delays in revenue generation due to prolonged implementation.

**Table A11: Economic Internal Rate of Return**  
(\$ million)

Year	Economic Costs			Economic Benefits		Net Income
	Capital Costs	O&M	Heat Production	Increased Billable Heat Supply	Pumping Power Savings	
1998	0.05	0.00				(0.05)
1999	0.71	0.02				(0.73)
2000	0.95	0.02				(0.97)
2001	6.38	0.15				(6.53)
2002	1.70	0.04	0.44	2.13	0.80	0.75
2003	5.44	0.13	0.65	3.38	2.14	(0.70)
2004	7.07	0.17	0.95	5.19	2.84	(0.16)
2005	8.03	0.19	2.10	10.62	4.07	4.37
2006	6.50	0.16	2.16	10.72	4.73	6.63
2007	0.47	0.01	2.51	12.88	5.52	15.41
2008		0.01	3.78	18.10	6.48	20.79
2009		0.01	4.78	22.46	6.87	24.54
2010		0.01	5.89	27.18	7.28	28.56
2011		0.01	7.14	32.28	7.72	32.85
2012		0.01	8.52	37.80	8.18	37.45
2013		0.01	10.05	43.75	8.67	42.36
2014		0.01	11.27	48.10	9.08	45.90
2015		0.01	11.83	49.54	9.35	47.05
2016		0.01	12.42	51.03	9.63	48.23
2017		0.01	13.04	52.56	9.92	49.83
2018		0.01	13.69	54.14	10.22	50.66
2019		0.01	14.10	55.76	10.53	52.18
2020		0.01	14.53	57.43	10.84	53.73
2021		0.01	14.96	59.16	11.17	55.36
2022		0.01	15.41	60.93	11.50	57.01
2023		0.01	15.88	62.76	11.85	58.72
2024		0.01	16.35	64.64	12.20	60.48
2025		0.01	16.84	66.58	12.57	62.30
					<b>EIRR</b>	<b>32.0%</b>

( ) = negative, EIRR = economic internal rate of return, O&M = operation and maintenance.

Source: Asian Development Bank estimates