

**PROJECT COMPLETION REPORT**

**ON THE**

**POWER REHABILITATION PROJECT**  
**(Loan 1334- MON [SF])**

**IN**

**MONGOLIA**

**November 2002**

## CURRENCY EQUIVALENTS

Currency Unit – togrog (MNT)

		<b>At Appraisal</b> (June 1994)	<b>At Project Completion</b> (June 2002)
MNT1.00	=	\$0.0025	\$0.0009
\$1.00	=	MNT400	MNT1,100

## ABBREVIATIONS

ADB	–	Asian Development Bank
DANIDA	–	Danish International Development Assistance
EIRR	–	economic internal rate of return
FIRR	–	financial internal rate of return
NDF	–	Nordic Development Fund
PIU	–	project implementation unit
TA	–	technical assistance
TES3	–	Thermal Energy Station No. 3

## WEIGHTS AND MEASURES

cc	–	cubic centimeter
c/kWh	–	cents per kWh
gm	–	grams
kv (kilovolt)	–	1,000 volts
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
MWh (megawatt-hour)	–	1,000 kWh
GWh (gigawatt-hour)	–	1,000,000 kWh
Gcal (gigacalorie)	–	1,000,000 kilocalories
MVA (megavolt-ampere)	–	1,000,000 volt-ampere

## NOTES

- (i) The fiscal year (FY) of the Government coincides with the calendar year.
- (ii) In this report, "\$" refers to US dollars.

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## BASIC DATA

### A. Loan Identification

1.	Country	Mongolia
2.	Loan Number	Loan 1334-MON
3.	Project Title	Power Rehabilitation Project
4.	Borrower	Government of Mongolia
5.	Executing Agency	Energy Authority
6.	Amount of Loan	\$40.0 million (SDR27,142,000.00)
7.	Project Completion Report Number	PCR: MON 694

### B. Loan Data

1.	Appraisal	
	– Date Started	31 May 1994
	– Date Completed	18 June 1994
2.	Loan Negotiations	
	– Date Started	17 October 1994
	– Date Completed	19 October 1994
3.	Date of Board Approval	24 November 1994
4.	Date of Loan Agreement	17 May 1995
5.	Date of Loan Effectiveness	
	– In Loan Agreement	17 August 1995
	– Actual	4 July 1995
	– Number of Extensions	Nil
6.	Closing Date	
	– In Loan Agreement	30 June 1998
	– Actual	16 July 2001
	– Number of Extensions	3
7.	Terms of Loan	
	– Service Charge	1% per annum on the amount of the loan withdrawn from the loan account
	– Maturity (number of years)	40 years
	– Grace Period (number of years)	10 years
8.	Terms of Relending	
	– Interest Rate	Variable rate applicable to multicurrency loans from Asian Development Bank's ordinary capital resources
	– Maturity (number of years)	20 years
	– Grace Period (number of years)	3 years

9. Disbursements  
a. Dates

Initial Disbursement	Final Disbursement	Time Interval
9 August 1995	2 April 2001	5 years, 8 months
Effective Date	Original Closing Date	Time Interval
4 July 1995	30 June 1998	2 years, 11 months

b. Amount (\$)

Category or Subloan	Original Allocation	Last Revised Allocation	Amount Disbursed	Undisbursed Balance
I. Equipment and Materials	28,640,000	35,634,470	35,576,692	57,778
II. International Training	200,000	30,423	29,000	1,422
III. Consulting Services	1,600,000	1,626,580	1,391,074	235,506
IV. A. Local Expenses – Materials and Civil Works for Boilers	1,700,000	0	0	0
B. Local Expenses – Materials for Building and Cooling Tower	500,000	0	0	0
C. Local Expenses – Materials and Civil Works for District Heating	800,000	0	0	0
D. Local Expenses – Materials and Civil Works for Venturi Scrubber	1,000,000	0	0	0
E. Local Expenses – Unallocated	600,000	0	0	0
V. Services Charges During Construction	500,000	467,668	467,668	0
VI. Unallocated	4,460,000	4,333	0	4,333
Total	40,000,000	37,763,474	37,464,434	299,039 <sup>a</sup>

<sup>a</sup> An undisbursed loan amount of SDR239,501 was cancelled on 16 July 2001.

10. Local Costs (ADB-Financed)	Appraisal Estimate	Actual
- Amount (\$million)	4.6	0
- Percent of Local Costs	38.0	0
- Percent of Total Cost	7.9	0

**C. Project Data**

1. Project Cost (\$ million)

Cost	Appraisal Estimate	Actual
Foreign Exchange Cost	46.0	48.20
Local Currency Cost	12.0	8.30
<b>Total</b>	<b>58.0</b>	<b>56.50</b>

## 2. Financing Plan (\$ million)

Cost	Appraisal Estimate			Actual		
	Foreign	Local	Total	Foreign	Local	Total
<b>Implementation Costs</b>						
Borrower-Financed	0	4.69	4.69	0	8.30	8.30
ADB-Financed	34.90	4.60	39.50	36.99	0	36.99
Other External Financing						
DANIDA	5.00	0	5.00 <sup>a</sup>	4.99	0	4.99 <sup>b/</sup>
NDF	5.25	0	5.25	5.45	0	5.45
E7 Group	0.30	0	0.30	0.30	0	0.30
<b>Total</b>	<b>45.45</b>	<b>9.29</b>	<b>54.74</b>	<b>47.73</b>	<b>8.30</b>	<b>56.03</b>
<b>IDC Costs</b>						
Borrower-Financed	0	2.71	2.71	0	0	0
ADB-Financed	0.50	0	0.50	0.47		0.47
Other External Financing						
NDF	0.05	0	0.05	0	0	0
<b>Total</b>	<b>46.0</b>	<b>12.00</b>	<b>58.00</b>	<b>48.20</b>	<b>8.30</b>	<b>56.50</b>

ADB = Asian Development Bank, DANIDA = Danish International Development Assistance, IDC = interest during construction, NDF = Nordic Development Fund.

<sup>a</sup> DANIDA allocation: DKr33.0 million

<sup>b</sup> Actual: DKr27.686 million

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

Components	Appraisal Estimate			Actual		
	Foreign	Local	Total	Foreign	Local	Total
(a) TES 3 Rehabilitation	33.29	6.84	40.13	41.02	8.30	49.32
(b) District Heating Rehabilitation	4.22	0.96	5.18	4.72	0	4.72
(c) Metering	0.20	0.05	0.25	0.27	0	0.27
(d) Training	0.50	0.05	0.55	0.33	0	0.33
(e) Consulting Services	1.55	0.20	1.75	1.39	0	1.39
(f) Contingencies	5.69	1.19	6.88	0	0	0
(g) IDC	0.55	2.71	3.26	0.47	0	0.47
<b>Total</b>	<b>46.00</b>	<b>12.00</b>	<b>58.00</b>	<b>48.20</b>	<b>8.30</b>	<b>56.50</b>

IDC = interest during construction, TES3 = Thermal Energy Station No.3.

## 4. Project Schedule

Item	Appraisal Estimate	Actual
Consulting Services		
Nondestructive Examination	Sep 1994	Sep 1994-Oct 1994
Preparation of Tender Documents for contract packages	Sep 1994	Sep 1994-Dec 1994
Project Implementation	Aug 1994/Mar 1995	Aug 1994-Feb 2001
Project Implementation		
TES 3 Boilers		
Tender and Contract	Dec 1994	Mar 1995-Feb 1996
Engineering, Manufacture and Supply	May 1994	
- Boiler No. 7		Jul 1996-Oct 1997
- Boiler No. 8		Oct 1996-Feb 1998
- Boiler No. 9		
- Boiler No. 10		Oct 1996-May 1998
- Boiler No. 11		Jan 1997-Oct 1998
- Boiler No. 12		Dec 1996-Jul 1998
- Boiler No. 13		Jun 1998-Oct 2000
Rehabilitation of Boilers	Sep 1995	
- Boiler No. 7		Sep 1996-Jun 1998
- Boiler No. 8		Dec 1996-Jul 1998
- Boiler No. 9		
- Boiler No. 10		May 1997-Sep 1998
- Boiler No. 11		Feb 1997-Aug 2000
- Boiler No. 12		Jun 1997-Dec 1998
- Boiler No. 13		Sep 1998-Dec 2000
TES 3 Turbines (NDF Financing)		
Tender and Contract Award	Jan 1995	Sep 1995-Jun 1996
Rehabilitation of Turbines	May 1995	
- Turbine No. 5		Jun 1997-Feb 1998
- Turbine No. 6		Oct 1997-Feb 1998
- Turbine No. 7		Jun 1997-Feb 1998
District Heating (DANIDA Financing)		
Tender and Contract Award	Jan 1995	Aug 1996-Dec 1996
Rehabilitation	Jun 1995	Mar 1996-Nov 1997

DANIDA = Danish International Development Assistance, NDF = Nordic Development Fund, TES3 = Thermal Energy Station No. 3.

## 5. Project Performance Report Ratings

Implementation Period	Ratings			
	Development Objectives		Implementation Progress	
	Last	Current	Last	Current
24 Nov 1995 (Pac Notes) Project Classification	Last: AAA		Current: AAA	
20 Jun 1996 (Pac Notes) Project Classification	Last: AAA		Current: AAA	
From 30 Sep 1998 to 30 Mar 1999	S	S	S	S
From 31 Mar 1999 to 30 May 1999	S	S	S	PS
From 31 May 1999 to 29 Jun 1999	S	S	PS	S
From 30 Jun 1999 to 29 Sep 2000	S	S	S	PS
From 30 Sep 2000	S	S	PS	PS

PS = partly satisfactory, S = satisfactory

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

Name of Mission	Date	No. of Persons	No. of Person-Days	Specialization of Members <sup>a</sup>
Fact-Finding	2-16 Feb 1994	4	60	a, b, d, e
Appraisal	31 May-18 Jun 1994 <sup>b</sup>	5	95	a, b, c, d, g
Inception	5-9 May 1995	2	10	a, d
Energy Sector	6-8 Nov 1995	2	6	a, d
Midterm Review	18-28 Jun 1996	5	55	a, b, c, d, g
Loan Disbursement	8-11 Aug 1996	2	8	f, i
Review 2	23-25 May 1997	3	9	a, d, h
Loan Disbursement	16-19 Sep 1997	2	8	f, i
Ongoing Projects Review <sup>c</sup>	3 Nov 1997	1	1	d
Review 3	24-27 Nov 1997	1	4	a
Review 4 <sup>d</sup>	3-16 Mar 1998	1	14	a
Review 5	7-11 Oct 1998	2	10	a, i
Review 6	17-21 May 1999	2	10	a, i
Review 7	4-8 Nov 1999	2	10	a, i
Review 8	20-24 Oct 2000	2	10	a, i
Review 9	13-17 Jun 2001	2	10	a, i
Project Completion Review <sup>e</sup>	20-25 Jun 2002	3	15	a, b, i

<sup>a</sup> a = engineer, b = financial analyst, c= counsel, d= economist, e = procurement consultant or specialist, f = control officer, g = programs officer, h = young professional, i = assistant/senior assistant.

<sup>b</sup> Included representatives from the Danish International Development Assistance, Nordic Development Fund, and the E7 Utility Group.

<sup>c</sup> While on Mission for Egiin Hydropower Project.

<sup>d</sup> While on Fact-Finding Mission for the proposed technical assistance for Energy Rehabilitation Project.

<sup>e</sup> The Mission comprised of S. Hasnie, Energy Specialist (Mission Leader), S. Zaidi, Staff Consultant, and C. B. Africa, Assistant Project Analyst.

## I. PROJECT DESCRIPTION

1. The Power Rehabilitation Project in Mongolia was designed to improve the reliability of heat supply for the population of Ulaanbaatar and to increase the power supply for consumers in the service area of the Energy Authority's grid.<sup>1</sup> An important design element of the Project was to reduce the vulnerability of power plant failure during the harsh winter months and to ease the energy supply bottleneck for economic recovery and growth.

2. The Project consisted of the following components:

- (i) **Rehabilitation of Thermal Energy Station number 3 (TES3)** – Convert seven high-pressure boilers to direct firing with flue gas coal drying, refurbish air heaters and economizers, repair boiler refractory, examine the boiler pressure parts and replace piping/tubes as required, refurbish high-pressure turbine generator auxiliaries and rehabilitate the generator cooling system, upgrade the instruments and controls, overhaul the venturi scrubber particulate control system, expand the ash-disposal pond facility, rehabilitate the high-pressure water cooling tower, repair the roof of the high-pressure section building, and install coal-measuring equipment and plant intercom system.
- (ii) **District Heating Rehabilitation** – Replace about 24 kilometers (km) of main district heating piping in the central district of Ulaanbaatar.
- (iii) **Metering** – Install about 115 heat meters in all the block substations in Ulaanbaatar.
- (iv) **Training** – Provide training in power station operation and management.
- (v) **Consulting Services** – Supervise project implementation and provide technical support for operation and maintenance.

3. The Project included technical assistance (TA) to strengthen the environmental management and planning capability of the Ministry of Nature and Environment.<sup>2</sup> The Government of Mongolia was the Borrower, and the Central Energy System was the Executing Agency. The Central Energy System was renamed Energy Authority in 1997; to avoid confusion, only Energy Authority will be used throughout this report. Appendix 1 shows a chronology of the major events in implementing the Project.

## II. EVALUATION OF DESIGN AND IMPLEMENTATION

### A. Relevance of Design and Formulation

4. About half the population of Mongolia relies on district heating, which is supplied from five Russian-made coal-fired thermal power plants. These power plants were designed to use a specific quality of coal that is no longer available from the nearby coal mines. The high pressure boilers were deteriorating because they were fired with non design coal from Baganuur and

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<sup>1</sup> ADB. 1994. *Report and Recommendation of the President to the Board of Directors on a Proposed Loan to Mongolia for the Power Rehabilitation Project*. Manila.

<sup>2</sup> ADB. 1994. *Technical Assistance to MON for Strengthening the Environmental Management Capacity of the Ministry of Nature and Environment*. Manila.

Shivee Ovee mines, which has higher ash and moisture content than the original design coal from Sharyn Gol mine. All five coal-fired power plants were designed for cogeneration of electricity, hot water for district heating, and steam for industry. These power plants were rapidly deteriorating as they lacked adequate maintenance because of the difficulty in obtaining foreign exchange for buying spare parts.

5. The district heating capability had deteriorated by 1993 to a point that the temperature in many buildings could not be constantly maintained at acceptable levels during the harsh winter months. The poor condition of the power plants and the shortages of coal during winter months resulted in the power and heat system being close to total collapse. A major explosion at the TES3 power plant during the winter of 1993 disrupted the supplies to the centrally heated residential areas and threatened the well being of Ulaanbaatar residents. With subzero temperature in the apartments, people had to sleep fully clothed; coal stove/heaters cannot be used because there are no chimneys in these buildings. Since electric stove elements are the only facility available in the apartment buildings in Ulaanbaatar for cooking, a segment of the population had to go without hot meals whenever the electricity was out.

6. The objective of the Project was to address the energy shortages in Mongolia, particularly in the capital city of Ulaanbaatar by (i) rehabilitating the high-pressure section at TES3 power station to extend its useful life by 10 years and increase its availability and output; (ii) rehabilitating a section of the district heating system in Ulaanbaatar to reduce heat losses from hot water leakage; (iii) providing district heating metering to encourage conservation; and (iv) providing training and technical support in power station operation and management to ensure sustainability of the Project.

## **B. Project Outputs**

7. As envisaged, the Project has successfully rehabilitated the boilers at TES3 power plant. The project facilities first arrested the further decline in electricity supply, and thereafter gradually increased the electricity output. Gross electricity output of the power plant increased from a low of 318 gigawatt hours (GWh) in 1996 to 531 GWh in 2001, an increase of about 67.0%. With the improvement in boiler efficiency and other related operational activities, the auxiliary power consumption (internal use of electricity) at the plant was reduced from 36% of the gross electricity generation in 1996 to about 26% in 2001. Appendix 2 provides relevant details.

8. In addition, the maximum capacity utilization period of the boilers at the power plant increased from a low of 2,342 hours in 1996 to 3,902 hours in 2001; an increase of 67%. Fuel consumption per kilowatt (kW) of power energy generation at TES3 plant fell from 558 grams per kilowatt-hour (gm/kWh) in 1995 to 466 gm/kWh in 2001, a reduction of about 17%. The Project's efficiency gains are presented in Appendix 3.

9. The Project helped to reduce the number of emergency power trips at TES3 from a high of 214 in 1996 to only 16 in 2001. The loss of power generation and the subsequent reduction in the supply of electricity, hot water, and process steam to consumers resulting from the emergency power trips, was reduced from a high of 43 GWh in 1996 to only about 3 GWh in 2001, a drop of about 92%. Thus, the total cumulative revenue loss due to power trips during this period amounted to MNT1,792 million (from a high of about MNT952 million in 1996 to about MNT127 million in 2001). This represents an increase in revenue of about MNT825 million during the same period. Appendix 4 shows the details.

10. The Project also replaced 2.1 km of main district heating pipe, 36 compensators, leak detection and welding equipment; and provided training for operational staff. These measures were very important for immediate reduction of water leakage. These components were funded by Danish International Development Assistance (DANIDA). DANIDA funding also included supply of 12 meters at the power stations, 19 at industries, and 45 to residential apartment end-users. Although it is practically impossible to measure the impact of each of these activities separately, together they arrested continuing leakage of the water.

11. Power station managers and professional staff were trained in E7 utilities in Italy, Germany, and France. This training—along with the consulting services for project implementation, supervision, and technical support for operation and maintenance—improved the professional ability of the management and technical staff. This capacity-building support was essential for sustainability of the Project to ensure appropriate management and operations by Energy Authority staff.

12. Another important contribution of the Project relates to reduced electricity imports from Russia, which fell 46% between 1987 and 2001, and a saving of \$7.0 million in 2001. About 40% of the reduction in electricity imports from Russia is attributable to the output from the Project. Table 1 shows the electricity imports from Russia during the period 1997-2001.

**Table 1: Electricity Imported from Russia**

Item	Year				
	1997	1998	1999	2000	2001
Amount of Electricity Imported in Gigawatt Hours	344.7	356.7	194.0	151.2	156.8

Source: Energy Authority.

### **C. Project Costs**

13. At appraisal, the total project cost, including service charges and interest during construction, was estimated at \$58.0 million equivalent, of which \$46.0 million (79%) was the foreign currency cost and \$12.0 million equivalent (21%) was the local currency cost. The actual project cost was \$56.50 million equivalent, comprising \$48.2 million (85%) in foreign currency and \$8.30 million equivalent (15%) in local currency cost. The original scope included seven boilers to be rehabilitated by Asian Development Bank (ADB) as well as Nordic Development Fund (NDF) financing with a total cost of \$40.13 million: \$33.29 million in foreign currency and \$6.84 million equivalent in local currency. During implementation the Government decided to finance two boilers, numbers 10 and 12 (which were in relatively good condition), with cheaper Russian spares at a total cost of \$8.3 million. ADB and NDF financed the complete rehabilitation of five boilers, which included upgrading the instrumentation controls of four boilers at a total cost of \$41.02 million: \$35.57 million by ADB and \$5.45 million by NDF. The Government decided to keep the materials purchased for boiler 9 as spares for future maintenance of the rehabilitated boilers.

14. During midterm review in 1996, supply of leak detection and welding equipment and 36 compensators were added to the district heating component and as a result the length of the pipe to be replaced was reduced to 7.2 km from 24 km. With advance capability of leak detection and repair, only 3.1 km of pipe was finally replaced. Table 2 outlines a summary of the project cost with details provided in Appendix 5.

**Table 2: Comparison of Project Costs**  
(\$ million)

Component	Appraisal			Actual		
	Foreign	Local	Total	Foreign	Local	Total
A. Base Costs <sup>a</sup>						
1. Thermal Energy Station 3 Rehabilitation	33.29	6.84	40.13	41.02	8.30	49.32
2. District Heating Rehabilitation	4.22	0.96	5.18	4.72	0	4.72
3. Metering	0.20	0.05	0.25	0.27	0	0.27
4. Training	0.50	0.05	0.55	0.33	0	0.33
5. Consulting Services	1.55	0.20	1.75	1.39	0	1.39
B. Contingencies						
1. Physical	2.91	0.59	3.50	0	0	
2. Price	2.78	0.60	3.38	0	0	
<b>Base Cost + Contingencies</b>	<b>45.45</b>	<b>9.29</b>	<b>54.74</b>	<b>47.73</b>	<b>8.30</b>	<b>56.03</b>
C. Interest During Construction	<b>0.55</b>	<b>2.71</b>	<b>3.26</b>	<b>0.47</b>	<b>0</b>	<b>0.47</b>
<b>Total Project Cost</b>	<b>46.00</b>	<b>12.00</b>	<b>58.00</b>	<b>48.20</b>	<b>8.30</b>	<b>56.50</b>

<sup>a</sup> Base cost reflects end-1993 year prices.

15. The financing envisaged at appraisal included an ADB loan of SDR 27.142 million (\$40.0 million equivalent) to be drawn from ADB's Special Funds resources. It was intended to finance \$35.4 million equivalent of the estimated foreign currency cost and \$4.6 million equivalent of the local currency cost of the Project. DANIDA and NDF provided a combination of parallel concessional and grant cofinancing in the amount of \$5.0 million equivalent and \$5.3 million equivalent, respectively. A grant of \$0.3 million equivalent was provided in kind from the E7 Utility Group<sup>3</sup> for international training of Energy Authority staff. The Government provided \$7.4 million equivalent to finance balance of the local cost. Table 3 shows the financing plan.

**Table 3: Project Financing Plan**  
(\$ million)

Source	Appraisal			Actual		
	Foreign	Local	Total	Foreign	Local	Total
Asian Development Bank (TES3 Boiler Rehabilitation)	35.4	4.6	40.0	37.46	0	37.46
DANIDA (District Heating Rehabilitation and Metering) <sup>a</sup>	5.0	0	5.0	4.99 <sup>b</sup>	0	4.99
NDF (TES 3 Turbine Rehabilitation)	5.3	0	5.3	5.45	0	5.45
E7 Group (Training)	0.3	0	0.3	0.30	0	0.30
Central Energy Systems (Energy Authority)	0	7.4	7.4	0	8.30	8.30
<b>Total</b>	<b>46.0</b>	<b>12.0</b>	<b>58.0</b>	<b>48.20</b>	<b>8.30</b>	<b>56.50</b>

DANIDA = Danish International Development Assistance, NDF = Nordic Development Fund, TES3 = Thermal Energy Station No. 3.

<sup>a</sup> DANIDA allocation amounted to DKr33.0 million.

<sup>b</sup> DANIDA's actual financing amounted to DKr27.686 million.

<sup>3</sup> The E7 is an international group of the world's largest electric utilities that provides expertise free of charge to further its objective of protecting the global environment and promoting efficient generation and use of electricity.

16. About 1.1% of the ADB loan not utilized, or SDR 0.240 million (\$0.30 million equivalent), was subsequently cancelled. The summary of contracts finance by ADB is in Appendix 6, and the exchange rates for 1995-2001 are in Appendix 7.

#### **D. Disbursements**

17. The summary of projected and actual disbursements is in Appendix 8. Total disbursements amounted to SDR26.902 million (\$37.5 million) compared with the approved amount of SDR27.142 million (\$37.8 million). The difference of SDR0.24 million (\$0.30 million) was canceled on 16 July 2001, after the loan account was closed effective 31 March 2001.

#### **E. Project Schedule**

18. The implementation schedule, as originally planned and as actually executed, is shown in Appendix 9.

19. The implementation schedule for the whole project at appraisal was 2 years and 10 months, commencing in early 1995, and to be completed by the end of December 1997. The schedule was considered realistic, but due to delays resulting from the contractor's performance, and also given the inexperience of the Energy Authority in implementing ADB projects (as this was ADB's first loan to the thermal power sector in Mongolia), the actual project implementation period was extended up to the end of January 2001. The loan was closed on 16 July 2001. The main reasons for the delays were late delivery of equipment material, delays in selection of domestic contractors, the engagement of local labor force by the international contractor (paras. 28-30), alleged asbestos contamination (paras. 31-34), and delays in custom clearance of goods and material by the Energy Authority.

#### **F. Implementation Arrangements**

20. The Energy Authority as the Executing Agency was responsible for the overall supervision and coordination of the Project. A project implementation unit (PIU) under the general guidance of a Project Steering Committee was established for the Project. The PIU was supported by implementation consultants financed under the loan. The PIU undertook the day-to-day implementation of the Project, including preparation of tender documents, tendering, and supervision of consultants. The committee, chaired by the Ministry of Energy, Geology and Mining included representatives from that ministry, the National Development Board, Energy Authority, and PIU and served as a forum for discussions on important issues concerning the Project.

21. No major changes occurred in the overall scope of the Project. However, minor rationalization of the Project's scope was made to improve the effective utilization of loan funds. In January 1997, ADB approved a minor change in scope whereby instead of financing the rehabilitation of all seven boilers, ADB financed five boilers (nos. 7, 8, 9, 11, and 13) and the Energy Authority funded rehabilitation of boilers 10 and 12. With these changes, the Project still comprised the original scope of rehabilitating seven boilers: 5 boilers under ADB funding and 2 boilers under Energy Authority funding. The operational performance of boilers 7 and 8 after rehabilitation was better than expected and, on that ground, ADB approved on 7 December 1999 a minor change in scope by deleting the rehabilitation of boiler 9. The amount allocated for rehabilitation work on boiler 9 was utilized for additional work incurred on boilers 7, 8, 11, and 13. The materials for boiler 9 that had already been delivered to the site were used as spare parts for the rehabilitated boilers. As a result, the Energy Authority's operation and maintenance

expenditure over the subsequent 5 years was reduced. On the District Heating Rehabilitation side of the Project, the original scope of 24 km pipe replacement was reduced to 7.2 km during midterm review in June 1996 and finally only 3.1 km of main district heating pipe was replaced. Similarly 76 meters were installed instead of the 115 meters in the original scope of the project; the scope was changed during the midterm review. Appendix 10 described the changes in the Project's scope.

22. The rationalization of the scope through these minor changes was considered necessary during the strip-down examination of the actual condition of boilers 7 and 8. The rationalization of scope was considered technically and economically expedient and increased the net heat and electricity output.

## **G. Conditions and Covenants**

23. Generally, the Government and the Energy Authority complied with all loan covenants. The Government implemented the energy sector restructuring action plan and the energy conservation plan agreed under a TA approved in 1991.<sup>4</sup> Since the Government had increased the tariff, meeting ADB's requirement before the Loan Agreement was finalized in October 1994, the proposed covenant related to tariff increases was deleted from the Loan Agreement. The current electricity tariff of MNT45 per kWh or 4.1 c/kWh is about 23% below the appraisal estimate of 5.3 c/kWh in 2001. Appendix 11 shows the status of compliance with the loan covenants.

## **H. Technical Assistance**

24. To address the environmental concerns in the power sector, ADB provided TA to the Government of Mongolia to strengthen the environmental management capability of the Ministry of Nature and Environment (footnote 1). The TA was implemented from July 1995 to June 1997. It addressed Mongolia's need to establish an institutional framework for environmental planning and management. The TA activities included reviewing the comprehensive environmental law and the environmental impact assessment procedures, developing national environmental standards, strengthening monitoring capabilities, preparing a pollution-discharge permit system, strengthening the capability of local governments, and examining disaster management (which included a public awareness and information program and an early warning system). The TA completion report was circulated to the Board on 9 November 1998, assessed the TA to be generally successful.<sup>5</sup>

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

### **1. Consultants**

25. To facilitate timely implementation of the Project, on 18 May 1994 ADB approved advance action for procurement. Advance recruitment of international consultants was carried out by the Energy Authority as scheduled and in accordance with ADB's *Guidelines on the Use of Consultants*.

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<sup>4</sup> ADB. 1991. *Technical Assistance to MON for Energy Audit, Efficiency and Conservation Study*. Manila.

<sup>5</sup> Board Information Paper IN. 255-98.

## **2. Procurement**

26. The Project was implemented on turnkey contract basis with full responsibility resting with the contractor to complete the work assignment as per the contractual agreement.

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

#### **1. Consultants**

27. Overall, the international implementation consultants performed satisfactorily. The consultants provided project management support and assistance to the Energy Authority in the preparation of contract documents, tendering, bid evaluation, review of engineering design proposed by contractors, contract negotiations, supervision of installation, and testing and commissioning of equipment. The consultants also provided on-the-job technical support and training in the operation and maintenance of TES3 power station. The consulting services were carried out over a period of 36 months utilizing 62 person-months. The foreign exchange costs were entirely financed by ADB. The international implementation consultants completed their assignment within the stipulated timetable. Early recruitment of the international consultants facilitated the timely startup of the Project.

#### **2. Contractors and Suppliers**

28. The contractor's performance was less than satisfactory. The Project was supposed to be completed within 22 months from the date of contract effectiveness (15 February 1996) as per the contract between the Energy Authority and the contractor on 31 December 1997. However, the delivery of equipment, material, and supplies to the project site was delayed by about 36 months.

29. The following items were the main reasons for the delay. According to the contract, the international contractor was required to fabricate, weld, and manufacture all items in its own country and deliver them to the project site in Ulaanbaatar. However, the international contractor decided to bring the material to Ulaanbaatar and have a domestic contractor build the items according to the approved design specification. The selection of domestic contractor by the international contractor was delayed and the domestic contractor failed to deliver as per specification.

30. Engagement of skilled local labor force by the international contractor caused further delays. As per the contract, the international contractor was required to bring in international experts to the project site, but the international contractor decided to employ local labor. In addition to these delays, the contractor had stopped work on two occasions due to an alleged asbestos problem at the project site. A summary of the alleged asbestos problem and its resolution is outlined below in paragraphs 31-34.

##### **a. Alleged Asbestos Contamination at project site**

31. The Energy Authority's contractors raised the issue of asbestos contamination to the Energy Authority, which subsequently brought it to the attention of ADB in November 1996. The contractor contended that the Energy Authority staff who were responsible for the demolition of the boilers had not followed internationally acceptable safety procedures in removing and storing the asbestos insulation in the boilers. The contractor expressed its concerns for the safety of the workers and stopped the work to minimize risk. The contractor also demanded use

of special equipment including protective suits for workers and threatened to activate ADB's Inspection Panel.

32. ADB and the Energy Authority were of the opinion that the contractor, being a large internationally renowned contractor, should have been aware of the asbestos hazards that are inherent in all Russian-made boilers of a certain age. Also, the contractor should have been fully aware of the specific situation in TES3 during the numerous pre-bid inspections of the boiler house. The Energy Authority also demanded an explanation from the contractor as to why the asbestos contamination problem was raised 6 months after the start of the boiler demolition work. The Energy Authority was of the opinion that the contractor raised this issue to cover up the delays in their work schedule.

33. To resolve the alleged asbestos contamination issue, ADB engaged the services of an international asbestos expert and financed these services under the implementation consultants' contract. The asbestos expert visited Mongolia between 29 August–12 September 1997 and recommended that the contractor apply the standards set by the Occupational Safety & Health Administration, U.S. Department of Labor (OSHA), which stipulates that 0.1 fibers/cubic centimeter (cc) be used as the asbestos limit before protection equipment is required for the workers.

34. At the recommendation of the asbestos expert, the contractor continuously monitored the asbestos contamination levels in the boiler house. The highest level recorded during cutting of asbestos was 0.067 fibers/cc, whereas the usual level was found to be only 0.015 fibers/cc. The asbestos expert developed procedures for asbestos handling and discussed the same with the asbestos expert of the contractor and other concerned staff. The asbestos expert visited the project site in Mongolia again in March/April 1998 before asbestos removal commenced on boiler no.13. Thus, the alleged asbestos contamination problem was resolved amicably to the satisfaction of all concerned.

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

### **1. Borrower**

35. The performance of the Borrower is considered satisfactory overall. The Borrower provided sufficient local currency funds for project implementation. Implementation arrangements were well established, and timely meetings were held to discuss and resolve the problems facing the implementation of the Project. Loan conditions and covenants stipulated in the loan and project agreements were complied with as outlined in Appendix 11.

### **2. The Executing Agency**

36. The Energy Authority's performance is also considered fully satisfactory. It coordinated well with the consultants and the contractor and other government agencies. Although the Energy Authority encountered delays in customs clearance of goods and materials, it implemented the Project smoothly, considering that it was its first ADB project.

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

37. ADB's performance in completing the Project was satisfactory. There were no major disagreements between the Borrower, Energy Authority, and ADB on implementation arrangements, including bid evaluation and contract awards. ADB project staff undertook

periodic project review missions and provided close monitoring not only during review missions but also during any energy sector mission to Mongolia.

### **III. EVALUATION OF INITIAL PERFORMANCE AND BENEFITS**

#### **A. Relevance**

38. The Project's rationale to assist the Government in rehabilitating the facilities at TES3 power plant was sound and premised on the need to provide an improved and reliable heat supply and power to the residents of Ulaanbaatar. Without the Project, the wellbeing of the people in Ulaanbaatar would have been threatened and resulted in social disruption.

39. The TA to address the environmental concerns in the power sector was also relevant (footnote 1). While the scope of the TA may be seen as overly ambitious, its design reflected the urgent need for sector priorities. Implementation of the TA was timely considering the critical stage of a basic shift in the management system of the Ministry of Nature and Environment. The TA had a positive impact on the institutional capacity building of that ministry, as well as on national environmental policy formulation. The performance of the TA consultants was satisfactory.

#### **B. Efficacy In Achievement of Purpose**

40. The Project was considered as the most expedient and cost-effective solution to ensure essential supplies of heat and power in the medium term before new capacity could be installed. The Project was completed satisfactorily, with most project components implemented substantially as conceived.

41. The safety of workers in the power plant has significantly improved and occupational health hazards have been substantially reduced with the installation of new firing system, rehabilitated boilers, and the new computerized instrumentation and controls. There has also been a reduction in coal consumption. The increased and reliable supply of electricity and hot water for district heating under the Project has provided the basic human needs of food (cooking meals using electricity) and keeping the body warm during the extreme winter conditions, enhanced the quality of life, and promoted the establishment of a number of new small-scale private businesses.

42. An important benefit of the Project is in providing a reliable physical environment and infrastructure in which private enterprises may invest, helping much needed economic growth in Mongolia. The rehabilitation of boilers for increased and reliable availability of electricity and hot water for district heating was an essential first step in preparing the power sector for unbundling, commercialization, and eventual private investment.

#### **C. Efficiency in Achievement of Outputs and Purpose**

##### **1. Financial Performance**

43. The Project achieved the expected benefits and a financial internal rate of return (FIRR) of 7.4%, which is lower than the 9.7% calculated at appraisal. The lower FIRR is a direct result of lower tariffs than were forecast at appraisal. Analysis of the project benefits are shown in Table A12.1 and the generation with and without-the-project is shown in Figures A12.1 and A12.2. Table A12.2 compares the forecast and actual FIRR. The FIRR calculated at appraisal

did not include the benefit of reduced imports from Russia, which is a direct cost savings for the Energy Authority. The FIRR would be higher if these benefits were taken into account. The estimated Weighted Average Cost of Capital (WACC), post-tax, in real terms was derived using actual capital mix of funds. The real WACC for the project is low as it was financed by 85% debt and 15% equity. The post-tax real WACC is calculated as 4.31% applying the minimum rate test of 4% for cost of debt as per the Guidelines for the Financial Governance and Management of Investment Projects Financed by ADB—and 12% cost of equity. The revised FIRR of the project remains above the WACC.

44. The Energy Authority's financial performance continues to be weak, with revenues not sufficient to cover operating expenses, although electricity sales grew steadily. Accounts receivable remains a problem. The accounts receivable at the end of 2000 were \$25 million or the equivalent of 3.1 months of gross billings, which has more than doubled from 1.4 months in 1995. Although the current average electricity tariff of 4.1 c/kWh is lower than the forecast of 5.3 c/kWh for 2001 at appraisal, the tariff increase made over last few years is a considerable achievement for the Government. Although the financial performance of the Project is satisfactory, the overall financial performance of the Energy Authority is not adequate as a result of lower tariff levels. Electricity and heat tariffs are shown in Table A12.3. Despite substantial tariff increases (about 200%) significant depreciation of the togrog has resulted in about 30% increase in United States dollar terms. Past financial statements are in Tables A12.4 to A12.6.

45. The financial analysis assumes that the benefits will continue until the end of 2007, the original expected life of the rehabilitated power station. This is done for the sake of consistency, although in reality, if properly maintained, the benefits will be more than 7 years, exceeding the design life of the Project. The electricity industry in Mongolia has been significantly restructured since the Project was initiated (Figure 12.3). The restructured industry that is to be privatized within the next few years and private management is likely to improve the maintenance and extend the Project's life beyond 2007.

## **2. Economic Performance**

46. The economic evaluation of the Project was carried out following the methodology used in the appraisal, without taking account of the additional benefits gained from reducing import from Russia. Incremental costs and benefits were determined for calculating the net benefit stream. The economic life of the project was assumed to be 10 years—as per appraisal estimate—and the residual value at the end of the economic life was assumed to be \$2.0 million. Actual capital costs rather than the economic capital costs—costs converted to economic values by applying appropriate conversion factors—were used in the calculation of the Project's economic internal rate of return (EIRR) following the approach taken during appraisal. The economic benefits were valued using the same willingness to pay tariff for the electricity and heat energy saved by (i) increased electricity generation, (ii) reduced auxiliary consumption, (iii) increased heat generation, and (iv) savings of heat energy from pipe replacement. The EIRR was calculated as 20.8% compared with the appraisal forecast of 18.3%. Comparison of EIRR calculation with appraisal is shown in Table A12.7. The economic value of coal at \$20 per ton (as per appraisal estimate) was used to quantify the benefits from efficient use of coal that reduced the coal consumption by 50,000 tons for producing the same amount of energy. The partly subsidized current price of coal per ton is about \$7-8 per ton. The analysis for EIRR used the same willingness to pay tariffs—5.9 c/kWh for electricity and 1.1 c/kWh for heat—as at appraisal.

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

47. The overall financial health of the Energy Authority is behind the expected level, which makes the forecast at appraisal appear optimistic, for example, in 2000, the overall energy generation was 20% less than appraisal forecast of 2,867 GWh and energy sales were about 30% lower. The expected \$600 million—to be spent on capital expenditure between 1998 and 2000—was not spent, the actual capital expenditure over the same period amounted to be about \$135 million equivalent, which highlight the poor condition of the overall power generation facilities. Despite this, the facilities provided under the Project are expected to last the projected economic life. The rehabilitated boilers and related facilities at TES3 are well maintained and kept in operating condition.

48. Energy Authority's total revenue for 2000 was expected to be about \$177 million but as a result of lower tariffs, reduced sales and currency depreciation, only about \$86 million was achieved in 2000. Although the revenue and the profitability of TES3's initial operations are less than projected, its operational performance is expected to improve further as the Government reviews the tariff structure for further increases. The ongoing ADB-funded projects will help the Government and the sector agencies in proceeding with the sector reform program. All these initiatives will help ensure that the benefits of the Project are sustained.

#### **E. Environmental, Sociocultural, and Other Impacts**

49. The Project is deemed to have no significant environmental impact and it was classified as category B; consequently, no such concerns were raised during project implementation. To facilitate continued environmentally friendly plant operation, a new ash-disposal pond was constructed and the venturi scrubber particulate control system was overhauled. These project components are considered to have contributed, to some extent, to improvement in the air quality of Ulaanbaatar, especially during winter months. As noted in the Report and Recommendation of the President for the Project, coal in Mongolia is in low supply in September and the ambient sulphur dioxide levels are well below the national air quality standards. Nitrogen dioxide levels are also below United States Environmental Protection Agency standards. The TES3 venturi scrubber system for particulate control was designed with 90% removal efficiency.

50. A better working environment has improved the health of workers at TES3 power plant. The number of industrial accidents injuring workers fell from 7 in 1999 to 4 in 2001. The person-days lost due to illness of the workers dropped from 11,305 in 1994 to 7,566 in 2001, a reduction of about 33%. Also, the annual average turnover of the labor force declined from a high of 210 persons to 118 persons during the same period, an improvement in labor turnover of about 44%. Appendix 13 provides the relevant details.

51. The efficient plant operation and improved maintenance resulting from the implementation of the Project has helped TES3 to reduce the total staff numbers from 1,153 in 1996 to 987 in 2002, a reduction in staff of about 13.5%. Safety at TES3 power plant has improved with the installation of the new firing system, the rehabilitated boilers, and the computerized instrumentation and controls. These improvements have increased significantly the workers' satisfaction, renewed their interest to work at the power plant, and reduced absenteeism and turnover.

52. The improvement in thermal efficiency of the boilers at TES3 plant has resulted in the reduction of coal consumption by about 21,000 tons per year, thereby reducing plant emissions

by about 20%, with increased electricity and heat output. The reduced coal consumption at TES3 plant has also benefited the local and regional environment due to reduction in emissions of acid rain precursors and in global-warming gases.

53. The E7 conducted three different programs and provided training to 20 TES3 staff (5 management staff, 10 operation superintendents/shift supervisors, and 5 maintenance superintendents). The training was held in E7's three utility countries namely, Italy, Germany, and France. Each training program was designed for a period of 2 months and completed by the end of 1996. The training provided to TES3 staff helped them to participate in the installation of project facilities and to conduct proper maintenance of boilers and other equipment.

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

##### **A. Overall Assessment**

54. Project implementation was delayed by about 3 years primarily because of the contractor's performance. However, the Project produced the designed socioeconomic benefits, covenants were complied with by the Government, the rehabilitation program was technically sound and reliable, output met appraisal targets, cost savings were achieved, safety improved, occupational health hazards were reduced, and generally no significant environmental impacts were felt.

55. A review of the relevance, efficacy, efficiency, sustainability, and institutional and development impacts of the Project indicates that the Project was successful.<sup>6</sup> Appendix 14 provides the quantitative assessments of the Project according to criteria used by ADB to determine project ratings.

##### **B. Lessons Learned**

56. Both ADB and the executing agency must exercise realistic planning during project design, and concentrate on activities that traditionally take disproportionately long periods in a land-locked country like Mongolia. Project implementation arrangements and schedules must also consider the inherent delays associated with the executing agencies that are first-time recipients of ADB funding.

57. The collection of reliable data and their analysis is a prerequisite for the assessment of socioeconomic benefits in power sector projects. Both ADB and the executing agency should make efforts during project formulation, implementation, and even after project completion to establish adequate baseline and benchmark information on socioeconomic conditions in project areas and on how to conduct a through analysis of potential impacts.

##### **C. Recommendations**

58. The Energy Authority must provide adequate training to its staff for upgrading their professional skills to maintain efficient operation of the Project's facilities. The Energy Authority should streamline the needs of personnel working in different disciplines and organize training in a scheduled manner to derive the full benefits of training courses. Procedures for collection and processing of benefit data by the Executing Agency should be improved.

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<sup>6</sup> This PCR is part of a sample PCRs independently reviewed by the Operation Evaluation Department. The review has validated the methodology used and the rating given.

59. The weakest link in the environmental management is the enforcement of rules, laws, and regulations. Assistance for capacity building for the enforcement of environmental laws and regulations would be useful.

60. A reliable supply of power is an essential part of the physical infrastructure, which is necessary for industrial expansion to support sustainable economic growth. Imports from Russia appear considerably cheaper than cost of locally generated electricity and the import prices have fallen over the years. It appears that both Mongolia and Russia could benefit from developing a framework for bilateral electricity trading that will maximize the benefits of the potential hydropower resources in the region. Access to Russian equipment and spare parts will enable Mongolia to extend the life of other assets requiring immediate rehabilitation at a cheaper cost.

## CHRONOLOGY OF MAJOR EVENTS

### 1994

2–16 Feb	Fact-finding mission fielded
18 May	Management Review Meeting held
	Asian Development Bank (ADB) approved advance procurement action for procurement under the Project and for the implementation consultants. ADB also approved retroactive financing of foreign exchange costs for project preparation work and implementation consultants up to about \$750,000 to expedite project implementation.
25 May	ADB approved technical assistance (TA) for preparing detailed scope of work for the Project including design specifications.
31 May – 18 Jun	Appraisal Mission fielded
29 Jul	Technical support services contract was awarded
23 Aug	Project Implementation Unit and a Project Steering Committee were established.
28 Sep	Consultant's contract under TA No. 2093-MON: Power Rehabilitation Project was signed for the preparation of bid documents for the Project .
30 Sep	Staff Review Committee Meeting held
17-19 Oct	Loan negotiations held
29 Nov	ADB approved Energy Authority's shortlist for implementation consulting services and technical support (Note: until 1997 the Energy Authority was still known as Central Energy Systems.)

### 1995

22 Feb	Portion of Thermal Energy Station number 3 (TES3) high-pressure side boiler roof collapsed necessitating emergency repair.
27 Feb	Bid documents for turbine generator island and for boiler island issued to bidders
5 Apr	ADB sent a fax to the United States Agency for International Development (USAID), enclosing the draft Terms of Reference for Nondestructive Examination work on 7 boilers.
19 Apr	USAID requested TA consultants to participate in the ongoing inspection of high-pressure plant roofing system in TES 3
20 Apr	Contract for implementation and technical support services awarded
28 Apr	Contract awarded for the accompanying TA 2208-MON: Strengthening the Environmental Management Capability of the Ministry of Nature and Environment
5-9 May	Inception Mission fielded
6 May	ADB mission held discussions with USAID regarding assistance to TES3 power plant
12 May	Notice to Proceed with consultancy work was issued.
17 May	Award of contract for operations and management training of Energy Authority personnel to be conducted by E7 Group
	Loan and Project Agreements signed
May-Jun	Module A Training for management level staff belonging to the power sector was conducted under E7 Group supervision
30 May	ADB approved a change in mode of procurement from local competitive bidding to International Shopping with regard to supply of materials, services and civil works for repair of collapsed boiler roof
Jun	Energy Authority-financed ash disposal pond completed at a cost of \$2.1 million
4 July	Loan declared effective
15 Jul	Contract for boiler roof repair was awarded.
Aug–Oct	Module C Training for maintenance staff was conducted by E7 Group
5 Aug	Repair work on the collapsed boiler roof commenced

9 Aug	Initial disbursement under the loan
13 Sep	ADB advised Energy Authority to commence contract negotiations with the lowest evaluated bidder, with the aim to seek reduction in contract amount to about \$32 million to be consistent with the loan allocation
Oct– Nov	E7 Group conducted Module B Training for superintendents and shift supervisors level
20 Oct	Contract awarded for Part A component, rehabilitation of the TES3 high pressure boilers
6-8 Nov	Energy Sector Mission fielded
10 Nov	Completion of repair works on collapsed boiler roof
<b>1996</b>	
3 Jan	Energy Authority advised the appointment of the project manager effective 1 January 1996.
15 Feb	The contractor, commenced work on rehabilitation of TES3 high-pressure side boilers
6 May	Energy Authority advised ADB on worse-than-expected condition of boilers 7, 8 and 11 when insulation was removed
20 May	Repair work resumed on the undamaged portion of boiler roof
5 June	Contract for the Nordic Development Fund-financed turbine island rehabilitation component was signed.
18-28 Jun	Midterm Review Mission fielded
3 Jul	Danish International Development Assistance (DANIDA) scope of work on the district heating system component finalized
8–11 Aug	Loan Disbursement Mission 1 fielded
25 Sep	Reallocation of loan proceeds to cover additional costs in TES3 boiler rehabilitation and boiler roof repair contracts
14 Sep	Energy Authority portion of high-pressure side roof repair work completed for \$0.3 million
13 Nov	Issue of asbestos first came to ADB's attention in connection with demolition of the third boiler which was reported in the Minutes of Weekly Progress Meeting No. 20 submitted by Energy Authority
5 Dec	Request from Energy Authority for a minor change in scope and implementation arrangements reducing contractor's scope of work to five boilers (7, 8, 9, 11, and 13) while Energy Authority's scope of work included two boilers (10 and 12)
12 Dec	ADB sent a fax to Energy Authority regarding adequate safety measures at site especially concerning handling and disposal of hazardous materials.
20 Dec	Contract for DANIDA-financed Part B: District Heating component awarded.
Late 1996	Training program financed by E7 Group completed
<b>1997</b>	
13 Jan	ADB approved a minor change in project scope and implementation arrangements and consequent reallocation of funds as per request of Energy Authority on 5 December 1996
11 Mar	Contractor advised Energy Authority that due to danger of asbestos contamination, they are taking preliminary action involving decontamination procedures in the boiler house
19 Mar	Contractor's representation to ADB through the Europe Resident Office by a lawyer.
20 Mar	ADB Fact-Finding Mission for Loan 1548-MON held separate meetings firstly with contractor's project manager and second during wrap-up discussions with Energy Authority and Ministry of Infrastructure Development on the asbestos issue
26 Mar	Because of structural changes in the Government of Mongolia, Central Energy Systems was reorganized and its title was changed to Energy Authority.

### PROJECT OUTPUT AND BENEFITS

Year	Gross Power Output (MWh)	Auxiliary Power Consumption (MWh)	Net Electricity Generation (MWh)	Auxiliary Power Consumption as % of Gross Power Generation	Process Steam Supply (Gcal)	DH Hot Water Supply (Gcal)
1996	318,582	113,600	204,971	35.7	239,793	861,549
1997	383,372	121,200	262,175	31.6	170,453	912,915
1998	431,662	136,500	295,118	31.6	166,253	930,901
1999	515,888	145,200	370,687	28.1	158,257	963,563
2000	529,402	143,700	382,070	27.1	144,337	1,095,647
2001	530,733	135,800	394,887	26.0	155,521	1,104,848

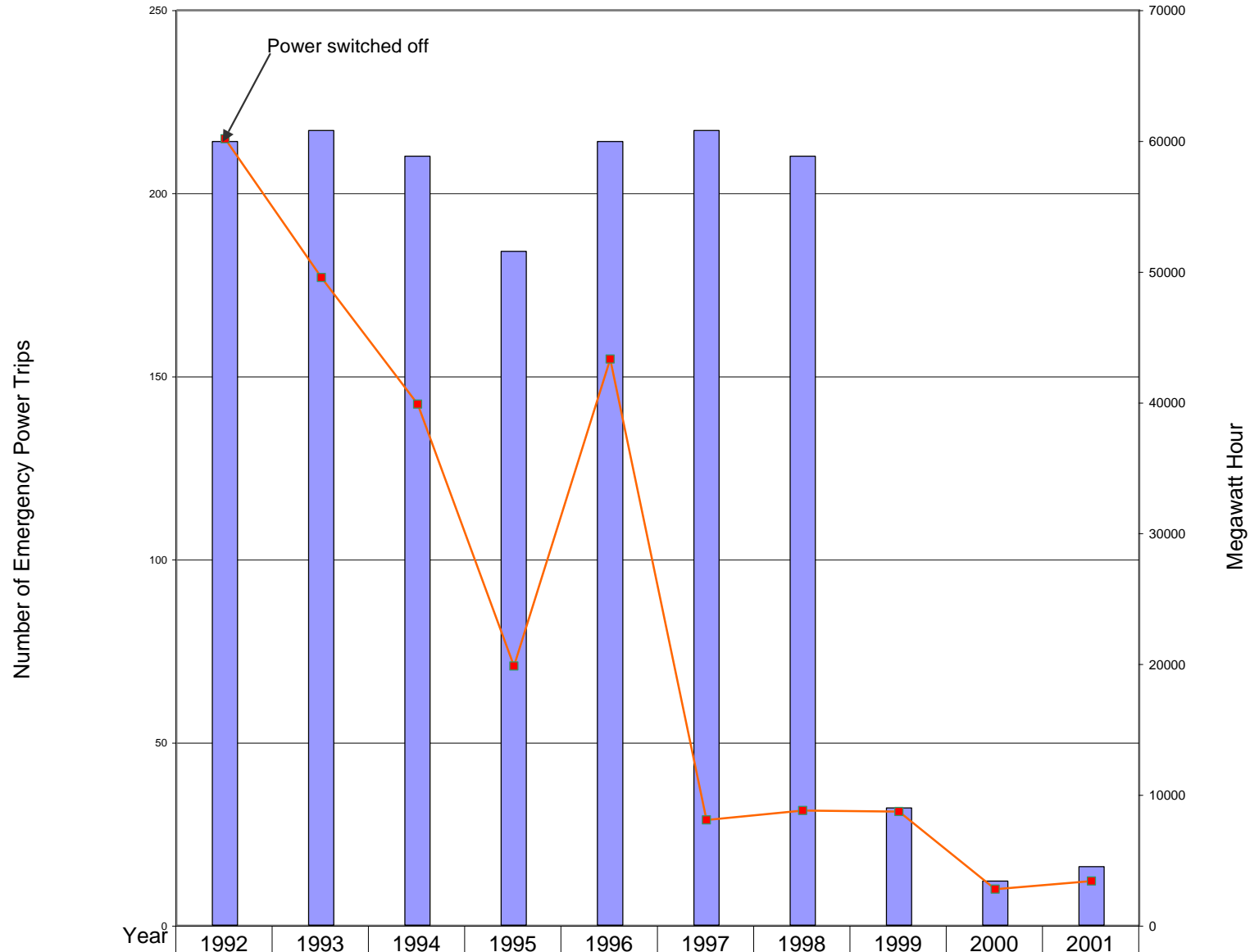
DH = district heating, Gcal = gigacalorie, MWh = megawatt-hour  
 Source: Energy Authority

## PROJECT EFFICIENCY AND GAINS

Year	Maximum Capacity Utilization Period (Hrs)	Maximum Capacity Utilization Factor (%)	Thermal Efficiency of the Boilers (%)	Specific fuel Consumption per KW of Power Generation (g/kW)	Unit Power Production Cost (MNT/kWh)	Unit Heat Production Cost (MNT/Gcal)
1994	3,721	65.3	89.6	511.0	6.23	2,414
1995	3,585	62.8	90.7	557.8	7.96	2,860
1996	2,342	41.0	90.8	519.5	9.83	3,841
1997	2,819	49.4	90.2	539.9	13.10	5,680
1998	3,174	55.6	89.5	562.1	24.00	5,125
1999	3,793	66.4	90.1	506.1	23.28	5,725
2000	3,893	68.2	90.9	484.1	22.91	5,691
2001	3,902	68.3	91.2	465.7	35.77	7,625

g = gram, Gcal = gigacalorie, kW = kilowatt, kWh = kilowatt-hour.  
Source: Energy Authority.

### EMERGENCY POWER TRIPS AND POWER GENERATION LOSS



■ No. of Emergency Power Trips	214	217	210	184	214	217	210	32	12	16
■ Loss of Power Generation Mwh	60119.5	49505.3	39823.3	19797.5	43272.1	8033	8751	8686.2	2738	3368

## PROJECT COSTS AND FINANCING PLAN

Table A5.1: Comparison of Project Costs  
(\$ million)

Component	Appraisal			Actual		
	Foreign	Local	Total	Foreign	Local	Total
A. Base Costs <sup>a</sup>						
1. Thermal Energy Station 3 Rehabilitation	33.29	6.84	40.13	41.02	8.30	49.32
2. District Heating Rehabilitation	4.22	0.96	5.18	4.72	0	4.72
3. Metering	0.20	0.05	0.25	0.27	0	0.27
4. Training	0.50	0.05	0.55	0.33	0	0.33
5. Consulting Services	1.55	0.20	1.75	1.39	0	1.39
B. Contingencies						
1. Physical	2.91	0.59	3.50	0	0	0
2. Price	2.78	0.60	3.38	0	0	0
<b>Base Cost + Contingencies</b>	<b>45.45</b>	<b>9.29</b>	<b>54.74</b>	<b>47.73</b>	<b>0</b>	<b>56.03</b>
C. Interest During Construction	<b>0.55</b>	<b>2.71</b>	<b>3.26</b>	<b>0.47</b>	<b>0</b>	<b>0.47</b>
<b>Total Project Cost</b>	<b>46.00</b>	<b>12.00</b>	<b>58.00</b>	<b>48.20</b>	<b>8.30</b>	<b>56.50</b>

<sup>a</sup> Base cost reflects end-1993 year prices.

Table A5.2: Project Financing Plan  
(\$ million)

Source	Appraisal			Actual		
	Foreign	Local	Total	Foreign	Local	Total
Asian Development Bank (TES 3 Boiler Rehabilitation)	35.4	4.6	40.0	37.46	0	37.46
DANIDA (District Heating Rehabilitation and Metering) <sup>a</sup>	5.0	0	5.0	4.99 <sup>b</sup>	0	4.99
NDF (TES 3 Turbine Rehabilitation)	5.3	0	5.3	5.45	0	5.45
E7 Group (Training)	0.3	0	0.3	0.30	0	0.30
Energy Authority	0	7.4	7.4	0	8.30	8.30
<b>Total</b>	<b>46.0</b>	<b>12.0</b>	<b>58.0</b>	<b>48.20</b>	<b>8.30</b>	<b>56.50</b>

DANIDA = Danish International Development Assistance, NDF = Nordic Development Fund, TES3= Thermal Energy Station No. 3.

<sup>a</sup> DANIDA allocation amounted to DKK 33.0 million.

<sup>b</sup> DANIDA's actual financing amounted to DKK 27.686 million

**SUMMARY OF CONTRACTS**

<b>Contract No.</b>	<b>Description</b>	<b>Date of Contract Award</b>	<b>Procurement Mode</b>	<b>Amount (\$ million)</b>
Category 01 – Equipment and Materials				
0003	TES 3 Emergency Roof Repair	15 Jul 95	IS	0.830
0005	TES 3 High Pressure Side Refurbishment for Boiler Island	20 Oct 95	ICB	34.728
0006	Training and After-Sales Services for TES 3 High Pressure Side Boilers 7 and 8	8 Nov 98	Direct Purchase Single Tender	0.017
Category 02 – International Training				
0004	Operations and Maintenance Training for Energy Authority Personnel	17 May 95	Others	0.029
Category 03 – Consulting Services				
0001	Implementation and Technical Support Services	20 Apr 95	ICB	0.320 1.022
0002	Technical Support Services	29 Jul 94	Others	0.049

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ICB = international competitive bidding, IS = International Shopping, TES3 = Thermal Energy Station No.3

**CURRENCY EXCHANGE RATES  
(1995-2001)**

<b>Year</b>	<b>US\$</b>		<b>Togrog Value</b>
1995	\$1.00	=	MNT499.0
1996	\$1.00	=	MNT548.0
1997	\$1.00	=	MNT790.5
1998	\$1.00	=	MNT841.0
1999	\$1.00	=	MNT1022.7
2000	\$1.00	=	MNT1077.0
2001	\$1.00	=	MNT1096.8

Source: Asian Development Bank

## LOAN DISBURSEMENTS

Year	Quarter	Projected (\$ million)	Actual		% of Loan
			Quarterly Disbursement (\$ million)	Cumulative Disbursement (\$ million)	
1995	I	0.000	0.000	0.000	0.0
	II	0.160	0.000	0.000	0.0
	III	0.200	0.461	0.461	1.2
	IV	2.960	0.533	0.944	2.7
	<b>Subtotal</b>	<b>3.320</b>	<b>0.944</b>		
1996	I	0.000	1.210	2.204	5.9
	II	2.100	0.132	2.336	6.2
	III	3.300	4.607	6.943	18.5
	IV	7.300	5.713	12.656	33.8
	<b>Subtotal</b>	<b>12.700</b>	<b>11.662</b>		
1997	I	2.400	3.760	16.416	43.8
	II	4.200	1.969	18.385	49.1
	III	4.200	3.582	21.967	58.6
	IV	4.200	2.613	24.580	65.6
	<b>Subtotal</b>	<b>15.000</b>	<b>11.924</b>		
1998	I	1.000	1.583	26.163	69.8
	II	0.500	0.788	26.951	71.9
	III	1.500	0.325	27.276	72.8
	IV	1.500	2.826	30.102	80.3
	<b>Subtotal</b>	<b>4.500</b>	<b>5.522</b>		
1999	I	1.800	1.837	31.939	85.3
	II	1.800	0.066	32.005	85.4
	III	1.800	0.000	32.005	85.4
	IV	1.800	0.695	32.700	87.3
	<b>Subtotal</b>	<b>7.200</b>	<b>2.598</b>		
2000	I	0.900	0.855	33.555	89.6
	II	0.900	0.327	33.882	90.4
	III	0.900	0.811	34.693	92.6
	IV	0.900	1.655	36.348	97.0
	<b>Subtotal</b>	<b>3.600</b>	<b>3.648</b>		
2001	I	0.820	0.776	37.124	99.1
	II	0.350	0.340	37.464	100.0
	III	0.000	0.000	37.464	
	IV	0.000	0.000	37.464	
	<b>Subtotal</b>	<b>1.170</b>	<b>1.116</b>		
		<b>Total</b>	<b>37.464</b>		



## CHANGES IN PROJECT SCOPE

Original Scope	Change in Scope
<p>Seven high-pressure boilers (Boilers 7, 8, 9, 10, 11, 12 and 13) in Thermal Energy Station (TES) 3 were to be rehabilitated under the Project under Asian Development Bank (ADB) financing. Boiler 12 suffered extensive damage in August 1996 when the single drum level control failed and the boiler ran dry. The boiler water walls were damaged and boiler misaligned. The Energy Authority estimated a repair bill of \$4 million using Russian materials and contractors. Upon stripping down the first two of the seven boilers for rehabilitation, it was discovered that the boilers were in worse condition than originally envisaged and additional works were necessary.</p> <p>The boiler rehabilitation contractor's scope of work comprised five boilers (Boilers 7, 8, 9, 11 and 13) while the Energy Authority's scope of work comprised two boilers (Boilers 10 and 12).</p>	<p>In January 1997, ADB approved a minor change in scope whereby instead of financing the rehabilitation of all seven boilers, ADB financed five (Boilers 7, 8, 9, 11 and 13) boilers. The Energy Authority funded entirely the rehabilitation of boilers 10 and 12. With this minor change in scope, the Project still comprised the original scope of rehabilitating 7 boilers: 5 boilers under ADB funding and 2 boilers under Energy Authority funding. The Project remained viable even with the additional work and consequent extra cost, nor did it affect the incremental energy output of the Project.</p> <p>The operational performance of the rehabilitated boilers 7 and 8 had been excellent. In view of the better than expected performance of these two boilers, on 7 December 1999, ADB approved a minor change in scope for the Project that in effect deleted the rehabilitation of Boiler 9 from the contractor's scope of work and utilized the savings amounting to \$1,243,155 for additional works incurred on boilers 7, 8, 11 and 13 while the materials intended for Boiler 9 that had already been delivered at site were used as spare parts for the rehabilitated boilers. As a result, the Energy Authority's operations and maintenance expenditure over the next 5 years had been reduced. The reduction in scope amounted to only 2% of the total project cost and the Project's economic internal rate of return (EIRR) did not change significantly from the originally estimated figure of 18% due to the increased availability and higher efficiency of the remaining boilers.</p>

## STATUS OF COMPLIANCE WITH LOAN COVENANTS

Loan Covenants	Target Date of Compliance	Status of Compliance
A		
1. ENERGY SECTOR RESTRUCTURING Except as the Asian Development Bank (ADB) may otherwise agree, the Government will, in consultation with ADB implement the energy sector restructuring action plan, which will be effective as of 1 January 1995.	October 1995	Completed in November 1997
B		
2. ENERGY CONSERVATION Except as ADB may otherwise agree, the Executing Agency will, in consultation with ADB, implement the energy conservation plan (resulting from TA No. 1750-MON), which will be effective as of 1 January 1995.	January 1995	Completed
C		
3. FINANCIAL Except as ADB may otherwise agree, the Executing Agency, in consultation with ADB, implement the recommendations resulting from the Agency's Institutional and Tariff Study (TA 2035-MON).	November 1995	Ongoing compliance
4. The Executing Agency will use its best effort to implement all actions prescribed in the Financial Action Plan, which will be effective as of 1 January 1995. Executing Agency, in consultation with ADB, will complete a review of the plan no later than 31 December 1995, and will thereupon modify the plan as appropriate in subsequent years.	January 1995	Implemented under Loan 1492-MON and Loan 1548-MON
5. The Executing Agency will, not later than 31 August 1995, implement an accounting system based on the internationally accepted accounting principles and satisfactory to ADB.	August 1995	Completed in November 1997 under TA 2571-MON
D		
6. TRAINING The Executing Agency will select approximately 20 of its personnel to receive overseas training in power station operation and management from utilities belonging to the E7 Group. The Executing Agency will ensure that all non-managerial staff selected for international training will, prior to their departure for such training, have successfully completed an English language training program and have achieved an acceptable level of proficiency in English. The Borrower and Executing Agency will use their best efforts to ensure that all staff who receive such international training will return immediately upon completion of their training and remain with the Executing Agency for a reasonable period of time thereafter	October 1995	Completed in 1996
E		
7. COFINANCING The Borrower and the Executing Agency will, no later than two months from the effective date, execute the necessary agreements for the cofinancing arrangements, or will make, in a timely manner, to ensure expeditious project implementation, other arrangements, satisfactory to ADB, to commit the foreign-currency funds intended to be provided under such cofinancing arrangements.	December 1997	Complied. cofinancing with Nordic Development Fund and Danish International Development Assistance for turbine rehabilitation and district heating system rehabilitation. Work completed in November 1997.

	Loan Covenants	Target Date of Compliance	Status of Compliance
F.	OPERATIONAL		
8.	The Executing Agency will ensure that the construction of an additional ash-disposal pond for TES3 is completed to the satisfaction of ADB prior to the operation of the rehabilitated project facilities.	December 1997	Completed in September 1995
9.	The Borrower will ensure the Executing Agency's access to foreign exchange at the times and in the amounts needed to permit the Executing Agency to procure the spare parts required for the future operation of the project facilities.	December 1997	Ongoing compliance
10.	The Executing Agency will have completed all repair and rehabilitation work on the existing TES3 cooling tower necessary to restore the capacity of the cooling tower to its original design efficiency by not later than the completion of the TES3 rehabilitation component of the Project.	December 1997	Completed in April 1997
11.	Executing Agency will have completed all repair and rehabilitation work on the venturi scrubber particulate control system necessary to restore its capacity to its original design efficiency not later than the completion of the TES3 rehabilitation component of the Project.	December 1997	Completed
12.	Except as ADB may otherwise agree, Executing Agency will implement and maintain at TES3 all plant safety, operation, maintenance and preventive maintenance procedures identified by the project implementation consultants.	December 1997	Ongoing compliance
13.	From the time of completion of the TES3 rehabilitation component of the Project and thereafter, the Borrower and Executing Agency will ensure that all coal delivered to and used in TES3 operations meet the quality standards established for the various coal mines supplying the power station.	December 1997	Ongoing compliance Baganuur coal being used

## FINANCIAL AND ECONOMIC ANALYSIS

### Table A12.1: Calculation of Project Benefits

#### Project Benefits

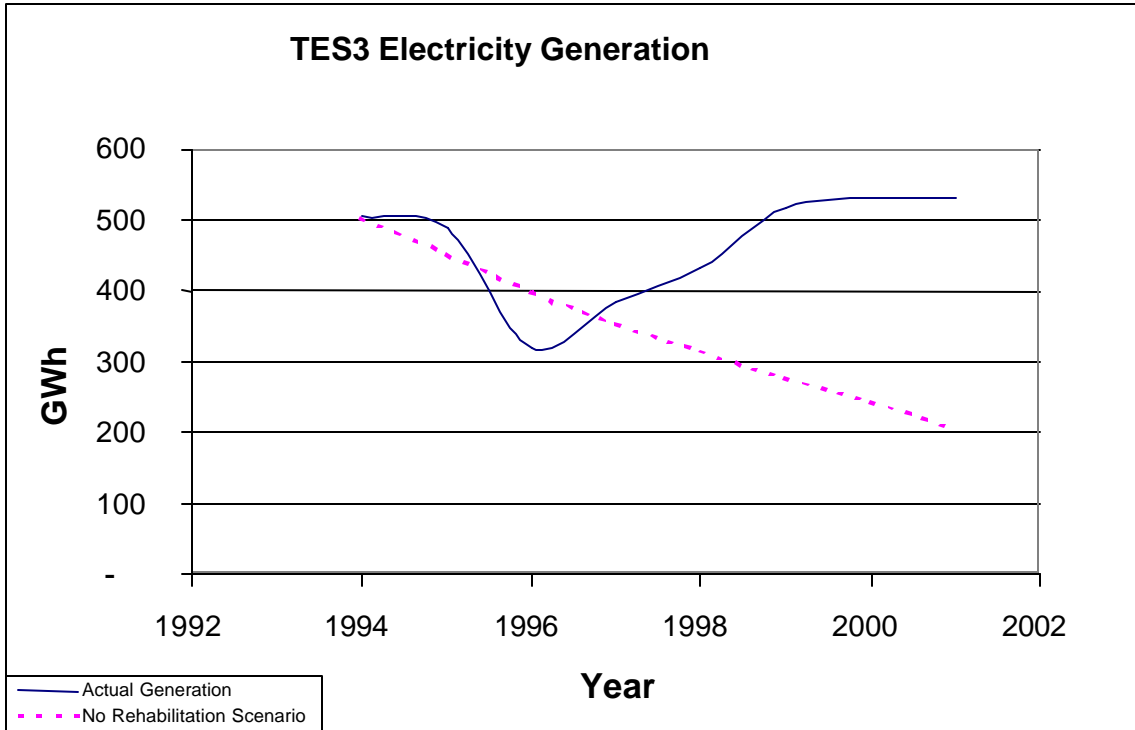
Item	Unit	Year			
		1998	1999	2002	2001
<b>A. Increased Electricity Generation</b>					
Actual Generation	GWh	432	516	529	531
Without Rehabilitation	GWh	315	276	242	204
Incremental Generation	GWh	117	240	287	327
Incremental Sales	GWh	91	187	224	255
Average Tariff	T/kWh	41	41	45	45
Incremental Revenue	million, MNT	3,742	7,673	10,079	11,484
<b>B. Reduced Auxiliary Consumption</b>					
Incremental Generation	GWh	39	46	48	48
Incremental Sales	GWh	34	41	42	42
Average Tariff	T/kWh	41	41	45	45
Incremental Revenue	million, MNT	1,402	1,675	1,887	1,892
<b>C. Increased Heat Generation</b>					
Actual	GWh	1,276	1,304	1,442	1,466
No Rehabilitation	GWh	1,123	985	848	711
Incremental Generation	GWh	153	319	594	755
Incremental Sales	GWh	100	207	386	490
Incremental Generation	Gcal	85,644	178,359	331,848	421,820
Average Tariff	T/Gcal	8,500	8,800	9,000	9,256
Incremental Revenue	million, MNT	908	1,870	3,487	4,504
<b>D. District Heating Rehabilitation (pipe replacement)</b>					
Pipe Replacement	GWh <sup>a</sup>	8	8	8	8
New Meters	GWh <sup>b</sup>	30	40	59	59
Total	GWh	38	48	67	67
Total	Gcal	32,474	40,988	58,016	58,016
Average Tariff	T/Gcal	8,500	8,800	9,000	9,256
Incremental Revenue	million, MNT	276	361	522	537
<b>Total Benefits (A+B+C+D)</b>	<b>million, MNT</b>	<b>6,328</b>	<b>11,579</b>	<b>15,975</b>	<b>18,417</b>
Exchange Rates	MNT per \$	841	1,023	1,077	1,097
Total Benefit (Real 1995 MNT)	million, MNT	7,949	13,518	17,253	18,417
<b>Total Benefit (Real 2001 dollars)</b>	<b>\$ million</b>	<b>7.25</b>	<b>12.33</b>	<b>15.73</b>	<b>16.79</b>

Gcal = gigacalorie, GWh = gigawatt-hour, km = kilometer, kWh = kilowatt-hour.

<sup>a</sup> Benefit adjusted to 13% (3.8 km pipe replaced compared to appraisal estimate of 24 km).

<sup>b</sup> Benefits adjusted to 66% (76 meters installed compared to appraisal estimate of 115 meters).

**Figure A12.1: Electricity Generation at TES3 With and Without the Project**



TES3 = Thermal Energy Station No. 3

**Figure A12.1: Electricity Generation at TES3 With and Without the Project**

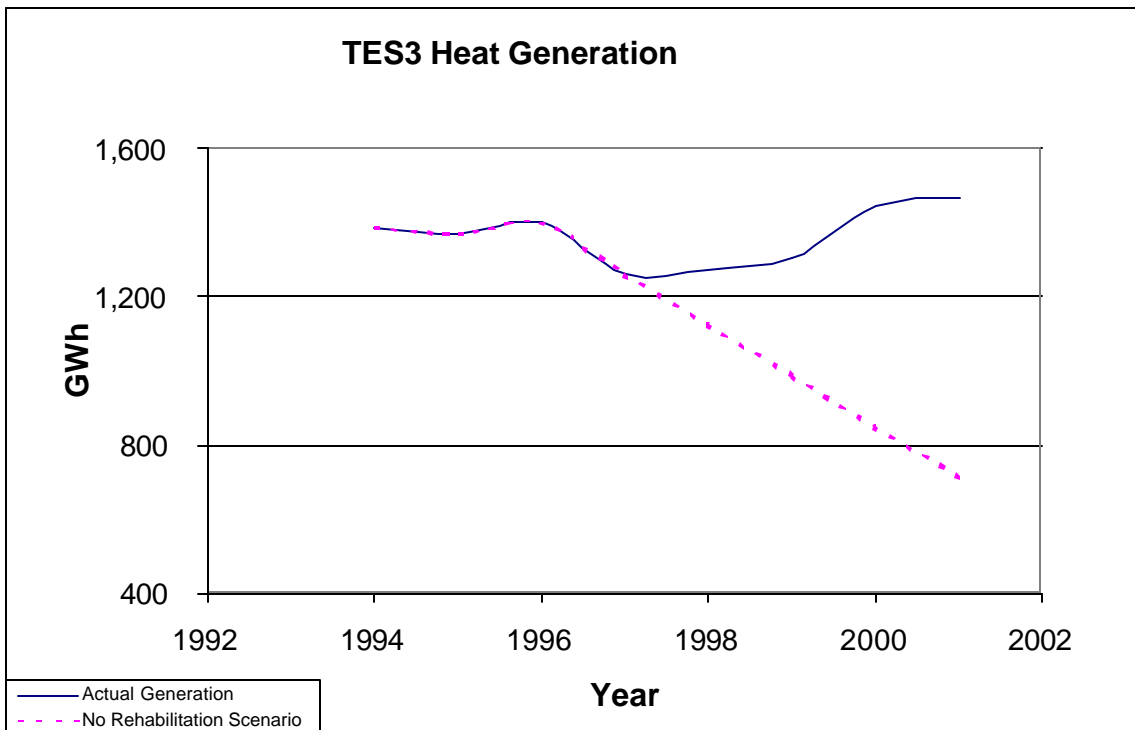


Table A12.2: Financial Internal Rate of Return

Year	Appraisal <sup>a</sup> (\$ million)			Net Cash Flow <sup>c</sup>	Actual <sup>b</sup> (\$ million)			Net Cash Flow
	Total Income	Capital	Operating		Total Income	Capital	Operating	
1995	0	17.7	0	(17.1)		6.7		(6.74)
1996	3.5	17.1	1.5	(15.9)	0	14.8		(14.78)
1997	6.7	17.1	2.9	(6.6)	2.44	20.3	0.22	(18.08)
1998	10.0		4.4	4.7	7.25	11.0	1.08	(4.86)
1999	11.3		4.9	5.2	12.33	3.0	2.79	5.32
2000	12.7		5.5	5.7	15.73	4.5	4.08	5.69
2001	21.4		9.6	8.5	16.79	1.4	4.75	7.59
2002	21.4		9.6	8.5	16.79		4.75	8.57
2003	21.4		9.6	8.5	16.79		4.75	8.57
2004	21.4		9.6	8.5	16.79		4.75	8.57
2005	21.4		9.6	8.5	16.79		4.75	8.57
2006	21.4		9.6	8.5	16.79		4.75	8.57
2007	21.4	(2.0)	9.6	8.5	16.79	(2.0)	4.75	8.57
<b>Total</b>	194.0	49.3	86.4	35.4	155.3	59.7	41.4	54.17
<b>FIRR</b>				<b>9.7%</b>				<b>7.4%</b>

FIRR = financial internal rate of return.

<sup>a</sup> Real 1995 dollar.

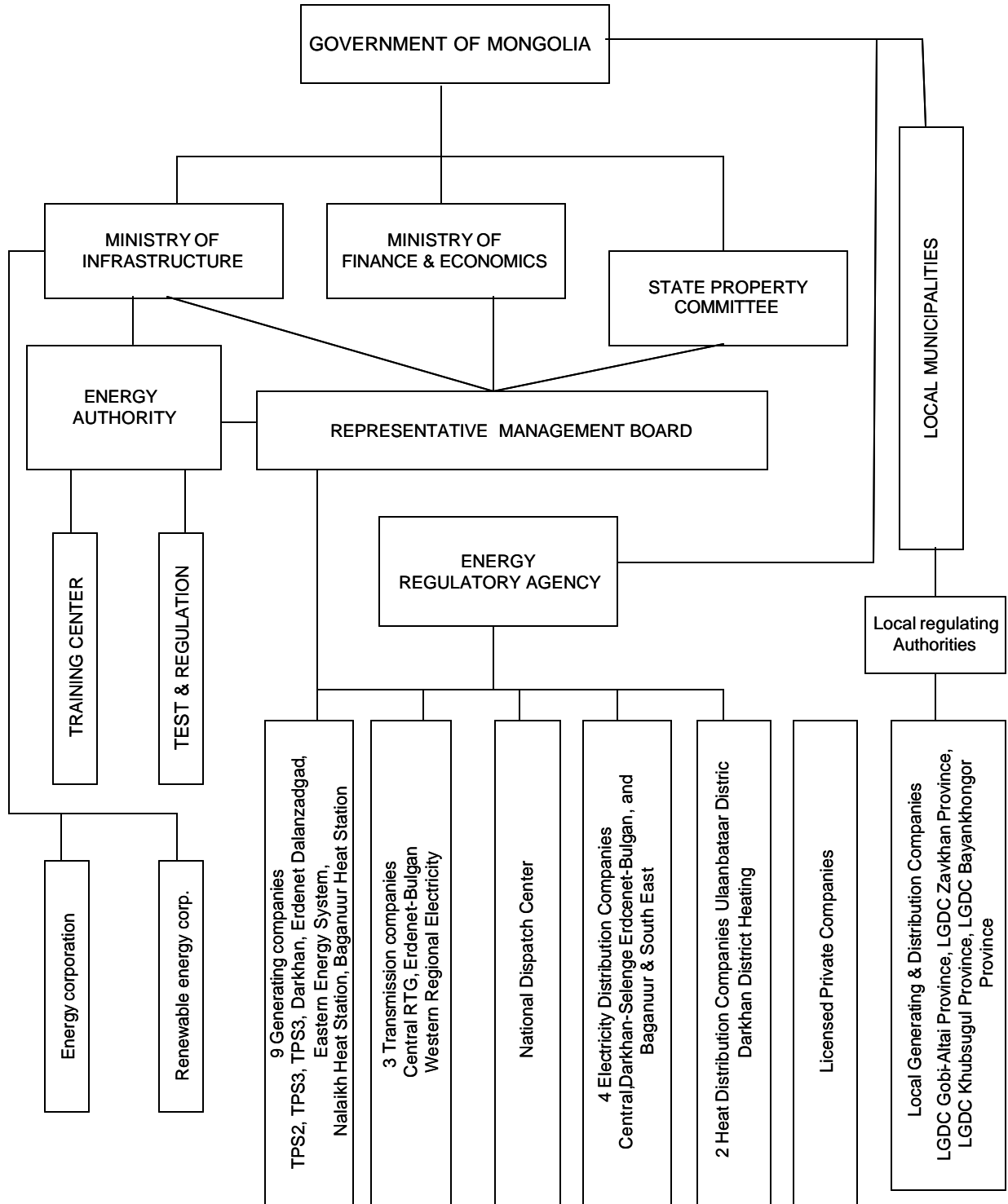
<sup>b</sup> Real 2001 dollar.

<sup>c</sup> Net of 40% income tax.

Table A12.3: Electricity and Heat Tariffs  
Energy Authority Mongolia

Effective Date	Unit	Unit Cost (tugrik/unit)						
		1995	1996	1997	1998	1999	2000	2001
Electricity								
Base Tariff								
Industrial Consumers	Tg/kWh	16	26	34	41	41	45	45
Residential Consumers	Tg/kWh	16	16	28	35	35	45	45
Heat								
Base Tariff								
Residential Consumers								
Apartments	Tg/kWh	30	48	60	65	65	160	160
Others (hot water)	Tg/kWh	42	67	100	109	109	400	400
Factories								
Industrial Hot Water	Tg/Gcal							5,000
Industrial Steam	Tg/Gcal	1,018	1,629	5,000	8,500	8,800	9,000	9,256

Figure A12.3: Restructured Electricity Industry



**Table A12.4: Income Statements of Energy Authority**  
(MNT million)

Item	Year					
	1995	1996	1997	1998	1999	2000
<b>Operating Data</b>						
Total Generation (GWh)		1,912	2,015	2,079	2,228	2,293
Increase in Generation			5.4%	3.2%	7.1%	2.9%
Energy Sales (GWh)	1,402	1,427	1,526	1,512	1,699	1,802
Heat Sales (Tcal)	5,078	5,002	4,913	4,860	4,834	5,136
<b>Average Revenue</b>						
Electricity (Tq/kWh)	14.9	16.9	34.4	36.1	36.0	35.7
Heat (Tq/Gcal)	1,231.6	1,626.3	2,738.9	4,006.2	3,482.4	3,368.4
<b>Revenues</b>						
Electricity Sales	20,901	24,163	52,570	54,584	61,224	64,300
Heat Sales	6,254	8,135	13,456	19,470	16,834	17,300
Others						
<b>Total Revenues</b>	<b>27,155</b>	<b>32,298</b>	<b>66,026</b>	<b>74,054</b>	<b>78,058</b>	<b>81,600</b>
<b>Operating Expenses</b>						
Fuel oil	14,673	15,583	27,957	34,374	36,665	39,300
Materials and equipment	2,560	3,965	6,386	7,346	6,099	2,200
Purchased power			1,062	1,251	1,475	1,493
Maintenance materials	4,496	9,229	7,946	11,911	1,053	4,100
Wages and administration	3,618	5,802	7,075	10,636	10,343	11,665
Depreciation	2,804	1,280	8,076	12,818	25,506	20,024
Others	199	654	395	1,370	986	7,765
<b>Total Operating Expenses</b>	<b>28,350</b>	<b>36,513</b>	<b>58,897</b>	<b>79,706</b>	<b>82,127</b>	<b>86,547</b>
<b>Operating Income</b>	<b>-1,195</b>	<b>-4,215</b>	<b>7,129</b>	<b>-5,652</b>	<b>-4,069</b>	<b>-4,947</b>
Non-Operating Income	338	645	2,219	1,908	0	0
Non-Operating Expenses					335	800
Interest expenses	8	8	8	0	0	8,933
Taxable Income	-865	-3,578	9,340	-3,744	-4,404	-14,680
Income Tax			-481			
<b>Net Income</b>	<b>-865</b>	<b>-3,578</b>	<b>8,859</b>	<b>-3,474</b>	<b>-4,404</b>	<b>-14,180</b>
<b>Ratios</b>						
Rate Base <sup>a</sup>	14,919	215,090	234,291	240,172	274,019	275,836
Operating Ratio <sup>b</sup> (%)	104%	113%	89%	108%	105%	106%
Working Ratio <sup>c</sup> (%)	94%	109%	77%	90%	73%	82%
Return on Net Fixed Assets <sup>c</sup> (%)	-6%	-2%	4%	-2%	-2%	-2%

<sup>a</sup> Total operating expenses as a percentage of total revenues.

<sup>b</sup> Total cash operating expenses as a percentage of total revenues.

<sup>c</sup> Net income before financial expenses as a percentage of rate base.

Source: Energy Authority, Mongolia (audited accounts)

**Table A12.5: Balance Sheet of Energy Authority**  
(MNT million)

Item	Year					
	1995	1996	1997	1998	1999	2000
<b>Assets</b>						
<b>Fixed Assets</b>						
Gross Fixed Assets	19,065	216,631	241,162	241,558	300,086	312,157
Accumulated Depreciation	5,096	6,376	14,452	27,270	52,776	72,800
<b>Net fixed Assets in Service</b>	<b>13,969</b>	<b>210,255</b>	<b>226,710</b>	<b>214,288</b>	<b>247,310</b>	<b>239,357</b>
Work in Progress	950	4,835	7,581	25,884	26,709	36,479
Total Fixed Assets	14,919	215,090	234,291	240,172	274,019	275,836
<b>Current Assets</b>						
Cash	1,288	1,145	1,683	1,342	1,993	3,500
Accounts Receivable	3,412	6,196	10,398	18,144	20,509	21,100
Inventories	6,026	7,300	15,932	26,897	16,795	7,800
Other Current Assets	1,812	922	967	0	7,295	14,200
<b>Total Current Assets</b>	<b>12,538</b>	<b>15,563</b>	<b>28,980</b>	<b>46,383</b>	<b>46,592</b>	<b>46,600</b>
<b>Total Assets</b>	<b>27,457</b>	<b>230,653</b>	<b>263,271</b>	<b>286,555</b>	<b>320,611</b>	<b>322,436</b>
<b>Equity and Liabilities</b>						
<b>Equity</b>						
Capital	18,337	207,420	211,138	211,138	211,138	211,138
Reserves and Retained Earnings	1025	-11579	-6099	-10223	-16134	-30514
<b>Total Equity</b>	<b>19,362</b>	<b>195,841</b>	<b>205,039</b>	<b>200,916</b>	<b>195,004</b>	<b>180,624</b>
<b>Long Term Debt</b>						
Power Rehabilitation Project	1,700	8,818	18,249	21,550	28,195	30,238
Other Capital Project		4,926	17,345	34,051	64,623	74,086
Other borrowing		8,285	12,620	8,263	3,976	
<b>Total Long Term Debt</b>	<b>1,700</b>	<b>22,029</b>	<b>48,214</b>	<b>63,864</b>	<b>96,794</b>	<b>104,324</b>
<b>Current Liabilities</b>						
Account Payable	5,670	6,266	8,343	21,709	27,816	26,690
Others	725	6,517	1,674	67	997	10,798
Short Term Loan						
<b>Total Current Liabilities</b>	<b>6,395</b>	<b>12,783</b>	<b>10,017</b>	<b>21,776</b>	<b>28,813</b>	<b>37,488</b>
<b>Total Equity and Liabilities</b>	<b>27,457</b>	<b>230,653</b>	<b>263,271</b>	<b>286,555</b>	<b>320,611</b>	<b>322,436</b>
<b>Ratios</b>						
Current Ratio	1.96	1.22	2.89	2.13	1.62	1.24
Debt/(Debt+Equity) Ratio (%)	8%	10%	19%	24%	33%	37%

<sup>a</sup> Ratio of current assets to current liabilities.

<sup>b</sup> Ratio of long-term debt to long-term debt plus equity.

Source: Energy Authority, Mongolia (audited accounts)

**Table A12.6: Cash Flow Statements of Energy Authority**  
(MNT million)

Item	Year					
	1995	1996	1997	1998	1999	2000
<b>Sources</b>						
Internal Sources						
Net Income before Interest	-857	-3,570	8,867	-3,474	-4,404	-5,247
Depreciation	2,804	1,280	8,076	12,818	25,506	20,024
Change in Working Capital		3,363	-16,183	-5,644	6,828	8,667
<b>Net Internal Cash Generation</b>	<b>1,947</b>	<b>1,073</b>	<b>759</b>	<b>3,700</b>	<b>27,930</b>	<b>23,444</b>
Long Term Loans	1,700	20,329	26,186	15,649	32,930	7,530
<b>Total Sources</b>		<b>21,402</b>	<b>26,945</b>	<b>19,349</b>	<b>60,860</b>	<b>30,974</b>
<b>Application</b>						
Capital Expenditures		19,970	27,278	18,698	59,353	21,841
<b>Debt Service</b>						
Principal						
Interest		8	8	0	0	8,933
<b>Total Applications</b>		<b>19,978</b>	<b>27,286</b>	<b>18,698</b>	<b>59,353</b>	<b>30,774</b>
Net Cash Inflow		1,424	-341	651	1,507	200
Cash, Beginning		259	1683.1	1342	1993	3500
Cash, Ending	259	1,683	1,342	1,993	3,500	3,700

**Table A12.7: Economic Internal Rate of Return**

Year	Appraisal <sup>a</sup> (\$ million)			Net Cash Flow <sup>c</sup>	Actual <sup>b</sup> (\$ million)			Net Cash Flow
	Total Income	Capital	Operating		Total Income	Capital	Operating	
1995	0	17.1	0	(17.1)		6.7		(6.74)
1996	5.4	17.1	2.5	(14.2)		14.8		(14.78)
1997	10.1	17.1	5.0	(12.0)	3.44	20.3	0.50	(17.36)
1998	14.8		7.5	7.3	9.44	11.0	2.29	(3.88)
1999	16.8		8.4	8.4	17.99	3.0	6.09	8.90
2000	19.0		9.5	9.5	24.05	4.5	8.78	10.81
2001	31.4		16.4	15.0	27.92	1.4	9.79	16.75
2002	31.4		16.4	15.0	27.92		9.79	18.14
2003	31.4		16.4	15.0	27.92		9.79	18.14
2004	31.4		16.4	15.0	27.92		9.79	18.14
2005	31.4		16.4	15.0	27.92		9.79	18.14
2006	31.4		16.4	15.0	27.92		9.79	18.14
2007	31.4	(2.0)	16.4	17.0	27.92	(2.0)	9.79	20.14
<b>Total</b>	<b>285.9</b>	<b>49.3</b>	<b>147.7</b>	<b>88.9</b>	<b>250.4</b>	<b>59.7</b>	<b>86.2</b>	<b>104.51</b>
<b>EIRR</b>				<b>18.3%</b>				<b>20.8%</b>

EIRR = economic internal rate of return.

<sup>a</sup> Real 1995 dollar.<sup>b</sup> Real 2001 dollar.<sup>c</sup> Net of 40% income tax.

### SAFETY AND HEALTH IMPROVEMENT

Item	1994	1995	1996	1997	1998	1999	2000	2001	2002
Daily Labor Force	5,484	5,295	5,126	4,969	4,759	1,379	1,234	1,115	987
Labor Turnovers	189	169	157	210	3,800 <sup>a</sup>	145	119	118	0
Major Industrial Injury	3	0	0	4	4	7	4	4	0
Occasional Illness									
Persons	964	1,056	1,032	1,083	919	793	928	842	0
Person-days	11,305	11,464	9,554	11,207	8,534	7,420	8,227	7,566	0
Average day-off <sup>b</sup>	11.72	10.85	9.28	10.34	9.28	9.35	8.76 <sup>c</sup>	8.98 <sup>c</sup>	

TES3 = Thermal Energy Station No. 3.

<sup>a</sup> Labor lay-off resulting from TES3 restructuring.

<sup>b</sup> Average day-off defined as occasional illness person-days divided by persons.

<sup>c</sup> Average of 8.92 for 2000 and 2001; this represents a 23% reduction in the average number of sick days per person per year.

## QUANTITATIVE ASSESSMENT OF OVERALL PROJECT PERFORMANCE

**Table A14.1: Overall Rating**

<b>Criterion</b>	<b>Assessment</b>	<b>Rating (0-3)</b>	<b>Weight (%)</b>	<b>Weighted Rating</b>
1. Relevance	Highly Relevant	3	20	0.60
2. Efficacy	Efficacious	2	25	0.50
3. Efficiency	Efficient	2	20	0.40
4. Sustainability	Likely	2	20	0.40
5. Institutional Development	Moderate	2	15	0.30
<b>Overall Rating</b>			<b>100</b>	<b>2.20</b>

Note:

*Relevance:* Project objectives and outputs were relevant to strategic objectives of the Government and the Asian Development Bank.

*Efficacy:* Project achieved its targets and objectives.

*Efficiency:* Project achieved objectives in an efficient manner.

*Sustainability:* Project benefits and development impacts are sustainable.

*Institutional Development* Project had beneficial impacts on government policy and institutional capacity, and had other positive social impacts.

**Table A14.2: Rating System**

<b>Rating Value</b>	<b>Relevance</b>	<b>Efficacy</b>	<b>Efficiency</b>	<b>Sustainability</b>	<b>Institutional Development</b>
3	Highly Relevant	Highly Efficacious	Highly Efficient	Most Likely	Substantial
2	Relevant	Efficacious	Efficient	Likely	Moderate
1	Partly Relevant	Less Efficacious	Less Efficient	Less Likely	Little
0	Irrelevant	Inefficacious	Inefficient	Unlikely	Negligible

>2.5 = highly successful; 1.6-2.5 = successful; 0.6-<1.6 = partly successful; <0.6 = unsuccessful.