Chapter 9 Economic and Financial Analyses

9.1 Economic Analysis

9.1.1 Methodology

The economic analysis of the project is made based on the discounted cash flow, which is derived from accounting the pre-determined economic cost and benefit. The equalizing discount rates (EDR; called EIRR in economic analysis) are calculated as a valuation method in the case of 150MW New Unit Project. EDR is the rate at which the accumulated cost and the accumulated benefit for the entire life of the project become equal. This is described mathematically by the following equation:

$$\sum_{t=1}^{n} \frac{Bt - Ct}{(1+r)^t} = 0$$

Where, *Bt* and *Ct* are the annual benefit and the cost, respectively, in the *t*-th year, *r* is the discount rate or interest rate, and *n* is the project period (years).

EDR thus calculated is compared with a social rate of discount which reflects opportunity cost of the capital in the project country. When an EDR is higher than the social rate of discount, the project is evaluated to be economical, and vice versa when the result is the opposite.

Net present value (NPV) and benefit/cost ratio (B/C ratio) are also used as indices for the evaluation.

In the case of renovation project of the existing facilities, Benefit/Cost Method is adopted for the evaluation index since technical alternative ways are limited to natural gas combustion and coal combustion with GSA equipment. This project covers renovation/replacement of existing 4 boilers and related equipment. When the result is bigger than 1.0, the proposed project is regarded advantageous to the alternative project, and the project is evaluated as feasible.

9.1.2 Adoption of Economic Price

Market prices of related goods and services in many development projects are converted to international market prices in order to avoid effects of imperfect market mechanism, so that current market prices reflect actual economic values.

Any developments and changes of the exchange rate of Hungarian Forint (HUF) are naturally under the control of National Bank of Hungary. Exchange rate of HUF has been steadily depreciating year after year since 1989, with accumulated adjustment of around 20% each year. Although National Bank of Hungary discloses 1.2% as monthly rate of depreciation, which is 14.4% annually, actual rate of depreciation has varied yearly. Actually, in 1995 and 1996 HUF was depreciated by around 20%, which roughly corresponds to the rate of inflation in Hungary.

Therefore, any significant deviation between official rate and actual rate does not seem to exist in the exchange market, meaning that actual exchange rates can be applied to the economic analysis. It is also estimated that in most instances of thermal power project the share of non-tradable goods, such as labor cost is relatively low, and market prices can be applied in the analysis.

Adjustment applied to this economic analysis are as follows:

1) Exclusion of Customs Duty

An import surcharge system was introduced in March 1995 as one means of the emergency economic measures; initial surcharge was levied at 8%, which was later reduced to current level of 6%, and is to be further reduced to 4% from March 1997.

2) Prices Denominated in US Dollar

In order to avoid underestimation of the project cost, it is appropriate that costs and benefits are denominated in US Dollar, which is stable in its value and used as the denomination unit in many projects.

1 US$ = 161.06 HUF (January 2, 1997)

9.1.3 Operation Plan

As conditions for calculating fuel cost, electricity and energy production volume, plant operation hours, volume of electricity and energy produced described in detail in Chapter 3 are summarized as follows:

(1) Construction of New Power Unit

According to the development program prepared by Hungarian side, 986GWh/a is projected to be generated at year 2005 by the newly installed 150MW Unit with the condensing operation of 7,200 hours/a. Although this plan is said to be confirmed by both Borsod Power Station and MVM. But it does not appear reasonable to assume 7,200 hours/a in operation because 7,200 hours/a is the maximum level with deduction of scheduled maintenance and forced outage only. In this project, therefore, it is appropriate to adopt 6,000 hours/a (plant load factor 68.5%) of operation as base case since 6,000 hours/a is granted as annual operation hours for base load operation in Hungary. Coal consumption and fuel cost will be calculated based on the corresponding heat input.

(Unit : Year)

Annual Operation Hours	Generation Volume (GWh) (sending end base)	Heat Input (TJ)
(Base Case) 6,000	822.0	8,248.0
(Sensitivity Analysis) 4,000	548.0	5,498.7
5,000	685.0	6,873.3
6,000	986.4	9,897.6
(Per Hour)	(137.0 MW)	(1.3747 TJ)

(2) Renovation of Existing Facilities

Although the existing facilities could also work in co-generation operation, it is assumed that the facilities is devoted to the production of heat and steam in this analysis. When the contracted (supply) volume of heat energy is 2,780TJ/a, 3,399TJ/a of heat energy needs to be consumed in the facilities with the assumption of thermal efficiency of boilers 87.0% and auxiliary consumption 6.0%. Fuel cost is calculated on this assumption. In case of pulverized coal combustion, thermal efficiency of boilers is lower by 5.0% than natural gas combustion; volumes of heat input differentiate accordingly.

(Unit : Year)

Contracted Heat Volume (TJ)	Heat Input (TJ) (Natural Gas)	Heat Input (TJ) (Pulverized Coal)
(Base Case) 2,780	3,399.4	3,606.6
(Sensitivity Analysis) 10%Down	3,059.5	3,245.9

9.1.4 Benefits

Valuation applied in economic analysis should be processed at national economy level, not at business entity level, which means that the result of economic analysis must inform the decision makers of the project country the optimum use of all the resources in the country to be employed in certain project. The benefits adopted in the economic analysis are defined as follows:

(1) Construction of New Power Unit

All project cost of an alternative project (construction cost including civil works and engineering services, operation and maintenance), that will be saved by implementing the present project, is regarded in this economic evaluation as the benefit, having adopted an alternative equipment approach.

The alternative project will be selected from those that have the same capacity of generation power and the same environmental (improvement) effect. The type of power generation of the alternative project must conform to the projected base load, average load and peak load of the power plant. In this regard, pulverized coal combustion plant with installation of flue gas desulfurization (FGD) has been selected as the alternative project.

With dual firing applied as a way of combustion for both projects, fuel consumed will be mixture of Borsod brown coal and imported coal based on calorific value of 1:1.

(2) Renovation of Existing Boilers

The project consists of renovation/replacement of the existing 4 boilers and related parts and equipment. The benefit of the project is defined in the same way as construction of new power unit; the cost of the alternative project (pulverized coal combustion with installation of GSA system) which is saved by implementing the proposed project (natural gas combustion) is regarded as the benefit.

9.1.5 Project Cost

(1) Construction Cost

Estimation of the construction cost of the project is processed in Chapter 8 Section 8.2, and it is summarized below. The direct construction cost is calculated by excluding the technical contingency cost and engineering fee from the total project cost. No sunk cost is accounted in the evaluation.

Project category		Cost category	Million HUF	Million USD
New Unit	Proposed Project	Total construction cost	24,223.8	150.402
		Direct construction cost	21,000.8	130.391
	Alternative Project	Total construction cost	22,623.3	140.465
		Direct construction cost	19,533.6	121.334
Facility Renovation	Proposed Project	Total construction cost	7,435.5	46.160
		Direct construction cost	6,289.2	39.043
	Alternative Project	Total construction cost	9,835.6	61.068
		Direct construction cost	8,301.2	51.541

(2) Annual Disbursement Plan

Construction schedule and annual disbursement plan are as follows; for details please refer to Chapter 8 Section 8.2.

1) Construction of New Power Unit

Year	Proposed Project (CFBC)		Alternative Project (PCF+FGD)	
	(%)	(1,000 US$)	(%)	(1,000 US$)
1st Year(1997)	0.41	620.9	0.26	369.4
2nd Year(1998)	19.30	29,020.2	18.91	26,556.6
3rd Year(1999)	41.57	62,517.1	41.78	58,686.2
4th Year(2000)	29.60	44,521.3	29.73	41,764.8
5th Year(2001)	9.12	13,722.8	9.32	13,088.3
Total	100.00	150,402.3	100.00	140,465.3

2) Renovation of Existing Facilities

The construction cost and annual disbursement plan of the project are also detailed in Chapter 8 Section 8.2. The operation is to start from 4th year, although construction period is 5 years.

Year	Proposed Project(Natural Gas)		Alternative Project (PCF+FGD)	
	(%)	(1,000 US$)	(%)	(1,000 US$)
1st Year(2001)	25.90	11,957.0	22.87	13,965.9
2nd Year(2002)	33.35	15,396.7	28.46	17,378.9
3rd Year(2003)	39.48	18,222.4	38.46	23,486.3
4th Year(2004)	0.88	404.2	0.60	367.6
5th Year(2005)	0.39	180.1	9.61	5,869.2
Total	100.00	46,160.4	100.00	61,067.9

(3) Fuel Cost

1) Unit Price

(a) Coal Price (Domestic Coal) 4,563 HUF/ton
(Ave. Calorie: 9.00GJ/ton) (per calorie unit: 507 HUF/GJ)

(Imported Coal) 8,141 HUF/ton
(Assumed imported from CIS) (per calorie unit: 318 HUF/GJ)
(Ave. Calorie: 25.60GJ/ton)

(b) Natural Gas Price 18 HUF/m^3
(Ave. Calorie: 33.94 MJ/m^3 (per calorie unit: 530 HUF/GJ)

(c) Heavy Oil Price 56,000HUF/t
(Ave. Calorie: 41.00 MJ/m^3) (per calorie unit: 1,365.85 HUF/GJ)

2) Fuel Cost

Fuel cost used is obtained by multiplying input fuel given in 9.1.3 Operation Plan by unit prices given in 1) above. In case of the alternative project with PCF+FGD, out of total heat input 90% is input from coal combustion and the remaining 10% is input from natural gas combustion. Also, the alternative project has lower thermal efficiency by 5% than the proposed project, which results in higher fuel cost by the same percentage for the alternative project.

(a) New Unit

(i) Proposed Project
(507 HUF/GJ + 318 HUF/GJ)/2 x 10^3 x 8,248.0 TJ/y
= 3,402,300.0 thousand HUF/y
= 21,124.4 thousand US$/y

(ii) Alternative Project

(507 HUF/GJ+318 HUF/GJ)/2x10^3x8,248TJ/y x90%x1.05

= 3,215,173.5 thousand HUF/y

= 19,962.6 thousand US$/y

Auxiliary Fuel (Natural Gas):

530 HUF/GJ x 10^3 x 8,248 TJ/y x 10%

= 437,144.0 thousand HUF/y

= 2,714.2 thousand US$/y

Total Fuel Cost: 22,676.8 thousand US$/y

(b) Existing Facilities

Necessary input fuel for each project is calculated as follows:

Total Input Fuel = (Contracted Heat Value) x (Boiler Efficiency) x (1 - Auxiliary Consumption)

Natural Gas : 2,780TJ/y／0.87／0.94 = 3,399.4 TJ/y

PCF+FGD : 2,780TJ/y／0.82／0.94 = 3,606.6 TJ/y

(i) Proposed Project (Natural gas)

530 HUF/GJ x 10^3 x 3,399.4 TJ/y = 1,801,682 thousand HUF/y

= 11,186.4 thousand US$/y

Heavy oil is regularly reserved for 3,000m^3 as alternative fuel in case of emergency condition such as disruption of natural gas supply. The cost of heavy oil reservation is, however, not counted in this analysis because the reservation is necessary irrespective of type of combustion and the relevant cost is incurred at any event.

(ii) Alternative project (PCF, mixture of Borsod brown coal and imported coal)

Same assumption is made as in the New Unit project that out of total input fuel 90% is input from coal combustion and 10% from natural gas combustion.

(507 + 318)/2 HUF/GJ x 10^3 x 3,606.6 TJ/y x 90%

= 1,338,950.3 thousand HUF/y

= 8,313.4 thousand US$/y

Natural gas as aid fuel input: 1,186.8 thousand US$/y
(Total) 9,500.2 thousand US$/y

(4) Solvent for Environmental Protection

1) 150MW New Unit

In case of coal combustion, limestone is fed in various processes and occasions as follows:

	Proposed Project	Alternative Project
Unit Price (per ton):	1,700 ~ 2,800 HUF/t	2,900 ~ 4,100 HUF/t
Consumption Volume:		
	18.4t/h for input fuel 1,375GJ/h	13.3t/h for input fuel 1,444GJ/h
Unit Price (per heat value) :		
	18.4 t/h x 2,800HUF/t/1,375GJ/h = 37.47 HUF/GJ	13.3t/h x 4,100HUF/t /1,444GJ/h = 37.76 HUF/GJ

[Consumption Price]

Proposed Project	Alternative Project
37.47 HUF/GJ x 8,248 x 10^3 GJ/y	37.76HUF/GJx8,248 x 90% x 1.05 x 10^3 GJ/y
= 309,052.6 thousand HUF/y	= 294,315.0 thousand HUF/y
= 1,918.9 thousand US$/y	= 1,827.4 thousand US$/y

2) Renovation of Existing Facilities

In stead of limestone, the by-product produced from the operation of New Unit is used; no cost is reckoned in this project.

(5) Other Parameters

Other parameters are assumed as follows:

Parameters	Proposed Project	Alternative Project
*Auxiliary consumption:		
- Power	8.7%	8.7%
- Energy	6.0%	6.0%
*Thermal efficiency		
	87.0%	82.0%
*Maximum operating hours/year	7,200 hours	7,200 hours
*Non-availability of plant due to:		
- Scheduled maintenance	760 hours	760 hours
- Forced outage	800 hours	800 hours
*Yearly operating hour (Base Case)	6,000 hours	6,000 hours
(Plant Loan Factor)	(68.5%)	(68.5%)
*Economic service life		

[150MW New Unit]	25 years	25 years
[Existing 4 Boilers]	15 years	15 years

(6) Operation and Maintenance (O & M) Cost

1) New Unit

A certain fixed ratio against direct construction cost (total project cost − technical contingency − Engineering Fee) is normally adopted for calculating O & M cost. A factor of 2.5%/year was adopted in F/S prepared by EGI.

In this project, with lessons and experiences obtained at Provence Power Station in France into account, a factor of 2.1%/a is assumed for the proposed (CFBC) project. For the alternative project (PCF+FGD), a factor of 2.8%/a is assumed as the project entails some additional investment for coal crushing equipment and replacement of parts to flue gas desulfurizer.

Proposed Project	Alternative Project
2.1%/y	2.8%/y

2) Existing Facilities

In principle O&M cost of maintaining boilers and other equipment for natural gas combustion should be cheaper than any coal combustion type including CFBC. But higher O&M cost ratio is assumed in this project because the whole system of the existing plant is aged and should be more expensive than a new unit.

Proposed Project	Alternative Project
2.5%/y	3.2%/y

(7) Direct Labor Cost

In this part, direct labor working for generation is calculated, excluding indirect labor cost, which is calculated in (8) Other Operation Cost below. 20 workers are assumed necessary for flue gas desulfurization process.

[New Unit]	Proposed Project	Alternative Project
	110 people	110 people
Desulfurization:	---	20 people
Wages and other cost:	1,209,600 HUF/man	1,209,600 HUF/man
	(7,510 US$/man)	(7,510 US$/man)
Total	133,056 thousand HUF	157,248 thousand HUF
	(826.1 thousand US$)	(976.3 thousand US$)
[Existing Facilities]	55 people	70 people
Wages and other cost:	1,209,600 HUF/man	1,209,600 HUF/man
	(7,510 US$/man)	(7,510 US$/man)
Total	66,528 thousand HUF	84,672 thousand HUF
	(413.1 thousand US$)	(525.7 thousand US$)

(8) Other Operation Cost

A ratio to the direct construction cost is assumed as other operation cost including salaries and wages of indirect and administrative staff and other indirect materials and equipment etc., taking ratios assumed in similar project in Hungary and other countries into consideration. Wet-type desulfurizer applied to the alternative project of the New Unit project consumes more industrial water than other types of desulfurization; produces more by-products causing higher disposal cost, a higher ratio for the alternative projects is assumed.

	Proposed Project	Alternative Project
New Unit:	3.9%/y	4.3%/y
Existing Facilities:	3.9%/y	4.3%/y

(9) Cost of Environmental Protection Measure

For the new power unit project, either CFBC unit or PFC+FGD unit, it is definitely necessary to lay impermeable sheet system in the disposal site of the sludge and fly ash discharged from the boilers. The laying should start in the same year of the construction, 1997, in accordance with the environmental regulations; the relevant expense are to be incurred in 1997 and every 6 years thereafter.

(Unit : HUF)

Measure/Year	1997	every 6 years	Total
Impermeable Sheet System	91,267,600	90,067,600	451,538,000
(US$)	(566,668.3)	(559,217.7)	(2,803,539.1)

9.1.6 Social Rate of Discount

The rate of 12.0% is adopted in this project, as the rate is used in the similar power sector project financed by World Bank.

9.1.7 Result of the Economic Analysis

On the basis of the flows of the benefits and costs calculated on the assumptions put so far , indices of the projects as net present value (NPV) , benefit/cost ratio (B/C ratio), and EIRR are calculated as given in Table 9.1.1 for the New Unit project and Table 9.1.2 for the Existing Facilities project, and explained briefly as follows:

(1) Net Present Value (NPV) and Benefit/Cost (B/C) Ratio

Cost and benefit of each year is discounted at 8.0%. This 8.0% is the target profit level, of which MVM assures the power stations by granting the capacity charge, contracted mining charge, energy charge and other revenues. The results are summarized below. They indicate that the proposed projects for both the new unit and the facilities renovation are more advantageous than the alternative projects, and can be judged to be feasible enough.

	NPV (thousand US$)	B/C	EIRR (%)
150MW New Unit	10,377.4	1.03	17.3
Facility Renovation	15,096.7	1.11	NA

(2) Economic Internal Rate of Return (EIRR)

EIRR for the New Unit project is 17.3%, which is well over 12.0% of social rate of discount.

For the Existing Facilities project, EIRR is not available by definition since the construction cost and the operation and maintenance cost of the proposed project are less than those of the alternative project.

9.1.8 Sensitivity Analysis

In order to measure the influence of the change of the related factors such as the plant load factor (PLF), sensitivity analyses were carried out as shown below.

[New Power Unit]

	NPV(thousand US$)	EIRR(%)	B/C	Table
Construction Cost 10% Up	-8,413.0	3.5	0.98	9.1.3
Coal Price 10% Up	9,465.8	16.6	1.02	9.1.4
PLF Down I	6,556.8	14.3	1.02	9.1.5
PLF Down II	8,467.0	15.9	1.02	---
PLF Up	12,669.8	19.0	1.03	---

(Note)

Variation of Plant Load Factor (PLF):

Base Case	= 6,000 hrs/y
PLF Down I	= 4,000 hrs/y
PLF Down II	= 5,000 hrs/y
PLF Up	= 7,200 hrs/y

In the case of 10% construction cost up, the analysis reveals the negative result in all the indices.

With better thermal efficiency for CFBC type, the indices go up along with increase of the fuel cost and the plant load factor.

[Facility Renovation]

	NPV(thousand US$)	B/C	Table
Construction Cost 10% Up	9,034.1	1.07	9.1.6
10% Unit Price of Natural Gas Up	9,293.1	1.07	9.1.7
Demand 10% Down	11,789.1	1.10	9.1.8

Technically alternatives are limited to only two types of combustion, of which the proposed project with natural gas combustion is definitely advantageous and feasible than the pulverized coal combustion with FGD equipment.

9.1.9 Evaluation of Socio-Economic Influence

Following items of cost (or losses) and benefit are generally suggested for inclusion to be evaluated in development projects which might cause any environmental derivative effects.

(Benefits)

- Reduction of diseases of the inhabitants
- Improvement of living, social and natural environment
- Economic growth and expansion of employment by the investment for environmental equipment
- Decrease of the sum paid for the indemnity for healthy damages

(Cost)

- Consumer price rise resulting from additional environmental cost and decrease of purchasing power of the inhabitants

Evaluating socio-economic impact on macro-basis by the introduction of a certain environmental project has not yet been fully developed methodologically. The following two subjects, though presented here only as a matter of possibilities, might be included in the subjects of future study.

1) Comparison between the sum of damages from environmental pollution and the cost incurred from countermeasure for environmental protection

   Accurate valuation of the amount of damages resulting from pollution (project benefit) where no investment as pollution countermeasures is difficult, and some bold some assumptions would be necessitated to reach any conclusions, which might not be objective enough.

2) Economic Impact of Environmental Protection Measure

   On one hand, cost for environmental protection is in principle passed on make a new and higher price. Full appreciation of the effect of the relevant cost increase is almost impossible. On the other, the investments for environmental protection put forth income effect in general by increasing sales of the companies which manufacture and sell the plant and equipment and other related goods and services for the investment. However, calculation of actual amount of the effect put forth by each investment is also very difficult.

With these situation in mind, the socio-economic influence is not taken up in this economic and financial evaluation.

[Base Case]
Operation Hour: 6,000/a
Generation: 822.0GWh
8,248.0TJ/a

Table 9.1.1 Economic Evaluation of Construction of New 150MW Unit

(Unit: 1,000 US$)

No.	Year	Proposed (CFBC) Construct. Cost	Fuel & Limestone	O & M and Other Cost	(C) TOTAL COST	Alternative (PCF+FGD) Construct. Cost	Fuel & Limestone	O & M and Other Cost	(B) TOTAL COST	(B) - (C)	Discouted Value (8%)
1	1997	620.9		566.7	1,187.6	369.4		566.7	936.1	-251.5	-251.5
2	1998	29,020.2			29,020.2	26,556.6			26,556.6	-2,463.7	-2,281.2
3	1999	62,517.1			62,517.1	58,686.2			58,686.2	-3,830.9	-3,284.4
4	2000	44,521.3			44,521.3	41,764.8			41,764.8	-2,756.5	-2,188.2
5	2001	13,722.8			13,722.8	13,088.3			13,088.3	-634.5	-466.4
6 1	2002		23,043.3	8,649.6	31,692.9		24,504.1	9,591.0	34,095.1	2,402.3	1,635.0
7 2	2003		23,043.3	9,208.8	32,252.1		24,504.1	10,150.2	34,654.4	2,402.3	1,513.8
8 3	2004		23,043.3	8,649.6	31,692.9		24,504.1	9,591.0	34,095.1	2,402.3	1,401.7
9 4	2005		23,043.3	8,649.6	31,692.9		24,504.1	9,591.0	34,095.1	2,402.3	1,297.9
10 5	2006		23,043.3	8,649.6	31,692.9		24,504.1	9,591.0	34,095.1	2,402.3	1,201.7
11 6	2007		23,043.3	8,649.6	31,692.9		24,504.1	9,591.0	34,095.1	2,402.3	1,112.7
12 7	2008		23,043.3	8,649.6	31,692.9		24,504.1	9,591.0	34,095.1	2,402.3	1,030.3
13 8	2009		23,043.3	9,208.8	32,252.1		24,504.1	10,150.2	34,654.4	2,402.3	954.0
14 9	2010		23,043.3	8,649.6	31,692.9		24,504.1	9,591.0	34,095.1	2,402.3	883.3
15 10	2011		23,043.3	8,649.6	31,692.9		24,504.1	9,591.0	34,095.1	2,402.3	817.9
16 11	2012		23,043.3	8,649.6	31,692.9		24,504.1	9,591.0	34,095.1	2,402.3	757.3
17 12	2013		23,043.3	8,649.6	31,692.9		24,504.1	9,591.0	34,095.1	2,402.3	701.2
18 13	2014		23,043.3	8,649.6	31,692.9		24,504.1	9,591.0	34,095.1	2,402.3	649.3
19 14	2015		23,043.3	9,208.8	32,252.1		24,504.1	10,150.2	34,654.4	2,402.3	601.2
20 15	2016		23,043.3	8,649.6	31,692.9		24,504.1	9,591.0	34,095.1	2,402.3	556.6
21 16	2017		23,043.3	8,649.6	31,692.9		24,504.1	9,591.0	34,095.1	2,402.3	515.4
22 17	2018		23,043.3	8,649.6	31,692.9		24,504.1	9,591.0	34,095.1	2,402.3	477.2
23 18	2019		23,043.3	8,649.6	31,692.9		24,504.1	9,591.0	34,095.1	2,402.3	441.9
24 19	2020		23,043.3	8,649.6	31,692.9		24,504.1	9,591.0	34,095.1	2,402.3	409.1
25 20	2021		23,043.3	9,208.8	32,252.1		24,504.1	10,150.2	34,654.4	2,402.3	378.8
26 21	2022		23,043.3	8,649.6	31,692.9		24,504.1	9,591.0	34,095.1	2,402.3	350.8
27 22	2023		23,043.3	8,649.6	31,692.9		24,504.1	9,591.0	34,095.1	2,402.3	324.8
28 23	2024		23,043.3	8,649.6	31,692.9		24,504.1	9,591.0	34,095.1	2,402.3	300.7
29 24	2025		23,043.3	8,649.6	31,692.9		24,504.1	9,591.0	34,095.1	2,402.3	278.5
30 25	2026		23,043.3	8,649.6	31,692.9		24,504.1	9,591.0	34,095.1	2,402.3	257.8
	TOTAL	150,402.3	576,082.3	218,476.1	945,527.4	140,465.3	612,602.8	242,012.7	995,647.5	50,120.1	10,377.4
				N.P.V. Total	376,559.2			N.P.V. Total	386,936.7		

N.P.V.	10,377.4
E.I.R.R.	17.3%
B/C	1.03

Table 9.1.2 Economic Evaluation of Renovation of Existing Facilities

Generation: 3,399.4TJ/a by Natural Gas
Generation: 3,606.6TJ/a by GSA System
(Unit: 1,000 US$)

No.		Year	Proposed (Natural Gas) Construct. Cost	Proposed (Natural Gas) Fuel	Proposed (Natural Gas) O & M and Other Cost	Proposed (Natural Gas) (C) TOTAL COST	Alternative (PCF + FGD) Construct. Cost	Alternative (PCF + FGD) Fuel	Alternative (PCF + FGD) O & M and Other Cost	Alternative (PCF + FGD) (B) TOTAL COST	(B) - (C)	Discouted Value (8%)
1		1997				-				-	-	-
2		1998				-				-	-	-
3		1999				-				-	-	-
4		2000				-				-	-	-
5	1	2001	11,957.0			11,957.0	13,965.9			13,965.9	2,008.9	2,008.9
6	2	2002	15,396.7			15,396.7	17,378.9			17,378.9	1,982.2	1,835.4
7	3	2003	18,222.4			18,222.4	23,486.3			23,486.3	5,263.9	4,512.9
8	4	2004	404.2	10,627.1	2,911.9	13,943.1	367.6	9,500.2	4,391.3	14,259.0	315.9	250.8
9	5	2005	180.1	10,627.1	2,911.9	13,719.0	5,869.2	9,500.2	4,391.3	19,760.7	6,041.7	4,440.8
10	6	2006		10,627.1	2,911.9	13,538.9		9,500.2	4,391.3	13,891.5	352.5	239.9
11	7	2007		10,627.1	2,911.9	13,538.9		9,500.2	4,391.3	13,891.5	352.5	222.1
12	8	2008		10,627.1	2,911.9	13,538.9		9,500.2	4,391.3	13,891.5	352.5	205.7
13	9	2009		10,627.1	2,911.9	13,538.9		9,500.2	4,391.3	13,891.5	352.5	190.5
14	10	2010		10,627.1	2,911.9	13,538.9		9,500.2	4,391.3	13,891.5	352.5	176.3
15	11	2011		10,627.1	2,911.9	13,538.9		9,500.2	4,391.3	13,891.5	352.5	163.3
16	12	2012		10,627.1	2,911.9	13,538.9		9,500.2	4,391.3	13,891.5	352.5	151.2
17	13	2013		10,627.1	2,911.9	13,538.9		9,500.2	4,391.3	13,891.5	352.5	140.0
18	14	2014		10,627.1	2,911.9	13,538.9		9,500.2	4,391.3	13,891.5	352.5	129.6
19	15	2015		10,627.1	2,911.9	13,538.9		9,500.2	4,391.3	13,891.5	352.5	120.0
20	16	2016		10,627.1	2,911.9	13,538.9		9,500.2	4,391.3	13,891.5	352.5	111.1
21	17	2017		10,627.1	2,911.9	13,538.9		9,500.2	4,391.3	13,891.5	352.5	102.9
22	18	2018		10,627.1	2,911.9	13,538.9		9,500.2	4,391.3	13,891.5	352.5	95.3
		TOTAL	46,160.4	159,406.2	43,678.0	249,244.7	61,067.9	142,502.8	65,869.2	269,439.9	20,195.2	15,096.7

N.P.V.	15,096.7
E.I.R.R.	N.A.
B/C	1.11

Table 9.1.3 Economic Evaluation of Construction of New 150MW Unit

[Sensitivity Analysis]
Cosntruction Cost 10% Up
Operation Hour: 6,000 hours/a
Geneartion: 822.0GWh (Unit: 1,000 US$)

No.	Year	Proposed (CFBC) Construct. Cost	Fuel & Limestone	O & M and Other Cost	(C) TOTAL COST	Alternative (PCF+FGD) Construct. Cost	Fuel & Limestone	O & M and Other Cost	(B) TOTAL COST	(B) - (C)	Discouted Value (8%)
1	1997	683.0		566.7	1,249.6	369.4		566.7	936.1	-313.5	-313.5
2	1998	31,922.3			31,922.3	26,556.6			26,556.6	-5,365.7	-4,968.2
3	1999	68,768.8			68,768.8	58,686.2			58,686.2	-10,082.6	-8,644.2
4	2000	48,973.4			48,973.4	41,764.8			41,764.8	-7,208.6	-5,722.4
5	2001	15,095.1			15,095.1	13,088.3			13,088.3	-2,006.8	-1,475.1
6 1	2002		23,043.3	9,431.9	32,475.2		24,504.1	9,591.0	34,095.1	1,619.9	1,102.5
7 2	2003		23,043.3	9,991.1	33,034.4		24,504.1	10,150.3	34,654.4	1,619.9	1,020.8
8 3	2004		23,043.3	9,431.9	32,475.2		24,504.1	9,591.0	34,095.1	1,619.9	945.2
9 4	2005		23,043.3	9,431.9	32,475.2		24,504.1	9,591.0	34,095.1	1,619.9	875.2
10 5	2006		23,043.3	9,431.9	32,475.2		24,504.1	9,591.0	34,095.1	1,619.9	810.4
11 6	2007		23,043.3	9,431.9	32,475.2		24,504.1	9,591.0	34,095.1	1,619.9	750.3
12 7	2008		23,043.3	9,431.9	32,475.2		24,504.1	9,591.0	34,095.1	1,619.9	694.8
13 8	2009		23,043.3	9,991.1	33,034.4		24,504.1	10,150.3	34,654.4	1,619.9	643.3
14 9	2010		23,043.3	9,431.9	32,475.2		24,504.1	9,591.0	34,095.1	1,619.9	595.6
15 10	2011		23,043.3	9,431.9	32,475.2		24,504.1	9,591.0	34,095.1	1,619.9	551.5
16 11	2012		23,043.3	9,431.9	32,475.2		24,504.1	9,591.0	34,095.1	1,619.9	510.7
17 12	2013		23,043.3	9,431.9	32,475.2		24,504.1	9,591.0	34,095.1	1,619.9	472.8
18 13	2014		23,043.3	9,431.9	32,475.2		24,504.1	9,591.0	34,095.1	1,619.9	437.8
19 14	2015		23,043.3	9,991.1	33,034.4		24,504.1	10,150.3	34,654.4	1,619.9	405.4
20 15	2016		23,043.3	9,431.9	32,475.2		24,504.1	9,591.0	34,095.1	1,619.9	375.4
21 16	2017		23,043.3	9,431.9	32,475.2		24,504.1	9,591.0	34,095.1	1,619.9	347.6
22 17	2018		23,043.3	9,431.9	32,475.2		24,504.1	9,591.0	34,095.1	1,619.9	321.8
23 18	2019		23,043.3	9,431.9	32,475.2		24,504.1	9,591.0	34,095.1	1,619.9	298.0
24 19	2020		23,043.3	9,431.9	32,475.2		24,504.1	9,591.0	34,095.1	1,619.9	275.9
25 20	2021		23,043.3	9,991.1	33,034.4		24,504.1	10,150.3	34,654.4	1,619.9	255.5
26 21	2022		23,043.3	9,431.9	32,475.2		24,504.1	9,591.0	34,095.1	1,619.9	236.5
27 22	2023		23,043.3	9,431.9	32,475.2		24,504.1	9,591.0	34,095.1	1,619.9	219.0
28 23	2024		23,043.3	9,431.9	32,475.2		24,504.1	9,591.0	34,095.1	1,619.9	202.8
29 24	2025		23,043.3	9,431.9	32,475.2		24,504.1	9,591.0	34,095.1	1,619.9	187.8
30 25	2026		23,043.3	9,431.9	32,475.2		24,504.1	9,591.0	34,095.1	1,619.9	173.9
	TOTAL	165,442.6	576,082.3	238,034.9	980,126.4	140,465.3	612,602.8	242,012.7	995,647.5	15,521.2	-8,413.0
				N.P.V. Total	395,349.7			N.P.V. Total	386,936.7		

N.P.V.	-8,413.0
E.I.R.R.	3.5%
B/C	0.98

Table 9.1.4 Economic Evaluation of Construction of New 150MW Unit

(Mixed) Coal Price: 10% Up
Operation Hour: 6,000/a
Generation: 822.0GWh (Unit: 1,000 US$)

No.	Year	Proposed (CFBC) Construct. Cost	Proposed (CFBC) Fuel & Limestone	Proposed (CFBC) O & M and Other Cost	Proposed (CFBC) (C) TOTAL COST	Alternative (PCF+FGD) Construct. Cost	Alternative (PCF+FGD) Fuel & Limestone	Alternative (PCF+FGD) O & M and Other Cost	Alternative (PCF+FGD) (B) TOTAL COST	(B) - (C)	Discouted Value(8%)
1	1997	620.9		566.7	1,187.6	369.4		566.7	936.1	-251.5	-251.5
2	1998	29,020.2			29,020.2	26,556.6			26,556.6	-2,463.7	-2,281.2
3	1999	62,517.1			62,517.1	58,686.2			58,686.2	-3,830.9	-3,284.4
4	2000	44,521.3			44,521.3	41,764.8			41,764.8	-2,756.5	-2,188.2
5	2001	13,722.8			13,722.8	13,088.3			13,088.3	-634.5	-466.4
6 1	2002		25,155.7	8,649.6	33,805.3		26,500.4	9,591.0	36,091.4	2,286.1	1,555.9
7 2	2003		25,155.7	9,208.8	34,364.5		26,500.4	10,150.3	36,650.6	2,286.1	1,440.6
8 3	2004		25,155.7	8,649.6	33,805.3		26,500.4	9,591.0	36,091.4	2,286.1	1,333.9
9 4	2005		25,155.7	8,649.6	33,805.3		26,500.4	9,591.0	36,091.4	2,286.1	1,235.1
10 5	2006		25,155.7	8,649.6	33,805.3		26,500.4	9,591.0	36,091.4	2,286.1	1,143.6
11 6	2007		25,155.7	8,649.6	33,805.3		26,500.4	9,591.0	36,091.4	2,286.1	1,058.9
12 7	2008		25,155.7	8,649.6	33,805.3		26,500.4	9,591.0	36,091.4	2,286.1	980.5
13 8	2009		25,155.7	9,208.8	34,364.5		26,500.4	10,150.3	36,650.6	2,286.1	907.8
14 9	2010		25,155.7	8,649.6	33,805.3		26,500.4	9,591.0	36,091.4	2,286.1	840.6
15 10	2011		25,155.7	8,649.6	33,805.3		26,500.4	9,591.0	36,091.4	2,286.1	778.3
16 11	2012		25,155.7	8,649.6	33,805.3		26,500.4	9,591.0	36,091.4	2,286.1	720.7
17 12	2013		25,155.7	8,649.6	33,805.3		26,500.4	9,591.0	36,091.4	2,286.1	667.3
18 13	2014		25,155.7	8,649.6	33,805.3		26,500.4	9,591.0	36,091.4	2,286.1	617.9
19 14	2015		25,155.7	9,208.8	34,364.5		26,500.4	10,150.3	36,650.6	2,286.1	572.1
20 15	2016		25,155.7	8,649.6	33,805.3		26,500.4	9,591.0	36,091.4	2,286.1	529.7
21 16	2017		25,155.7	8,649.6	33,805.3		26,500.4	9,591.0	36,091.4	2,286.1	490.5
22 17	2018		25,155.7	8,649.6	33,805.3		26,500.4	9,591.0	36,091.4	2,286.1	454.1
23 18	2019		25,155.7	8,649.6	33,805.3		26,500.4	9,591.0	36,091.4	2,286.1	420.5
24 19	2020		25,155.7	8,649.6	33,805.3		26,500.4	9,591.0	36,091.4	2,286.1	389.4
25 20	2021		25,155.7	9,208.8	34,364.5		26,500.4	10,150.3	36,650.6	2,286.1	360.5
26 21	2022		25,155.7	8,649.6	33,805.3		26,500.4	9,591.0	36,091.4	2,286.1	333.8
27 22	2023		25,155.7	8,649.6	33,805.3		26,500.4	9,591.0	36,091.4	2,286.1	309.1
28 23	2024		25,155.7	8,649.6	33,805.3		26,500.4	9,591.0	36,091.4	2,286.1	286.2
29 24	2025		25,155.7	8,649.6	33,805.3		26,500.4	9,591.0	36,091.4	2,286.1	265.0
30 25	2026		25,155.7	8,649.6	33,805.3		26,500.4	9,591.0	36,091.4	2,286.1	245.4
	TOTAL	150,402.3	628,893.4	218,476.2	998,338.5	140,465.3	662,509.3	242,012.7	1,045,554.0	47,215.5	9,465.8
				N.P.V. Total	393,134.1			N.P.V. Total	402,599.9		

N.P.V.	9,465.8
E.I.R.R.	16.6%
B/C	1.02

[Variation of Operation I]
Operation Hour: 4,000/a
Generation: 548.0GWh
5,498.7TJ/a

Table 9.1.5 Economic Evaluation of Construction of New 150MW Unit

(Unit: 1,000 US$)

No.		Year	Proposed (CFBC) Construct. Cost	Proposed (CFBC) Fuel & Limestone	Proposed (CFBC) O & M and Other Cost	Proposed (CFBC) (C) TOTAL COST	Alternative (PCF+FGD) Construct. Cost	Alternative (PCF+FGD) Fuel & Limestone	Alternative (PCF+FGD) O & M and Other Cost	Alternative (PCF+FGD) (B) TOTAL COST	(B) - (C)	Discouted Value (8%)
1		1997	620.9		566.7	1,187.6	369.4		566.7	936.1	-251.5	-251.5
2		1998	29,020.2			29,020.2	26,556.6			26,556.6	-2,463.7	-2,281.2
3		1999	62,517.1			62,517.1	58,686.2			58,686.2	-3,830.9	-3,284.4
4		2000	44,521.3			44,521.3	41,764.8			41,764.8	-2,756.5	-2,188.2
5		2001	13,722.8			13,722.8	13,088.3			13,088.3	-634.5	-466.4
6	1	2002		15,362.3	8,649.6	24,011.9		16,336.2	9,591.0	25,927.2	1,915.3	1,303.6
7	2	2003		15,362.3	9,208.8	24,571.1		16,336.2	10,150.3	26,486.4	1,915.3	1,207.0
8	3	2004		15,362.3	8,649.6	24,011.9		16,336.2	9,591.0	25,927.2	1,915.3	1,117.6
9	4	2005		15,362.3	8,649.6	24,011.9		16,336.2	9,591.0	25,927.2	1,915.3	1,034.8
10	5	2006		15,362.3	8,649.6	24,011.9		16,336.2	9,591.0	25,927.2	1,915.3	958.2
11	6	2007		15,362.3	8,649.6	24,011.9		16,336.2	9,591.0	25,927.2	1,915.3	887.2
12	7	2008		15,362.3	8,649.6	24,011.9		16,336.2	9,591.0	25,927.2	1,915.3	821.5
13	8	2009		15,362.3	9,208.8	24,571.1		16,336.2	10,150.3	26,486.4	1,915.3	760.6
14	9	2010		15,362.3	8,649.6	24,011.9		16,336.2	9,591.0	25,927.2	1,915.3	704.3
15	10	2011		15,362.3	8,649.6	24,011.9		16,336.2	9,591.0	25,927.2	1,915.3	652.1
16	11	2012		15,362.3	8,649.6	24,011.9		16,336.2	9,591.0	25,927.2	1,915.3	603.8
17	12	2013		15,362.3	8,649.6	24,011.9		16,336.2	9,591.0	25,927.2	1,915.3	559.1
18	13	2014		15,362.3	8,649.6	24,011.9		16,336.2	9,591.0	25,927.2	1,915.3	517.7
19	14	2015		15,362.3	9,208.8	24,571.1		16,336.2	10,150.3	26,486.4	1,915.3	479.3
20	15	2016		15,362.3	8,649.6	24,011.9		16,336.2	9,591.0	25,927.2	1,915.3	443.8
21	16	2017		15,362.3	8,649.6	24,011.9		16,336.2	9,591.0	25,927.2	1,915.3	410.9
22	17	2018		15,362.3	8,649.6	24,011.9		16,336.2	9,591.0	25,927.2	1,915.3	380.5
23	18	2019		15,362.3	8,649.6	24,011.9		16,336.2	9,591.0	25,927.2	1,915.3	352.3
24	19	2020		15,362.3	8,649.6	24,011.9		16,336.2	9,591.0	25,927.2	1,915.3	326.2
25	20	2021		15,362.3	9,208.8	24,571.1		16,336.2	10,150.3	26,486.4	1,915.3	302.0
26	21	2022		15,362.3	8,649.6	24,011.9		16,336.2	9,591.0	25,927.2	1,915.3	279.7
27	22	2023		15,362.3	8,649.6	24,011.9		16,336.2	9,591.0	25,927.2	1,915.3	259.0
28	23	2024		15,362.3	8,649.6	24,011.9		16,336.2	9,591.0	25,927.2	1,915.3	239.8
29	24	2025		15,362.3	8,649.6	24,011.9		16,336.2	9,591.0	25,927.2	1,915.3	222.0
30	25	2026		15,362.3	8,649.6	24,011.9		16,336.2	9,591.0	25,927.2	1,915.3	205.6
		TOTAL	150,402.3	384,057.2	218,476.2	753,502.4	140,465.3	408,404.4	242,012.7	791,449.1	37,946.7	6,556.8
					N.P.V. Total	316,292.0			N.P.V. Total	322,848.7		

N.P.V.	6,556.8
E.I.R.R.	14.3%
B/C	1.02

[Sensitivity Analysis]
Cosntruction Cost 10% Up
Geneartion: 3,399.4 TJ/a / 3,606.6TJ/a
(Unit: 1,000 US$)

Table 9.1.6 Economic Evaluation of Renovation of Existing Facilities

No.		Year	Proposed (Natural Gas) Construct. Cost	Fuel	O & M and Other Cost	(C) TOTAL COST	Alternative (PCF + FGD) Construct. Cost	Fuel	O & M and Other Cost	(B) TOTAL COST	(B) - (C)	Discouted Value (8%)
1		1997				-				-	-	-
2		1998				-				-	-	-
3		1999				-				-	-	-
4		2000				-				-	-	-
5	1	2001	13,152.7			13,152.7	13,965.9			13,965.9	813.2	813.2
6	2	2002	16,936.4			16,936.4	17,378.9			17,378.9	442.5	409.7
7	3	2003	20,044.6			20,044.6	23,486.3			23,486.3	3,441.6	2,950.6
8	4	2004	444.6	10,627.1	3,161.7	14,233.4	367.6	9,500.2	4,391.3	14,259.0	25.6	20.3
9	5	2005	198.1	10,627.1	3,161.7	13,986.9	5,869.2	9,500.2	4,391.3	19,760.7	5,773.8	4,243.9
10	6	2006		10,627.1	3,161.7	13,788.8		9,500.2	4,391.3	13,891.5	102.6	69.9
11	7	2007		10,627.1	3,161.7	13,788.8		9,500.2	4,391.3	13,891.5	102.6	64.7
12	8	2008		10,627.1	3,161.7	13,788.8		9,500.2	4,391.3	13,891.5	102.6	59.9
13	9	2009		10,627.1	3,161.7	13,788.8		9,500.2	4,391.3	13,891.5	102.6	55.5
14	10	2010		10,627.1	3,161.7	13,788.8		9,500.2	4,391.3	13,891.5	102.6	51.3
15	11	2011		10,627.1	3,161.7	13,788.8		9,500.2	4,391.3	13,891.5	102.6	47.5
16	12	2012		10,627.1	3,161.7	13,788.8		9,500.2	4,391.3	13,891.5	102.6	44.0
17	13	2013		10,627.1	3,161.7	13,788.8		9,500.2	4,391.3	13,891.5	102.6	40.8
18	14	2014		10,627.1	3,161.7	13,788.8		9,500.2	4,391.3	13,891.5	102.6	37.7
19	15	2015		10,627.1	3,161.7	13,788.8		9,500.2	4,391.3	13,891.5	102.6	34.9
20	16	2016		10,627.1	3,161.7	13,788.8		9,500.2	4,391.3	13,891.5	102.6	32.4
21	17	2017		10,627.1	3,161.7	13,788.8		9,500.2	4,391.3	13,891.5	102.6	30.0
22	18	2018		10,627.1	3,161.7	13,788.8		9,500.2	4,391.3	13,891.5	102.6	27.7
		TOTAL	50,776.5	159,406.2	47,426.1	257,608.9	61,067.9	142,502.8	65,869.2	269,439.9	11,831.0	9,034.1

N.P.V.	9,034.1
E.I.R.R.	N.A.
B/C	1.07

Table 9.1.7 Economic Evaluation of Renovation of Existing Facilities

[Sensitivity Analysis]
Natural Gas Price: 10% Up
Generation: 3,399.4TJ/a by Natural Gas
Generation: 3,606.6TJ/a by GSA System

(Unit: 1,000 US$)

No.		Year	Proposed (Natural Gas) Construct. Cost	Fuel	O & M and Other Cost	(C) TOTAL COST	Alternative (PCF + FGD) Construct. Cost	Fuel	O & M and Other Cost	(B) TOTAL COST	(B) - (C)	Discouted Value (8%)
1		1997				-				-	-	-
2		1998				-				-	-	-
3		1999				-				-	-	-
4		2000				-				-	-	-
5	1	2001	11,957.0			11,957.0	13,965.9			13,965.9	2,008.9	2,008.9
6	2	2002	15,396.7			15,396.7	17,378.9			17,378.9	1,982.2	1,835.4
7	3	2003	18,222.4			18,222.4	23,486.3			23,486.3	5,263.9	4,874.0
8	4	2004	404.2	11,689.8	2,911.9	15,005.9	367.6	9,618.9	4,391.3	14,377.7	-628.1	-538.5
9	5	2005	180.1	11,689.8	2,911.9	14,781.7	5,869.2	9,618.9	4,391.3	19,879.4	5,097.7	4,046.7
10	6	2006		11,689.8	2,911.9	14,601.7		9,618.9	4,391.3	14,010.1	-591.5	-434.8
11	7	2007		11,689.8	2,911.9	14,601.7		9,618.9	4,391.3	14,010.1	-591.5	-402.6
12	8	2008		11,689.8	2,911.9	14,601.7		9,618.9	4,391.3	14,010.1	-591.5	-372.8
13	9	2009		11,689.8	2,911.9	14,601.7		9,618.9	4,391.3	14,010.1	-591.5	-345.1
14	10	2010		11,689.8	2,911.9	14,601.7		9,618.9	4,391.3	14,010.1	-591.5	-319.6
15	11	2011		11,689.8	2,911.9	14,601.7		9,618.9	4,391.3	14,010.1	-591.5	-295.9
16	12	2012		11,689.8	2,911.9	14,601.7		9,618.9	4,391.3	14,010.1	-591.5	-274.0
17	13	2013		11,689.8	2,911.9	14,601.7		9,618.9	4,391.3	14,010.1	-591.5	-253.7
18	14	2014		11,689.8	2,911.9	14,601.7		9,618.9	4,391.3	14,010.1	-591.5	-234.9
19	15	2015		11,689.8	2,911.9	14,601.7		9,618.9	4,391.3	14,010.1	-591.5	-217.5
20	16	2016		11,689.8	2,911.9	14,601.7		9,618.9	4,391.3	14,010.1	-591.5	-201.4
21	17	2017		11,689.8	2,911.9	14,601.7		9,618.9	4,391.3	14,010.1	-591.5	-186.5
22	18	2018		11,689.8	2,911.9	14,601.7		9,618.9	4,391.3	14,010.1	-591.5	-172.7
		TOTAL	46,160.4	175,346.9	43,678.0	265,185.3	61,067.9	144,283.0	65,869.2	271,220.1	6,034.8	9,293.1

N.P.V.	9,293.1
E.I.R.R.	N.A.
B/C	1.07

Sensitivity Analysis :
(Contracted Demand 10% Down)
Generation: 3,059.4TJ/a by Natural Gas
Generation: 3,245.9TJ/a by GSA System

Table 9.1.8 Economic Evaluation of Renovation of Existing Facilities

(Unit: 1,000 US$)

No.		Year	Proposed (Natural Gas) Construct. Cost	Proposed (Natural Gas) Fuel	Proposed (Natural Gas) O & M and Other Cost	(C) TOTAL COST	Alternative (PCF + FGD) Construct. Cost	Alternative (PCF + FGD) Fuel	Alternative (PCF + FGD) O & M and Other Cost	(B) TOTAL COST	(B) - (C)	Discouted Value (8%)
1		1997				-				-	-	-
2		1998				-				-	-	-
3		1999				-				-	-	-
4		2000				-				-	-	-
5	1	2001	11,957.0			11,957.0	13,965.9			13,965.9	2,008.9	2,008.9
6	2	2002	15,396.7			15,396.7	17,378.9			17,378.9	1,982.2	1,835.3
7	3	2003	18,222.4			18,222.4	23,486.3			23,486.3	5,263.9	4,512.9
8	4	2004	404.2	10,147.2	2,911.9	13,463.3	367.6	8,550.1	4,391.3	13,308.9	-154.4	-122.5
9	5	2005	180.1	10,147.2	2,911.9	13,239.1	5,869.2	8,550.1	4,391.3	18,810.6	5,571.4	4,095.2
10	6	2006		10,147.2	2,911.9	13,059.1		8,550.1	4,391.3	12,941.3	-117.7	-80.1
11	7	2007		10,147.2	2,911.9	13,059.1		8,550.1	4,391.3	12,941.3	-117.7	-74.2
12	8	2008		10,147.2	2,911.9	13,059.1		8,550.1	4,391.3	12,941.3	-117.7	-68.7
13	9	2009		10,147.2	2,911.9	13,059.1		8,550.1	4,391.3	12,941.3	-117.7	-63.6
14	10	2010		10,147.2	2,911.9	13,059.1		8,550.1	4,391.3	12,941.3	-117.7	-58.9
15	11	2011		10,147.2	2,911.9	13,059.1		8,550.1	4,391.3	12,941.3	-117.7	-54.5
16	12	2012		10,147.2	2,911.9	13,059.1		8,550.1	4,391.3	12,941.3	-117.7	-50.5
17	13	2013		10,147.2	2,911.9	13,059.1		8,550.1	4,391.3	12,941.3	-117.7	-46.8
18	14	2014		10,147.2	2,911.9	13,059.1		8,550.1	4,391.3	12,941.3	-117.7	-43.3
19	15	2015		10,147.2	2,911.9	13,059.1		8,550.1	4,391.3	12,941.3	-117.7	-40.1
20	16	2016		10,147.2	2,911.9	13,059.1		8,550.1	4,391.3	12,941.3	-117.7	-37.1
21	17	2017		10,147.2	2,911.9	13,059.1		8,550.1	4,391.3	12,941.3	-117.7	-34.4
22	18	2018		10,147.2	2,911.9	13,059.1		8,550.1	4,391.3	12,941.3	-117.7	-31.8
		TOTAL	46,160.4	152,208.2	43,678.0	242,046.7	61,067.9	128,250.9	65,869.2	255,188.0	13,141.3	11,789.1

N.P.V.	11,789.1
E.I.R.R.	N.A.
B/C	1.10

9.2 Financial Analysis

9.2.1 Methodology

The financial analysis of the project is made by using the following two methods:

(1) Financial Internal Rate of Return (FIRR)

As adopted in economic analysis, a discount rate which equalizes total sum of the discounted present value of revenue to total sum of the discounted present value of costs incurred during the whole service life of the project is calculated. In this project, the revenue comes from the sale of electricity generated by the New Unit with capacity of 150MW and sold to MVM, and heat energy produced by the existing facilities and sold to chemical companies and other manufactures and household near Borsod Power Station. The costs include the investment cost including customs duty, fuel cost, O&M cost, and other cost. For financial analysis, market prices are directly applied to calculating the costs and benefits.

Interests for the borrowing and depreciation cost are reckoned in to obtain operational result after interest and depreciation, but those two items are excluded when calculating FIRR and other indices.

(2) Profit and Loss Statement

The cash flow is developed with two-fold purposes; one for financial evaluation based on the indices, and the one for the profit and loss statement indicating net operating profit after deducting items such as depreciation of the fixed asset and financial cost (interest).

9.2.2 Assumptions for the Analysis

(1) Proposed Project

As analyzed in 9.2.6 Revenue Structure of Borsod Power Station, major portion of the revenue of Hungarian power stations come from fixed amount items like Capacity Charge, which is by contract with MVM irrespective of facility operation and volume of electricity and heat energy in the short run, except fuel charge and start charge which are compensated for actual cost. Fixed amount items in the contract with MVM should cover the normal operation expenses of both New Unit and Existing Facilities. Therefore, it is not appropriate to separate the two projects and to carry out analysis as in economic analysis; the proposed project in this financial analysis should cover the entire power station, combining the operation of New Unit and Existing Facilities.

(2) Construction Cost and Annual Disbursement Plan

The prices of the items of revenue and cost in this analysis is quoted at the beginning of 1997. Customs duties are included in the prices of imported goods.

Year	150MW New Unit		Existing Facilities		Total
	(%)	(1,000 US$)	(%)	(1,000 US$)	(1,000 US$)
1st Year(1997/2001)	0.40	620.9	25.61	11,991.8	12,612.7
2nd Year(1998/2002)	18.98	29,603.9	33.63	15,745.7	45,349.6
3rd Year(1999/2003)	42.10	65,658.8	39.49	18,490.0	84,148.8
4th Year(2000/2004)	29.72	46,351.0	0.86	404.2	46,755.2
5th Year(2001/2005)	8.80	13,722.8	0.40	186.3	13,909.1
Total	100.00	155,957.4	100.00	46,818.0	202,775.4
(Direct Construction Cost)		135,884.1		39,700.7	175,584.9

(3) Financing Source

The same ratio as the feasibility study by EGI Rt. between own fund and borrowing is adopted, which is 30 : 70. Regarding the use of the proceeds of the loan the assumption is made that own funds will be used in the beginning period of the investment until they are exhausted and then the investment will be financed using the loans. Conditions for borrowing and repayment schedule is assumed on the premise that all necessary funds including foreign and domestic portions are procured from international financial organizations.

(Unit: thousand US$)

	Total	Own Fund (30%)	Loan (70%)
150 MW Unit	155,957.4	46,787.2	109,170.2
Existing 4 Boilers	46,818.0	14,045.4	32,772.6
Total	202,775.4	60,832.6	141,942.8

Borrowings should be sought at lowest possible interest rate, with longest possible period of grace and repayment. In this analysis an un-tied loan from the Export-Import of Japan is employed. Details of the borrowings are as follows:

a) Borrowing Schedule

Year	150MW New Unit	Existing Facilities	Total
	(1,000 US$)	(1,000 US$)	(1,000 US$)
1st Year(1997/2001)	0.0	0.0	0.0
2nd Year(1998/2002)	0.0	13,692.1	13,692.1
3rd Year(1999/2003)	49,096.4	18,490.0	67,586.4
4th Year(2000/2004)	46,351.0	404.2	46,755.2
5th Year(2001/2005)	13,722.8	186.3	13,909.1
Total	109,170.2	32,772.6	141,942.8

b) Interest : 8.2%p.a.

(Applicable as of March 3, 1997. Interest rate of the Japanese Government fiscal investment and loan program (3.1%)+ 0.2% + handling commission and other charges of the Government and lending bank(5.0%):
Exchange risk born by end-borrower)

c) Loan period: 13~15 years

d) Grace period: 3~5 years

e) Repayment period: 10 years

(4) Foreign Exchange Rates Applied

The exchange rates used in the calculation of the price of imported materials are as follows:

HUF/US$: 161.06 HUF/US$
HUF/¥ : 138.86 HUF/100 ¥
Yen/US$: 116.65 Yen/US$

HUF rates against foreign currencies are Official Medium Rates quoted on January 2, 1997 by National Bank of Hungary, except Yen/US$ rate, which is quoted on January 6, 1997 by the Bank of Tokyo-Mitsubishi, Tokyo. In case goods and services are initially denominated in other foreign currencies such as SFr , DM, they are arbitrated to be US$-priced based on the above Official Medium Rates.

(5) Other Operation Cost

Same percentages as assumed in the economic analysis are employed to fuel cost, O & M cost, direct labor cost, and other operation cost.

Straight-line method is employed assuming that residual value is zero, and that durable service life is same as the project life, which is 25 years for the New Unit and 15 year for the Existing Facilities.

(6) Benefits

1) Electricity Tariff

As detailed in Section 9.2.6, MVM purchases 100% of the electricity generated by Borsod Power Station in accordance with the PPA. The contracted revenue is composed of fixed sum portion such as capacity charge, contracted mining charge and variable sum portion such as fuel charge, start charge.

The purpose of the financial analysis is evaluate the amount or the level of profit earned through the investment for entire period life under certain conditions. Therefore, a revenue which can be earned irrespective of "With Project" or " Without Project" must be excluded from the benefit of the project.

In this analysis an average electricity tariff is used. This tariff is calculated by dividing total sales amount for a year paid by MVM by yearly total generation volume. According to the data obtained from the Power Station the scheduled tariff for year 1997 was 17.1 HUF/kWh against their generation of 327GWh for the year.

But using scheduled revenue amount effective from the beginning of April 1997 provided in Magyar Közlöny, 14.93 HUF/kWh is calculated and employed for this analysis against the generation of 822 GWh/a.

2) Heat Energy Price

Also as detailed in Section 9.2.6, the power station has adopted the average heat price, 897.79 HUF/GJ, for year 1997. This tariff is also employed is this analysis.

9.2.3 Profit and Loss Statement

Net operating profits after deduction of interests on borrowing and depreciation of the fixed asset are calculated on the same cash flow sheets in all cases.

9.2.4 Result of the Financial Analysis

Financial indices of NPV, FIRR, and B/C ratio are calculated on the relevant cash flow.

	NPV(thousand US$)	FIRR(%)	B/C	Table
Base Case	185,297.5	17.4	1.37	9.2.1

The FIRR at 17.4% is well over the interest rate (8.2%) applied to the borrowing from the financial institution and the target profit level which is currently set at 8.0% by MVM. With all the indices calculated in consideration, the project is regarded as financially feasible and attractive.

9.2.5 Sensitivity Analysis

The sensitivity of the proposed project is analyzed under the following conditions; the results are summarized in Table 9.2.2~9.2.4.

- Construction cost increased by 10%
- Fuel cost increased by 10%
- Both construction cost and fuel cost increased by 10%

	NPV(thousand US$)	FIRR(%)	B/C	Table
Construction Cost 10% Up	160,631.6	15.7	1.31	9.2.2
Fuel Cost 10% Up	162,990.5	16.4	1.31	9.2.3
Construction Cost and Fuel Cost 10% Up	138,324.6	14.7	1.25	9.2.4

In addition to the analyses of the sensitivity to cost factors, sensitivity to revenue factors are analyzed. The results are as follows:

	NPV(thousand US$)	FIRR(%)	B/C
Electricity Tariff 10% Down	125,510.4	14.7	1.25
Heat Energy Price 10% Down	176,938.8	17.1	1.36
Electricity Tariff and Heat Energy Price 10% Down	117,151.7	14.3	1.24

FIRR in the case of electricity tariff 10% down is 14.7%, which is the same as that in the case of 10 % up of both the construction cost and fuel cost. This indicates that the project is fairly sensitive to the change of the electricity tariff.

The break-even point of the electricity tariff which balances the revenue and the cost after deduction of interest and depreciation is 10.3 HUF/kWh (0.06 US$/kWh). This is about 70% of 14.93 HUF/kWh(0.09 US$/kWh), the tariff rate applied to estimate the revenue from electricity sales in this analysis. As the revenue from heat energy sales has been and will be quite stable, the project would be financially profitable until the electricity tariff is reduced by more than 30%. Even in the case that the electricity tariff is reduced a little more than 20% from the adopted rate, the project could expect 8% return at net operating profit.

Table 9.2.1 Financial Evaluation

[Base Case]

(Unit: 1,000 US$)

No.	Year	Cost: Construction Cost	Cost: Fuel & Limestone	Cost: O & M and Other Cost	Cost: (C) Total Cost	Cost: Payment of Interest	Cost: Depreciation	Benefit: Electricity	Benefit: Steam and Hot Water	Benefit: (B) Total Benefit	(B) - (C) Operating Result	After Int. & Depreciation
1	1997	620.9		566.7	1,187.6	-				-	-1,187.6	-1,187.6
2	1998	29,603.9			29,603.9	-				-	-29,603.9	-29,603.9
3	1999	65,658.8			65,658.8	4,025.9				-	-65,658.8	-69,684.7
4	2000	46,351.0			46,351.0	7,826.7				-	-46,351.0	-54,177.7
5 1	2001	25,714.6			25,714.6	8,952.0				-	-25,714.6	-34,666.6
6 2	2002	15,745.7	23,043.3	12,482.4	51,271.4	10,074.7	6,238.3	76,198.1		76,198.1	24,926.7	8,613.7
7 3	2003	18,490.0	23,043.3	13,041.6	54,574.9	11,590.9	6,238.3	76,198.1		76,198.1	21,623.1	3,794.0
8 4	2004	404.2	33,670.4	12,482.4	46,557.0	11,221.4	9,359.5	76,198.1	15,496.4	91,694.5	45,137.5	24,556.6
9 5	2005	186.3	33,670.4	12,482.4	46,339.0	10,454.1	9,359.5	76,198.1	15,496.4	91,694.5	45,355.5	25,541.9
10 6	2006		33,670.4	12,482.4	46,152.8	9,558.9	9,359.5	76,198.1	15,496.4	91,694.5	45,541.7	26,623.4
11 7	2007		33,670.4	12,482.4	46,152.8	8,551.4	9,359.5	76,198.1	15,496.4	91,694.5	45,541.7	27,630.8
12 8	2008		33,670.4	12,482.4	46,152.8	7,392.3	9,359.5	76,198.1	15,496.4	91,694.5	45,541.7	28,789.9
13 9	2009		33,670.4	13,041.6	46,712.0	6,229.9	9,359.5	76,198.1	15,496.4	91,694.5	44,982.5	29,393.1
14 10	2010		33,670.4	12,482.4	46,152.8	5,066.0	9,359.5	76,198.1	15,496.4	91,694.5	45,541.7	31,116.3
15 11	2011		33,670.4	12,482.4	46,152.8	3,902.0	9,359.5	76,198.1	15,496.4	91,694.5	45,541.7	32,280.2
16 12	2012		33,670.4	12,482.4	46,152.8	2,738.1	9,359.5	76,198.1	15,496.4	91,694.5	45,541.7	33,444.1
17 13	2013		33,670.4	12,482.4	46,152.8	1,574.2	9,359.5	76,198.1	15,496.4	91,694.5	45,541.7	34,608.1
18 14	2014		33,670.4	12,482.4	46,152.8	812.8	9,359.5	76,198.1	15,496.4	91,694.5	45,541.7	35,369.4
19 15	2015		33,670.4	13,041.6	46,712.0	431.6	9,359.5	76,198.1	15,496.4	91,694.5	44,982.5	35,191.4
20 16	2016		33,670.4	12,482.4	46,152.8	162.8	9,359.5	76,198.1	15,496.4	91,694.5	45,541.7	36,019.4
21 17	2017		33,670.4	12,482.4	46,152.8	6.4	9,359.5	76,198.1	15,496.4	91,694.5	45,541.7	36,175.9
22 18	2018		33,670.4	12,482.4	46,152.8	1.5	9,359.5	76,198.1	15,496.4	91,694.5	45,541.7	36,180.7
23	2019		23,043.3	8,979.1	32,022.4	-	6,238.3	76,198.1		76,198.1	44,175.6	37,937.3
24	2020		23,043.3	8,979.1	32,022.4	-	6,238.3	76,198.1		76,198.1	44,175.6	37,937.3
25	2021		23,043.3	9,538.4	32,581.7	-	6,238.3	76,198.1		76,198.1	43,616.4	37,378.1
26	2022		23,043.3	8,979.1	32,022.4	-	6,238.3	76,198.1		76,198.1	44,175.6	37,937.3
27	2023		23,043.3	8,979.1	32,022.4	-	6,238.3	76,198.1		76,198.1	44,175.6	37,937.3
28	2024		23,043.3	8,979.1	32,022.4	-	6,238.3	76,198.1		76,198.1	44,175.6	37,937.3
29	2025		23,043.3	8,979.1	32,022.4	-	6,238.3	76,198.1		76,198.1	44,175.6	37,937.3
30	2026		23,043.3	8,979.1	32,022.4	-	6,238.3	76,198.1		76,198.1	44,175.6	37,937.3
	TOTAL	167,949.2	735,488.5	286,837.6	1,225,101.5	110,573.5	202,775.4	1,904,951.6	232,446.6	2,137,398.1	912,296.7	598,947.8
				N.P.V. Total	496,160.4				N.P.V. Total	681,457.9		

N.P.V.	185,297.5
F.I.R.R.	17.4%
B/C	1.37

[Sensitivity Analysis 1]
Construction Cost 10% Up

Table 9.2.2 Financial Evaluation

(Unit: 1,000 US$)

No.		Year	Cost						Benefit				
			Construction Cost	Fuel & Limestone	O & M and Other Cost	(C) Total Cost	Payment of Interest	Depreciation	Electricity	Steam and Hot Water	(B) Total Benefit	(B) - (C) Operating Result	After Int. & Depreciation
1		1997	683.0		566.7	1,249.6	-				-	-1,249.6	-1,249.6
2		1998	32,564.3			32,564.3	-				-	-32,564.3	-32,564.3
3		1999	72,224.6			72,224.6	4,025.9				-	-72,224.6	-76,250.5
4		2000	50,986.2			50,986.2	7,826.7				-	-50,986.2	-58,812.8
5	1	2001	28,286.1			28,286.1	8,952.0				-	-28,286.1	-37,238.1
6	2	2002	17,320.3	23,043.3	13,595.5	53,959.0	10,187.0	6,862.1	76,198.1		76,198.1	22,239.1	5,189.9
7	3	2003	20,339.0	23,043.3	14,154.7	57,537.0	11,854.8	6,862.1	76,198.1		76,198.1	18,661.1	-55.8
8	4	2004	444.6	33,670.4	13,595.5	47,710.5	11,488.7	10,295.4	76,198.1	15,496.4	91,694.5	43,984.0	22,199.9
9	5	2005	204.9	33,670.4	13,595.5	47,470.7	10,722.8	10,295.4	76,198.1	15,496.4	91,694.5	44,223.8	23,205.5
10	6	2006		33,670.4	13,595.5	47,265.8	9,827.6	10,295.4	76,198.1	15,496.4	91,694.5	44,428.7	24,305.6
11	7	2007		33,670.4	13,595.5	47,265.8	8,808.9	10,295.4	76,198.1	15,496.4	91,694.5	44,428.7	25,324.3
12	8	2008		33,670.4	13,595.5	47,265.8	7,623.4	10,295.4	76,198.1	15,496.4	91,694.5	44,428.7	26,509.8
13	9	2009		33,670.4	14,154.7	47,825.1	6,434.3	10,295.4	76,198.1	15,496.4	91,694.5	43,869.4	27,139.7
14	10	2010		33,670.4	13,595.5	47,265.8	5,243.5	10,295.4	76,198.1	15,496.4	91,694.5	44,428.7	28,889.7
15	11	2011		33,670.4	13,595.5	47,265.8	4,052.7	10,295.4	76,198.1	15,496.4	91,694.5	44,428.7	30,080.5
16	12	2012		33,670.4	13,595.5	47,265.8	2,861.9	10,295.4	76,198.1	15,496.4	91,694.5	44,428.7	31,271.3
17	13	2013		33,670.4	13,595.5	47,265.8	1,671.1	10,295.4	76,198.1	15,496.4	91,694.5	44,428.7	32,462.1
18	14	2014		33,670.4	13,595.5	47,265.8	882.9	10,295.4	76,198.1	15,496.4	91,694.5	44,428.7	33,250.4
19	15	2015		33,670.4	14,154.7	47,825.1	474.7	10,295.4	76,198.1	15,496.4	91,694.5	43,869.4	33,099.3
20	16	2016		33,670.4	13,595.5	47,265.8	179.1	10,295.4	76,198.1	15,496.4	91,694.5	44,428.7	33,954.1
21	17	2017		33,670.4	13,595.5	47,265.8	7.0	10,295.4	76,198.1	15,496.4	91,694.5	44,428.7	34,126.2
22	18	2018		33,670.4	13,595.5	47,265.8	1.7	10,295.4	76,198.1	15,496.4	91,694.5	44,428.7	34,131.5
23		2019		23,043.3	9,794.5	32,837.7	-	6,862.1	76,198.1		76,198.1	43,360.3	36,498.2
24		2020		23,043.3	9,794.5	32,837.7	-	6,862.1	76,198.1		76,198.1	43,360.3	36,498.2
25		2021		23,043.3	10,353.7	33,397.0	-	6,862.1	76,198.1		76,198.1	42,801.1	35,939.0
26		2022		23,043.3	9,794.5	32,837.7	-	6,862.1	76,198.1		76,198.1	43,360.3	36,498.2
27		2023		23,043.3	9,794.5	32,837.7	-	6,862.1	76,198.1		76,198.1	43,360.3	36,498.2
28		2024		23,043.3	9,794.5	32,837.7	-	6,862.1	76,198.1		76,198.1	43,360.3	36,498.2
29		2025		23,043.3	9,794.5	32,837.7	-	6,862.1	76,198.1		76,198.1	43,360.3	36,498.2
30		2026		23,043.3	9,794.5	32,837.7	-	6,862.1	76,198.1		76,198.1	43,360.3	36,498.2
		TOTAL	223,052.9	735,488.5	312,282.1	1,270,823.5	113,126.5	223,052.9	1,904,951.6	232,446.6	2,137,398.1	866,574.7	530,395.3
					N.P.V. Total	520,826.3				N.P.V. Total	681,457.9		

N.P.V.	160,631.6
F.I.R.R.	15.7%
B/C	1.31

Table 9.2.3 Financial Evaluation

[Sensitivity Analysis 2]
Fuel Cost 10% Up

(Unit: 1,000 US$)

No.	Year	Cost						Benefit				
		Construct-ion Cost	Fuel & Limestone	O & M and Other Cost	(C) Total Cost	Payment of Interest	Depreci-ation	Electricity	Steam and Hot Water	(B) Total Bene-fit	(B) - (C) Operating Result	After Int. & Depre-ciation
1	1997	620.9		566.7	1,187.6	-				-	-1,187.6	-1,187.6
2	1998	29,603.9			29,603.9	-				-	-29,603.9	-29,603.9
3	1999	65,658.8			65,658.8	4,025.9				-	-65,658.8	-69,684.7
4	2000	46,351.0			46,351.0	7,826.7				-	-46,351.0	-54,177.7
5 1	2001	25,714.6			25,714.6	8,952.0				-	-25,714.6	-34,666.6
6 2	2002	15,745.7	25,155.7	12,482.4	53,383.8	10,074.7	6,238.3	76,198.1		76,198.1	22,814.2	6,501.2
7 3	2003	18,490.0	25,155.7	13,041.6	56,687.4	11,590.9	6,238.3	76,198.1		76,198.1	19,510.7	1,681.5
8 4	2004	404.2	36,845.5	12,482.4	49,732.1	11,221.4	9,359.5	76,198.1	15,496.4	91,694.5	41,962.4	21,381.4
9 5	2005	186.3	36,845.5	12,482.4	49,514.2	10,454.1	9,359.5	76,198.1	15,496.4	91,694.5	42,180.3	22,366.8
10 6	2006		36,845.5	12,482.4	49,327.9	9,558.9	9,359.5	76,198.1	15,496.4	91,694.5	42,366.6	23,448.2
11 7	2007		36,845.5	12,482.4	49,327.9	8,551.4	9,359.5	76,198.1	15,496.4	91,694.5	42,366.6	24,455.7
12 8	2008		36,845.5	12,482.4	49,327.9	7,392.3	9,359.5	76,198.1	15,496.4	91,694.5	42,366.6	25,614.8
13 9	2009		36,845.5	13,041.6	49,887.1	6,229.9	9,359.5	76,198.1	15,496.4	91,694.5	41,807.4	26,218.0
14 10	2010		36,845.5	12,482.4	49,327.9	5,066.0	9,359.5	76,198.1	15,496.4	91,694.5	42,366.6	27,941.1
15 11	2011		36,845.5	12,482.4	49,327.9	3,902.0	9,359.5	76,198.1	15,496.4	91,694.5	42,366.6	29,105.0
16 12	2012		36,845.5	12,482.4	49,327.9	2,738.1	9,359.5	76,198.1	15,496.4	91,694.5	42,366.6	30,269.0
17 13	2013		36,845.5	12,482.4	49,327.9	1,574.2	9,359.5	76,198.1	15,496.4	91,694.5	42,366.6	31,432.9
18 14	2014		36,845.5	12,482.4	49,327.9	812.8	9,359.5	76,198.1	15,496.4	91,694.5	42,366.6	32,194.3
19 15	2015		36,845.5	13,041.6	49,887.1	431.6	9,359.5	76,198.1	15,496.4	91,694.5	41,807.4	32,016.3
20 16	2016		36,845.5	12,482.4	49,327.9	162.8	9,359.5	76,198.1	15,496.4	91,694.5	42,366.6	32,844.2
21 17	2017		36,845.5	12,482.4	49,327.9	6.4	9,359.5	76,198.1	15,496.4	91,694.5	42,366.6	33,000.7
22 18	2018		36,845.5	12,482.4	49,327.9	1.5	9,359.5	76,198.1	15,496.4	91,694.5	42,366.6	33,005.6
23	2019		25,155.7	8,979.1	34,134.9	-	6,238.3	76,198.1		76,198.1	42,063.2	35,824.9
24	2020		25,155.7	8,979.1	34,134.9	-	6,238.3	76,198.1		76,198.1	42,063.2	35,824.9
25	2021		25,155.7	9,538.4	34,694.1	-	6,238.3	76,198.1		76,198.1	41,504.0	35,265.7
26	2022		25,155.7	8,979.1	34,134.9	-	6,238.3	76,198.1		76,198.1	42,063.2	35,824.9
27	2023		25,155.7	8,979.1	34,134.9	-	6,238.3	76,198.1		76,198.1	42,063.2	35,824.9
28	2024		25,155.7	8,979.1	34,134.9	-	6,238.3	76,198.1		76,198.1	42,063.2	35,824.9
29	2025		25,155.7	8,979.1	34,134.9	-	6,238.3	76,198.1		76,198.1	42,063.2	35,824.9
30	2026		25,155.7	8,979.1	34,134.9	-	6,238.3	76,198.1		76,198.1	42,063.2	35,824.9
	TOTAL	202,775.4	804,240.2	286,837.6	1,293,853.2	110,573.5	202,775.4	1,904,951.6	232,446.6	2,137,398.1	843,545.0	530,196.1
				N.P.V. Total	518,467.4				N.P.V. Total	681,457.9		

N.P.V.	162,990.5
F.I.R.R.	16.4%
B/C	1.31

Table 9.2.4 Financial Evaluation

[Sensitivity Analysis 3]
Construction Cost and Fuel Cost 10% Up

(Unit: 1,000 US$)

No.	Year	Cost: Construction Cost	Cost: Fuel & Limestone	Cost: O & M and Other Cost	Cost: (C) Total Cost	Cost: Payment of Interest	Cost: Depreciation	Benefit: Electricity	Benefit: Steam and Hot Water	Benefit: (B) Total Benefit	(B) - (C) Operating Result	After Int. & Depreciation
1	1997	683.0		566.7	1,249.6	-				-	-1,249.6	-1,249.6
2	1998	32,564.3			32,564.3	-				-	-32,564.3	-32,564.3
3	1999	72,224.6			72,224.6	4,025.9				-	-72,224.6	-76,250.5
4	2000	50,986.2			50,986.2	7,826.7				-	-50,986.2	-58,812.8
5 1	2001	28,286.1			28,286.1	8,952.0				-	-28,286.1	-37,238.1
6 2	2002	17,320.3	25,155.7	13,595.5	56,071.5	10,187.0	6,862.1	76,198.1		76,198.1	20,126.6	3,077.5
7 3	2003	20,339.0	25,155.7	14,154.7	59,649.4	11,854.8	6,862.1	76,198.1		76,198.1	16,548.6	-2,168.3
8 4	2004	444.6	36,845.5	13,595.5	50,885.6	11,488.7	10,295.4	76,198.1	15,496.4	91,694.5	40,808.9	19,024.8
9 5	2005	204.9	36,845.5	13,595.5	50,645.9	10,722.8	10,295.4	76,198.1	15,496.4	91,694.5	41,048.6	20,030.4
10 6	2006		36,845.5	13,595.5	50,441.0	9,827.6	10,295.4	76,198.1	15,496.4	91,694.5	41,253.5	21,130.5
11 7	2007		36,845.5	13,595.5	50,441.0	8,808.9	10,295.4	76,198.1	15,496.4	91,694.5	41,253.5	22,149.2
12 8	2008		36,845.5	13,595.5	50,441.0	7,623.4	10,295.4	76,198.1	15,496.4	91,694.5	41,253.5	23,334.7
13 9	2009		36,845.5	14,154.7	51,000.2	6,434.3	10,295.4	76,198.1	15,496.4	91,694.5	40,694.3	23,964.6
14 10	2010		36,845.5	13,595.5	50,441.0	5,243.5	10,295.4	76,198.1	15,496.4	91,694.5	41,253.5	25,714.6
15 11	2011		36,845.5	13,595.5	50,441.0	4,052.7	10,295.4	76,198.1	15,496.4	91,694.5	41,253.5	26,905.4
16 12	2012		36,845.5	13,595.5	50,441.0	2,861.9	10,295.4	76,198.1	15,496.4	91,694.5	41,253.5	28,096.2
17 13	2013		36,845.5	13,595.5	50,441.0	1,671.1	10,295.4	76,198.1	15,496.4	91,694.5	41,253.5	29,287.0
18 14	2014		36,845.5	13,595.5	50,441.0	882.9	10,295.4	76,198.1	15,496.4	91,694.5	41,253.5	30,075.2
19 15	2015		36,845.5	14,154.7	51,000.2	474.7	10,295.4	76,198.1	15,496.4	91,694.5	40,694.3	29,924.1
20 16	2016		36,845.5	13,595.5	50,441.0	179.1	10,295.4	76,198.1	15,496.4	91,694.5	41,253.5	30,779.0
21 17	2017		36,845.5	13,595.5	50,441.0	7.0	10,295.4	76,198.1	15,496.4	91,694.5	41,253.5	30,951.1
22 18	2018		36,845.5	13,595.5	50,441.0	1.7	10,295.4	76,198.1	15,496.4	91,694.5	41,253.5	30,956.4
23	2019		25,155.7	9,794.5	34,950.2	-	6,862.1	76,198.1		76,198.1	41,247.9	34,385.7
24	2020		25,155.7	9,794.5	34,950.2	-	6,862.1	76,198.1		76,198.1	41,247.9	34,385.7
25	2021		25,155.7	10,353.7	35,509.4	-	6,862.1	76,198.1		76,198.1	40,688.7	33,826.5
26	2022		25,155.7	9,794.5	34,950.2	-	6,862.1	76,198.1		76,198.1	41,247.9	34,385.7
27	2023		25,155.7	9,794.5	34,950.2	-	6,862.1	76,198.1		76,198.1	41,247.9	34,385.7
28	2024		25,155.7	9,794.5	34,950.2	-	6,862.1	76,198.1		76,198.1	41,247.9	34,385.7
29	2025		25,155.7	9,794.5	34,950.2	-	6,862.1	76,198.1		76,198.1	41,247.9	34,385.7
30	2026		25,155.7	9,794.5	34,950.2	-	6,862.1	76,198.1		76,198.1	41,247.9	34,385.7
	TOTAL	223,052.9	804,240.2	312,282.1	1,339,575.2	113,126.5	223,052.9	1,904,951.6	232,446.6	2,137,398.1	797,823.0	461,643.6
				N.P.V. Total	543,133.2				N.P.V. Total	681,457.9		-

N.P.V.	138,324.6
F.I.R.R.	14.7%
B/C	1.25

Table 9.2.5 Borrowing/Repayment Schedule and Financial Cost

(Unit: 1,000 US$)

No.		Year	Borrowing (beginning)	Repayment (end)	Balance of Borrowing	Payment of Interest
1		1997	-		-	-
2		1998	-		-	-
3		1999	49,096.4		49,096.4	4,025.9
4		2000	46,351.0		95,447.4	7,826.7
5		2001	13,722.8		109,170.3	8,952.0
6	1	2002	13,692.1		122,862.4	10,074.7
7	2	2003	18,490.0	4,909.6	136,442.8	11,590.9
8	3	2004	404.2	9,544.7	127,302.2	11,221.4
9	4	2005	186.3	10,917.0	116,571.4	10,454.1
10	5	2006		12,286.2	104,285.2	9,558.9
11	6	2007		14,135.2	90,150.0	8,551.4
12	7	2008		14,175.7	75,974.3	7,392.3
13	8	2009		14,194.3	61,780.0	6,229.9
14	9	2010		14,194.3	47,585.7	5,066.0
15	10	2011		14,194.3	33,391.4	3,902.0
16	11	2012		14,194.3	19,197.2	2,738.1
17	12	2013		9,284.6	9,912.5	1,574.2
18	13	2014		4,649.5	5,263.0	812.8
19	14	2015		3,277.3	1,985.7	431.6
20	15	2016		1,908.0	77.7	162.8
21	16	2017		59.0	18.6	6.4
22	17	2018		18.6	0.0	1.5
23	18	2019				
24	19	2020				
25	20	2021				
26	21	2022				
27	22	2023				
28	23	2024				
29	24	2025				
30	25	2026				
		TOTAL	141,942.9	141,942.9		110,573.5

9.2.6 Revenue Structure of Borsod Power Plant

(1) Premises

MVM Rt. had taken practically sole responsibility of generation and transmission in Hungarian power sector till 1995. (98.6% of generation and 92.35% of transmission in 1995 record.) As privatization of Hungarian power sector proceeds, 4 power stations out of 7 owned and managed by MVM Rt. had been sold to private sector by the end of 1996. Transmission still remains entirely in MVM's competency.

Hungarian government promulgated a new basic law on energy sector, Law No.48 by IKIM dated May 7, 1994, which became the basis of various measures and laws effected to put energy related prices in fair market mechanism. The IKIM Law (No.55/1996) was promulgated on December 20, 1996 and made effective from January 1, 1997 as general provisions on energy prices, which changed not only energy prices in general drastically, but also wholly changed the revenue structure of Hungarian power stations. Another IKIM Law (No.26/1997) was issued on March 24, 1997 and was made effective from April 1, 1997 to give another revision of energy prices. This law is the basis of this financial analysis.

Detailed view and explanation of current revenue components of Borsod Power Station is given in the sections to follow. It is summarized in a word that under the current revenue structure, only a fraction is dependent on the facility operation, but the majority is separate, at least for the contracted term, from the volume of electricity sales to MVM Rt.

Following sections are devoted to the analysis of the revenue structure of Borsod Power Plant. Having faced with constraints that most of the data are prepared in Hungarian language, a part of the analysis is based on the stated information provided by the staff of the power station.

(2) Revenue from Electricity Sales

As stated above, Hungarian power stations are connected to MVM Rt. through national transmission network to sell their electricity based on the Power Purchase Agreement (PPA) with MVM Rt. Amount and/or unit price of each component of the revenue is provided in the latest IKIM Law effective from April 1, 1997. Note should taken that the amount has been periodically reviewed and might be revised in the future. Based on this law the unit electricity price, 14.93 HUF/kWh, is calculated, then multiplied by the generation volume of the new 150MW unit, the total sales amount is calculated. It is shown below. Detailed explanation of each component is provided later in this section.

Revenue Components of Borsod Power Plant, and its Tentative Calculation

The following amounts and unit prices have been decided based on the existing facilities of the power station; as stated above they have been provided in the latest IKIM Law and made effective from April 1, 1997.

(Fixed Amount Portion)

① Capacity Charge Rate : 42.340 million HUF/MW/year
② Contracted Mining Capacity Charge : 2,313.0 million HUF/year

(Variable Amount Portion)

③ Cold Start Charge : 0.086 million/start
④ Energy Charge : 2.06 HUF/kWh

Tentative calculation to estimate the total revenue and average electricity tariff for this financial analysis is proceeded as follows:

(Fixed Amount Portion)

① Capacity Charge = capacity charge rate x condensing capacity tied up
= 42.340 MHUF/MW/year x 137.0 MW = 5,800.58 MHUF/year *[1]

② Contracted Mining Capacity Charge Rate
= 2,313.0 million HUF/year / 66.3 MW *[2] = 34.886877 MHUF/MW/year

Contracted Mining Capacity Charge adjusted to new 150MW CFBC unit *[3]
= 34.886877 MHUF/MW/year x 137 MW = 4,779.502 MHUF/year

(Variable Amount Portion)

③ Cold Start Charge = cold start fee rate x number of start expected
= 0.086 million/start x 5 times/year = 2.06 MHUF/year

④ Energy Charge = energy fee rate x expected electricity production
= 2.06 HUF/kWh x 822 GWh *[4] = 1,693.32 MHUF/year

Total Revenue = ① + ② + ③ + ④ = 12,273.832 MHUF/year
Average electricity tariff = total revenue / expected electricity production
= 12,273.832 MHUF/year / 822 GWh = 14.93 HUF/kWh

(Note) *1: While generating capacity of new unit with CFBC boilers is 150MW at generator end, the capacity is 137MW at sending end.

*2: The generating capacity of the existing facilities at sending end.

*3: Contracted Mining Capacity Charge should increase in proportion to the increase of generating capacity.

*4: While annual generation volume of the existing facilities is 327GWh; projected generation volume of the proposed new unit is 822 GWh.

The above composition is illustrated more clearly by the following figure.

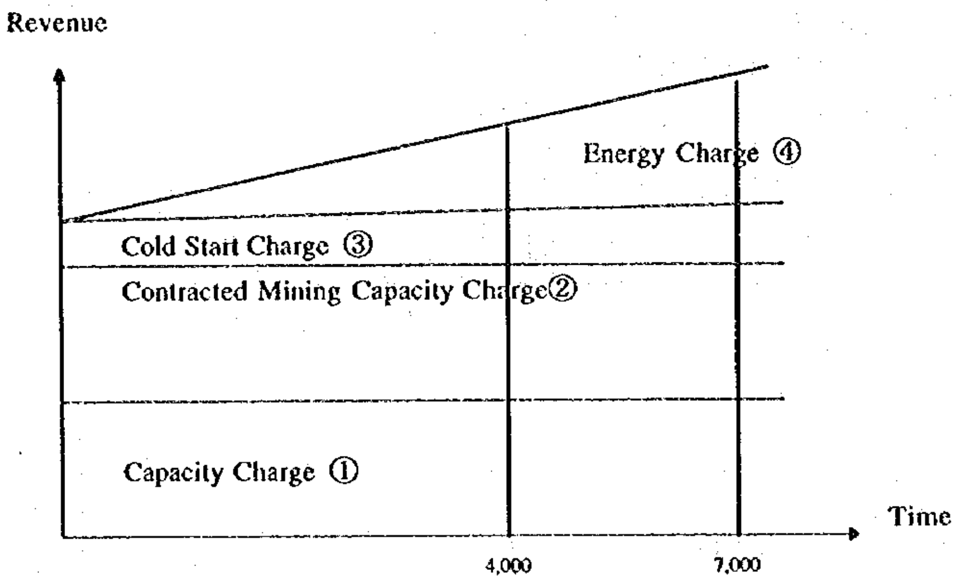


Figure 9.2.1 Revenue Structure from Electricity Sales

(3) Revenue from Heat Energy Sales

The following Table 9.2.6 is built based on the record of heat energy sales of 1994～1996 and forecast of 1997, the data collected from the power station.

Table 9.2.6 Sales Volume of Heat Energy

	1994		1995		1996		1997 (forecast)	
	Calorie (GJ)	10^3HUF	Heat (GJ)	10^3HUF	Heat (GJ)	10^3HUF	Heat (GJ)	10^3HUF
Steam 29 bar	1,980,157	672,914	1,831,386	869,537	1,798,388	1,020,456	1,804,600	1,253,370
Steam 15 bar	44,157	13,247	51,898	23,180	88,860	47,563	115,500	78,540
Steam 6 bar	123,392	34,550	154,950	61,941	220,094	109,830	225,000	146,251
Sub-total	2,147,706	720,711	2,038,234	954,658	2,107,342	1,177,849	2,145,100	1,478,161
Heat	623,423	155,856	615,209	224,761	633,908	297,701	599,100	356,952
Total	2,771,129	876,567	2,653,443	1,179,419	2,741,250	1,475,550	2,744,200	1,835,113

The trends of sales volume and amount by bar of steam heat covering four years are illustrated in the following figures.

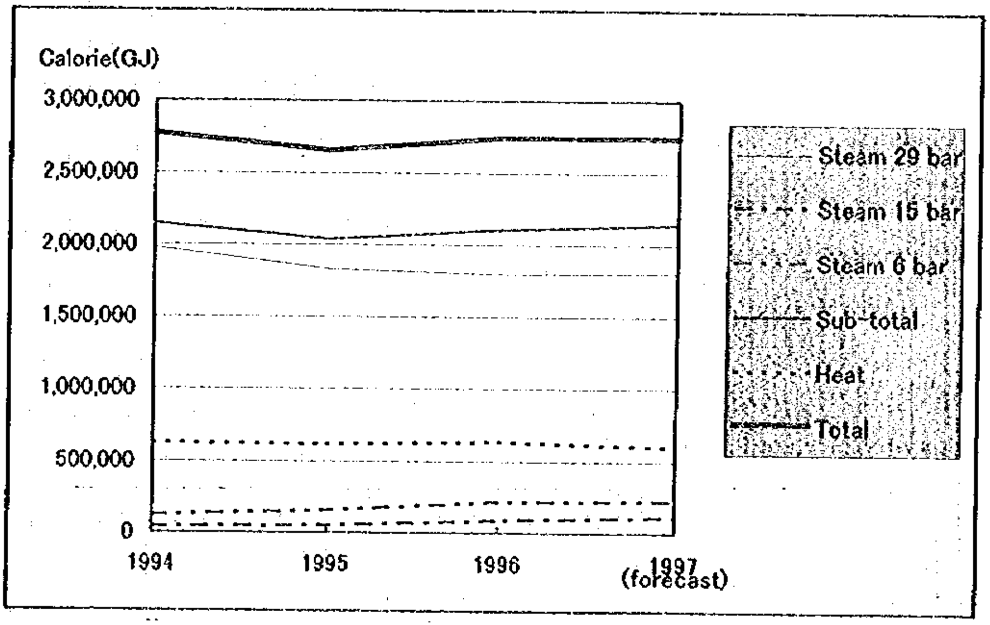


Figure 9.2.2 Trend of Sales Volume of Heat Energy

Table 9.2.6 Sales Volume of Heat Energy

	1994		1995		1996		1997 (forecast)	
	Calorie (GJ)	10^3HUF	Heat (GJ)	10^3HUF	Heat (GJ)	10^3HUF	Heat (GJ)	10^3HUF
Steam 29 bar	1,980,157	672,914	1,831,386	869,537	1,798,388	1,020,456	1,804,600	1,253,370
Steam 15 bar	44,157	13,247	51,898	23,180	88,860	47,563	115,500	78,540
Steam 6 bar	123,392	34,550	154,950	61,941	220,094	109,830	225,000	146,251
Sub-total	2,147,706	720,711	2,038,234	954,658	2,107,342	1,177,849	2,145,100	1,478,161
Heat	623,423	155,856	615,209	224,761	633,908	297,701	599,100	356,952
Total	2,771,129	876,567	2,653,443	1,179,419	2,741,250	1,475,550	2,744,200	1,835,113

The trends of sales volume and amount by bar of steam heat covering four years are illustrated in the following figures.

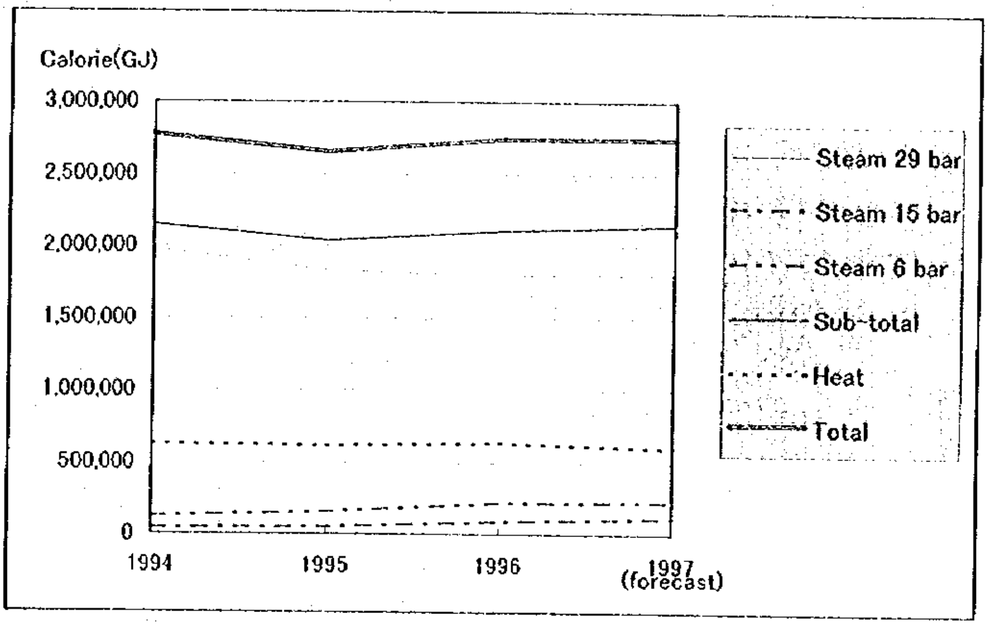


Figure 9.2.2 Trend of Sales Volume of Heat Energy

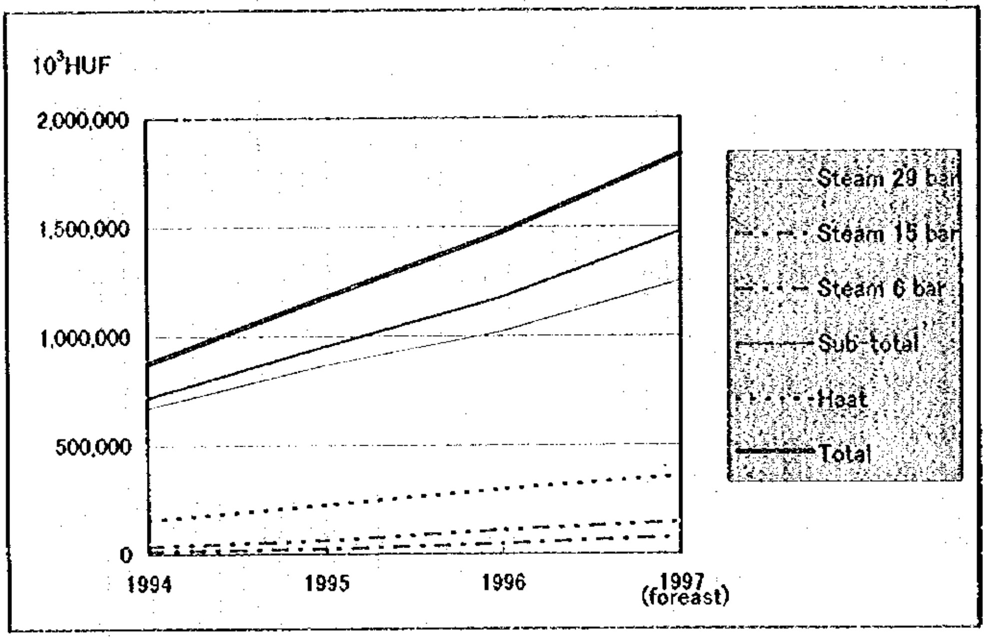


Figure 9.2.3 Trend of Sales Amount of Heat Energy

The following conclusions of the above analyses are obtained; then the premises necessary to carry out the financial analysis of the project are introduced.

1) The lowest sales volume of heat energy in total is 2,653,443GJ in 1995 and the highest is 2,771,129GJ in 1994. This tells that the sales volume has been quite stable during the survey period of four years, which is backed by the trends illustrated in figure 9.2.2.

   [Premise adopted for the analysis]

   As stated in Table 3.2.2 of Chapter 3 total volume of heat energy production in the project is assumed to be 2,780TJ.

2) The sales amount, on the contrary, has been increasing with constant upward trend as illustrated in figure 9.2.3. The lowest sales is 876,567 thousand HUF in 1994; the highest is 1,835,113 thousand HUF in 1997. The average rate of increase during this period is 28%/year.

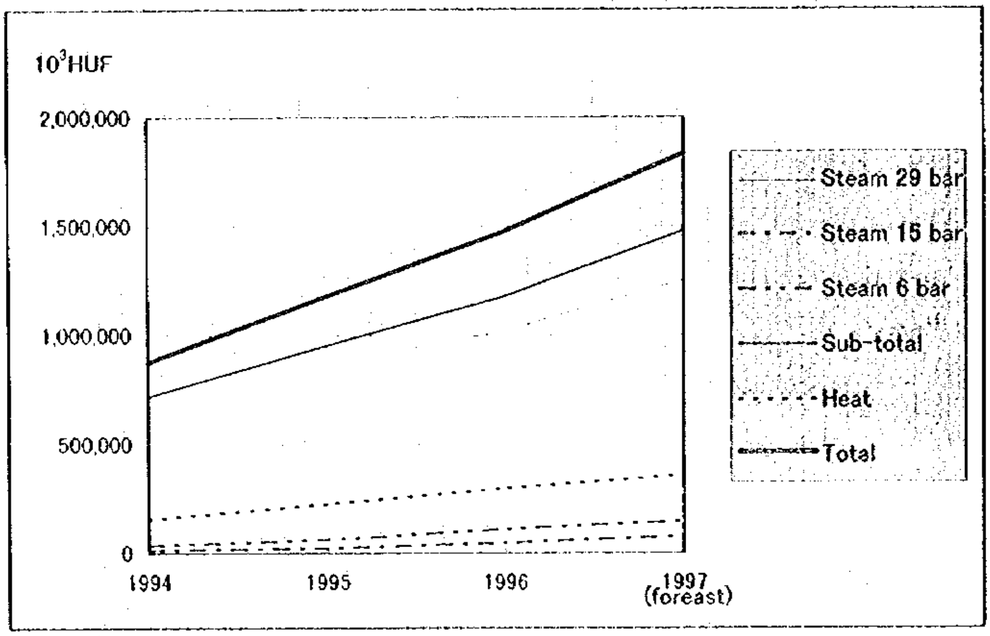


Figure 9.2.3 Trend of Sales Amount of Heat Energy

The following conclusions of the above analyses are obtained; then the premises necessary to carry out the financial analysis of the project are introduced.

1) The lowest sales volume of heat energy in total is 2,653,443GJ in 1995 and the highest is 2,771,129GJ in 1994. This tells that the sales volume has been quite stable during the survey period of four years, which is backed by the trends illustrated in figure 9.2.2.

   [Premise adopted for the analysis]

   As stated in Table 3.2.2 of Chapter 3 total volume of heat energy production in the project is assumed to be 2,780TJ.

2) The sales amount, on the contrary, has been increasing with constant upward trend as illustrated in figure 9.2.3. The lowest sales is 876,567 thousand HUF in 1994; the highest is 1,835,113 thousand HUF in 1997. The average rate of increase during this period is 28%/year.

[Premise adopted for the analysis]

Unit price of heat energy is assumed to be 897.79HUF/GJ in this analysis, being currently adopted from the beginning of 1997.

(4) Supplement ---- Explanation on each payment component of MVM based on PPA ----

Basis of the following explanation of each revenue component of a power station lies in IKIM Decree 55/1996(XII.20), section 5, clause 8, and section 8 supplement 2.

[Capacity Charge]

This charge might be called " availability charge" because in the essence the element is the fee paid by MVM to each power plant for the commitment of their availability of each power generating plant. The owner of each plant, with a long term power purchase agreement (PPA) concluded, can be sure of its yearly income. The owner earns the capacity charge each year after signing the PPA during the term of validity of contract, irrespective of the operating hours performed by the plant.

[Contracted Mining Capacity Charge]

When a power station maintains coal mine like Borsod Power Station, MVM pays some fixed amount as contracted mining capacity charge.

[Cold Start Charge]

A power station sometimes stops its operation on their own reasons such as regular maintenance, or at the request of MVM whose responsibility is to control national generating conditions. For Borsod Power Station it has been 4 or 5 times a year. Although cold start charge is a variable component, the revenue amount has been almost constant.

[Energy Charge]

MVM pays for the purchase of fuel used for power generation, which is indirectly equivalent to rate of utilization.

Chapter 10

Suggestions for Power Plant Development in Hungary

Chapter 10 Suggestions for Power Plant Development in Hungary

10.1 Coal Combustion Technology in Power Plants

(1) Power Plants Development Plan in Hungary

The electric power demand in Hungary continually decreased during the period from 1989 to 1993 due to the industrial stagnation, but thereafter, it has been on the trend of gradual increase. While the total electric power consumption in 1995 was 36.5 TWh, it is projected to increase to a range of 43.3 - 49.3 TWh in 2010, a considerable increase even with the lowest growth of demand.

On the other hand, thermal power generation facilities, which account for 74 % of the Hungary's present total power generation capacity of about 7,400 MW, are mostly superannuated with decreased efficiency, and are urged to be renewed since they are not able to meet the environmental protection requirements comparable to those of EU countries that are to be effected in 2005.

Through the national energy policy, coal mines in vicinity of power plants have been managerially integrated into the power plants. Therefore, such power plants are obliged to use their own coal thereby contributing also to the regional employment stability, while implementing sufficient environmental protection measures. Borsod Power Plant is one of such power plants.

Under these circumstances, MVM conducted a economic efficiency analysis of the power plant development scheme for the period 1998 - 2010 using the least cost planning (LCP) method. The candidates for type of power generation unit, fuel, and capacity by sites were selected as shown in Table 10.1.1.

The power generation units which were judged to be appropriate for construction as the result of above analysis included 4 cogeneration units and 5 - 6 condensing units of the FBC type with 150 - 155 MW capacity. The new unit for Borsod Power Plant belongs to the former. These units to be built in existing plant sites need to utilize low-quality domestic coal, and satisfy the environmental protection requirements.

Table 10.1.1 Candidates of Power Plant Development

Site	Type of unit		Fuel	Units x MW	Total MW
Existing Plant Sites	1	C. C. + cogeneration unit	natural gas	4 x 100	400
	2	C. C. + condensing unit	natural gas	6 x 225	1,350
	3	FBC + cogeneration unit	coal	4 x 150	600
	4	FBC + condensing unit	coal	6 x 155	960
	5	Gas turbine (peak load)	light fuel oil	6 x 155	930
	6	Oil fired large unit	heavy fuel oil	1 x 550	550
	7	PCF large unit	coal	3 x 350	1,050
	8	Nuclear unit	nuclear	2 x 630	1,260
New Plant Sites	9	Gas turbine with inert gas unit	inert gas	1 x 80	80
	10	Lignite-fired unit	lignite	3 x 450	1,350
	11	PCF unit	coal	3 x 550	1,650
	12	Nuclear unit	nuclear	2 x 630	1,260

Source : The Economic Efficiency Analysis of the Long Term Expansion Strategy of the Hungarian Power System, provided by MVM in March 1996.

The CFBC technology selected by MVM in the previous feasibility study for Borsod Power Plant is a variation of FBC technology, and it has the following advantages from the environmental view point:

1) Since desulfurization agents circulate within the combustion chamber, the agent utilization ratio is high resulting in a high removal efficiency of sulfur in fuel (above 90 %).

2) Because the combustion temperature is low at about 850 ℃, generation of NOx is reduced.

3) The high combustion efficiency results in the reduction of fuel consumption.

Because of above advantages, the CFBC technology has been widely employed in the world including Japan where 11 boilers of 50 - 250 t/h capacities are operated. However, there are only three cases of application of this technology to large-scale power generation boilers of the capacity class at around 460 t/h, which is required in aforementioned FBC power units in Hungary including Borsod Power Plant. These are one in the USA (499 t/h), one in Germany (400 t/h), and one in France (700 t/h).

In the present Study, investigations were made on above three CFBC boilers concerning operational problems and their countermeasures. As a result, the following measures were adopted in application of the CFBC technology in Borsod Power Plant where brown coal having high ash content (35 - 45 %) and sulfur content (above 2 %) is to be used:

1) To reduce the total ash content by mixing the brown coal and imported coal of low ash content

2) To install external heat exchangers (EHE) of appropriate capacity corresponding to the amount of ash produced

3) To install high-accuracy automatic control system for optimization of separation, circulation, and heat recovery of ash

4) To reduce the amount of ash generation by optimizing the amount of limestone addition

With above measures, it is considered that the CFBC technology can be commonly applied to aforementioned 150 MW class units being planned in Hungary, subject to careful study of particular conditions of each power plant including the quality of domestic coal to be used.

As a reference for such study, considerations to be given in the application of the CFBC technology are suggested below based on the investigations of the existing CFBC boilers made in the present Study.

(2) Considerations for Application of the CFB Technology

The Study Team conducted investigations of the large-scale CFB boilers in power plants operated in the world. As mentioned above, there are three power plants using a CFB boiler firing relatively low-quality coal. They are as follows:

1) Goldenberg Power Station (Germany)
2) Texas - New Mexico Thermal Power Plant, TNP-1 (USA)
3) Provence - Gardanne Power Plant (France)

The results of the investigations of CFB boilers in these power plants are described in detail in the Supporting Report.

The CFB boiler at Goldenberg Power Station (400 t/h) is of the EVT type, and those at TNP-1 (499 t/h) and Provence Power Plant (700 t/h) are of the Lurgi type. The largest difference between these two types is that external heat exchangers (EHE) are provided in the later. This chapter focuses on the problems of CFB at TNP-1 and Provence Power Plant with the EHE. The findings from these problems and studies for their solutions can be reflected on planning new CFB boilers in Hungary.

The commission of TNP-1 in U.S.A. was 1991. The operation of the CFB unit in Provence Power Plant started in 1995. During this 4 year period, however, the capacity was increased from 499 to 700 t/h. Findings at TNP-1 were reflected to the CFB unit at Provence Power Plant, reducing number of plant outage during the first year operation. As a result of many improvements made in the CFB design, the capability of the CFB unit has increased to 700 t/h. Based on these examples, the following issues were examined and proposed for planning application of the CFB technology to brown-coal-firing power plants in Hungary.

1) Appropriate loading on the separation and recycle system or EHE system of ash from the combustor

   Reduce loading on separation and recycle system or EHE system of ash from the combustor to a similar level of the CFB unit at the Provence Power Plant that has already been proven. The ash yield of a 150 MW CFB unit should be reduced from 80 t/h (brown coal used by 100 %) to 44 t/h by mixing local brown coal and import coal at a ratio of 1:1 in calorific value.

2) Quality of import coal

   Import coal to be mixed must be of high quality with a calorific value of 25 MJ/kg or more, and 0.8-1.0% of sulfur content.

3) Limestone feeder

   The findings from frequent failure of limestone feeders in TNP-1 should be reflected to the new CFB boilers.

4) Heat load balance

   Heating loads of the superheating and reheating done in the superheater, the reheater, the ash separator and recycle system or in the EHE system must be well-balanced.

5) Control of ash separator and recycle system or EHE system

To achieve close cooperation between the ash separator, the recycle system, the EHE system, the combustor, and the primary air fan, monitoring and automatic operation control of these components should be done by minutes or seconds using computers.

6) Summary

A new technology develops with the process of solving various problems encountered in attempting scale-ups. It is suggested that the problems and solutions mentioned above be properly fed-back in planning, designing, and operation of CFB boilers considered in Hungary for new coal-fired power units in the existing power stations.

10.2 Environmental Impact Study and Environmental Protection Measures for Thermal Power Plants

10.2.1 General Recommendation for Development of Thermal Power Plants

(1) Survey of Environmental Impact of Thermal Power Plant Projects

To prepare an environmental impact statement of thermal power plant, environmental conditions, including air quality, water quality, and natural environment, in the proposed plant site and its surrounding area are surveyed, this is referred to as the Environmental Survey.

Then, taking account of the contents of the power plant project; the results of the environment survey; and the characteristics of the area, environmental protection measures are worked out which will deal with air pollutant, such as sulfur oxides, and thermal effluent. With these measures in mind, potential impacts of the project on the environmental are assessed dispersion forecast calculations, wind tunnel tests, and thermal effluent dispersion model experiments.

Furthermore, an environmental monitoring plan follow-up surveys of air and marine environments after the power plant goes into service.

A flow diagram of the assessment process of the potential environmental impacts of the thermal power plant project is shown in Figure 10.2.1.

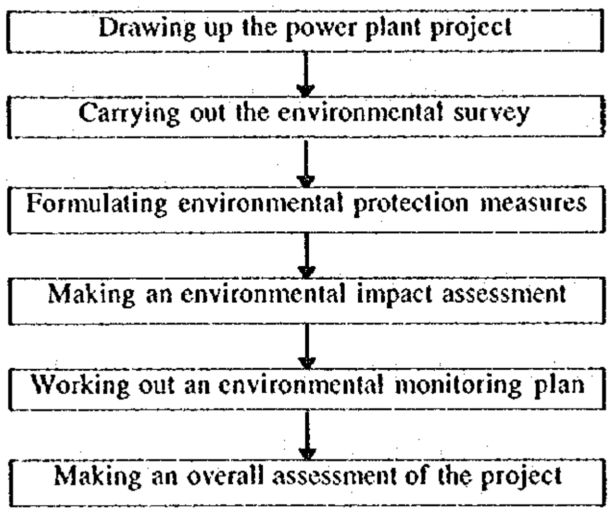


Figure 10.2.1 A flow Diagram of the Assessment Process of the Potential Environmental Impacts of the Thermal Power Plant Project

(2) Clarifying Outline of Power Plant Project

It is necessary to clarify the site, facility and construction, etc. as the outline of the power plant project. The items are as follows:

- Generating Capacity
- Date to be commissioned
- Kind of fuel
- Annual fuel consumption
- Site area
- Air ; exhaust gas volume, stack height, SO_2, NOx, Dust
- Water ; Quantity of cooling water, method and temperature difference of intake and discharge, quantity of general effluent
- Noise and vibration ; boiler, turbine, generator, transformer, draft, air compressor, coal elevator, pulverizer
- Soil
- Groundwater

(3) Environmental Survey

The items of a survey identify the existing natural and social conditions at the proposed plant site and its surrounding area, covering a wide variety of subjects such as air quality, water quality, and fauna and flora.

The findings of the environmental survey are compiled in a report called " Current Environmental Conditions", which is used as the basic data for formulating environmental protection measures to deal with air pollutants and thermal effluent, as well as for making an assessment of potential environmental impacts.

Environmental survey items are shown in Table 10.2.1.

(4) Environmental Protection Measures

Taking into consideration the contents of the power plant project, the results of the environmental survey and the characteristics of the proposed plant site environmental protection measures with regard to matters, that are projected to have a significant impact on the environment are formulated so as to preserve natural and social environments.

Major items of environmental protection and the majors are summarized in Table 10.2.2.

Table 10.2.1 Environmental Survey Items

Item	Description	Scope
Air quality	Sulfur oxides, nitrogen oxides, suspended particulate matter	Within radius of 30 km
Water quality	Water temperature (horizontal and vertical distribution, changes near water intake and outlet), pH, COD or BOD, DO, SS, transparency, N, P, others	Area in front of water intake and where temperature of thermal effluent increases by 1 ℃.
Quality of sediment	COD or BOD, ignition loss, particle size distribution, total sulfide, others	
Soil pollution	Present state of pollution	Power plant premises and construction site
Noise and vibration	Morning, afternoon, evening and night (afternoon and night only for vibration)	Plant site boundary and its environs
Ground subsidence	Present state of subsidence	When underground water is taken
Offensive odor	Present state of offensive odor (ammonia concentration)	Plant site boundary
Meteorology (General)	Weather, wind direction, wind velocity, temperature, humidity and precipitation	10 - 30 years' observation at meteorological station
(Surface)	Wind direction, wind velocity. atmospheric temperature, humidity, sunshine percentage, cloud amount or radiation balance and atmospheric stability	More than 1 year's observation
(Upper air)	Wind direction, wind velocity, temperature, temperature lapse and pressure pattern	Up to 1,500 meters in midair
Topography and geology	Altitude above sea level, slopes, geological composition, formations, rack composition, soil, geological features, etc.	Plant site and the surroundings
Inland water	Mountain torrent, groundwater, fresh water intake river, lakes and marshes	
International convention for environmental protection	Washington convention, convention on biological diversity, convention for the protection of the world cultural and natural heritage, Ramsar convention, etc.	Plant site and the surroundings
Nature conservation	Natural parks, nature conservation areas, wild life sanctuaries, conservation forests, fishery resources protection waters, spa areas, etc.	
Flora	Existing flora, major communities and soil, degree of nature and ecological importance, rare plants, potential natural flora.	Within radius of 30 km
Animals	Land animals, aquatic animals, rare animal	
Natural landscapes, etc.	Natural landscapes, Landscapes at major tourist resorts or roads.	Plant site and the surroundings
Local community	Geographical location, population, industrial activities.	
Traffic and public facilities	Traffic condition, state of public facilities.	
Land use	State of land use, land use plans.	
Water system utilization	Condition of fresh-water fishery, state of water utilization.	
Culture and recreation	Cultural properties, recreational facilities.	
Other	Matters which are specific to the area concerned and to which particular consideration should be given with regard to environmental protection.	

Table 10.2.2 Major Items of Environmental Protection and the Measures

Item	Measures
Measures against air pollution	1. Measures against sulfur dioxides Low-sulfur fuel, FGD, desulfurization in combustion chamber 2. Measures against nitrogen oxides Combustion improvements (low NOx burner, two-stage combustion, EGR), flue gas denitrizer, denitrification in combustion chamber 3. Measures against soot and dust EP, mechanical dust collector 4. Measures against dust or coarse particulate Windbreak net, water sprinkler, planting, dust collection in gallery 5. Improvement of smoke and soot dispersion effect Tall stacks, centralized smoke stacks
Measures against thermal effluent	1. Installation of cooling tower 2. Taking water from deep sea (curtain wall) 3. Condenser bypassing (mixed dilution discharge) 4. Discharge in deep water 5. Discharge in survey layer
Measures against water contamination	1. Installation of integrated liquid-waste treatment facility 2. Laying impermeable sheet at the bottom of at coal ash disposal ground and installation treatment facility for the leachate 3. Recycling of treated wastewater for sprinkling, etc.
Measures against noise and vibration	1. Suppression within building, introduction of low-noise, low-vibration equipment, installation of sound-proof walls and mufflers 2. Isolation of premises from boundary
Measures for conservation of life	1. Minimization of area for flora change, afforestation 2. Protection of precious organisms
Measures for preservation of landscapes	1. Attention to configuration, arrangement and color scheme of buildings, etc. 2. Landscaping and afforestation

1) Measures against air pollution

In order to hold down environmental loads to as low a level as possible, positive environmental protection through such measures as the increased use of low-sulfur fuels and natural gas, the improvement of combustion and the development of desulfurization and denitrification technologies should be introduced.

a) Measures taken in the field of fuels

To reduce emissions of sulfur oxides, nitrogen oxides and soot and dust from thermal power plants, efforts should be made toward the increased use of quality fuels, such as low-sulfur, low-nitrogen fuel and crude oil and coal, and natural gas (NG) that does not contain sulfur or soot and dust. The use of these quality fuels is giving stimulus to fuel diversification, contributing a lot to the enhanced energy security of our country.

b) Measures taken with regard to equipment

In addition to the above mentioned measures a), the following measures are taken with regard to equipment used at the site to lower emissions of air pollutants from thermal power plants.

- Measures against sulfur oxides
  Sulfur oxides can be removed by installation of FGD or by fluidized bed boilers which enables desulfurization in combustion chamber.

- Measures against nitrogen oxides
  Production of nitrogen oxides can be decreased by improvements in combustion methods which enables to suppress Thermal-NOx (boilers ; two-stage combustion, EGR and low-NOx burner, gas turbine ; preheated and mixed fuel combustion) and by the installation of denitrification equipment (dry type SCR method, dry type activated carbon method, and denitrification in combustion chamber).

Table 10.2.3 shows the concentrations of NOx emissions treated by the methods mentioned above.

Table 10.2.3 Nitrogen Oxide Reducing Options and Resultant Concentrations (ppm)

	Gas-fired P.P.	Oil-fired P.P.	Coal-fired P.P.
EGR + two-stage combustion	55-110	95-180	300-350
EGR + two-stage combustion + low-NOx burner	40-100	85-180	160-300
EGR + two-stage combustion + low-NOx burner + denitrification in combustion chamber	40	50-85	-
EGR + two-stage combustion + low-NOx burner + SCR method	10-20	20-30	60

- Measures against soot and dust
  For soot and dust, high-performance equipment capable of collecting more than 80 percent of unburnt carbon from fuel or crude oil-fired units and more than 99 percent of fly ash from coal-fueled plants should be used.

- Measures against particulate
  In the case of coal-fired power plants, some measures should be taken to prevent the dispersion of particulate produced from coal storage yards and

in coal unloading, transfer and handling processes. Windbreak nets, tree planting, and domed or gabled indoor coal storage facilities are adopted for this purpose depending on where coal storage yards are to be located. When space available for coal storage is limited, a dome or silo will be used because of the large storage capacity per unit area. These also help prevent the scattering of particulate.

2) Measures against thermal effluent

Discharging thermal effluent is likely to cause changes in the habitats of aquatic life and hence adverse effects on fishery and the measures should be taken. Closed system cooling tower does not discharge the thermal effluent due to the recirculation and recycle. In the design process of plant condensers and cooling water intake and discharge facilities, a set of measures befitting the geographical conditions of plant sites should be taken to reduce the impact of thermal effluent on the surrounding sea area to the lowest possible level, such as restricting the difference between the temperature of the water taken in and that of the water released or slowing down the flow speed of water taken in and discharged. Measures employed include taking in deep sea water (with curtain wall and sea bottom water intake pipes) to prevent a rise in water temperatures due to the thermal effluent released and to prevent adverse effects on fish eggs and larvae taken in with the water ; condenser bypassing (mixed dilution discharge); and discharging thermal effluent in the water to reduce its dispersion range.

3) Measures against water pollution

Effluent from a power plant is properly treated before it is released into the water system so as to prevent pollution of the water area. Plant effluent is treated in an integrated wastewater treatment facility; domestic sewage treated in a purifying tank; and leachate from an ash dumping ground settled and neutralized before being discharged into the water. Turbid rainwater during construction and after plant start-up is settled in a sedimentation basin and the resultant supernatant is discharged into the water.

4) Measures for landscape preservation, afforestation, etc.

In a power plant project, consideration should be given to preservation of natural landscapes and afforestation be conducted. Attention to the configuration, arrangement and color scheme of buildings is needed. Efforts minimize the area of land to be altered and the lumbering range also needs to be made. Green belts should be established around the premises, facilities and along a main road, where chiefly trees of native species are planted. It is also important to open greens, a playing ground and other environmental facilities to local inhabitants, thus helping to build closer relations between the utility and the local community.

5) Measures for waste disposal

Wastes produced from a power plant include: sludge generated in the effluent treatment facility, coal and fuel oil ash produced as a result of coal and fuel oil combustion; desulfurization plaster as a by-product from desulfurization equipment; and organisms attached to cooling water channels. In order not to cause soil and groundwater pollution, the appropriate management for the treatment and disposal or the utilization of proper dealer, depending on the properties, is needed. Desulfurization plaster is fully used to make plaster boards; coal ashes are partially used as cement material; and other wastes are disposed of under ground.

(5) Environmental Impact Assessment

Taking into consideration the contents of the project, the current state of the environment, and measures to be taken for environmental conservation, potential impacts of those items likely to have significant influences on the environment are estimated and assessed.

1) Air pollutant dispersion forecasting with simulation model

Ground concentrations of sulfur oxides and other air pollutants after the start-up of a power plant are forecast and estimated through dispersion forecasting calculations. Effects of topography on dispersion of smoke and soot are assessed through wind tunnel tests.

2) Thermal effluent dispersion forecasting with simulation model

Dispersion forecasting calculations and hydrodynamic model experiments are performed to forecast how far thermal effluent might be dispersed.

(Distribution of water temperature increases at depths of 1 meter and 2 meters respectively)

(6) Environmental Monitoring

To observe air pollutant emissions, differences in intake and outlet temperatures of cooling water; and general effluent, etc. after startup of a power plant, a plan is drawn up for monitoring concentrations of sulfur oxides; nitrogen oxides; SPM etc. ; ambient air concentration; water temperature; and marine life and others. The findings of this survey are used to confirm the appropriateness of the environmental impact assessment and to heck that plant operations have limited pact on the environment.

An example of environmental monitoring at thermal power plant is shown in Table 10.2.4.

Table 10.2.4 An Example of Environmental Monitoring at Thermal Power Plant

Item	Contents
Air quality	Regular monitoring of sulfur oxides, nitrogen oxides and SPM
Meteorological conditions	Continuous observation
Water quality	Continuous measurement of water temperature at the intake and discharge Water quality (pH, COD or BOD, DO, SS, transparency, N, P, others) Sediments (COD, ignition loss, particle size distribution, total sulfide, others)
Noise	Measurement at the border of power plant site once a year
Vibration	Measurement at the border of power plant site once a year
River	Observation of hydrological regime
Aquatic fauna and flora	Survey of aquatic life, bentos, egg and larvae of aquatic organisms, plankton, etc. every season

10.2.2 Recommendation for Development of Thermal Power Plants in Hungary

The past industrial development in Hungary lacked considerations for environmental protection as in the case of other advanced countries which experienced serious environmental pollution in the past. The industrialization under the socialistic system affected the environment heavily and resulted in the present environmental pollution. In consideration of such circumstances, the following are suggested, proposed, or recommended concerning the development of electric power in Hungary.

Thermal power plants in Hungary have many common problems. Therefore, the following suggestions and recommendations are largely applicable to Borsod Power Plant as well.

(1) Observation of Regulations and Standards

The Hungarian Government intends to enforce new emission standards for air pollutants from 1st January, 2005. In urbanized areas, it may be difficult to observe the ambient air quality standards even in the case power plants take adequate environmental protection measures to meet the emission standards, unless appropriate measures are taken at other sources including residences. The following measures are suggested in order to satisfy environmental standards such as of SO_2. The target year should be set for 2005, or a proper year for each development program.

1) For stationary air pollution sources, guidance and control are strengthened so as to observe the new emission standards.

2) The degree of contribution by coal-fired home heating to air pollution is high. At present, changing the fuel for home heating from coal to naturalgas is in progress. Compared to the amount of coal used during 1992-1993 when the JICA's air pollution control study for the Sajo Valley area was conducted, it may be reduced to a half by 2005. However, to satisfy the environmental standards, further promotion of gasification is required.

3) In many cases, coal fired power plants are located in the neighborhood of industrial zones. In general, there are many waste storage areas, and even illegal dumping sites. For the treatment and disposition of wastes, guidances should be given to observe the environmental protection regulations laid down in various ordinances and to reinforce the control of illegal dumping.

4) Protection of the environment during the construction period and protection of the working environment tend to be neglected. The persons concerned should observe the regulations and standards applicable to the work environment. Supervisory bodies should also give thorough guidances.

(2) Considerations for Environmental Survey

1) General consideration

In Hungary, there are many places with marvelous nature to be protected, including the national parks and the areas designated by international environmental protection treaties. However, in some of industrial zones, urban areas and tourism areas, man-made environmental pollution has become prevalent. In some places, the problem is serious.

Air pollution is significant during heating seasons. In residential areas, home heating is substantially contributing to the pollution. In urban areas, automobile emissions are added, and in the neighborhood of industrial zones, emissions from factories are added. Combined with meteorological conditions that give rise to the formation of ground-level inversion layers, the air pollution becomes serious.

In industrial zones and adjacent areas, there are factories and related residences. Thus, polluters can be also sufferers of pollution.

Another feature is that wastes have to be either landfilled or dumped into rivers except the cases of reuse.

When planning development of power plants in Hungary, it is important to know exactly the present conditions of natural and social environments of the areas which may be affected, based on the understanding of above-mentioned features of Hungary.

2) Considerations in environmental measurements

There are many excellent environmental engineers in Hungary, but the function of data cross-checking is not sufficient. The term "environmental measurement" not only aims to judge whether the environment is conforming to the applicable standards but also aims to examine the background of the measurement results and to analyze them comprehenlysive. In this way, "environmental measurement" forms the foundations for promoting environmental protection.

In the "environmental measurement," the following considerations are required.

a) To establish accurate measurement system

If measurement is inaccurate, the standards themselves become meaningless. Measurements should be done in accordance with the official methods in principle, but suitable application technologies are required depending on the nature of samples.

b) Efforts of analysts to improve accuracy

Analysts tend to maintain that good instruments produce correct results. But any analysis or measurement involves errors. Therefore, it is proposed to establish a system where data are cross-checked between analysts or analytical institutions to confirm their technical levels. If any problem occurs, the cause should be searched, and analysts should attempt to improve techniques constantly. Only with these efforts, it is possible to maximize the benefit of the capacity and characteristics of measuring instruments.

c) Public participation

For improving and protecting the environment, widespread participation and cooperation of local residents, in addition to those of power plants, are indispensable. Also for this purpose, disclosure of data, whether convenient or not for respective parties, is important.

d) Representativity of samples

For setting up sampling spots, it is necessary to consider about what areas are to be represented by the spots. In some cases, sampling errors can be far larger than analytical errors. In addition, simultaneity and continuity of sampling should be taken into consideration.

(3) Environmental Protection Measures at Power Plants

The following measures are recommended in power plants in Hungary for securing environmental protection.

1) For preventing the groundwater pollution by coal ash, various techniques can be considered in power plants, including the thick sludge technique and the impermeable sheet technique, etc. According to the information from power plants, they intend to apply the thick sludge technique only for preventing groundwater pollution. Even though satisfactory results have been obtained using quality coal with less ash content, it is not guaranteed that similar results can be obtained for domestic coal of low quality. It is unnecessary to take excessive measures for preventing groundwater pollution, but it is necessary to prove in advance that the thick sludge technique is capable of preventing the groundwater pollution. The use of the water treatment plant effluent containing salts is not recommendable at this stage.

2) The recovery of environemtnal degradation requires a large cost and a considerable time in general. For removing the source of trouble in the future, safer and more reliable measures should be taken instead of the measures with insufficient verification.

3) The development of power plants contributes to the regional development. On the other hand, it affects the environment considerably together with other plants and factories. When considering the environment for the future, it is recommended not only to avoid or reduce negative environmental impacts, but also to create semi-

natural environments and to consider the landscape. For example, creation of a new environment in place of a environmental resource lost by the development can be also regarded as a positive measure of environmental protection.

4) Hg and As contents in Hungarian coal are high. Compared to imported coal, the content per calorific value is much larger. Most of Hg scatters in a vapour form, and As remaining in ash results in groundwater pollution. This fact, should be taken into consideration for planning environmental protection measures.

5) Consideration for downwash

If emission gas from a stack is subjected to downwash by the influence of buildings, a high concentration of the gas may occur at the ground level near the stack. It is recommended to examine the possibility of and the prevention measures for the downwash when planning construction of a power plant.

(4) Environmental Impact Prediction and Assessment

When developing a power plant, it is necessary to predict and assess impacts on the environment, and provide for measures to avoid or reduce such impacts in relation to the target of the environmental protection.

Various methods are available for predicting and assessing the impacts. It is necessary to adopt methods that enable objective assessment under natural and social conditions of the areas concerned. The same are applicable to the setup of parameters used for prediction models.

There are cases in Hungary where sufficient environmental considerations were not taken for industrial development including power plant construction.

In conducting environmental impact surveys, it is recommended to invite local residents and specialists for participation, as many as possible, to take account of their opinions. This will bring about satisfactory results for both entrepreneurs and local residents in the future.

(5) Environmental Monitoring

In general, the purposes of environmental monitoring include: to judge necessity of emergency measures, to compare the actual data with the applicable environmental standards, to judge the effect of the measures taken, and to utilize the data for management of the environment. For maximizing monitoring functions at power plants in Hungary, the following are recommended.

1) At present, the control of sources and the environmental monitoring are undertaken separately by Regional Environmental Protection Inspectorates and Regional Institutes of National Public Health Services. It is proposed that above two functions be integrated through close cooperation of the two administrative bodies, so that necessary actions can be taken promptly.

2) It is proposed to prepare manuals and draw up programs for the operation and maintenance of measuring instruments.

3) It is proposed to secure the budget for environmental monitoring with high priority.

(6) Environmental Management System in Power Plants

In Hungary, privatization of state-owned enterprises including electric power companies and gas companies has been promoted. In power plants in general, responsible staff is assigned for each field of environment, boilers, power generation and water production, etc.. Recently privatized power plants, such as Borsod Power Plant, seem to have certain confusions in environmental management system. In some cases, the environmental control system is not fully functioning.

As an example for the system, it is suggested to organize an Environmental Management Committee headed by the plant manager or the manager in charge of environment. Under this, subcommittees for fields such as environment, energy saving and disaster prevention may be placed. Each subcommittee proposes implementation of measures within its field in charge. It is desirable that each subcommittee is participated by many sections concerned. The subjects to be dealt with the environmental management committee generally include the following:

1) Protection and improvement of the environment through all activities.
2) Energy sawing, and reduction and control of emissions and wastes
3) Development and application of environmental protection technologies
4) Emergency measures
5) Clarification of the persons in charge and define their responsibility
6) Cooperation with local society
7) Environmental education and enlightenment of employees
8) Regular monitoring of the environment and emission sources

10.3 Possibilities of Financial and Technical Cooperation on the Official Basis

(1) Possibility of Japanese Assistance for the Hungarian Power Sector

Former centrally planned economies including Hungary have been pushing forward the scenario of transition of their economy to market-oriented by reducing the role of public sector on one hand, and introducing private initiatives as much as possible in their economic activities on the other. At the same time, irrespective of economic system and situation, both developed and developing countries, private participation in many economic infrastructure utilizing private funds, and technology and know-how has been actively and progressively pursued recently.

While economic development through private initiatives should be in principle advanced in concerted effort of the government and private sector of each country, Japanese government has selectively extended assistance, when requested by the government and/or private sector of the project country, and when the assistance is considered really contributive and indispensable to the project.

Bilateral Japanese official assistance to Hungary, who is a member of OECD, should be selectively provided, in addition to multilateral assistance provided by international financing institution like EBRD and World Bank. Means and schemes which might be considered possible for Japanese financial assistance and cooperation by institution including Export -Import Bank of Japan are illustrated in Figure 10.3.1.

All parties concerned in Hungarian power sector should review the possible means and schemes of Japanese financial cooperation for consultation with development consultants and institutions.

(2) JICA

Major portion of Japanese bilateral grants is undertaken by the Japan International Cooperation Agency(JICA). JICA's program in environmental sector is summarized as follows:

1) assistance in project formulation by dispatching JICA's own administrative staff, expert and/or preliminary study team;

2) implementation of various development study (ex. master plan, feasibility study, after-care study, inclusive of various recommendations);

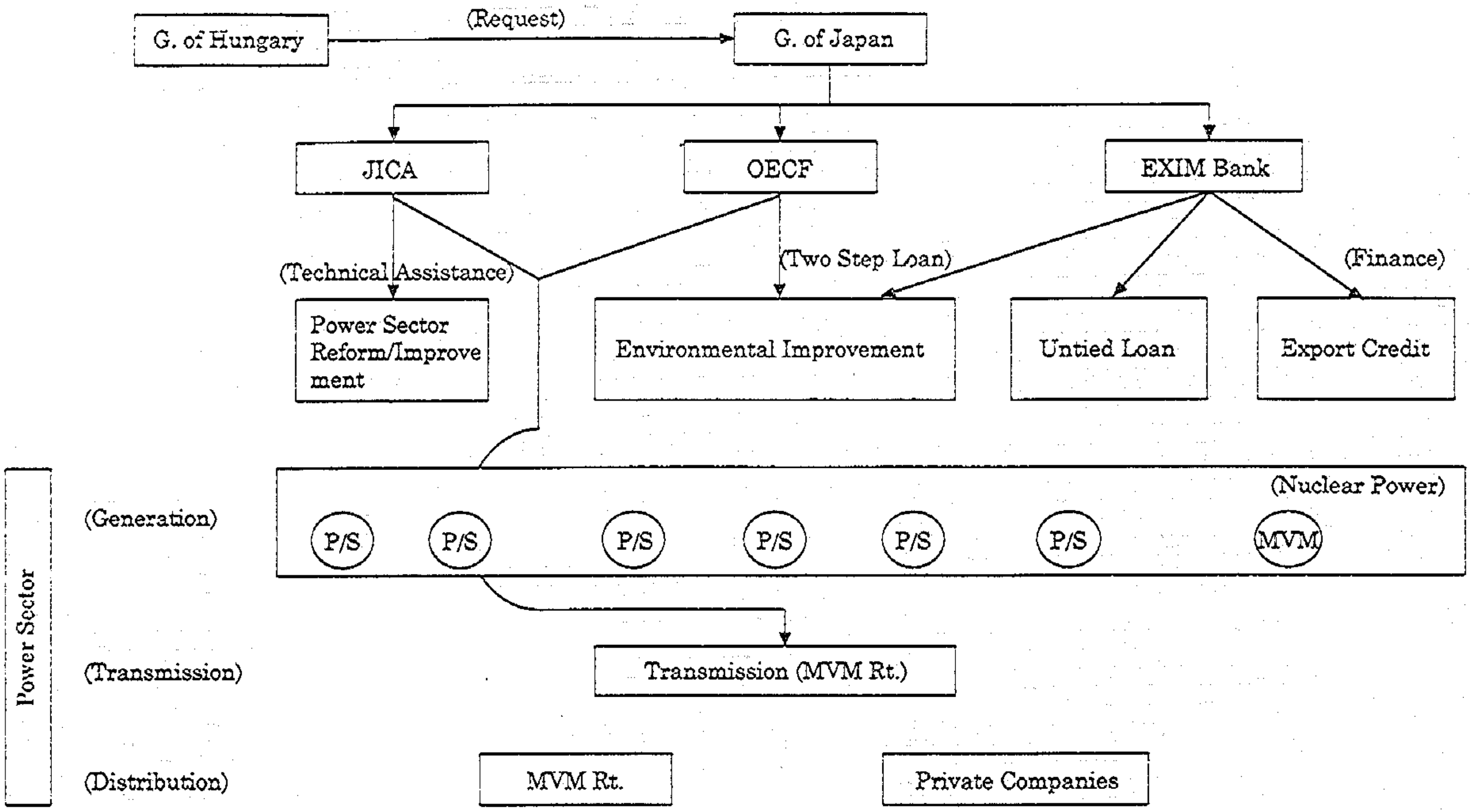


Figure 10.3.1 Possibility of Financial and Technical Assistance of Japanese Government for the Electric Power Sector in Hungary

3) intellectual assistance through transfer of specialized knowledge and technology through various means and occasions;

4) JICA's Expert Dispatch Program aimed at transfer and dissemination of technical knowledge and skills most suited to the needs of the country and the project (aggregated number of people dispatced: 28);

5) training of qualified personnel and future leaders for technical cooperation through various training programs in Japan and in third country (aggregated number of people trained: 527).

(3) OECF Loan

In targeting at environmental protection and improvement, there might be a possibility that an already privatized power station is involved as one of implementing parties or end-borrowers of a sub-project consisting of a comprehensive project which is financially assisted by OECF. Hungarian government's guarantee is a prerequisite for receiving OECF loan since the loan is in principle contracted between the governments of both sides. Terms and conditions of the loan is currently 4.0% as interest, 25 years of loan period with 7 years of grace period. They are periodically reviewed.

In power sector generation appears to have better possibility as a recipient sector of OECF loan than transmission and distribution in environmental protection project. A privatized power station might become an end-borrower of a comprehensive project for improving regional environment which is financially assisted by OECF loan under two-step-loan scheme.

(4) EXIM Japan

The purpose of the activities of the Export-Import Bank of Japan (EXIM) is to facilitate Japan's economic interchange with foreign countries through providing their financial services available. It should be noted that extending financial cooperation toward other countries to help a recipient country promote her economy is included as one of the bank's objectives. Backed by EXIM's financial cooperation a project may be facilitated with less project risks like political risk, and reduced financial cost. Except untied loan program, EXIM's service is usually more conveniently and timely available than OECF loan since the bank does not require a government guarantee for their loans and other services.

In addition to their loan facility, guarantee facility to private financial institutions in Japan are available to private infrastructure project.

Specific EXIM programs available to infrastructure and environmental projects are as follows:

1) Buyer credit to finance the purchase of Japanese goods and services.

2) Overseas investment loan to be extended to Japanese corporation, or foreign government or foreign banks for equity participation in or loans to corporation in which a Japanese corporation has an equity share.

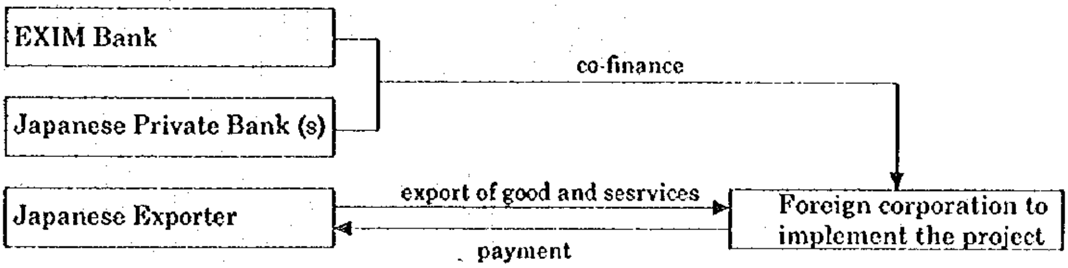
3) Guarantee to private financial institutions in Japan for their financing to foreign entity.

4) Untied loan to be extended to foreign government and institutions for high priority projects and economic restructuring programs in foreign countries on condition of government's guarantee to EXIM.

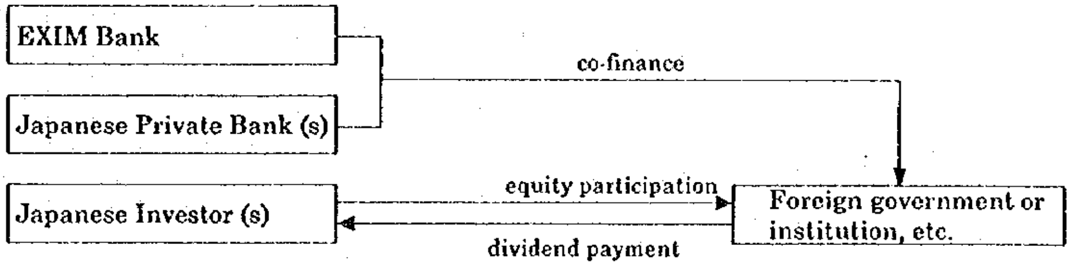
5) Project finance extended to infrastructure project undertaken by Japanese corporations.

These programs are illustrated in Figure 10.3.2.

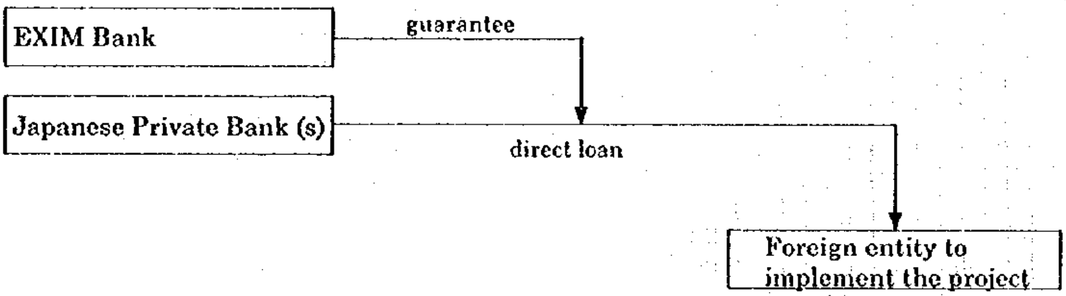
1. Buyer Credit



2. Overseas Invesgment Loan



3. Guarantee



4. Untied Loan

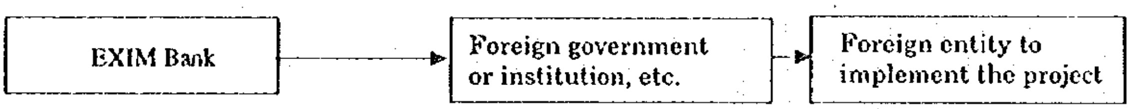


Figure 10.3.2 EXIM Bank's Facilities for Infrastructural Project Implemented by Private Sector

JICA