5) Amortization

The pre-operation cost and IDC are amortized in equal installments for five years after the plant operation.

6) Summary of the Operational Costs

The summary of the operation costs for model plants based upon the above conditions is shown in Table VII.2-6-1 (without escalation) and Table VII.2-6-2 (with escalation).

2.4 Sources of Funds

2.4.1 Equity

Since there are no long term loans available in Romania at the moment, the study is premised on the preparation by SIDEX of an amount equivalent to the local portion of the project costs for equity, and the remaining project costs are supplemented by a foreign loan.

2.4.2 Loan

Besides the equity, the remaining project costs are scheduled to be fully supplemented by foreign loans whose details are shown below. The foreign borrowing is estimated based on three loan conditions, CASE A, B, and C. CASE A is based upon the condition of an ODA fund from governmental institutions, CASE B, a soft loan from foreign banks, and CASE C, a typical long-term commercial credit.

(1) Long-term Foreign Currency Loan

1. CASE A

Interest rate:	3% per annum
Grace period:	seven years
Repayment:	equal annual installments for eighteen years after grace period

2. CASE B

Interest rate:	5% per annum
Grace period:	five years
Repayment:	equal annual installments for ten years after grace period

3. CASE C

Interest rate:	15% per annum
Grace period:	four years, which is the same period of construction of facilities
Repayment:	equal annual installments for eight years after grace period

2.4.3 Summary for the sources of fund

For the conclusion of this Section, the total amount of this project and the source of the funds required for the project are exhibited in Table VII.2-7-1 (without escalation) and Table VII.2-7-2 (with escalation) below.

2.4.4 Hedging of foreign currency fluctuation on long-term debts

Though it is difficult to mention hedging the fluctuations of foreign currencies on long-term loans at the present stage because the currencies on long-term debts have not been decided yet, the following hedging (minimizing) is considered and recommended in general:

a) Swapping to stabilized currency in international money market
b) Forward exchange contract in international foreign exchange market
c) Direct settlement with foreign currency earned by export of products

2.5 Cost Effective Analysis by Financial Internal Rate of Return

2.5.1 Definition

The financial internal rate of return (FIRR) is defined as discount rate equalizing net present value of costs and net present value of returns earned by investments, and shown an "R" calculated in the following formula :

$$\sum_{t=0}^{n} \frac{I_t}{(1+R)^t} = \sum_{t=0}^{n} \frac{S_t}{(1+R)^t}$$

It	:	Costs funds in the t-th year
St	:	Returns in the t-th year

According to the above formula, FIRR is calculated in the following conditions :

FIRR = profit before tax + depreciation cost + amortization cost of deferred assets + interest expense - interest income + book value of fixed assets and inventories at the projection year end + working capital fund at the projection year end

2.5.2 Results of Financial Internal Rate of Return

The result of cost effective analysis for each model plant is summarized in Table VII.2-8-1 (without escalation) and Table VII.2-8-2 (with escalation), and the FIRR for total energy saving, one of the most important figures, is shown below. While FIRR in a fundamental industry like the steel industry is generally around 8.0~15.0%, the revolving rate of capital tends to be high for energy saving projects in general. Irrespective of the difference in the long-term loan conditions in the three cases, CASE A. CASE B, and CASE C, the FIRRs are approximately 19.5% (without escalation), 21.0%(with escalation) in CASE A, 19.2% (w/o escal.), 20.6% (w/ escal.) in CASE B, and 17.2% (w/o escal.), 18.6% (w/ escal.) in CASE C. Therefore, we can say that the investment for energy savings in the study is financially feasible. Since at present LIBOR 6 month (London Inter - Bank Offered Rate) as of September 30, 1994, is 5.6%, the FIRRs in this project are approximately 13 - 15 % better than LIBOR. This means that investment in this project is 13 - 15 % more profitable, if the same amount as the investment were deposited in a bank, although this 13 - 15 % range of profit carries an element of variable risk for the project's operation and implementation.

Financial Internal Rate of Return on Total Energy Saving (Model Plants)

	< Without Escalation >	< With Escalation >
CASE A	19.5 %	21.0%
CASE B	19.2 %	20.6%
CASE C	17.2 %	18.6%

2.6 Sensitivity Analysis on FIRR

The sensitivity in terms of the savings and the costs to the FIRRs for model plants is analyzed for each loan case, and the result is indicated in Figure VII. 2-1-1. ~ Figure VII .2-3-1. for without-escalation, and Figure VII. 2-1-2. ~ Figure VII .2-3-2. for with-escalation. As a result of the sensitivity analysis, it can be concluded that the viability of the project can be maintained, even if the savings and the costs fluctuate by 5% through 20%.

2.7 Economic Analysis for Energy Saving

In evaluating economic impact for energy saving for model plants by using economic internal rate of return (EIRR) from a country point of view, the key is energy prices that are base for calculating amount of savings. In this study, energy prices are adjusted with international prices listed in Diagram VII 2-2 as the optimal allocated prices of resources. As regards adjustments to shadow wage, shadow exchange coefficient and so on, please note that the same information on wages and exchange rates as those used for the FIRR are adopted in the calculating EIRR, partly because basic information required for calculation is insufficient or not ready for use due to the transition period to the market economy from the socialist planned economy, and partly because most of the costs under the existing system can be utilized as sunk costs, which indicates that the impact of new input data to be converted by shadow conversion factors is small. The summary of the EIRRs is shown below.

Economic Internal Rate of Return on Total Energy Saving (Model Plants)

	< Without Escalation >	< With Escalation >
CASE A	21.3 %	22.8 %
CASE B	20.9 %	22.4 %
CASE C	18.9 %	20.4 %

2.8 Appraisal of Effectiveness of Other Related Plants on Energy Saving

2.8.1 General

Evaluated were the effect of investment in other related plants, to which most of the same measures on model plants are applied in the same manner as that in the model plants. The objective sectors are coke oven batteries including CDQs and chemical plants, sintering plants, and blast furnaces. The results of the evaluation from a technical standpoint is described in Article 7 of Chapter IV. Please note that any information or any analysis on model plants are not included in other related plants in Article 2.8 of Chapter VII.

2.8.2 Basis of calculation of FIRR on related plants

The project costs and the amounts of energy saving, as base data for cost effective analysis for other related plants, are respectively US$ 127,238,000.- and US$ 21,095,600.-/year. As regards the details, please refer to Table VII.2-9. The schedule of plant construction whose period is 4 years is planned to be started after completion of construction of model plants. The project life is considered to be 15 years from the commencement of commercial operations.

2.8.3 Analysis of effect

The result of cost effective analysis in the case is summarized in Table VII.2-10-1 (without escalation) and Table VII.2-10-2 (with escalation), and the financial internal rate of return for total energy saving in the case is shown below in order to provide a big picture for consideration.

<u>Financial Internal Rate of Return on Related Plants for Energy Saving to which the measurements of Model Plants are extended (Related Plants)</u>

	< Without Escalation >	< With Escalation >
CASE A	8.9 %	10.0 %
CASE B	8.6 %	9.7 %
CASE C	7.1 %	8.1 %

As the above FIRRs suggest, it is difficult to say if this investment for other related plants is financially feasible. This is partly because the model plants, compared with the other related plants, can preferentially be operated from a productive efficiency point of view, and this is partly because the other related plants are so obsolete that the investment for other related plants could not gain higher profitability than that for model plants. Because the study of other related plants was only a preliminary one, more detailed survey would be recommendable. Yet please notice that as regards cokes oven batteries, the FIRRs in all loan cases are over 20 %. Therefore, the effect on energy saving of No. 6 & No.7 cokes oven battery (including CDQs) can be said to be financially feasible, in case that the same measurement for No.5 coke model plant is rippled to No. 6 & No.7 cokes.

3 COST ANALYSIS FOR ENVIRONMENTAL POLLUTION CONTROL

3.1 Cost Effectiveness Analysis

3.1.1 General

Strategies on environmental policy differ from country to country, such as Best Available Control Technology (BACT) in the United States, Best Practical Means (BPM) approach in the United Kingdom, a combined form of BACT and Precautionary approach in EU, and so forth. On the other hand, as regards economic analysis of environmental impacts, there are many methods from an academic standpoint, such as valuation methodology, cost-benefit approaches, willingness-to-pay versus willingness-to-accept approach, and so forth. Those methods are not easily accepted publicly since the economic costs of a project are not relatively easy to quantify, in cases where significant externalities such as environmental impacts are involved. In this study, as described in Chapter VII, 1.1.2, the method of cost-effectiveness analysis is adopted.

Although stage-wise programs for abatement of environmental pollution are supposed to be prepared at the beginning of the study, we set up overcoming Romanian environmental standards as the target.

As ways (= technologies) of achieving the target, particularly, dust collectors and discharging phenol, the technologies for measurement that are described in Chapter III are generic ones and there are little alternatives on the technologies.

As regards NOx from the cokes plant and the sintering plant, the measurement for energy saving concurrently leads to overcoming the environmental emission standards for waste gas.

Although, as regards SOx from the sintering plant in this study, dry type of de-sulfurization system by moving bed of activated coke is recommended, while there is another technology for de-sulfurization, wet type of de-sulfurization system, which additionally requires facilities for treatment for waste water and needs the same cost as that for the dry type of de-sulfurization system, or a little higher cost. In terms of protecting concomitant pollution out of the first measurement of environmental protection and in terms of monetary view, the dry type of de-sulfurization system is recommended. We have deeply discussed the measurements of SOx with one of our counterparts, SIDEX from technical and economic points of view since the second site survey. As a result of our discussion, the dry type of de-sulfurization system was chosen, which expands that our recommendation has been established based upon the method of cost-effectiveness analysis.

As a result of the evaluation based upon the method of cost-effectiveness analysis, the estimated costs for the environmental pollution control, including the cost of capital and the operational cost are shown as least costs in 3.1.2 and 3.1.3 below.

3.1.2 Cost of capital

The cost for environmental pollution control for model plants and other related plants is estimated in the same manner and the same conditions as those for energy saving. As regards the summary of costs, please refer to Table VI.1-2. (The escalation factor is not considered in the case.) Besides, the costs sorted in the modification costs and the renewal costs of equipment are shown below.

Table VII. 3-1. : Sorted Capital Cost for Environmental Pollution Control

A) Model Plants	(Unit: K US$/Year)
a) Modification of Equipment	32,121.-
b) Renewal of Equipment	45,979.-
Total	78,100.-
B) Other Related Plants	(Unit: K US$/Year)
a) Modification of Equipment	28,362.-
b) Renewal of Equipment	67,306.-
Total	95,668.-

3.1.3 Operational cost

The cost of electricity and active coke for each plant, indicated in Table VII.3-2 below, is required annually.

Table VII. 3-2. : Variable Cost on Investment for Environmental Pollution Control for Model Plant and Other Related Plant

A) Model Plant	(Unit: US$/Year)
No. 5 Cokes Oven Battery Plant	426,000.-
No.7 Sintering Plant	3,564,000.-
No.6 Blast Furnace	560,000.-
Total	4,550,000.-
B) Other Related Plant	(Unit: US$/Year)
No. 5 Cokes Oven Battery Plant	589,000.-
No.7 Sintering Plant	2,730,000.-
No.6 Blast Furnace	374,000.-
Total	3,693,000.-

3.2 Analysis of Benefits of Environmental Pollution Control and Alternatives

As regards benefits out of the measurements for environmental pollution control, such benefits are considered;

- benefits on health of human beings, such as reduction of occurrence ratio for sickness,
- benefits on living environment, such as the beauties of nature, and
- benefits on economics, such as increase of land prices thanks to the beauties of nature

Since those benefits are difficult enough to measure in monetary terms, the decision maker must determine that the potential benefits justify the costs involved. Accordingly, it is recommended that a decision on environmental pollution control be made mainly from three points of view, : a monetary one, such as investment costs; a legal one, such as environmental standards; and a scientific one, such as decreased amount of SOx. Since SIDEX is forced to accord with Romanian environmental standards that is not inferior to that in the EU and the technology on environmental pollution control that SIDEX will promote has already been practiced in Japan, it is recommended that SIDEX carry out the benefits on environmental pollution control based upon the study.

For reference, the financial internal rate of return on total investment for both energy saving and environmental pollution control against the amount of savings, as return, from only energy saving for model plants is calculated and shown in Table VII.3-3. These figures illustrate the profitability for the total investment for both energy saving and environmental pollution control from a company, SIDEX's point of view, which means those minimum values can be earned from the study.

Table VII.3-3. : Financial Internal Rate of Return on Total Project

	< Without Escalation >	< With Escalation >
CASE A	9.9 %	10.8 %
CASE B	9.4 %	10.3 %
CASE C	7.0 %	7.9 %

4. COST ANALYSIS FOR OPERATIONAL ASSISTANCE

4.1 Cost of Operational Assistance

The cost for operational assistance for the model plants is estimated in the same manner as that for energy saving. As regards the summary of the cost, please refer to Table VI.4-1. (The escalation factor is not considered in the case.) Note it is difficult to evaluate the impact of the operational assistance on energy savings because the effect varies depending upon to what extent the operational assistance would technically be transferred and to what extent that assistance would be recognized by operators for appropriate and stable operations. Therefore, in the study, the cost of operational assistance is estimated under normal practice based upon the experience of the study team.

Table VII.4-1. Cost on Operational Assistance

	(Unit: US$)
No. 5 Cokes Oven Battery Plant	310,000.-
No.6 Blast Furnace Plant	250,000.-
Total	560,000.-

4.2 Effect of Operational Assistance

The effect of operational assistance on energy saving on a 100% technically transferred basis is evaluated in Table VII. 4-2:

Table VII.4-2. Effect of Operational Assistance

	(Unit: US$/Year)
No. 5 Cokes Oven Battery Plant	327,000.-
No.6 Blast Furnace Plant	9,283,000.-
Total	9,610,000.-

5. ECONOMIC ANALYSIS

5.1 Effect of Foreign Currency Saving

In this study, the foreign portion (85.03%) in the amount of savings without escalation used in the financial analysis on energy saving directly illustrates the effect of foreign exchange saving. In order to precisely determine the net amount of savings of foreign currency, it can be calculated by subtracting the foreign portion of the repayments and the interest for long-term borrowing and the payment for the variable cost from the amount of savings. The summary of Balance of Foreign currencies is shown in Table VII.5-1. The result of calculation is as follows;

	Total Amount	The Annual Average
CASE A	US$ 556,714,000.	US$ 37,114,000.
CASE B	US$ 546,320,000.	US$ 36,421,000.
CASE C	US$ 438,119,000.	US$ 29,208,000.

5.2 Improvement of Environment and Its Technical and Educational Influence

As described in Chapter III, the countermeasure on environmental pollution control based on this study leads to reducing the emissions air & water pollution, and waste from SIDEX, and contributes to the improvement of the environment around the works and the workshops. Technology on facilities and know-how in terms of environmental protection based upon the study will have an influence on not only other steel plants, but also other industries in Romania as well as surrounding countries. In this sense, this project is a step in the improvement of the environment by the Romanian iron making industry. In addition, concern for environmental preservation will be sweeping through people around SIDEX and in Romania generally, which will help SIDEX as well as the government of Romania in order to establish a production system for preserving ecological foundations and promote the environmental consciousness of the people.

5.3 Advancement of Energy Saving Technology, and Effective Use of Natural Resources

The measurement on the energy saving based upon the study will promote a steady supply of energy, which will contribute to improvements of the whole industrial structure in Romania. It will also promote the suitable usage of energy, enable the people and companies to utilize existing resources efficiently, and reduce environmental degradation generated by such energy consumption.

5.4 Effect of Environmental Pollution Control and Energy Saving on Other Industries

When this project is completed, it is expected that technology for the saving of energy and environmental pollution control will extend socio-economic added values to all over Romania, and that it will have ripple-effects on other industries that are deeply connected with the steel making industry, such as ;

a) Construction
b) Piping and other engineering industries
c) Transportation, and repair and maintenance
d) Manufacturing and distribution of parts and materials.

Table VII. 2-1. Energy price of SIDEX

Item	Energy Unit Price			Carolific Value		Unit price
	$	Lei.				($/Gcal)
COKING COAL	60.00		$/t	7,000	kcal/kg	8.57
ENERGETIC COAL	45.00		$/t	6,000	kcal/kg	7.50
COKE (BLAST FURNACE)	83.64	138,000	$/t	6,300	kcal/kg	13.28
COKE (SINTERING PLANT)	55.27	91,200	$/t	6,300	kcal/kg	8.77
TAR	40.61	67,000	lei/t	8,500	kcal/kg	4.78
LIGHT OIL	116.97	193,000	lei/t			
BTX	123.64	204,000	lei/t			
NH3	30.30	50,000	lei/t			
NATURAL GAS	90.00		$/kNm3	8,050	kcal/Nm3	11.18
ELECTRIC POWER	40.61	67,000	$/MWh	2,450	kcal/kWh	16.57
HIGH PRESSURE STEAM	16.38	27,030	lei/Gcal	35-40	ata	16.38
MID. PRESSURE STEAM	10.73	17,700	lei/Gcal	8 -13	ata	10.73
BFG	8.95	14,760	lei/kNm3	800	kcal/Nm3	11.18
COG	47.52	78,400	lei/kNm3	4,250	kcal/Nm3	11.18
O2	28.33	46,750	lei/kNm3	1,710	kcal/Nm3	16.57
N2	16.57	27,341	lei/kNm3	1,001	kcal/Nm3	16.55
AIR	16.57	27,340	lei/kNm3	1,000	kcal/Nm3	16.57
(Exchange Rate : 1 $ = 1,650 Lei)						

Diagram VII. 2-1. CALCULATION OF COKE PRICE

Average Yield Rate of Coke	; 75.0 %
Unit Rate of COG	; 305 Nm^3/t
Yield Rate of Tar	; 2.9 %
Yield Rate of Light Oil	; 1.0 %
Yield Rate of Ammonia	; 0.2 %

Unit Rate for Fuels	; 669 x 10^3 kcal/t
Unit Rate for Electricity	; 32 kWh/t
Unit Rate for Steam high press.	; 378 kg/t
medium press.	; 143 kg/t

Coal Cost	; 60 $/t
COG Cost	; 11.18 $/$10^6$ kcal
Tar Cost	; 67,000 lei/t
Light Oil Cost	; 193,000 lei/t
Ammonia Cost	; 50,000 lei/t

Fuel Price	; 11.18 $/$10^6$kcal
Electricity Price	; 67.0 lei/kWh
Steam Price high press.	27,030lei/t
medium press.	17,700lei/t

: Average Price for Cost (Variable Cost) = $\frac{\text{Coal Cost} + \text{Processing Fees} - \text{(COG, Tar, Ammonia,etc)}}{\text{Average Yield of Coke}}$

= 79.5 $/t

: Price of Coke Powders = Price for Lumps of Coke × 0.66

(0.66 = price ratio as of Sept.,1994)

Assuming that the ratio between lumps of coke and coke powders is 85% to 15% and that the ratio is applicable for calculating those prices in the study, each price for the lumps of coke and the coke powders is set up, as follows:

Price for Lumps of Coke	=	83.8	$/t
Price for Coke Powders	=	55.3	$/t

Table VII. 2-2. Summary for Saving Amounts

(Unit: K US$/Year)

Sect	Measurement for Energy Saving	Basic Saving Amounts	Escalated Saving Amounts
1)	No. 5 Coke Oven Battery Plant	6,583.55	7,632.14
2)	No.7 Sintering Plant	6,024.35	6,983.87
3)	No.6 Blast Furnace Plant	30,216.09	35,028.73
4)	No.3 Reheating Furnace Plant	11,313.00	13,114.87
5)	Energy Supply	4,950.00	5,738.41
	TOTAL FOR ENERGY SAVING	59,086.99	68,498.02

The escalated saving amounts are calculated by multiplying the basic ones by an escalation factor, 1.03^5.

Table VII.2-3-1. Summary for Escalated Capital Cost, Preoperation Cost, and IDC (Without Escalation)

(Unit: K US$)

	Capital Investment			Pre-Operation cost			IDC			TTL		
	F. Portion	L. Portion	Sub-TTL	F. Portion	L. Portion	Sub-TTL	F. Portion	L. Portion	Sub-TTL	F. Portion	L. Portion	TTL
No.5 Coke Oven Battery Plant												
Case A	6,769	17,129	23,898	389	0	389	302	0	302	7,460	17,129	24,589
Case B	6,769	17,129	23,898	389	0	389	510	0	510	7,668	17,129	24,797
Case C	6,769	17,129	23,898	389	0	389	1,608	0	1,608	8,766	17,129	25,895
No.7 Sintering Plant												
Case A	7,830	7,430	15,260	339	0	339	686	0	686	8,855	7,430	16,285
Case B	7,830	7,430	15,260	339	0	339	1,166	0	1,166	9,335	7,430	16,765
Case C	7,830	7,430	15,260	339	0	339	3,846	0	3,846	12,015	7,430	19,445
No. 6 Blast Furnace Plant												
Case A	70,620	19,270	89,890	389	0	389	3,604	0	3,604	74,613	19,270	93,883
Case B	70,620	19,270	89,890	389	0	389	6,077	0	6,077	77,086	19,270	96,356
Case C	70,620	19,270	89,890	389	0	389	19,283	0	19,283	90,292	19,270	109,562
No.3 Reheating Furnace												
Case A	10,175	8,584	18,759	339	0	339	978	0	978	11,492	8,584	20,076
Case B	10,175	8,584	18,759	339	0	339	1,665	0	1,665	12,179	8,584	20,763
Case C	10,175	8,584	18,759	339	0	339	5,560	0	5,560	16,074	8,584	24,658
Energy Supply												
Case A	29,767	8,658	38,425	100	0	100	1,640	0	1,640	31,507	8,658	40,165
Case B	29,767	8,658	38,425	100	0	100	2,768	0	2,768	32,635	8,658	41,293
Case C	29,767	8,658	38,425	100	0	100	8,840	0	8,840	38,707	8,658	47,365
Total for Energy Saving												
Case A	125,161	61,071	186,232	1,556	0	1,556	7,210	0	7,210	133,927	61,071	194,998
Case B	125,161	61,071	186,232	1,556	0	1,556	12,186	0	12,186	138,903	61,071	199,974
Case C	125,161	61,071	186,232	1,556	0	1,556	39,137	0	39,137	165,854	61,071	226,925

Table VII.2-3-2. Summary for Escalated Capital Cost, Preoperation Cost, and IDC (With Escalation)

(Unit: K US$)

	Capital Investment			Pre-Operation cost			IDC			TTL		
	F. Portion	L. Portion	Sub-TTL	F. Portion	L. Portion	Sub-TTL	F. Portion	L. Portion	Sub-TTL	F. Portion	L. Portion	TTL
No.5 Coke Oven Battery Plant												
Case A	7,430	18,783	26,213	420	0	420	327	0	327	8,177	18,783	26,960
Case B	7,430	18,783	26,213	420	0	420	551	0	551	8,401	18,783	27,184
Case C	7,430	18,783	26,213	420	0	420	1,738	0	1,738	9,588	18,783	28,371
No.7 Sintering Plant												
Case A	8,253	7,841	16,094	353	0	353	720	0	720	9,326	7,841	17,167
Case B	8,253	7,841	16,094	353	0	353	1,222	0	1,222	9,828	7,841	17,669
Case C	8,253	7,841	16,094	353	0	353	4,031	0	4,031	12,637	7,841	20,478
No. 6 Blast Furnace Plant												
Case A	76,818	20,789	97,607	414	0	414	3,883	0	3,883	81,115	20,789	101,904
Case B	76,818	20,789	97,607	414	0	414	6,544	0	6,544	83,776	20,789	104,565
Case C	76,818	20,789	97,607	414	0	414	20,751	0	20,751	97,983	20,789	118,772
No.3 Reheating Furnace												
Case A	10,638	8,974	19,612	348	0	348	1,019	0	1,019	12,005	8,974	20,979
Case B	10,638	8,974	19,612	348	0	348	1,736	0	1,736	12,722	8,974	21,696
Case C	10,638	8,974	19,612	348	0	348	5,790	0	5,790	16,776	8,974	25,750
Energy Supply												
Case A	32,249	9,380	41,629	113	0	113	1,759	0	1,759	34,121	9,380	43,501
Case B	32,249	9,380	41,629	113	0	113	2,968	0	2,968	35,330	9,380	44,710
Case C	32,249	9,380	41,629	113	0	113	9,475	0	9,475	41,837	9,380	51,217
Total for Energy Saving												
Case A	135,388	65,767	201,155	1,648	0	1,648	7,708	0	7,708	144,744	65,767	210,511
Case B	135,388	65,767	201,155	1,648	0	1,648	13,021	0	13,021	150,057	65,767	215,824
Case C	135,388	65,767	201,155	1,648	0	1,648	41,785	0	41,785	178,821	65,767	244,588

Table VII. 2-4-1. Summary for Annual Project Costs (Without Escalation)

Rate of escalation = 0.00%

A) CAPITAL INVESTMENT (Escalated)

		1995	1996	1997	1998	1999	TOTAL	
No.5 Coke	Total of Foreign (W/ Esc)	0	1,436	3,360	2,634		7,430	28.3%
Oven Plant	Total of Local (W/ Esc)	0	3,634	9,160	5,989		18,783	71.7%
	Sub Total		5,070	12,520	8,623		26,213	
No.7 Sintering	Total of Foreign (W/Esc)	2,342	5,337	574			8,253	51.3%
Plant	Total of Foreign(W/Esc)	2,187	4,843	811			7,841	48.7%
	Sub Total	4,529	10,180	1,385			16,094	
No.6 Blast	Total of Foreign (W/Esc)	1,056	23,788	37,299	14,675		76,818	78.7%
Furnace Plant	Total of Local (W/Esc)	1,557	7,881	9,177	2,174		20,789	21.3%
	Sub Total	2,613	31,669	46,476	16,849		97,607	
No.3 Reheating	Total of Foreign (W/Esc)	5,240	5,398				10,638	54.2%
Furnace	Total of Local (W/Esc)	4,421	4,553				8,974	45.8%
	Sub Total	9,661	9,951				19,612	
Energy	Total of Foreign (W/Esc)	0	15,790	9,758	6,701		32,249	77.5%
Supply	Total of Local (W/Esc)	0	4,593	2,838	1,949		9,380	22.5%
	Sub Total	0	20,383	12,596	8,650		41,629	
Energy	Total of Foreign (W/Esc)	8,638	31,749	50,991	24,010		135,388	67.3%
Saving	Total of Local (W/Esc)	8,165	25,504	21,986	10,112		65,767	32.7%
Total	TOTAL	16,803	77,253	72,977	34,122		201,155	

B) Pre-Operation (Escalated)

		1995	1996	1997	1998	1999	TOTAL	
No.5 Coke	Total of Foreign (W/ Esc)	195	0	0	225		420	100.0%
Oven Plant	Total of Local (W/ Esc)	0	0	0	0		0	0.0%
	Sub Total	195	0	0	225		420	
No.7 Sintering	Total of Foreign (W/Esc)	189	0	164			353	100.0%
Plant	Total of Foreign(W/Esc)	0	0	0			0	0.0%
	Sub Total	189	0	164			353	
No.6 Blast	Total of Foreign (W/Esc)	189	0	0	225		414	100.0%
Furnace Plant	Total of Local (W/Esc)	0	0	0	0		0	0.0%
	Sub Total	189	0	0	225		414	
No.3 Reheating	Total of Foreign (W/Esc)	189	159				348	100.0%
Furnace	Total of Local (W/Esc)	0	0				0	0.0%
	Sub Total	189	159				348	
Energy	Total of Foreign (W/Esc)	0	0	0	113		113	100.0%
Supply	Total of Local (W/Esc)	0	0	0	0		0	0.0%
	Sub Total	0	0	0	113		113	
Pre-	Total of Foreign (W/Esc)	762	159	164	563		1,648	100.0%
Operation	Total of Local (W/Esc)	0	0	0	0		0	0.0%
Total	TOTAL	762	159	164	563		1,648	

C) IDC (= Interest During Construction)

		1995	1996	1997	1998	1999	TOTAL	
No.5 Coke	Case A (Interest: 3.0%)	3	27	100	197		327	
Oven Plant	Case B (Interest: 5.0%)	5	46	168	332		551	
	Case C (Interest: 15.0%)	15	139	520	1,064		1,738	
No.7 Sintering	Case A (Interest: 3.0%)	38	157	253	272		720	
Plant	Case B (Interest: 5.0%)	63	263	428	468		1,222	
	Case C (Interest: 15.0%)	190	808	1,385	1,648		4,031	
No.6 Blast	Case A (Interest: 3.0%)	19	395	1,323	2,146		3,883	
Furnace Plant	Case B (Interest: 5.0%)	31	659	2,219	3,635		6,544	
	Case C (Interest: 15.0%)	93	1,985	6,864	11,809		20,751	
No.3 Reheating	Case A (Interest: 3.0%)	81	249	339	350		1,019	
Furnace	Case B (Interest: 5.0%)	136	417	577	606		1,736	
	Case C (Interest: 15.0%)	407	1,292	1,903	2,188		5,790	
Energy	Case A (Interest: 3.0%)	0	237	627	895		1,759	
Supply	Case B (Interest: 5.0%)	0	395	1,053	1,520		2,968	
	Case C (Interest: 15.0%)	0	1,184	3,278	5,013		9,475	
	Sub Total							
	Case A (Interest: 3.0%)	142	1,065	2,642	3,859		7,708	7,708
	Case B (Interest: 5.0%)	235	1,780	4,445	6,561		13,021	13,021
	Case C (Interest: 15.0%)	705	5,408	13,950	21,722		41,785	41,785

GRAND TOTAL (A)+B)+C))

		1995	1996	1997	1998	1999	TOTAL	
Total	Total of Foreign (W/ Esc)							
	Case A (Interest: 3.0%)	9,542	52,973	53,797	28,432		144,744	144,744
	Case B (Interest: 5.0%)	9,635	53,688	55,600	31,134		150,057	150,057
	Case C (Interest: 15.0%)	10,105	57,316	65,105	46,295		178,821	178,821
	Total of Local (W/Esc)	8,165	25,504	21,986	10,112		65,767	65,767

Table VII. 2-4-2. Summary for Annual Project Costs (With Escalation)

Rate of escalation= 3.00%

A) CAPITAL INVESTMENT (Escalated)

		1995	1996	1997	1998	1999	TOTAL	
No.5 Coke	Total of Foreign (W/ Esc)	0	1,436	3,360	2,634		7,430	28.3%
Oven Plant	Total of Local (W/ Esc)	0	3,634	9,160	5,989		18,783	71.7%
	Sub Total		5,070	12,520	8,623		26,213	
No.7 Sintering	Total of Foreign (W/Esc)	2,342	5,337	574			8,253	51.3%
Plant	Total of Foreign(W/Esc)	2,187	4,843	811			7,841	48.7%
	Sub Total	4,529	10,180	1,385			16,094	
No.6 Blast	Total of Foreign (W/Esc)	1,056	23,788	37,299	14,675		76,818	78.7%
Furnace Plant	Total of Local (W/Esc)	1,557	7,881	9,177	2,174		20,789	21.3%
	Sub Total	2,613	31,669	46,476	16,849		97,607	
No.3 Reheating	Total of Foreign (W/Esc)	5,240	5,398				10,638	54.2%
Furnace	Total of Local (W/Esc)	4,421	4,553				8,974	45.8%
	Sub Total	9,661	9,951				19,612	
Energy	Total of Foreign (W/Esc)	0	15,790	9,758	6,701		32,249	77.5%
Supply	Total of Local (W/Esc)	0	4,593	2,838	1,949		9,380	22.5%
	Sub Total	0	20,383	12,596	8,650		41,629	
Energy	Total of Foreign (W/Esc)	8,638	51,749	50,991	24,010		135,388	67.3%
Saving	Total of Local (W/Esc)	8,165	25,504	21,986	10,112		65,767	32.7%
Total	TOTAL	16,803	77,253	72,977	34,122		201,155	

B) Pre-Operation (Escalated)

		1995	1996	1997	1998	1999	TOTAL	
No.5 Coke	Total of Foreign (W/ Esc)	195	0	0	225		420	100.0%
Oven Plant	Total of Local (W/ Esc)	0	0	0	0		0	0.0%
	Sub Total	195	0	0	225		420	
No.7 Sintering	Total of Foreign (W/Esc)	189	0	164			353	100.0%
Plant	Total of Foreign(W/Esc)	0	0	0			0	0.0%
	Sub Total	189	0	164			353	
No.6 Blast	Total of Foreign (W/Esc)	189	0	0	225		414	100.0%
Furnace Plant	Total of Local (W/Esc)	0	0	0	0		0	0.0%
	Sub Total	189	0	0	225		414	
No.3 Reheating	Total of Foreign (W/Esc)	189	159				348	100.0%
Furnace	Total of Local (W/Esc)	0	0				0	0.0%
	Sub Total	189	159				348	
Energy	Total of Foreign (W/Esc)	0	0	0	113		113	100.0%
Supply	Total of Local (W/Esc)	0	0	0	0		0	0.0%
	Sub Total	0	0	0	113		113	
Pre-	Total of Foreign (W/Esc)	762	159	164	563		1,648	100.0%
Operation	Total of Local (W/Esc)	0	0	0	0		0	0.0%
Total	TOTAL	762	159	164	563		1,648	

C) IDC (= Interest During Construction)

		1995	1996	1997	1998	1999	TOTAL	
No.5 Coke	Case A (Interest: 3.0%)	3	27	100	197		327	
Oven Plant	Case B (Interest: 5.0%)	5	46	168	332		551	
	Case C (Interest: 15.0%)	15	139	520	1,064		1,738	
No.7 Sintering	Case A (Interest: 3.0%)	38	157	253	272		720	
Plant	Case B (Interest: 5.0%)	63	263	428	468		1,222	
	Case C (Interest: 15.0%)	190	808	1,385	1,648		4,031	
No.6 Blast	Case A (Interest: 3.0%)	19	395	1,323	2,146		3,883	
Furnace Plant	Case B (Interest: 5.0%)	31	659	2,219	3,635		6,544	
	Case C (Interest: 15.0%)	93	1,985	6,864	11,809		20,751	
No.3 Reheating	Case A (Interest: 3.0%)	81	249	339	350		1,019	
Furnace	Case B (Interest: 5.0%)	136	417	577	606		1,736	
	Case C (Interest: 15.0%)	407	1,292	1,903	2,188		5,790	
Energy	Case A (Interest: 3.0%)	0	237	627	895		1,759	
Supply	Case B (Interest: 5.0%)	0	395	1,053	1,520		2,968	
	Case C (Interest: 15.0%)	0	1,184	3,278	5,013		9,475	
	Sub Total							
	Case A (Interest: 3.0%)	142	1,065	2,642	3,859		7,708	7,708
	Case B (Interest: 5.0%)	235	1,780	4,445	6,561		13,021	13,021
	Case C (Interest: 15.0%)	705	5,408	13,950	21,722		41,785	41,785

GRAND TOTAL (A)+B)+C))

		1995	1996	1997	1998	1999	TOTAL	
Total	Total of Foreign (W/ Esc)							
	Case A (Interest: 3.0%)	9,542	52,973	53,797	28,432		144,744	144,744
	Case B (Interest: 5.0%)	9,635	53,688	55,600	31,134		150,057	150,057
	Case C (Interest: 15.0%)	10,105	57,316	65,105	46,295		178,821	178,821
	Total of Local (W/Esc)	8,165	25,504	21,986	10,112		65,767	65,767

Table VII. 2-5. Salaries Levels for Operators in SIDEX

on June 30th, 1994

	Basic salary lei (@)	Additional salaries for special working conditions = @ * %	Tax = @ * %	Pension = @ * %
coke-maker	184,000	60	30	3
analyst	184,000	60	30	3
blast-furnace worker	172,500	55	30	3
sintering worker	172,500	55	30	3
locksmith, mechanic, electrician for maintenance	166,750	55	30	3
reheating furnace operator	172,500	55	30	3
Hot Strip Rolling Mill	243,800	50	30	3
engineer (university)	254,150	45	30	3
unskilled worker	126,500	50	30	3

Table VII.2-6-1. Summary for Annual Operation Cost (Without Escalation)

(Unit; K US$/Year)

	Variable Costs	Labor Cost	Maintenace	Depreciation Engineering	Depreciation Equip. & Matls	Amortization	TTL
No.5 Coke Oven Battery Plant							
Case A	24.0	0.0	563.3	233.0	1,022.3	138.2	1,980.8
Case B	24.0	0.0	563.3	233.0	1,022.3	179.8	2,022.4
Case C	24.0	0.0	563.3	233.0	1,022.3	399.4	2,242.0
No.7 Sintering Plant							
Case A	43.9	9.6	496.0	184.2	663.1	205.0	1,601.8
Case B	43.9	9.6	496.0	184.2	663.1	301.0	1,697.8
Case C	43.9	9.6	496.0	184.2	663.1	837.0	2,233.8
No. 6 Blast Furnace Plant							
Case A	90.0	23.9	1,798.0	1,014.2	4,546.2	798.6	8,270.9
Case B	90.0	23.9	1,798.0	1,014.2	4,546.2	1,293.2	8,765.5
Case C	90.0	23.9	1,798.0	1,014.2	4,546.2	3,934.4	11,406.7
No.3 Reheating Furnace							
Case A	19.0	0.0	375.0	208.6	923.6	263.4	1,789.6
Case B	19.0	0.0	375.0	208.6	923.6	400.8	1,927.0
Case C	19.0	0.0	375.0	208.6	923.6	1,179.8	2,706.0
Energy Supply							
Case A	38.0	0.0	769.0	403.2	1,812.1	348.0	3,370.3
Case B	38.0	0.0	769.0	403.2	1,812.1	573.6	3,595.9
Case C	38.0	0.0	769.0	403.2	1,812.1	1,788.0	4,810.3
Total for Energy Saving							
	215	34	4,001	2,043	8,967	1,753	17,013
	215	34	4,001	2,043	8,967	2,748	18,009
	215	34	4,001	2,043	8,967	8,139	23,399

(*) The depreciation of engineering and the amortization are valid for 5 years from the start-up of operations base upon the staraight-line mehtos, and the depreciation of equipment and machinery, 15 years.

Table VII.2-6-2. Summary for Annual Operation Cost (With Escalation)

(Unit: K US$/Year)

	Variable Costs	Labor Cost	Maintenace	Depreciation		Amortization	TTL
				Engineering	Equip. & Matls		
No.5 Coke Oven Battery Plant							
Case A	26.0	0.0	563.3	255.8	1,121.5	149.4	2,116.0
Case B	26.0	0.0	563.3	255.8	1,121.5	194.2	2,160.8
Case C	26.0	0.0	563.3	255.8	1,121.5	431.6	2,398.2
No.7 Sintering Plant							
Case A	43.9	9.6	496.0	194.2	699.3	214.6	1,657.6
Case B	43.9	9.6	496.0	194.2	699.3	315.0	1,758.0
Case C	43.9	9.6	496.0	194.2	699.3	876.8	2,319.8
No. 6 Blast Furnace Plant							
Case A	98.0	23.9	1,952.0	1,103.2	4,941.5	859.4	8,978.0
Case B	98.0	23.9	1,952.0	1,103.2	4,941.5	1,391.6	9,510.2
Case C	98.0	23.9	1,952.0	1,103.2	4,941.5	4,233.0	12,351.6
No.3 Reheating Furnace							
Case A	20.0	0.0	392.0	218.0	965.6	273.4	1,869.0
Case B	20.0	0.0	392.0	218.0	965.6	416.8	2,012.4
Case C	20.0	0.0	392.0	218.0	965.6	1,227.6	2,823.2
Energy Supply							
Case A	42.0	0.0	833.0	436.8	1,963.2	374.4	3,649.4
Case B	42.0	0.0	833.0	436.8	1,963.2	616.2	3,891.2
Case C	42.0	0.0	833.0	436.8	1,963.2	1,917.6	5,192.6
Total for Energy Saving							
	230	34	4,236	2,210	9,691	1,871	18,272
	230	34	4,236	2,210	9,691	2,934	19,335
	230	34	4,236	2,210	9,691	8,687	25,087

(*) The depreciation of engineering and the amortization are valid for 5 years from the start-up of operations base upon the staraight-line mehtos, and the depreciation of equipment and machinery, 15 years.

Table VII. 2-7 : Required Funds

CASE A	With Escalation		(Unit: K US$/Year)	Without Escalation		(Unit: K US$/Year)
	Loan	Equity	Total	Loan	Equity	Total
No.5 Cokes Oven Battery Plant	8,177	18,783	26,960	7,460	17,129	24,589
No.7 Sinter Plant	9,326	7,841	17,167	8,855	7,430	16,285
No.6 Blast Furnace Plant	81,115	20,789	101,904	74,613	19,270	93,883
No.3 Reheating Furnace Plant	12,005	8,974	20,979	11,492	8,584	20,076
Energy Supply	34,121	9,380	43,501	31,507	8,658	40,165
Total for Energy Saving	144,744	65,767	210,511	133,927	61,071	194,998
	68.76%	31.24%		68.68%	31.32%	

CASE B	With Escalation		(Unit: K US$/Year)	Without Escalation		(Unit: K US$/Year)
	Loan	Equity	Total	Loan	Equity	Total
No.5 Cokes Oven Battery Plant	8,401	18,783	27,184	7,668	17,129	24,797
No.7 Sinter Plant	9,828	7,841	17,669	9,335	7,430	16,765
No.6 Blast Furnace Plant	83,776	20,789	104,565	77,086	19,270	96,356
No.3 Reheating Furnace Plant	12,722	8,974	21,696	12,179	8,584	20,763
Energy Supply	35,330	9,380	44,710	32,635	8,658	41,293
Total for Energy Saving	150,057	65,767	215,824	138,903	61,071	199,974
	69.53%	30.47%		69.46%	30.54%	

CASE C	With Escalation		(Unit: K US$/Year)	Without Escalation		(Unit: K US$/Year)
	Loan	Equity	Total	Loan	Equity	Total
No.5 Cokes Oven Battery Plant	9,588	18,783	28,371	8,766	17,129	25,895
No.7 Sinter Plant	12,637	7,841	20,478	12,015	7,430	19,445
No.6 Blast Furnace Plant	97,983	20,789	118,772	90,292	19,270	109,562
No.3 Reheating Furnace Plant	16,776	8,974	25,750	16,074	8,584	24,658
Energy Supply	41,837	9,380	51,217	38,707	8,658	47,365
Total for Energy Saving	178,821	65,767	244,588	165,854	61,071	226,925
	73.11%	26.89%		73.09%	26.91%	

Table VII. 2-8-1. Summary of FIRR on Energy Saving of Model Plants (Without Escalation)

	CASE A	CASE B	CASE C
1) Cokes Oven Battery	19.1%	19.0%	18.2%
2) Sintering	20.2%	19.9%	17.9%
3) Blast Furnace	21.4%	21.0%	18.9%
4) Reheating Furnace	27.5%	27.0%	24.7%
5) Energy Supply	5.9%	5.6%	4.1%
6) Total (Energy)	19.5%	19.2%	17.2%

The word, FIRR means "Financial Rate of Return."

Remarks

a) Equity Condition

Since there are no long term loan available locally in Romania at present, this study is examined based upon premise that SIDEX could prepare an amount equivalent to the local portion of inflated project cost as equity and that the remained project costs could be supplemented by foreign loan(s) for each case.

b) Loan Conditions

	CASE A	CASE B	CASE C
Interest Rate	3% per annum	5% per annum	15% per annum
Repayment Period	25 years (inclining Grace Period)	15 years (incl. G/P)	12 years (incl. G/P)
Grace period	7 years	5 years	4 years(=Modernization Period)

Table VII. 2-8-2. Summary of FIRR on Energy Saving of Model Plants (With Escalation)

	CASE A	CASE B	CASE C
1) Cokes Oven Battery	20.4%	20.2%	19.5%
2) Sintering	22.1%	21.7%	19.7%
3) Blast Furnace	22.8%	22.4%	20.2%
4) Reheating Furnace	29.5%	29.0%	26.7%
5) Energy Supply	6.8%	6.5%	4.9%
6) Total (Energy)	21.0%	20.6%	18.6%

The word, FIRR means "Financial Internal Rate of Return."

Remarks

a) Equity Condition

Since there are no long term loan available locally in Romania at present, this study is examined based upon premise that SIDEX could prepare an amount equivalent to the local portion of inflated project cost as equity and that the remained project costs could be supplemented by foreign loan(s) for each case.

b) Loan Conditions

	CASE A	CASE B	CASE C
Interest Rate	3% per annum	5% per annum	15% per annum
Repayment Period	25 years (inclining Grace Period)	15 years (incl. G/P)	12 years (incl. G/P)
Grace period	7 years	5 years	4 years(=Modernization Period)

CASE A
(FIRR W/O Escal.)

FIRR ON INVESTMENT(Before Tax)

Analysis Item(s)	-20.00	-10.00	-5.00	Sensitivity (%) Base Case	5.00	10.00	20.00
Investment	23.43	21.33	20.41	19.54	18.73	17.98	16.60
Sales Amount	15.57	17.62	18.60	19.54	20.46	21.35	23.09
Variable Cost	19.56	19.55	19.55	19.54	19.54	19.54	19.53
Production	15.59	17.53	18.60	19.54	20.46	21.35	23.08

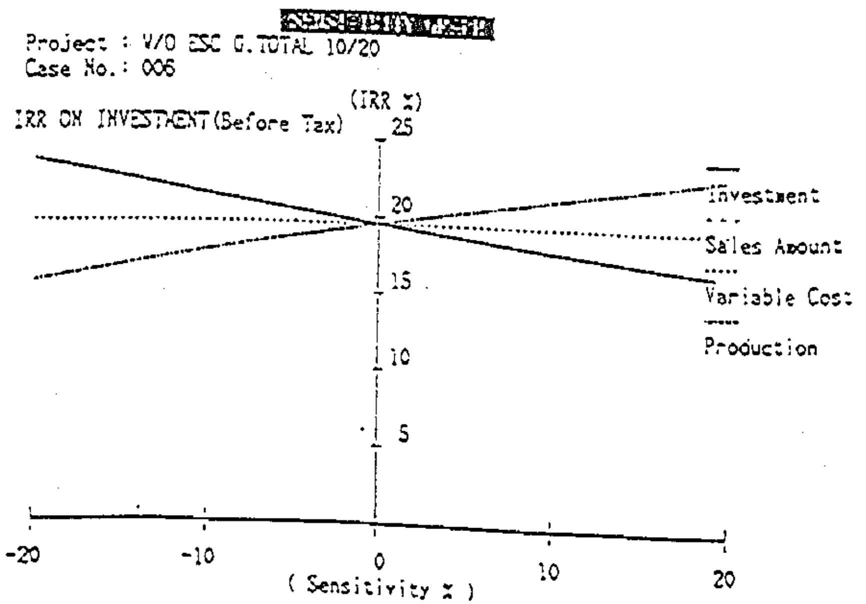

Fig. VII.2-1-1. Case A : Sensitivity analysis (without escalation)

CASE B
(FIRR W/O Escal.)

FIRR ON INVESTMENT (Before Tax)

Analysis Item (%)	-20.00	-10.00	-5.00	Base Case	5.00	10.00	20.00
			Sensitivity (%)				
Investment	22.89	20.88	19.99	19.16	18.37	17.63	16.29
Sales Amount	15.22	17.25	18.22	19.16	20.07	20.96	22.67
Variable Cost	19.17	19.16	19.16	19.15	19.15	19.15	19.14
Production	15.23	17.26	18.22	19.15	20.07	20.95	22.65

[redacted]

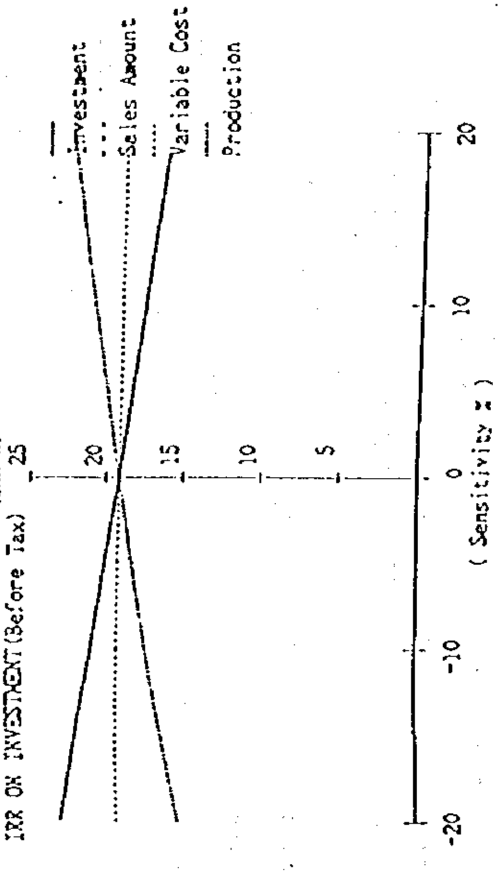

Fig. VII.2-2-1. Case B : Sensitivity analysis (without escalation)

CASE C
(FIRR W/O Escal.)

FIRR ON INVESTMENT(Before Tax)

Analysis Item(s)	-20.00	-10.00	-5.00	Base Case	5.00	10.00	20.00
			Sensitivity (%)				
Investment	20.30	18.67	17.93	17.24	16.55	15.90	14.72
Sales Amount	13.45	15.40	16.33	17.24	18.11	18.97	20.62
Variable Cost	17.25	17.24	17.24	17.24	17.23	17.23	17.22
Production	13.46	15.41	16.34	17.24	18.11	18.95	20.60

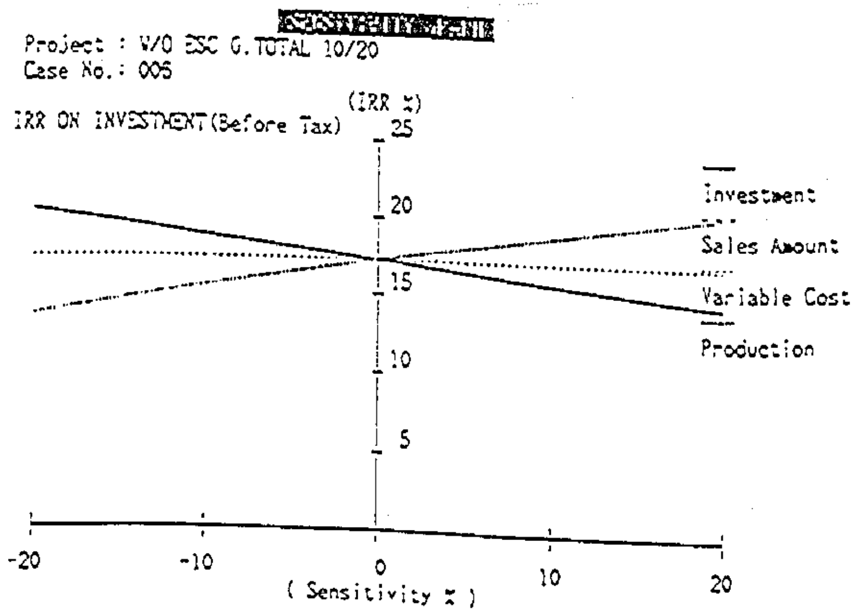

Fig. VII.2-3-1. Case C : Sensitivity analysis (without escalation)

CASE A
(FIRR W/ Escal.)

FIRR ON INVESTMENT(Before Tax)

Analysis Item(s)	-20.00	-10.00	-5.00	Base Case	5.00	10.00	20.00
			Sensitivity (%)				
Investment	25.05	22.85	21.89	20.99	20.15	19.36	17.92
Sales Amount	16.88	19.00	20.01	20.99	21.95	22.87	24.66
Variable Cost	21.00	21.00	20.99	20.99	20.99	20.98	20.98
Production	16.89	19.01	20.01	20.99	21.94	22.87	24.65

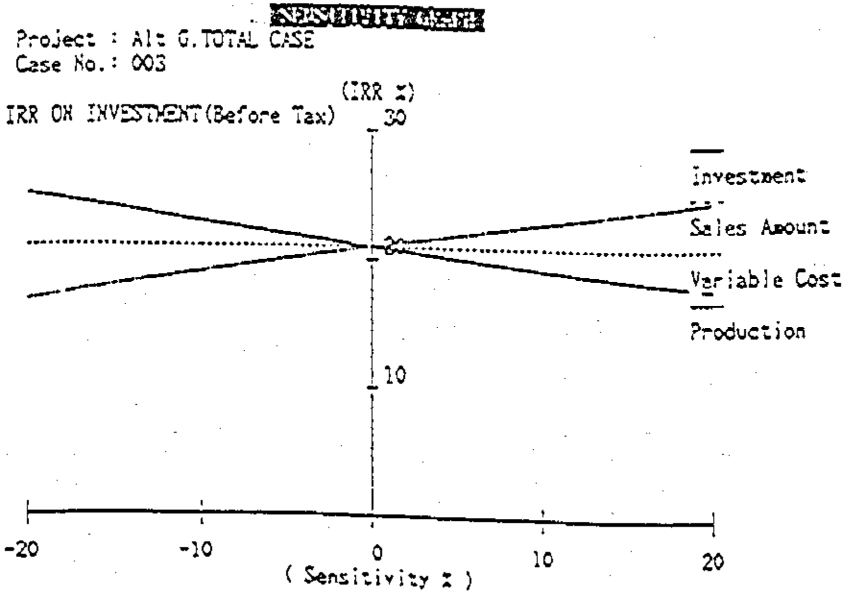

Fig. VII.2-1-2. Case A : Sensitivity analysis (with escalation)

CASE B
(FIRR W/ Escal.)

FIRR ON INVESTMENT(Before Tax)

Analysis Item(s)	-20.00	-10.00	-5.00	Sensitivity (%) Base Case	5.00	10.00	20.00
Investment	24.50	22.40	21.46	20.59	19.77	19.00	17.60
Sales Amount	16.51	18.62	19.62	20.59	21.54	22.46	24.24
Variable Cost	20.61	20.60	20.60	20.59	20.59	20.59	20.58
Production	15.53	18.62	19.62	20.59	21.54	22.46	24.23

[redacted]
Project : Alt G.TOTAL CASE
Case No.: 003

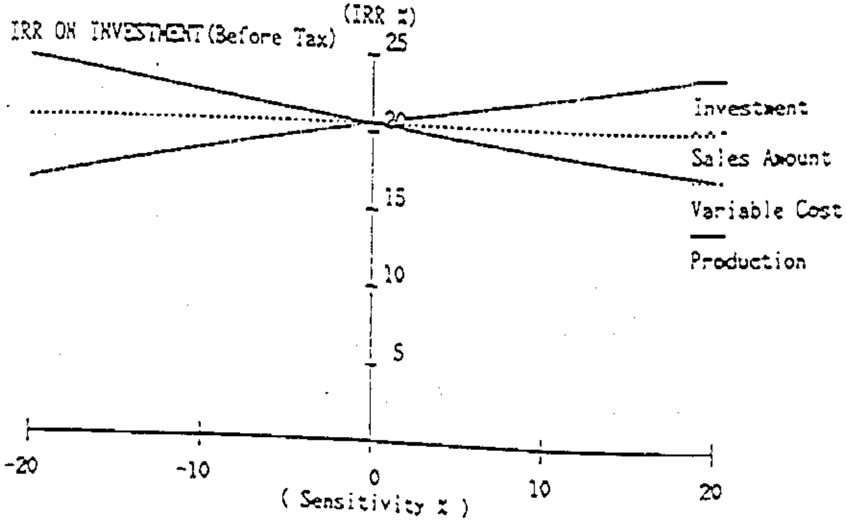

Fig. VII.2-2-2. Case B : Sensitivity analysis (with escalation)

CASE C
(FIRR W/ Escal.)

FIRR ON INVESTMENT(Before Tax)

Analysis Item(s)	-20.00	-10.00	-5.00	Sensitivity (%) Base Case	5.00	10.00	20.00
Investment	21.84	20.13	19.35	18.63	17.91	17.24	16.00
Sales Amount	14.71	16.73	17.69	18.63	19.54	20.43	22.13
Variable Cost	18.64	18.63	18.63	18.63	18.62	18.62	18.62
Production	14.72	16.73	17.70	18.63	19.54	20.42	22.12

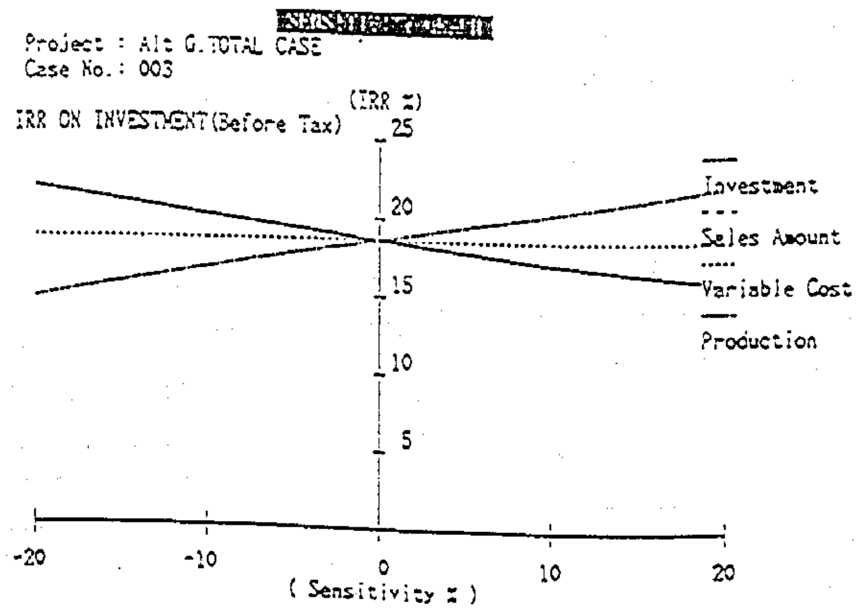

Fig. VII.2-3-2. Case C : Sensitivity analysis (with escalation)

Diagram VII. 2-2. International Energy Price for EIRR

1) Natural Gas

- Reference: BP REVIEW OF WORLD GAS, Aug. 1993 (p.18)
- Method of Calculation: Average price of OECD Europe, USA(Wellhead), USA(Import) in 1992

2.23US$/MMBTU = 88.5US$/KN㎥

2) Electricity

- Reference: SRI PEP YEARBOOK 1991 (p.21)
- Method of Calculation Average price of USA, WEST GERMANY, JAPAN

(3.7+4.92+7.94) / 3 = 5.42 ¢ /kWh = 54.2 $ /mWh

3) Coke

- Reference: Statistics of Japan Customs Institute, 1993
- Method of Calculation: Since cokes purchased from other countries are very little at present and in the future as long as the cokes are produced in SIDEX, those cokes have to be multiplied by economic conversion factor, because those are non-tradeable costs. However, basic data for setting up economic conversion factor is insufficient at the present, 83.8$/t (lumps of coke) and 55.3$/t (coke powders), used for calculating FIRRs, are also adopted as the unit prices for coke in the economic evaluation.

4) Metallurgical Coal

- Reference: COAL MANUAL 1994 (p. 118)
- Method of Calculation: Average price of coaking coal based upon US$ per MT internationally

41.20US$/t

5)Energetic Coal for PCI

- Reference: COAL MANUAL 1994 (p. 119)
- Method of Calculation: Average price of coaking coal based upon US$ per MT internationally

32.41US$/t

Table VII. 2-9. Base of Calculation for Related Plants

1)Capital Cost for Related Plant(Energy Saving only) Without Escalation

(Unit: K US$)

	Coke Oven Battery			Sintering Plant			Blast Furnace Plant			Reheating Furnace Plant			Energy Supply			Total for Energy Saving		
	Foreign	Local	Sub-Total	Foreign	Local	Sub-Total	Foreign	Local	Sub-Total	Foreign	Local	Sub-Total	Foreign	Local	Sub-Total	Foreign	Local	Sub-Total
Engineering Fee	1,477	0	1,477	850	0	850	5,432	0	5,432	0	0	0	0	0	0	7,759	0	7,759
Equipment & Materials	8,595	10,909	19,504	6,228	5,050	11,278	71,443	1,800	73,243	0	0	0	0	0	0	86,265	17,759	104,024
Transportation	427	0	427	327	0	327	3,961	0	3,961	0	0	0	0	0	0	4,715	0	4,715
Civil & Erection	0	870	870	0	2,810	2,810	0	7,060	7,060	0	0	0	0	0	0	0	10,740	10,740
Contingency	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sub Total (1)	10,499	11,779	22,278	7,405	7,860	15,265	80,836	8,860	89,696	0	0	0	0	0	0	98,739	28,499	127,238

2) Capital Cost for related Plant (Energy Saving only) With Escalation

(Unit: K US$)

	Coke Oven Battery			Sintering Plant			Blast Furnace Plant			Reheating Furnace Plant			Energy Supply			Total for Energy Saving		
	Foreign	Local	Sub-Total	Foreign	Local	Sub-Total	Foreign	Local	Sub-Total	Foreign	Local	Sub-Total	Foreign	Local	Sub-Total	Foreign	Local	Sub-Total
Engineering Fee	1,623	0	1,623	897	0	897	5,944	0	5,944	0	0	0	0	0	0	8,464	0	8,464
Equipment & Materials	9,436	11,960	21,396	6,561	5,327	11,888	78,186	1,954	80,140	0	0	0	0	0	0	94,183	19,241	113,424
Transportation	468	0	468	340	0	340	4,334	0	4,334	0	0	0	0	0	0	5,142	0	5,142
Civil & Erection	0	954	954	0	2,964	2,964	0	7,665	7,665	0	0	0	0	0	0	0	11,583	11,583
Contingency	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sub Total (1)	11,527	12,914	24,441	7,798	8,291	16,089	88,464	9,619	98,083	0	0	0	0	0	0	107,789	30,824	138,613

3) Energy Saving for Related Plant

(Unit: K US$/Year)

	Basic Saving Amount	Escalated Saving Amount
No.5 Coke Oven Battery Plant	7215.20	8364.30
No.7 Sintering Plant	1524.00	1766.70
No.6 Blast Furnace	12356.40	14324.50
TOTAL FOR ENERGY SAVING	21095.60	24455.50

4) Others

1) Starting Date of Construction : January 1, 2001
: This means the above IRRs are calculated based upon present value of 2001 year, 1st year.

2) Starting Date of Operation : January 1, 2005

3) Loan Condition : The loan conditions are the same as those used for IRR for Model plants.

4) Other conditions : The other conditions are the same as those used for IRR for Model plants

Table VII. 2-10-1. Summary of FIRR on Energy Saving of Related Plants (Without Escalation)

		CASE A	CASE B	CASE C
1)	Cokes Oven Battery	22.0%	21.7%	20.5%
2)	Sintering	0.6%	0.3%	-0.9%
3)	Blast Furnace	6.5%	6.2%	4.6%
6)	Total (Energy)	8.9%	8.6%	7.1%

Table VII. 2-10-2. Summary of FIRR on Energy Saving of Related Plants (With Escalation)

		CASE A	CASE B	CASE C
1)	Cokes Oven Battery	23.4%	23.2%	21.9%
2)	Sintering	2.0%	1.7%	4.0%
3)	Blast Furnace	7.4%	7.1%	5.5%
6)	Total (Energy)	10.0%	9.7%	8.1%

Table VII. 5-1 Balance of Saved Foreign currencies

(Unit: K US$)

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	
Saving Amounts without escalation	44,315	59,087	59,087	59,087	59,087	59,087	59,087	59,087	59,087	59,087	59,087	59,087	59,087	59,087	59,087	871,533
Saving Amounts in Foreign Currency	37,681	50,242	50,242	50,242	50,242	50,242	50,242	50,242	50,242	50,242	50,242	50,242	50,242	50,242	50,242	741,064
Consumables from outside Romania	174	232	232	232	232	232	232	232	232	232	232	232	232	232	232	3,422
Sub Total	37,507	50,010	50,010	50,010	50,010	50,010	50,010	50,010	50,010	50,010	50,010	50,010	50,010	50,010	50,010	737,642
Case A																
Repayment on Long-term Loan				8,041	8,041	8,041	8,041	8,041	8,041	8,041	8,041	8,041	8,041	8,041	56,291	144,742
Interest on Long-term Loan				4,342	4,101	3,860	3,619	3,377	3,136	2,895	2,654	2,412	2,171	1,930	1,689	36,186
Annual Foreign Currency Saving	37,507	50,010	50,010	37,627	37,868	38,109	38,350	38,592	38,833	39,074	39,315	39,557	39,798	40,039	-7,970	556,714
Case B																
Repayment on Long-term Loan		15,005	15,005	15,005	15,005	15,005	15,005	15,005	15,005	15,005	15,009					150,054
Interest on Long-term Loan		7,503	6,752	6,002	5,252	4,502	3,751	3,001	2,251	1,501	753					41,268
Annual Foreign Currency Saving	37,507	27,502	28,253	29,003	29,753	30,503	31,254	32,004	32,754	33,504	34,248	50,010	50,010	50,010	50,010	546,320
Case C																
Repayment on Long-term Loan	22,353	22,353	22,353	22,353	22,353	22,353	22,353	22,350								178,821
Interest on Long-term Loan	26,823	23,470	20,117	16,764	13,411	10,058	6,705	3,354								120,702
Annual Foreign Currency Saving	-11,669	4,187	7,540	10,893	14,246	17,599	20,952	24,306	50,010	50,010	50,010	50,010	50,010	50,010	50,010	438,119

(Remark)
Annual Foreign Currency to be saved is calculated as follows:

Sub-Total(Saving Amts in F.C.- Consumables)
▲ Repayment
▲ Interest.
Annual Foreign Currency to be saved

VIII. CONCLUSION

The Study for energy saving and environmental pollution control for SIDEX were conducted by a team of Japan International Cooperation Agency (JICA) since November 1993. The Study was in compliance with the Agreement made between the Government of Romania and Government of Japan.

Under the initiative of the Government of Romania, Iron and Steel Industries of Romania have launched a program for Restructuring and Modernization to be completed in the year 2002. JICA's study has therefore paid due regard to this restructuring and modernization program, and the study is complimentary to the goals of SIDEX. Mainly the studies were conducted on selected representative model plants for each group of production units that were in the scope of JICA's study. Besides, we roughly studied the other related plants to which the same measures as that of the model plants are applied.

The study highlights the following:

- Measures for efficient and effective way in energy saving and environmental pollution control
- Cost effective analysis of investment in terms of Financial Internal Rate of Return and Economic Rate of Return
- Maximum utilization of Romanian manufacturers to achieve minimum cost for implementation

The results of the cost effective analysis show that when the proposed measures are implemented, the energy saving is quite considerable from standpoint of cost effectiveness. The measures of environmental pollution control will meet the legal regulations which are being strictly implemented by the Government of Romania.

The Study recommends early implementation for the economical benefit of SIDEX in particular and for the overall beneficial effects in general that the cities and surroundings will gain from the anti-pollution measures.

In a nutshell, the following are the results of the major items of the study :

1. Energy saving

From the view point of effective utilization and saving of energy, and suppression of the pollutants, the Study proposes a positive integration of the production plants (to reduce the variety of the production units to a minimum operating numbers) with all that to achieve the production target of the year 2002 as projected in the Restructuring Program.

The energy consumption of the production plants which were in the scope of study, account for more than 70% of the total consumption of the Steel Complex. By implementing the measures proposed in the Report, SIDEX can save approximately 1.5 G cal. of energy for every ton of crude steel produced which works out to an annual savings of 700 million Nm3 of natural gas, 170 Gwh of electric power and 700,000 tons of coke.

The dependency on high priced purchased natural gas for fuel could decrease to 12% from the present dependency of 42% which has the added benefit of not having to depend too much on the seasonally unstable supply of natural gas and the precarious operation at levels of insufficient energy can be alleviated.

The Financial Internal Rate of Return (FIRR) are calculated for three cases of financial sources.

Case-A	Overseas Development Aids from Government of Japan (ODA).
Case-B	Soft Loan
Case-C	Commercial bank Loan

The FIRR is in the range of 17% to 21% for any of the above financial sources. Besides, the investment in the energy saving measures will certainly improve the financial performance of SIDEX.

2. Environmental Pollution Control

To meet the legal regulations which shall be in place by year 2002, it is essential to implement the environmental protection measures as detailed in chapter III of the Report.

These measures will greatly reduce the pollution to the town of Galati and river Danube. Particularly, the emission rate of SO_2 and NO_2 in the exhaust gas could be reduced by 66% and 20% respectively, and as a result the pollution by the Steel Complex in the center of the town will be less than 2 ppb and 3 to 5 ppb respectively.

The visible soot and dust particles from the coke oven batteries and the sintering plants which are the two major sources of emission, will be reduced to the same level as other OECD countries. This will be a significant improvement and benefit the town area.

The cyanides in the waste water discharged from SIDEX will reduce by 93%, Organic contaminants of Phenol by 99% and Ammonia by 83%. The combined effect on the water quality in the river Danube will be significant.

Besides the above advantageous effects on the surrounding, the working atmosphere in the plant itself will improve to make the work place conducive for efficient working by improved morale of the workers. This means that international standards on environmental control would have been met and this will generate an unquantifiable knock-on effect in the technological, educational and psychological fields throughout Romania.

It is recommended that the implementation of the environmental pollution control measures be appraised from three points of views, legal Regulations, and financial & technical viability.

- Romanian Authorities have indicated their determination to apply stringent standards for environmental protection as that of other OECD countries. This policy will make it obligatory for SIDEX and other industries to follow the Law.

- The present market economy suggests that funds will be not sufficient. Therefore, the estimation in the study has taken into consideration the least cost necessary to meet the regulations for the environmental protection.

- With regards to the technical viability, technologies which have proven performances and which are most suitable for SIDEX are proposed taking into consideration the local conditions.

In conclusion, in order to ensure an early return on investment on advanced Energy Saving and Environmental Pollution control measures and to manifest their effectiveness on a long term basis, enhancement of Operation and Maintenance Skills are essential. For this purpose, it will be effective and beneficial to introduce operation and/or maintenance technologies from other advanced countries along with the introduction of the Equipment.

The Study suggests that through the implementation of the measures for energy saving and environmental pollution control, ripple effects such as technical transfer to the domestic companies in Romania, will be generated. This in turn will propagate that influence upon other steel works and industries in Romania.

IX. RECOMMENDATION

Foreword

Sidex is the largest industrial facility in Romania and this JICA Study tries to bear this in mind in developing an effective strategy to a shape the cleaner, more efficient and therefore profitable future. Sidex should become a model works with modern standards applied to the efficient use of energy and the control of environmental pollution. The recommendations, which are all considered essential and therefore they are not list in any priority, are divided into three categories:-

Recommendations 1 to 3 General matters
Recommendations 4 to 5 Energy efficiency
Recommendations 6 to 11 Pollution control

General matters

Recommendation 1

Sidex and the Romanian Government should study energy saving and environmental pollution control for the facilities other than the facilities covered in this report as they are in a similar condition.

Recommendation 2

Soft-loans will be needed for the foreign currency to import equipment and local funding for construction costs to actually take the measures recommended by this Study.
The Romanian Government should extend guarantees and other financial support so that Sidex can have access to the necessary amount of the foreign currency and preferably take over the costs temporarily or re-loan the necessary amount of money with manageable rates of interest.

Recommendation 3

The use of appropriate technology developed in advanced countries should be positively introduced to solve the actual environmental problems and to achieve effective energy saving .

Energy Efficiency

Recommendation 4

Promotion of comprehensive measures for energy saving in steelworks

Energy saving in steelworks starts first by focusing on reduction of energy loss, second on the enhancement of efficiency in each manufacturing process and third on recovery of energy.
Comprehensive energy measures linked with the following production improvements should be effectively developed:-

- i Energy saving by improvement of productivity and quality, yield,
- ii Energy saving by successive or omission of processes,
- iii Reduction of energy cost by the tie-up of production control and energy control,
- iv Reinforcement of energy and thermal control in each plant.

Recommendation 5

Promotion of energy saving by the Government

In addition to the energy saving effort of Sidex it is essential that the Government or the local self-governing body promotes parallel policies encouraging energy efficiency in the same way that the administrative organizations of most modern countries including Japan do. The following suggestions may be relevant to Romania:-

i Encouraging a supply-demand structure based on estimated energy supply-demand in the long and medium term for the whole country by drafting regulations in energy saving to each industry.

ii Setting macro targets for the saving of energy and giving guidance in energy saving to each industry.

iii Establishing an organization for energy saving education making it possible for people to acquire special skills in practical thermal control technology.

iv Publication of actual case studies in energy saving.

v To penetrate the consciousness and skill of energy saving into every company encourage a government controlled qualification system to certify energy control specialists and legally control the employment of specialists in each industry.

vi Establish regulations on energy and technical standards, and require by regulation all large consumers to arrange an energy control systems.

vii Standardize efficient energy control by means of the publication of guidelines.

viii Motivate employees by adopting a prize system for energy saving.

ix Wherever possible structure the tax system so it becomes a supporting system for promoting energy saving.

x Assist companies financially by adopting low interest rate loans for investment in energy saving.

Pollution Control

Recommendation 6

Promotion of comprehensive measures for environmental pollution control in steelworks

This report describes the details of investigation on measures for environmental pollution control in the coke plant, sintering plant and blast furnace, which are the main processes which pollute the environment.

After taking the recommended measures in those plants, the steel making plant and material yard should be the next areas to be improved with regard to dust emission and the treatment of sewage.

Recommendation 7

The followings items should be implemented as soon as possible as set out in the report.

i Expansion of environmental monitoring equipment and system,

ii Amplification of re-cycle system by effective utilization of waste.

Recommendation 8

Promotion of pollution control by the Government

In order to control discharge of contaminants, in addition to the controlling regulations, it is important that the Government assists companies by adopting an advantageous loan system and a tax system encouraging the prevention of pollution at the time a new plant is built.
The Romania Government should study economic stimulating policies, a surcharge policy, etc. referring to the Japanese systems, and is expected to reinforce the domestic environmental policy.
In Japan there is a loan system with low interest rates (monetary step), a system of short depreciation periods, and a tax exemption system for fixed asset (tax step) and other incentives. The following are concrete examples:-

(Example of loaning system with low interest)

Loan organization	Subject of loan	Ratio of loan	Interest	Term of redemption
Japan Development Bank	[Anti-pollution facilities] Conversion to non-pollution process, Facilities with protective measures for ozone layer	within 40 %	4.4 %	10 years 1 year deferment
	[Anti-pollution facilities] Treatment equipment of soots, dusts, sewage, industrial waste, De-SOx device, De-NOx device, Noise/smell-proof facilities, etc.	within 40 % (within 30 % for smellproof facilities)	4.4 %	10 years 1 year deferment
	[Effective utilization of resources] Resource re-cycle facilities, Effective utilization facilities of water resource	within 40 %	4.4 %	10 years 1 year deferment
	[Environmental control of factory, plant, etc.]	within 30 %	4.4 %	

(Example of life of assets for depreciation)

Facilities	Type	Details	Life
Soots treatment	Structure	Tank, tower, waterway, and reservoir, built by reinforcement concrete or brick	30 years 20 years
Sewage treatment	Machinery and device		7 years

Recommendation 9

The re-cycling of slag requires total teamwork and the combined effort of the "supplier" and "user". Political assistance is also important.
Sidex as a supplier needs to:-

i expand the slag water granulation equipment,
ii install a crushing and pulverizing equipment, and
iii stabilize the quality of product.

Users mainly the cement, civil engineering and construction industries should be encouraged to study extending the use of re-cycled products.
In order to support them the Government and other administrative organizations should take supporting measures, such as approval of the quality standard, designation of materials for public construction.

Recommendation 10

A special organization should be established for promoting environmental protection and pollution control. It should have as its policy the enlightenment and motivation of individuals, companies, research organizations and universities by encouraging developed technology, improvement case studies, and by introducing the ISO environmental control system in relation to environmental control.

Recommendation 11

A government controlled qualification system encouraging and educating pollution engineers and controllers and a system that stations the qualified engineers and controllers in a company should be legally framed to penetrate the sense and technology about environmental pollution control in every industry.

Appendix-1 NAME OF MAIN COUNTERPARTS

1. Council for Coodination Strategy and Economic Reform

CECILIA VLASCEANU	Counselor

2. Ministry of Industry

DANION POPESCU	Secretary of State,Financial & Strategy
IANC PETRU	General Director,Strategy of Metallurgical Industry..
CAPOTA ION	Deputy General Director
SAVA NICOLAE	Expert of Energy
CHISER ZAMFIR	Special Adviser

3. Ministry of Environment

AUREL CONSTANTIN LLIE	Minister
LUCIA CEUCA	Director International and Public Relations
SPERANTA IANCULESCU	Director
DUMITRU MIHU	Director
GEORGE MIHAI PRETORIAN	Head of Regulatory Activity
SERENA ADLER	Expert
TANIA PAPADOPOL	Expert

4. Ministry of Finance Romania

MIHAI BOGZA	General Director for International Relation

5. The Integrated Iron and Steel Complex "SIDEX" S.A. GALATI

FLORENTIN SANDU	General Manager
SEBASTIAN STAVAR	Assistant General Manager
DUMITRU NICOLAE	Assistant General Manager

ALEXANDRU FLOREA	Technical Manager
ALEXANDRU DOBRE	Maintenance Manager
CONSTANTIN ZAHARIA	Manager Planning & Economical Operation
RACHITAN CONSTANTIN	Chief Engineer Coke plant
BANU STEFAN	Chief Engineer Blast furnace
BELCIUG SPILIDON	Chief Engineer Blast furnace
DAN IONEL	Chief Engineer Rolling mill
CHICULITA MIHAI	Chief of Modernization Dept.
GROSU ION	Chief of Environment office
OSTACHE STAN	Chief of Energy office
CULESCA CONSTANTIN	Investment
CHIMET MARIA	Environment
MARIAN BAKLAN	DIPL Engineer

6. Engineering center

6.1. IPROMET S.A

PRISECARU ION	Director General
PANAIT TEOKEANU	Technical Director
BULUC DUMITRU	Head of Designing shop, Environmental Protection
IORDACHE DUMITRU	Head of Designing shop, Water treatment
AMANCEI LUCIAN	Head of branch technology

6.2 IPROLAM S.A

NEDELESCU PETRE	Director General
STOENESCU ALEXANDRU	Director Technical
MAUTHNER ANDREI	Head of Designing Shop
CAMPENU DAN	Head of Designing Shop

6.3 ICEM S.A

CONSTANTIN RADU GERU	Director General
DOBRESCU MIRCEA	Vice President steel making
DEBIASIRODICA	Head of Laboratory "Environment Protection"

7. Romania National Bank

VASILE EMIL	Director Adjunct

8. Environmental Control Agency of Galati

TLIE TRUTA	Manager
GEORGE TUDOSESCU	General Inspector
CARMEN ANDREI	Inspector
ION DRUGAN	Inspector

9. ECOSIDER

MIHAI TEACA	Chief Ecological Laboratory

10. RENEL (Romanian Electric Authority)

10.1. Head office

GABRIEL POPESCU	Director Strategy & Economic Development Division
ION TUDOR IONESCU	Director Operation Division
CATALIN - MARIN DRAGOSTIU	Deputy Director Finance & Accounting Division

10.2. Galati blanch

GROSARIU	Director Technical General Manager

Appendix-2 MEMBERS LIST OF JICA TEAM

Name	In charge	1st. Site survey From Nov.22.93' To. Dec.18.94'	2nd. Site survey From Jly.06.94' To Aug.10.94'	3rd. Site survey From Nov.26.94' To Dec.13.94'
Hiroshi Tsutsumi	Team Leader	○	○	○
Takuzou Shimizu	Vice-team leader / Production planning and management	○	○	○
Mitsuaki Takeuchi	Leader for the study on Environmental pollution control	○	○	○
Hideo Tatemichi	Leader for the study on Energy saving /Reheating furnaces	○	○	○
Masato Kato	Coke plants	○	○	○
Kazunori Hayashi	Coke chemical plants	○	○	○
Kunihiro Imada	Sintering plants	○	○	○
Reiji Ono	Blast furnaces and Hot stoves	○	○	○
Shigeki Inoue	Environmental analysis	○		
Hiroyuki Mitake	Maintenance	○	○	○
Yuji Murata	Planning of Electrical systems		○	
Yoshikazu Aono	Planning of Instrumentation systems	○	○	
Yoji Morishita	Financial/ economical analysis		○	○
Tamotsu Inoue	Coordinator	○	○	○

JICA