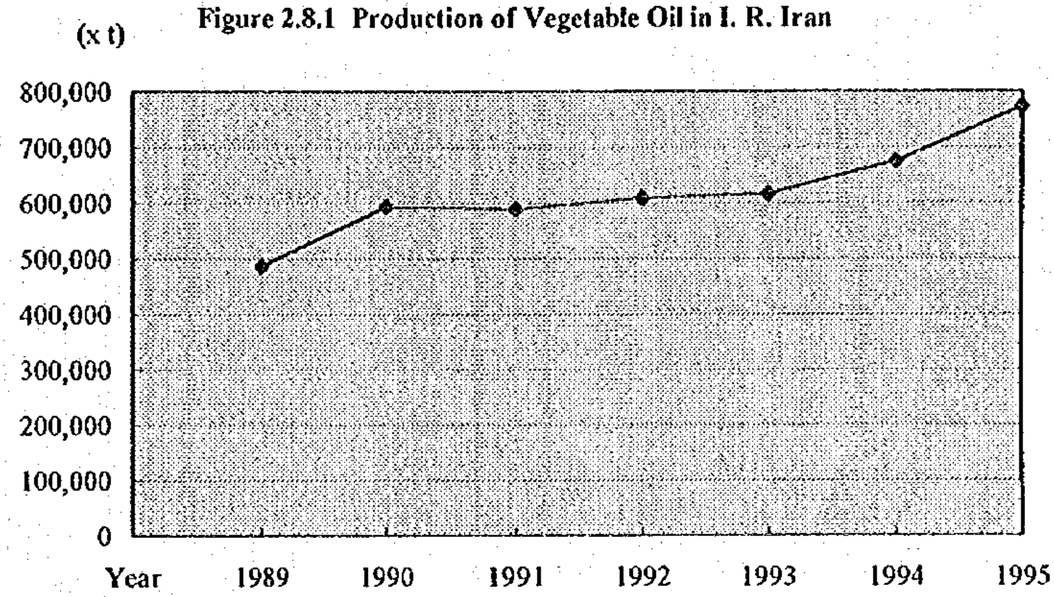
2.8 Food Industry(Vegetable Oil Industry)

2.8.1 Outline of Vegetable Oil Industry

(1) Trend of Production

According to the Industry Statistics Year Book 1374 published by the Ministry of Industry, production of vegetable oil has been increasing since 1989. (ref. Figure 2.8.1)

Figure 2.8.1 Production of Vegetable Oil in I. R. Iran



Since 1992, domestic production has exceeded 600,000 t/y, and annual production per head in 1995 is about 13 kg, which approximates the level of Japan (14.4 kg in 1993). (ref. Table 2.8.1)

Table 2.8.1 Raw Materials of Vegetable Oil in I. R. Iran

(unit : t)

	Domestic		Crude Oil Import		Total
1991	41,000	7.8%	486,000	92.2%	527,000
1992	64,000	11.6%	487,000	88.4%	551,000
1993	80,000	11.4%	620,000	88.6%	700,000
1994	80,000	10.9%	656,000	89.1%	736,000
1995	54,000	7.0%	721,000	93.0%	775,000

Source: Oilseed Research & Development Co.

About 90-95% of products are supplied by refining imported crude oil, and only about 5-10% of products are produced by pressing-refining from domestic raw materials (oilseed) as shown in Table 2.8.1.
The supply of domestic raw materials is unstable, and there have been considerable fluctuations, as shown in Table 2.8.2.

Table 2.8.2 Domestic Supply of Oilseed for Vegetable Oil Industry

(unit : t)

	Sunflower	Soyabean	Cottonseed	Total
1974	43,055	34,918	449,000	526,973
1979	4,055	94,558	184,000	282,613
1984	4,620	45,480	166,450	216,550
1989	23,023	90,388	134,240	247,651
1990	22,020	72,316	149,318	243,654
1991	19,938	55,891	121,715	197,544
1992	58,451	103,946	126,444	288,841
1993	72,650	178,070	ca.100,000	350,720
1994	52,578	208,726	ca.120,000	381,304
1995	29,359	69,268	187,991	286,618

Source: Oilseed Research & Development Co.

Also, about 90-95% of the products are hardening oils which are produced by hydrogenation, and only about 5-10% of the products are liquid oils at room temperature, such as sunflower oil and olive oil.

(2) Outline of the factories

There are currently 15 factories, located in the suburbs of major cities such as Tehran.

Location, production start-up year, production capacity, recent production, and main fuel of the vegetable oil factory are shown in Table 2.8.3
Among them, Behshahr exceeds 30%, and a total of three companies in the higher rank also exceed 55% of the industry share.

As for hydrogen generation for hydrogenation, most of the factories have converted to a natural gas reforming process from a water electrolysis method.

2.8.2 Present Situation of Energy Consumption

To grasp the present situation of energy consumption at vegetable oil factories, energy intensity of Behshahr Ind. obtained from a factory audit, and Shiraz Vegetable Oil from an interview survey are shown in Table 2.8.4.
For the other 13 factories, data and information regarding energy intensity, as well as the actual situation, were not obtained.

According to the table, the latest energy intensity of Behshahr Ind. is 3,782 Mcal/t, which is greater than that of Shiraz Vegetable Oil at 2,980 Mcal/t
The main reason for this seems to be the inclusion of the energy consumption of Behshahr Industry in the supply of steam and electricity to the adjacent factory.
It is thus more appropriate to adopt the latest value of Shiraz Vegetable Oil as the representative value of the industry.
The estimation of fuel consumption was based totally on natural gas, because the actual fuel situation of each factory could not be sufficiently grasped.
Table 2.8.5 shows substantial electricity consumption. Shiraz Vegetable Oil depends on purchased electricity, and does not generate electricity by in-house generation facility.
(ref. Table 2.8.5)

In the future, to improve the accuracy of this estimated value, revisions from the following viewpoint are required.

(1) Starting raw materials : ratio oilseed to crude oil
(2) Products : ratio hydrogenated oil to total products
(3) Method of Hydrogen generation :
    natural gas reforming (299 Mcal/t-V.oil)
    water electrolysis (563 Mcal/t-V.oil)
(4) Combined products : such as soap and cans for product packing

Table 2.8.3 Vegetable Oil Factories in I. R. IRAN

Company	Location	Start up	Employee (1981)	Capacity	Production (1995)	Fuel	Share
				(t/y)	(t/y)		
1 Behshahr	Tehran	1953		227,500	243,475	NG/Gas Oil	31 %
2 Pars	Tehran		1012	140,000	112,106	N. Gas	14.4%
3 Shiraz Vegetable Oil	Shiraz	1969	966	140,000	80,151	N. Gas	10.3%
4 Jahaan Vegetable Oil	Karadj	1956	417	70,000	67,421	Gas Oil	9.3%
5 Margarin	Tehran	1960	647	140,000	60,121	N. Gas	
6 Naab	Tehran	1963	131	35,000	40,600	Gas Oil	
7 Golnaz	Kerman	1989		37,500	37,892	G.O/F.O	
8 Kesht Va Sanat	Sari			35,000	34,261		
9 Naz-Esfahan	Esfahan			35,000	30,649		
10 Fazle Neishaboor	Neishaboor		195	17,500	20,055		
11 Etka Co.(Processing oil)	Varamin		245	35,000	16,724		
	Shar Ray				15,931		
12 Gorgan Center Cutton	Kordkooy		157	5,250	6,869		
13 Ganje Roodbar	Roodbar	1959		(30T/D)	5,863	Fuel Oil	(Olive oil)
14 Shokufeh Oil Industry	Babol		182	11,900	3,195		
15 Tehran Golnaab	Arak	1995-96	–	3,000	0		
(Sub-total)				932,650	775,313		

Source : Oil Seed Research & Development Co.

Table 2.8.4 Energy Consumption of the Representative Vegetable Oil Factories

Company	Location	Capacity (t/y)	Production	Energy Consumption Kind	Quantity		(Gcal/y)	(Mcal/t)
Behshahr Industry	Tehran	227,500	(in 1994)	Gas Oil	6,460	(kl/y)	59,432	297
			200,000	Natural Gas	70,620	(1,000Nm³/y)	692,076	3,460
				Electricity	2,227	(MWh/y)	5,010	25
				(Total)				3,783
			(in 1993)	Gas Oil	7,191	(kl/y)	66,157	396
			167,000	Natural Gas	65,460	(1,000Nm³/y)	641,508	3,841
				Electricity	2,249	(MWh/y)	5,060	30
				(Total)				4,268
Shiraz Vegetable Oil	Shiraz	140,000	(in 1994)					
			92,062	Natural Gas	19,888	(1,000Nm³/y)	194,902	2,117
				Electricity	35,298	(MWh/y)	79,421	863
				(Total)				2,980
			(in 1993)					
			110,508	Natural Gas	21,887	(1,000Nm³/y)	214,493	1,941
				Electricity	26,040	(MWh/y)	58,590	530
				(Total)				2,471

Source : Ministry of Industry
Behshahr Ind., Shiraz Vegetable Oil

Table 2.8.5 Estimation of Total Energy Consumption for Vegetable Oil Production

Estimation basis :	Total Production of Vegetable Oil in 1995				772,478 t/y	
	Overall Energy Intensity				2,980 Mcal/t	
			(Shiraz Vegetable Oil, 1994)			
		Natural gas		71%	2,117 Mcal/t	
			for Fuel of Steam Boiler		1,818 Mcal/t	
			for Hydrogenation		299 Mcal/t	
		Electricity		29%	863 Mcal/t	
Energy Consumption :	Total Energy				2,302 Tcal/y	
(in 1994)		Natural gas			1,635 Tcal/y	167 Mm^3/y
			for Fuel of Steam Boiler			143 Mm^3/y
			for Hydrogenation			24 Mm^3/y
		Electricity			667 Tcal/y	296 GWh/y

2.8.3 Energy Conservation Potential and Cost of Countermeasures

Regarding the 15 vegetable oil factories in I. R. Iran, the business status shown in items(1)-(4) is not clear, (except for two factories where energy consumption data were collected), and analysis of energy consumption is difficult.
Therefore, estimation of the energy conservation potential and measures, (mainly those proposed following the factory diagnosis for Behshahr) are shown below, classified on the basis of facility investment.

(1) Improvement of management for operation and maintenance

a. Adjustment of vacuum degree at the deodorizing process (from 3 to 6 Torr.)
Adjustment of ejector steam pressure (from 10 to 7 kg/cm^{2}G)
Reduction of cooling water temperature for the barometric condenser
(from 24 to 21° C)

(Behshahr Ind.)	Energy conservation effect	n.g.e	5,534 * 1,000m ^{3}/y
	Cost of measure		0 M Rial
(All factories)	Energy conservation effect	n.g.e	13,193 * 1,000m ^{3}/y
	Cost of measure		0 M Rial

b. Boiler combustion control

(Behshahr Ind.)	Energy conservation effect	n.g.e	1,342 * 1,000m ^{3}/y
	Cost of measure		525 M Rial
(All factories)	Energy conservation effect	n.g.e	3,174 * 1,000m ^{3}/y
	Cost of measure		2,100 M Rial

(2) Modification of facility

a. Heat insulation of steam valves & flanges

(Behshahr Ind.)	Energy conservation effect	n.g.e	266 * 1,000m ^{3}/y
	Cost of measure		333 M Rial
(All factories)	Energy conservation effect	n.g.e	629 * 1,000m ^{3}/y
	Cost of measure		1,330 M Rial

b. Recovery of exhaust gas heat from diesel generator

(Behshahr Ind.)	Energy conservation effect	n.g.e	798 * 1,000m ^{3}/y
	Cost of measure		875 M Rial
(All factories)	Energy conservation effect	n.g.e	944 * 1,000m ^{3}/y
50%	Cost of measure		4,375 M Rial

Note ; n. g. e Natural gas equivalent

2.8.4 Economic Assessment of Energy Conservation Potential

Assuming that countermeasures for energy conservation potential mentioned in the previous paragraph are implemented by the year 2000, an economic assessment of the potentials was made using two cases.

Case 1 : A. E. C. case
Case 2 : E. C. case

The basis for energy prices for each case can be seen in Table 2.1.2, and the Rial vs. the US$ rate is based on the rate in 1993 (1,750 Rial/US$).
The results of the assessment are shown in Table 2.8.6 and Table 2.8.7.

According to the assessment, because countermeasures that require modifications of facilities or processes are not feasible in Case 1, promotion of energy conservation will depend largely on improving operation and maintenance of the facility.
On the other hand, some factories are proceeding with renewal projects for superannuated facilities. Undertaken simultaneously with facility renewal, improvements of product yield as well as improvements of operation and maintenance technology, are expected, and energy conservation will be achieved.

Table 2.8.6 Economic Evaluation of Measures for Energy Conservation in the Vegetable Oil Industry

A. E. C. Case

(Natural Gas 123 Rial/Nm^3, Fuel Oil 75 Rial/l, Electricity 100 Rial/kWh)
(1,750 Rial/US$)

Energy Conservation Potential	Factory	Benefit					Countermeasure Cost		Economic Evaluation	Note
		Natural Gas ($1,000m^3/y$)	Electricity (MWh/y)	(M Rial/y)	for 3 years (M Rial)	for 10 years (M Rial)	(M ¥)	(M Rial)		
Improvement of Management										
Adjustment of	Behshahr Ind.	5,534		681	1,688	4,179	0	0	feasible	
Vacuum Degree										
Ejector Steam Pressure										
CW Temp. for B. Condenser										
	All Veg. Oil F.	13,193		1,623	4,024	9,964	0	0	feasible	
Boiler Combustion Control	Behshahr Ind.	1,342		165	409	1,014	30	525	feasible for 10 Ys.	
	All Veg. Oil F.	3,174		390	968	2,397	120	2,100	feasible for 10 Ys.	
Modification of Facility										
Heat Insulation of Steam V & F	Behshahr Ind.	266		33	81	201	19	333	not feasible	
	All Veg. Oil F.	629		77	192	475	76	1,330	not feasible	
Recovery of Exhaust Gas Heat from Diesel Generator	Behshahr Ind.	798		98	243	603	50	875	not feasible	
	All Veg. Oil F.	944		116	288	713	250	4,375	not feasible	
Modification of Process										

Table 2.8.7 Economic Evaluation of Measures for Energy Conservation in the Vegetable Oil Industry

E.C. Case (Natural Gas 22.4 Rial/Nm^3, Fuel Oil 17.0 Rial/l, Electricity 40.7 Rial/kWh, for 2000-2002)
(Natural Gas 30.0 Rial/Nm^3, Fuel Oil 22.7 Rial/l, Electricity 54.5 Rial/kWh, for 2000-2009)
(1,750 Rial/US$)

Energy Conservation Potential	Factory	Benefit					Countermeasure Cost		Economic Evaluation	Note
		Natural Gas (1,000m^3/y)	Electricity (MWh/y)	(M Rial/y)	for 3 years (M Rial)	for 10 years (M Rial)	(M ¥)	(M Rial)		
Improvement of Management										
Adjustment of Vacuum Degree	Behshahr Ind.	5,534		124	307	1,019	0	0	feasible	
Ejector Steam Pressure										
CW Temp. for B. Condenser										
	All Veg. Oil F.	13,193		296	733	2,430	0	0	feasible	
Boiler Combustion Control	Behshahr Ind.	1,342		30	75	247	30	525	not feasible	
	All Veg. Oil F.	3,174		71	176	585	120	2,100	not feasible	
Modification of Facility										
Modification of Process										

3. ENERGY UTILIZATION PLAN

3. ENERGY UTILIZATION PLAN

3.1 Objective

This section of the study presents an improved energy utilization plan from the perspective of efficient energy conservation. Improved energy utilization means economic and social improvements affecting the whole of Iranian society. Therefore, such a plan should be considered from as broad an economic and social context as possible.

In practice, the analysis involves such major energy sources as oil, gas, and coal in addition to such economic factors as prices, and future production volume. The primary part of this section of the study is to identify, then evaluate, relationships among these factors of energy and economy.

3.2 Approach

To identify better options of energy utilization, factors will be studied using models. Such models include analytic models for qualitative analysis and simulation models for quantitative analysis. The simulation models, which are proposed in the form of optimization models in this report, require actual data to simulate reality. Considering the simulation models in this study, to include all related variables in simulation models is not the best option. The focus of this study is on energy conservation and the focus of data collection encompasses energy-related data. Therefore, time, resources, and data are limited. Consequently, a complex model with many variables, which are not directly related to our objects of interest, could obscure the mechanism and the transparency of our model. Rather, the models should be simple and easy to understand, as far as they consider important factors of energy conservation.

The single most important factor of energy is oil, occupying more than 60% of GDP in 1993/94 (oil and services combined). For any quantitative analysis with optimization model, reliable and consistent data are essential through the industries of this study's subject. Technical and engineering data and information are the primary subjects of this study at a micro-level. Therefore, these data are expected to predominate.

Considering this, the subject of the quantitative model focuses on oil. At the same time, a tool to solve such a model is developed for the purposes of this study, especially taking the expandability and the applicability of that tool into account. Therefore, such important factors as oil savings, oil prices, plant costs, and the oil consumption of specific industries are the primary variables in the model. At the same time other energy resources such as the coal and gas can be incorporated into the model, depending on the availability and the reliability of data.

Policy variables such as domestic oil prices, labor productivity, subsidies, and taxes are also important, and should be analyzed here quantitatively as much as possible.

3.3 Optimization Model

3.3.1 Model 1: Optimum Investment Schedule For Maximum Oil Conservation

Under constraints such as investment fund and energy prices, the model finds optimal allocation(s) of the investment fund for the six manufacturing industries in question, which are studied in this project, to maximize energy conservation benefit.

3.3.2 Model 2: Optimum Investment Schedule For Maximum Value Added

Provided that realistic and reliable data on the value added of each industry in question can be obtained and that an appropriate relationship between domestic oil prices and production (and/or value added) can be estimated for each industry, the model finds optimal combination(s) of investment funds and price level for each industry, to maximize the total value added (GDP) of that industry as well as the optimum of all industries in question combined.

Actual simulation and analysis of Model 2 will not be included in this study because of the lack of data. However, Model 1 will be designed to be able to be extended to Model 2, hoping that reliable data for such industries will be available in the future.

3.4 Fundamental Concept and "Best" Optimum

The fundamental assumption in this part of the study is, considering energy conservation from the view point of the whole Iranian economy, that the most valuable resource is oil and the most expensive part is plant and equipment imported from abroad. Regarding that most of the cost to conserve energy is for imported goods and most of the conserved energy is oil for export, an optimum point exists, in economic theory, at which the marginal cost (to save one liter of oil) meets the marginal benefit. Figures 3.4.1 and 3.4.2 show optimum points which give "Max Net Benefit" where the slope of the benefit curve is equal to that of the cost curve. At this point, "benefit" minus "cost" is maximized.

Figure 3.4.1 shows the potential optimum level for the current market price. This is from the viewpoint of an individual factory with domestic oil price given. The vertical axis shows the value of the cost or benefit in Rial (or $). The cost curve is the cost or payment for imported plant equipment. The benefit curve (line) is the benefit of the quantity of oil saved multiplied by the domestic price of oil, which each factory has to pay.

From the point of the Iranian national interest, Figure 3.4.2 shows the potential optimum with the international oil price as a given shadow price. The shadow price of the equipment is the same as the former case, because the cost considered for that imported. Iran is a major oil supplier in international market. Therefore, the shadow price of oil is the opportunity cost of domestic consumption. That is, the economic value or the shadow price of oil should be the international market price. The benefit is the value of the quantity of oil saved multiplied by this shadow price. Here, the benefit to the whole Iranian economy at the international price is shown with a much larger "potential" net benefit than that at the domestic price.

The above concept is itself a model of very simplified case. However, in this study, we need to consider the limitations of available resources, fluctuation of international oil prices and other social constraints such as domestic oil prices and the industrial priorities of Iranian society. That is, because of such constraints, the optimum in figure 3.4.2 is an impossible "moving" target to reach. Rather, below that "best" optimum, parameters with realistic constraints should be considered to find the "second best" allocation of the limited investment fund (foreign currency reserve).

Figure 3.4.1

Potential Optimum in Domestic Market

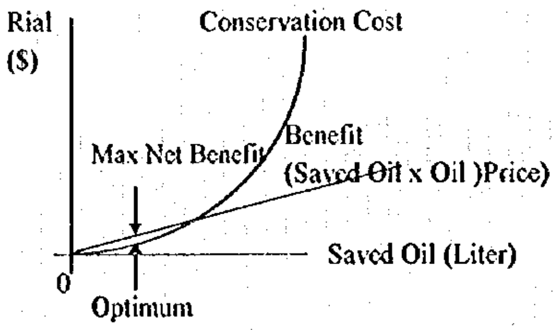
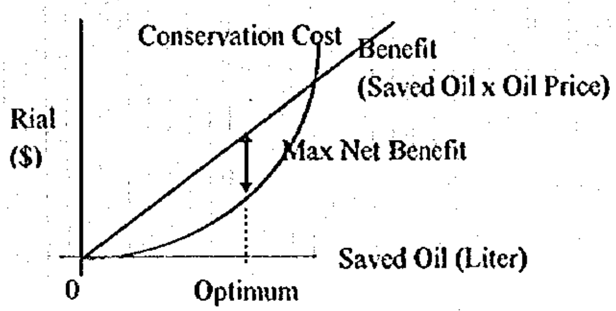


Figure3.4.2

Potential Optimum in Economic



3.5 Proposed Model 1: Constrained (Secondary) Optimum of Budget Allocation for Maximum Oil Saving

3.5.1 Estimation of Cost-Benefit Function

(1) Necessary Data:

a) For each industry, three or more cases of energy conservation measures with necessary investment costs and the expected volumes of saved oil.
b) Oil Export Price

(2) Relations to be Modeled:

For Each Industry:
a) Cost Function: Cost (Investment) vs. Potential oil saving
b) Benefit Function: Benefit (potential oil export revenue) vs. Volume of potential oil saving
c) Benefit-Cost Function: Benefit vs. Cost

(3) Concept

The benefit from the saved oil is the same for all industries from the viepoint of potential oil export revenue. The cost function will differ from one industry to another. Figure 3.5.1 is a simplified diagram of high-cost oil saving industry A. Figure 3.5.2 is a low-cost oil saving industry B. In these simplified models, because of the concave shape of the cost function, the marginal benefit from one unit of oil saving (marginal benefit) is larger first, decreasing to zero at the point of "Optimum," then the additional saving or investment makes the net benefit smaller.

From the viewpoint of investment, the net benefit is presented on the horizontal axis opposite the axis for oil saving. The left side of each figure with solid bold lines is the cost-benefit function for the cases of industries A and B.

Figure 3.5.1
Potential Optimum for Industry A

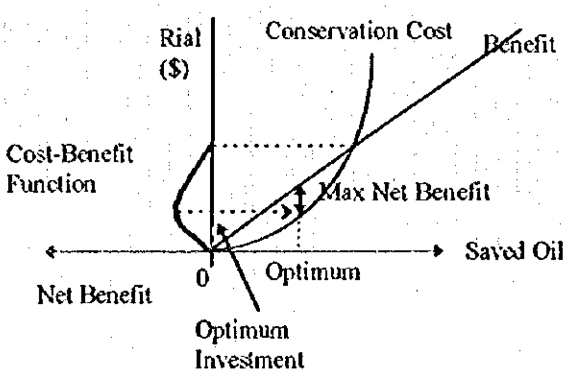
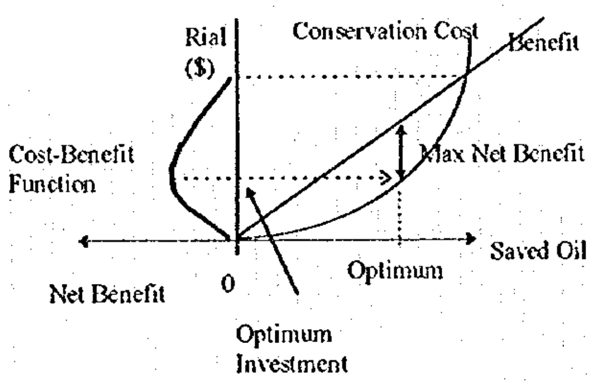


Figure 3.5.2
Potential Optimum for Industry B



3.5.2 Formulation of Basic Optimization Model

(1) Necessary Data: No additional Data necessary at this stage

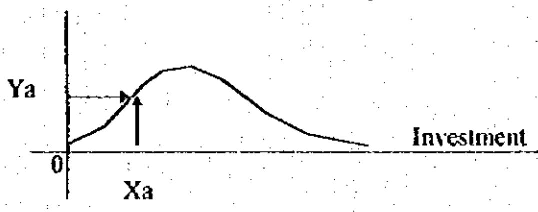
(2) Relations to be Modeled:

For all Industries in question combined:
a) Objective Function: Maximize the sum of net benefits of all industries in question
b) Constraints: Assume realistic investment scale and allocation limits

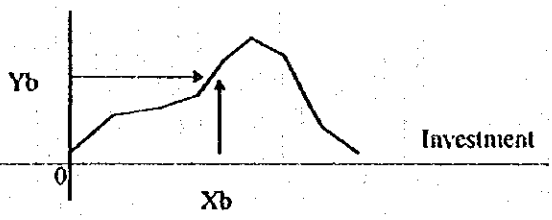
(3) Concept

Figures of 3.5.3 and 3.5.4 show hypothetical cost-benefit functions for industries A and B. In this simplified two-sector model, the objective function is Ya+Yb and the constraint is Xa+Xb. The optimization model is formulated to maximize Ya+Yb with the constraint that Xa+Xb is constant.

Figure 3.5.3
Benefit-Cost Function of Industry A



Benefit-Cost Function of Industry B



An analysis from viewpoint of marginal net benefit helps one to understand the nature of the optimal point. Figures of 3.5.5 and 3.5.6 show simplified model of marginal net benefit (with simple diminishing return). In this example, the marginal net benefit is defined as a net benefit from a unit increase of investment (or the first derivative of Benefit-Cost function in respect to Investment).

Figure 3.5.5
Marginal Net Benefit for Industry A

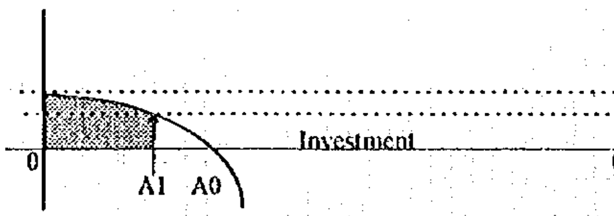
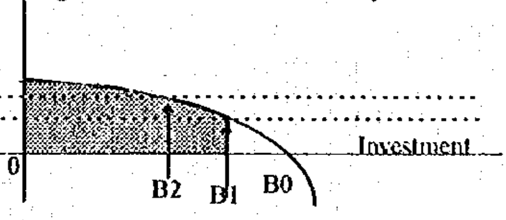


Figure 3.5.6
Marginal Net Benefit for Industry B



To maximize the net benefit, in principle, the investor should pick up the option of highest marginal benefit. In this case, there are two options: industries of A and B. From this principle,

a) if Budget < B2 (Industry B), all budget should be allocated to industry A, because this is the highest area of marginal benefit.

b) if B2 <Budget(A1+B1) < A0+B0, the remainder of fund after the investment to B2 should be allocated to both A and B so that the marginal benefits from both industries are the same. (Net Benefit = Sum of Gray Area)

c) if A0+B0 < Budget: Allocate A0 to A and B0 to B. Investment exceeding this amount reduces the net benefit. Therefore, no further investment than A0+B0 is necessary.

3.5.3 Introduction of "Time" constraint: Conversion of Future Investment Plan into Present Value

(1) Necessary Data:

a) For each industry, the expected scales of production or other related data, for which the proposed investment plans or investment cases assumed to gain the expected energy conservation potential.

b) For each industry, forecast of production or related data such as value added.

c) Assumed Discount Rate

(2) Relations to be Modeled:

For Each Industry:

a) Benefit-Cost or Marginal Benefit-Cost Function in Present Value

b) The above function in a) vs. Rate of production expansion (or year of investment schedule): At this stage, the Net Benefit is the function of Investment and Rate of Production Expansion (or "Time of investment").

(3) Concept

Often, the investment in a plant does not occur at the same time. For example, a plant modification or small improvements can be efficient for energy conservation measures for any plant with any scale of production. However, a certain kind of new plant or production system may be efficient only with a much larger production scale size. In such a case, we need to employ the concept of present value.

In figure 3.5.5, the investment schedule of industry A was divided to two: one in 1996 and the other in 2000. Because both the amount of investment in year 2000 and the corresponding value of the benefit should be discounted to compare present value, the Marginal Benefit-Cost Function shrinks. As a result, the total net benefit (energy conservation "economic" potential) from the full investment looks smaller than the case of fatal investment in 1996. This is the result of the new constraint on investment, "TIME," or of production scale.

Because the delayed investment plan depends on the production scale a future forecast of production can change this investment timing. In general, a larger production forecast will invite an earlier investment in new plant. Therefore, the larger the production forecast, the larger is the potential "economic" net benefit.

Figure 3.5.6 shows the case of two industries with different investment schedules. The discounted Marginal Benefit-Cost Function of industry B is projected on the axis for 1996 with a dotted line. The initial marginal benefit is larger for industry A than for industry B in present value. Therefore, although the absolute marginal benefit is larger for industry B, the investment should be allocated to industry A, without waiting for the investment of industry B in year 2000.

As these examples show, the result of the optimum investment under the "TIME" constraint can lead to a completely different allocation of resources.

3.5.4 Effects of Export Oil Price Changes on Optimum

(1) Necessary Data: Assumed export oil price (international oil price)

(2) Relations to be Modeled:

a) Effects of export oil price change on the maximum net benefit for each industry
b) Effects of export oil price change on the optimum allocation of investment

(3) Concept

The export oil price is the single most important factor for the benefit function. The export oil price is also one of the most volatile external variables which cannot be controlled. In this study, potential future export prices will be assumed to see the effects on the net benefit and the optimal allocation of investments.

Figure 3.5.7 shows a case of an increase of international oil prices in year 2000. Within the framework of this model, the price increase only affects the benefit of future investment. As a result, in this example, the present value of the marginal benefit of industry B has increased proportionally to the increase of the marginal benefit function of industry B in year 2000.

In this example, the initial marginal net benefit of industry B in present value is larger than that of industry A. This means, if your budget is very limited, you should wait until year 2000 to use that budget for industry B.

3.5.5 Effects of Domestic Oil Price Changes on Optimum

(1) Necessary Data:

a) Assumed domestic oil prices for all industries
b) For each industry, estimated production (or oil consumption) with the assumed oil prices; Or short-term and long-term price elasticity of oil consumption.

(2) Relations to be Modeled:

a) Effects of domestic oil price change on the maximum net benefit for each industry
b) Effects of domestic oil price change on the optimum allocation of investment

(3) Concept

a. Industry that can make an easy transition to less energy-consuming products

As for the effects of a domestic price change, the short-term and long-term price elasticity of oil consumption are most important. Usually the elasticity is larger in the long run and smaller in the short-run.

Figure 3.5.8 shows the effects of such a difference. Assume that the domestic price of oil has doubled in early 1995. There are two hypothetical industries: A and B. In response to the oil price rise, both industries can shift their product lines into less energy consuming products in the long-run. The doubled oil price can reduce the opportunity cost of domestic oil consumption (Oil export price minus domestic price). Considering the current low level of domestic prices, however, doubling or tripling the price is still within the range of fluctuations of international oil price. Taking this into account, the following discussion assumes there is no reduction in the opportunity cost. (It is considered in a formulated model)

The industry which is preparing an investment on energy conservation measures in the production line of energy-consuming products from 1996. Because of the sudden price rise, the industry A is not ready to adjust for such price changes. A possible response is shifting the cost to the consumer by raising the product price. Reluctantly, it continues operation with a slight decrease of production because of a possible decrease of demand for its primary product at a higher price. As a result, the industry's potential oil savings will not dramatically decrease.

On the other hand, industry B will have enough time to make a substantial change to adjust to the environment of reduced oil consumption. Namely, it can shift its production line from energy-consuming to less energy-consuming products. Therefore, by the year 2000, the actual use of oil will already have been reduced. Consequently, the decrease of potential benefit by 2000 will be more significant than that in year 1996. The net benefit of industry B in present value will be much smaller with the domestic price rise than without a price rise.

As discussed above, for an industry that can make an easy transition to less energy-consuming products, the rise of domestic energy price may reduce not only the economic value of energy conservation, but also their incentive to conserve. Under such a market structure of flexible choice, just a simple domestic energy price rise can bring economic value without investing on energy conservation.

b. Industry for which transition to less energy-consuming products is difficult

Conversely, if the industry's main products cannot be easily replaced with less energy-consuming ones, the economic value of energy conservation would rather increase by year 2000, unless demand for that products falls significantly.

From the management perspective of one factory, the decision on energy conservation investment depends on the investment cost and the benefit of that investment, for the expected fuel cost that is otherwise incurred. For an industry of this type, it is better to bring forward the energy conservation to adjust to the rising cost of fuel to raise more revenue, because they cannot shift the production line to less energy-consuming alternatives. Therefore, the rise of energy price can result in an earlier investment schedule for energy conservation.

In such a case, as shown in figure 3.5.9, the net present value of energy conservation of industry B can be larger than industry A, if the investment begins earlier. If the budget is limited, it is better to wait until 1998 for investment in industry B.

Figure 3.5.7 Effect of Discount

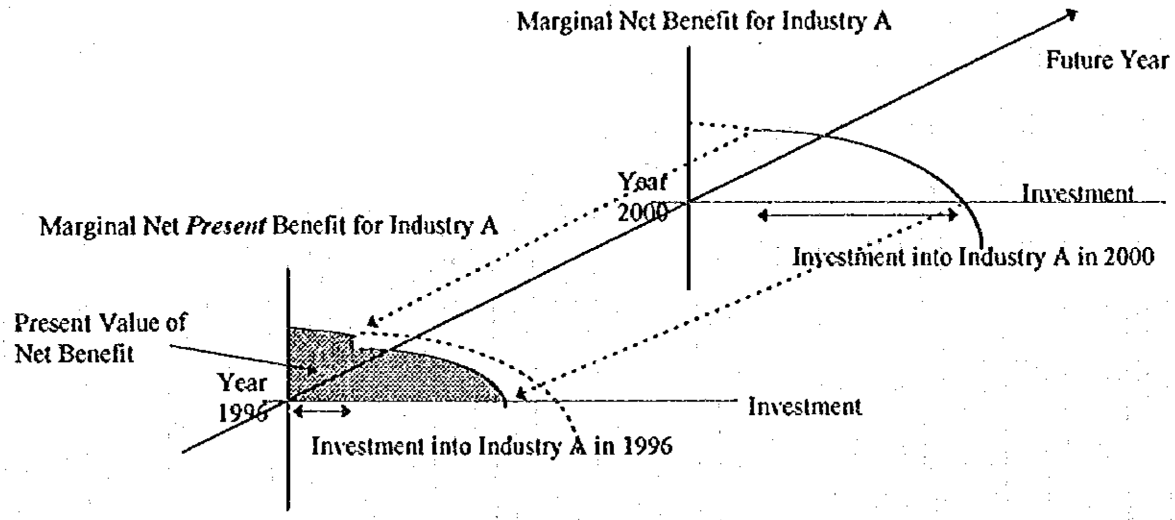


Figure 3.5.8 Different Investment of Different Industry

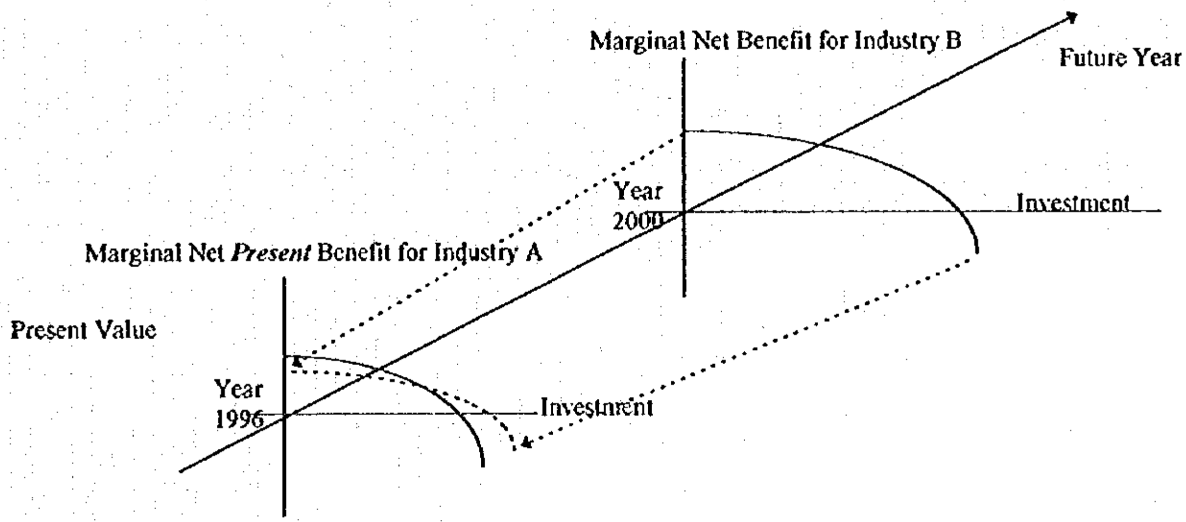


Figure 3.5.9 Effect of International Oil Price

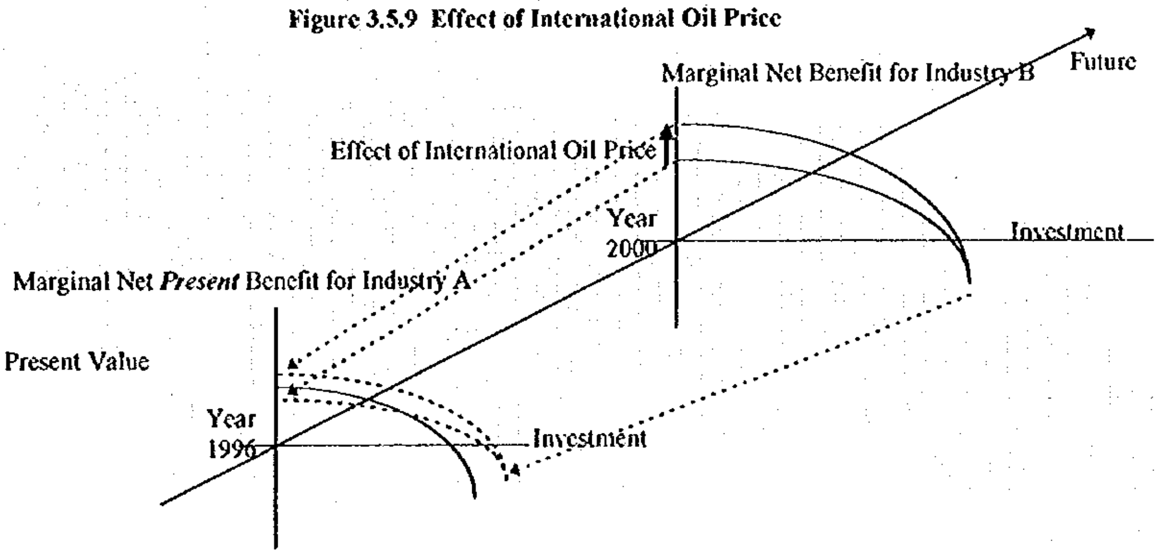


Figure 3.5.10 Effect of Domestic Oil Price 1

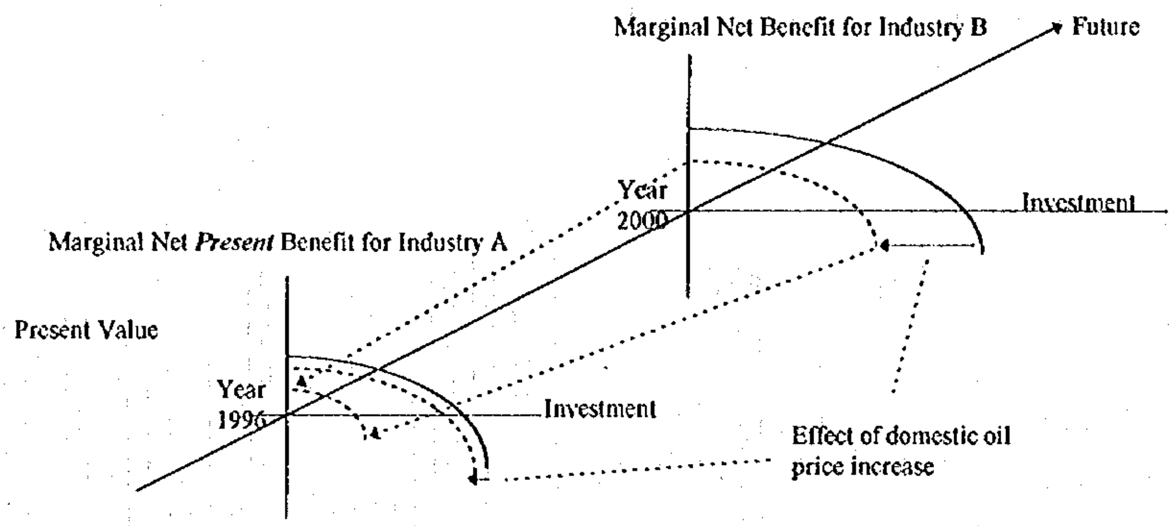
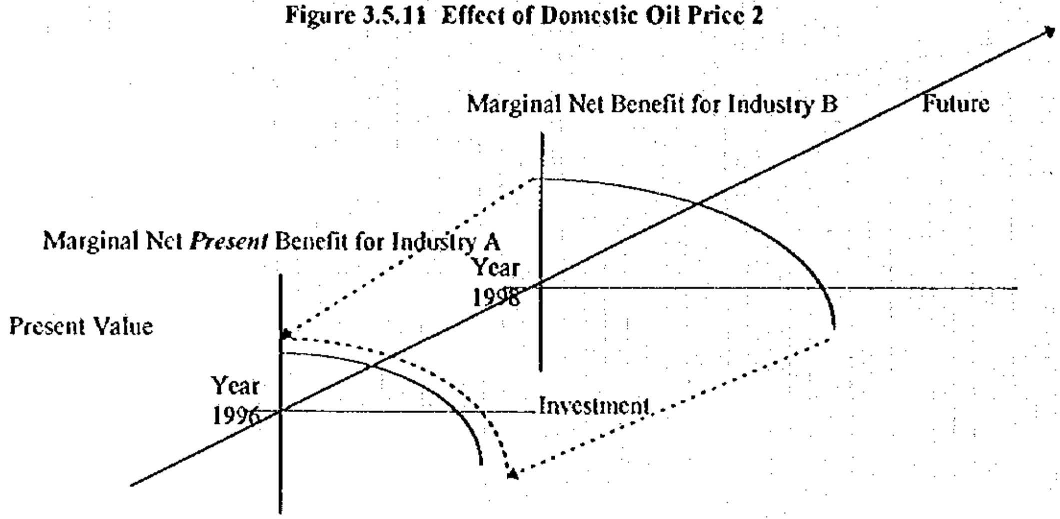


Figure 3.5.11 Effect of Domestic Oil Price 2



3.6 Tool for Optimization Models

In this study, the optimization models are simulated and solved with the spreadsheet EXCEL. This choice makes the design of a total system easy to integrate with other systems such as the database of this study. Such a tool can also share the advantages of that spreadsheet.

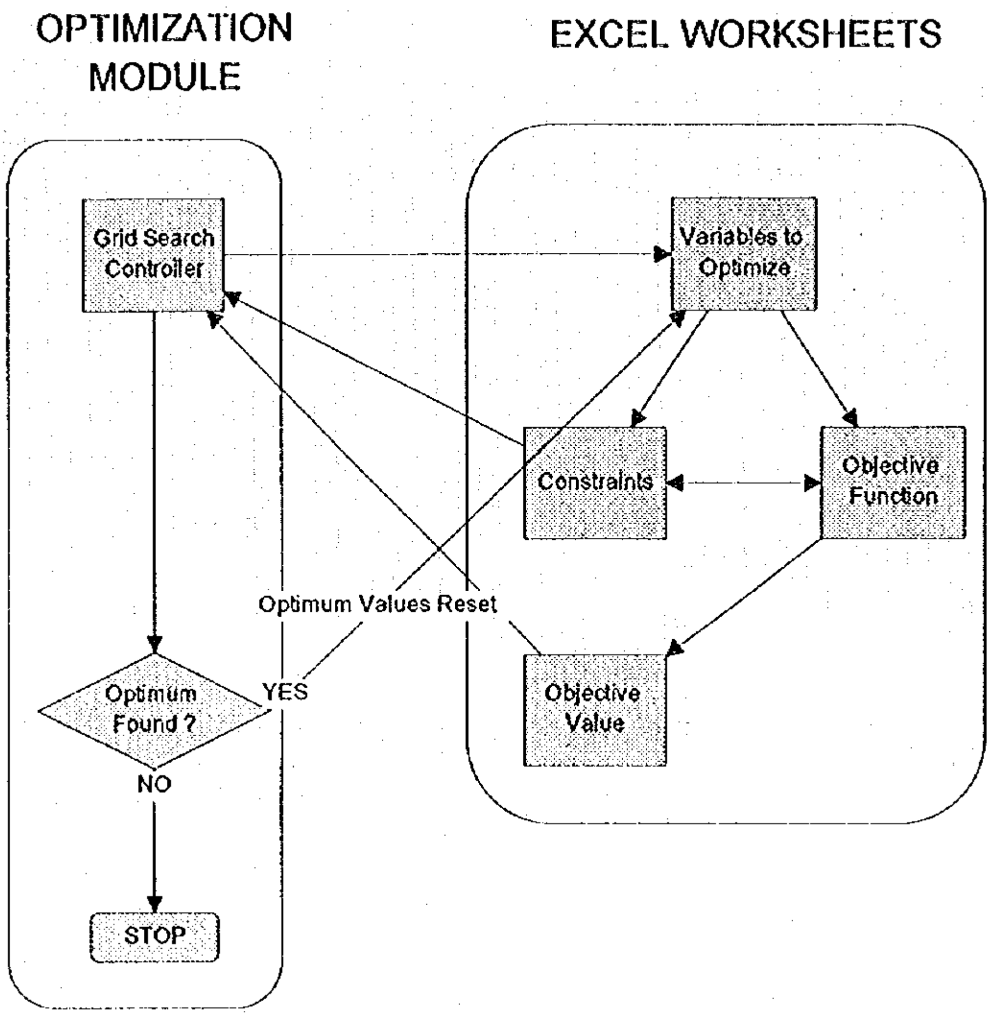
The above-mentioned conceptual models are non-linear and dynamic after actual formulation. In such a case, EXCEL cannot solve the model with its own standard functions. Therefore, to solve our models, a general optimization program for the purposes of this project is developed as a module of EXCEL.

This module is a small program with several hundred steps of Visual Basic. The primary tasks of this module are to judge whether the calculated value of the objective function is optimal or not, and to control the flow of the calculation by EXCEL to reach the target value by changing the values of variables to be optimized.

The basic algorithm used in this module is the so-called "Grid Search." This method is highly applicable to various types of optimization model to find a global optimal point. First, the Grid Search method divides the variables to be optimized. For the grid of all combinations of values of divided variables, the value of the objective function is calculated. Next, it picks up the grid that gives closest value to the target. Then again, it divides the close neighbor of that grid in more detail to find a grid of more close value to target. This grid search will be continued until it reaches a given accuracy or the given numbers of repetition.

Figure 3.6.1 shows the conceptual relationship between EXCEL and this optimization module. The source code of this module is presented in the appendix of this section.

Figure 3.6.1 EXCEL and the Optimization Module



3.7 Optimal Model Simulation

3.7.1 Basic Data

In this chapter, we simulate the cost of the energy saving measures for seven industries and investigate benefits using the model. The purpose is to make an effective investment plan for energy saving measures. However, as shown in chapter 2, the industries for which we could obtain comprehensive data on energy saving and energy conservation investment are the sheet-glass industry and the cement industry. Therefore, in this simulation, we selected measures to save the fuel oil directly from among energy saving measures in the sheet-glass industry and the cement industry. Based on the data for these industries, the optimal energy saving investment plan are simulated as realistically as possible. Therefore, it does not deal with all energy saving measures for the seven industries. However, it gives useful suggestions as a case study for the sheet-glass and cement industries. This case study did not assume that the saved fuel oil could directly result in crude oil savings. Rather, it assumed that fuel oil could be exported to increase the export value.

The table 3.7.1 shows the basic assumptions and the data on energy saving measures and as well as costs and benefits for the simulation.

Table 3.7.1 Energy Conservation Measures and the Cost-Benefit Data for Simulation

Base Assumptions (1994)
- Exchange Rate: $US1=1750RI
- Fuel Oil Caloric Value: 1kl=9250 Mcal
- Caloric Share of Fuel Oil in the Fuel Mix: 0.8
- International Price of Fuel Oil: $US 100.00 /kl
- Domestic Fuel Oil Price: $US 5.00/kl (8.5Rl/l)

Sheet Glass (production in1994: 259,000 ton/year)

	Unit Cost $US/ton/year	Unit Caloric Benefit Mcal/ton/year	Unit Fuel Benefit Litter/ton/year	Applicable Share of Production	Saved Fuel Benefit kl/year	Cost 1000 $US/year	Benefit 1000 $US/year
Improvement of Yield	0.000	107	9.25	1.00	2.4	0.0	239.7
Combustion Control	0.633	218	18.85	1.00	4.9	163.8	488.3
Light Insulation	2.468	216	18.68	0.37	1.8	236.5	179.0
Mod'n. of Forming Machine	3.899	394	34.08	0.81	7.1	818.1	714.9
Modification of Regenerato	31.793	313	27.07	0.81	5.7	6669.8	567.9
Heavy Insulation	9.592	213	18.42	0.68	3.2	1689.3	324.4

Cement (production in1994: 16,840,000 ton/year)

	Unit Cost $US/ton/year	Unit Caloric Benefit Mcal/ton/year	Unit Fuel Benefit Litter/ton/year	Applicable Share of Production	Saved Fuel Benefit kl/year	Cost 1000 $US/year	Benefit 1000 $US/year
Capacity-up of EP	0.050	17.2	1.49	1.00	25.1	846.8	2505.1
Draft control for W.P.	0.215	43.0	3.72	1.00	62.6	3627.8	6262.7
No.6 Kiln ope.	0.609	50.0	4.32	1.00	72.8	10248.3	7282.2
Ope. Improvement	1.563	65.0	5.62	1.00	94.7	26318.5	9466.8
Satellite to grate A	15.200	140.0	12.11	0.10	20.4	25596.8	2039.0
Satellite to grate B	6.606	160.0	13.84	0.37	86.2	41158.9	8622.1
Wet to NSP	16.333	760.0	65.73	0.02	22.1	5501.0	2213.8
Dry to NSP	15.445	380.0	32.86	0.14	77.5	36412.1	7748.2
Automatic Operation	2.778	31.6	2.73	0.77	35.4	36018.1	3543.8

3.7.2 Estimation of Cost-Benefit Function

The procedure to estimate the cost-benefit function of each industry based on the above data is as follows.

(1) The list shows the possible energy saving measure and the possible cost, as well as petroleum (fuel oil) saved.

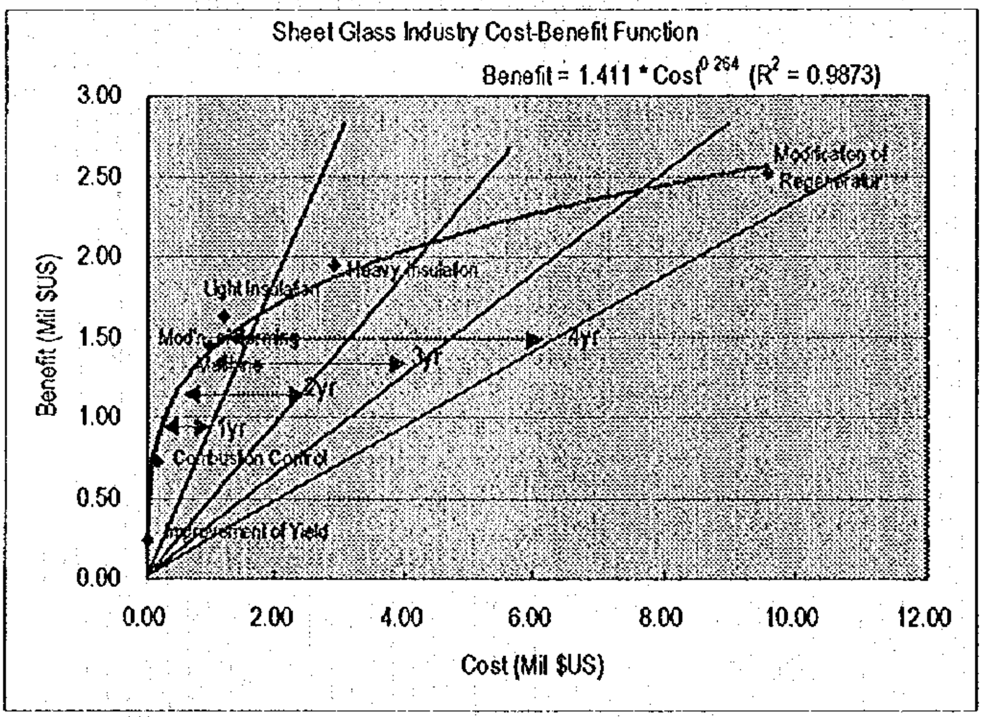
(2) Arranges the energy conservation measures in the order of biggest benefit. That is, it arranges measures in the order of the highest value of benefit divided by cost, because, the rule of thumb of the investment is to begin the investment of maximum benefit with minimum cost. It is assumed here that an investment in that order is possible.

(3) Supposing an energy saving measure is executed in the order of the biggest marginal benefit, accumulated cost is plotted from the corresponding benefit.

(4) Next, an approximate function on the curve is found which links the plotted points.

The following Figures 3.7.1 and Figure 3.7.2 show cost-benefit functions of the sheet-glass industry and the cement industry, which were estimated through the above procedure. (The degree of approximation is shown with the coefficient of determination R^2).

Figure 3.7.1 Cost-Benefit Function for Sheet Glass Industry



Note: R^2 is the Coefficient of Determination

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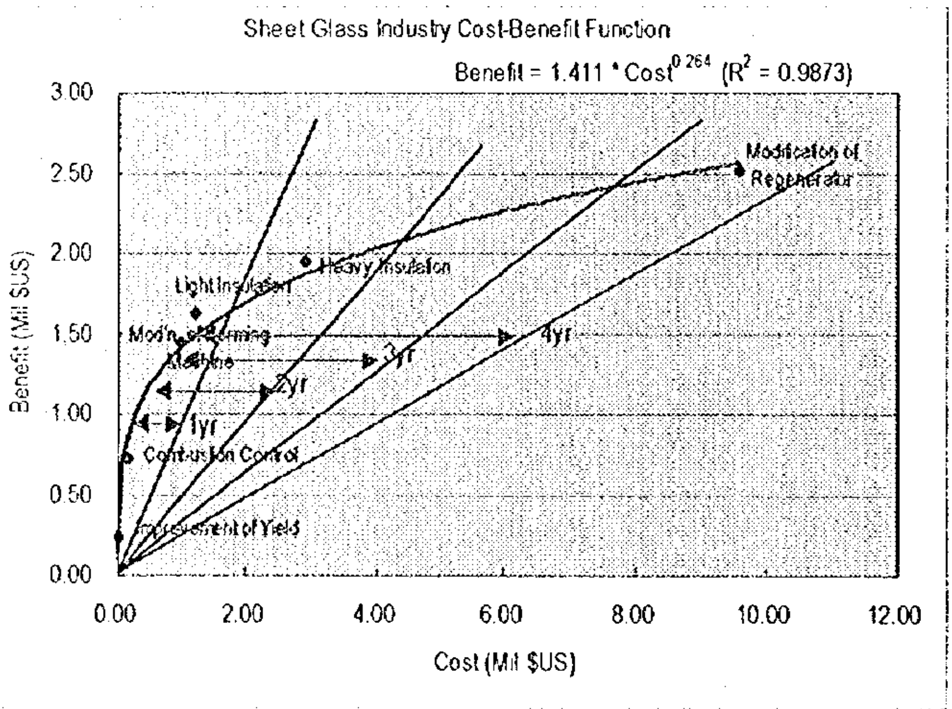
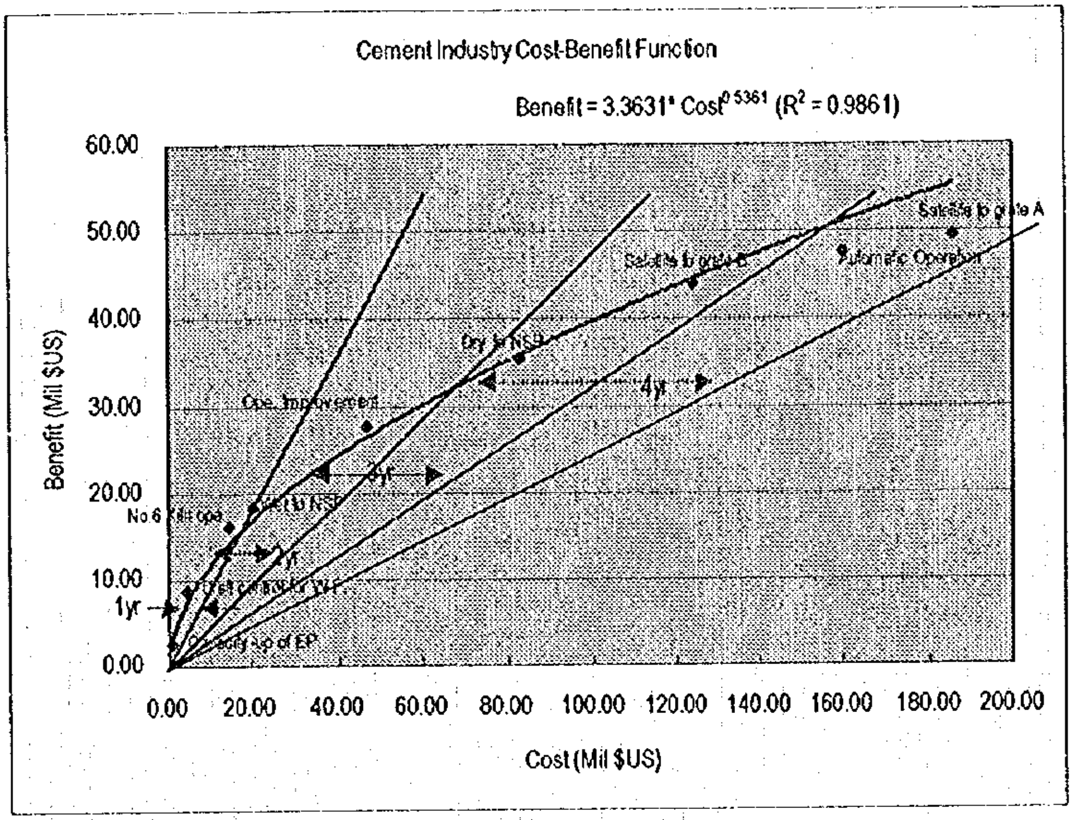


Note: R^2 is the Coefficient of Determination

Figure 3.7.2 Cost-Benefit Function for the Cement Industry



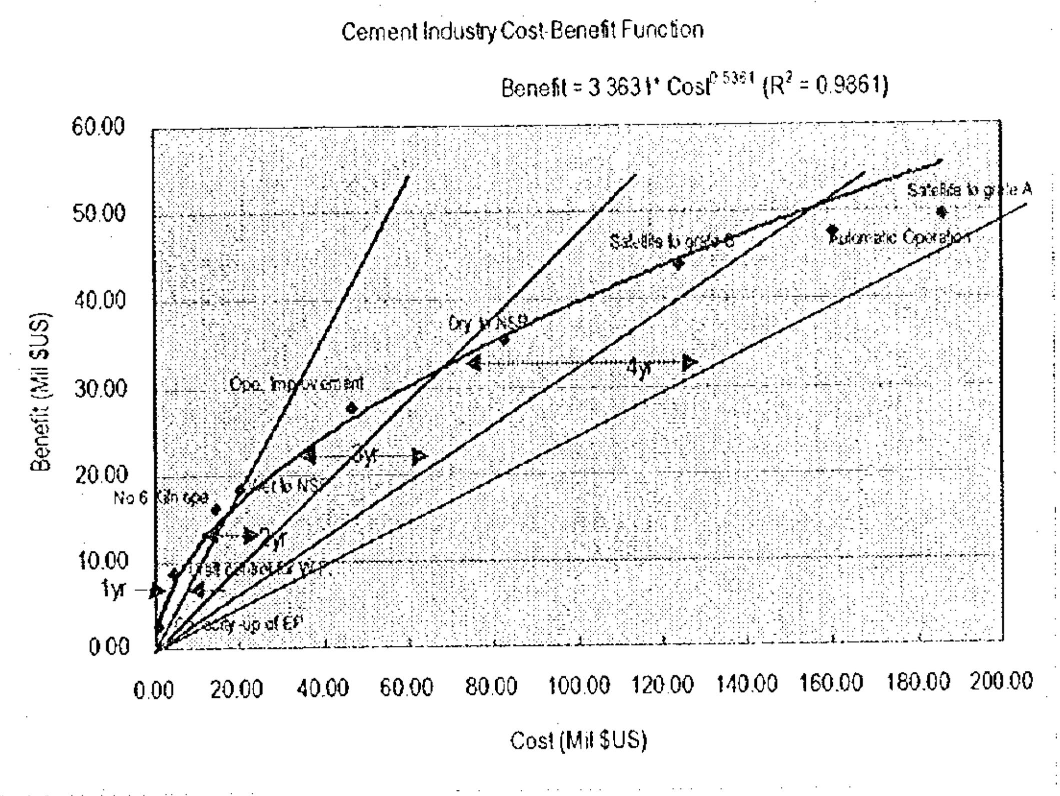
Note: R^2 is the Coefficient of Determination

The straight lines going up to the right in the figure show Cost = Benefit * Year(s). These lines represent the functions of one to four years. If the cost-benefit function is to the left of this straight line, the accumulated cost is smaller than the accumulated benefit over the number of years represented by the line. The horizontal distance gives the net benefit. Also, for each straight line from one to four years, the maximum horizontal distance is shown by a two-way arrow "←-→". Therefore, the energy saving measure, in which to be invested is that where the cost-benefit curve crosses an arrow from the starting point.

Based on the data from our study, these figures show that both costs and benefits of the energy savings of sheet-glass industry are less than about one-tenth of the cement industry. Also, the curve of the cost-benefit function of sheet-glass industry is stronger than that of the cement industry. That is, in the sheet-glass industry, the first implementation of several energy saving measures (up to "Light Insulation") increases the benefits rapidly within several years, whereas investment over that "Light Insulation" decreases efficiency, so it takes more time to recover. In other words, a profit is immediately brought about by several economical energy conservation measures, and economical energy conservation measures runs out soon.

In contrast to sheet-glass industry, the cost-benefit curve of the cement industry rises gently, whereas according to the data based on this investigation, the rising curve does not decelerate

Figure 3.7.2 Cost-Benefit Function for the Cement Industry



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In contrast to sheet-glass industry, the cost-benefit curve of the cement industry rises gently, whereas according to the data based on this investigation, the rising curve does not decelerate immediately. That is, there are few cheap energy saving measures in the cement industry, whereas there is a possibility of bringing about a very big energy saving benefit if it is possible to invest steadily.

By observing these two cost-benefit curves, we can get the rough idea of the benefits brought by the energy conservation investment.

Below are the simulation results of the optimal investment based on the cost-benefit function in consideration of export fuel oil price, domestic fuel oil price, subsidy, etc. Also, as an application of this study, an example of the energy saving investment plan, that brings profits to both government and industries is simulated.

As for the presupposition of the analysis, implementation of any energy conservation measures requires a very short time, and the benefit from implementation is generated immediately. Also, in the analyses of following model simulations, the social discount rate is assumed to be 10%.

3.7.3 Change of Optimal Allocation of Investment that Accompanies Exportation of Fuel Oil and a Fuel Oil Price Rise

Purpose:
This is a case of investing on possible energy conservation measures at once within a given budget. The purpose is to maximize economic value, i.e., to maximize net benefit (the present value) through the investment.

Cases:
Three scenarios of export fuel oil prices are assumed-- 0, 10, and 20% annual rates of rising. Supposing that investment funds will be allocated for the most effective energy conservation measure, it simulates the accumulated net benefit for cases over 3-years and 10-years.

Result:
The priority order of the energy conservation measures and the accumulated net benefit are shown in figures 3.7.3 and 3.7.4. Figure 3.7.3 shows the net benefit after three years, Figure 3.7.4 shows it after 10 years. The priority order of the investment is the order of the energy conservation measures, which is shown in the x axis from the left. The bold line shows the accumulated investment in both the cement industry and the sheet-glass industry. The bold broken line shows the accumulated investment in the sheet-glass industry. Therefore, the accumulated investment in the cement industry is shown by the difference between the bold line and the bold broken line.

First, consider the three-years accumulation of net benefit from energy conservation investment. When the rise of the oil price is 0% as shown in the figure, the rise of the oil price can maximize the net benefit by implementing measures up to "Wet to NSP" of the cement industry. Likewise, for the cases of 10% and 20%, the investment up to "Ope. Improvement" of the cement industry will maximize net benefit.

Next, consider the ten-year accumulation of net benefit from energy conservation investment. For the case of a 0% rise, the figure shows that investment up to "Heavy Insulation" in the sheet-glass industry can maximize net benefit. Similarly, for oil price rise of 10% and 20%, investing respectively up to "Automatic Operation" and "Satellite to grate A" can maximize net benefit. Here, attention should be paid to the point that the longer the scope of the investment becomes, the bigger the influence of the price rise rate becomes. That is, 0% of the oil price rise rate and that of 20% differences are about 30% for the case of three years, but it becomes 300% for the case 10 years. This suggests that for implementation of energy conservation measures, the longer the scope of the investment is, the more important it becomes to forecast the oil price.

3.7.4 When Can the Optimal Investment Priority Change?

Purpose :

The investment priority can change because of a difference in the timing of investment and benefits, because, a time dependent variable such as the social discount rate or the oil price rise can cause differences in the future costs and the future benefits of the investment. The example here considers the optimal investment plan when investment in one industry at a different time is prioritized over the investment in another industry. The purpose is to maximize economic value, i.e., the net benefit (the present value) of such an investment under such constraints.

Cases :

One case assumed that the investment in both industries began at once. Another case assumed that investment in the cement industry started five years later than investment in the sheet-glass industry, because of some political and social constraints. Each case simulated the five years of accumulated benefits after the investment at 20% annual rates of fuel oil price rises.

Result :

Figure 3.7.5 shows the accumulated net benefit for the case of simultaneous investment case. The accumulated net benefit of the cement industry is the accumulated net present value of the benefit five years after initiating the investment. Figure 3.7.6 shows the accumulated net benefit for the case of delayed investment of cement industry.

Figure 3.7.5 is the case of simultaneous investment. Now, assume that the investment budget is limited to $US15Million. For the case of simultaneous investment, the optimum priority is as follows.

1) Improvement of Yield (Glass)
2) Combustion Control (Glass)
3) Capacity-up of EP (Cement)
4) Draft control for W.P. (Cement)
5) Mod'n. of Forming Machine (Glass)
6) Light Insulation (Glass)
7) No.6 Kiln Operation (Cement)
8) Wet to NSP (Cement)

Figure 3.7.6 is the case of a delayed investment in the cement industry. The optimum priority is as follows. It should be noted that this order is not the order of investment time.

1) Improvement of Yield (Glass)
2) Capacity-up of EP (Cement)
3) Draft control for W.P. (Cement)
4) Combustion Control (Glass)
5) No.6 Kiln Operation (Cement)
6) Wet to NSP (Cement)
7) Mod'n. of Forming Machine (Glass)

The sheet-glass industry invests in measures 1), 4), 7) only and it does not invest in "Light Insulation." The rest of the budget will be allocated to measures 2), 3), 5), 6), five years later for cement industry.

Here, conservation measures in the cement industry have raised priorities, because the oil price hike in the future increases the efficiency of investing in the cement industry compared to investing in the sheet-glass industry.

Assume a simple example. There is only a $1000 budget. Investment on measure A costs $1000 at present and the benefit is $1100. Measure B costs $1000 and the benefit is $2000, but the possibility of this investment is available only five years later. In this case, a rational investor who does not care about waiting for five years will choose the investment on measure B. As such, in cases of investing on energy conservation, it is not unusual to have the case of measure B depending on future oil prices.

3.7.5 Optimal Investment Schedule to Balance Cost and Benefit

Purpose :
So far, the simulation has been analyzed under the supposition that there is some investment budget. Here, it attempts to simulate an optimal investment plan, presupposing that there is no investment budget. Fortunately, the conservation measure of "Improvement of Yield" in the sheet-glass industry is an improvement of management and does not require a specific budget. Regarding this, we start energy conservation here and keep the investment fund for the next measure. Likewise, the investment for the next conservation measure will be funded from the benefit of past implemented energy conservation measures. Here, we allocate the initial benefit to fund the next investment. In this way, the objective is to find an optimal schedule to fund all conservation measures step by step without any monetary support from outside.

The cases :
1) Fuel oil price $100/kl, rising at 20% annual rate
2) Fuel oil price $100/kl, constant
3) Fuel oil price $5/kl, rising at 20% annual rate
4) Fuel oil price $5/kl, constant
5) Fuel oil price $5/kl, investment cost decreased to half

Result :

The result of the simulation is shown in figure 3.7.7. The numbers of years taken to complete the investment on all energy saving measures for the above listed cases from 1) to 5) are 5.83, 9.09, 19.17, 108.17, and 67.41 respectively. The former two cases, which begin with $100/kl, can be completed within 10 years. From the viewpoint of state policy planning, this is a realistic range. The latter three cases, which begin with $5/kl are simulated from the viewpoint of private enterprises by assuming the present domestic price (about 10Rls). For the case of a constant domestic price, an investment plan which takes more than 100 years is out of the question. Under the present domestic price, it appears clear that the private enterprise cannot take a lead in energy conservation investment. Even if government shouldered half of the cost of the energy conservation investment, it requires nearly 70 years. One reason for this is that the present domestic price is too low. On the other hand, the case of a domestic price rise of 20% annually can reduce the required number of years from 108 to 19. Although, is still too long to be a realistic plan.

As simulated at here, under the present domestic price, it is difficult to expect energy conservation by a private enterprise. To make a business adopt an energy saving measure, one policy is to raise the domestic price. However, if it is politically difficult to raise domestic energy prices, the government has to take a strong initiative to promote the investment. For example, a policy simulation is demonstrated below for the case in which the government shoulders investment cost.

3.7.6 Policy Simulation : The Optimal Investment Schedule: Subsidy from the Government to the Degree of Realization of the Energy Conservation

Purpose :

For the simulation above, it is assumed that the government or the business exported fuel oil which earned foreign currency. Allocating that foreign currency to conservation investment, they could complete the investments in 10 years without monetary help from outside. Considering this result, presented here is an example of a policy simulation when the government shoulders all of the investment cost.

Case :

The optimal investment schedule of (3.7.5) above will be simulated by changing the fuel oil price from $100 to $50/kl with a 20% price rise rate. Here, it was expected that the fuel oil can be exported at $100/kl with a 20% price rise. From this saved export income, the government provides half as a subsidy for energy conservation investments. However, in this case, if all the recipients invest all subsidies, there is no profit for them. Therefore, to promote the policy the government provides an additional 25% of the fuel oil sold as a premium. The remainder left to the government is 25% of the exported fuel oil income.

That is, during the period of energy conservation investment, it is the policy for half of the saved fuel oil export value to be turned over to the following energy conservation measure. The remainder is divided equally between the government and the factory which realized the energy conservation.

Result :

The simulation result is shown in 3.7.8. It takes about eight years to complete the investment in the simulation. Compared to the case of no action, the policy generates a profit of $US50Million, for both government and the participating enterprises.

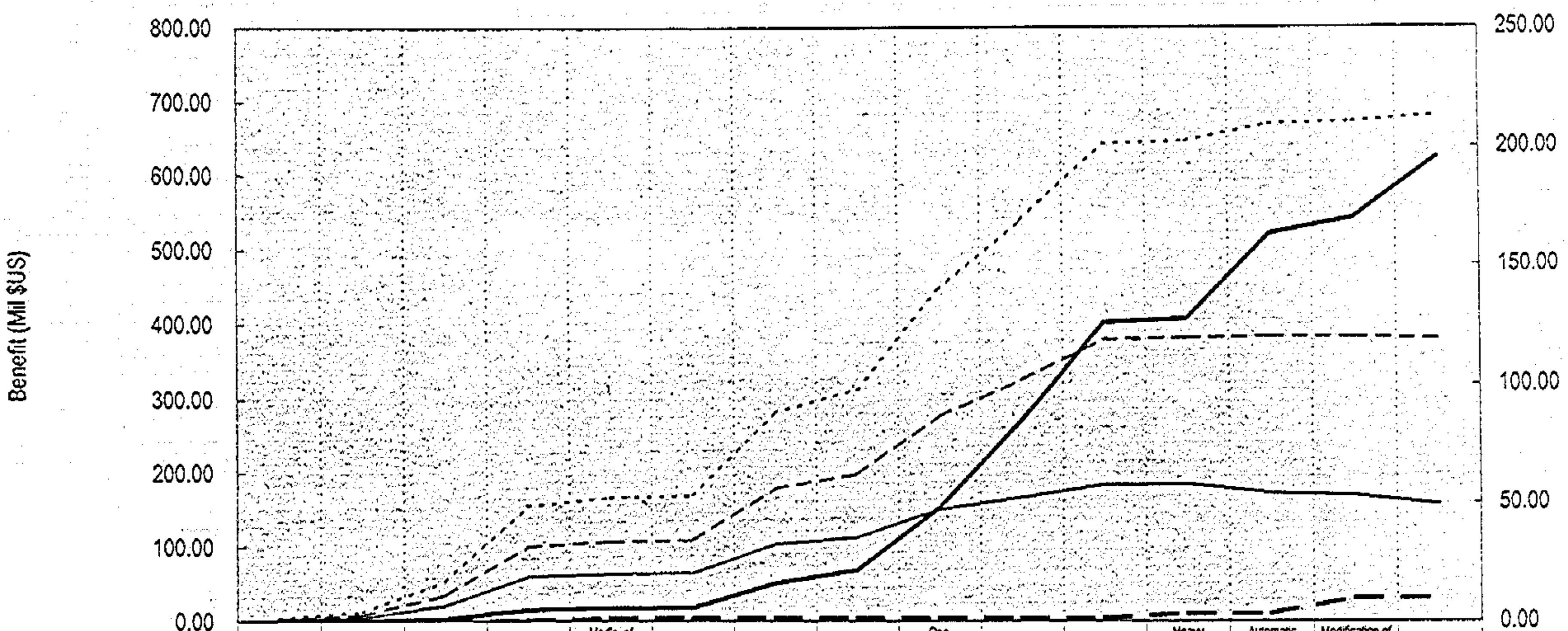
The important assumption in this policy is the existence of the export market for fuel oil. If there is no mechanism to sell the fuel oil or the market, a policy like this becomes nonsense. To make this policy effective, the government should make an effort using the 25% of the government export income of fuel oil, for example, to lower the price to make it more competitive and to develop foreign markets for Iranian fuel oil.

Figure 3.7.3 Optimum Allocation of Investment to Maximize 3 Years Net Benefit

	Improvement of Yield (Glass)	Combustion Control (Glass)	Capacity-up of EP (Cement)	Draft control for W.P. (Cement)	Mod'n. of Forming Machine (Glass)	Light Insulation (Glass)	No.6 Kiln ope. (Cement)	Wet to NSP (Cement)	Ope. Improvement (Cement)	Dry to NSP (Cement)	Satellite to grate B (Cement)	Heavy Insulation (Glass)	Automatic Operation (Cement)	Modification of Regenerator (Glass)	Satellite to grate A (Cement)
Fuel Oil Price 0% Rise	0.66	1.83	7.83	21.34	22.47	22.73	32.40	32.96	32.53	17.32	-0.26	-1.06	-27.38	-32.50	-52.52
Fuel Oil Price 10% Rise	0.79	2.24	9.67	26.72	28.26	28.62	42.42	44.22	49.17	38.34	25.66	25.04	0.72	-4.07	-22.94
Fuel Oil Price 20% Rise	0.87	2.47	10.67	29.66	31.42	31.83	47.88	50.38	58.25	49.82	39.80	39.28	16.06	11.44	-6.79
Accumulated Total Investment	0.00	0.16	1.01	4.64	5.46	5.69	15.94	21.44	47.76	84.17	125.33	127.02	163.04	169.71	195.31
Accumulated Investment (Glass)	0.00	0.16	0.16	0.16	0.98	1.22	1.22	1.22	1.22	1.22	1.22	2.91	2.91	9.58	9.58

Conservation Measures

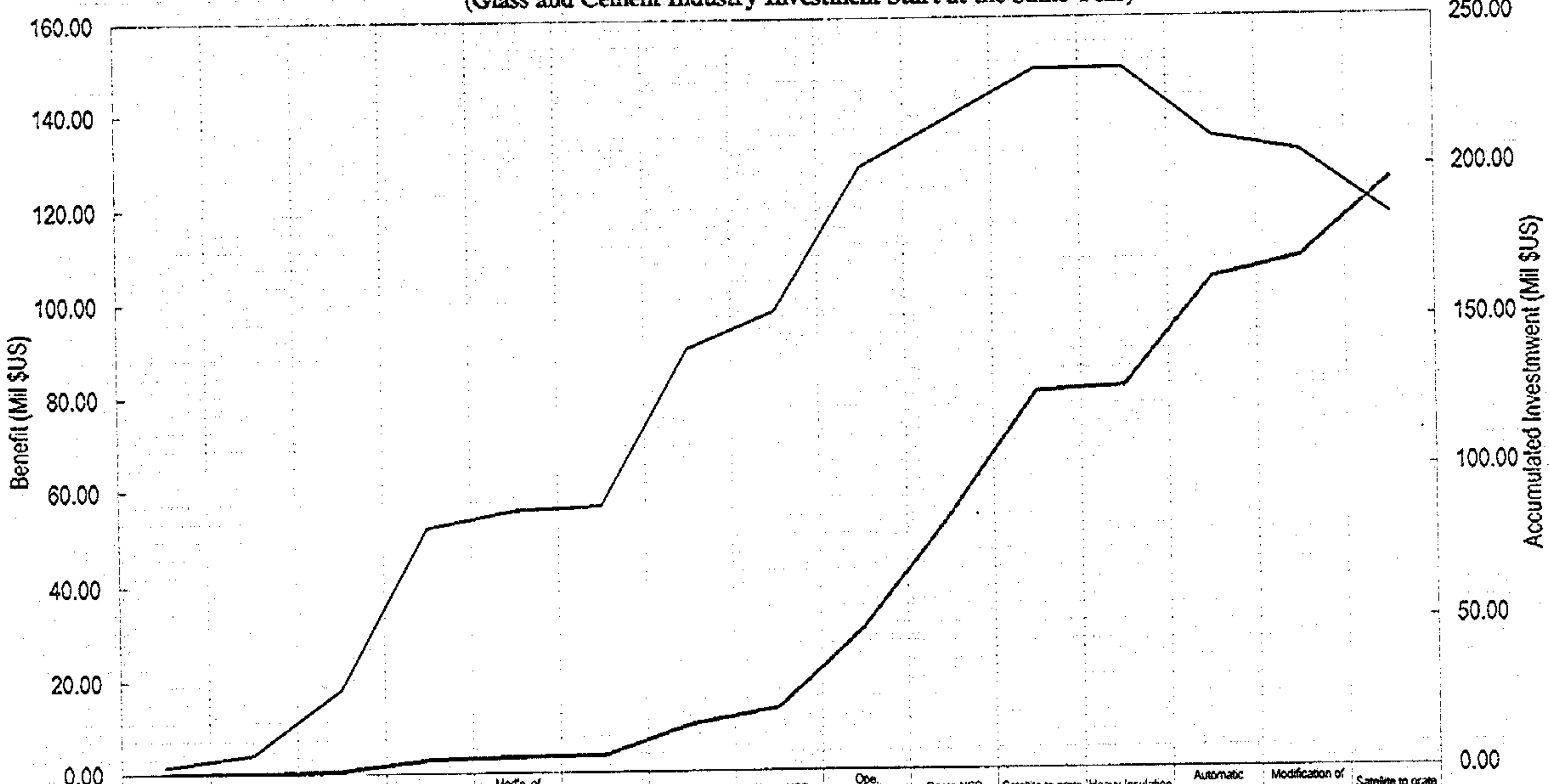
Figure 3.7.4 Optimum Allocation of Investment to Maximize 10 Years Net Benefit



	Improvement of Yield (Glass)	Combustion Control (Glass)	Capacity-up of EP (Cement)	Draft control for W.P. (Cement)	Mod'n. of Forming Machine (Glass)	Light Insulation (Glass)	No.6 Kiln ope. (Cement)	Wet to NSP (Cement)	Ope. Improvement (Cement)	Dry to NSP (Cement)	Satellite to grate B (Cement)	Heavy Insulation (Glass)	Automatic Operation (Cement)	Modification of Regenerator (Glass)	Satellite to grate A (Cement)
Fuel Oil Price 0% Rise	1.62	4.76	20.84	59.54	63.56	64.53	103.50	112.96	150.63	166.59	183.71	184.21	172.15	169.32	157.50
Fuel Oil Price 10% Rise	2.64	7.85	34.58	99.89	106.94	108.67	178.58	197.45	275.34	324.21	377.96	379.84	382.83	382.41	379.26
Fuel Oil Price 20% Rise	4.03	12.06	53.29	154.86	166.04	168.81	280.88	312.56	445.25	538.98	642.64	646.40	669.91	672.78	681.43
Accumulated Total Investment	0.00	0.16	1.01	4.64	5.46	5.69	15.94	21.44	47.76	84.17	125.33	127.02	163.04	169.71	195.31
Accumulated Investment (Glass)	0.00	0.16	0.16	0.16	0.98	1.22	1.22	1.22	1.22	1.22	1.22	2.91	2.91	9.58	9.58

Conservation Measures

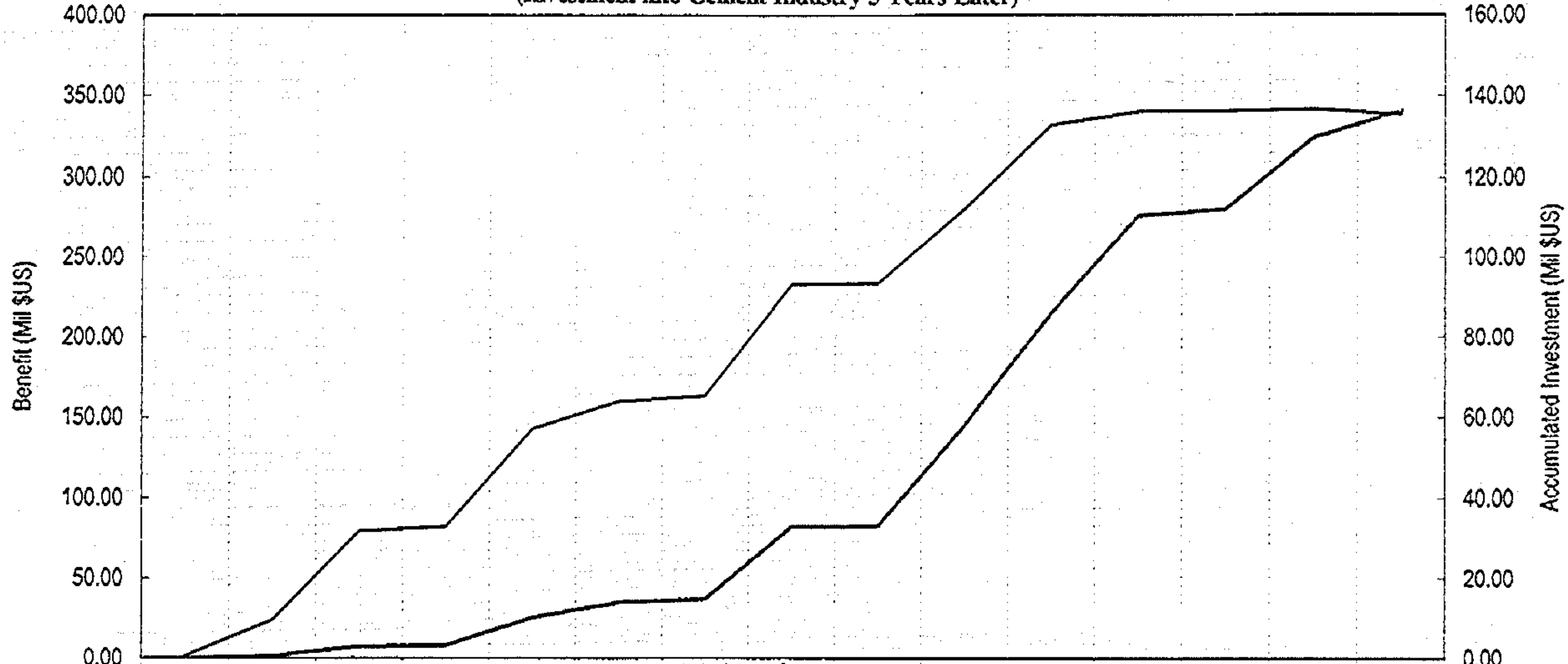
Figure 3.7.5 **Optimum Allocation of Investment to Maximize 5 Years Net Benefit with International Fuel Oil Price 20% Rise (Glass and Cement Industry Investment Start at the Same Year)**



	Improvement of Yield (Glass)	Combustion Control (Glass)	Capacity-up of EP (Cement)	Draft control for W.P. (Cement)	Mod'n. of Forming Machine (Glass)	Light Insulation (Glass)	No.6 Kiln ope. (Cement)	Wet to NSP (Cement)	Ope. Improvement (Cement)	Dry to NSP (Cement)	Satellite to grate B (Cement)	Heavy Insulation (Glass)	Automatic Operation (Cement)	Modification of Regenerator (Glass)	Satellite to grate A (Cement)
Net Benefit	1.44	4.20	18.37	52.29	55.76	56.60	90.01	97.78	128.22	138.27	148.80	149.06	134.29	131.02	117.65
Accumulated Investment	0.00	0.16	1.01	4.64	5.46	5.69	15.94	21.44	47.76	84.17	125.33	127.02	163.04	169.71	195.31

Conservation Measures

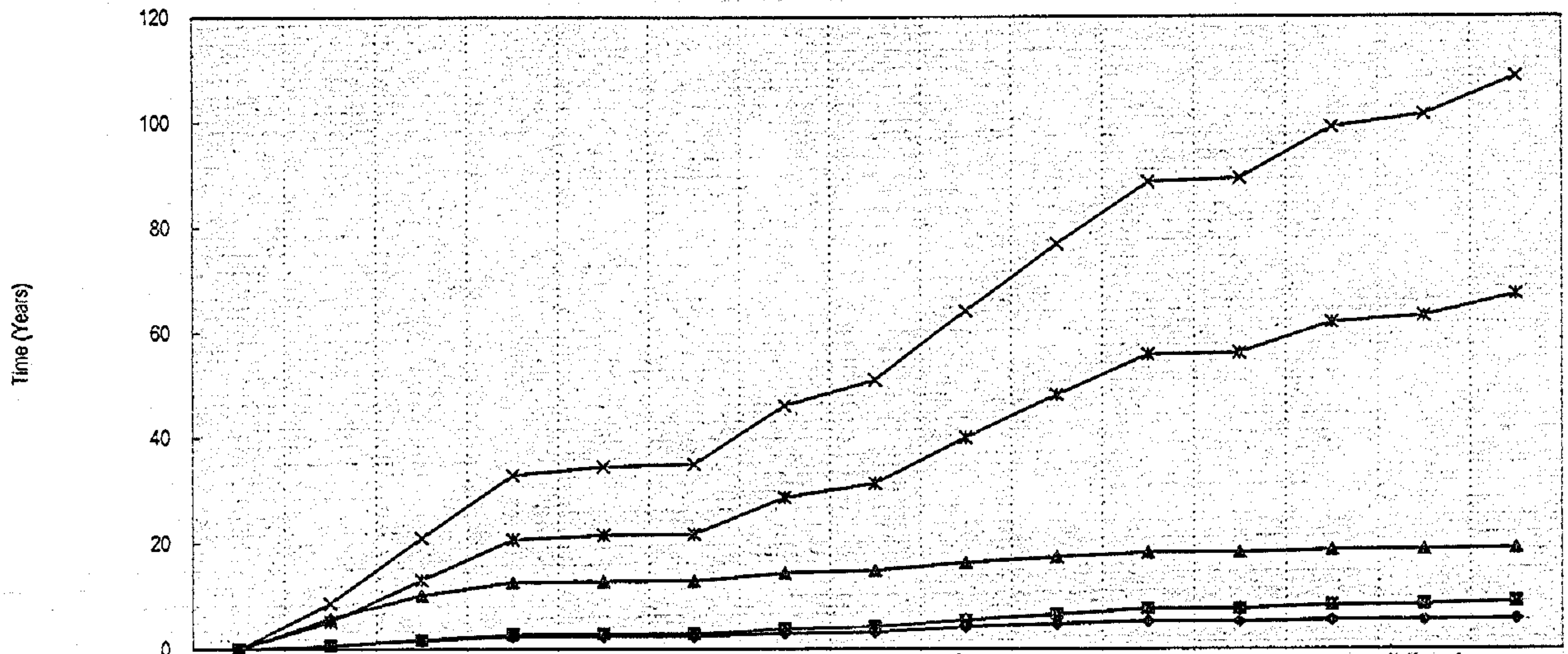
Figure 3.7.6 Optimum Allocation of Investment to Maximize 5 Years Net Benefit with International Fuel Oil Price 20% Rise (Investment into Cement Industry 5 Years Later)



	Improvement of Yield (Glass)	Capacity-up of EP (Cement)	Draft control for W.P. (Cement)	Combustion Control (Glass)	No.6 Kiln ope. (Cement)	Wet to NSP (Cement)	Mod'n. of Forming Machine (Glass)	Ope. Improvement (Cement)	Light insulation (Glass)	Dry to NSP (Cement)	Satellite to grate B (Cement)	Automatic Operation (Cement)	Heavy insulation (Glass)	Satellite to grate A (Cement)	Modification of Regenerator (Glass)
Net Benefit	1.44	24.06	79.60	82.36	142.82	159.57	163.04	232.76	233.60	280.50	332.26	340.49	340.74	342.15	338.88
Accumulated Investment	0.00	0.58	3.06	3.22	10.22	13.98	14.80	32.77	33.01	57.88	85.99	110.59	112.28	129.76	136.43

Conservation Measures

Figure 3.7.7 Optimum Investment Schedule to Balance Cost and Benefit



	Improvement of Yield (Glass)	Combustion Control (Glass)	Capacity-up of EP (Cement)	Draft control for W.P. (Cement)	Mod'n. of Forming Machine (Glass)	Light Insulation (Glass)	No.6 Kiln ope. (Cement)	Wet to NSP (Cement)	Ope. Improvement (Cement)	Dry to NSP (Cement)	Satellite to grate B (Cement)	Heavy Insulation (Glass)	Automatic Operation (Cement)	Modification of Regenerator (Glass)	Satellite to grate A (Cement)
$100/kl, 20%	0.00	0.63	1.63	2.39	2.44	2.46	3.05	3.23	4.23	4.80	5.26	5.28	5.59	5.64	5.83
$100/kl Constant	0.00	0.66	1.77	2.83	2.92	2.94	3.88	4.19	5.44	6.61	7.66	7.70	8.45	8.59	9.09
$5/kl, 20%	0.00	5.93	10.24	12.70	12.87	12.91	14.43	14.65	16.30	17.39	18.22	18.24	18.77	18.85	19.17
$5/kl Constant	0.00	8.75	21.01	33.01	34.61	35.06	46.16	51.05	64.26	76.99	88.91	89.63	99.20	101.60	108.73
$5/kl Constant, Cost 1/2	0.00	5.26	13.09	20.72	21.55	21.78	28.73	31.46	40.02	48.21	55.78	56.14	61.99	63.25	67.41

Conservation Measures

Figure 3.7.8 A Policy Case of Shared Conservation Benefit with Industries and Government

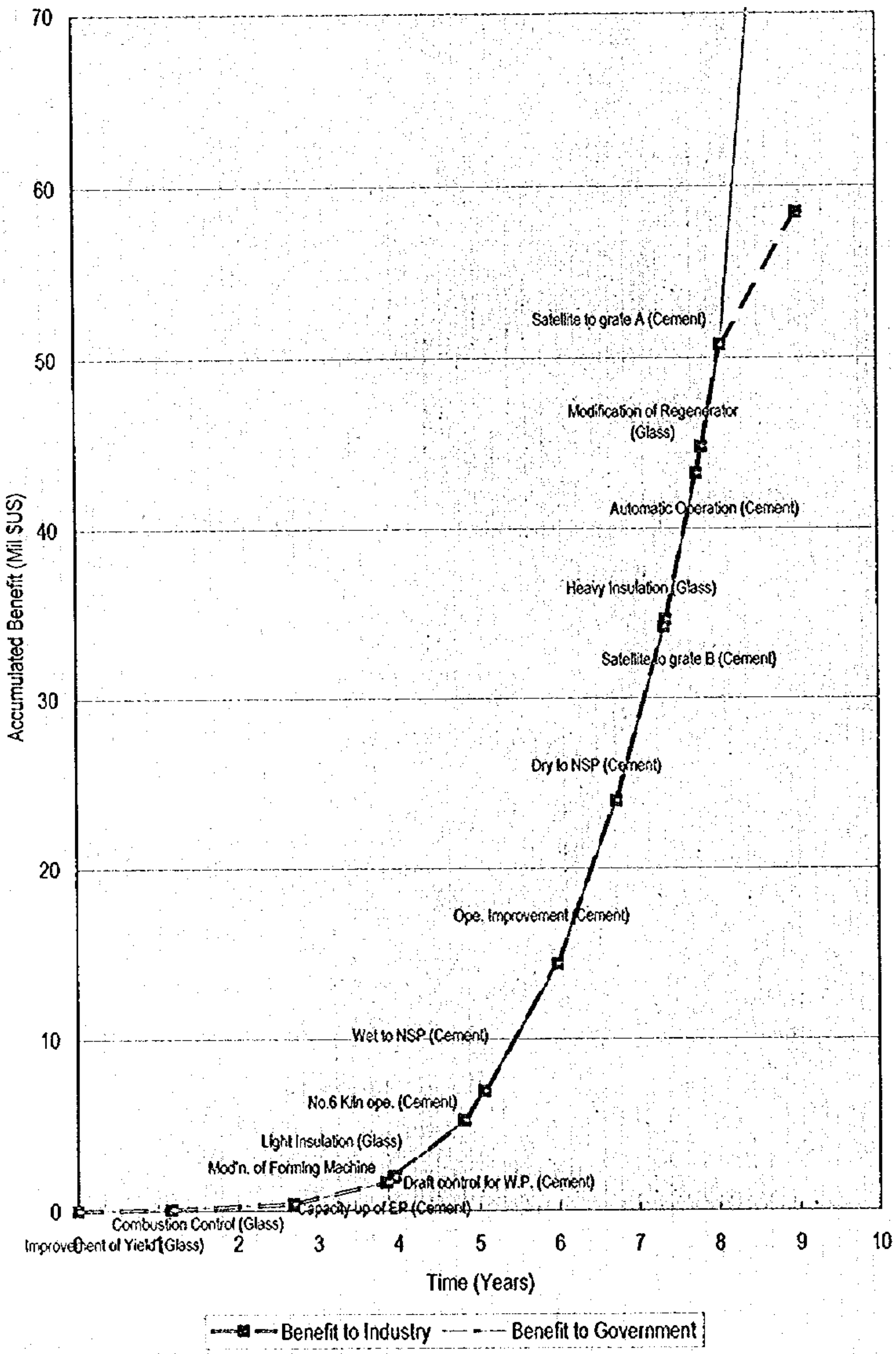
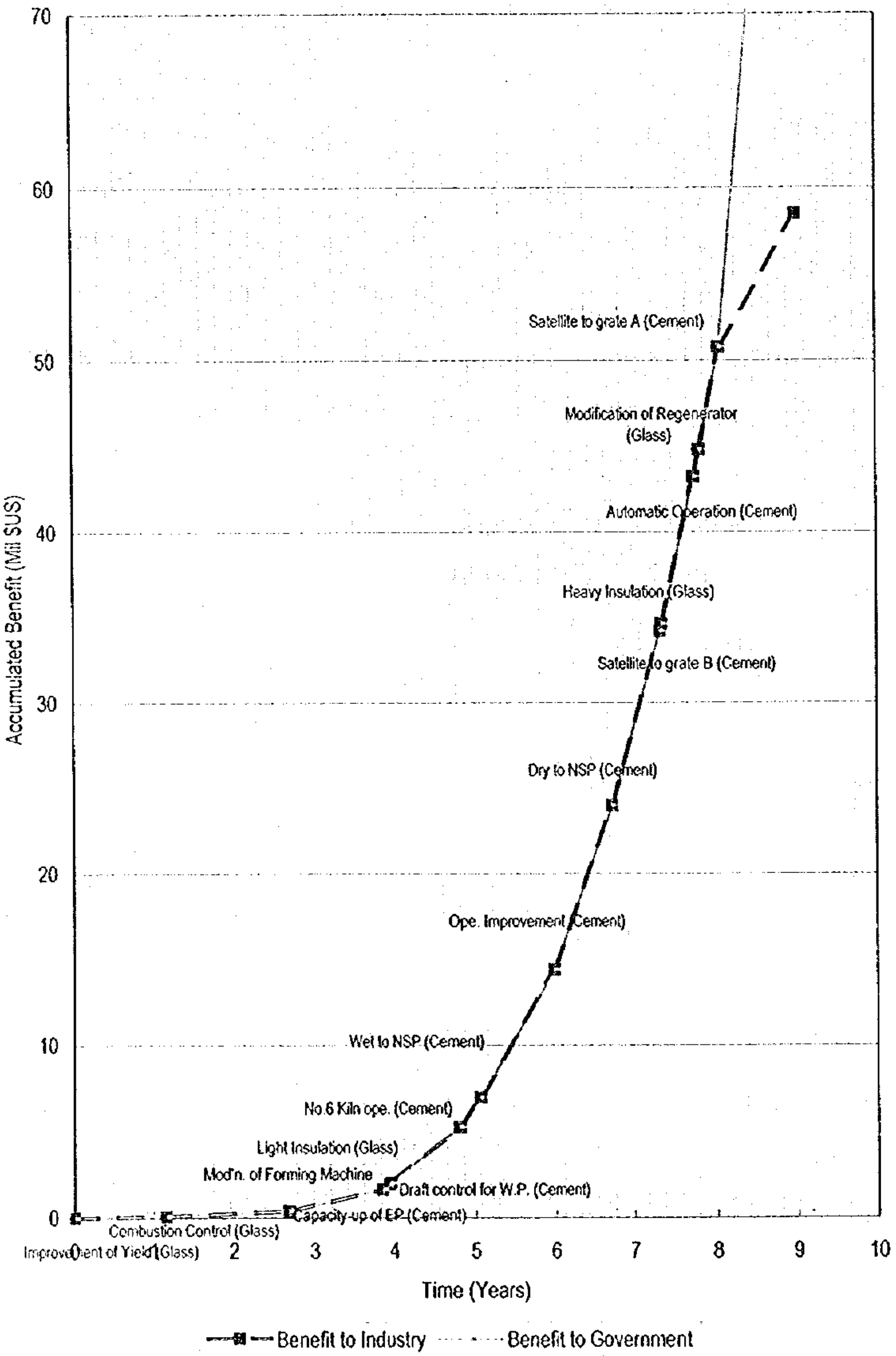


Figure 3.7.8 A Policy Case of Shared Conservation Benefit with Industries and Government



3. APPENDIX

OPTIMIZATION MODULE SOURCE CODE

```
Public TargetValue, Prec, VLoc(), TLoc, Counter(), CounterFlg(), tempV(), ChangeV() As Si
ngle
Public OptType, Div(), Divisions, VNumbers, VNo, CNo(1), TotalTrial, NestNo, VIntFlg() As
 Integer
Public CRange As Range
Option Explicit

Sub FindLocation()
    Dim i, j, k As Integer
    Dim temp As String
    i = Application.CountA(Range("C10:C16384"))
    ReDim VLoc(1 To i)
    VNumbers = 0
    k = 0
    For j = 10 To 16384
        If Cells(j, 3) <> "" Then
            k = k + 1
            If Application.IsNumber(Cells(j, 3)) And Cells(j, 3).Font.ColorIndex = 5 And
Cells(j, 3).Font.Bold = True Then
                VNumbers = VNumbers + 1
                VLoc(VNumbers) = j
            ElseIf Application.IsNumber(Cells(j, 3)) And Cells(j, 3).Font.ColorIndex = 3
And Cells(j, 3).Font.Bold = True Then
                TLoc = j
            End If
        End If
        If k = i Then Exit For
    Next j
    i = Application.CountIf(Range("E10:E16384"), True) + Application.CountIf(Range("E10:E
16384"), False)
    k = 0
    CNo(0) = 1
    CNo(1) = 1
    For j = 10 To 16384
        If Cells(j, 5) <> "" Then
            k = k + 1
            If (Cells(j, 5).Value = True Or Cells(j, 5).Value = False) And Cells(j, 5).Fo
nt.ColorIndex = 5 And Cells(j, 5).Font.Bold = True Then
                If CNo(0) = 1 Then
                    CNo(0) = j
                Else
                    CNo(1) = j
                End If
            End If
        End If
        If k = i Then Exit For
    Next j
    If CNo(0) < CNo(1) Then
        temp = "E" & CNo(0) & ":" & "E" & CNo(1)
    Else
        temp = "E" & CNo(0)
    End If
    Set CRange = Range(temp)
End Sub

Sub Optimization()
    Dim t1, k As Single
    Dim i, j, Div1, Div2, Div3, MaxNests As Integer
    Dim temp, temp1 As String

    FindLocation

    ReDim Counter(1 To VNumbers)
    ReDim CounterFlg(1 To VNumbers)
    ReDim tempV(1 To VNumbers)
    ReDim ChangeV(1 To VNumbers, 4)


    Cells(TLoc + 1, 4) = Cells(TLoc, 4)
```

```
temp = Cells(TLoc, 4).NumberFormat
temp1 = Cells(TLoc + 1, 4).NumberFormat
If InStr(1, UCase(Cells(TLoc - 1, 2).Value), "MIN") > 0 Then
    Cells(TLoc, 4).Value = 10 ^ 100
    OptType = 0
ElseIf InStr(1, UCase(Cells(TLoc - 1, 2).Value), "MAX") > 0 Then
    Cells(TLoc, 4).Value = -(10 ^ 100)
    OptType = 1
Else
    Cells(TLoc, 4).Value = -(10 ^ 100)
    TargetValue = Cells(TLoc - 1, 2).Value
    OptType = 2
End If
Cells(TLoc, 4).NumberFormat = temp
Cells(TLoc + 1, 4).NumberFormat = temp1

MaxNests = Cells(7, 3)
ReDim Div(MaxNests)
temp = Cells(6, 3).Value
Div1 = 5
Div2 = 4
Div3 = 3
If Val(temp) > 2 Then Div1 = Val(temp)
temp = Mid(temp, Len(Div1) + 2)
If Val(temp) > 2 Then Div2 = Val(temp)
temp = Mid(temp, Len(Div2) + 2)
If Val(temp) > 2 Then Div3 = Val(temp)
For i = 1 To MaxNests
    If i = 1 Then
        j = Div1
    ElseIf i = 2 Then
        j = Div2
    ElseIf i = 3 Then
        j = Div3
    Else
        j = 3
    End If
    Div(i) = j
Next i

Prec = Cells(8, 3)

VNo = 0
For i = 1 To VNumbers
    ChangeV(i, 0) = Val(Cells(VLoc(i), 4).Value)
    Cells(VLoc(i), 3) = ChangeV(i, 0)
    ChangeV(i, 1) = Val(Mid(Cells(VLoc(i), 4).Value, InStr(1, Cells(VLoc(i), 4).Value
, ",") + 1))
    ChangeV(i, 2) = ChangeV(i, 0)
    ChangeV(i, 3) = ChangeV(i, 1)
    ChangeV(i, 4) = (ChangeV(i, 1) - ChangeV(i, 0)) / 2
    If ChangeV(i, 4) < 0.00000001 Then
        CounterFlg(i) = 1
    Else
        VNo = VNo + 1
        CounterFlg(i) = 0
    End If
    tempV(i) = ChangeV(i, 0) + ChangeV(i, 4)
Next i
ReDim Counter(1 To VNo, 1 To 2)
ReDim VIntFlg(1 To VNo)
j = 0
For i = 1 To VNumbers
    If CounterFlg(i) = 0 Then
        j = j + 1
        Counter(j, 1) = i
        If Cells(VLoc(i), 3).Font.Italic = True Then
            VIntFlg(j) = 1
```

```
            Else
                VIntFlg(j) = 0
            End If
        End If
    Next i

    For NestNo = 1 To MaxNests
        Divisions = Div(NestNo)
        For i = 1 To VNumbers
            ChangeV(i, 0) = Application.Max(ChangeV(i, 2), tempV(i) - ChangeV(i, 4))
            ChangeV(i, 1) = Application.Min(ChangeV(i, 3), tempV(i) + ChangeV(i, 4))
            ChangeV(i, 4) = (ChangeV(i, 1) - ChangeV(i, 0)) / Divisions
        Next i

        SimpleSIteration

    Next NestNo
MaximizationLast:
    For i = 1 To VNo
        Cells(VLoc(Counter(i, 1)), 3) = tempV(Counter(i, 1))
    Next i
End Sub

Sub SimpleSIteration()
    Dim temp, tempCounter() As Single
    Dim i, j, k As Integer

    ReDim tempCounter(1 To VNo)
    For i = 1 To VNo
        Counter(i, 2) = 0
    Next i

    Do
        Counter(1, 2) = Counter(1, 2) + 1
        If VNo > 1 Then
            If Counter(1, 2) >= Divisions Then
                For i = 2 To VNo
                    Counter(i, 2) = Counter(i, 2) + Int(Counter(i - 1, 2) / Divisions)
                Next i
            End If
        End If
        k = 0
        For i = 1 To VNo
            If Counter(i, 2) <> tempCounter(i) Then
                k = k + 1
                temp = ChangeV(Counter(i, 1), 0) + ChangeV(Counter(i, 1), 4) * Counter(i,
2)
                If VIntFlg(i) = 1 Then temp = Int(temp)
                If Cells(VLoc(Counter(i, 1)), 3).Value <> temp Then Cells(VLoc(Counter(i,
1)), 3).Value = temp
            End If
        Next i
        If k > 0 Then ResultSet
        k = 0
        j = 0
        For i = 1 To VNo
            Counter(i, 2) = Counter(i, 2) Mod Divisions
            If Counter(i, 2) <> tempCounter(i) Then
                k = k + 1
                temp = ChangeV(Counter(i, 1), 0) + ChangeV(Counter(i, 1), 4) * Counter(i,
2)
                If VIntFlg(i) = 1 Then temp = Int(temp)
                If Cells(VLoc(Counter(i, 1)), 3).Value <> temp Then Cells(VLoc(Counter(i,
1)), 3).Value = temp
            End If
            j = j + Counter(i, 2)
            tempCounter(i) = Counter(i, 2)
        Next i
        If k > 0 Then ResultSet
```

```
        If j = 0 Then Exit Do
    Loop
SimpleSIterationLast:
End Sub
Sub ResultSet()
    Dim i As Integer
    Dim temp As String
    If CNo(0) > 0 Then
        If Application.CountIf(CRange, False) = 0 Then
            If (OptType = 0 And Cells(TLoc, 3).Value < Cells(TLoc, 4)) Or (OptType = 1 An
d Cells(TLoc, 3).Value > Cells(TLoc, 4)) Or (OptType = 2 And Abs(TargetValue - Cells(TLoc
, 3).Value) < Abs(TargetValue - Cells(TLoc, 4))) Then
                For i = 1 To VNo
                    tempV(Counter(i, 1)) = Cells(VLoc(Counter(i, 1)), 3).Value
                Next i
                Cells(TLoc, 4) = Cells(TLoc, 3)
            End If
        End If
    End If
End Sub
```

4. DATABASE

4. DATABASE

4.1 Objective

In this study, a database will be constructed to store the all necessary data for work related to the macro-part of the study in this project. The data collected and the data management system are expected to assist future studies both in I. R. Iran and Japan.

4.2 The Current Status of Database in I. R. Iran

At present, our counterpart is now constructing a comprehensive database which is integrated into a supply-side optimization model. In general, a database can be defined as an integrated system of data and the database management system. As for the database management system, there are many packages from those used by PCs to mainframes. These database management systems are designed to construct a database. However, most of the packaged database management systems are not designed to integrate with other systems such as an supply optimization model. Therefore, an integrated system such as that under construction has to be designed from scratch. Therefore, the task of constructing such a system is painstaking; however, the system could be better designed to serve the needs of the user.

At the current stage, part of the database including that related to industry and economics has almost been completed, although much of the data has not yet been prepared.

The database is very large and is designed to include the energy consumption data to the last digit of ISIC (International Standard of Industrial Code).

However, most of the detailed data necessary for this study do not exist and are not in the database. Therefore, the most difficult issue after the completion of the system will be to search for and to collect data to put into the database.

4.3 The Basic Contents of the Database of This Project

4.3.1 System Configuration

Considering the scale of the system, ease of use, and its flexibility, DBMS has applications worldwide using a personal computer with a popular operating system. Such a DBMS has advantages from the viewpoint of maintenance and the future expansion. The DBMS used for this study is "ACCESS" of Microsoft corporation, which is one of the most popular DBMS of personal computers using the popular operating system "Windows 95."

4.3.2 Basic Contents of Database

The basic contents or the appearance of the database should be similar to that of the Iranian database. At the same time the database should focus on data from this project. The basic structure and the contents of the database are presented in Figure 4.3.1.

The macro-level analysis of this project has three parts: economic evaluation of energy conservation potential, demand forecast, and energy utilization plan. To serve these analyses, the database consists of two parts. One is focused on data for energy conservation potential. The data are the results of an economic evaluation from the micro-level survey. They are not in time series, but rather consists of various types of investment and the respective energy conservation potential. The time series data are general economic and industrial data. These data are used primarily for the demand forecast and the related analysis.

Historical data consist of these two parts.

Figure 4.3.2 shows the basic data flow structure of energy utilization. The figure itself does not show the framework of the database. However, the flow chart helps one to understand the data necessary for part of the energy utilization plan. These data are not historical, but rather are assumptions and the results of models.

Efficiently organizing these three groups of data is the fundamental criterion for the design of this database.

Figure 4.3.1 Basic Database Structure

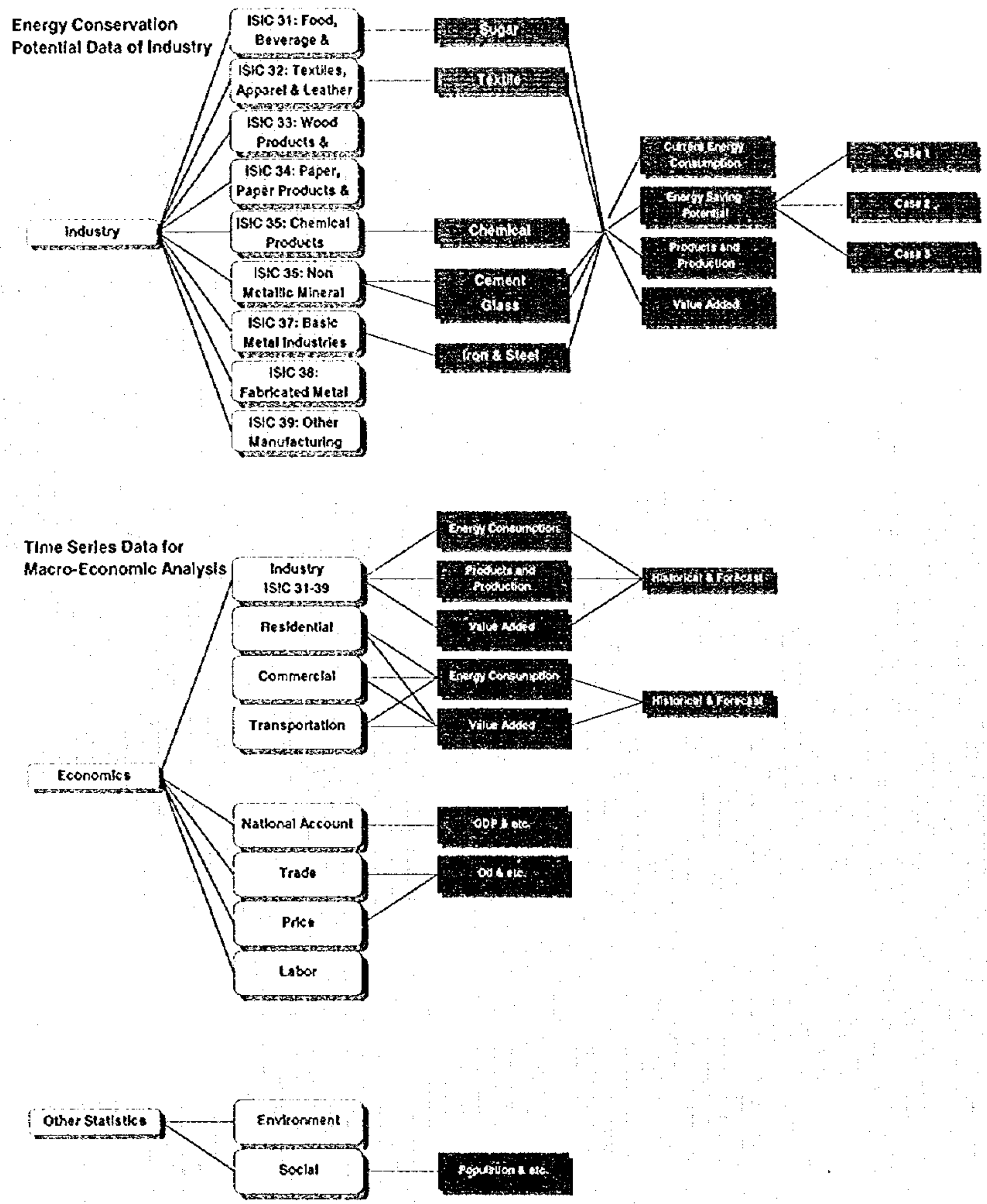
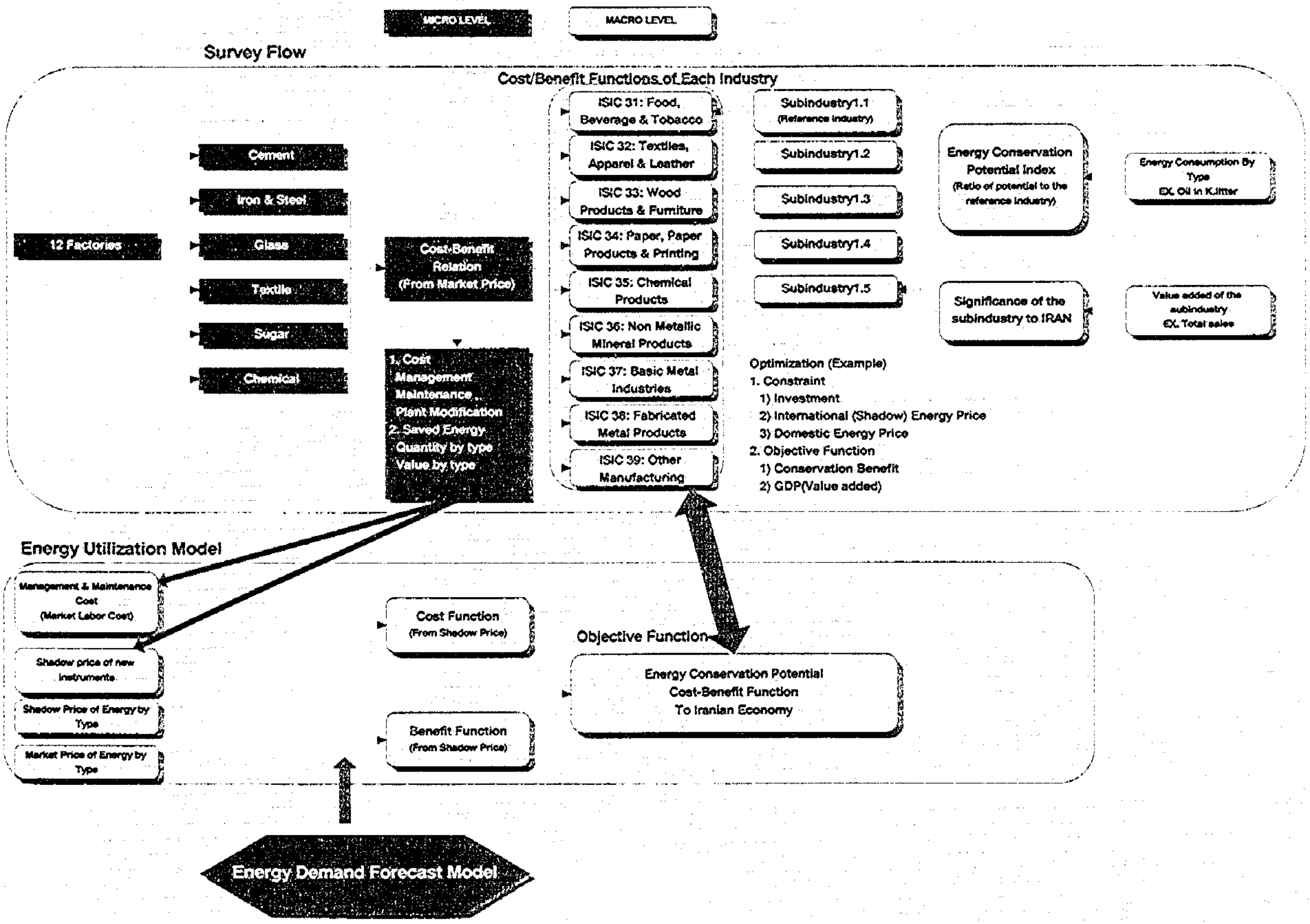


Figure 4.3.2 Data Flow



4.4 Approach to Object Oriented DBMS

The data structure shown in figure 4.3.1 is based on the inherent hierarchy of the data. From such a data structure, we can easily see the relationships among data. If we put emphasis on these relationships, such models as hierarchical or relational models could be natural candidates for the Database Management System (DBMS).

Conversely, there are three objectives of the macro-analysis in this study. They are:

1) Economic evaluation of energy conservation potential,
2) Macro-economic analysis and energy demand forecast, and
3) Optimum energy utilization.

If we emphasize these tasks, the data structure would encompass them. The objective of this database is to organize and facilitate the JICA study and is not just a place to store data. Therefore, this database, which is a collection of data may be accessed from the viewpoints of above tasks. To implement this type of database, the increasingly popular concept of 'Object' or 'Object Oriented' DBMS is employed.

The concept of Object DBMS (ODBMS) emerged in the early 1980s with the emergence of object oriented programming techniques. In a relational model, each entity is represented by a form of table and the relationship between tables is processed through a separate language such as Structured Query Language (SQL). Therefore, a change of entity or relationship can cause changes in any query operation which includes that relationship or the entity. Conversely, in ODBMS, the entity and the relationships are considered as one unified set of 'semantic' objects. For example, the meaning of "optimum energy utilization" contain not only such data as investment schedule and the economic benefit, but also the relationships with other data for economic evaluations. Therefore, a change in one semantic object does not affect other objects. This makes maintenance and conceptualization of a database easier than with a relational model. Moreover, the simple representation of a user's concepts enables easier construction of complex models. Here, the word 'semantic' means meaning. Semantic objects model the user's perceptions more closely than does the Entity-Relationship model. A comparison of Figure 4.3.1 and 4.3.2 shows the idea of the conceptual simplicity of an object model compared to the relational model.

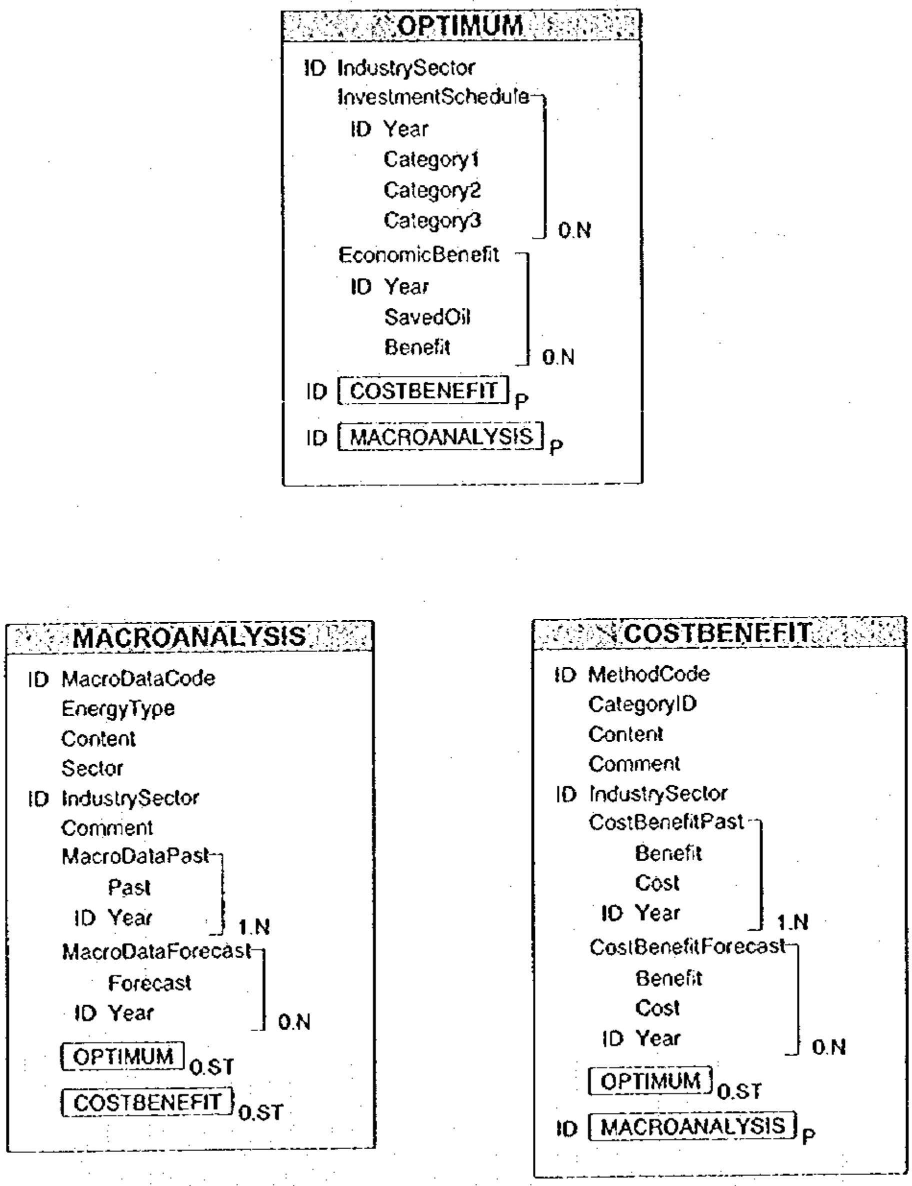
In this context, the concept of ODBMS is increasingly popular. However, the software, which enables the concept of a semantic object is still in the development phase and the real commercial ODBMS is not common and no ODBMS for personal computer is available at this time. Nonetheless, the concept of a semantic object is very important considering future trends. Therefore, the semantic objects in this study are implemented by converting them into a relational model.

4.5 Data Structure: (Semantic) Object Model and Relational Model

The semantic objects thus consist of objects representing the three tasks: 1) Macro-economic analysis; 2) Economic evaluation; and, 3) Energy utilization plan. These three objects are named 1) MACROANALYSIS; 2) COSTBENEFIT; and, 3) OPTIMUM. The contents of each object are shown in Figure 4.5.1. Each object contains time series data and two other objects. Their details are given in the appendix.

In this study, we do not use actual ODBMS, because there is no ODBMS commercially available for PC. Instead, we use Microsoft ACCESS for the relational DBMS by converting the objects into entities and their relationships. However, these objects and their profiles can be applied to any system that supports ODBMS.

Figure 4.5.1 Semantic Objects

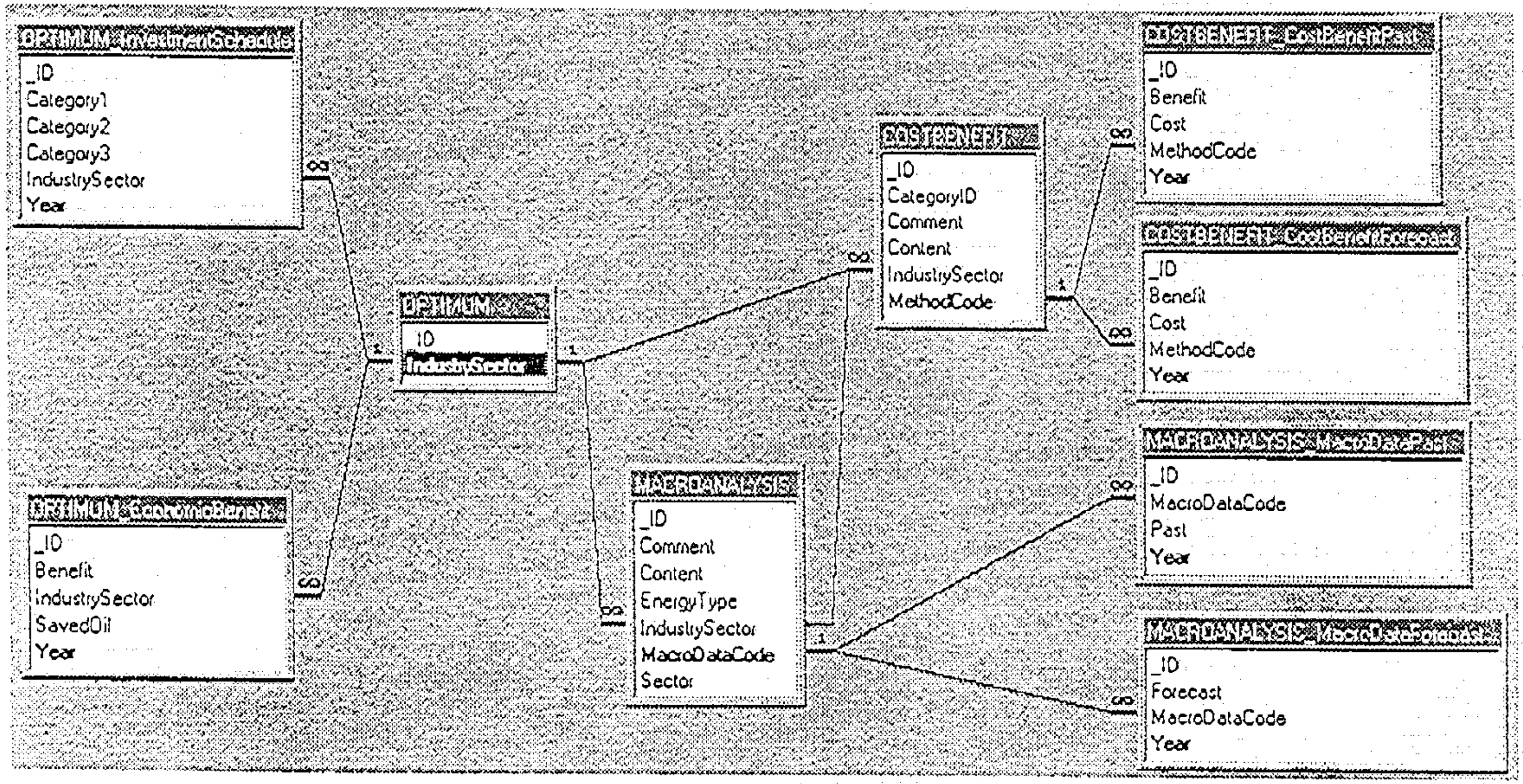


4.6 Conversion to Relational Model

The semantic objects are converted into a relational model as shown in Figure 4.6.1. In this model, as mentioned above, the relationships among entities are visible and the query program has to respond to this complexity.

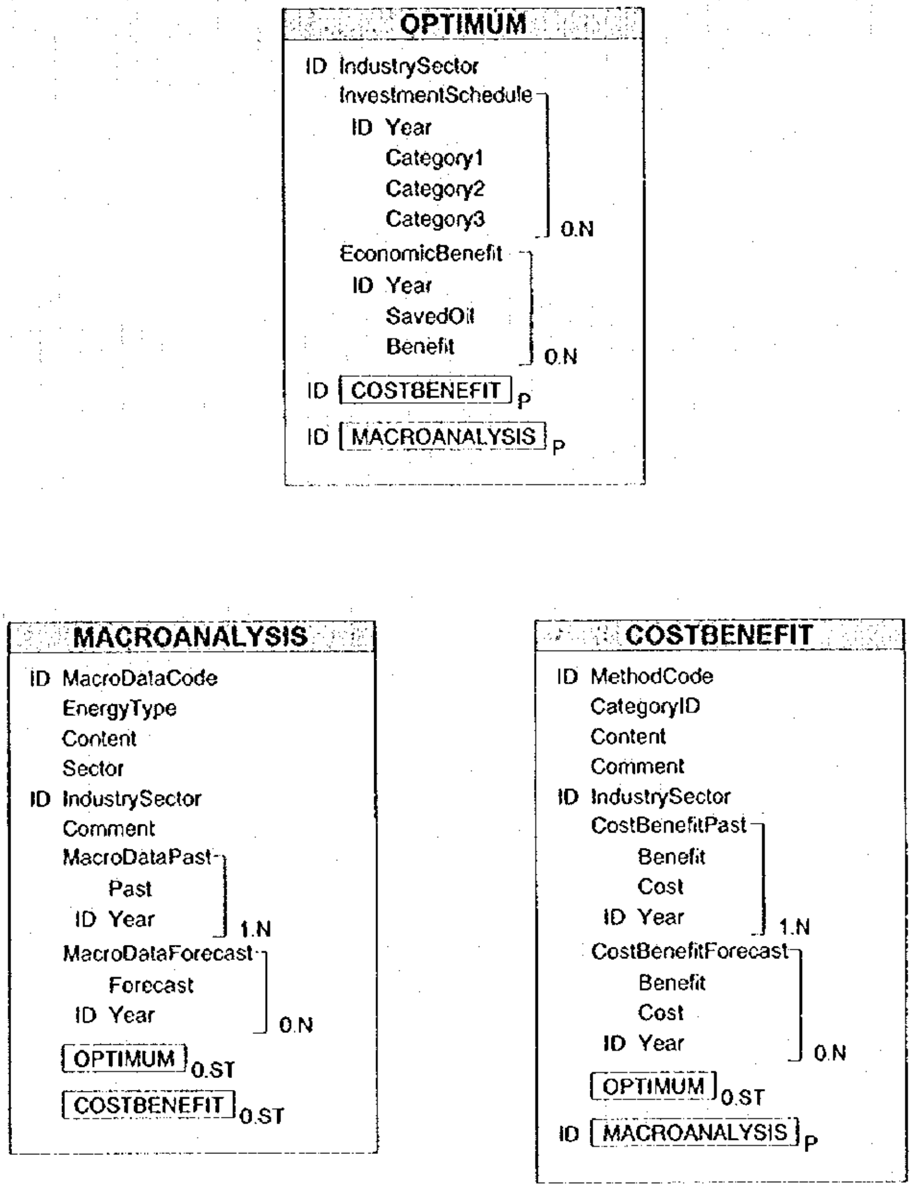
In this relational model, the basic entities are 1) MACROANALYSIS; 2) COSTBENEFIT; and, 3) OPTIMUM, which is the same as the object model. However, the entities for time series data are separated from their main bodies in the above three entities. Also, all entities are connected with relations represented by lines. Details of the model are presented in the appendix.

Figure 4.6.1 Entity-Relationship



4. APPENDIX 1

DATABASE
SEMANTIC OBJECT DETAIL


OPTIMUM
ID IndustrySector
InvestmentSchedule
ID Year
Category1
Category2
Category3
0.N
EconomicBenefit
ID Year
SavedOil
Benefit
0.N
ID COSTBENEFIT P
ID MACROANALYSIS P
MACROANALYSIS
ID MacroDataCode
EnergyType
Content
Sector
ID IndustrySector
Comment
MacroDataPast
Past
ID Year
1.N
MacroDataForecast
Forecast
ID Year
0.N
OPTIMUM 0.ST
COSTBENEFIT 0.ST
COSTBENEFIT
ID MethodCode
CategoryID
Content
Comment
ID IndustrySector
CostBenefitPast
Benefit
Cost
ID Year
1.N
CostBenefitForecast
Benefit
Cost
ID Year
0.N
OPTIMUM 0.ST
ID MACROANALYSIS P

SEMANTIC OBJECTS

Semantic Object Report

Album: IRAN.ALB

MACROANALYSIS Semantic Object

Caption:
Description:

Data Attributes:

Attribute Name	ID Status	Minimum Required	Maximum Allowed	Value Type	Length	Formula Expression
MacroDataCode	Unique	1	1	Text	10	
EnergyType	None	0	1	Text	15	
Content	None	0	1	Text	25	
Sector	None	0	1	Text	20	
Comment	None	0	1	Text	50	
MacroDataPast	None	1	N (No Limit)	Group		
Past	None	1	1	Short Integer		
Year	Unique	1	1	Short Integer		
MacroDataForecast	None	0	N (No Limit)	Group		
Forecast	None	0	1	Short Integer		
Year	Unique	1	1	Short Integer		
OPTIMUM	None	0	1	Semantic Object		

Semantic Object Report

Album: IRAN.ALB

COSTBENEFIT Semantic Object

Caption:
Description:

Data Attributes:

Attribute Name	ID Status	Minimum Required	Maximum Allowed	Value Type	Length	Formula Expression
MethodCode	Unique	1	1	Text	10	
CategoryID	None	0	1	Tiny Integer		
Content	None	0	1	Text	25	
Comment	None	0	1	Text	50	
IndustrySector	Non-unique	1	1	Text	10	
CostBenefitPast	None	1	N (No Limit)	Group		
Benefit	None	1	1	Currency		
Cost	None	1	1	Currency		
Year	Unique	1	1	Short Integer		
CostBenefitForecast	None	0	N (No Limit)	Group		
Benefit	None	1	1	Currency		
Cost	None	1	1	Currency		
Year	Unique	1	1	Short Integer		
OPTIMUM	None	0	1	Semantic Object		

Semantic Object Report

Album: IRAN.ALB

OPTIMUM Semantic Object

Caption:
Description:

Data Attributes:

Attribute Name	ID Status	Minimum Required	Maximum Allowed	Value Type	Length	Formula Expression
IndustrySector	Non-unique	1	1	Text	10	
InvestmentSchedule	None	0	N (No Limit)	Group		
Year	Unique	1	1	Short Integer		
Category1	None	0	1	Text	10	
Category2	None	0	1	Text	10	
Category3	None	0	1	Text	10	
EconomicBenefit	None	0	N (No Limit)	Group		
Year	Unique	1	1	Short Integer		
SavedOil	None	0	1	Text	10	
Benefit	None	1	1	Currency		
MACROANALYSIS	None	0	N (No Limit)	Semantic Object		
COSTBENEFIT	None	0	N (No Limit)	Semantic Object		

SEMANTIC OBJECTS

Attribute Report

Album: IRAN.ALB

Benefit

Type: Simple Value
Profile: Benefit
Contained in: COSTBENEFIT.CostBenefitPast
Caption:
Description:
ID Status: None
Minimum Required: 1
Maximum Allowed: 1
Value Type: Currency
Length:
Format:
Initial Value:

Benefit

Type: Simple Value
Profile: Benefit
Contained in: OPTIMUM.EconomicBenefit
Caption:
Description:
ID Status: None
Minimum Required: 1
Maximum Allowed: 1
Value Type: Currency
Length:
Format:
Initial Value:

Benefit

Type: Simple Value
Profile: Benefit
Contained in: COSTBENEFIT.CostBenefitForecast
Caption:
Description:
ID Status: None
Minimum Required: 1
Maximum Allowed: 1
Value Type: Currency
Length:
Format:
Initial Value:

Category1

Type: Simple Value
Profile: Category1
Contained in: OPTIMUM.InvestmentSchedule
Caption:
Description:
ID Status: None
Minimum Required: 0
Maximum Allowed: 1
Value Type: Text
Length: 10
Format:
Initial Value:

SEMANTIC OBJECTS

Attribute Report

Album: IRAN.ALB

Category2	Type: Simple Value Profile: Category2 Contained in: OPTIMUM.InvestmentSchedule Caption: Description: ID Status: None Minimum Required: 0 Maximum Allowed: 1 Value Type: Text Length: 10 Format: Initial Value:
Category3	Type: Simple Value Profile: Category3 Contained in: OPTIMUM.InvestmentSchedule Caption: Description: ID Status: None Minimum Required: 0 Maximum Allowed: 1 Value Type: Text Length: 10 Format: Initial Value:
CategoryID	Type: Simple Value Profile: CategoryID Contained in: COSTBENEFIT Caption: Description: ID Status: None Minimum Required: 0 Maximum Allowed: 1 Value Type: Tiny Integer Length: Format: Initial Value:
Comment	Type: Simple Value Profile: Comment Contained in: MACROANALYSIS Caption: Description: ID Status: None Minimum Required: 0 Maximum Allowed: 1 Value Type: Text Length: 50 Format: Initial Value:

SEMANTIC OBJECTS

Attribute Report

Album: IRAN.ALB

Comment	Type: Simple Value Profile: Comment Contained in: COSTBENEFIT Caption: Description: ID Status: None Minimum Required: 0 Maximum Allowed: 1 Value Type: Text Length: 50 Format: Initial Value:
Content	Type: Simple Value Profile: Content Contained in: MACROANALYSIS Caption: Description: ID Status: None Minimum Required: 0 Maximum Allowed: 1 Value Type: Text Length: 25 Format: Initial Value:
Content	Type: Simple Value Profile: Content Contained in: COSTBENEFIT Caption: Description: ID Status: None Minimum Required: 0 Maximum Allowed: 1 Value Type: Text Length: 25 Format: Initial Value:
Cost	Type: Simple Value Profile: Cost Contained In: COSTBENEFIT.CostBenefitPast Caption: Description: ID Status: None Minimum Required: 1 Maximum Allowed: 1 Value Type: Currency Length: Format: Initial Value:

SEMANTIC OBJECTS

Attribute Report

Album: IRAN.ALB

Cost	Type: Simple Value Profile: Cost Contained in: COSTBENEFIT.CostBenefitForecast Caption: Description: ID Status: None Minimum Required: 1 Maximum Allowed: 1 Value Type: Currency Length: Format: Initial Value:		
COSTBENEFIT	Type: Object Link Profile: COSTBENEFIT Contained in: OPTIMUM Caption: Description: ID Status: None Minimum Required: 0 Maximum Allowed: N (No Limit)		
CostBenefitForecast	Type: Group Profile: CostBenefitForecast Contained in: COSTBENEFIT Caption: Description: ID Status: None Minimum Required: 0 Maximum Allowed: N (No Limit) Minimum Count: 0 Maximum Count: ALL	Attributes Contained:	Benefit Cost Year
CostBenefitPast	Type: Group Profile: CostBenefitPast Contained in: COSTBENEFIT Caption: Description: ID Status: None Minimum Required: 1 Maximum Allowed: N (No Limit) Minimum Count: 0 Maximum Count: ALL	Attributes Contained:	Benefit Cost Year
EconomicBenefit	Type: Group Profile: EconomicBenefit Contained in: OPTIMUM Caption: Description: ID Status: None Minimum Required: 0 Maximum Allowed: N (No Limit) Minimum Count: 0 Maximum Count: ALL	Attributes Contained:	Year SavedOil Benefit

SEMANTIC OBJECTS

Attribute Report

Album: IRAN.ALB

EnergyType	Type: Simple Value Profile: Comment Contained in: MACROANALYSIS Caption: Description: ID Status: None Minimum Required: 0 Maximum Allowed: 1 Value Type: Text Length: 15 Format: Initial Value:		
Forecast	Type: Simple Value Profile: Forecast Contained in: MACROANALYSIS.MacroDataForecast Caption: Description: ID Status: None Minimum Required: 0 Maximum Allowed: 1 Value Type: Short Integer Length: Format: Initial Value:		
IndustrySector	Type: Simple Value Profile: IndustrySector Contained in: COSTBENEFIT Caption: Description: ID Status: Non-unique Minimum Required: 1 Maximum Allowed: 1 Value Type: Text Length: 10 Format: Initial Value:		
IndustrySector	Type: Simple Value Profile: IndustrySector Contained in: OPTIMUM Caption: Description: ID Status: Non-unique Minimum Required: 1 Maximum Allowed: 1 Value Type: Text Length: 10 Format: Initial Value:		
InvestmentSchedule	Type: Group Profile: InvestmentSchedule Contained in: OPTIMUM Caption: Description: ID Status: None Minimum Required: 0 Maximum Allowed: N (No Limit) Minimum Count: 0 Maximum Count: ALL	Attributes Contained:	Year Category1 Category2 Category3

SEMANTIC OBJECTS

Attribute Report

Album: IRAN.ALB

MACROANALYSIS	Type: Object Link Profile: MACROANALYSIS Contained in: OPTIMUM Caption: Description: ID Status: None Minimum Required: 0 Maximum Allowed: N (No Limit)		
MacroDataCode	Type: Simple Value Profile: MacroDataCode Contained in: MACROANALYSIS Caption: Description: ID Status: Unique Minimum Required: 1 Maximum Allowed: 1 Value Type: Text Length: 10 Format: Initial Value:		
MacroDataForecast	Type: Group Profile: MacroDataForecast Contained in: MACROANALYSIS Caption: Description: ID Status: None Minimum Required: 0 Maximum Allowed: N (No Limit) Minimum Count: 0 Maximum Count: ALL	Attributes Contained:	Forecast Year
MacroDataPast	Type: Group Profile: MacroDataPast Contained in: MACROANALYSIS Caption: Description: ID Status: None Minimum Required: 1 Maximum Allowed: N (No Limit) Minimum Count: 0 Maximum Count: ALL	Attributes Contained:	Past Year
MethodCode	Type: Simple Value Profile: MethodCode Contained in: COSTBENEFIT Caption: Description: ID Status: Unique Minimum Required: 1 Maximum Allowed: 1 Value Type: Text Length: 10 Format: Initial Value:		

SEMANTIC OBJECTS

Attribute Report

Album: IRAN.ALB

OPTIMUM	Type: Object Link Profile: OPTIMUM Contained in: MACROANALYSIS Caption: Description: ID Status: None Minimum Required: 0 Maximum Allowed: 1
OPTIMUM	Type: Object Link Profile: OPTIMUM Contained in: COSTBENEFIT Caption: Description: ID Status: None Minimum Required: 0 Maximum Allowed: 1
Past	Type: Simple Value Profile: Past Contained in: MACROANALYSIS.MacroDataPast Caption: Description: ID Status: None Minimum Required: 1 Maximum Allowed: 1 Value Type: Short Integer Length: Format: Initial Value:
SavedOil	Type: Simple Value Profile: SavedOil Contained in: OPTIMUM.EconomicBenefit Caption: Description: ID Status: None Minimum Required: 0 Maximum Allowed: 1 Value Type: Text Length: 10 Format: Initial Value:
Sector	Type: Simple Value Profile: Sector Contained In: MACROANALYSIS Caption: Description: ID Status: None Minimum Required: 0 Maximum Allowed: 1 Value Type: Text Length: 20 Format: Initial Value:

SEMANTIC OBJECTS

Attribute Report

Album: IRAN.ALB

Year	Type: Simple Value Profile: Year Contained in: COSTBENEFIT.CostBenefitPast Caption: Description: ID Status: Unique Minimum Required: 1 Maximum Allowed: 1 Value Type: Short Integer Length: Format: Initial Value:
Year	Type: Simple Value Profile: Year Contained in: OPTIMUM.InvestmentSchedule Caption: Description: ID Status: Unique Minimum Required: 1 Maximum Allowed: 1 Value Type: Short Integer Length: Format: Initial Value:
Year	Type: Simple Value Profile: Year Contained in: OPTIMUM.EconomicBenefit Caption: Description: ID Status: Unique Minimum Required: 1 Maximum Allowed: 1 Value Type: Short Integer Length: Format: Initial Value:
Year	Type: Simple Value Profile: Year Contained in: MACROANALYSIS.MacroDataPast Caption: Description: ID Status: Unique Minimum Required: 1 Maximum Allowed: 1 Value Type: Short Integer Length: Format: Initial Value:

SEMANTIC OBJECTS

Attribute Report

Album: IRAN.ALB

Year	Type: Simple Value Profile: Year Contained in: MACROANALYSIS.MacroDataForecast Caption: Description: ID Status: Unique Minimum Required: 1 Maximum Allowed: 1 Value Type: Short Integer Length: Format: Initial Value:
Year	Type: Simple Value Profile: Year Contained in: COSTBENEFIT.CostBenefitForecast Caption: Description: ID Status: Unique Minimum Required: 1 Maximum Allowed: 1 Value Type: Short Integer Length: Format: Initial Value:

SEMANTIC OBJECTS

Profile Report

Album: IRAN.ALB

Benefit	Type: Simple Value Contained In: CostBenefitPast, CostBenefitForecast, EconomicBenefit Caption: Description: ID Status: None Minimum Required: 1 Maximum Allowed: 1 Value Type: Currency Length: Format: Initial Value:
Category1	Type: Simple Value Contained in: InvestmentSchedule Caption: Description: ID Status: None Minimum Required: 0 Maximum Allowed: 1 Value Type: Text Length: 10 Format: Initial Value:
Category2	Type: Simple Value Contained in: InvestmentSchedule Caption: Description: ID Status: None Minimum Required: 0 Maximum Allowed: 1 Value Type: Text Length: 10 Format: Initial Value:
Category3	Type: Simple Value Contained In: InvestmentSchedule Caption: Description: ID Status: None Minimum Required: 0 Maximum Allowed: 1 Value Type: Text Length: 10 Format: Initial Value:
CategoryID	Type: Simple Value Contained in: Caption: Description: ID Status: None Minimum Required: 0 Maximum Allowed: 1 Value Type: Tiny Integer Length: Format: Initial Value:

SEMANTIC OBJECTS

Profile Report

Album: IRAN.ALB

Comment	Type: Simple Value Contained in: Caption: Description: ID Status: None Minimum Required: 0 Maximum Allowed: 1 Value Type: Text Length: 50 Format: Initial Value:	
ConservationMethods	Type: Group Contained in: Caption: Description: ID Status: None Minimum Required: 0 Maximum Allowed: 1 Format: Minimum Count: 0 Maximum Count: ALL	Profiles Contained:
Content	Type: Simple Value Contained in: Caption: Description: ID Status: None Minimum Required: 0 Maximum Allowed: 1 Value Type: Text Length: 25 Format: Initial Value:	
Cost	Type: Simple Value Contained in: CostBenefitPast, CostBenefitForecast Caption: Description: ID Status: None Minimum Required: 1 Maximum Allowed: 1 Value Type: Currency Length: Format: Initial Value:	
COSTBENEFIT	Type: Object Link Contained in: Caption: Description: ID Status: None Minimum Required: 0 Maximum Allowed: N (No Limit)	

SEMANTIC OBJECTS

Profile Report

Album: IRAN.ALB

CostBenefitForecast	Type: Group Contained in: Caption: Description: ID Status: None Minimum Required: 0 Maximum Allowed: N (No Limit) Format: Minimum Count: 0 Maximum Count: ALL	Profiles Contained:	Benefit Cost Year
CostBenefitPast	Type: Group Contained in: Caption: Description: ID Status: None Minimum Required: 1 Maximum Allowed: N (No Limit) Format: Minimum Count: 0 Maximum Count: ALL	Profiles Contained:	Benefit Cost Year
EconomicBenefit	Type: Group Contained in: Caption: Description: ID Status: None Minimum Required: 0 Maximum Allowed: N (No Limit) Format: Minimum Count: 0 Maximum Count: ALL	Profiles Contained:	Year SavedOil Benefit
Forecast	Type: Simple Value Contained in: MacroDataForecast Caption: Description: ID Status: None Minimum Required: 0 Maximum Allowed: N (No Limit) Value Type: Short Integer Length: Format: Initial Value:		
IndustrySector	Type: Simple Value Contained in: Caption: Description: ID Status: Non-unique Minimum Required: 1 Maximum Allowed: 1 Value Type: Text Length: 10 Format: Initial Value:		

SEMANTIC OBJECTS

Profile Report

Album: IRAN.ALB

InvestmentSchedule	Type: Group Contained in: Caption: Description: ID Status: None Minimum Required: 0 Maximum Allowed: N (No Limit) Format: Minimum Count: 0 Maximum Count: ALL	Profiles Contained:	Year Category1 Category2 Category3
MACROANALYSIS	Type: Object Link Contained in: Caption: Description: ID Status: None Minimum Required: 0 Maximum Allowed: N (No Limit)		
MacroDataCode	Type: Simple Value Contained in: Caption: Description: ID Status: Unique Minimum Required: 1 Maximum Allowed: 1 Value Type: Text Length: 10 Format: Initial Value:		
MacroDataForecast	Type: Group Contained in: Caption: Description: ID Status: None Minimum Required: 0 Maximum Allowed: N (No Limit) Format: Minimum Count: 0 Maximum Count: ALL	Profiles Contained:	Forecast Year
MacroDataPast	Type: Group Contained in: Caption: Description: ID Status: None Minimum Required: 1 Maximum Allowed: N (No Limit) Format: Minimum Count: 0 Maximum Count: ALL	Profiles Contained:	Past Year

SEMANTIC OBJECTS

Profile Report

Album: IRAN.ALB

MethodCode	Type: Simple Value Contained in: Caption: Description: ID Status: Unique Minimum Required: 1 Maximum Allowed: 1 Value Type: Text Length: 10 Format: Initial Value:
OPTIMUM	Type: Object Link Contained in: Caption: Description: ID Status: None Minimum Required: 0 Maximum Allowed: 1
Past	Type: Simple Value Contained in: MacroDataPast Caption: Description: ID Status: None Minimum Required: 1 Maximum Allowed: N (No Limit) Value Type: Short Integer Length: Format: Initial Value:
SavedOil	Type: Simple Value Contained in: EconomicBenefit Caption: Description: ID Status: None Minimum Required: 0 Maximum Allowed: 1 Value Type: Text Length: 10 Format: Initial Value:
Sector	Type: Simple Value Contained in: Caption: Description: ID Status: None Minimum Required: 0 Maximum Allowed: 1 Value Type: Text Length: 20 Format: Initial Value: