3. ESTABLISHING POLICY SCENARIOS AND ESTIMATE OF POTENTIAL FOR ENERGY CONSERVATION

3.1 Introduction

In this chapter, we assess how the government's economic incentives can promote measures for energy conservation, based upon the economic evaluation of measures in the previous chapter, and then estimate the economic potential for energy conservation in seven industries.

For this purpose, first, we define "measures" for energy conservation and "policies" as those that support or promote the measures. Second, we establish scenarios for energy conservation policies, and, third, estimate the economic potential for energy conservation according to the policy scenarios.

3.2 "Measures" and "Policy" for Energy Conservation

3.2.1 What are the "Measures" ?

(1) Basic Technical Measures for Energy Conservation in the Industrial Sector

"Measures" for energy conservation are defined here as technical measures adopted for energy conservation in individual factories. Generally, the following are included in the measures:

a. Improvement of fuel combustion
b. Improvement of heating and cooling
c. Prevention of heat loss
d. Recovery of waste heat
e. Improvement of conversion from heat to power
f. Prevention of electric resistance loss
g. Improvement of conversion from electricity to power

(2) Three Categories of Measures for Energy Conservation in the Industrial Sector

Measures for energy conservation in factories can be divided into three categories from the viewpoint of being implemented easily or with difficulty, or costly or not costly:

The first category: Measures that can be implemented through the proper management of operations and maintenance of factories, equipment, and others. In other words, they can be said to be implemented to keep the designed value (or the value guaranteed by maker) of energy consumption of factories, equipment, and others as high as possible.
These measures usually do not require any significant costs.

The second category: Measures that can be implemented by improving or modernizing existing equipment, machines, etc. They can be said to be implemented to improve the designed energy consumption of the equipment, machines, etc. and usually require a certain amount of costs.

The third category: Measures that can be implemented by the replacement or modernization of existing equipment or machines. They can be said to be implemented by introducing new equipment or machines with improved level of the designed value of energy consumption, and usually require a significant amount of cost.

3.2.2 What is the "Policy" ?

"Policy" is defined here as one set of policy measures adopted to promote or support "measures" implemented in individual factories as mentioned above.
T. Haugland, who is Senior Economist of ECON Centre for Economic Analysis in Norway, wrote, in his paper on energy conservation policy in Norway, "Obviously, the simple engineering studies, based strictly on technical data and calculations, do not account for behavioral features."
Generally, there are compulsory policies and non-compulsory ones (those based upon education or suggestions). Examples of the former are closure of gas stations on certain days and prohibition of using certain kinds of equipment. Increases in energy prices and favorable treatment for some kinds of equipment in the taxation system are two examples of the latter.

From such a viewpoint, the "policy" for accelerating the "measures" in category 1, which are those for improving the management of factories in a broad sense, should be considered first as most important in this study. This is mainly because such measures can be implemented financially even in the short period of three to five years while measures in category 2 and 3 cannot be justified financially in the short term.
The "policy" for supporting measures in category 2 and 3 are considered second as those that can be implemented mainly in the medium and long term.

3.3 Considerations on Energy Conservation Measures

3.3.1 Energy Conservation through Proper Management

(1) Current status of management in the Iranian factories

The "Factory Energy Audit" in this study proposed many energy conservation measures for improving the management of operations and maintenance, which are equivalent to those in category 1 above. These measures were also introduced in Chapter 2 of the first volume of this study report.
The following are measures for improving management which are often common to each industry:

a. Improving yields of products --------- This is proposed for iron and steel, sheet glass, textiles, and sugar. Improving yields of products is one of the most basic measures for improving productivity, as well as decreasing production costs in factories, which naturally results in energy conservation. The fact that Iranian factories are facing big problems in basic measures for improving management efficiency means that they need to tackle such basic measures to solve as the first step if they are to be successful in promoting energy conservation.
b. Improving management of combustion in boilers, furnaces, and others --------- This is proposed for iron and steel, cement, petroleum refining, sheet glass, textiles, and vegetable oil. These measures are also among the most basic ones for promoting energy conservation in factories. In the same sense as above, the facts that such measures are proposed for many factories means that the Iranian factories need to improve management efficiency at its most basic level.
c. Improving management of unnecessary lighting --------- This is proposed for petroleum refining and sugar. Although it is proposed for only two factories by the "Factory Energy Audit," it can be supposed that there are many factories facing the same problem. This measure

is also one of the most basic measures for avoiding waste in factories, which means that the Iranian factories need to implement energy conservation efforts from the most basic level.

(2) Some examples of proper management

As already mentioned above, it is usual in existing factories for energy conservation measures to be implemented in the following order: first, efforts for improving the management of operations and maintenance, second, improvements of existing machines or equipment, and third, introduction of new processes.

Taking the experiences of Japanese oil refineries as an example, the measure of "improvement in air ratio" was implemented as follows:

The first step was properly monitoring and measuring the "air ratio" in heating furnaces and boilers, measures for which are among the most important ones for energy conservation in petroleum refineries. Because this is done using an analytical device, its installation or repair will be necessary if this device is not installed or is out of order in the plants.

The next step was controlling air supply. It is the responsibility of the operator to carefully control damper of the air register finely by hand.

The third step was preventing air leakages. To stop holes, materials such as aluminum tape and asbestos yarn are used. The installation of stopcocks on burners, as well as the improvement of check-windows, are also necessary.

After taking these measures mainly in category 1, low O_2 burners, the automatic damper control system, and others devices which are measures in category 2, were introduced.

The measure to "improve the air ratio" is usually done in the steps mentioned above. As can be seen in this example, both ideas on work and sufficient skills on production lines in factories are necessary for executing the proper management of equipment.

It is reported that in Japanese petroleum refineries operators or workers on production lines were responsible for proposing ideas and doing the work in many cases. The same can be said on other industries.

In addition, measures in category 1 are not the only measures for which the ideas and work of operators or workers were effective for energy conservation, but they played a very important role in proposing the ideas as well as in doing the work for measures in all categories, particularly in categories 1 and 2.

Looking at the history of energy conservation activities in power plants in Japan, our attention is turned to the following facts for proposing ideas on energy conservation and for implementing measures based upon the ideas:

First, many energy conservation ideas were proposed by operators at power plants.

What should not be forgotten here, however, is the fact that they were motivated by basic guidelines and systems or organizations for energy conservation which the management of firms or factories had established. This is shown in the fact that many ideas were proposed according to proposing systems (including invitations for proposing as well as rewards for adopted proposals) prepared by the management of firms or factories.

Second, "groups" or "circles" were organized for executing energy conservation measures to play a big role in execution. In particular, we should pay attention to an examples in which a "combustion management group" in a power plant was successful in persuading operators to improve

management, acting as a core for all operators.
Then, what motivated the "behavior" of such operators ?

(3) System and Mechanism determining the Management Efficiency in Factories (or Firms)

According to studies done by the "Comparative Institutional Analysis" school, which originated at Stanford University in California in the early 1990s, the following differences in the "Coordination System" can be found between the automobile industries in the U.S. and Japan:
In the Japanese industry, workers are requested to have common knowledge of the whole production system. They are qualified to stop production lines, and also requested to react and cope with emergency including machine failures, for instance.
Such a production system is in contrast to that in the U.S. automobile industry during the period from around 1970 to 1980. Duties were distributed more strictly with production lines under the control of centralized management and emergencies were dealt with by staff who had specialized knowledge.
The "Comparative Institutional Analysis" insists that workers' behavior is determined not only by the "Coordination System" but also by the "Incentive Mechanism." In Japan, the "Incentive Mechanism," of which "permanent employment," "seniority pay," and "seniority promotion" are characteristics, supported the "behavior" of workers.
In addition, more specifically, proposals for improvements and providing rewards were important for promoting energy conservation in Japanese factories.

Based upon such an analysis, we think the following considerations are necessary to implement "Improvement in management":

a. Energy conservation is an activity common to all industries including those mentioned above. The Japan-type "System," however, may be appropriate for promoting energy conservation, mainly because energy conservation in the industrial sector has been very successful in Japan.
b. The "Coordination System" in a country is formulated during the historical development of the country. Therefore, its simple transfer from one country to another is impossible. Nevertheless, if we look at the U.S. automobile industry which has recovered its competitive strength by learning from the Japan-type "System," it can be said that industries in I.R.Iran will be successful upon adopting some parts of the Japan-type "System."
c. In parallel, some parts of the U.S.-type "System" and others may be able to be transferred to Iranian industries.
d. A similar consideration can be made for the "Incentive Mechanism," again taking into account the characteristics of the Iran-type "Mechanism."

3.3.2 Necessity of Comparing Costs and Benefits of Measures

Comparing costs and benefits of measures for energy conservation is indispensable in the consideration of economic incentives. Namely, it is indispensable in cases (a) that a company determines the priorities of measures, or estimates their effects, and (b) that the government examines economic incentives for energy conservation, or estimates the necessary expenditures for the incentives.
The results of the economic evaluations are described in Chapter 2.

3.4 Consideration of Basic Policy Direction for Energy Conservation

3.4.1 Basic Policy for Proper Management

(1) Programs of firms (or factories) for proper management

As already mentioned, improving the "Coordination System" and the "Incentive Mechanism" for the realities in I.R.Iran is necessary for firms or factories to improve their management of equipment and machines for promoting energy conservation.

The following are "some sample key deficiencies in the existing entities" in the electric power industry, which we consider can be applicable to other industries in many cases.

a. Salaries are often based on complex formula, and pay differentials are small. A suitable salary system should be developed, which reflects adequate differentials for responsibility and takes account of the scarcity of skills concerned;

b. Job descriptions, where they exist, do not focus on individual accountability and responsibilities, nor are they part of an overall organization plan. For every position, a complete job description should be written, highlighting the required qualifications and experience;

c. There is no comprehensive, long-term, training programme for the industry. A thorough analysis of training needs for all the different jobs should be carried out and required training modules should be developed;

d. No formal performance management review and improvement processes, or development systems or incentives exist for employees. A system of performance management incorporating target setting and performance appraisal should be established;

e. Much of the decision-making is generally carried out at quite a senior level, so that operational decisions are often referred upwards when responsibility could be delegated to lower levels of management. It is necessary to develop clear statements of corporate and departmental objectives, roles, and responsibilities.

We think attentions should be turned to these suggestions for improving the "System" and "Mechanism" in factories. Taking into account the views of experts on this issue including the one above , the following items should be considered :

a. Project for improving management efficiency of a whole factory on a Top-down basis

1) The top management's leadership is thought to be critical for such a project. Accordingly, serious attention should be paid to comments made by the World Bank ---- "Management appointments should be based on professional qualifications and experience, and management training should be expanded."

2) System or organization for preparing a program for the project and executing it are also critical for the project to be successful. The program should contain a wide range of large and small issues including establishing "realistic" targets, and developing a method of collecting and organizing data.

b. Some examples of important issues to be considered

1) How middle management can be urged to accomplish the targets

2) Economic incentives for proposing and executing measures

(2) Issues to be Considered by the Government

We considered that the following policy measures are to be adopted by the government for solving the problems in factories mentioned in (1) above.

a. Management of public enterprises

---- Improving the method of making management appointments (Professional qualifications and experience should be considered.)

---- Management training (For management to improve various abilities for coping with following problems; To prepare proper job descriptions for employees, to prepare proper performance management for employees, and to provide for efficient and appropriate decision-making at each level of operations)

b. Workers in factories

---- Improving labor laws (According to factory managers, labor laws in I.R.Iran have been preventing increases in productivity. Therefore, it is necessary for the government to improve the laws) (Note).

(Note) "The labor regulations in Iran are comprehensive and detailed. In general, they are intended to provide protection to workers, specifying minimum conditions of work and remuneration. An important element of the regulations is the set of procedures and conditions restricting dismissal under Article 27 and 165 of the Labor Law of Iran."

"Current indications from factory managers in Iran are that the labor laws are a major impediment to increasing labor productivity. A comment repeated on several occasions by factory managers in Iran was that it was easier to get a divorce than to dismiss an inefficient worker."

(From a report of the World Bank)

---- Improving salary system (To prepare a system which reflects adequate differentials for responsibility and skill)

---- Training workers (To develop the method and the system of training workers for improving operations and maintenance, as mentioned in 3.3.1 above)

To prepare above mentioned policy measures for implementing them as concrete and realistic ones, the following items should be studied under the guidance of the government:

a. Concrete policy measures for energy conservation in factories

--------- Concrete policy measures for supporting and accelerating realistic programs for promoting energy conservation in factories should be prepared by experts inside the government and/or specialized consultants. They will also consider the other policy measures mentioned below.

b. Guidelines for energy conservation in each group of public enterprises

--------- To prepare guidelines on programs for energy conservation in factories, the "Energy Conservation Committee" should be established in each group of public enterprises. The guidelines will also include other aspects of measures for energy conservation in factories than improving management efficiency (Note). The results of such studies may be disclosed to private enterprises for their reference.

(Note) Most public enterprises in I.R.Iran belong to one of following groups:

1) Those under NIIO (National Iranian Industrial Organization) and IDRO

(Industrial Development and Renovation Organization). Both NIIO and IDRO are holding companies of the Ministry of Industry.

2) Those under NISC (National Iranian Steel Corporation). NISC is a holding company of the Ministry of Mines and Metals.
3) Those under BIM (the Bank of Industry and Mines).
4) Those under MJF (Mostazafan and Janbazan Foundation). According to a brochure of MJF, "Moatazafan and Janbazan Foundation (The Foundation for the Oppressed & Disabled of the Islamic Revolution) as a non-governmental complex, is a huge economic and cultural conglomerate establishment founded on 28th Feb., 1979 by a decree of the great leader of the Islamic Revolution, the late Imam Khomeini."

In Ahwaz Steel and Mobarakeh Steel, both of which are under NISC, sections in charge of energy conservation have already been established.
MJF consists of "Economic Section" and "Janbazan Section," and there are seven Organizations under the former, including "Mines and Petroleum Products Organization" where the "Energy Committee" has already been established for the purpose of promoting energy conservation. And also the "Energy Sub-committee," which has the same purpose as the "Committee," has been established in each factory under the Organization.

c. Concrete or specific programs based upon the guidelines in each factory.

d. Model energy conservation factories
---------- At least one model factory should be selected in each group where the project on improving management efficiency will be implemented in consultation with outside experts on the management efficiency and energy conservation. If necessary, foreign consultants and experts would be invited.

3.4.2 Policy Measures for Recovering Investments (or Expenditures)

The following are policy measures for recovering investments (or expenditures). First, we describe their current status in I.R.Iran, and then propose what policy measures should be taken.

(1) Energy pricing

a. Current status
Prices of energy carriers have already been increased in the second five year plan, where an average increase of 20% per annum is envisaged during the period from March 1995 to March 2000.

b. Future policy
Present prices of energy carriers are significantly lower than their costs. According to the estimate made by the PBO team, the price of fuel oil, for instance, was 10.7 Rial/l in 1995, which can be compared to the cost of 75Rial/l (Both are those delivered to factories, and in 1993 prices in real terms).
The difference between the costs and the prices has been actually subsidized by the government. Increasing prices mentioned above is aimed at decreasing the government's

budget deficit by decreasing or abolishing subsidies, as well as promoting energy conservation. The Iranian government, however, has been very careful in its approach to increasing energy prices partly because it may have a bad and serious effect on poor people. A 20% increase per annum in energy prices means an average annual increase of around 8% in real terms, because around 12% inflation is assumed in the five year plan. In fact, commodity prices were increasing at an annual rate of dozens of percent during these years (For instance, the consumer price index increased at an annual rate of 32% from 1990 to 1994, and it is estimated that around the same percentage increase was recorded after 1994). As a result, the prices of energy carriers, which were increased since 1995, have declined in real terms, having less effect on energy conservation than expected.

Nevertheless, we think that it is desirable for the government to continue to increase energy prices at least around 20% annually for the period of the current five year plan, not only for energy conservation, but also for decreasing the government's budget deficit.

In the period after 2000, energy prices can be increased in real terms, because such economic indicators as GDP growth rates and commodity prices will be improved, as described in detail when explaining the results of the "Energy demand forecast" later.

(2) Taxation

a. Current status

There has been no policy measure for energy conservation in the taxation system.

b. Future policy

Discussions with the PBO team concluded that, at least for the short term, tax incentives will not be effective for promoting energy conservation. The reasons are as follows:

---- In general, the current effective rate of taxes is so low in I.R.Iran that any favorable taxation treatment will not have a big influence on energy conservation measures (Note 1).

---- Because the Iranian government has recently started its efforts to re-establish an effective taxation system, it is desirable for it to hammer out tax policy measures for energy conservation after the re-establishment (Note 2).

(Note 1) According to a report of the World Bank, the effective rate of taxation is low in the Iranian taxation system, which has following characteristics:

"The income taxation system in Iran is characterized by relatively high nominal tax rates and a vast array of attractive exemptions or incentives."

"The high income tax rates and low tax receipts suggest that, in combination, the effects of exemptions and avoidance are high."

(Note 2) According to The Economist Intelligence Unit, a British consulting firm, the Iranian government is now planning to expand tax revenues, which is very low at present.

"A major weakness in current government economic planning is the relatively low level of tax revenue upon which it can count. With the development of Iran's economy, it is accepted that a parallel development of a tax culture and rise in tax revenue is essential."

"The Iranian government has announced an ambitious programme of increasing the proportion of tax revenue collected during the Second Five-Year Development Plan (1995-2000) to 26% of entire government revenue, from a figure of around 17.5% in fiscal year 1995/96."

Looking at the current situations of the Iranian taxation system above, we think that it is desirable for the government not to hammer out any tax measure for energy conservation during the period until 2000.

In the period after 2000, however, favorable taxation treatment including tax credits and special depreciation can be implemented for energy conservation, assuming the taxation system will have been re-established by that time.

For reference, we show the current system of taxation for promoting energy conservation in Japan ---------- (a) Objective: Energy efficient equipment specified by laws and regulations. (b) Tax exemption: Either of the following; 1) Tax exemption equivalent to 7% of the equipment acquisition cost (which should be not more than 20% of income tax or corporate tax payable), 2) Special depreciation of 30% of the acquisition cost in the year of acquisition, in addition to ordinary depreciation.

(3) Financing

a. Current status

There has been no policy of assisting factories to finance energy conservation measures. For reference, however, the five-year plan states that such measures should be adopted for energy conservation: "The necessary criteria for granting financial support with preferential rates to the industries and organizations will be announced and implemented in order to execute operations for improving the structure of energy consumption." (Article 19. f.5).

b. Future policy

It is desirable that the policy of low-interest, long-term loans will be implemented for factories to adopt energy conservation measures in the period from 1997 to 2000 and be continued in the period from 2000 to 2005.

The loans, however, should be given to factories only for measures evaluated as economically "feasible" in both periods, while carefully monitoring the re-establishing of the taxation system, mainly because the government's budget balance might not necessarily be much improved, as explained in the results of the "Energy demand forecast" later.

For reference, we show the current system of financing for promoting energy conservation in Japan (loan by the Japan Development Bank) ---------- (a) Objective: Energy efficient equipment specified by law and regulation. (b) Financing ratio: Within 40%. (c) Interest rate: 3.15% (As of November 28, 1995)

(4) Subsidies

a. Current status

There has been no policy measure on subsidizing factories for promoting energy conservation.

b. Future policy

As mentioned above, the government has been suffering from the burden of subsidies given for many commodities, and has already hammered out the general direction of decreasing or abolishing subsidies. Subsidization for energy conservation, however, does not contradict the general direction, if it can satisfy a certain condition, because energy conservation is one of important policies on which the government has put priority.

"A certain condition" above means that the costs of importing equipment for an energy conservation measure are to some extent less than the export price of energy (oil) saved by the measure, as will be explained in detail for the results of a study on the "Energy utilization plan" later. The scale of "to some extent" depends upon the prices of energy (oil) for domestic use and for export. In establishing policy scenarios mentioned below, we assumed that measures will be subsidized if their benefits exceed 50% of cost.

For reference, we show the current system of energy conservation subsidies (in a broad meaning) in Japan --------- (a) Objective: Photovoltaic power generation system for household.
(b) Amount of subsidy (As of fiscal year 1995): A * B

A: Lower one of the following

1) 850 thousand yen plus consumption tax
2) 1/2 of the system cost per 1kW

B: Maximum output of solar battery module (kW) (5kW is the upper limit)

3.4.3 Other Policy Measures

The following are other policy measures for promoting energy conservation. As many of them can be implemented without a large investment, such policy measures should be adopted as soon as possible.

(1) Establishing the standards and the targets of energy consumption on machines and equipment in factories.
(2) Designating energy intensive factories
(3) Obligation for nominating energy managers in factories
(4) Assistance on research and development for energy conservation --------- The current five-year plan states that "0.2% of income that accrues from sales of energy carriers during the Plan period will be allocated to research by the relevant ministries necessary for saving and managing of energy consumption." (Article 19 f.5)
(5) Reducing electricity consumption --------- The plan states that "the seasonal program of factory and industry works will be regulated by the relevant ministries to reduce the electricity and energy consumption during the months subject to the highest consumption." (Article 19 f.4)
(6) Providing information on energy conservation --------- Factory energy audit made by experts; publishing guideline for energy conservation; demonstration for energy conservation; awarding successful cases on energy conservation; others

3.5 Establishing Policy Scenarios for Energy Conservation

We have established policy scenarios to estimate the potential for energy conservation, based upon the examinations above. Factors (policy measures) incorporated in the scenarios have to be suitable for quantitative examinations because they are to be established for estimating potential. We have selected as such factors (a) energy prices, (b) economic incentives (financing, taxation, subsidies, etc.), and (c) improvement in management.
The following scenarios are established by incorporating the policy measures above:

- ◆ Energy Conservation (E. C.) Scenario
- ◆ Accelerated Energy Conservation (A. E. C.) Scenario

Estimation of potential for energy conservation, however, is made only for the E. C. scenario for the reasons mentioned in the next chapter. Table 3.3.1 shows an outline of policy scenarios.

Table 3.3.1 Scenarios for Forecasting Energy Demand in the Industry Sector

Scenario	Energy Conservation	Accelerated Energy Cons.
Energy Price	•1995-2000;According to 5 year plan •2001-2005;The same as above	•1995-2000;To reach price representing real cost. •2001-2005;To be maintained
Incentives or Subsidization	•1995-2000;Subsidy & loan •2001-2005;The same as above.	•1995-2000;Subsidy & loan •2001-2005;The same as above.
Improved Management	•1995-2000;To be strengthened •2001-2005;The same as above	•1995-2000;To be much more strengthened. •2001-2005;The same as above
Others (R & D; etc)	To be considered only qualitatively	The same as Ene. Con. Scenario

a. Energy prices

As mentioned already, energy prices are assumed to increase at a rate of around 8% per annum at real prices in 1993 in the E. C. scenario.
In the A.E.C. scenario, energy prices are assumed to increase to a level representing real costs at the real prices in 1993 in 2000, and to be maintained at the same level after that.
Table 3.3.2 shows the assumptions of energy prices by scenario.

Table 3.3.2 Assumption of Energy Prices by Scenario

	Electricity (Rl/kWh)		Natural Gas (Rl / m^3)		Fuel Oil (RL / l)		Gas Oil (RL / l)		Coal (US$ / t)	
	Ene. Con.	Acc. Ene. Con.	Ene. Con.	Acc. Ene. Con.	Ene. Con.	Acc. Ene. Con.	Ene. Con.	Acc. Ene. Con.	Ene. Con.	Acc. Ene. Con.
1993	N.A.	N.A.	18.2	18.2	15	15	20	20	N.A.	N.A.
1994	28.6	28.6	15.7	15.7	10.7	10.7	14.3	14.3	N.A.	N.A.
1995	25.6	25.6	14.1	14.1	10.7	10.7	16	16	N.A.	N.A.
1996	27.7		15.2		11.5		17.3			
1997	29.9		16.4		12.4		18.7			
1998	32.3		17.7		13.4		20.2			
1999	34.8		19.2		14.5		21.8			
2000	37.6	100	20.7	123	15.7	75	23.5	474		60
2001	40.6	100	22.4	123	16.9	75	25.4	474		60
2002	43.9	100	24.1	123	18.3	75	27.4	474		60
2003	47.4	100	26.1	123	19.8	75	29.6	474		60
2004	51.2	100	28.2	123	21.3	75	32	474		60
2005	55.3	100	30.4	123	23	75	34.6	474		60
2006	59.7	100	32.8	123	24.9	75	37.3	474		60
2007	64.5	100	35.5	123	26.9	75	40.3	474		60
2008	69.7	100	38.3	123	29	75	43.5	474		60
2009	75.2	100	41.4	123	31.3	75	47	474		60
2010	81.3	100	44.7	123	33.9	75	50.8	474		60

(Note) Prices are in the real term of 1993 price, including the transportation costs except for electricity. The costs are 10 % of the price for natural gas, 10 Rials for fuel oil and gas oil, and negligible for coal.

b. Economic incentives

The following two kinds of policy measures are assumed to be adopted in the future:

First, the government will give a company or a factory a "subsidy" for an energy conservation measure in 2000 and after, which is evaluated as "not feasible" according to the evaluation explained previously, providing the condition below is satisfied (See the previous chapter on B and C):

$$B / C > 0.5$$

The amount of the subsidy is the same as the difference between C and B. This formula means that the subsidy is given to the company or the factory if the present value of total energy saved by the measure exceeds half of the cost of the measure.
Only measures, the cost of which is less than 1,750 million Rial for 2000 and 8,750 million for 2005, will be subsidized, taking into account the difficulties of financing investment costs including foreign currency.

Second, the government will finance 40% of the cost of an energy conservation measure under favorable conditions in 2000 and after, which is evaluated as "feasible" according to the economic evaluation, providing the costs do not reach 1,750 million Rial for 2000 and 8,750 million Rial for 2005, respectively.

c. Improvement in management

Management of operation and maintenance in factories are assumed to be improved through the efforts mentioned above in this chapter.

3.6 Estimating Potential for Energy Conservation

We have estimated the economic potential of energy conservation in seven industries according to the E. C. scenario.

3.6.1 Iron and Steel

We have estimated the potential by factory in the iron and steel industry.

a. 2000

- Esfahan Steel
We have assumed that any measures for which the cost exceeds 1,750 million Rials cannot be implemented from the viewpoint of financing even if they are evaluated as "feasible." Other measures will result in a total saving of more than 11% of the energy intensity from 1994.
Accordingly, the potential which can be actually realized is assumed around 10% of the 1994 energy intensity.

- Mobarakeh Steel
  We have made the same estimation as that for Esfahan Steel, assuming the energy intensity of Mobarakeh Steel in 2000 will be 12.5% lower than that in 1994.
- Khouzestan Steel
  We have made the same estimation as that for Esfahan Steel, assuming the energy intensity of Khouzestan Steel in 2000 will be 15% lower than that in 1994.

b. 2005

- Esfahan Steel
  Two additional measures of "Yield increase" and "Low coke operation" will be "feasible" by 2005, and energy intensity will be decreased about 2% by the measures.
  Accordingly, the energy intensity in 2005 is assumed to decline to 87.5% of that in 1994.
- Mobarakeh Steel
  In existing facilities, a further 2-3% reduction of energy intensity can be achieved. Accordingly, we have assumed that the intensity in 2005 will be 85% of that in 1994.
  In addition, we have assumed that new facilities with a capacity of producing around 500 thousand tons of crude steel equivalent per annum will have been completed by 2005, and that the energy intensity of the facilities will be around 6,500 Mcal/t.
- Khouzestan Steel
  In existing facilities, a further 5-6% reduction of energy intensity can be achieved. Accordingly, we have assumed that the intensity in 2005 will be 80% of that in 1994.
  We have also assumed that new facilities with the capacity for producing around 1,000 thousand tons of crude steel equivalent per annum will have been completed by 2005, and that the energy intensity of the facilities will be 6,500 Mcal/t.

The estimation of potential above shows that the energy intensity in the iron and steel industry will decrease from 8,830 Mcal/t in 1994 to 7,760 Mcal/t in 2000 and 7,340 Mcal/t in 2005. Future production of crude steel and energy consumption in the iron and steel industry are shown in Table 3.3.3 and Table 3.3.4, respectively.

Table 3.3.3 Future Production of Crude Steel in I.R.Iran

	1994		2000		2005	
	Capacity	Product.	Capacity	Product.	Capacity	Product.
	(1,000t/y)		(1,000t/y)		(1,000t/y)	
Esfahan	2,100	1,880	2,100	2,100	2,100	2,100
Mobarake.	2,770	1,480	2,770	2,600	3,270 (500)	3,000 (430)
Khuzest.	1,700	1,350	1,700	1,600	2,700 (1,000)	2,200 (900)
Total	6,570	4,710	6,570	6,300	8,070	7,300

(Note) Figures in parentheses are additional capacity and crude steel produced by the additional capacity, respectively.

Table 3.3.4 Future Consumption of Energy and Energy Intensity in the Iron and Steel Industry in I.R.Iran

	1994	2000		2005	
		No Meas.	Measures	No Meas.	Measures
	(Mcal/t-c.s.)	(Mcal/t-c.s.)		(Mcal/t-c.s.)	
Esfahan	9,140	9,140	8,230	9,140	8,000
Mobarak.	8,890	8,890	7,780	8,890	7,410
Khuzest.	8,350	8,350	7,100	8,350	6,610
Total	8,830	8,840	7,760	8,430	7,340
Energy Consumpt. (Mill. Mcal/y)	41,536	55,690 (100)	48,890 (88)	61,540 (100)	53,580 (87)

3.6.2 Cement

We have estimated the potential in five groups of production lines in the cement industry.

a. 2000

Looking at measures belonging to "Improvement in management," we have estimated that "feasible" measures can reduce energy intensity in 1994 by 6-8% in Sepahan Cement. It is also estimated that, in No.6 kiln of Tehran Cement and No.4 kiln of Soufian Cement, "feasible" measures can decrease energy intensity by 5-10% and 6-7%, respectively (See the "Factory Energy Audit" on these three factories).
Accordingly, we have assumed that around 10% energy conservation can be accomplished by these measures in the whole industry (which means each of five groups can accomplish this scale of energy saving).
On the other hand, we have assumed that facilities which will have been operating for more than 30 years by 2000 will be replaced or scrapped. In our forecast, many facilities in the "Wet kiln– Planetary cooler" group will be replaced or scrapped by 2000, and the production capacity of this group will decrease from 2,200 t/d in 1994 to only 300 t/d in 2000.
In contrast, a large number of new facilities will be built by 2000 to replace the facilities mentioned above and to fill increased demand. We forecast the production capacity of these new ones will reach 20,970 t/d in 2000.
Such replacement, scrapping, and new construction will result in a big decline of the energy intensity in the industry.

b. 2005

First, we have assumed that an energy saving of around 2.5% can be additionally accomplished by measures belonging to "Improvement in management." Second, measures for the raw mill and the cement mill, which belong to "Modification of equipment and facilities," will be "feasible" by 2005. If these measures are adopted by three groups excluding the "Dry kiln – Planetary cooler" group (No line in "Wet kiln – Planetary cooler" group will exist in 2005), the energy intensity in the whole industry will decline another 2.5% by 2005.

The estimation of the potential above shows that the energy intensity in the existing facilities will decline from 1,370 Mcal/t - cem to 1,220 Mcal/t - cem in 2000 and 1,140 Mcal/t - cem in 2005.

On the other hand, new facilities will be built from 2000 to 2005, the production capacity of which is forecast to be 10,660 t/d in 2005. The energy intensity of these facilities is forecast to be 960 Mcal/t.

These developments will result in an energy intensity of 1,060 Mcal/t in the industry by 2005.

Future cement production and energy consumption are shown in Tables below.

Table 3.3.5 Future Production of Cement in I.R.Iran

Group	1994 Capacity (1,000t/d)	1994 Product. (1,000t/y)	2000 Capacity (1,000t/d)	2000 Product. (1,000t/y)	2005 Capacity (1,000t/d)	2005 Product. (1,000t/y)
<Existing>						
Wet-Plan.	2,200		300		0	
	(5)		(1)		0	
Dry-Plan.	8,100		8,100		4,000	
	(5)		(5)		(3)	
SP-Plan.	19,750		16,850		16,850	
	(11)		(5)		(8)	
SP-Grate	18,000		17,000		14,450	
	(10)		(9)		(6)	
NSP-Grate	6,050		8,050		8,050	
	(3)		(4)		(4)	
Total	54,100	16,840	50,300	12,570	43,350	10,840
	(34)		(27)		(21)	
<Newly built>						
SP(NSP)- Grat.	0	0	20,970	6,290	31,630	9,490
Grand Tot.	54,100	16,840	71,270	18,860	74,980	20,330

(Note) Figures in parenthesis are the number of kiln-line.

Table 3.3.6 Future Consumption of Energy and Energy Intensity in the Cement Industry in I.R.Iran

	1994	2000		2005	
		No Meas.	Measures	No Meas.	Measures
	(Mcal/t-c.)	(Mcal/t-c.)		(Mcal/t-c.)	
<Existing>					
Wet-Plan.	1,960	1,960	1,760	1,960	0
Dry-Plan.	1,510	1,510	1,360	1,510	1,320
SP-Plan.	1,390	1,390	1,250	1,390	1,180
SP-Grate	1,280	1,280	1,150	1,280	1,090
NSP-Grat.	1,230	1,230	1,110	1,230	1,050
Total	1,370	1,350	1,220	1,340	1,140
<Newly built>					
SP(NSP)-Grate	0	960	960	960	960
Grand Tot.	1,370	1,220	1,130	1,160	1,060
Energy Consump (Mill. Mcal/y)	23,070	23,010 (100)	21,310 (93)	23,580 (100)	21,560 (91)

3.6.3 Sheet Glass

We have estimated the potential for energy conservation by factory in the sheet glass industry.

a. 2000

First, "Improvement of yield" and "Combustion control," both of which belong to "Improvement in management" will be "feasible" for implementation by all factories by 2000. The energy saving achieved by these measures is around 2% and 4% for the whole industry, respectively. Supposing that other measures belonging to "Improvement in management" can be added , however, we have estimated that around 10% energy saving can be accomplished by these measures in the industry.
Second, "Light insulation" and "Improvement productivity" will be "feasible," depending upon the government's economic incentives.
Furthermore, the commissioning of Azar Glass (Float process) in 2000 will contribute to decreasing the average intensity of energy in the industry.
These measures will decrease the energy intensity of the industry to 5,290 Mcal/t-product in 2000 from 6,710 Mcal/t-product in 1995, taking into account the effects of a deterioration in efficiency caused by the duration of operations.

b. 2005

First, we have assumed that there will remain almost no room for measures belonging to "Improvement in management" to decrease energy intensity.
Second, we have assumed that the Float process will be installed by Ghazvin Glass around 2002-2003, and that, accordingly, the capacity of existing four furnaces will be curtailed.
Third, Azar Glass can improve its energy intensity by increasing capacity utilization, which will have been low soon after its commissioning in 2000.
All the measures above will reduce energy intensity in the industry to 4,090 Mcal/t in 2005 from 5,290 Mcal/t in 2000.
The tables below show future production of sheet glass and consumption of energy in the sheet glass industry.

Table 3.3.7 Future Production of Sheet Glass in I.R.Iran

	1995		2000		2005	
	Capacity (1,000t/y)	Product.	Capacity (1,000t/y)	Product.	Capacity (1,000t/y)	Product.
Gazvin	130	89	130	125	260	160
Abguineh	98	72	98	93	98	82
Saveh Jam	60	56	60	20	60	50
Iran	14	11	14	10	14	10
Azar	0	0	100	56	100	80
Total	302	228	402	304	532	382

Table 3.3.8 Future Consumption of Energy and Energy Intensity in the Sheet Glass Industry in I.R.Iran

	1995	2000		2005	
		No Meas.	Measures	No Meas.	Measures
	(Mcal/t-p.)	(Mcal/t-p.)		(Mcal/t-p.)	
Gazvin	7,230	6,440	5,300	4,020	3,650
Abguineh	7,010	7,010	5,920	7,010	5,920
Saveh Jam	4,170	4,170	3,570	4,170	3,570
Iran	8,040	8,040	6,850	8,040	6,850
Azar	0	3,480	3,480	3,480	3,090
Total	6,450 <6,710>	5,970 <6,210>	5,090 <5,290>	4,670 <4,860>	3,930 <4,090>
Energy Consump. (Tcal/y)	1,530	1,890 (100)	1,610 (85)	1,860 (100)	1,560 (84)

(Note) 6,440 Mcal/t-p.for Gazvin in 2000 is the actual record in 1994.
Figures in <parenthesis> are those reflecting the effect of deterioration in efficiency caused by the duration of operation.

3.6.4 Textiles

For the following three industries, a more simplified method has been adopted, mainly because of the availability of data and information by factory.

According to the "Factory Energy Audit," we have estimated that "feasible" measures belonging to "Improvement in management" can contribute to reducing the energy intensity by 8-9% in Polyacryl Iran. In addition, "feasible" measures belonging to "Conversion of equipment and facilities" are estimated to decrease around another 3% in the factory.
For Kashan Velvet, we have estimated that "feasible" measures can contribute to a decline of electricity intensity by around 7%, based upon the results of the "Factory Energy Audit."
In addition, the energy intensity of Iranian textile factories is significantly higher than that of Japanese factories or the standard values, as explained in Chapter 2, which implies there is a lot of room for saving energy in the Iranian textile industry.
Based upon these figures and considerations, we have assumed that the energy intensity of existing factories in the Iranian textile industry will decline to 90 in 2000 and 85 in 2005, taking the value in 1995 as 100.
According to our forecast, no additional facilities will be needed by 2005.

3.6.5 Sugar

a. Beet Sugar

Based upon the "Factory Energy Audit," we have estimated that measures belonging to "Improvement in management" will contribute to reducing energy intensity by around 10% by 2000 in Abkouh Sugar. It is also assumed that another 5% energy saving can be accomplished by 2005.
If all of beet sugar factories follow, their energy intensity will decrease to 90 in 2000 and 85 in 2005, taking the value in 1995 as 100.

b. Cane Sugar

In Karun Agro, which was targeted for the "Factory Energy Audit," around 10% energy saving can be accomplished by effectively using baggasse by 2000. We have estimated that some additional measures, including those which will be "feasible" with the government's economic incentives, can accomplish around a 7% energy saving by 2005 in the factory.
Depending upon these measures in Karun Agro, we have assumed that the energy intensity of cane sugar factories in I.R.Iran will decline to 85 in 2000 and 80 in 2005, taking the value in 1995 as 100.

c. Refining

The energy intensity of sugar refiners will decline to 90 in 2000 and 85 in 2005, taking the value in 1995 as 100, assuming the beet sugar factories above.

3.6.6 Vegetable Oil

The energy intensity of vegetable oil factories is estimated to be 2,980 Mcal/ t-product in 1994.
In the Behshar factory targeted for the "Factory Energy Audit," "feasible" measures belonging to "Improvement in management" can accomplish a 6-7% energy saving by 2000. Depending upon this estimate, as well as taking into consideration the fact that production of Behshar accounts for about one third of the total in the industry, we have estimated that around a 10% energy saving can be accomplished in the whole industry by 2000.
Although concrete figures are not available on the estimate of the economic potential for energy conservation, we have assumed that another 5% saving can be accomplished mainly by measures belonging to "Improvement in management" by 2005.

3.6.7 Petroleum Refining

Two opposing trends will affect energy consumption in the Iranian petroleum refining industry in the future.
One is the direction in which energy consumption will increase by installing cracking, reforming, de-sulfurizing, and other energy intensive facilities. Another is one where energy savings will be accomplished by improving management of operations and maintenance, and other measures.
Taking into account these two trends, we have assumed that the energy intensity of Iranian petroleum refineries will decline to 90 in 2000, taking the value in1994 as 100, but will remain at 90 in 2005.

3.7 Conclusion

We have estimated the potential for energy conservation in seven industries by acting on the policy scenario. The following are the conclusions of the estimation (See Table 3.3.9).

Table 3.3.9 Future Consumption of Energy in Targeted Industries

	1994	2000		2005	
		No Meas.	Measures	No Meas.	Measures
	(Tcal/y)	(Tcal/y)		(Tcal/y)	
Iron & Steel	41,540	55,690	48,890	61,540	53,580
Cement	23,100	23,010	21,310	23,580	21,560
Glass	1,530	1,890	1,610	1,860	1,630
Textile	5,650	6,240	5,600	7,220	6,130
Sugar	7,630	10,280	9,320	12,220	10,640
Vegetable Oil	2,190	2,880	2,600	3,430	2,900
Sub-total	81,640	99,990	89,330	109,850	96,440
Petroleum Refining	54,780	67,900	61,110	81,790	69,520
Grand Total	136,420	167,890	150,440	191,640	165,960

(Note) Figures for glass, textile, and sugar in the 1994 column are those in 1995.

First, energy consumption in six industries excluding petroleum refining will increase from 81,600 million Mcal in 1994 to 89,300 million Mcal in 2000 and 96,400 million Mcal in 2005.
Second, energy consumption will increase to 100,000 million Mcal in 2000 and 110,000 million Mcal in 2005, if no measures are taken for energy conservation in existing facilities.
In other words, energy consumption in the case of "measures for energy conservation" will be 89 in 2000 and 88 in 2005 if energy consumption in the case of "no measures for energy conservation" is 100, which means that measures can reduce energy consumption in the industry by around 10% in the future. The difference between energy consumption in the case of "measures for energy conservation" and that in "no measures" is estimated to be 1,150 thousand kl in 2000 and 1,450 thousand kl in 2005 in six industries.
Third, in the petroleum refining industry, the difference between energy consumption in the case of "measures" and "no measures" is estimated to be 730 thousand kl in 2000 and 1,330 thousand kl in 2005.
Finally, in seven industries including the petroleum refining industry, the potential for energy conservation, that is, the difference between energy consumption in the case of "measures" and that with "no measures," is estimated to be 1,880 thousand kl in 2000 and 2,780 thousand kl in 2005.

4. EVALUATION OF POLICY SCENARIOS AND INVESTMENTS FOR ENERGY CONSERVATION

4.1 Introduction

In this chapter, we evaluate policy scenarios (and potential for energy conservation estimated according to the scenarios) from the viewpoint of macro-economy and also investments for energy conservation from the viewpoint of its optimization.

The former is evaluated in terms of its impact on economic growth, international balance of payments, commodity and service prices, balance of the government's budget, and other macro-economic factors.

The latter is evaluated in terms of the maximization of "net benefits" from investments on energy conservation.

4.2 Evaluation from "Energy Demand Forecast"

The evaluation from the macro-economic viewpoint is based upon the results of the "Energy Demand Forecast" in this study.

4.2.1 Development of Model

We have developed a forecasting model combining a macro-economic model and a energy supply and demand model, taking into account current economic situations in I.R.Iran (Macro-Energy Model : MEM).

In developing the macro-economic model, the impacts of the following factors on the domestic economy are taken into account: (a) foreign debt, (b) government's budget deficit, and (c) domestic energy prices.

In the energy model, energy demand is basically determined by real income, real prices, and technonlogy improvement. For more details on the MEM, please see Chapter 5.

4.2.2 Establishing Cases (Scenarios)

In this study, two simulations have been made: the "Reference" case (scenario) and the "Energy Conservation" case (scenario). The purpose of the simulations is to get knowledge, through a comparison of two cases (scenarios), about the impacts of energy pricing policies and other policies upon the macro-economy and energy supply and demand.

As mentioned below, we have found that commodity and service prices will be higher, and economic growth rate lower in the Energy Conservation case than the Reference case. It is obvious that commodity prices are projected to be much higher and economic growth rate much lower in the Accelerated Energy Conservation case if we use the MEM. Accordingly, we have not made any simulation for the A.E.C. case.

The simulation period is about 10 years through 2005 with 1994 as the base year.

First, the results of the simulation for the Reference case are described. Assumption of simulation and simulation results are shown in the Tables below.

Table 3.4.1 Assumptions of Simulation for the Reference Case

		1990		1994		2000		2005		
	Unit	1369	90/80	1373	94/90	1379	00/94	1384	05/00	05/94
1.World Economy										
a. World Oil Price	$/bbl	23.2	-1.5	16.5	-8.2	20.6	3.8	23.9	3.0	3.4
b. Price Deflator Export Goods	1980=100	133.8	2.9	133.5	-0.1	159.4	3.0	184.8	3.0	3.0
2.Economic Policy										
a. Interest	%	9.0	-1.2	11.5	6.3	11.5	0.0	11.5	0.0	0.0
b.Government										
Current Expenditure	Bil. Rials	4,285	9.8	18,841	44.8	71,873	25.0	150,958	16.0	20.8
Development Expnd.	Bil. Rials	1,766	12.0	9,071	50.5	27,087	20.0	56,891	16.0	18.2
c.Exchange Rate										
for Oil Exports	Rials/US$	211	11.6	1,646	67.2	4,500	18.2	5,000	2.1	10.6
for Other Exports	Rials/US$	1,445	34.0	1,646	3.3	4,500	18.2	5,000	2.1	10.6
for Imports	Rials/US$	371	13.9	1,829	49.1	4,500	16.2	5,000	2.1	9.6
d. Balance of Payment										
Service net	Bil. US$	-3.15	-2.6	-2.99	-1.3	-2.99	0.0	-2.99	0.0	0.0
Transfer	Bil. US$	2.50		1.20	-16.8	1.20	0.0	1.20	0.0	0.0
Capital Balance	Bil. US$	0.30	138.3	-2.23		0.00	-100	0.00		-100
Errors	Bil. US$	-0.92		-1.13	5.1	-1.13	0.0	-1.13	0.0	0.0
Over All Balance	Bil. US$	-0.30		1.23		1.23	0.0	1.23	0.0	0.0
e. Others										
Inventory and Stts.Dif	Bil. Rials	-327		-2,288	62.6	-2,288	0.0	-2,288	0.0	0.0
same as abv. in nominal	Bil. Rials	4,254	24.3	1,948	-17.7	1,948	0.0	1,948	0.0	0.0
3.Energy Policy										
a.Resource Development(Production)										
Crude Oil	Mil. BOE	1,192	8.4	1,382	3.7618	1,460	0.9	1,643	2.4	1.6
Solid Fuel	Mil. BOE	4	-1.0	4	3.5	6	5.0	7	5.0	5.0
Natural Gas	Mil. BOE	351	13.2	458	6.9	687	7.0	964	7.0	7.0
b.Energy Plices										
Gasoline	Rials/l	50	5.2	50	0.0	200	26.0	300	8.4	17.7
Electricity	Rials/kWh	5.7	7.3	28.5	49.7	38.2	5.0	48.7	5.0	5.0
c.Power Development										
Hydro	Mil. BOE	-9.5	0.8	-11.6	5.1196	-14.7	4.0	-17.9	4.0	4.0
Petro.Products	Mil. BOE	-38.4	9.4	-45.4	4.3149	-45.4	0.0	-45.4	0.0	0.0
Solid Fuel	Mil. BOE	0		0		0		0		
Nuclear	Mil. BOE	0		0		0		0		
d.Energy Export										
Lean Gas	Mil.BOE	-13.1		-0.84	-49.68	-0.84	0.0	-0.84	0.0	-
e.Efficiency										
Rate of Effic., ELE	%	32.5	0.7	34.6	1.6	35.0	0.2	36.0	0.6	0.4
Rate of Own Use, ELE	%	5.3	4.7	4.6	-3.6	4.0	-2.2	4.0	0.0	-1.2
Rate of Loss, ELE	%	14.4	-0.6	14.8	0.6	14.5	-0.3	14.5	0.0	-0.2
Rate of Effic., Petro.	%	4.4	4.3	2.2	-15.8	4.0	10.1	4.0	0.0	5.4
Rate of Own Use, Petro.	%	3.8	-0.1	3.3	-3.2	3.0	-1.7	3.0	0.0	-0.9
Rate of Effic., LG	%	8.5	-0.6	11.4	7.5	9.0	-3.8	9.0	0.0	-2.1
Rate of Own Use, LG	%	37.9		16.1	-19.2	35.0	13.8	35.0	0.0	7.3
4. Others										
a. Population	1000 P.	54,504	3.7	62,150	3.3	72,075	2.5	81,546	2.5	2.5
b. Time Trend	1959=1	32	3.8	36	3.0	42	2.6	47	2.3	2.5
c. Dummy	1 or 0	0		1		1	0.0	1	0.0	0.0
	1 or 0	1		1	0.0	1	0.0	1	0.0	0.0

Table 3.4.2 Simulation Result of Macro Economy ('Reference Case')

(Unit:Billion Rials, 1982 prices)

	1990	1994	2000	2005	94/90	00/94	05/00	05/94
Gross Domestic Expenditure	10,930	13,066	14,944	17,482	4.6	2.3	3.2	2.7
Domestic Demand	10,279	12,929	14,624	16,847	5.9	2.1	2.9	2.4
Private Demand	8,329	10,251	11,627	12,982	5.3	2.1	2.2	2.2
Private Consumption Expenditure	7,564	9,038	9,524	9,957	4.6	0.9	0.9	0.9
Private Investment	766	1,213	2,102	3,025	12.2	9.6	7.5	8.7
Pubric Demand	1,950	2,678	2,997	3,864	8.3	1.9	5.2	3.4
Government Consumption Expenditure	1,337	1,953	2,231	2,666	9.9	2.2	3.6	2.9
Pubric Fixed Capital Formation	613	726	766	1,199	4.3	0.9	9.4	4.7
Net Foreign Demand	978	2,425	2,607	2,923	25.5	1.2	2.3	1.7
Exports of Goods & Services	2,253	3,372	4,046	5,191	10.6	3.1	5.1	4.0
Oil & Gas	2,098	2,992	3,330	4,148	9.3	1.8	4.5	3.0
Others	154	380	716	1,043	25.3	11.2	7.8	9.6
Imports of Goods & Services	1,274	947	1,438	2,268	-7.2	7.2	9.5	8.3
Norminal GDE	36,645	125,789	476,712	950,323	36.1	24.9	14.8	20.2
Wholesale Price Index(1990=100)	100	304	1,076	1,633	32.0	23.5	8.7	16.5
Consumer Price Index(1990=100)	100	249	1,052	1,963	25.6	27.2	13.3	20.6
Exchange Rate for Export(Rials/US$)	301	1,646	4,500	5,000	52.9	18.2	2.1	10.6
Active Labor Population(1,000 persons)	14,167	17,898	22,097	24,331	6.0	3.6	1.9	2.8
Unemployment Rate(%)	13.96	8.33	4.85	3.16	-12.1	-8.6	-8.2	-8.4

Table 3.4.3 Simulation Result of Primary Energy Requirement ('Reference Case')

(Units:MBOE,%)

	1990	1994	2000	2005	1990	1994	2000	2005	94/90	00/94	05/00	05/94
Total	624	751	950	1,140	(100)	(100)	(100)	(100)	4.7	4.0	3.7	3.9
Solid Fuel	5	8	8	9	(1)	(1)	(1)	(1)	13.5	0.4	2.0	1.1
Oil	352	431	495	535	(56)	(57)	(52)	(47)	5.2	2.3	1.6	2.0
Crude Oil	318	427	489	529	(51)	(57)	(52)	(46)	7.6	2.3	1.6	2.0
Petroleum Products	34	5	6	5	(6)	(1)	(1)	(0)	-39.1	2.7	-0.5	1.2
Gas	255	297	429	576	(41)	(40)	(45)	(50)	3.9	6.3	6.0	6.2
Hydro	10	12	15	18	(2)	(2)	(2)	(2)	5.1	4.0	4.0	4.0
Others	3	4	4	4	(1)	(0)	(0)	(0)	2.3	0.1	-0.1	0.0
GDP(1982 Billion Rials)	10930	13066	14944	17482					4.563	2.263	3.188	2.682
Intensity(1990=100)	100	100.7	111.3	114.2					0.168	1.689	0.511	1.152
Elastisity									1.038	1.763	1.165	1.441

[Note]Figures in parentheses show percentage share of total

Table 3.4.4 Simulation Result of Final Energy Demand ('Reference Case')

(Units:MBOE,%)

	1990	1994	2000	2005	1990	1994	2000	2005	94/90	00/94	05/00	05/94
Total	425.3	564.8	705.3	843.2	(100)	(100)	(100)	(100)	7.3	3.8	3.6	3.7
Solid Fuel	4.7	7.798	7.964	8.79	(1)	(1)	(1)	(1)	13.5	0.4	2.0	1.1
Petroleum	288.1	365.3	418.9	455.8	(68)	(65)	(59)	(54)	6.1	2.3	1.7	2.0
Gas	102.7	151.9	228.9	321.4	(24)	(27)	(32)	(38)	10.3	7.1	7.0	7.1
Electricity	26.53	36.29	46.02	53.68	(6)	(6)	(7)	(6)	8.1	4.0	3.1	3.6
Others	3.3	3.51	3.541	3.524	(1)	(1)	(1)	(0)	1.6	0.1	-0.1	0.0
Industrial Sector	149.8	170.8	190.8	199.7	(35)	(30)	(27)	(24)	3.3	1.9	0.9	1.4
Transportation Sector	96.8	140.4	156.3	168.8	(23)	(25)	(22)	(20)	9.7	1.8	1.5	1.7
Agricultural Sector	27.67	27.94	31.84	34.74	(7)	(5)	(5)	(4)	0.2	2.2	1.8	2.0
Residential Sector	128	190.2	288.1	397.8	(30)	(34)	(41)	(47)	10.4	7.2	6.7	6.9
Household Sector	101.1	139.9	212.6	299.6	(24)	(25)	(30)	(36)	8.5	7.2	7.1	7.2
Commercial Sector	26.94	50.36	75.45	98.07	(6)	(9)	(11)	(12)	16.9	7.0	5.4	6.2
Non-Energy Use Total	23	35.37	38.25	42.15	(5)	(6)	(5)	(5)	11.4	1.3	2.0	1.6
Population(1,000 persons)	54,504	62,150	72,075	81,546					3.3	2.5	2.5	2.5
Per Capita(BOE/Person)	7.8	9.1	9.8	10.3					3.9	1.2	1.1	1.2

[Note]Figures in parentheses show percentage share of total

Table 3.4.5 Simulation Result of Energy Demand in the Industrial Sector ('Reference Case')

(Units:MBOE,%)

	1990	1994	2000	2005	1990	1994	2000	2005	94/90	00/94	05/00	05/94
Industrial Sector Total	149.8	170.8	190.8	199.7	(100)	(100)	(100)	(100)	3.3	1.9	0.9	1.4
Solid Fuel	4.7	7.798	7.964	8.79	(3)	(5)	(4)	(4)	13.5	0.4	2.0	1.1
Petrolium Total	58.34	56.65	65.14	66.96	(39)	(33)	(34)	(34)	-0.7	2.4	0.6	1.5
Gas	80.75	94.49	105.4	111.3	(54)	(55)	(55)	(56)	4.0	1.8	1.1	1.5
Electricity	6.01	11.9	12.3	12.66	(4)	(7)	(6)	(6)	18.6	0.6	0.6	0.6
Food	21.63	32.17	38.48	41.33	(14)	(19)	(20)	(21)	10.4	3.0	1.4	2.3
Textile	8.1	12.12	13.23	13.42	(5)	(7)	(7)	(7)	10.6	1.5	0.3	0.9
Wood & Products	1.37	2.018	2.261	2.356	(1)	(1)	(1)	(1)	10.2	1.9	0.8	1.4
Paper & Pulp	1.7	2.538	2.887	3.077	(1)	(1)	(2)	(2)	10.5	2.2	1.3	1.8
Chemical	56.39	32	33.6	35.32	(38)	(19)	(18)	(18)	-13.2	0.8	1.0	0.9
Ceramics & Non-metal	45.15	67.05	72.17	74.13	(30)	(39)	(38)	(37)	10.4	1.2	0.5	0.9
Primary Metal	8.63	12.84	15.16	15.65	(6)	(8)	(8)	(8)	10.4	2.8	0.6	1.8
Machinery	6.67	9.886	12.74	14.1	(4)	(6)	(7)	(7)	10.3	4.3	2.1	3.3
Other Manufacturing	0.16	0.232	0.294	0.318	(0)	(0)	(0)	(0)	9.8	4.0	1.5	2.9
Value Added(Billion Rials)	1163.9	1375.6	1997.8	3057.3					4.3	6.4	8.9	7.5
Intensity(BOE/M.Rials)	128.71	124.19	95.514	65.318					-0.9	-4.3	-7.3	-5.7

[Note]Figures in parentheses show percentage share of total

Domestic energy prices should be paid special attention as exogenous variables, because they are important factors in the policy scenarios.

The gasoline price, which is taken representative of all of petroleum product prices, is assumed to be 130 Rial per liter in 1996, 200 Rial in 2000, and 300 Rial in 2005 (An average increase rate per annum are 26% from 1994 to 2000 and 8% from 2000 to 2005, respectively). The prices of other petroleum products are assumed to increase correlating with the price of gasoline. The price of electric power is expected to rise at an annual rate of 5% from 1994 to 2005.

These assumptions mean that energy prices will be declining in real terms, because domestic commodity prices will be increasing more rapidly than domestic energy prices in the results of the forecast (For instance, consumer prices will increase at an average annual rate of 27% and 13% from 1994 to 2000 and from 2000 to 2005, respectively).
In the Energy Conservation case, it is assumed that energy prices will increase at an average rate of 8% per annum in real terms from 1994 to 2000 and 2005, and that energy conservation will be promoted in the industry sector as the results of policies for energy conservation which is described in Chapter 3.

4.2.3 Results of Forecast and Evaluation of Policy Scenarios

The following is a comparison of the Reference case and the Energy Conservation case:

	(Reference)	(E. C.)	<Difference>
Real GDP Growth Rate	2.3 %	1.4 %	– 0.9 %
Real Energy Exports	-----	+ 12 %	+ 12 %
Rate of Increase in Consumer Price	27 %	33 %	+ 6 %
Balance of Government's Budget	(–)7 trillion Rl	(+)12 trillion Rl	+ 19 trillion Rl

(Note) % ---- annual rate. (--) and (+) show the deficit and surplus, respectively.

The tables below show assumptions of the simulation, comparison of energy intensities, and other information.

The simulation for the two cases implies the following:
First, a large increase in domestic energy prices will result in an increase in domestic commodity prices and a decrease in the GDP growth rate. This is because the effect of a. below will be larger than those of b. and c. below.

a. Increase in energy prices – increase in commodity and service prices – decline of purchasing power – decrease in GDP
b. Increase in energy prices – acceleration of energy saving – expansion of oil export – increase in GDP
c. Increase in energy prices – expansion of government's revenue -- expansion of public fixed capital formation and reduction of incremental money supply – reduction of price increase

Table 3.4.6 Assumption of Simulation for the Energy Conservation Case

		1990		1994		2000		2005		
	Unit	1369	90/80	1373	94/90	1379	00/94	1384	05/00	05/94
b.Energy Prices										
Gasoline	Rials/l	50	5.2	50	0.0	297.6	34.6	930.1	25.6	30.4
Electricity	Rials/kWh	5.68	7.3	28.5	49.7	171.00	34.8	538.80	25.8	30.6

[Note]Other exogenous variables are the same as the reference case.

Table 3.4.7 Comparison of Energy Intensities between MEM Results and Micro Analysis

(Unit: 1994=10

Industry	1994 Index	2000 (a)High-Price	2000 (b)Energy Conservation	2000 (a)/(b)	2005 (a)High-Price	2005 (b)Energy Conservation	2005 (a)/(b)	Note Source
Food	100	94	*89*	*0.95*	82	*77*	*0.94*	Micro-analysis[1]
Textile	100	99	*86*	*0.87*	93	*78*	*0.84*	Average[2]
Wood & Products	100	99	*86*	*0.87*	94	*78*	*0.83*	Average[2]
Paper/pulp	100	92	92	1.00	81	81	1.00	High-price[3]
Chemical	100	99	*86*	*0.87*	96	*78*	*0.81*	Average[2]
Ceramics & Non-materia	100	99	*82*	*0.83*	95	*77*	*0.81*	Micro-analysis[1]
Primary Metal	100	94	*88*	*0.94*	81	81	1.00	Micro-analysis[1]
Machinery	100	84	84	1.00	63	63	1.00	High-price[3]
Other Manufacturing	100	94	*86*	*0.92*	79	*78*	*0.99*	Average[2]

Note) 1)Micro-analysis means the results in the Chapter 2 and 6, 2)Average means the average results among the industries analyzed in the Chapters 2 and 6,
and 3)High-Price means the results by MEM with higher domestic energy prices.
The figures in bold and italics are adopted as exogenous in the Energy Conservation Case.

Table 3.4.8 Factors of Energy Conservation in the Industrial Sector

(Units: MBOE, %)

Cases and Factors	1994	2000	2005	00/94	05/00	05/94
(a)Reference Case	170.8	190.8	199.7	1.9	0.9	1.4
(b)High-Price Case	170.8	169.4	163.8	-0.1	-0.7	-0.4
(c)Ene. Consrv Case	170.8	149.7	141.6	-2.2	-1.1	-1.7
Factor by Price(a)-(b)	-	-21.4	-35.9	*-2.0*	*-1.6*	*-1.8*
Factor by Others(b)-(c)	-	-19.6	-22.2	*-2.0*	*-0.4*	*-1.3*
Total factors	-	-41.1	-58.1	*-4.0*	*-2.0*	*-3.1*

On the other hand, as mentioned already, it is obvious that domestic commodity prices will be much higher and GDP will grow less rapidly in the A.B.C. case. In addition, we considered that it would be politically as well as socially difficult for the government to launch such a big increase in domestic energy prices as assumed in the A.B.C. case (In the case of fuel oil, the average annual rate of increase is assumed more than 40% in real terms from 1995 to 2000). Consequently, we have not made the simulation for this case.

Second, increase in energy prices will result in a reduction of the deficit of the government's budget and expansion of energy exports.

Third, energy savings accomplished by the effects of other policies are estimated to be around the same degree as that from the effects of energy pricing policy. It is desirable that a policy accomplish energy savings without any negative effects on the macro-economy. The policy adopted for promoting "Improvement in management of operation and maintenance" is one such policy.

Finally, we wish to point out the following issues to be discussed and studied further in the future:

a. Only the industrial sector is targeted in this study. It is necessary to make studies on household, transport, and other sectors, and to clarify differences in their results from this study, especially from the viewpoint of the macro-economy.

b. The biggest barrier to MEM is the availability of data and their reliability. Although the collection and the organization of data is not flashy, the improvement of institutional arrangements for data collection and organization is indispensable to create more proper models and to estimate energy conservation potential more precisely.

c. The simulation results are calculated by MEM, which is based upon econometric methodology with time series data. Since we fully understand that the simulation results and their sensitivity depend upon the model, we do not have any intention to say that the view shown here is the only answer for the evaluation of the policy scenarios on energy conservation. The policy scenarios should be evaluated finally by a more comprehensive analysis.

4.3 Evaluation from "Energy Utilization Plan"

The evaluation for the optimization of investments for energy conservation is based upon the results of studying the "Energy Utilization Plan" in this study.

4.3.1 Development of Optimization Model

One of the most important criteria of energy conservation from the viewpoint of the government or the national economy as a whole is that foreign currency obtained from exports of oil saved through an energy conservation measure shall exceed the foreign currency necessary for importing equipment or facilities for the measure.

It is considered that, generally, the marginal cost of investment for energy conservation is increasing while their marginal benefit depends upon movements of energy (oil) prices.

We have developed an optimization model by which a point where the difference between the benefit and the cost (namely, the net benefit) can be found (The point actually means one of many measures for energy conservation executed in a certain order). For more details on the model, please see Chapter 5.

4.3.2 Targeted Industries

We selected two industries, cement and sheet glass, as targets. The reasons are as follows:

First, we can consider rather even concrete measures for energy conservation in these industries due to the availability of data and information.

Second, we can estimate rather accurately the effects and costs of the measures in the two industries using collected data and information.

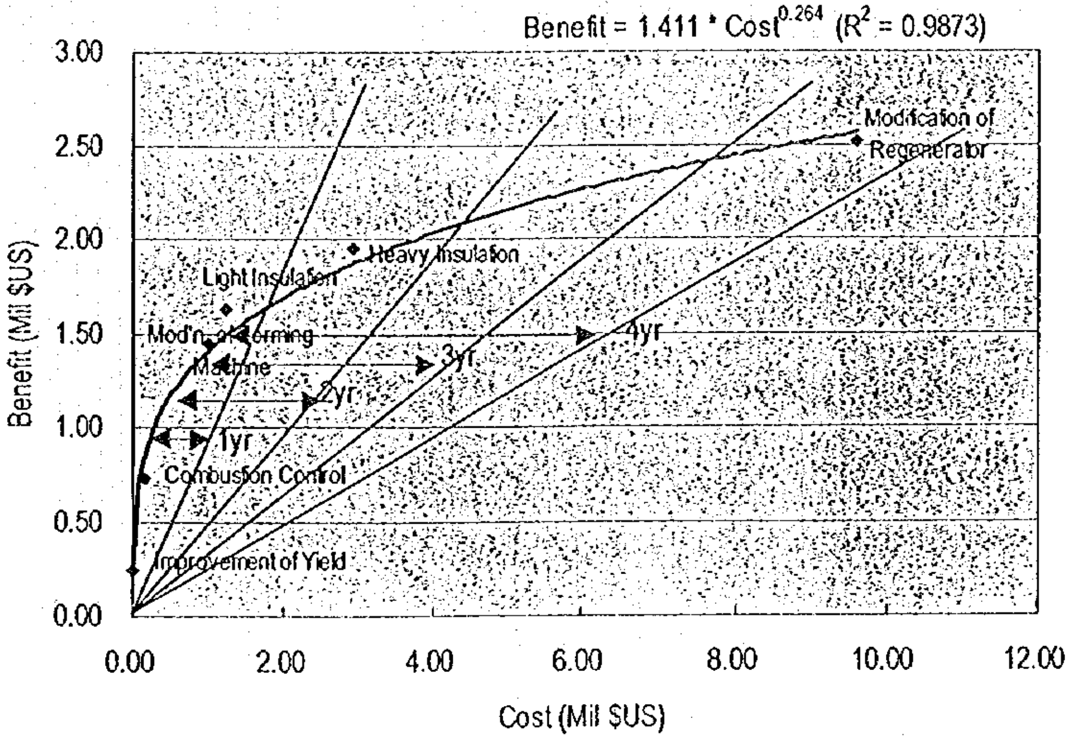
4.3.3 Results of the Evaluation

In the evaluation, we have developed "Cost-benefit functions" for the cement and sheet glass industries. These are shown in Figure 3.4.1 and 3.4.2 below.

Based upon these functions, we have evaluated the optimum allocation of investments for energy conservation in the two industries as a whole. Looking at the case of "10 years net benefit," the "net benefit" of measures for energy conservation reached a point at "Satellite to grate cooler at B Cement" in either case for a fuel oil price rise of "0 %", "10%", or "20%". Beyond this limit point, the accumulated "net benefit" begins to decline in two of three cases of fuel oil prices, while even in one of them, that is the 20% rise, it shows a declining tendency after leveling off in the short term.

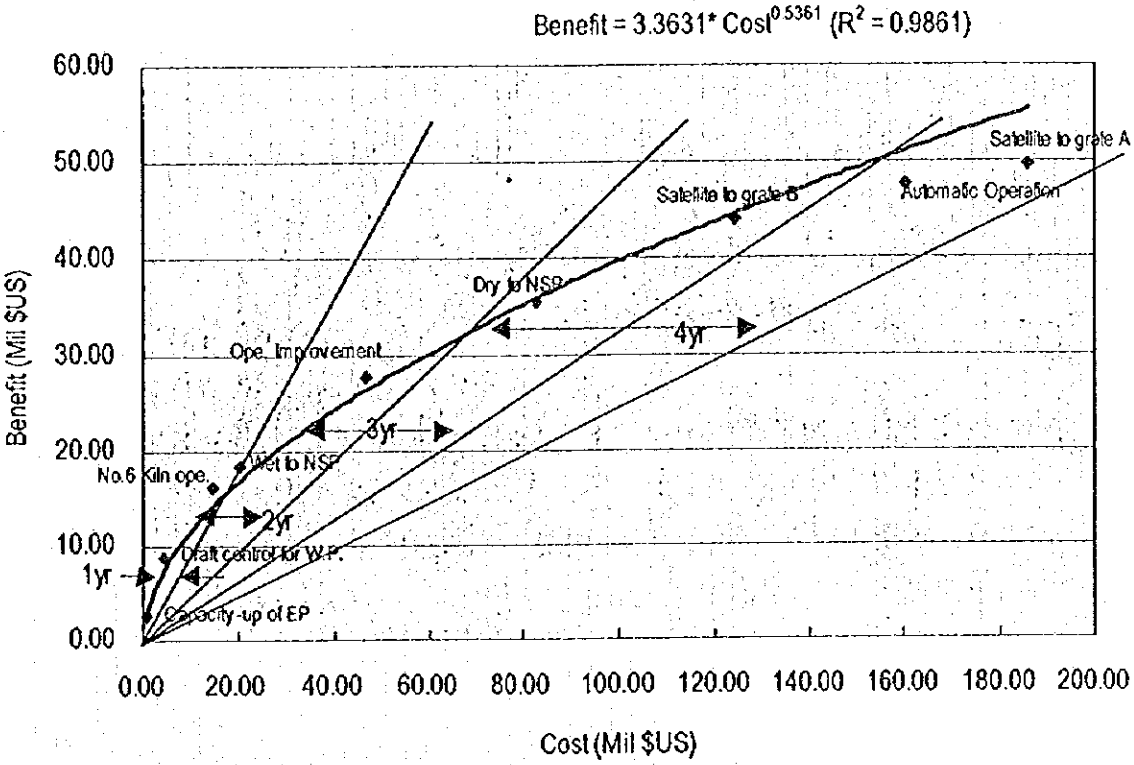
The results of the evaluation are shown in Figure 3.4.3 and 3.4.4.

Figure 3.4.1 Sheet Glass Industry Cost-Benefit Function



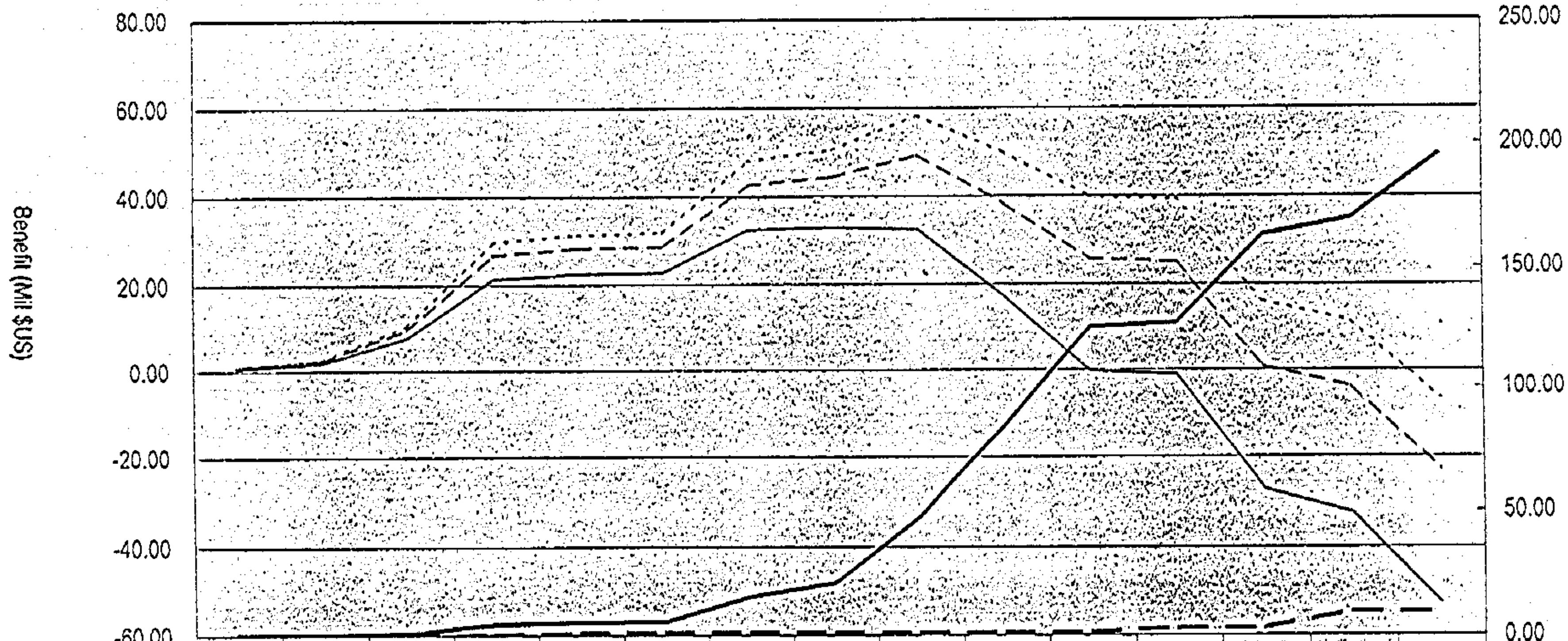
Note: R^2 is the Coefficient of Determination

Figure 3.4.2 Cement Industry Cost-Benefit Function



Note: R^2 is the Coefficient of Determination

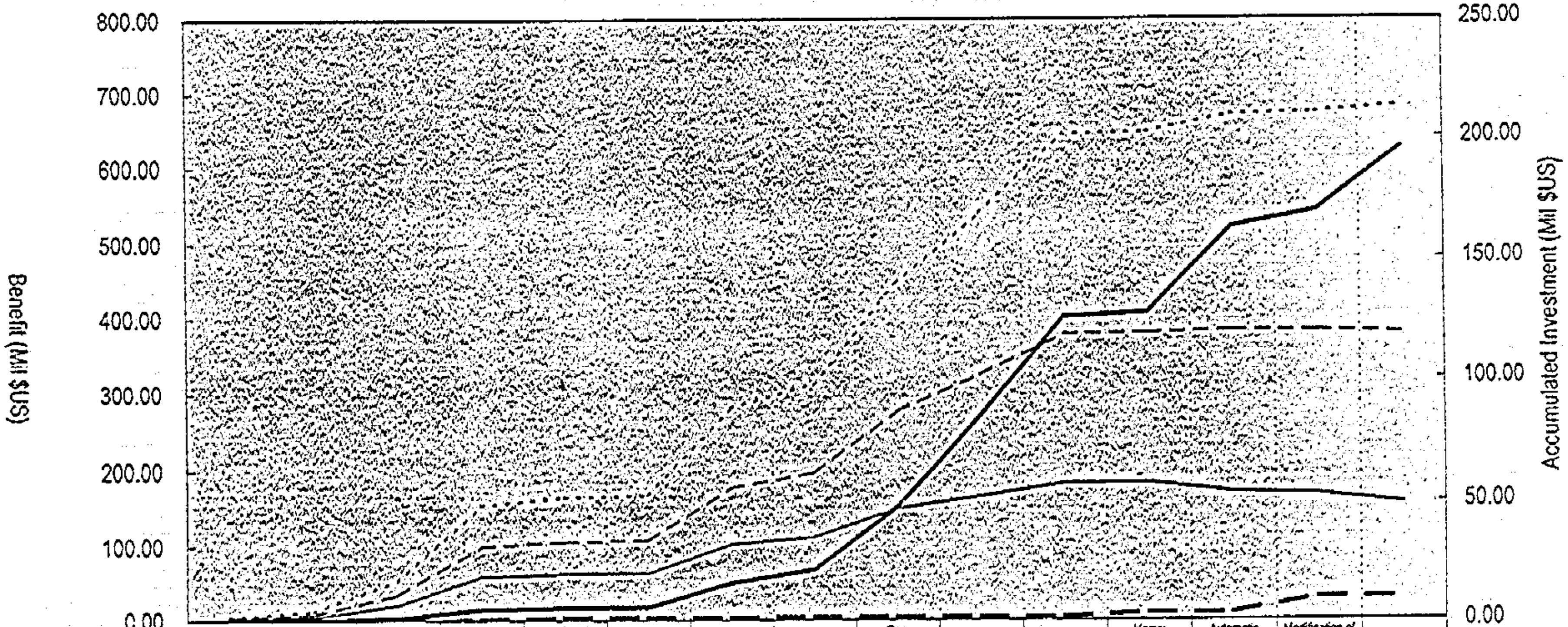
Figure 3.4.3 Optimum Allocation of Investment to Maximize 3 Years Net Benefit



	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	10.87	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 3.4.4 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

4.4 Conclusion

4.4.1 Evaluation of Policy Scenarios

The results of the evaluation from the "Energy Demand Forecast" can be summarized as follows:

a. Increasing domestic energy prices for energy conservation should be implemented very carefully, taking into consideration that it may have negative effects on GDP growth, commodity and service prices, and others.

b. Consequently, it is desirable that, for the time being, the government put priority on energy conservation measures which can be accomplished without any increase in energy prices (In other words, they belong to the first category or "Improvement in management").

c. At the same time, it is the most important duty for the government to strengthen the capability of formulating a master plan for energy conservation, including (a) institutional arrangements for data collection and organization, and (b) improvement of methodologies for forecasting energy supply and demand.

4.4.2 Evaluation of Optimal Investment for Energy Conservation

Unfortunately, we could not evaluate the optimal allocation of investment for energy conservation for all of six industries targeted in this study, because of the availability of data and information. The results of the evaluation made on two industries, however, suggest us that the government should proceed with policies for energy conservation, carefully taking into consideration the following:

a. An energy conservation measure, even if it can be implemented by obtaining government's economic incentives, does not necessarily provide an "net benefit" from the viewpoint of the government or the national economy.

b. In other words, the accumulated "net benefit" reaches a limit, beyond which it usually declines.

5. METHODOLOGIES AND TOOLS USED IN THIS STUDY

5.1 Introduction

In this chapter, the methodologies and the tools used in this study are explained, mainly focusing on "Energy Demand Forecast" and "Energy Utilization Plan."

5.2 Economic Evaluation

In the economic evaluation, we determined that a energy conservation measure is "feasible" or "viable" if the benefit (B) of the measure is larger than its cost (C). We do not think there are elegant methods for making such an evaluation, which means that collecting and checking data on the effects and costs of those measures was the most important task for the evaluation in this study.

a. Data and information on B and C

a-1. We collected data and information on B above from the results of the "Factory Energy Audit" and sources in Japan, and checked and organized them.

a-2. With regard to data and information on C, we assumed that equipment and facilities for energy conservation measures are mainly supplied from Japan.

1) Data and information on equipment and facilities are collected from the same sources as B. In converting original data to 1993 prices, we used the "cost index" published by Japanese business associations.
2) We estimated the transportation costs of equipment and facilities from Japan to I.R.Iran including inland transportation.
3) We estimated their costs assuming that such work as engineering, installation, and construction are done by Iranians.

b. Prices

b-1. 1993 prices in real terms have been used in (1) the cost of energy conservation measures, and (2) domestic energy prices used for calculating the benefits of the measures.

b-2. Exchange rate is also that in 1993: US$ 1= 100 yen = 1,750 Rial.

c. Model value

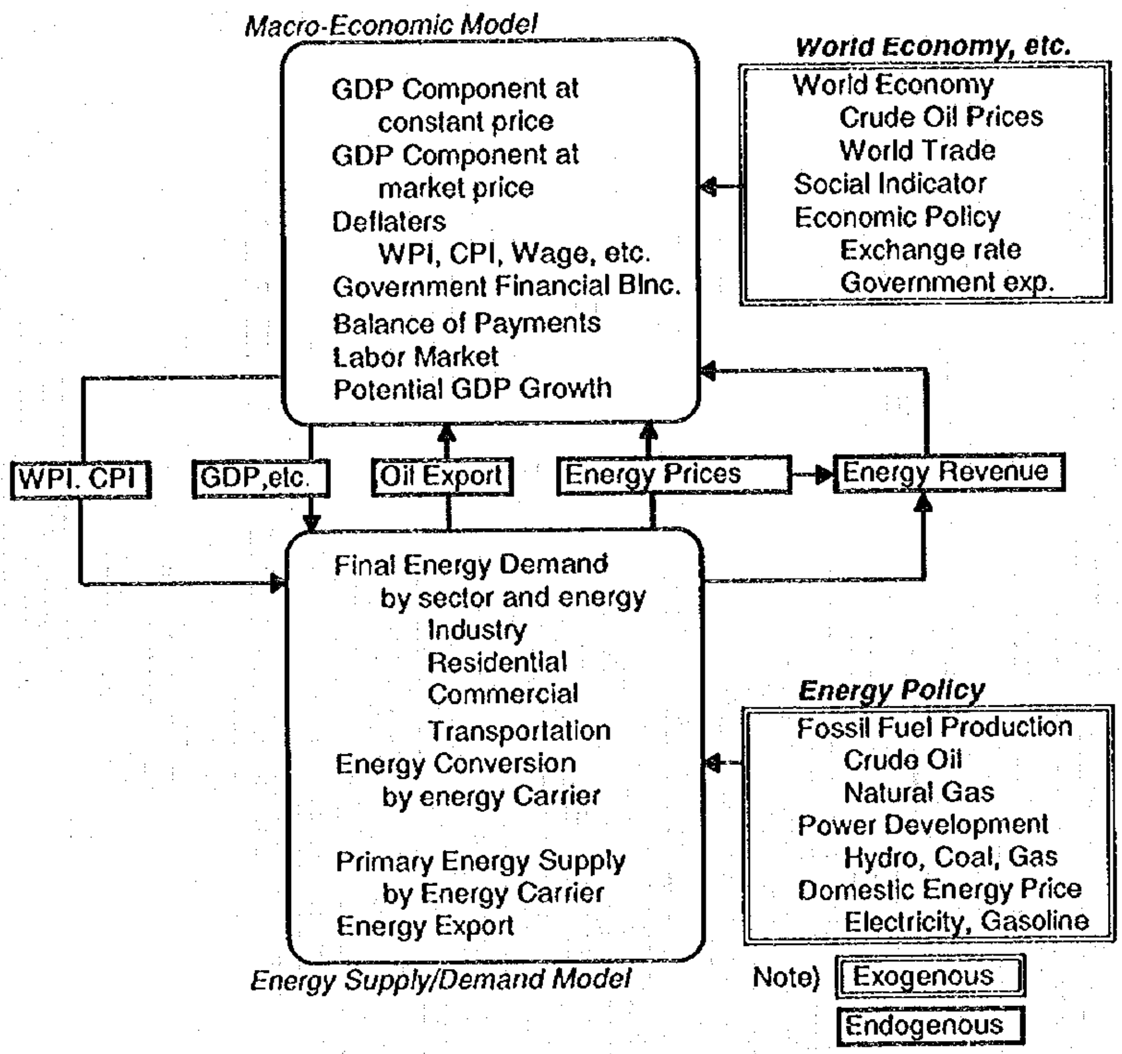
In grasping the energy intensity in the industries, if necessary, we estimated the model value of intensity for each producing process. Specifically, model values have been estimated for the direct reduction process in iron and steel, various types of kiln in cement, the float process in sheet glass, the ring spinning and open end spinning in textiles, and cane sugar in sugar.

5.3 "Energy Demand Forecast"

5.3.1 On the model (MEM)

The basic design concept of MEM is as follows (See Figure 3.5.1):
First, the variables in the macro-economic model and the energy supply/demand model are solved simultaneously.

Figure 3.5.1 Flow Chart of Macro-energy Model(MEM)



Second, it is possible to evaluate the effects of energy policy on the macro-economy.
Third, the model is easy to use.
Fourth, the type of model is based upon econometrics with time series data.
Fifth, the model is composed of two sub-models: macro-economic model and energy supply/demand model.

As already mentioned in Chapter 4, economic problems which I.R.Iran is facing currently are taken into account in developing the MEM. In addition, we tried to include the following items in the model.
First, the model is designed to grasp the energy flow from the primary energy supply to the final energy consumption by sector.
Second, energy demand is responsive to energy pricing, which is one of the energy policy measures.
Third, energy intensity denominated by physical output is taken into account in the industrial sector.

MBM, which was built with the fundamental design mentioned above, has the following characteristics:
First, the model is composed of demand equations with time series data and definition equations.
Second, it is possible to examine model performance using several tests.
Third, because variables in the whole model are solved simultaneously, the influence of energy policy on economic activities can be easily estimated by the model.
Fourth, since the model is compact, we can use it on a personal computer.

5.3.2 On Data Used

When we developed the model, we employed data principally published in I.R.Iran. For data collection, the PBO team provided us with almost all of data we needed from a data base being developed by the Team. With regard to data which is not in their database, however, we made efforts to obtain them from different statistical sources with the cooperation of the PBO Team.
Moreover, as for data which is still missing, we used sources such as international organizations including the World Bank, OECD/IEA, OPEC, and British Petroleum.
To keep consistency of data as well as to complete the database for the model, the JICA Team added several estimations in the data.

5.4 "Energy Utilization Plan"

5.4.1 On the Model

The purpose of building the model is to find the optimal allocation of investments ----- the limit point of investments for energy conservation ----- for seven industries as a whole or each of the industries to maximize the benefits of energy conservation.
The marginal benefit and the marginal cost mentioned in Chapter 4 are shown in a benefit curve and a cost curve in Figures 3.5.2 and 3.5.3. In the Figures, the optimum point which gives the "maximum net benefit" to the government or the national economy is found where the slope of the benefit curve is equal to the slope of the cost curve. At this point, the "benefit" minus "cost" is largest.

Figure 3.5.2
Potential Optimum in Domestic Market Value

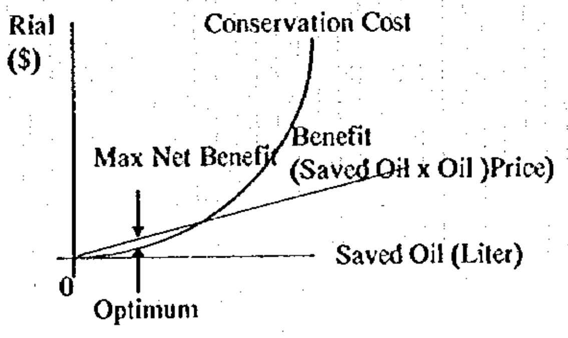
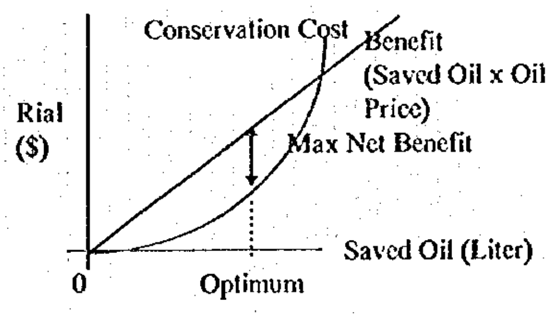


Figure3.5.3
Potential Optimum in Economic Value

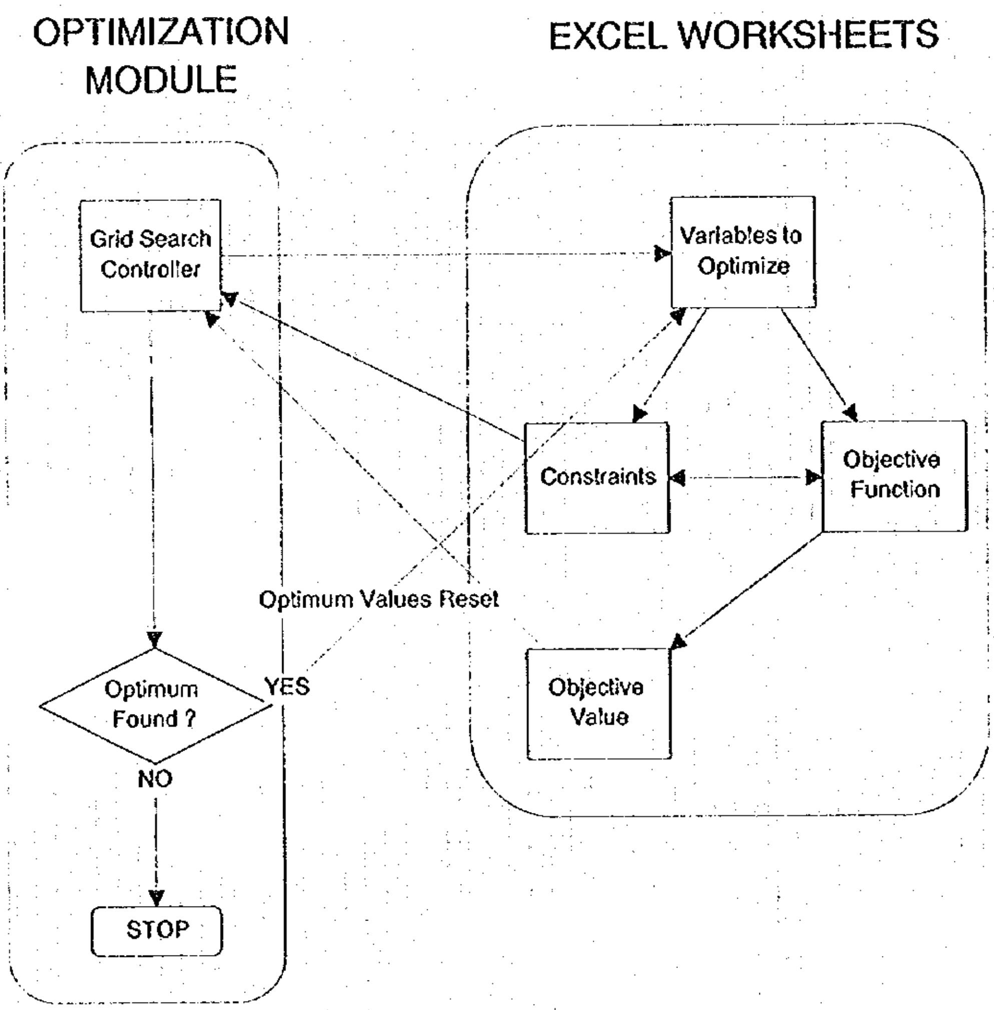


In addition, we tried to develop another model by which we can evaluate the optimal allocation of investments to maximize the total value added of seven industries as a whole or each of them. However, we found that simulations based upon reliable data on value added cannot be done in this study. Accordingly, we designed the model mentioned above, which is for maximizing energy saving, as one that can be easily extended to the model mentioned here.

5.4.2 On Tools

The solution and the simulation of the optimization model applies the spreadsheet EXCEL.
With regard to the program, we have developed a general optimization program as a module of EXCEL.
Figure 3.5.4 shows the conceptual relationship between EXCEL and the optimization modules.

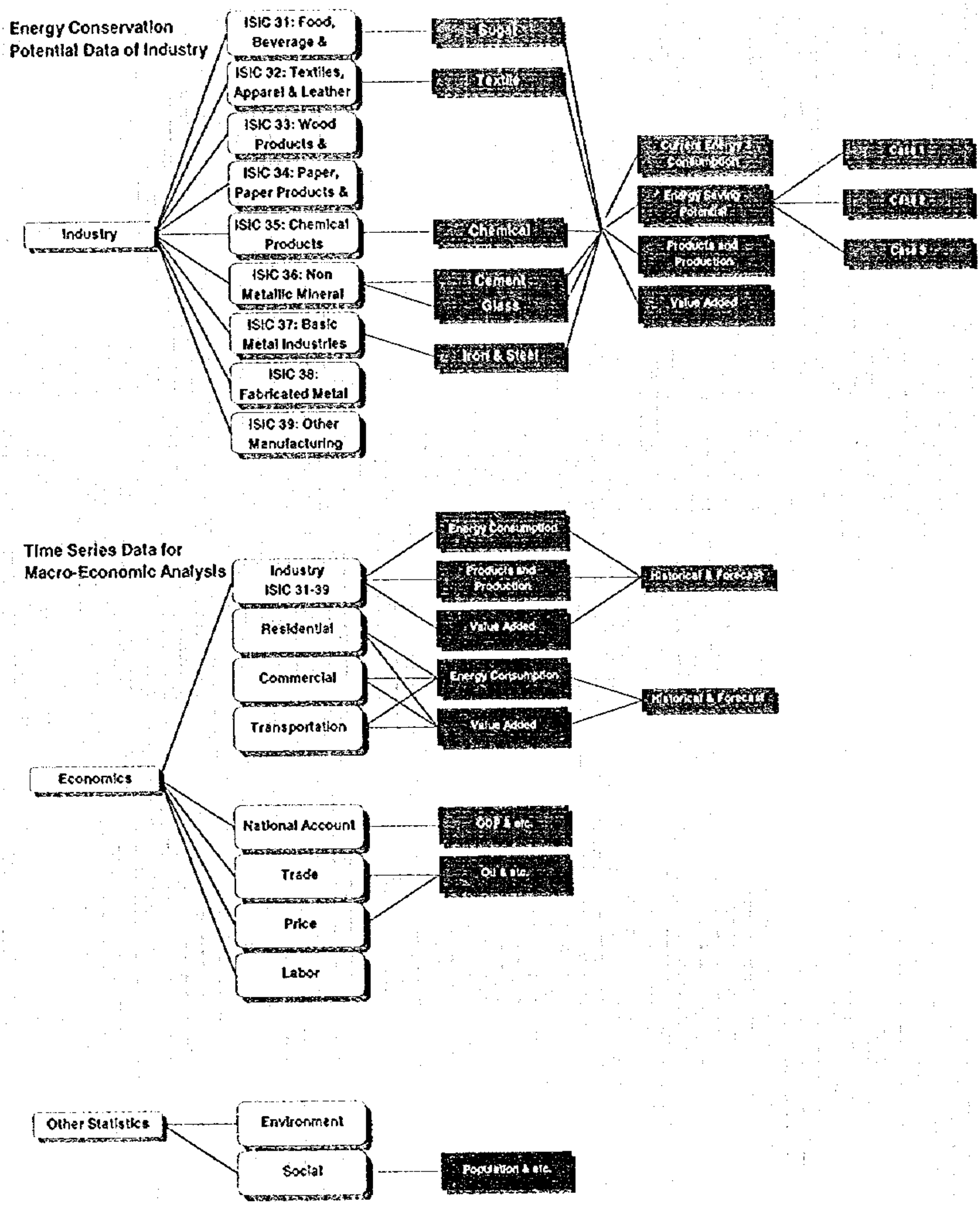
Figure 3.5.4 EXCEL and the Optimization Module



5.5 Database

A database has been established using data collected in the "Economic Evaluation" and the "Energy Demand Forecast." Figure 3.5.5 shows the basic structure of the database.

Figure 3.5.5 Basic Database Structure



6. MASTER PLAN FOR ENERGY CONSERVATION IN SIX INDUSTRIES

6.1 Current Status of Energy Use in Six Industries

The current status of energy use in seven industries is as follows.

a. The energy intensity of each industry in I.R.Iran is significantly higher than that of the comparable Japanese industry or its standard value of the similar process. Some examples comparing Iranian figures set at 100 with their Japanese counterparts include

- Iron and steel (Esfahan) 60
- Cement (Whole industry) 70
- Sheet glass (Whole industry) 44
- Sugar (Whole industry) 65

b. These figures show that the technical potential for energy conservation of Iranian industries are very large.

c. The big differences in energy intensity between Iranian and Japanese industries are due to (1) insufficient management of operations and maintenance in factories, (2) few measures adopted for energy conservation with equipment and facilities, and (3) some obsolete processes being still operated.

6.2 Economic Evaluation of Measures for Energy Conservation

We considered measures for energy conservation based upon the current status of energy use in the industries.

Next, we considered the government's policies for supporting and promoting the measures in factories and industries, and incorporated them into policy scenarios for energy conservation: Energy Conservation (E. C.) scenario and Accelerated Energy Conservation (A. E. C.) scenario.

Then, we made an economic evaluation of the measures, using the assumption of future energy prices, which is one of main factors incorporated into the policy scenarios.

The results of the economic evaluation made by acting on the E. C. scenario, which we thought more realistic, are as follows:

a. Many measures belonging to "Improvement in management of operations and maintenance" are evaluated as "feasible."

b. On the contrary, many of measures belonging to "Modification of equipment and facilities" and "Modification of processes" are evaluated as "not feasible."

However, we should note that energy prices used for the evaluation are lower than those in other countries including Japan, even in the A. E. C. scenario, although they are much higher than those in the E. C. scenario.

6.3 Estimate of the Economic Potential for Energy Conservation in Six Industries

We estimated the economic potential for energy conservation in seven industries, based upon the economic evaluation of the measures above. The results of the estimation are as follows:

a. Six industries excluding petroleum refining can save energy by more than 10 % in 2000 and 2005, respectively, by implementing measures for energy conservation with support from government's policies.

b. Petroleum refining also may be able to save energy by the same percentage as other industries in 2000 and 2005, respectively.
c. Seven industries including petroleum refining can save 1,880 thousand kl (crude oil equivalent) in 2000 and 2,780 thousand kl in 2005.

6.4 Evaluation of Policy Scenarios and Investments for Energy Conservation

We have evaluated policy scenarios and investments for energy conservation. The results are as follows.

6.4.1 Evaluation of Policy Scenarios

a. Increase in energy prices may unfavorably affect GDP growth, commodity prices, and other indicators of the macro-economy.
b. Consequently, it is very important for the government to put priority on measures that can be taken even without any increase in energy prices, among those belonging to the first category or "Improvement in management."
c. It is also very important to make institutional arrangements for collecting and organizing data and information, as well as developing proper methodologies for forecasting energy supply and demand and evaluating policy scenarios.

6.4.2 Evaluation of Optimal Investments for Energy Conservation

Individual measures for energy conservation in factories, if they are implemented by obtaining government's economic incentives, do not necessarily have positive effects on the Iranian economy as a whole. Usually, the "net benefit" of measures for energy conservation, which is the difference between the benefit of expanded oil exports and the cost of importing equipment and facilities for energy conservation, will become "negative" during implementing the measures.
In promoting energy conservation policies, the government should pay a careful attention to this fact.

6.5 Establishing Targets and "Action Plan"

The results of examinations on energy conservation in six industries are summarized above.
We propose the Action Plan, which includes "policy measures" for energy conservation as well as "items to be discussed" for making the "policy measures" more concrete and realistic, for the period from 1997 to 2005, based upon the results of the examinations.

First, we present our view on the general framework of policy for energy conservation in the industrial sector, as the prerequisite for considering the "Action Plan" for energy conservation.

6.5.1 The Framework of Policies for Energy Conservation

The following is the framework of energy conservation policies, which is prepared mainly based upon experiences in Japan. Initially, basic "policies" for energy conservation are determined and announced, then, "policy measures" are considered and implemented, based upon the policy.

a. Determination and announcement of basic policies for energy conservation
   a-1. Formulation of a master plan including the targets for energy conservation
   a-2. Incorporation of the master plan into the national economic and social plan
   a-3. Legislation of energy conservation policies
   a-4. Incorporation of the energy conservation targets into the national energy supply and demand forecast
   a-5. Preparing a fund for energy conservation policies
   a-6. Determination of pricing policy for energy carriers

b. Improvement of management's and workers' awareness of energy conservation
   b-1. Appointment of proper persons to management
   b-2. Management education and training
   b-3. Establishment of a system or an organization for promoting energy conservation in company groups
   b-4. Education of employees on energy conservation

c. Designation of factories for energy conservation
   c-1. Compulsory arrangement of energy managers in factories
   c-2. Compulsory reporting of energy consumption of factories
   c-3. Establishment of an organization for promoting energy conservation in factories

d. Economic policy measures for energy conservation
   d-1. Taxation ----- tax credit, tax exemption, special depreciation, etc.
   d-2. Subsidy ----- on a certain part of costs for a energy conservation measure
   d-3. Finance ----- loans with low interest and long term
   d-4. Allocation of foreign currency ----- for imports of machines and equipment for energy conservation measures

e. Providing information for promoting energy conservation
   e-1. Dispatching experts on energy conservation to factories
   e-2. Establishment of guidelines for promoting energy conservation in factories
   e-3. Holding seminars on energy conservation
   e-4. Preparation of standards on energy consumption of machines and equipment

f. Research and development for promoting energy conservation
   f-1. Assistance to private companies, universities, and others

g. Other general policy measures for energy conservation
   g-1. Improvement of labor laws
   g-2. Improvement of salary system
   g-3. Improvement of education system

6.5.2 Proposing the "Action Plan"

In proposing the "Action Plan" based upon the framework of policy measures for energy conservation mentioned above, we followed the three guidelines shown below, which were introduced from the results of this study.

First, the government should be careful in its approach to increasing energy prices so that general commodity prices will not drastically rise and economic growth rates will not be significantly decreased (From the conclusion of the "Energy demand forecast").
Second, the government should put priority on policy measures that can be implemented without any increase in energy prices, as policy measures at least for the short term (Same as above).
Third, the government should confirm in advance of policy implementation whether an energy conservation measure, for which it is going to give an economic incentive to a company or a factory, can provide a "net benefit" or not from the viewpoint of the government or the national economy (From the conclusion of studying the "Energy utilization plan").

The "Action Plan" is composed of the following which are shown for each of several periods in the future:
(1) Targets of energy conservation,
(2) Policy measures adopted for achieving the targets, and
(3) Items to be studied, in parallel to implementing the policy measures mentioned above, for preparing more concrete and realistic policy measures for energy conservation.

Outlines of "policy measures" and "items to be discussed" are shown in Tables 3.6.1 and 3.6.2, respectively. In the tables, policy measures are described according to three categories, which are those on "Improvement in management," "Recovery of investments," and "Others," based upon the results of this study.

(1) Future Period

We divided the period from 1995 to 2005 into "March 1995 to March 2000" and "March 2000 to March 2005." These correspond to the second and the third five-year plan period, respectively.
According to the conclusion of the "Energy demand forecast," economic indicators will be generally improved in the latter period compared to the former, which can make the government adopt a wider range of policies, economic incentives in particular, in the latter period.

(2) Outlook of Economic Situations

According to the "Reference" scenario, the economic outlook for I.R.Iran is as follows:

a. 1995 to 2000

----- economic growth: increase of 2.3% per annum, which is lower than 4.6% per annum during the period from 1990 to 1994.

----- commodity prices: increase of 27% per annum, which is still at a high level, although it is a little lower than the 32% per annum experienced during the period from 1990 to 1994.

----- government's budget balance: the deficit of 7 Trillion Rial in 2000, which means the deficit will continue.

----- international capital account: the balance of zero in 2000, as the result of the government's efforts for the last few years, which can be compared to 2.2 Billion Rial in 1994. A British consulting firm predicts that the Iranian foreign debt will decrease from US$30 Billion (49% of GDP) in 1995 to US$23 Billion (17% of GDP) in 2000.

Table 3.6.1 Targets and Policies for Energy Conservation in the Industry Sector

Period	1990-1994	March 1995-March 2000	March 2000-March 2005
Economic background	• Economic growth…4.6%/y • Consumer price…32%/y • Gov. budget…△0.5Trill.Rl (93) • Capital account…△2.2Bill US$ (94) • Unemployment…8.3% (1994)	• Economic growth…2.3%/y • Consumer price…27%/y • Gov. budget…△7 Trill. Rl (2000) • Capital account…0 (2000) • Unemployment…4.9% (2000)	• Economic growth…3.2%/y • Consumer price…13%/y • Gov. budget…△47 Trill. Rl (2005) • Capital account…0 (2005) • Unemployment…3.2% (2005)
Policy 1: Improvement of management		• Improvement of appointment of directors in companies & factories • Training system for directors • Improvement of labor laws including salary system • Training system for workers	• The same as the previous period
Policy 2: Economic incentives		• Energy pricing…According to 5 year plan (20% increase per annum in nominal terms) • Finance…low interest and long-term loan • Subsidy…paid for "not feasible" measures * in case of sheet glass industry: Subsidy: 0.5 Bill Rl (price in 1993)	• Energy pricing…at least around a 5% increase per annum in real terms • Finance…to be continued • Subsidy…to be continued • Taxation…tax incentives or special depreciation * in case of steel industry: Finance: 2.8 Bill Rl (price in 1993) Subsidy: 1.5 Bill Rl (price in 1993) * in case of sugar industry: Finance: 0.5 Bill Rl (price in 1993)
Policy 3: Others		• Standards and targets for equipment and facilities • Designated factories • Energy managers • Research and development • Leveling-off of electricity demand • Factory energy audit by expert groups • Others…successful cases, bills, information, etc.	• The same as the previous period
Target of energy conservation		around 7~8% (2000)	around 10~12% (2005)

Table 3.6.2 Items to be studied for Promoting Energy Conservation

Title of Items	Contents of Items
◎Collection and organization of data and information for energy conservation	• To improve institutional arrangements for collecting and organizing data and information for energy conservation • To develop methodologies for estimating data for energy conservation
◎Development of methodologies for evaluating energy conservation policies	• To improve institutional arrangements for developing methodologies for evaluating energy conservation policies • To develop methodologies for energy modeling for energy conservation
◎Preparing guidelines on programs for energy conservation in each group of public enterprises	• To establish systems or organizations for preparing guidelines in each group of public enterprises • To prepare guidelines for improving management efficiency, as well as other aspects of measures for energy conservation in factories
◎Preparing programs for energy conservation in each factory of the groups	• To establish systems or organizations for preparing programs in each factory • To prepare programs for improving management efficiency, as well as other aspects of measures for energy conservation in each factory
◎Selection of model energy conservation factories	• To select one model factory in each group of public enterprises • To implement the project on improving management efficiency in the model factory

----- unemployment: the rate of unemployment of 4.9% in 2000, which can be compared to 8.3% in 1994.

b. 2000 to 2005

----- economic growth: increase of 3.2% per annum, which shows some improvement compared to the previous period.

----- commodity prices: increase of 13% per annum, which also shows a significant improvement compared to the previous period.

----- government's budget balance: the deficit of 47 Trillion Rial in 2005, which will grow together with economic growth.

----- international capital account: the balance of zero in 2005, which is the same as in 2000.

----- unemployment: the rate of unemployment of 3.2% in 2005, which means it will be improved further after 2000.

(3) Establishing the Targets of Energy Conservation

We established the targets of energy conservation in seven industries as follows:

----- In 2000: around 7-8% (Compared to energy consumption in the case that no energy conservation measures will be implemented in existing factories.)

----- In 2005: around 10-12%

For 2000, energy conservation potential of around 10% has been estimated in the "Energy conservation" scenario as already mentioned in Chapter 3 in this study report. We, however, proposed in the "Action Plan" that energy prices should be increased at an annual rate of 20% in nominal terms, which means energy prices will be decreasing in real terms. Accordingly, we can expect less potential energy conservation than that in the "Energy conservation" scenario, which will be around 7-8%.

In 2005, the potential of around 13% has been estimated in the same scenario. However, we established the targets at 10-12%, because the increase of energy prices until 2000 is proposed to be lower than that assumed in the "Energy conservation" scenario as stated above and also the increase from 2000 to 2005 is proposed to be 5% per annum in real terms as stated below.

(4) Proposing the "Policies" for Energy Conservation

In the "Factory energy audit," we considered and proposed many energy conservation measures for factories. They are shown together with their potential results in Table 2.2. In addition to these measures, we considered and proposed many energy conservation measures in targeted industries.

Based upon these examinations, we propose the following as desirable policies for promoting energy conservation in the industrial sector.

a. Policies for "Improvement of Management"

We propose the policy measures considered in "3.4" above to be implemented in the period from 1995 to 2000 and the period from 2000 to 2005.

< 1995 to 2000 >

----- To improve management appointment for the public enterprises or their factories

----- To prepare systems for training managers

----- To improve labor laws including salary system (During this period, the rate of unemployment will be lower than that in the previous one)

----- To prepare systems for training workers

< 2000 to 2005 >

----- To continue the policy measures above (We have only three years from now to 2000, which is not enough time for the government to substantially implement policy measures. Thus, the government will need to continue its policies during this period)

b. Policies for Recovering Investments

< 1995 to 2000 >

----- energy prices: To increase energy prices at the rate of 20% per annum in nominal terms according to the five year plan (Energy prices will decline in real terms because general commodity prices will rise much more than energy prices).

----- finance: To provide favorable loans for measures evaluated economically "feasible" (For 2000, we estimated no loan would be given to seven industries targeted in this study, because measures will not be found that satisfy the conditions mentioned already).

----- subsidy: To provide subsidy to some of measures which are evaluated economically "not feasible" (We estimated that a subsidy of 450 million Rial would be provided to the sheet glass industry in 2000).

< 2000 to 2005 >

----- energy prices: To increase energy prices at the rate of at least 5% per annum in real terms (The government needs to very carefully monitor general commodity prices so that they do not rise drastically).

----- finance: To continue the same policy as that in the previous period (We estimated that loans of 2.8 billion Rial would be provided to the iron and steel industry in 2005).

----- subsidy: To continue the same policy as that in the previous period (We estimated that subsidies of 1.5 billion Rial and 450 million Rial would be provided to the iron and steel and the sugar industries, respectively).

----- taxation: To provide favorable taxation treatment (tax credit, tax exemption, and special depreciation) for measures evaluated economically "feasible" (This policy measure can be implemented due to the re-establishment of the taxation system by the early 2000s. However, serious attention should be turned to the fact that this policy measure as well as finance and subsidies will have to be affected with a balanced government budget).

c. Other Policy Measures

< 1995 to 2000 >

----- To establish the standards and the targets for energy consumption of machines and equipment used in factories.

----- To designate factories where energy consumption is to be managed (Stipulated in the five year plan).

----- To prepare systems for allocating energy managers in factories.

----- To assist private companies or universities on research and development for promoting energy conservation (Same as above).

----- To decrease electricity consumption in factories (Same as above).

----- Others (Awarding successful cases of energy conservation, providing information on energy conservation, factory energy audit by experts, etc.).

< 2000 to 2005 >

----- To continue the same policies as those in the previous period.

(5) Proposing Items to be Studied for Promoting Energy Conservation

To make policy measures more concrete and realistic, it is desirable for the government to carry out the following policy measures:

a. To collect and organize data and information for promoting energy conservation, including institutional arrangements.

b. To develop methodologies for evaluating energy conservation policies, including institutional arrangements.

c. To establish a system or an organization in five groups of public enterprises for preparing concrete and realistic guidelines for energy conservation in factories according to policies formulated by the government (The "Guideline", which was prepared by the JICA team, will contribute to preparing the guidelines above).

d. To establish a system or an organization for preparing concrete and realistic programs according to the guidelines above in each factory of the groups (The "Guidelines" also will contribute to preparing programs above).

e. To select at least one "model" factory in each group where a project on improving management efficiency will be executed in consultation with outside experts.

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