Japan International Cooperation Agency (JICA)

Plan and Budget Organization (PBO)
The Islamic Republic of Iran

TECHNICAL COOPERATION ON ANALYSIS OF ENERGY CONSERVATION AND RATIONAL USE OF ENERGY IN THE SOCIAL AND ECONOMIC SECTORS OF THE ISLAMIC REPUBLIC OF IRAN

FINAL REPORT

I. Description of the Study
II. Master Plan for Energy Conservation in Six Industries

September 1997

The Energy Conservation Center, Japan (ECCJ)
The Institute of Energy Economics, Japan (IEEJ)

Japan International Cooperation Agency (JICA)

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PREFACE

In response to a request from the Government of the Islamic Republic of Iran, the Government of Japan decided to conduct the Technical Cooperation for Analysis of Energy Conservation and Rational Use in the Social and Economic Sectors of the Islamic Republic of Iran and entrusted the study to Japan International Cooperation Agency (JICA).

JICA sent a study team led by Mr. Mitsuo Iguchi of The Energy Conservation Center, Japan to the Islamic Republic of Iran six times from September 1995 to July 1997.

The team held discussions with the officials concerned of the Government of the Islamic Republic of Iran, and conducted related field surveys. After returning to Japan, the team conducted further studies and compiled the final results in this report.

I hope this report will contribute to the promotion of the plan and to enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Islamic Republic of Iran for their close cooperation throughout the study.

September 1997

Kimio Fujita

Kimio FUJITA
President
Japan International Cooperation Agency

Foreword

Plan and Budget Organization (PBO) of the Islamic Republic of Iran initiated a study on developing a "Comprehensive Energy Plan" in 1992 and this project was carried out at Institute for Research in Planning and Development (IRPD). At the same time, the government of the Islamic Republic of Iran had requested the Japan International Cooperation Agency (JICA) for a technical and scientific cooperation on comprehensive energy studies and detailed analysis of energy conservation and environmental impact of energy in the framework of the comprehensive energy studies. This cooperation was started in 1992 and finalized in 1994. The main outcome of this study indicated that energy audit for developing a reliable energy database and more elaboration on energy conservation measures could be an important element of the energy policy. Therefore, PBO initiated a project of analysis of energy conservation in the social and economic sectors of the country and requested JICA to cooperate on this project with establishing an energy audit bus. This request was well received by JICA.

Technical cooperation on analysis of energy conservation in the social and economic sectors of the Islamic Republic of Iran started in 1995. PBO introduced IRPD and the Sharif University of Technology (SUT) as the Iranian counterpart organizations. JICA dispatched the JICA Study Team consists of Energy Conservation Center, Japan (ECCJ) and Institute of Energy Economics, Japan (IEEJ).

Upon the approval of the project, the counterpart institutions prepared a detailed scope of work and time schedule for implementing the project. In the framework of this collaborative project energy audit bus and necessary energy measuring equipment are presented by JICA to PBO and they are installed at SUT. The counterpart study teams carried out an energy audit in 11 energy intensive factories in the Islamic Republic of Iran in the summer of 1996. The aim of this collaborative work was twofold. First objective was to train the Iranian counterpart on energy audit and to transfer the technology and know how to the Iranian team. The second objective was to initiate an energy database for analysis of energy conservation at the macro and micro level in the industrial sector. The energy audit bus has been established at SUT and the result of analysis of energy conservation in 11 factories was presented in a seminar in February 1997. In addition, potentials for energy conservation have been estimated and energy conservation policies proposed for the industrial sector. This collaborative project has provided a scientific and technical infrastructure for further development of energy studies in the Islamic Republic of Iran.

The present collaborative study has been implemented and finalized successfully and this success is attributed to efforts and enthusiastic work of the members of both study teams which we would like to appreciate deeply. We would like to acknowledge the support of PBO, JICA, Iranian Advisory Committee, and all companies and organizations we visited. We hope this project will provide the necessary infrastructure for further development of energy studies in the Islamic Republic of Iran.

Mr. M. Iguchi
Project Manager
JICA Study Team

Dr. Y. Saboohi
Project Manager
PBO Team

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1.1 Background of the Study

(1) In the Islamic Republic of Iran, it is now an issue of great concern, which may influence the future economic growth, to establish a reliable, efficient and economical energy supply system in good harmony with the social development and environment. In this regard, it is vitally important to work out a comprehensive energy policy.

(2) Plan and Budget Organization of the Islamic Republic of Iran (hereinafter referred to as "PBO") decided to formulate a "Comprehensive Energy Development Plan" which aims at providing a rational and scientific basis and organizing the data in order to establish a long-term energy strategy, along with the 1st 5-year Economic, Social, and Cultural Development Plan (March 1989 to March 1994) drawn up in July 1989. Hence PBO consulted "Institute for Research in Planning and Development" (hereinafter referred to as IRPD) about drafting the plan.

(3) In response to the request of the Government of the I.R. Iran for the development and study for providing technical and theoretical recommendations, the Japan International Cooperation Agency (hereinafter referred to as "JICA"), conducted "A Study of the Comprehensive Energy Development Plan of the Islamic Republic of Iran" with IRPD as the counterpart for the period of February 1992 to March 1994.

The purpose of this study was to establish a scientific basis for formulating a comprehensive energy development plan through the Iranian-Japanese joint work as well as to improve the technical capability of the Iranian counterpart.

The following were mainly studied:

a. Development of energy database
b. Analysis of economic development
c. Analysis of energy demand
d. Analysis of the energy supply system
e. Review of the energy market
f. Consideration of energy conservation potentials
g. Consideration of environmental problems involved in energy supply and consumption

(4) As a result of this study, the following were suggested to be important for attempting the rational use of energy.

a. To optimize the energy supply cost
b. To reduce the environmental load as much as possible
c. To preserve the resources necessary for acquisition of foreign currency to continue the development
d. To optimize energy intensities

e. To establish the policy for controlling the energy supply and demand
f. To proceed with energy-related research and development activities

Specifically, optimization of energy consumption intensity among these is one of the important items for I.R. Iran where energy prices are relatively low, and the quantification has been found to be vitally important for promoting the rational use of energy in the social and economic sectors. The necessary data and information available are, however, not so sufficient, thus making it difficult to plan a fully reliable and practical measure at present.

(5) Hence, the Government of the I.R. Iran requested the Government of Japan to conduct a more detailed study on the current situation of energy use in I.R. Iran, and concurrently to carry out the survey related to the planning of an energy policy based on the foregoing study.

(6) JICA dispatched the preliminary study team in October 1994 to discuss various necessary issues which would be involved in the implementation of this study. After necessary study and discussion, a Scope of Work (S/W) was concluded between PBO, the counterparting organ of the requesting country for this study and the Japanese study team.

1.2 The Objectives of the Study

The objectives of the study are:

(1) to analyze the use of energy at micro level in the main energy consuming sectors, such as industrial sector, in order to provide detailed information for identifying the potentials of energy conservation and rational use of energy,

(2) to help expand the energy data and information system and

(3) to provide a scientific basis for evaluation of the potentials of energy conservation and identification of appropriate measures for improving energy management in the I.R. Iran.

1.3 Counterparts

(1) Plan and Budget Organization (PBO)
(2) Institute for Research in Planning and Development (IRPD)
(3) Sharif University of Technology (SUT)

1.4 Japanese Organization Responsible for Implementation of the Study

The study was conducted jointly by The Energy Conservation Center, Japan (Representative) and The Institute of Energy Economics, Japan.

1.5 Description of the Study

The study was conducted with regard to the following points according to the "IV. Scope of the Study" in the Scope of Work signed on October 18, 1994.

(1) Upgrading the existing energy database

a. Confirmation of the existing energy database
b. Identification of data necessary for microanalysis of energy conservation
c. Upgrading of energy database based on the data obtained through the factory diagnosis

(2) Study on the present status of energy use in the 6 main industries

a. To study the current situation and the future perspective of energy use in the energy consuming sectors, and to investigate the present situation and the future plan of the laws, regulations, activities relevant to energy conservation
b. To investigate the current situation of energy utilization in the steel, cement, glass, food, textile, and chemical industries
c. To investigate the energy management situation in the above-mentioned industries(3)

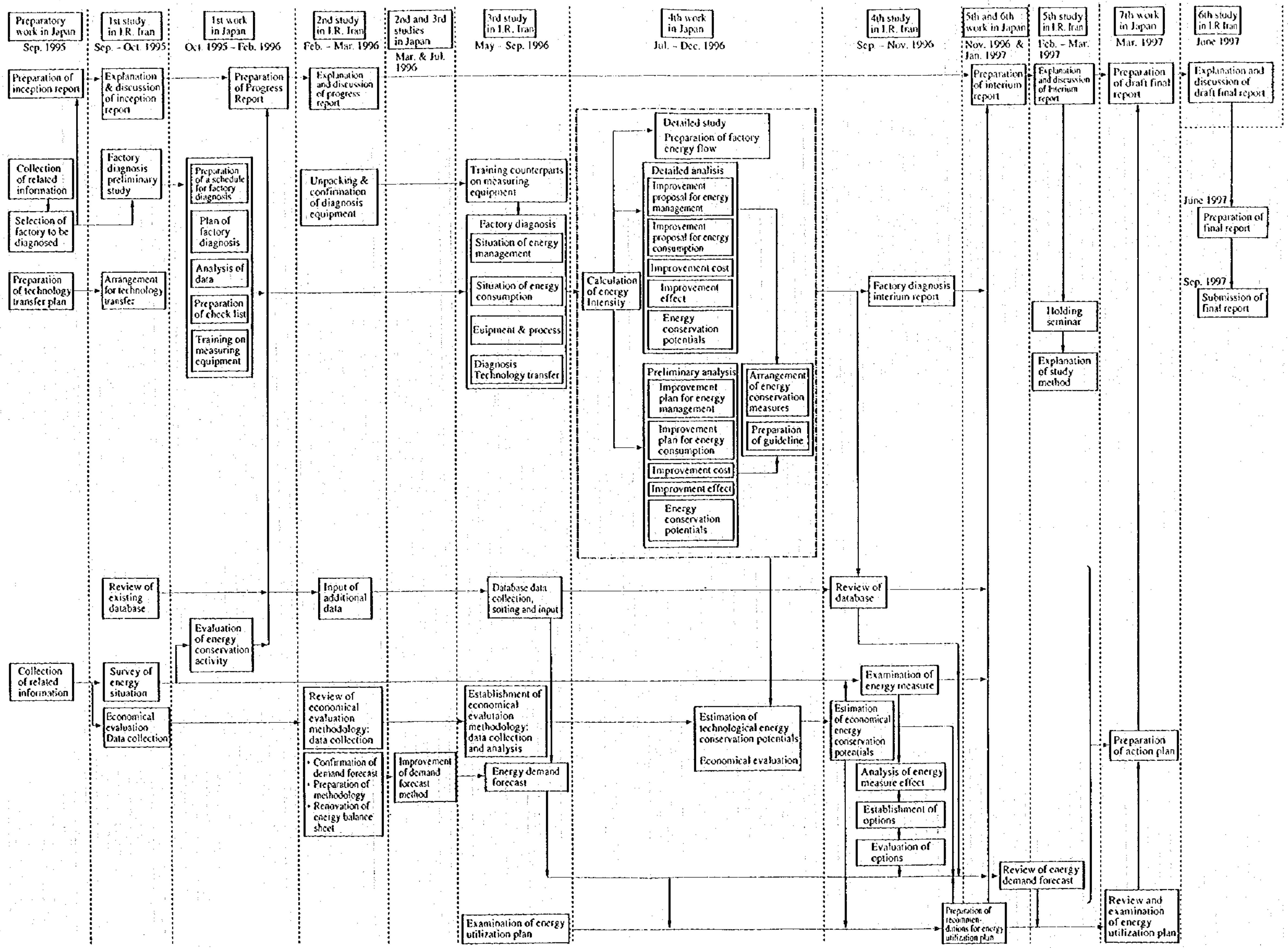
(3) Consideration of energy conservation measures and estimation of energy conservation potentials

a. To examine the energy conservation technical measures in the main 6 industries
b. To estimate the technical potentials for energy conservation after implementation of energy conservation measures
c. To review the energy conservation technological measures in terms of economical efficiency
d. To investigate the optimization of energy intensities in the economic and social sectors
e. To formulate the framework for energy management measures through establishing energy prices, modernization of technology, improvements of various systems, etc.

1.6 Methodology of the Study and the Implementation Status

The overview of the study is illustrated in Figure 1.1.

Figure 1.1 Overview of the Study



1.6.1 Preparatory Work in Japan (Sept. 1995)

(1) The JICA team collected the relevant information in Japan based on the result of "A Study of the Comprehensive Energy Development Plan of the Islamic Republic of Iran" conducted for the period of 1992 to 1994 and the result of the preliminary survey for this present study to prepare for the first study in I.R. Iran.

(2) Inception Report was prepared so that the counterpart would be able to understand the outline of the field study in advance.

1.6.2 The First Study in I.R. Iran (September to October 1995)

(1) The JICA team explained the methodology of the study to the counterpart using the inception report for discussion.

(2) The JICA team conducted hearing from counterparts and energy-related organizations concerning the energy policy.

(3) The JICA team confirmed the existing database updating status and reviewed the existing data items and the data structure.

(4) Through discussion with the counterparts, the JICA team examined the procedure for economic assessment and survey, and investigated the trend of the industrial field through hearing survey at the factories selected for factory diagnosis.

(5) The JICA team visited the factories planned to be selected for factory diagnosis for 1 or 2 days to conduct a preparatory study through interviews and observation of the operation at the workshops, and finally selected the factories to be surveyed.

In addition, the purpose and the method of factory diagnosis were explained to the factory side to ask them for their cooperation in factory diagnosis.

1.6.3 The first work in Japan (October 1995 to February 1996)

(1) Energy policy implementation data in I.R. Iran were summarized based on the result of the first study in I.R. Iran.

(2) The JICA team reviewed the energy demand forecast model at the time of "A Study of the Comprehensive Energy Development Plan of the Islamic Republic of Iran", surveyed the documents for expanding the macro economic model, and reviewed the model system for integrating the energy forecast model and the macro economic model.

(3) The JICA team analyzed the data and information acquired through the preliminary study for factory diagnosis conducted in the first study in I.R. Iran to prepare an implementation plan for factory diagnosis.

A check list summarizing the data to be collected at the time of factory diagnosis was prepared for each industrial category for the convenience of factory diagnosis.

(4) These were summarized in the progress report and sent to the Iranian side.

1.6.4 The Second Study in I.R. Iran (February to March 1996)

(1) The JICA team explained the progress report to the counterpart and discussed it.

(2) The JICA team examined the model for evaluating the optimization of energy utilization in the industrial sector, as well as the suggestions and requests from the counterpart.

(3) The JICA team coordinated the concept design of the macroeconomic and energy forecasting model, confirmed the macroeconomic and social index as well as energy data collection status, and requested the counterpart to correct the data. In addition, the energy balance sheet was updated.

(4) The measuring equipment to be used for factory diagnosis were unpacked and accepted upon inspection.

Technology transfer to the counterpart was conducted with regard to the details and the method of factory diagnosis.

1.6.5 The Second and Third Work in Japan (March to July, 1996)

(1) Improvement and adjustment were made on the macroeconomic model and the energy demand forecasting model.

1.6.6 The Third Study in I.R. Iran (May to September, 1996)

(1) The JICA team surveyed the energy conservation policy situation, and views and opinions of the people responsible for the said policy through the interviews with energy-related organs, industrial groups and organization.

(2) Simulation of energy demand forecast and extraction of implication were conducted.

(3) The JICA team collected information for economic assessment at energy conservation through interview survey of energy-related organs, industrial organization and factories.

Through exchange of views with Iranian counterparts, the JICA team established an energy potential estimating method for each industry and a cost calculation method for the energy conservation measure, and coordinated the preconditions for the economic assessment.

(4) A lecture was given to Iranian counterparts regarding the energy conservation points for each category of industry.

Factory diagnoses were conducted at the factories representing 6 industries (steel, chemical, cement, glass, food and textile) each for 3 to 5 days by means of measuring equipment.

1.6.7 The Fourth Work in Japan (July to October 1996)

(1) The JICA team analyzed the results of the factory diagnoses conducted in the third study in I.R. Iran to get a good understanding of the present situation for each factory, and extracted energy conservation potentials.

(2) Based on the result of the study in I.R. Iran and factory diagnoses carried out so far, the following were conducted:

- estimation of energy potentials for each industry,
- review of the calculation method
- trial calculation of energy potentials for each industry
- trial calculation of energy conservation potentials for each industry
- trial calculation of energy conservation measure cost and economic potentials for each industry and
- trial calculation of energy consumption for each energy

1.6.8 The Fourth Study in I.R. Iran (September to November 1996)

(1) Through discussion with Iranian counterparts, the following were conducted:

a. Qualitative analyses of various policy measures which will affect energy demand, establishment of options for the energy conservation policy and evaluation of the options
b. Determination of the method for an energy use plan model and evaluation of the simulation result
c. Estimation of energy conservation potentials by industry, evaluation of economic potentials for energy conservation by industry and estimation of energy consumption by industry.

(2) The JICA team discussed the results of factory diagnoses with Iranian counterparts.

1.6.9 The Fifth and Sixth Work in Japan (November 1996 and January 1997)

(1) Qualitative analyses of various energy conservation measures were continuously conducted to set up the options for measures.

(2) Formulation of an energy utilization plan was carried out with models, and simulation of arbitrary models was conducted.

(3) The factory diagnosis results were finally summarized to prepare the guideline.

(4) All the study results were summarized into the interium report, and sent to the Iranian side.

1.6.10 The Fifth Study in I.R. Iran (February to March 1997)

(1) The JICA team explained the interium report to Iranian counterparts to discuss it.

(2) The JICA team held seminars for PBO, IRPD, SUT and factory people so that the content of the interium report was widely understood to the people concerned.

(3) Detailed explanation was given to Iranian counterparts with regard to the study method related to the content of the interium report.

1.6.11 The Seventh Work in Japan (March 1997)

(1) The energy utilization plan was reviewed, and recommendations were prepared.

(2) Recommendations concerning the action plan for the energy policy were prepared.

(3) The study results were summarized into the draft final report to be sent to the Iranian side.

1.6.12 The Sixth Study in I.R. Iran (June 1997)

(1) The draft final report was explained to Iranian counterparts, and discussed.

1.6.13 Submission of the Final Report (September 1997)

1.7 Organizations and Factories to be Studied

(1) Interview survey (Ministries, industrial organizations and Japanese enterprises operating in I.R.Iran)

a. Institute for Research in Planning and Development
b. Plan and Budget Organization (Library)
c. Ministry of Industry
d. Ministry of Mines and Metals
e. Central Bank of the Islamic Republic of Iran
f. Iran Statistics Center
g. Association of Iran Textile Industries
h. Sugar Factories Syndicate
i. State Sugar Organization
j. Iran Cement Engineering Center
k. Oilseed Research and Development
l. Cement Research Center
m. Consulting Office for Sugar Industries
n. JETRO, Tehran Office
o. Marubeni, Iran
p. Nikki Engineering

(2) Interview survey (Factories)

(Steel Industry)	a.	Mobarakeh Steel
	b.	Khouzestan Steel
(Chemical Industry)	c.	Razi Petrochemical
(Glass Industry)	d.	Mina Glass
	e.	Saveh Jam Glass
(Textile Industry)	f.	Aliaf
	g.	Yazd Baf
(Food Industry)	h.	Esfahan Sugar
	i.	Shiraz Vegetable Oil

(3) Factory survey

(Steel Industry)	a.	Esfahan Steel
(Chemical Industry)	b.	Tehran Refinery
(Cement Industry)	c.	Sephahan Cement
	d.	Tehran Cement
	e.	Soufian Cement
(Glass Industry)	f.	Ghazvin Glass
(Textile Industry)	g.	Polyacryl Iran
	h.	Kashan Velvet & Rayon Mills, Ltd.
(Food Industry)	i.	Behshar Industry
	j.	Karun Cane
	k.	Abkouh Sugar

(4) Interview survey and observation at organizations and factories in Japan

a. Japan Sugar Refiners' Association
b. Petroleum Association of Japan
c. Japan Chemical Fibres Association
d. Japan Oilseed Processors Association
e. Japan Cement Association
f. The Japan Iron and Steel Federation
g. Association of Japan Beet Sugar Manufacturers
h. Japan Spinners' Association
i. Kawasaki Heavy Industries
j. Kobe Steel
k. Nisshin Sugar Manufacturing
l. Nisshin Plant Engineering
m. Nihon Cement
n. Nippon Beet Sugar Manufacturing, Memuro Sugar Beets Factory
o. Higashi Nihon Sugar Manufacturing, Chiba Plant
p. Hokuren Federation of Agricultural Cooperatives, Shimizu Sugar Beets Factory
q. Meiji Sugar Manufacturing

1.8 Measuring Equipment for Factory Energy Diagnosis

The Iranian side received the measuring equipment in March 1996, which were used for factory diagnoses. The bus for factory diagnosis could not clear customs by the end of factory diagnosis, and the equipment were transported by general vehicles and by air cargo.

The list of the measuring equipment is shown in "III Appendix 3".

1.9 Members of the JICA Team

No	Name	Assignment
1.	Mr. Mitsuo Iguchi	Team leader
2.	Mr. Toru Kimura	Deputy team leader, Energy policy A
3.	Mr. Shin-ya Udou	Energy policy B
4.	Mr. Norio Fukushima	Energy conservation potential analysis
5.	Mr. Kaoru Yamaguchi	Database and energy utilization plan
6.	Mr. Hisao Kibune	Energy demand forecasting A
7.	Mr. Hiroyuki Ishida	Energy demand forecasting B
8.	Mr. Shigeaki Kato	Economic evaluation
9.	Mr. Akihiro Koyamada	Measuring equipment
10.	Mr. Jiro Konishi	Energy management (Heat)
11.	Mr. Kazuo Usui	Energy management B (Electricity)
12.	Mr. Yukio Nozaki	Energy management C (Heat)
13.	Mr. Ken-ichi Nakayama	Energy management D (Electricity)
14.	Mr. Katsuhiko Kaburagi	Energy management E (Heat)
15.	Mr. Toshio Sugimoto	Energy management F (Electricity)
16.	Mr. Seiichiro Maruyama	Factory management A (Steel process)
17.	Mr. Takashige Taniguchi	Factory management B (Textile process)
18.	Mr. Hisashi Ikeda	Factory management C (Cement process)
19.	Mr. Masami Kato	Factory management D (Glass process)
20.	Mr. Shiro Honda	Factory management E (Food process)
21.	Mr. Teruo Anzai	Factory management F (Chemical process)
22.	Mr. Kenji Kazuma	Factory management G (Chemical process)

1.10 Counterpart Members

Dr. Saboohi	Manager
Mr. Ali Mazhari	Energy conservation
Mr. Saeed Akhavan	Energy conservation
Mr. Fereidoun Mianji	Micro level energy management
Mr. Kasra Azizi	Macro level energy management
Mr. S. Mehdi Sajadifar	Factory management
Mr. Abolghasem Schayesteh	Instrumentation
Mr. Hossein Moosavi	Macro level energy management
Mr. Tohangchi	Micro level energy management
Mr. Seid-Reyhani	Micro level energy management
Ms. Zarvani	Macro level energy management

II. MASTER PLAN
FOR ENERGY CONSERVATION
IN SIX INDUSTRIES

1. ENERGY DEMAND AND SUPPLY AND ENERGY POLICY

1. ENERGY DEMAND AND SUPPLY AND ENERGY POLICY

1.1 Present Situation of Iran

The policies of the Iranian Government have been based on the first Five-year Plan (for March 1989 to March 1994), and the current second Five-year Plan (March 1995 to March 2000) which was approved by the Islamic Consultative Assembly in December 1994.

This chapter will focus on the economic and financial positions during the first Five-year Plan period, and summarize the energy situation. Also it will mention the long-term forecast on energy as well as explain about Iranian energy-related organs.

1.1.1 Outlook on the Economy

During the first Five-year Plan period, the Gross Domestic Products (GDP) grew by 7.5% compared to the target of 8.1%, resulting in the target attainment of 92.6% (see Table 1.1).

Table 1.1 Target and Results of the First Five-year Plan

(in Billion Rials)
based on the price in the year 1982

Item/fiscal year	1988/1989	1993/1994	Yearly average growth (%)	1st Plan Target	Target attainment rate (%)	GDP ratio (%)
Agriculture	2,648	3,410	5.2	6.1	85.2	23.2
Oil	1,754	3,078	11.9	9.5	125.6	21.0
Mining and manufacturing industries	1,358	2,192	10.1	15.0	67.3	14.9
Water/Electricity/Gas	186	407	17.0	9.1	186.8	2.8
Construction	433	472	1.7	14.5	11.7	3.2
Services	3,981	5,120	5.2	6.7	77.6	34.9
Total added value price	10,360	14,679				
Excluding the trade	1,126	1,421				
GDP	9,234	13,258	7.5	8.1		100.0

Source: prepared by JETRO Tehran Office based on "The Second Five-year Plan (draft)" by PBO

Analyzed by sector, oil, water, electricity and gas surpassed the respective target figures. Water, electricity and gas, however, contributed so little to the total GDP, which means that oil was the only factor which virtually helped to push up the GDP result.
On the other hand, agriculture, mining and manufacturing industries, construction and service sectors failed to attain the targets. Apart from the worst-performing construction industry whose share in the GDP was virtually small, the results from mining and manufacturing industries as well as service sectors remained really unsatisfactory.

The target figure of the GDP growth for the second Five-year Plan is set at 5.1%, relatively lower than the first period figure of 8.1%. (See Table 1.2 for GDP growth by industrial sectors.)

Table 1.2 GDP Growth Rate and Added Value Price by Sector during the Second Plan Period
(In Billion Rials; %; based on the price in the year 1982)

	1991	1992	1993	1994	1999	Average growth rate
Agriculture	3,120	3,352	3,536	3,687	4,545	4.3
Oil	2,517	2,554	2,645	2,687	2,903	1.6
Mining and manufacturing industries	2,009	2,075	2,099	2,222	2,954	5.9
Water/Electricity/Gas	285	309	399	366	537	8.0
Construction	508	549	562	584	711	4.0
Services	4,946	5,344	5,744	5,919	6,888	3.1
Transportation	851	957	1,030	1,079	1,359	4.7
Communications	57	62	67	72	100	6.8
Others	4,039	4,325	4,646	4,769	5,429	2.6
Trade and service income	13,385	14,181	14,925	15,465	18,539	3.7
and expenditure	1,561	1,703	1,824	1,699	904	D11.9
GDP	11,824	12,478	13,101	13,766	17,635	5.1

(source): The second Five-year Plan Law by PBO

1.1.2 Public Finance and Credit Situation

The wartime budgets organized with priority on war expenses during the War (1980 to 1988) continued to be a curtailed type due to declined earnings from oil. In particular, the budget portions appropriated to development and investment-related areas were reduced sharply, causing a delay in the economic and social development of the country.

Then, the budgets during the first Five-year Plan period were designed to restore the economy, by revitalizing the domestic industries already in operation, establishing economic infrastructure and promoting key industries of the country.

In particular, the original budget for the fiscal year 1993/94 was expanded remarkably from the previous fiscal year (over 120%) due to the planned unification of foreign exchange rates. In the final year for the first Five-year Plan, the budget managed to be nominally balanced. After the budget finalization, however, the fiscal authorities are still making efforts to operate on a tightened budget due to the shortage of foreign currencies (about 4 billion dollars in short of the estimate in the initial budget) caused by lower crude oil prices.

As the most important policy task for the moment, the fiscal authorities have to reduce the excessive money supply to curb inflation, and help expand the production of existing domestic industries, as well as promote investment and financing for implementation of various projects. In this regard, the stock exchange market is being improved, and non-strategic industries privatized, while on the other hand, the exchange rate was unified finally in the spring of 1993.

1.1.3 Energy Situation

(1) Oil

According to its official statement, Iran has crude oil reserves of 92.9 billion barrels, 9.4% of the worldwide total, ranking third as Japan's crude oil supplying country (as of 1994). While it was able to produce 6 million barrels daily some time before the Islamic Revolution, the production capacity dropped drastically after the Revolution, due to curtailed oil-field maintenance, Iran's resources conservation policy, influences of the War and other reasons. After the War, however, the production volume is said to be firmly regaining.

a. Production Capacity

It increased to 4 million barrels daily in 1993 from 2.8 million barrels in 1988. In 1993, 54 million cubic meters of gas was injected for the protection of oil fields, compared to 25 million cubic meters in 1988.
(Source: The review of First Five-year Plan by the President in Islamic Consultative Assembly on 13 December 1994 and Newspaper)

b. Projects

For the enhancement of oil production capacity together with the protection of oil fields, Persian-gulf oil field projects were to be completed during the Plan period, including the following projects: new oil field production projects at four sites; desalinization projects at five sites; gas injecting projects at Gachsaran, Maroon and Karanj field; restoration of Naftshar field; and repair of Hendijian, Behregansar, Salman and Resalat fields.

The number of oil rigs was increased to 20 during the Plan period, extended to the point 404 km offshore, away from the 101 km point at the start of the period. The seismic, gravity and magnetic surveys were made on 18,000 km^2 of land onshore.
(Source: The review of First Five-year Plan by the President in Islamic Consultative Assembly on 13 December 1994 and Newspaper)

c. Oil Field Locating

Six oil fields were found which are estimated to be capable of producing 3 billion barrels of oil. In addition, 3 trillion cubic meters of gas and 3 billion barrels of liquefied gas are believed to be deposited at the four fields.
(Source: The review of First Five-year Plan by the President in Islamic Consultative Assembly on 13 December 1994 and Newspaper)

d. Oil Export

The export of oil was increased from 1.92 million barrels per day in 1988 to 2.55 million in 1993, a yearly increase of 5.8% on average during the first Five-year Plan period.

e. Oil Refinery

The Arak refinery started to operate with the daily capacity of 150,000 barrels, while the Abadan refinery was restored, presenting the capacity of 250,000 barrels daily. The Mahshabr refinery was also reconstructed, and the pipelines between Tange Fanni and Arak, Bandar Abbas and Rafsanjan, and Arak and Malayer were completed. All this helped to improve Iran's supply capability of oil products, which increased from 134,000 cubic meters in 1988 up to 181,000 cubic meters in 1993, showing a yearly average growth of 6.2%.

This resulted in a sharp increase in the domestic consumption of oil products during the first Plan period, making the annual average consumption growth of gasoline 8.5%, that of kerosene 8.8%, and that of gas oil 4.3%.

(2) Natural Gas

It is officially announced that natural gas reserves in I. R. Iran are estimated to amount roughly to 20 trillion cubic meters, the world's second largest after those in the former Soviet Union. Iran's major gas fields include the associated type like the gas field in Khuzestan state, as well as the structural type like those at Kangan, and Pars.

a. Consumption

Natural gas consumption increased from 12 billion cubic meters in 1988 to 29.5 billion cubic meters in 1933, corresponding to the daily consumption of 48 million and 110 million cubic meters respectively, which almost met the planned figures.

Among hydrocarbon products, the increase in natural gas consumption was among the most important targets set in the first Five-year Plan. With the enhancement of gas refining capacity as well as the expansion of the gas-supplying network, natural gas came to occupy 33% of the total hydrocarbon products in 1993, up from 22% in 1988.

b. Production Capacity

Natural gas production rose to 110 million cubic meters in 1993, owing to the successful progress of the first stage of construction of the Kangan refinery, which has a production capacity of 45 million cubic meters.
(Source: The review of First Five-year Plan by the President in Islamic Consultative Assembly on 13 December 1994 and Newspaper)

c. Pipelines

While the gas-transporting pipeline length totaled 5,000 km in 1988, it grew to 8,250 km in 1993, with 3,250 km newly constructed during the Plan period.

d. Gas Supply

The gas supply network was expanded effectively, which made it possible to supply gas to 186 additional cities/towns during the first Five-year Plan period. The total length of gas supply pipes was more than doubled to 33,800 km in 1993 from 15,800 km in 1988, well surpassing the planned target figure. On the receiving side, 3.6 million families were supplied with city gas in 1993, a sharp increase compared to 880,000 families in 1988, as a result of which 53% of the urban population has become able to get natural gas.

(3) Electricity (under control of the Ministry of Energy)

Since the end of the War, the Iranian government has been making efforts to solve its electric power shortage, by helping damaged power plants in repair and restoration, as well as resuming the construction of power plants which was forced to halt amid the intensified conflict.

a. Electric Power Generation Capacity

During the first Plan period, the generating capacity of 5,200 MW was added. This total was made up of 2,297 MW produced by 10 turbine power plants, 1,973 MW by 19 gas power plants, 900 MW by the Gilan province plant and 30 MW by hydroelectric power stations. This resulted in a 10% yearly average increase from the generating force of 49 billion kWh in 1988.

During the first Plan period, 230 kV power cable lines were extended from 10,000 km to 15,200 km, and 400 kV lines from 5,600 km to 6,220 km.

1.1.4 Long-term Forecast on Energy Supply and Demand

Even after the end of the first Five-year Plan, the expansion in usage of natural gas has been among the essential tasks as an alternative energy source to replace oil products being consumed domestically in Iran.
The 16th World Energy Congress was held in Japan in October 1995. According to the latest forecast on energy submitted by the Iranian government at the Congress, natural gas consumption will grow within 15 years to an extent comparable to oil consumption; the ratio of oil and natural gas consumed in 1993 was 66.6% and 24.3%, and it will be 57.8% and 31.3% in 2000, and then 47.4% and 38.6% in 2010 respectively (see Table1.3, 1.4 and 1.5).

Table 1.3 General Energy Data

	1970	1973	1979	1980	1985	1990	1992	1993	2000	2010
Population 10^5	28,7	31,1	38,0	39,6	47,8	54,5	59,2	60,7	73,0	94,0
GDP 10^9 USD (1987) 1)	na	na	136	117	154	149	169	na	na	na
GDP 10^9 NC (1982)	6,522	8,452	10,543	9,323	11,607	10,665	12,478	13,101	na	na
Per Capita USD (1987)	na	na	3571	2941	3227	2729	2857	na	na	na
Per Capita NC (1982)	227,034	271,878	277,516	235,159	242,797	195,665	210,670	215,796	na	na
Primary Energy Supply PJ	625	882	1,584	1,474	2,371	3,062	3,702	4,033	6,655	11,944
Per Capita GJ	22	28	42	37	50	56	63	66	91	127
Per GDP MJ/USD	na	na	12	13	15	21	22	na	na	na
(1987)	0.10	0.10	0.15	0.16	0.20	0.29	0.30	0.31	na	na
Per GDP MJ/NC (1982)										
	489	715	1,328	1,267	1,987	2,429	2,961	3,253	5,208	9,664
Final Energy Demand PJ	17	23	35	32	42	45	50	54	71	103
Per Capita GJ	na	na	10	11	13	16	17	na	na	na
Per GDP MJ/USD (1987)	0.08	0.09	0.13	0.14	0.17	0.23	0.24	0.25	na	na
Per GDP MJ/NC (1982)										
	7	12	22	22	39	59	68	76	159	409
Electricity Supply TWh	235	389	577	564	820	1,084	1,155	1,255	2,171	4,347
Per Capita kWh	na	na	161	192	254	397	404	na	na	na
Per GDP Wh/USD	1.0	1.4	2.1	2.4	3.4	5.5	5.5	5.8	na	na
(1987)										
Per GDP Wh/NC (1982)										

1) from the World Bank

Source: Iranian National Committee/WEC; Ministry of Energy

Table 1.4 Primary Energy Supply (PJ)

	1970	1973	1979	1980	1985	1990	1992	1993	2000	2010
Indigenous Production										
Coal	9	25	23	25	30	23	20	23	38	61
Oil	8551	13127	7706	3312	5595	7295	8249	8731	8935	11168
Natural Gas	138	493	335	179	352	937	1143	1327	3195	8286
Nuclear	0	0	0	0	0	0	0	0	0	0
Hydro	6	10	20	20	20	22	34	35	65	198
Other	25	21	21	21	21	20	21	21	24	30
Total Production	8728	13676	8105	3557	6018	8296	9467	10138	12257	19743
Imports(+)										
Coal	0	1	23	23	9	6	17	22	17	6
Oil	0	0	22	20	391	272	376	331	470	715
Natural Gas	0	0	0	0	0	0	0	0	0	0
Electricity	0	0	0	0	0	0	0	0	0	0
Other	0	0	0	0	0	0	0	0	0	0
Total Imports	0	1	45	43	400	278	393	352	487	721
Exports (-)										
Coal	0	0	0	0	0	0	0	0	0	0
Oil	8147	12447	6388	2007	3991	5545	6244	6507	5859	6751
Natural Gas	37	335	135	0	0	80	16	0	330	1928
Electricity	0	0	0	0	0	0	0	0	0	0
Other	0	0	0	0	0	0	0	0	0	0
Total Exports	8185	12781	6523	2007	3991	5625	6260	6507	6189	8679
Bunkers	-4	-6	-6	0	-1	-12	-10	-16	-25	-40
Change in Stocks	86	-8	-37	-119	-55	124	113	65	125	199
Total Primary Energy Supply PJ	625	882	1584	1474	2371	3062	3702	4033	6655	11944
Mtoe	15	21	38	35	57	73	88	96	159	285

Source: Iranian National Committee/WEC; Ministry of Energy

Table 1.5 Final Energy Demand by Source and Sector (PJ)

	1970	1973	1979	1980	1985	1990	1992	1993	2000	2010
Coal										
Industry	9	26	46	48	39	29	37	45	55	67
Transport	0	0	0	0	0	0	0	0	0	0
Other	0	0	0	0	0	0	0	0	0	0
- of which: Residential	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0	0	0
Non-Energy Use	0	0	0	0	0	0	0	0	0	0
Total Coal	9	26	46	48	39	29	37	45	55	67
Oil										
Industry	92	125	234	252	386	407	442	372	456	692
Transport	108	166	358	330	507	589	677	747	993	1797
Other	154	215	451	409	645	660	773	916	1408	1864
- of which: Residential	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0	0	0
Non-Energy Use	17	28	58	59	82	86	132	133	155	230
Total Oil	371	535	1100	1049	1619	1741	2025	2167	3012	4583
Natural Gas										
Industry	3	23	9	20	58	214	269	386	1026	2421
Transport	0	0	0	0	0	0	0	0	0	0
Other	0	1	20	33	127	128	288	339	605	1311
- of which: Residential	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0	0	0
Non-Energy Use	59	71	65	26	1	116	112	63	0	0
Total Natural Gas	62	94	94	79	185	458	669	789	1631	3732
Other										
Industry	0	0	0	0	0	0	0	0	0	0
Transport	0	0	0	0	0	0	0	0	0	0
Other	25	21	21	21	21	20	21	21	24	30
- of which: Residential	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0	0	0
Non-Energy Use	0	0	0	0	0	0	0	0	0	0
Total Other	25	21	21	21	21	20	21	21	24	30
Electricity										
Industry	14	25	31	31	41	53	66	75	139	376
Transport	0	0	0	0	0	0	0	0	0	0
Other	9	14	36	39	81	128	144	156	347	876
- of which: Residential	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0	0	0
Total Electricity	22	39	67	69	122	181	209	231	486	1252
Heat										
Industry	0	0	0	0	0	0	0	0	0	0
Transport	0	0	0	0	0	0	0	0	0	0
Other	0	0	0	0	0	0	0	0	0	0
- of which: Residential	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0	0	0
Total Heat	0	0	0	0	0	0	0	0	0	0
Final Energy Demand										
Industry	118	198	319	351	524	703	814	878	1676	3556
Transport	108	166	358	330	507	589	677	747	993	1797
Other	187	252	529	501	874	936	1226	1433	2384	4081
Non-Energy Use	77	99	122	85	83	202	244	196	155	230
Total Final Energy Demand PJ	489	715	1328	1267	1987	2429	2961	3253	5208	9664
Mtoe	12	17	32	30	47	58	71	78	124	231

Source: Iranian National Committee/WEC; Ministry of Energy

The rate of consumption of electricity was estimated to roughly double from 7.1% in 1993 to 13.0% in 2010. The total energy consumption was forecast to almost triple (9,664PJ) in 2010 compared to the result in 1993 (3,253PJ).

1.1.5 Energy-related Organizations

(1) Governmental Form of Iran

The Iranian political form is the Islamic Republic, which governmental organization is as shown below (as of June 1997).

President (Hashemi RAFSANJANI)

Office of the President
Head
Atomic Energy Organization
Administrative and Recruitment
Environment Protection
Administration Organization
Judicial Administration and the National Assembly Organization
Physical Education Organization
Plan and Budget Organization

Ministries	
Ministry of Foreign Affairs	Ministry of Labour
	Ministry of Post and Telecommunications
Ministry of Economy and Finance	Ministry of Culture and Higher Education
Ministry of Agriculture	Ministry of Education
Ministry of Industry	Ministry of Culture and Islamic Guidance
Ministry of Commerce	Ministry of Justice
Ministry of Road and Transportation	Ministry of Housing and Urban City Development
Ministry of Energy	
Ministry of Defense	Ministry of Mines and Metals
Ministry of Construction Crusade	Ministry of Information
Ministry of Interior	Ministry of Cooperative
Ministry of Health, Treatment and Medical Training	Ministry of Oil

(2) Energy-related organizations

The governmental organizations relating to the energy sector are given below:

a. Plan and Budget Organization (PBO)

It belongs to the Office of the President.

It draws up an overall energy demand and supply plan, and makes arrangements in its implementation.

b. Ministry of Energy

The Ministry of Energy is in charge of planning and implementing the development of electric power sources.

c. Ministry of Oil

The Ministry of Oil is responsible for planning and implementation of the production and supply of oil and natural gas.

d. Ministry of Mines and Metals

The Ministry of Mines and Metals is responsible for the development of mines, including coal mines.

e. Ministry of Industry

The Ministry of Industry is in charge of operation of each factory, its energy management, higher efficiency, etc.

f. Others

The energy-related organizations include many other organizations such as the Organization of Environment Protection from the viewpoint of environmental conservation, etc.

1.2 Second Five-year Plan

The following measures were recommended to be taken in the first five-year plan to promote the energy conservation policy:

(1) to draw up and adopt the measure for realizing the optimum use of energy
(2) to save energy consumption for each type of equipment
(3) to modify the energy price policy

a. setting the reasonable price relating to economical resources
b. making prices of electricity, gas and oil products equal to the ceiling cost level
c. setting special prices for low-income people and the agricultural sector
d. raising the prices for excessive consumption

To start the second plan in the fiscal year 1995/96, the law concerning "Second Five-year Economic, Social & Cultural Development Plan of the Islamic Republic of Iran" was ratified by the Supreme Council on 11 December 1994 after being approved by the national assembly, and made public through the official gazette dated 29 December.
The second five-year plan is now in the stage where it is embodied by the organic law called "law of second plan," stipulating basic policies and regulations on energy. In particular, the Articles 16 and 19 for energy saving have utmost importance.

Energy-related subjects stipulated in this second Plan are summarized in the following.

1.2.1 Principal Measures on Energy

The basic measures of the governmental ministries/ organizations to be taken are indicated under relevant Articles in the second Plan. The stipulated basic economy and industry-related measures are as follows:

(1) to increase the prices of gasoline and other oil products at the start of the new fiscal year (1995) on 21 March to double the current ones, for the purpose of saving consumption. The oil consumption growth is targeted at 3% or less a year during the Plan period.

(2) to increase the price of electricity by 20%, and industrial-use water by 25% in the new fiscal year (1995).

(3) to take appropriate actions for energy conservation as well as prevention of environmental pollution.

(4) to protect domestic products in order to improve the self-sufficiency rate. For the enhancement of infrastructure for promotion of export;

1) to abolish all favorable treatments and tax exemptions which have been granted to

ministries/agents, governmental organizations, national enterprises, etc.

2) to have customs duties determined by the national assembly, and commercial benefit tax by the government.

3) to limit the special protection only to cases in which Iranian domestic firms re-invest a part of their profit to newly install or to modernize facilities, or to improve or transfer technologies.

(5) to require technology transfer and staff training of the project counterpart, when concluding a contract with a foreign firm on projects relating to Oil, Road and Transportation, Mines and Metals, Industry and other Ministries. To make maximum use of service capacity of Iranian domestic firms in designing, engineering, installation of manufacturing equipment, etc.

(6) to place priority on the investment for the purpose of infrastructure improvement in rural areas. Increase the investment amount by 20% on yearly average for road, electricity and environment protection, and by 15% in promotion of water supply.

(7) to take measures to prevent environmental pollution caused either in normal life or industrial operations.

(8) to take necessary measures to remove environmental pollution caused by waste water from factories.

(9) to expand research and survey institutions.

1.2.2 Energy Conservation Measures

Following is the summary of the Articles 16 and 19 stipulating energy conservation related measures of the second Five-year Plan. As stated before, this is the basic organic law, while enforcement laws to be called Standard, Regulation, and Criteria will be enacted successively. For the establishment of such enforcement laws, the study conducted this time will be expected to be taken into consideration, together with the experiences of Japan and other countries.

(1) Increasing energy prices

The content of article 16 (clauses b and c) is as mentioned below.
In order to save the consumption of oil products and to secure social justice, the prices of oil products will be increased during the second Plan period. Its effects will be compensated in an expedient manner. (b)

The water, power and gas rates will be raised so that the rates for low-consumption subscribers will remain unchanged, while the average price is increased. (c)

In this respect, the flow of energy price decision is: proposal by PBO, coordination and decision by the President or the government approval by the assembly.

a. Oil

1) The selling prices of each litre of 4 principal oil products, i.e. gasoline, kerosene, gas oil and fuel oil are determined to be one hundred (100), twenty (20), twenty (20) and ten (10) rials, respectively.

   In order to implement the energy conservation policy, the government is authorized as of the year 1375 (March 21, 1996 to March 20, 1997) to increase prices of oil products in such a proportionate manner that the total duties collected up to the end of the Plan period will amount to eleven thousand billion (11,000,000,000,000) Rials at maximum. The government has also the authority to foresee its compensation method in the annual budget bills. (article 19.a)

2) In the course of the 2nd Five-year Plan period the government shall regulate its policies so that the growth rate of product consumption for each year will not exceed three (3) percent. (article 19a.)

The increase rate for the oil product prices at the beginning of the second five-year plan is 100% over the preceding year as mentioned above 1). In addition, to proceed with the energy conservation policy, the government has determined a 20% increase over the prices in the year 1996 starting in March 1996. This rate 20% was determined by the Ministry of Oil, since it would constitute the fund to be required in the future, and also it would be the highest possible limit. Concerning the rate of future price increase, a demand increase should curb the increase rate since the maximum limit of the income arising from price increase has been fixed as mentioned above 1).

b. Natural gas

The average sale price of each cubic metre of natural gas will be increased yearly based on the year 1373 (1994) up to twenty percent (20%) over the preceding year (article 19 b.)

The price of natural gas is drastically lower than that of oil or electricity. (Table 1.6)

Table 1.6 Energy Average Price of Public Utility

	Elec. [Rs/kWh]	N. Gas [Rs/m^3]	Gas oil [Rs/L]	Kerosene [Rs/L]	Lpg [Rs/kg]	Fuel Oil [Rs/L]	Jet fuel [Rs/L]	Gasoline [Rs/L]
1974	2.34	1.12	2.40	2.50	8.37	1.20	0.78	8.92
1975	2.34	1.14	2.40	2.50	9.53	1.20	0.78	8.92
1976	2.34	1.17	2.40	2.50	10.85	1.20	0.78	8.92
1977	2.34	1.29	2.40	2.50	12.35	1.20	0.78	9.26
1978	2.34	1.30	2.40	2.50	14.06	1.20	0.78	9.63
1979	2.34	1.38	2.40	2.50	16.00	1.20	2.15	10.00
1980	2.82	1.49	2.40	2.50	18.21	1.20	16.29	30.00
1981	3.16	3.41	2.60	2.50	20.73	1.20	19.69	30.00
1982	3.86	3.68	3.01	2.50	23.60	1.20	22.94	30.00
1983	3.54	3.80	3.01	2.50	23.60	1.20	27.51	30.00
1984	3.53	3.56	3.01	2.50	23.60	1.20	28.71	30.00
1985	3.59	3.54	3.01	2.50	23.60	1.20	28.41	30.00
1986	3.85	3.48	3.01	2.50	23.60	1.20	25.04	30.00
1987	5.17	3.56	4.63	4.00	23.60	2.00	24.38	37.80
1988	5.51	3.56	4.72	4.00	23.60	2.00	24.38	40.80
1989	5.27	3.20	4.72	4.00	23.60	2.00	24.38	42.72
1990	5.25	3.67	10.00	15.00	23.60	5.00	12.40	50.00
1991	8.49	5.43	10.00	15.00	23.60	5.00	11.00	50.00
1992	16.5	5.71	10.00	15.00	48.00	5.00	33.00	50.00
1993	16.5	7.69	10.00	15.00	48.00	5.00	12.20	50.00

Source: Plan and Budget Organization (PBO)

Although the demand for natural gas has been remarkably increasing for these five years, its price remains still low. The demand for natural gas comes to its peak in the winter season (due to heating). Hence, in order to increase the demand in the summer season, the wide use of air conditioners powered by natural gas has been proposed.

c. Electric power

1) The average sale price of electric power per kilowatt/hour will be increased during the period from the year 1374 (March 21, 1995) to the year 1378 (March 21, 1999) on average up to twenty percent (20%) over the preceding year. (article 19 c.1.)

2) The sale price of each kilowatt/hour of electricity consumed in the agricultural works (farming, gardening, animal husbandry, fishery and natural resources) will be equivalent to those for the year 1372 (1993). (article 19 c.1)

The residential electric consumption is 40 to 50 kWh/month, the price of which is 6 Rials/kWh. Power consumption comes to its peak during the time from seven P.M. to nine

P.M in the summer season.

The Ministry of Energy (MOE) is requested by the government to draw up a plan for "seasonal tariff" of electric power.

(2) Standardization of systems and equipment, and regulation of imported equipment

a. The technical specifications and criteria for energy-consuming systems and equipment will be designated, which all the manufacturers and importers of such systems and equipment will be required to observe.

A committee consisting of the representatives of the Ministry of Energy, Ministry of Oil, Standard and Industrial Research Organization and the relevant industrial ministries or organizations will be responsible to prepare such technical specifications and to submit the regulations for the implementation to the government (article 19.f.1)

b. The rates of duties or commercial profit will be designated for the manufacturers and the importers of equipment who might fail to observe the technical specifications and criterions regarding such equipment announced by the government. (article f.2)

(3) Leveling of electric power

a) The opening hours of shops will be regulated by the Ministry of Commerce in order to reduce their power consumption at the peak time and to establish social discipline.

b) The seasonal program of factory and industry works will be regulated by the relevant ministries in order to reduce the electricity and energy consumption during the months subject to the highest consumption. (article f.4)

(4) Financial support

a. 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. 0.2 percent of income which accrues from the sale of energy carriers during the Plan period will be allocated to researches by the relevant ministries necessary for saving and management on energy consumption. (article 19.f.5)

(5) Standardization of buildings and housings

Regulations and criteria relating to the observance of energy consumption standards for buildings will be prepared to avoid the waste of energy. Furthermore, the encouragement methods in this respect will be drawn up and implemented by a committee comprised of the representatives of the Ministry of Housing and Urban City Development, the Ministry of Interior, the Ministry of Oil and the Ministry of Energy. (article 19.f.7)

(6) Education and research

a. A part of the content of school and university tuition books will be allocated to the importance of water, types of energy and the necessity of energy management. General public will be educated in this respect through radio, television and press for the purpose of bringing up the energy conservation spirit and thus avoiding the waste and ravishment of natural sources. (article 19.f.8)

b. Relevant authorities will prepare criterions relating to the establishment of energy management units (sections) in factories whose consumption potential is above 5 megawatt electricity or whose annual energy consumption would be above 5,000 cubic meters of oil; and the Oil and Energy Ministries will train experts relating to energy. (article 19.f.9.)

(7) Others

a. The Ministries of Energy, Post and Telecommunications and Oil shall prepare from the beginning of the year 1374 (1995) the electricity, water, telephone and gas bills for their subscribers so that they will be able to easily calculate the payable amount of the bills for their consumption. (article 19 g.)

b. By the end of the second Plan period the government shall supply electricity to the villages in warm climate provinces and gas to the cold climate towns and villages respectively within the distance of 5 km from the transmission line. (article 19 i)

1.3 Taxation and Financing Systems Relating to Investment in Energy Conservation

Some points of the systems created for supporting Iranian factories in their investment in energy conservation are summarized below, in sections Corporate Income Tax, Depreciations, Customs Duty and Finance.

1.3.1 Corporate Income Tax

The direct tax law of Iran was enacted on 21 March 1989, and revised in May 1992. Aiming at promoting investment primarily in mining and manufacturing industries, deductions from income and tax exemptions are stipulated in this law. For Iranian domestic firms, tax is imposed on the 90% of the taxable income in accordance with the Article 131, after deducting 10% (See Table 1.7). Foreign firms are not subject to this 10% deduction. Tax is imposed on the taxable income according to this Article.

Table 1.7 Taxation Table for Income Tax (Based on Article 131, Taxation Law)

Amount of (Annual) taxable incomes		Taxation rates		Accumulation
Up to	Rls.1,000,000.	12%		Rls.120,000.
Up to	Rls.2,500,000.	18% on sums in excess of	Rls.1,000,000.	Rls.390,000.
Up to	Rls.4,000,000.	25% on sums in excess of	Rls.2,500,000.	Rls.765,000.
Up to	Rls.9,000,000.	35% on sums in excess of	Rls.4,000,000.	Rls.2,515,000.
Up to	Rls.25,000,000.	40% on sums in excess of	Rls.9,000,000.	Rls.8,915,000.
Up to	Rls.50,000,000.	45% on sums in excess of	Rls.25,000,000.	Rls.20,165,000.
Up to	Rls.100,000,000.	50% on sums in excess of	Rls.50,000,000.	Rls.45,165,000.
Up to	Rls.300,000,000.	52% on sums in excess of	Rls.100,000,000.	Rls.149,165,000.
Over	Rls.300,000,000.	54% on sums in excess of	Rls.300,000,000.	

The above-said rates are effective for the income tax of legal entities whose fiscal year from the beginning of 1370 (1991) fiscal year onwards to its end.
As with other cases, the rates will be effective since the beginning of 1371 (1992).

No tax support is given to energy conservation activities, since the very low tax level makes tax incentive measures virtually ineffective. On the other hand, subsidies are given to the government-authorized factories.

Among industrialized countries, US and Germany have investment promoting tax systems, exempting investment tax. These two countries are, however, attempting to reduce the systems. Japan has the system permitting a 7% tax credit or special cost depreciation (to be optionally selected) for a certain amount of facility investment for a limited period aiming at the control of energy demand and supply. There is no investment tax credit in UK or France (see Table 1.8).

Table 1.8 Outline of the Investment Tax Deduction System in Countries

Country	Japan	U.S.	Germany
Outline of the System	• A certain amount of tax deduction for a certain investment is permitted during a limited period for the purpose of energy demand and supply measures, enhancement of the basic structure of small- and medium-enterprises, etc.	• 10% to 20% tax deductions are permitted for a certain amount of capital expenditure relating to the repairs of buildings for business use. • 10% tax deduction is permitted for a specific energy conservation investment.	• The government may, through the ordinance, permit tax deduction up to 7.5% of the invested amount for the asset ordered or transferred within a certain period. This system, however, has never been put into effect so far.

1.3.2 Depreciation

The depreciation of assets in I. R. Iran shall be computed according to the rules laid down hereunder;

(1) that part of the fixed assets which, regardless of price fluctuation, is liable to decline in value resulting from wear and tear, lapse of time or other causes are subject to depreciation.

(2) The book values of machines and equipment shall be the purchase price. The cost for their repair shall be also included. When machines, equipment or assets have been sold, income tax based on article 131 shall be imposed.

(3) Depreciation shall be computed from the date when any depreciable asset is held at the disposal of the firm in a usable condition.

In this respect there is no special accelerated depreciation system available for procurement of energy conservation equipment. Table 1.9 shows depreciation and special cost depreciation systems for reference.

Table 1.9 **International Comparison of Depreciation and Special Cost Depreciation Systems (Major items)**

Item	Japan	U.S	U.K	Germany	France
Depreciation method	Straight-line and fixed rate methods	Legal deprecia-tion rate and straight-line method based on the accelerated depreciation system	Straight-line and fixed rate methods	Straight-line and fixed rate methods	Straight-line and fixed rate methods
Durable years	Based on a ministerial ordinance	Years specified under the accelerated depreciation system	Based on laws and ordinances	Ordinary durable years	Ordinary durable years
Special cost depreciation	Pollution-preventive	Pollution-preventive facilities	Assets for scientific researches, etc.	Energy conservation facilities	Pollution-preventive facilities

1.3.3 Customs Duty

(1) Duty System

In the pre-revolution duty system of Iran the commodity classification was standardized according to the Brussels system adopted in 1973, while at present it uses the CCCN method. The import taxes consist of customs duties and commercial benefit tax; the former to be decided by the national assembly, the latter by the government. The government policies, being exercised by manipulating the commercial benefit tax rates, are based on the protection of the Iranian domestic industries.

The tax rates are lower for industrial materials as well as capital goods. Almost all goods are taxed ad valorem, while some specific duties remain as arbitrated duties. Ad-valorem tax is imposed on the CIF price, whereas specific duty is arbitrationally imposed at 10 Rial per kg.

(2) Customs Duty on Imported Facilities and Equipment

The customs duty rates vary from 5% to 35% for imported facilities and equipment. There is no preferential measure for imported facilities. Failure to observe the equipment standards will be penalized.

The customs duty rates for energy conservation facilities and equipment are shown in the Table 1.10.

Table 1.10 Import Duties on Facilities and Equipment Relating to Energy Conservation

Name of Product	Tax Rate (%)
Auxiliary equipment for a boiler	
Economizer, Superheater, Steam accumulator, Smoke remover, Condenser for steam power plant and similar equipment and cooler for steam	
a. Auxiliary equipment for boiler and cooler for steam	5
1) Economizer	5
2) Superheater	5
3) Smoke remover	5
4) Other auxiliary equipment for boilers	5
5) Cooler for steam	
	2
b. Parts	
Gas generator and water gas & gas generator (irrespective of the use of a purifier)	
• Acetylene gas generator	
(Water process) and other similar water process	10
gas generator (irrespective of the use of a	10
purifier)	10
a) Oxygene generator	
b) Acetylene generator	
c) Others	
Vapour equipment or other steam equipment	13
(including separated equipment)	
a. Equipment	–
1) Steam turbine	–
2) Others	
b. Parts	

(Source: Import Duties Table in I. R. Iran)

Name of Product	Tax Rate (%)
Burners for furnace (only for liquid fuel, pulverized coal or gas fuel) and mechanical stokers (including mechanical grate, mechanical ash discharger and other similar machines)	12
a) Burners	25
1) Burners for gas fuel	25
2) Burners for gas oil	25
3) Burner for fuel oil [MAZUI]	25
4) Others	5
b) Parts for burner	25
c) Others	
Furnaces (only for industrial or physical and chemical use; including incinerators but excluding electric furnaces)	25
Generator, motor, rotary converter and balance converter, wire-wound variable resistor (transformer) and selfs	
a. DC motor and generator	5
b. Other motors including general motors:	
1) Single phase (single rotation) AC motors	20
2) Single phase (double rotation) AC motors	
No.1) those with 1/8 HP	20
No.2) those with more than 1/8 and 1 or less HP	20
No.3) Others	20
3) Three-phase AC motors	
No.1) those with 15 or less HP	20
No.2) those with 15 or more HP	20
4) Other AC motors	15
5) Others	15
c. AC generators	
1) those with 150 kW or less	15
2) those with output of more than 150 kW, and 400 or less kW	5
3) those with output of 400 or more kW output	–

Name of Product	Tax Rate (%)
d. Piston type compression ignition internal combustion engine motors	13
1) Diesel engine motors	
No.1) those with output of 180 or less kW	15
No.2) those with output of more than 180 kW, and 400 or less kW	15
No.3) those with output of more than 400 kW	-
2) Others	15
e. Rotary converter	5
f. Parts for the equipment under clauses a, b, c, d, and e	
1) Parts for the equipment under clause b	5
2) Parts for the equipment under clauses a, c, d, and e.	5
g. Liquid dielectric transformer	12
1) Transformers with 24 or less kV	15
2) Transformers with 24 or more kV	15
h. Other transformers	12
1) Measurement of current	
No.1) Voltage of 1 or less kV	15
No.2) Voltage of 1 or more kV	15
2) Measurement of voltage	15
3) Adjustment of voltage for household use	
No.1) Output of 2 or less kW	15
No.2) Output of 2 or more kW	15
4) Others	15
i Balance converter, rectifiers	15
j Wire-wound variable resistor and selfs	20
k Parts for the equipment under clauses g, h, i, and j	5
Equipment for physical or chemical analysis (i.e. Polarimeter, refractometer, spectrometer and gas or smoke analyzer) • equipment for measurement or inspection of viscosity, porosity, dilation, surface tension and other similar properties (i.e. viscosity meter, porosemeter and dilatometer)	

Name of Product	Tax Rate (%)
• equipment for measurement or inspection of the volume and property of heat, light or sound (including calorimeter and exposure meter) and microtome	
Gas meter for use and manufacture, liquid meter, watt-meter or measuring equipment for inspection and adjustment (for calibration)	
a. Watt-meter	15
b. Others	
1) Water meter	15
2) Gas meter	15
3) Others	1

(3) Import Procedures and Rules

a. The foreign exchange law enacted in 1930 stipulates that the only possessor of foreign currencies is the state. In reality, however, the state transfers the import and export rights to the private sector, as a result of which import and export are carried out by both governmental organizations and private firms.

b. The authorities concerned will allocate foreign currencies as well as verify the quality of imported products.

c. In principle, the import of foreign goods which can be produced domestically is not permitted. The foreign currency situation makes import limited to military necessity goods, food, medicines and the like which are urgently needed.

d. In importing goods, the importing firm has to get the import license after submitting the pro-forma invoice to the ministry/organization concerned, and then go through the foreign currency allocation procedures with the ministry/ organization or the government organization concerned.

e. The foreign exchange control is the authority given to the central bank, "Bank Markazi." Except for those permitted to operate in the free foreign exchange market, all foreign exchange transactions should be carried out through the main Bank Markazi, or its authorized banks.

f. Unifying the foreign exchange rates in 1993, the central bank abolished the competitive rate (about 600 Rials/US Dollar) applied to machinery and industrial materials.

g. Protection of Rial

The central bank held the foreign exchange market control committee meeting in 1994, and announced its protective measures of the Rial, as outlined in the following:

(1) The foreign currencies approved by the central bank for import will be allocated by the end of the fiscal year on 20 March.
(2) For priority import goods, foreign currencies will be allocated by the end of the fiscal year.
(3) The central bank will permit commercial banks to open letters of credit (L/C's) during the new fiscal year starting on 21 March for the goods to be registered through the commercial banks.
(4) The goods to be permitted for import will be limited to those which have received registration of the Ministry of Commerce.
(5) The central bank will intervene in the foreign exchange market as it deems necessary.
(6) Price increases of national enterprises' products will be prohibited, unless government approval is given.
(7) National enterprises are prohibited to procure foreign currencies in the free market.

1.3.4 Finance

The new bank law was enforced on 21 March 1984, to prohibit interest based on the Islamic doctrine. What this law stipulates are:

1 Instead of providing interest for financing and loans from the bank, the bank and the firm will be made partners, between whom the profit will be shared.
2 There will be three types of bank deposits: current deposit, ordinary deposit and investment time deposit (short and long terms), from which rewards will be paid to depositors or profit dividend to investors, instead of interest
3 Financing and housing loans for the poor will be interest free.

The money supply for the five years from 1989 to 1993 is shown in Table 1.11, for reference.

Table 1.11 Money Supply (1989 to 1993)

(in a billion Rials)	1989	1990	1991	1992	1993
M_1 (Cash at bank demand deposit)	8,087	9,546	11,713	13,522	17,444
M_2 (Fixed deposit)	9,045	10,663	13,342	17,770	23,181
Private sector liquidity	17,132	20,209	25,055	31,292	40,629

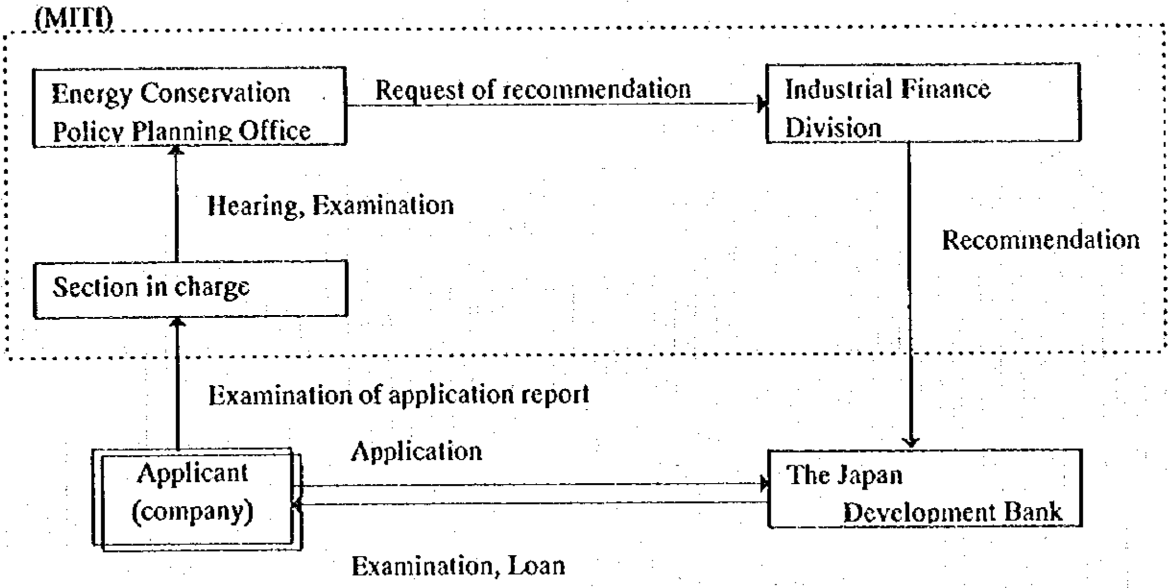
Source: IMF; International Financial Statistics

The methods of financial support to promote energy conservation investment include low interest loan system, subsidy system, tax reduction system and customs duties reduction for imported equipment. JICA team shall study the suitable methods in I. R. Iran in this project.

Examples of financial support for energy conservation investment affiliated with the Ministry of International Trade and Industry (MITI) in Japan are shown as follows:

(REFERENCE)

1. Low interest loan system for energy conservation equipment by the Japan Development Bank which is a governmental bank

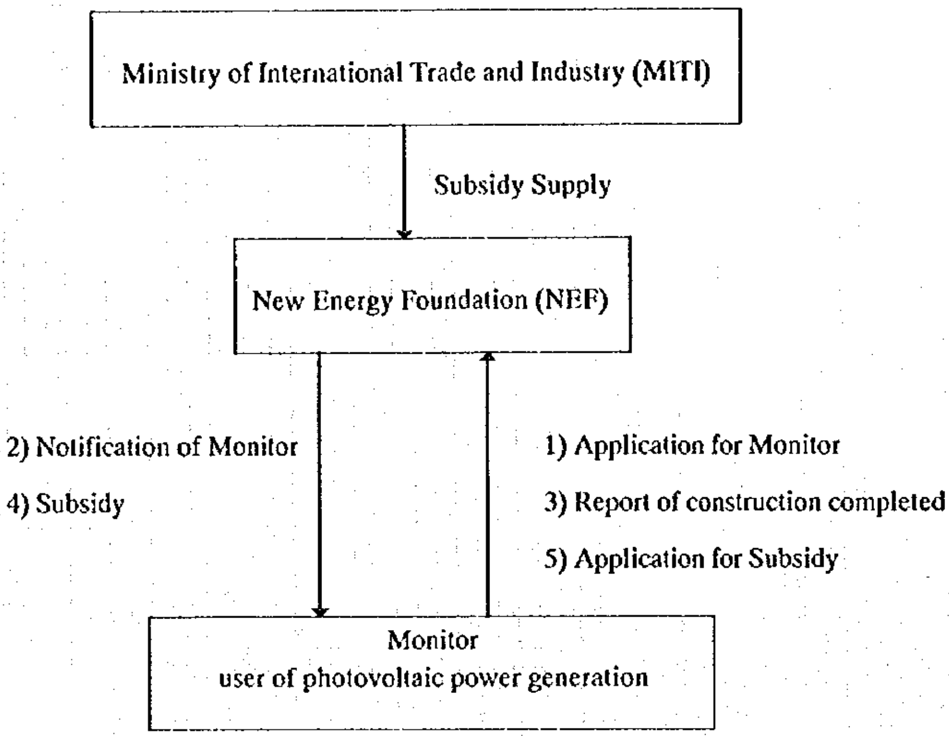


(1) Objective equipment
Energy efficiency equipment specified by law and regulation

(2) Financing ratio
Within 40%

(3) Interest rate
3.15% (as of 28 November, 1995)
Interest partially subsided by Oil Special Account

2. Subsidy system for monitor program of photovoltaic power generating system for household by New Energy Foundation



(1) Objective

Photovoltaic power generation system for household (solar battery module, construction cost and so on)

(2) Amount of subsidy (as of 1995 fiscal year)

A × B

A: lower one of the following amount:

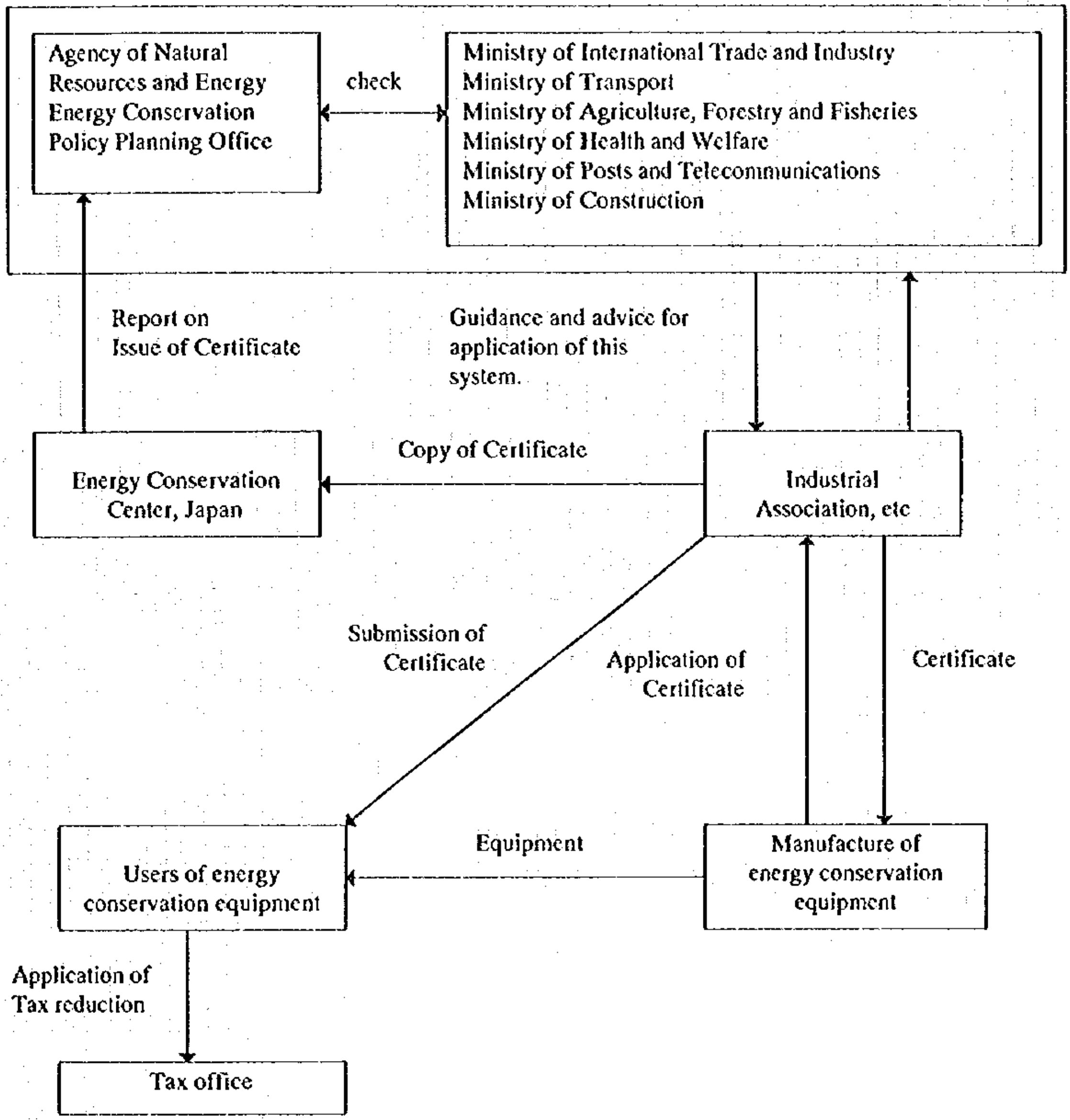
1) 850 thousand yen plus consumption tax

2) 1/2 of the system cost per 1kW

B: maximum output of solar battery module (kW)

(5kW is the upper limit)

3. Tax reduction system for Promotion of Investment in Reformation of Energy Supply and Demand Structure (1 April 1992 to 31 March 1995)



(1) Objective

Energy efficient equipment specified by law

(2) 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 the income tax or corporate tax payable)

2) Special depreciation of 30% of the equipment acquisition cost in the year of acquisition, in addition to ordinary depreciation

2. ECONOMIC ASSESSMENT OF ENERGY CONSERVATION POTENTIAL

2. ECONOMIC ASSESSMENT OF ENERGY CONSERVATION POTENTIAL

2.1 Method of Estimating Energy Conservation Potential in the Selected Industry

2.1.1 Estimation of Energy Consumption in the Selected Industry

Obtaining accurate actual data on present energy consumption in a selected industry is often difficult, and it requires verification, if available. Therefore, it is necessary to estimate present energy consumption ($E_{a(S\,Ind)}$) in a selected industry using the following formula:

$$E_{a(S.Ind)} = P_{(S.Ind)} * I_{(R\,Fac)} * f_P * f_S * f_M \quad \text{(kcal/y)} \qquad \text{------} \quad (1\text{-}1)$$

where

$P_{(S\,Ind)}$: Total production of the concerned products in the selected industry (t/y)

$$= \sum_{i=1}^{n} P_i$$

$I_{(R\,Fac)}$: Energy intensity of the concerned products at the surveyed factory (kcal/t)

f_P, f_S, f_M are correction coefficients for each factor at other factories compared to the surveyed factory. i.e. ;

f_P : Process coefficient (It is estimated by the type and the scale of the facilities).

$$= (f_{P1} * P_1 + f_{P2} * P_2 \cdots + f_{Pn} * P_n)/P_{(S\,Ind)} \qquad \text{------} \quad (1\text{-}2)$$

f_S : Service year coefficient (Estimated by the construction/operation start up year).

$$= (f_{s1} * P_1 + f_{s2} * P_2 \cdots + f_{sn} * P_n)/P_{(S\,Ind)} \qquad \text{------} \quad (1\text{-}3)$$

f_M : Management coefficient (Estimated by operation rate, yield of the products, and energy management activity).

$$= (f_{M1} * P_1 + f_{M2} * P_2 \cdots + f_{Mn} * P_n)/P_{(S\,Ind)} \qquad \text{------} \quad (1\text{-}4)$$

Provided that in the industry there are many factories whose individual situations are difficult to ascertain, the correction coefficient for the factor shall be treated as 1.
Target value of energy consumption in the industry ($E_{t(S\,Ind)}$) is shown as the following formula :

$$E_{t(S\,Ind)} = P_{(S\,Ind)} * I_t \quad \text{(kcal/y)} \qquad \text{------} \quad (1\text{-}5)$$

Where

I_t : Energy intensity (target) ···· Actual results in Japan/advanced country

Also, there is no choice but to depend on statistical data or industry surveys obtained using questionnaires to get actual data on energy consumption in the industry for a certain kind of energy.

2.1.2 Estimation of Energy Conservation Potential in the Selected Industry

Energy conservation potential ($\Delta E_{(S\ Ind)}$) in the industry is obtained from the difference between the present actual value of energy consumption and the target value of energy conservation.
That is :

$$\Delta E_{(S\ Ind)} = E_{a(S\ Ind)} - E_{t(S\ Ind)} \quad \text{(kcal/y)} \quad \text{----------} \quad (2\text{-}1)$$

Energy conservation potential in an industry, meanwhile, is obtained by totaling each energy conservation potential.
That is :

$$\Delta E_{(S\ Ind)} = \sum_{j=1}^{n} A_{j(S\ Ind)} \quad \text{-----------} \quad (2\text{-}2)$$

Where
$A_{j(S\ Ind)}$: Technical potential of energy conservation measure "j" in the selected industry

Technical potential of energy conservation measure in the selected industry is estimated using technical potential of energy conservation measure at the surveyed factories,
That is :

$$A_{j(S\ Ind)} = A_{j(R\ Fac)} * P_{(S\ Ind)}/P_{(R\ Fac)} * f_P * f_S * f_M \quad \text{-----------} \quad (2\text{-}3)$$

Where
$A_{j(R\ Fac)}$: Technical potential of energy conservation measure "j" at the surveyed factories (kcal/y)
$P_{(R\ Fac)}$: Production of the products at the surveyed factories (t/y)

Provided that f_P, f_S, or f_M shall be considered for each potential.

2.1.3 Estimation of Cost for Energy Conservation Measure in the Selected Industry

Cost of energy conservation measure in the selected industries ($C_{(S\ Ind)}$) is obtained by totaling the costs of measures of each technical potential.
That is :

$$C_{(S\ Ind)} = \sum_{j=1}^{n} C_{j(S.\ Ind)} \quad \text{(Rial)} \quad \text{-----------} \quad (3\text{-}1)$$

Where
$C_{j(S\ Ind)}$: Cost of energy conservation measure for technical potential "j" in the selected industry

Cost of energy conservation measure for technical potential "j" in the selected industries is able to be estimated using cost of energy conservation measure for technical potential "j" in the surveyed factory, that is;

$C_{j(S\ Ind)} = C_{j(R\ Fac)} * f_{sc} * f_{Lo} * f_{C1}$ (Rial) ------------ (3-2)

Where

$C_{j(R\ Fac)}$: Cost of energy conservation measure for technical potential "j" at the surveyed factory

f_{sc} : Scale-up coefficient

f_{Lo} : Location coefficient

f_{C1} : Escalation coefficient

When the cost of energy conservation measure for technical potential "j" at the surveyed factory is estimated with the present value in I. R. Iran, it is possible to estimate it as $f_{Lo} = 1$, $f_{C1} = 1$.
When the cost is supplied by a past Japanese base, it is necessary to estimate it using location coefficient and escalation coefficient as follows :

(1) Location coefficient (f_{Lo})

Location coefficient (f_{Lo}) is shown by the following formula:

$f_{Lo} = C_I/C_J$

Where

C_I : Cost of energy conservation measure (I. R. Iran base)

$= C_I.e + C_I.c + C_I.g$ (Rial)

$= (C_{Je} * f_e + C_{Jc} * f_c + C_{Jg} * f_g) * r$

in case of domestic procurement for equipment

$= C_{Ie} + (C_{Jc} * f_c + C_{Jg} * f_g) * r$

C_{Ie} : Cost of equipment and machinery portion

C_{Ic} : Cost of construction expense portion

C_{Ig} : Cost of engineering and management expense portion

C_J : Cost of energy conservation measure (the results in Japan)

$= C_{Je} + C_{Jc} + C_{Jg}$ (Yen)

$= C_J(a + b + c)$

C_{Je} : Cost of equipment and machinery portion

C_{Jc} : Cost of construction expense portion

C_{Jg} : Cost of engineering and management expense portion

f_e : Custom duty and domestic transportation expense coefficient

f_c : Labor expense coefficient

f_g : Design and management expense coefficient

r : Yen - Rial exchange coefficient

a,b,c : Cost composition rate in the construction cost
equipment and machinery portion (a)
materials and construction expenses portion (b)

engineering and management expense portion (c)

(Example 1) cement industry, a= 0.329, b= 0.498, c=0.173
(Example 2) chemical industry, a= 0.371, b= 0.422, c=0.207

Source :The Japanese Machinery Federation, The Japan Society of Industrial Machinery Manufactures

a. Cost of equipment and machinery, and materials that can be procured in I. R. Iran (C_{Ie})

Equipment and machinery, and materials shown in the separate list can be procured in I. R. Iran. In this case, C_{Ie} shall be estimated as 75-80% of the procurement base in Japan.

b. Cost coefficient, when importing procurement articles in Japan into Iran (f_e)

1) Freight (IRISL)

Yokohama/Kobe → Bandar Abbas/Bandar Imam Khomeini

20 ft Container (30 M^3)	2,000 US$
40 ft Container (60 M^3)	3,400 US$

2) Insurance (BIMEH IRAN)

Ship : BASE 0.7% + WAR SRCC 0.05% = TOTAL 0.75%
Airplane : BASE 0.7% + WAR SRCC 0.275% = TOTAL 0.975%

3) Duty and custom clearance fee (excl. warehouse, loading and unloading charge)

CIF Value(US$) ＊281(Rial/US$)

4) Inland transportation cost

Bandar Abbas/Bandar Imam Khomeini
→ Central Iran 24 t Trailer 400 US$

For the following example, the coefficient (f_e) is estimated to be 1.15.

Example : When equipment of US$ 50,000 is procured in Japan and is transported by 20 ft container,

Freight		2,000 US$
Insurance	50,000＊0.75%	375
Duty and custom clearance fee		
	(50,000+375+2,000)＊281/3,000	4,905
Inland transportation cost		400
Total		7,680

f_e = (50,000 + 7,680)/50,000
≒ 1.15

c. Labor cost coefficient (f_c)

Based on Table 2.1.1, labor cost coefficient is estimated to be 0.2 .

Table 2.1.1 Comparison of Labor Cost for Estimation of Labor Cost Coefficient

	Iran US$/Hr	Japan (Tokyo) ¥/8Hr	I/(J*1.5)
Foreman	8.8	22,500	0.208
Rebar Worker	4.5	20,600	0.117
Welder	9.2	21,500	0.228
Pipe Fitter	6.7	21,400	0.166
X-ray Technic	9.8		
Electrician	5.3	19,700	0.144
Insulator	5	19,000	0.140
Instrument Te	9.8		
Common Labor	2.9	15,500	0.100

(1 US$ = 100¥)

Source : Bulletin of Construction Cost in Japan (1996, Spring)

(Note)

Labor unit price of Iran is "All-In-Rate" base, which includes labor supplier's expense (exceptional labor salary, labor supplier's office expenses)

Labor unit price of Japan is not included in the labor supplier's expenses

Therefore, adjustment is made as follows :

"All-In-Rate" base

= Net-Rate base for 8 hours of work. * 1.5

d. Engineering and management expense coefficient (f_g)

In general, average Man-Hour Rate of engineering firms in I. R. Iran is 10-19 US$/Hr.

Based on the rate, engineering and management expense coefficient of f_g shall be estimated as 0.3.

(2) Escalation coefficient (f_{CI})

Escalation coefficient shall be able to be referred the investigation report of plant cost index in 1994.

(ref. Table 2.1.2)

Table 2.1.2 Plant Cost Index in Japan

(1985 = 100)

	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Chemical Plant	66.6	70.6	75.7	79.9	84.5	90.8	93.9	95.6	96.9	99.0	100.0	100.2	101.7	106.1	111.3	115.6	126.2	128.3	129.1	129.6	131.4
Petroleum Refinery	66.9	70.6	75.7	80.0	84.7	91.0	94.0	95.7	97.1	99.2	100.0	100.3	102.0	106.4	111.6	115.6	126.4	128.8	129.7	130.3	132.1
Cement Plant	65.0	68.5	73.4	78.1	83.8	90.1	92.8	97.6	96.4	98.3	100.0	100.3	101.8	106.2	110.7	115.5	126.6	128.2	129.3	130.1	132.0
Desalination Plant	71.6	77.4	80.2	80.8	88.3	96.0	96.5	97.7	98.0	99.0	100.0	96.9	98.3	104.8	110.5	111.9	116.7	116.7	114.7	116.0	119.7
Civil Work	58.3	60.4	66.6	75.7	85.1	95.8	96.5	97.8	99.2	100.7	100.0	99.8	103.3	110.0	114.5	115.2	132.6	138.6	139.2	138.8	140.9
Architectural Work	62.5	65.1	69.9	75.7	84.8	91.4	93.9	94.8	95.9	97.6	100.0	99.2	101.3	107.4	111.2	117.5	138.7	138.7	138.4	138.7	140.7
Structural Work	62.5	67.7	73.1	79.6	87.4	93.3	94.9	95.4	96.6	97.8	100.0	97.7	100.2	106.5	110.6	117.0	137.8	137.9	137.1	136.7	138.9

Source : The Japanese Machinery Federation, The Japan Society of Industrial Machinery Manufacturers

The above cost estimation method for the energy conservation countermeasure is suitable for calculating the individual measure cost accurately. However, in this study, the method could not be applied, due to constraints of various related data and information.
In this study, as the convenient method, each energy conservation countermeasure cost was estimated using location coefficient (f_{Lo}) of 17.5 based on the exchange rate prevailing in 1993 (1 US$ = ¥100 = 1,750Rial) and escalation coefficient (f_{CI}) of 1.
It is expected that the above estimation method will be applied actually, when the necessary data and information become available in the future.

2.1.4 Extraction of Energy Conservation Economical Potential in the Selected Industry

To extract the energy conservation economical potential in the selected industry from the energy conservation technical potential, the energy conservation technical potential in the selected industry is evaluated by the following standard :

$$\sum_{i=1}^{n} B_{j(S.Ind)}(1/(1+d))^i > C_{j(S\ Ind)} \quad \text{-------------------} \quad (4\text{-}1)$$

When the above formula is materialized, potential "j" is economical potential.
Where,

$\sum_{i=1}^{n} B_{j(S.Ind)}(1/(1+d))^i$	:	Net present value(NPV) of Energy conservation profit in a certain period "n"
d	:	Discount rate
$B_{j(S\ Ind)}$	:	Annual profit of energy conservation potential "j" (Rial/y) (in case of estimation as crude oil value) = $A_{j(S\ Ind)} * 1/9{,}250 * P_{mean}$
P_{mean}	:	Average price of crude oil in a certain period "n" (Rial/L)
9,250	:	Caloric value of crude oil(kcal/L)

At the above-mentioned computation, the following numerical value and computation method were decided through discussions with PBO Team.

1) It makes d = 10% , and n = 3 and n = 10.
(The study shall be made for two cases.)
That is

$$\sum_{i=1}^{n} (1/(1+d))^i = 2.48, \text{ and } 6.14$$

2) Annual profit of energy conservation potential "j"
Using the unit price of Table 2.1.3, it is estimated for every kind of energy.
(ref. Table 2.1.3)

Table 2.1.3 Mean Value of Energy Price for Estimation of Energy Conservation Benefit by Scenario

		Energy Conservation		Accelerated Energy Conservation	
		2000-2002	2000-2009	2000-2002	2000-2009
Electricity	(Rial/kWh)	40.7	54.5	100.0	100.0
Natural Gas	(Rial/Nm^3)	22.4	30.0	123.0	123.0
Fuel Oil	(Rial/L)	17.0	22.7	75.0	75.0
Gas Oil	(Rial/L)	25.4	34.1	474.0	474.0
Coal	(US$/t)	N.A.	N.A.	60.0	60.0

2.2 Iron and Steel Industry

2.2.1 Outline of Iron and Steel Industry

The iron and steel industry in I. R. Iran consists of five factories which are under the administration of the state-owned National Iranian Steel Co.(NISCO). It is possible to classify these as follows:

a. Integrated steel works which make pig iron with coke and sintered iron ore in the blast furnace, and make steel in the basic oxygen furnace, and then make steel products such as beams and bars in the rolling process. (Esfahan Steel Complex) (ref. Figure 2.2.1)

b. Integrated steel works which make reduced iron with sintered pellets made from iron ore and reformer gas (H_2 + CO) made from natural gas, by reducing in the direct reducing furnace at temperatures of 800 – 900℃, and make steel together with ferrous scraps in the electric arc furnace, and then make steel products such as rolled coils, beams, and bars in the rolling process. (Mobarakeh Steel Complex, Ahwaz Steel Complex) (ref. Figure 2.2.2)

c. Electric arc furnace works which have neither a blast furnace nor a direct reduction furnace, and make steel products by melting ferrous scraps the electric arc furnace. (Iran National Steel Industry Group (INSIG)) (ref. Figure 2.2.3)

d. Simple rolling works which receive supplies of semi-processed steel articles and produce steel products with the rolling mill. (Kavian Steel Co.)

In addition, there are some factories producing pipes and other steel products under the control of the Ministry of Industry. But they were excluded from the scope of this survey as it was not possible to fully grasp the production situation of the product.

(1) Trend of production

The trend of iron and steel production of each company since 1990 is shown in Table 2.2.1.

Iron and steel production since 1990 has been developing at an average annual rate of 20% or more. In 1995, It seems to have exceeded 5,000,000 t. Development of production of Mobarakeh Steel Complex and Ahwaz Steel Complex, which produce direct reduced iron, has mainly contributed to the figure.
On the other hand, production of Esfahan Steel Complex using the blast furnace method has been declining 5% or less every year since 1991. The reduction seems to be due to renewal work for the basic oxygen furnace and the rolling mill, etc.
As a result, the production share of the direct reduction method was 50.1% in 1994. This exceeded production share of the blast furnace method of 47.4%. This difference is expected to increase as the production capacity of the direct reduction method (4,319,000 t/y) greatly exceeds that of the blast furnace method. (2,100,000 t/y).

Figure 2.2.1 Production Process by Blast Furnace / Steel- Making Method

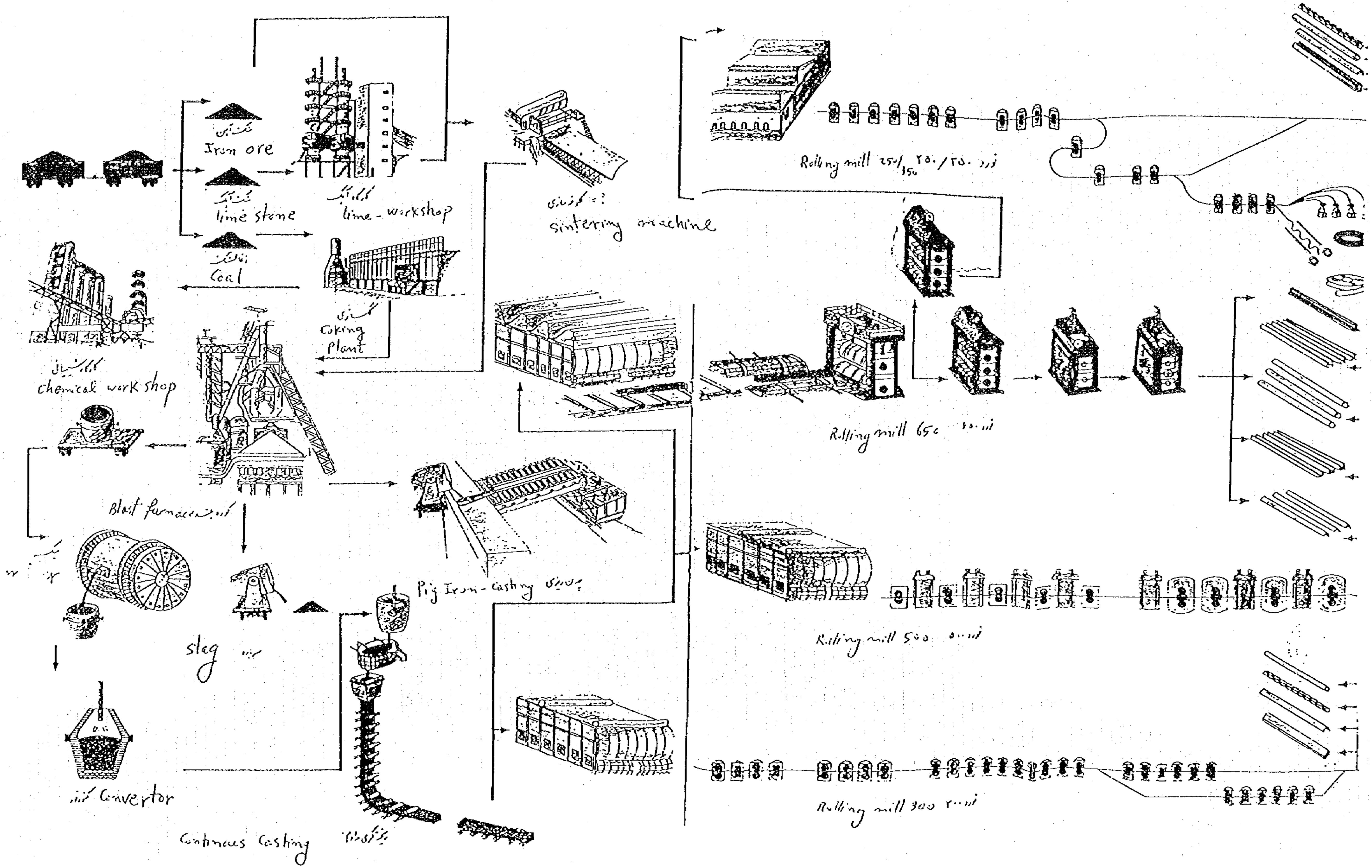


Figure 2.2.2 Production Process by Direct Reduction / Steel-Making Method

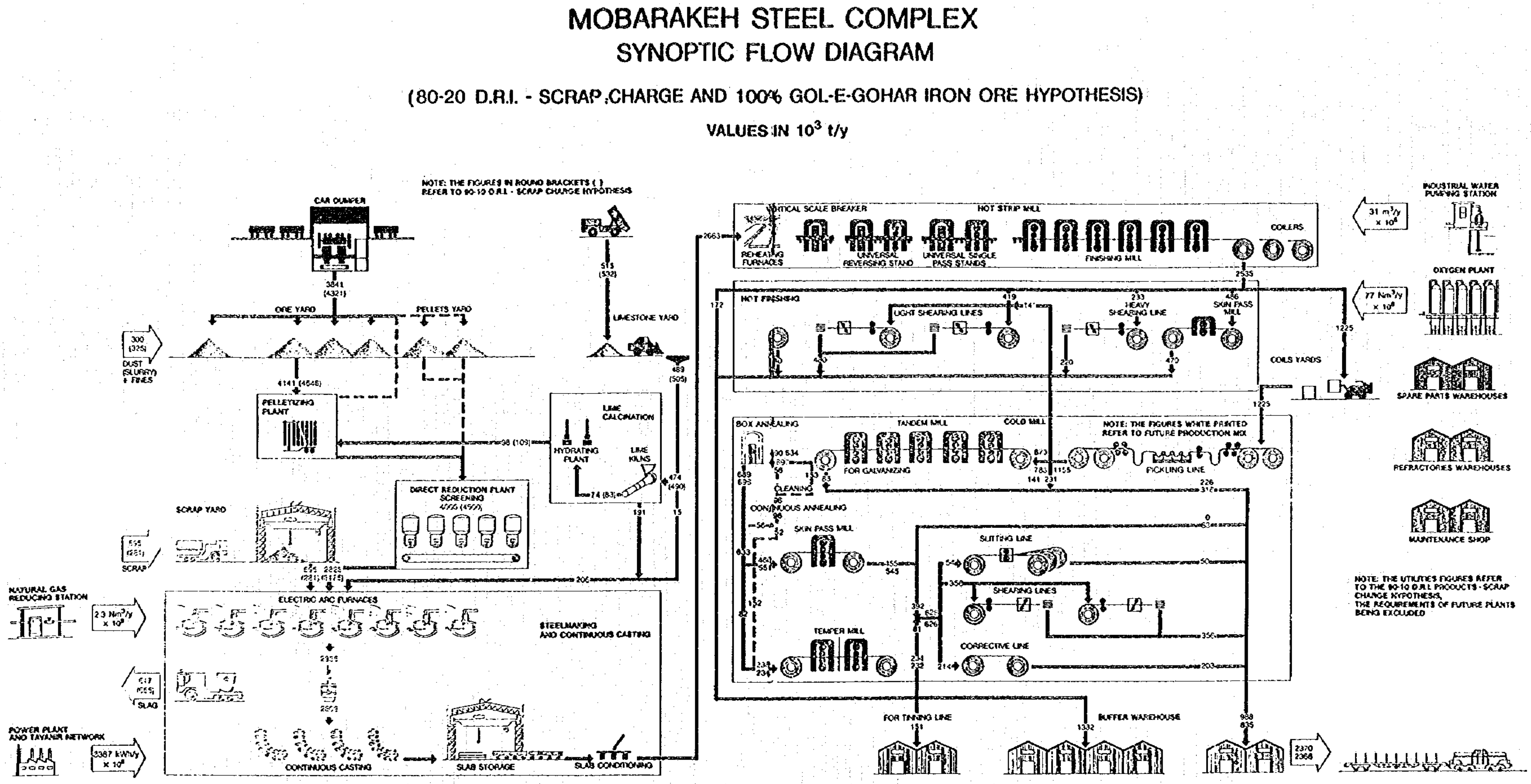


Figure 2.2.3 Production Process by Arc Furnace Steel- Making Method

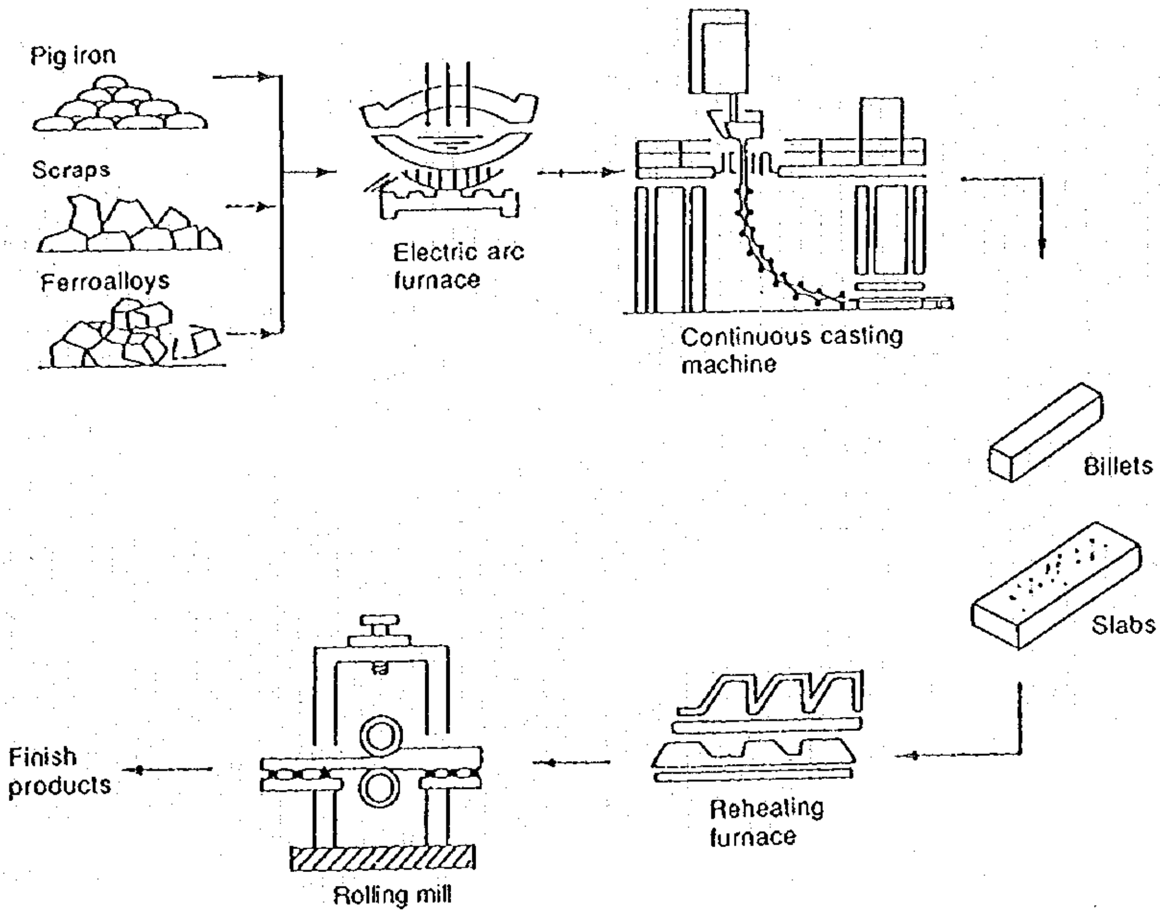


Table 2.2.1 Steel Production in I. R. Iran

	Esfahan Steel Complex	Mobarakeh Steel Complex	Ahwaz Steel Complex	Iran National Steel Group	Kavian Steel Co.	Total
Crude Steel	t	(Molten S.) t	(Molten S.) t	(Molten S.) t	t	t
1990	1,152,818			102,937		
1991	1,756,563	39,000		104,902		
1992	1,968,244	342,000		142,902		
1993	1,924,302	984,000	1,047,633	100,595		4,056,530
1994	1,880,982	1,534,400	1,330,836	97,308		4,843,526
1995		1,865,600				
Total Final Products						
1990	1,309,190		327,851	618,885		2,255,926
1991	2,080,289	9,629	521,154	761,657	25,015	3,397,744
1992	1,961,501	305,100	804,731	578,709	173,101	3,823,142
1993	1,865,597	713,320	1,007,980	347,941	129,114	4,063,952
1994	1,783,552	1,540,124	1,255,986	587,738	238,496	5,405,896
(ratio)						
91/90	1.5890		1.5896	1.2307		1.5061
92/91	0.9429	2.1591	1.2460	0.7598	6.9199	1.1252
93/92	0.9511	2.3380	1.2526	0.6012	0.7459	1.0630
94/93	0.9560	2.1591	1.2460	1.6892	1.8472	1.3302

Source : Ministry of Mines and Metals
Mobarakeh Steel

(2) Outline of the factory

Location, production start-up year, outline of the main facility, and production capacity of each iron and steel factory are shown in Table 2.2.2.

The factories are concentrated in the Esfahan and Ahwaz areas. Both seem to be favorable locations for supplying iron ore and fuels.
Three factories in the Ahwaz area merged to form Khouzestan Steel in 1994.
Concerning future plans, there are plans to construct the Meybod(Yazd) project with a blast furnace of 1,000,000 t/y and a rolling mill in Asadabad (Hamedan) .
As for production capacity, Mobarakeh Steel has the largest capacity with a 2,769,000 t/y crude steel base, followed by Esfahan Steel 2,100,000 t/y, and Ahwaz Steel 1,550,000 t/y, INSIG 150,000 t/y.

Table 2.2.2 Iron & Steel Factories in I.R. Iran

(1/2)

Company Name	Location	Production Start up	Manufacturer	Production Capacity(t/y)		Product (1994 Product Output)		
Esfahan	Esfahan	Phase 1	USSR	(Crude Steel)	2,100,000	Crude Steel	1,881	Mt
Steel Co.		1972		Coke Oven *2	1,150,000	Hot Rolled Prod.		
		Phase 2		Sinter Plant *3	2,516,000	I-beam	936	Mt
		1983		Blast Furnace *2	1,925,000	Bar	703	
				LD Converters *3	3*130t/charge	Billet	229	
				Billet C.C. *7	2,500,000	Channel	28	
				Rolling Mill *6	2,150,000	Angle & rail	13	
				Oxygen Plant *6	11,000NM3/H	(Total)	1,909	
Mobarakeh	Esfahan	1993	Kobe Steel	(Crude Steel)	2,769,000	Sponge Iron	1,624	Mt
Steel Complex			Italimpianti	Iron Ore Pelletizing	4,500,000	Crude Steel	1,534	
				D-Reductn. Unit	3,200,000	Hot Coil	1,105	
				Electric Arc Furnaces	8*180-200t	Pickling Coil	341	
					/charge	Cold Coil	253	
				C.C. Slab *4	2,700,000			
				Rolling Mill *2				
				Hot Strip Mill	2,500,000			
				Hot Finishing	1,550,000			
				Cold Rolling	986,000			
				Oxygen Plant *3	10,400NM3/H			

continued

Company Name	Location	Production Start up	Manufacturer	Production Capacity(t/y)		Product (1994 Product Output)
Khouzestan Steel Co.						
Ahwaz Steel Complex	Ahwaz			(Crude Steel)	1,550,000	Crude Steel
			Lurgie Chemie	Sinter Plant *2	5,000,000	
		1978	Thyssen(G)	D-Reductn. Unit No.1	330,000	(Purofer 1 set)
		1984	Korf(G)	D-Reductn. Unit No.2	1,200,000	(Midrex 3set)+600,000
		1985	Pullmann Swindell	D-Reductn. Unit No.3	1,000,000	(HYL 3set)
			Lectromelt	Electric Arc Furnaces	6*180t /charge	Main products ;
				C.C. Slab & Billet	1,550,000	Bloom 1 line & Slab 2line
Iran National Steel Indu. G.	Ahwaz			(Crude Steel)	150,000	Crude Steel
		1972		Melting 60t/b*4set	360,000	
				Casting 2lines		Beam
		1967-1973		Round & Rod Rolling	505,000	Plain & Ribbed Rounds
		1977		Beam Rolling	385,000	Flange Beams & channels
		1977	Demag	Pipe Mill	190,000	Welded Pipe & Seamless Pipe
		1973	(Germany)	Metal Industry	119,000	Profile,Frame & Electrod
Kavian Steel Co.	Ahwaz	1991	Spezial Stahl (Germany)	Hot Rolled Semifinished Products Plate 12% Bloom 43% Slab 55%	Total 840,000	mainly Plate, Bloom & Slab

Source : Ministry of Mines and Metals
Metal Bulletin Books 11Ed. P.228-9
Esfahan Steel Complex
Mobarakeh Steel Complex

The operation rate of Esfahan Steel was 89.6%, Ahwaz Steel, 81.0%, INSIG, 64.9% and Mobarakeh Steel, 53.3% in 1994, and 64.6% in 1995.
There are several expansion plans for implementation by 1999. According to the plans, the predominance of the direct reduction method will continue, even if the Meybod project using the blast furnace method is implemented,.

Esfahan Steel Complex	3,300,000 t/y	(incl. Direct Reduction)
Mobarakeh Steel Complex	3,200,000	
Ahwaz Steel Complex	2,600,000	
Iran National Steel Group	500,000	
Meybod Steel Complex	1,000,000	(B.F. Method)
Asadabad Steel	?	

Product composition of five factories have no competition as shown in Table 2.2.3.

That is:

Esfahan Steel Complex	Hot Rolled Products (I-Beams, Bars, Billet, Channel, Angle & Rail)
Mobarakeh Steel Complex	Hot Coil, Cold Coil, Pickling Coil
Ahwaz Steel Complex	Slabs, Blooms (It does not possess a rolling mill).
Iran National Steel Group	Beams, Wire Rods, Pipes, Profile & Wire Grids
Kavian Steel Co.	Slabs, Blooms, Steel Sheets (It plays a part of rolling mill of ASCO products)

2.2.2 Present Situation of Energy Consumption

In the iron and steel industry, there are three big energy consumption divisions, that is, a pig iron producing division which reduces iron ore, a steel producing division which refines pig iron and ferrous scraps, and a power division which generates the complex's electric power.
To estimate the energy consumption of each complex, it is necessary to correctly determine energy consumption.
Recent energy consumption data obtained by a factory audit of Esfahan Steel Complex (hereinafter called Esfahan) and interview surveys of Mobarakeh Steel Complex (hereinafter called Mobarakeh) and Khouzestan Steel Co. (hereinafter called Khouzestan) are shown in Table 2.2.4.

In the case of Mobarakeh, data on the consumption of fuel and electric power were obtained, but data on purchased electric power or fuel consumption for in-house generation of electricity were not available. As a result, purchased electric power was estimated to be 50% of the balance of electric power and fuel.
Energy consumption data obtained from Esfahan and Ahwaz were used as reference for the other factories.

Table 2.2.3 Iron and Steel Production in each Factories

(Unit : t)

	1990	1991	1992	1993	1994	1995
Esfahan Iron & Steel Complex						
1 Dry Coke	893,577	1,012,331	1,017,624	955,413	1,033,015	
2 Metallurgical Coke	829,590	989,502	962,419	897,648	959,402	
3 Agglomerate	1,776,860	2,334,220	2,424,478	2,479,330	2,368,359	
4 Molten Steel of F-1	687,192	712,421	764,385	737,486	721,014	
5 Molten Steel of F-2	721,874	1,237,984	1,288,977	1,178,733	1,189,038	
6 Total Molten Steel	1,409,066	1,981,408	2,052,092	1,916,219	1,910,052	
7 Ready Billet	1,152,818	1,756,563	1,968,344	1,924,302	1,880,982	
8 Rolling Mill 650	605,474	641,747	636,122	670,262	666,356	
9 R.M.650(for sale)	339,459	478,822	404,068	420,091	427,040	
10 R.M.500(for sale)	467,848	865,499	799,898	683,875	652,527	
11 R.M.350(for sale)	288,555	345,329	213,781	280,812	240,852	
12 R.M.300(for sale)	213,320	390,642	543,752	490,917	463,133	
13 T. Rolled Product	1,309,190	2,080,289	1,961,501	1,865,597	1,783,552	
Mobarakeh Steel Complex						
1 Spongy Iron			307,800	872,597	1,631,445	
2 Molten Steel		39,000	342,000	984,000	1,534,400	1,865,600
3 Slab		34,000	302,000	934,000	1,475,200	1,788,200
4 Hot Rolling		3,200	201,000	750,000	1,105,000	
5 Pickling Coil			94,000	228,000	341,000	
6 Cold Rolling			40,000	157,000	253,500	
7 Total Final Product(4+6)		3,200	241,000	907,000	1,358,500	
Ahwaz Steel Complex						
1 Sinter	644,684	950,643	1,245,111	1,643,265	2,013,200	
3 Spongy Iron	405,616	621,109	850,310	1,196,267	1,463,929	
4 Molten Steel				1,047,633	1,330,836	
5 Bloom				451,436	403,877	
6 Slab				556,434	852,109	
7 Bloom & Slab	327,834	652,024	804,753	1,007,870	1,255,986	
Iran National Steel Industry						
1 Bloom (Melt No.1)	102,937	104,902	143,089	100,595	97,308	
2 Rolling Sec. No.1	228,804	304,750	220,893	167,158	369,847	
3 Rolling Sec. No.2	289,941	201,456	270,744	166,077	287,438	
4 Pipe Making	47,188	71,603	54,657	2,137	23,569	
5 Metal Industry	52,951	64,854	63,350	12,563	6,861	
6 Total Final Product	618,885	769,657	578,709	347,941	587,738	
Kavian Steel Co.						
1 Slab				13,009	45,034	
2 Bloom					1,410	
3 Steel Sheet				116,105	193,054	
4 Total Final Product		25,015	172,101	129,114	238,496	

Source : Ministry of Mines and Metals, Mobarakeh Steel Complex, and Ahwaz Steel Complex

Table 2.2.4 Energy Consumption of the Iron & Steel Industry

Company Name	Production 1994 (t/y)	kind	Quantity		(Tcal/y)	(Mcal/t-CS)
		Energy Consumption in 1994				
Esfahan	Crude Steel	Coal	1,301	(1,000t/y)	9,630	5,120
Steel Co.	1,881,000	Coke	20.5	(1,000t/y)	146	78
		Tar	-48.9	(1,000t/y)	-430	-229
		Gas Oil	71.0	(1,000kl/y)	643	342
		Natural Gas	707		6,791	3,610
		Electricity	169	(GWh/y)	416	221
		Total			17,196	9,142
Mobarakeh	Crude Steel	Kerosene	223	(kl/y)	2	1
Steel Cmpx	1,475,200	Gas Oil	18,000	(kl/y)	166	112
		Natural Gas	1,062	(M Nm³/y)	10,408	7,055
		Electricity	1,126	(GWh/y)	2,534	1,717
		Total			13,109	8,886
Ahwaz	Crude Steel	Kerosene		(kl/y)		
Steel Cmpx	1,256,000	Gas Oil		(kl/y)		
		Natural Gas	674	(M Nm³/y)	6,605	5,259
		Electricity	1,391	(GWh/y)	3,130	2,492
		Total			9,735	7,751
Iran Natnl	Crude Steel	Kerosene		(kl/y)		
Steel I. G.	91,835	Gas Oil		(kl/y)		
		Natural Gas	64	(M Nm³/y)	627	6,830
		Electricity	151	(GWh/y)	340	3,700
		Total			967	10,529
Kavian	Crude Steel	Kerosene		(kl/y)		
Steel Co.	0	Gas Oil	575	(kl/y)	5	--
		Natural Gas	31	(M Nm³/y)	304	--
		Electricity	23	(GWh/y)	52	--
		Total			361	--
Iron & Steel	Crude Steel	Coal	1,301	(1,000t/y)	9,630	2,047
Industry	4,704,035	Coke	20.5	(1,000t/y)	146	31
		Tar	-48.9	(1,000t/y)	-430	-91
		Gas Oil	18,646.0	(1,000kl/y)	814	173
		Natural Gas	2,538.0	(M Nm³/y)	24,735	5,258
		Electricity	2,860.0	(GWh/y)	6,471	1,376
		Total			41,365	8,794

Source : Esfahan Steel, Mobarakeh Steel, & Ahwaz Steel

In the case of INSIG, information about the capacity and tap-to-tap time of the electric arc furnace, and raw materials (ferrous scraps ratio is about 90%) were used for the estimation.
For Kavian Steel Co., meanwhile, information about fuel intensity and electricity intensity obtained in the 1992 survey was reviewed as reference.
Total energy consumption for these two complexes was estimated and totaled using the production figures shown in Table 2.2.3. Energy intensity was estimated using the same process as at the other complex.

Based on the above results, total energy consumption of the whole iron and steel industry in I. R. Iran is 41,369,000 Gcal/y .
Breakdown of total energy consumption is natural gas, 60%, coal, 23%, purchased electricity, 16%, and others, 1%.
The weighted average of energy intensity is 8,834 Mcal/t-CS. Compared to the model complex for energy conservation, the factories have been consuming energy by as much as 50% in excess.

Comparing the energy intensity of each complex in Table 2.2.4, the complexes can be ranked as follows (from least energy-intensive): Ahwaz, Mobarakeh, Esfahan. It should be noted that the existence or non-existence of a rolling mill and in-house generation of electricity or rate of dependence on purchased electricity at each complex, differences of facility composition, utilization rate of by-produced gas, operation rate of a whole facility vary.

Assuming that Esfahan and Mobarakeh do not have any in-house generation plants like Ahwaz, the energy intensity of each complex is estimated to be as follows.

Esfahan	8,425 Mcal/t (= 9,142-717)
Mobarakeh	8,003 Mcal/t (= 8,885-882)
Ahwaz	7,875 Mcal/t (= 7,875- 0)

These indicate that having highly efficient in-house electricity generation facilities contributes to improving the energy intensity of the whole complex.

The other reasons behind the high energy intensity of each complex are discussed below:

a. Esfahan Steel Complex

Energy consumption situation of each process in Esfahan was analyzed in detail during the factory audit, and energy saving potential and measures were investigated in comparison with data from the latest complex.
A summary of the results, (reported in detail in 3.1.1) follows below:

Although Esfahan uses the blast furnace method which uses coal for reducing of iron ore, excessive consumption of natural gas is notable.
Energy intensity of Esfahan is 9.142 Mcal/t-crude steel, consuming 66% of excess energy, which is compensated for by natural gas. This is rather high compared to the energy intensity of the

latest complex, which has a similar product composition (5,495 Mcal/t).
It seems to be strange that energy intensity is poor, although the data of neither production amount, operation rate nor yield of product are unfavorably.
The following factors seem to be aggravating the energy intensity of the whole complex:

1) Because of a strong desire to increase production of blast furnaces, they are operated at a high fuel ratio. This lowers net energy intensity.
2) Fuel intensity of both furnaces and reheating furnaces is poor.
3) Coordination among processes (which is necessary for the efficient operation of the integrated iron and steel complex) is not being carried out.
4) By-produced energy such as BFG, COG, and BOG are not effectively utilized.
5) Efficiency of the energy facilities including the power plant is low.

b. Mobarakeh Steel Complex

Using data on the capacity of the main facilities and recent production, fuel and electric power consumption, electricity intensity of electric arc furnace (780 kWh/t) and scrap ratio (15-20%), fuel intensity (320 Nm^3/MWh) at the power plant, etc., obtained through an interview survey at Mobarakeh Complex, energy intensity of the complex was estimated to be 8,885 Mcal/t-crude steel. This was arrived at by assuming the that energy intensity of each process and the ratio of in-house generation is 50% and by preparing a fuel and electricity balance table of the complex. Assuming the ratio of in-house generation is 45%, energy intensity of the complex is estimated to be 9,061 Mcal/t-crude steel.

Mobarakeh applies the so-called direct reduction method, which uses natural gas for reducing iron ore. Fifty to sixty percent of the electric power consumed by the whole complex is supplied by an in-house power generation plant, which uses natural gas. Therefore, the complex depends substantially on natural gas for most of its energy requirements.
Overall energy intensity is not too different from Esfahan in spite of the new facilities.
Given that the standard energy intensity of the complex, which uses the DR process, is 6,500 Mcal/t, Mobarakeh is consuming about 37% excess energy,
The following factors seem to be aggravating the energy intensity of the whole complex.

1) Facilities operation rate was as low as 60% in 1995.
When facilities are operated at a low production rate, energy intensity declines significantly because the rate of fixed energy consumption increases.
For example, when the operation rate of the facilities (where the rate of fixed energy is 30%) falls to 60%, energy intensity increases by at least 20%.
2) Many facility problems occur.
When a problem occurs at some facilities, the operation rate of upstream and downstream processes fall as well, and both energy intensity and product yield fall.
3) A high energy consuming process is being used.
It is possible that use of such a process was decided during a regime of low natural gas and electricity prices.

C. Khouzestan Steel Co.

Khouzestan Steel Co. is a new company formed from the merger of ASCO, INSIG, and Kavian in 1994. ASCO is in charge of the only upstream process because it does not have any rolling mills. It is supplying billets or slabs to INSIG and Kavian.

Using data on the production capacity of the main facilities and the actual production, fuel and electricity consumption since 1994 obtained through on interview survey at Khouzestan Complex, energy intensity of the complex is estimated to be 8,347 Mcal/t-crude steel.

Because Khouzestan does not have any in-house power plant, dependence on electricity is apparently greater than at the other complexes.

C-1 Ahwaz Steel Complex (ASCO)

Energy intensity of ASCO (which is the core of Khouzestan) is estimated to be 7,875 Mcal/t. Electricity intensity of the DR plant (estimated using steam turbine driven equipment) is low. When target intensity is assumed to be 6,240 Mcal/t (because there is no rolling process) then ASCO is consuming 26% excess energy. Although ASCO started operations at almost the same time as Mobarakeh, its energy intensity is higher due to the following reasons:

1) There are 7 DR plants utilizing three processes, that is, Purofer method, Midrex method and HYL method. Only three plants using the Midrex process are operating normally, however, the others are operating at below normal levels.
2) Productivity of the electric arc furnace is low and electricity intensity is poor.

(ref. Table 2.2.5)

Table 2.2.5 Energy Consumption of Ahwaz Steel Complex

		Production	Consumption		Intensity	
			Elec.	Nat. Gas	Elec.	Nat. Gas
		(1,000t)	(MWh)	(1,000Nm^3)	(kWh/t)	(Nm^3/t)
Sintering P.	1993	1,643	99,119	37,433	60.3	22.8
	1994	2,013	128,140	55,941	63.7	27.8
Reduction P1	1993	150	4,405	14,837	29.4	98.9
	1994	198	5,077	12,567	25.6	63.5
Reduction P2	1993	1,003	99,119	248,619	98.8	247.9
	1994	1,140	120,686	312,516	105.9	274.1
Reduction P3	1993	43	3,304	223,726	76.8	5,202.9
	1994	126	4,267	264,952	33.9	2,102.8
Factory	1993	1,008	1,101,332	546,465	1,092.6	542.1
	1994	1,276	1,390,916	673,961	1,090.1	528.2

Source : Ahwaz Steel Complex

C-2 INSIG

INSIG has four small electric arc furnaces (60 t/ch×4). It uses about 90% scraps and about 10% of ASCO's DR-products as the iron source, for producing billets, and rods, I-beams, pipes, etc. Other billets are supplied by ASCO.

Because INSIG has no reduction division for iron ore, (with most billets supplied by ASCO) energy intensity per ton of products is 1,451 Mcal/t. Compared to the standard plant (880 Mcal/t), there is 65% room for energy saving.

The following reasons is given for the poor energy intensity:

1) Electricity intensity is poor due to the small scale of the electric arc furnace, and frequent facility problems.
2) Operation rate of the rolling process is low.
3) Combustion management of the furnace is not being satisfactorily carried out.

C-3 Kavian Steel

Kavian accepts slabs from ASCO, rolls them at the slabbing mill and produces blooms, slabs and plates. Energy intensity, however is very poor at 1,494 Mcal/t.

Because 100% of the cold slabs are rolled, 136% of excess energy is consumed compared to the intensity of a standard complex, which is 632 Mcal/t.

The following reasons explain why energy intensity is this high.

1) Designed fuel intensity of the reheating furnace is higher.
2) Combustion management of the reheating furnace is not being carried out sufficiently.
3) Production efficiency of the rolling process is lower.
4) Facility problems often occur.

2.2.3 Energy Conservation Potential and Cost of Countermeasures

(1) Esfahan Steel Co

The energy conservation potential and countermeasure costs mentioned in Vol. 3.1.1 are shown in Table 2.2.6.

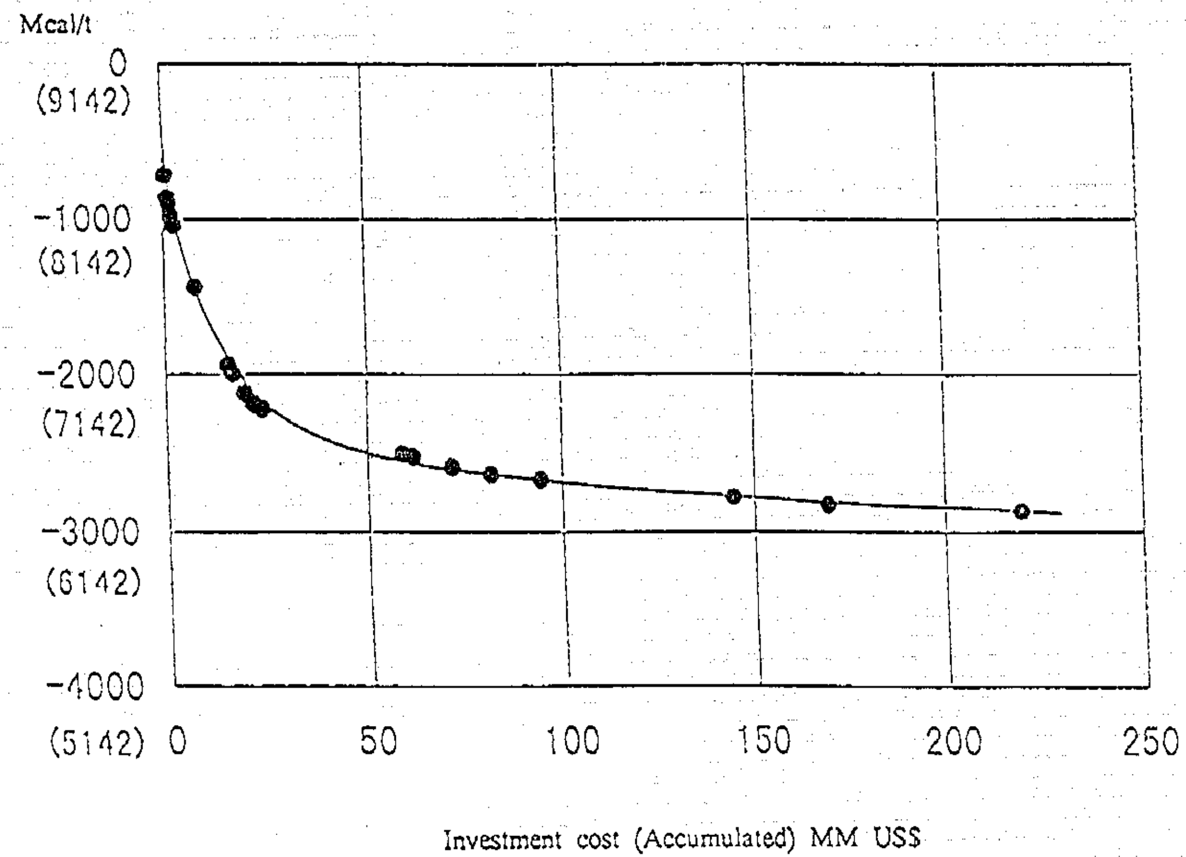
After the items in this table were arranged in order of investment cost, an accumulation curve of energy conservation potentials was derived as shown in Figure 2.2.4.

Table 2.2.6 Energy Conservation Potential of Esfahan Steel Complex

	Energy Conservation Potential	Saved Energy N.G. (1,000m3/y)	Saved Energy Electricity (MWh/y)	Countermeasure Cost (M ¥)
<Improvement of Management>				
(C.O.P)	Air Ratio for Combustion	2,549		0
	Carbonization Temperature	5,501		200
	Steam Utilization Method	7,111		0
(S.P)	Yield Increase	10,252		100
	High Efficiency Burner	11,474		200
	Low Coke Operation	24,413		300
	Prevention of Air Leak		7,104	30
(B.F)	Production Increase	76,443		500
	Low O_2 Operation of Hot Oven	2,364		10
(S.M.P)	Converter Yield			
	O_2 and Electricity		15,424	0
	Fuel	20,750		0
	Reduction of Fuel	38,785		0
	Boiler Aux. Combustion Method	7,757		0
(R.P)	Process Management	44,828		0
	Reheating Furnace Operation	28,335		50
	Reheating F. Combustion Control	10,572		50
	Hot Charge Ratio	14,802		50
	Yield	5,709	5,948	0
(C.P.P)	Low O_2 Combustion et al.	4,073		10
(O_2 P)	Operation Method		13,167	0
	Reduction of O_2 Supply Loss		11,286	0
	Water Pump Operation Method		13,080	10
	Sub total	315,718	66,009	1,510
<Modification of Facility>				
(C.O.P)	Moisture Control Facilities	9,124		1,000
(S.P)	Steam Recovery from Waste Heat	6,592	996	1,300
(B.F)	Air Preheater for Hot Oven	3,349		250
(S.M.P)	Exhaust Gas Recovery Equp.	7,757		5,000
(C.P.P)	Efficiency of the BF Blower	54,687		3,500
(T.P.P)	Multi-Purpose Power G.Turbine	(incl. in the above)		
(O_2 P)	Air Compressor Efficiency		39,501	2,500
(Other)	BFG, CDG Holder	97,738		800
	Sub total	179,247	40,497	14,350
<Modification of Process>				
(C.O.P)	Introducing CDQ	22,138		5,000
(B.F)	Introducing TRT		50,641	1,000
	Sub total	22,138	50,641	6,000

Note : (Abbreviation) Coke Oven Plant (C.O.P) Sintering Plant (S.P), Blast Furnace (B.F) Steel Making Process(S.M.P) Rolling Process (R.P) Central Power Plant (C.P.P) O_2 Plant (O_2 P), Thermal Power Plant (T.P.P)

Figure 2.2.4 Accumulated Curve of Energy Conservation Potential and Investment Cost (Esfahan)



Energy conservation technologies in the iron and steel industry are described in Vol. 4, 1.4 "Energy conservation of the iron and steel industry" the main items of which are as follows:

a. Stabilization of operation
b. Selection of reasonable energy
c. Improvement of product yield
d. Operation improvement and facility improvement
   (Improvement of productivity (t/h) etc.)
e. Effective use of sensible heat of the steel in the foreprocess
f. Recovery of waste energy
g. Continuation and modernization of the facilities
h. Increasing efficiency energy facilities

For items a., b., c., g., and h. the energy conservation effect is huge, because they are not only implemented for the purpose of energy conservation investment, but as a business strategy.
As for items d. and e., the energy conservation effects are huge in spite of the relatively small investment. For items f. and g. meanwhile, investment and the energy conservation effect are both bigger.

Figure 2.2.4 shows that investment is not necessary to reduce 20% of energy intensity from the present level, whereas a major remodeling of the process and waste heat recovery are necessary to reduce to the extent of the ideal intensity.

(2) Mobarakeh Steel Co

The present situation is discussed in the previous paragraph, but a more detailed explanation of the energy conservation potential follows below:

a. Improvement of operation rate of the facility

Assuming that the low operation rates of facilities is the biggest factor reducing energy intensity, production increase by reducing facility problems, realizing stable operation, and improving production efficiency for the early stages are effective for improving energy intensity. For instance, when the operation rate rises to 85%, intensity will reduce by 17% from the present level.
(If a production increase is impossible due to the market situation, only the number of the facilities equivalent to the target production should be operated.)
To improve facilities' operation rate, a multilateral study and measures such as a revision of the operation technology standard and the maintenance standard, education of operators and the maintenance person in charge, facility improvement and the operational improvement are necessary.
As these measures immediately result in increased production, they should be adopted as one of the main corporate policies or strategies.
Therefore, such an investment cost were not estimated as an energy saving measure cost.

b. Operation improvement

- Fuel -

At the iron and steel works there are many furnaces and pans, and a large quantity of fuel is used for heating products, or drying/keeping the temperature of the furnace and the pan. When using this fuel, operation standards (for example, heating temperature of the products, rising temperature standard of the furnace, keeping temperature standard of the furnace, etc.) are established, and to judge whether the usage conditions are appropriate or not, thermometers or O_2 meters for exhaust gas are installed as required.

Because consumption of natural gas at Mobarakeh is rather high, it is necessary to check whether the operation standard is maintained in each process or not. If the standard is not kept, or if it is impossible to judge whether it is kept or not, the facility shall be improved out so that it is easy to execute an operation manual or to check the results. In addition, the operation method or the operation standard shall be reconsidered as to whether targeted results are obtained by less fuel or not. These measures cost very little, but the effect is large. It is empirically estimated to be able to reduce 5% of natural gas consumption at the whole works.

To reduce fuel in the rolling process, by finding the optimal heat pattern for the furnace and acquiring a heating technique with the optimal heat pattern according to the rolling speed, the fuel intensity of the reheating furnace must fall from 50 Nm^3/t (current estimate) to at least 35 Nm^3/t.

- Electric power -

A large quantity of electric power is used in each process for the transport of products, delivery of cooling water, and discharge and ventilation of exhaust gas, among other tasks.

Saving electricity by improving operations is introduced in chapter 4, "Energy saving case in the iron and steel industry" , the main items of which are as follows:

1) Productivity of the process is raised and equipment is stopped if downtime occurs.
2) Idling is reduced.
3) Impeller is cut, if specifications are excessive following a check of pressure and flow rate of the fluid in the process.
4) Connecting pipe for the pump and the compressor with the same specification is installed to rationalize operation.
5) An examination is carried out on stopping parallel running of pumps or fans.

In particular, there are many cases in which a problem does not occur even if a cooling water pump stops.

However, as pump capacity declined, extra pumps are sometimes operating, and they should be recovered by maintenance after an investigation.

These measures can achieve a 10% reduction of electric power empirically.

c. Improvement of product yield

The improvement of product yield is as big as the energy conservation effect. However, as information about product yield in Mobarakeh was not available, energy conservation potential could not be estimated.

d. Improvement of facility

As the energy conservation potential for cases requiring investments in large facilities, are not feasible in I. R. Iran, as shown in the example of Esfahan, a study was omitted.

For example, a DC furnace could be proposed for the electric arc furnace. However, as the merits of introducing the furnace were rather small (maximum 60 KWh/t or so), and a study of the electric power system and estimation of cost were necessary, it was omitted .

e. Efficiency improvement of in-house generation plant

At Mobarakeh, where the unit prices of natural gas and electricity are remarkably low and the electricity supply was not always stable, the steam condition of the 67MW * 3 set in-house generation plant is determined to be 64 kg/cm^2, 465° C. In addition, an atmospheric evaporation-type cooling system must be used due to the geographical conditions.

Net fuel intensity of Mobarakeh's in-house power plant (fuel intensity at the end of the power transmission) is estimated to be 3,564 Kcal/kWh. Compared to the case in which the entire quantity is purchased, energy intensity deteriorates with 882 Mcal/t-crude steel, that is;

Energy intensity improvement when purchasing entire quantity of electricity
= <natural gas consumption * 9.8
- (generation of electricity - electricity consumption at the power plant) * 2.25 > /crude steel production
= <360,182 * 9.8 - (1,125,570 - 135,068) * 2.25>/1,475.2
= 882 Mcal/t crude steel

To improve energy intensity at the iron and steel works, it is necessary to improve the efficiency of the in-house generation plant. However, as the huge investments will be necessary to modify existing facilities, the improvement shall be strategically executed from the state's standpoint.

To improve efficiency using existing facilities, a top turbine scheme or a gas turbine combined cycle system should be studied.

A summary of the energy conservation potential of the Mobarakeh Complex is shown in Table 2.2.7.

Table 2.2.7 Energy Conservation Potential in Mobarakeh Steel Complex

	Energy Conservation Potential	Factory	Saved Energy N.G 1,000Nm³/y	Saved Energy Electricity MWh/y	Countermeasure Cost M US$
<Improvement of Management>					
(P.P)	Increasing of productivity	Mobarakeh		21,240	
(DR. P)	Stability of DR plant operation	Mobarakeh	64,984	48,738	
(S.M.P)	Stability of EAF operation	Mobarakeh	7,672	122,752	
	Improvement of EAF heat loss	Mobarakeh		46,032	
	Stability of CC by stability of EAF	Mobarakeh	7,376	14,752	
(H. R)	Increasing of productivity	Mobarakeh		54,872	
	Improvement of furnace operation	Mobarakeh	20,577		0.5
(C. R)	Increasing of productivity	Mobarakeh		12,675	
	Improvement of furnace operation	Mobarakeh	2,535		
(Others)	Improvement of pump and blower operati	Mobarakeh		26,554	0.1
(Sub total)			103,144	347,615	0.6
<Modification of Facility >					
(DR. P)	Increasing of waste heat recovery	Mobarakeh	32,492		15.0
(Sub total)			32,492		15.0
<Modification of Process >					
(P. P)	Replacement to high eff. power plant	Mobarakeh	121,562	33,767	70.0
(Sub total)			121,562	33,767	70.0

Note : (Abbreviation) Pelletizing Plant (P. P) Direct Reduction Plant (DR. P)
Steel Making Process (S.M.P) Hot Rolling (H. R)
Cold Rolling (C. R)

(3) Khouzestan

3-1 ASCO

a. Replacement of DR furnace

The DR section is assumed to be consuming 65% of the energy of the entire works. Because the operation rate of the furnace of Purofer and HYL.1 type is too low, these furnaces should be replaced by more efficient furnaces to improve energy intensity and to increase production.

b. Modification of electric arc furnace

The project to increase the transformer capacity which measures the improvement of production efficiency (abridgment of tap-to-tap interval of the furnace) is progressing. In addition, electricity intensity will be reduced by 100 kWh/t due to the implementation of measures to suppress cooling loss and exhaust gas loss to the lowest possible fixed level, and adding coke.

c. Operational improvement for CC

The improvement of productivity and the revision of temperature keeping standards for pans and tongue dishes will help reduce energy consumption.

3-2 INSIG

a. Electric arc furnace and CC

To reduce fixed losses such as cooling loss and radiation loss, remodeling to 150 t/ch is progressing. By simultaneously implementing a modification which makes tap-to-tap intervals shorter to improves productivity (t/h), as well as decreases facility problems with the electric arc furnace, substantial energy conservation can be achieved.

If the electric arc furnace can be operated in a stable manner, the energy intensity of the continuous casting facility will also be improved.

b. Rolling facility

Productivity improvements (t/h) and operational improvements such as to the air ratio and the heat pattern of the reheating furnace will result in substantial energy savings.

3-3 Kavian

a. Operational improvement of rolling process

Because it is a new complex, it is possible to achieve a substantial improvement of energy intensity by making operation stable and improving operation rate.

A summary of the energy conservation potential in the Khouzestan Complex, which consists of Ahwaz, INSIG, and Kavian (three works), is shown in Table 2.2.8.

Table 2.2.8 Energy Conservation Potential in Khouzestan Steel Complex

	Energy Conservation Potential	Factory	Saved Energy NG 1,000Nm³/y	Saved Energy Electricity MWh/y	Countermeasure Cost M US$
<Improvement of Management>					
(P. P)	Improvement of blower and pump efficiency	ASCO		47,512	0.1
(DR. P)	Stop or replacement of old type DR plant	ASCO	150,782		
(S.M.P)	Increasing of productivity of EAF	ASCO	6,654	133,080	
	Increasing productivity of CC	ASCO	6,280	12,560	
(Sub total)			163,716	193,152	0.1
<Improvement of Management>					
(S.M.P)	Increasing of EAF productivity	INSIG		7,785	-
	Stability of EAF	INSIG	973	7,785	-
	Increasing of productivity of CC by Stability of	INSIG	918	918	-
(P. M)	Increasing of pipe mill productivity	INSIG	613	1,886	-
	Improvement of furnace operation	INSIG	471		
(R.R.M)	Increasing of round rolling mill productivity	INSIG	7,397	7,767	-
	Improvement of furnace operation	INSIG	7,397		-
(B.R.M)	Increasing of beam rolling mill productivity	INSIG	5,749	6,036	-
	Improvement of furnace operation	INSIG	5,749		
(Sub total)			29,267	32,177	0
<Improvement of Management>					
(R. M)	Improvement of rolling mill furnace operation	Kavian	2,395		-
	Improvement of rolling mill productivity	Kavian	6,227	5,029	-
(Sub total)			8,622	5,029	
<Modification of Facility>					
(R. M)	Improvement of rolling mill furnace	Kavian	7,185		0.5
(Sub total)			7,185		0.5

Note : (Abbreviation) Pelletizing Plant (P.P) Direct Reduction Plant (DR. P)
Steel Making Process (S.M.P) Pipe Mill (P. M)
Round Rolling Mill (R.R.M) Beam Rolling Mill(B.R.M)
Plate & Slab Rolling Mill(R. M)

2.2.4 Economic Assessment of Energy Conservation Potential

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

Case 1 : Accelerated energy conservation (A. E. C.) case
Case 2 : Energy conservation (E. C.) case

The basis for the energy price in each case can be seen in Table 2.1.2, and the Rial vs. US$ rate is based on the rate in 1993 (1,750 Rial/US$).
The result of the assessment is shown in Table 2.2.9, and Table 2.2.10.

The results of the economic assessment are summarized below:

Table 2.2.9-1 Economic Evaluation of Measures for Energy Conservation in the Iron & Steel Industry (Esfahan Steel)

A. E. C. Case (Natural Gas 123 Rial/Nm^3, Electricity 100 Rial/kWh)

(1,750 Rial/US$)

(1/2)

Energy Conservation Potential		Factory	Benefit					Countermeasure Cost		Economic Evaluation
			N.G. (1,000m^3/y)	Electricity (MWh/y)	(M Rial/y)	for 3 years (M Rial)	for 10 years (M Rial)	(M ¥)	(M Rial)	Note
<Improvement of Management>										
(C.O.P)	Air Ratio for Combustion	Esfahan Steel	2,549		314	778	1,925	0	0	feasible
	Carbonization Temperature	Esfahan Steel	5,501		677	1,678	4,154	200	3,500	feasible for 10 Ys.
	Steam Utilization Method	Esfahan Steel	7,111		875	2,169	5,371	0	0	feasible
(S.P)	Yield Increase	Esfahan Steel	10,252		1,261	3,127	7,742	100	1,750	feasible
	High Efficiency Burner	Esfahan Steel	11,474		1,411	3,500	8,665	200	3,500	feasible
	Low Coke Operation	Esfahan Steel	24,413		3,003	7,447	18,438	300	5,250	feasible
	Prevention of Air Leak	Esfahan Steel		7,104	710	1,762	4,362	30	525	feasible
(B.F)	Production Increase	Esfahan Steel	76,443		9,403	23,318	57,731	500	8,750	feasible
	Low O2 Operation of Hot Oven	Esfahan Steel	2,364		291	721	1,786	10	175	feasible
(S.M.P)	Converter Yield	Esfahan Steel								
	O2 and Electricity			15,424	1,542	3,825	9,470	0	0	feasible
	Fuel		20,750		2,552	6,330	15,671	0	0	feasible
	Reduction of Fuel	Esfahan Steel	38,785		4,770	11,831	29,291	0	0	feasible
	Boiler Aux. Combustion Method	Esfahan Steel	7,757		954	2,366	5,858	0	0	feasible
(R.P)	Process Management	Esfahan Steel	44,828		5,514	13,674	33,855	0	0	feasible
	Reheating Furnace Operation	Esfahan Steel	28,335		3,485	8,643	21,399	50	875	feasible
	Reheating F. Combustion Control	Esfahan Steel	10,572		1,300	3,225	7,984	50	875	feasible
	Hot Charge Ratio	Esfahan Steel	14,802		1,821	4,515	11,179	50	875	feasible
	Yield	Esfahan Steel	5,709	5,948	1,297	3,217	7,964	0	0	feasible
(C.C.P)	Low O2 Combustion et al.	Esfahan Steel	4,073		501	1,242	3,076	10	175	feasible
(O_2 P)	Operation Method	Esfahan Steel		13,167	1,317	3,265	8,085	0	0	feasible
	Reduction of O2 Supply Loss	Esfahan Steel		11,286	1,129	2,799	6,930	0	0	feasible
	Water Pump Operation Method	Esfahan Steel		13,080	1,308	3,244	8,031	10	175	feasible

continued

(1,750 Rial/US$) (2/2)

Energy Conservation Potential	Factory	Benefit					Countermeasure Cost		Economic Evaluation Note
		N.G. (1,000m³/y)	Electricity (MWh/y)	(M Rial/y)	for 3 years (M Rial)	for 10 years (M Rial)	(M ¥)	(M Rial)	
<Modification of Facility>									
(C.O.P) Moisture Control Facilities	Esfahan Steel	9,124		1,122	2,783	6,891	1,000	17,500	not feasible
(S.P) Steam Recovery from Waste Heat	Esfahan Steel	6,592	996	910	2,258	5,590	1,300	22,750	not feasible
(B.F) Air Preheater for Hot Oven	Esfahan Steel	3,349		412	1,022	2,529	250	4,375	not feasible
(S.M.P) Exhaust Gas Recovery Equip.	Esfahan Steel	7,757		954	2,366	5,858	5,000	87,500	not feasible
(C.C.P) Efficiency of the BF Blower	Esfahan Steel	54,687		6,726	16,682	41,301	3,500	61,250	not feasible
(T.P.P) Multi-Purpose Power G.Turbine	Esfahan Steel			(incl. in the above)					
(O_2 P) Air Compressor Efficiency	Esfahan Steel		39,501	3,950	9,796	24,254	2,500	43,750	not feasible
(Other) BFG, CDG Holder	Esfahan Steel	97,738		12,022	29,814	73,814	800	14,000	feasible
<Modification of Process>									
(C.O.P) Introducing CDQ	Esfahan Steel	22,138		2,723	6,753	16,719	5,000	87,500	not feasible
(B.F) Introducing TRT	Esfahan Steel		50,641	5,064	12,559	31,094	1,000	17,500	feasible for 10 Ys.

Note : (Abbreviation) Coke Oven Plant (C.O.P), Sintering Plant (S.P), Blast Furnace (BF), Steel Making Process (S.M.P)
Rolling Process (R.P), O_2 Plant (O_2 P), Blast & Power Plant (CPP), Thermal Power Plant (T.P.P)

Table 2.2.9-2 Economic Evaluation of Measures for Energy Conservation in the Iron & Steel Industry (Esfahan Steel)

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

(1/2)

Energy Conservation Potential		Factory	Benefit					Countermeasure Cost		Economic Evaluation
			N.G.	Electricity		for 3 years	for 10 years			Note
			(1,000m^3/y)	(MWh/y)	(M Rial/y)	(M Rial)	(M Rial)	(M ¥)	(M Rial)	
<Improvement of Management>										
(C.O.P)	Air Ratio for Combustion	Esfahan Steel	2,549		57	142	470	0	0	feasible
	Carbonization Temperature	Esfahan Steel	5,501		123	306	1,013	200	3,500	not feasible
	Steam Utilization Method	Esfahan Steel	7,111		159	395	1,310	0	0	feasible
(S.P)	Yield Increase	Esfahan Steel	10,252		230	569	1,888	100	1,750	feasible for 10 Ys.
	High Efficiency Burner	Esfahan Steel	11,474		257	637	2,114	200	3,500	not feasible
	Low Coke Operation	Esfahan Steel	24,413		547	1,356	4,497	300	5,250	not feasible
	Prevention of Air Leak	Esfahan Steel		7,104	289	717	2,377	30	525	feasible
(B.F)	Production Increase	Esfahan Steel	76,443		1,712	4,247	14,081	500	8,750	feasible for 10 Ys.
	Low O_2 Operation of Hot Oven	Esfahan Steel	2,364		53	131	435	10	175	feasible for 10 Ys.
(S.M.P)	Converter Yield	Esfahan Steel								
	O_2 and Electricity			15,424	628	1,557	5,161	0	0	feasible
	Fuel		20,750		465	1,153	3,822	0	0	feasible
	Reduction of Fuel	Esfahan Steel	38,785		869	2,155	7,144	0	0	feasible
	Boiler Aux. Combustion Method	Esfahan Steel	7,757		174	431	1,429	0	0	feasible
(R.P)	Process Management	Esfahan Steel	44,828		1,004	2,490	8,257	0	0	feasible
	Reheating Furnace Operation	Esfahan Steel	28,335		635	1,574	5,219	50	875	feasible
	Reheating F. Combustion Control	Esfahan Steel	10,572		237	587	1,947	50	875	feasible for 10 Ys.
	Hot Charge Ratio	Esfahan Steel	14,802		332	822	2,726	50	875	feasible for 10 Ys.
	Yield	Esfahan Steel	5,709	5,948	370	918	3,042	0	0	feasible
(C.C.P)	Low O_2 Combustion et al.	Esfahan Steel	4,073		91	226	750	10	175	feasible
(O_2 P)	Operation Method	Esfahan Steel		13,167	536	1,329	4,406	0	0	feasible
	Reduction of O_2 Supply Loss	Esfahan Steel		11,286	459	1,139	3,777	0	0	feasible
	Water Pump Operation Method	Esfahan Steel		13,080	532	1,320	4,377	10	175	feasible

continued

(1,750 Rial/US$) (2/2)

Energy Conservation Potential	Factory	Benefit N.G. (1,000m³/y)	Benefit Electricity (MWh/y)	Benefit (M Rial/y)	Benefit for 3 years (M Rial)	Benefit for 10 years (M Rial)	Countermeasure Cost (M Y)	Countermeasure Cost (M Rial)	Economic Evaluation Note
<Modification of Facility>									
(Other) BFG, CDG Holder	Esfahan Steel	97,738		2,189	5,430	18,003	800	14,000	feasible for 10 Ys.
<Modification of Process>									
(B.F) Introducing TRT	Esfahan Steel		50,641	2,061	5,111	16,946	1,000	17,500	not feasible

Note : (Abbreviation) Coke Oven Plant (C.O.P), Sintering Plant (S.P), Blast Furnace (BF), Steel Making Process (S.M.P)
Rolling Process (R.P)

Table 2.210-1 **Economic Evaluation of Measures for Energy Conservation in the Iron & Steel Industry (Mobarakeh/Khouzestan Steel)**

A. E. C. Case (Natural Gas 123 Rial/Nm³, Electricity 100 Rial/kWh)

(1,750 Rial/US$) (1/2)

	Energy Conservation Potential	Factory	Benefit					Countermeasure Cost		Economic Evaluation	Note
			N.G. (1,000m³/y)	Electricity (MWh/y)	(M Rial/y)	for 3 years (M Rial)	for 10 years (M Rial)	(M US$)	(M Rial)		
<Improvement of Management>											
(P.P)	Increasing of productivity	Mobarakeh		21,240	2,124	5,268	13,041	0	0	feasible	
(DR. P)	Stability of DR plant operation	Mobarakeh	64,984	48,738	12,867	31,910	79,002	0	0	feasible	
(S.M.P)	Stability of EAF operation	Mobarakeh	7,672	122,752	13,219	32,783	81,164	0	0	feasible	
	Improvement of EAF heat loss	Mobarakeh		46,032	4,603	11,416	28,264	0	0	feasible	
	Stability of CC	Mobarakeh	7,376	14,752	2,382	5,908	14,628	0	0	feasible	
(H. R)	Increasing of productivity	Mobarakeh		54,872	5,487	13,608	33,691	0	0	feasible	
	Furnace operation improvement	Mobarakeh	20,577		2,531	6,277	15,540	0.5	875	feasible	
(C. R)	Increasing of productivity	Mobarakeh		12,675	1,268	3,143	7,782	0	0	feasible	
	Furnace operation improvement	Mobarakeh	2,535		312	773	1,914	0	0	feasible	
(Others)	Pump and blower operation	Mobarakeh		26,554	2,655	6,585	16,304	0.1	175	feasible	
(P. P)	Blower and pump efficiency	ASCO		47,512	4,751	11,783	29,172	0.1	175	feasible	
(DR. P)	Stop of old type DR plant	ASCO	150,782		18,546	45,995	113,874	0	0	feasible	
(S.M.P)	Productivity of EAF	ASCO	6,654	133,080	14,126	35,034	86,736	0	0	feasible	
	Increasing productivity of CC	ASCO	6,280	12,560	2,028	5,031	12,455	0	0	feasible	

continued

(2/2)

	Energy Conservation Potential	Factory	Benefit					Countermeasure Cost		Economic Evaluation	Note
			N.G. (1,000m^3/y)	Electricity (MWh/y)	(M Rial/y)	for 3 years (M Rial)	for 10 years (M Rial)	(M US$)	(M Rial)		
(S.M.P)	Increasing of EAF productivity	INSIG		7,785	779	1,931	4,780	0	0	feasible	
	Stability of EAF	INSIG	973	7,785	898	2,227	5,515	0	0	feasible	
	Productivity increase of CC	INSIG	918	918	205	508	1,257	0	0	feasible	
(P. M)	Pipe mill productivity	INSIG	613	1,886	264	655	1,621	0	0	feasible	
	Furnace operation	INSIG	471		58	144	356	0	0	feasible	
(R.R.M)	Round rolling mill productivity	INSIG	7,397	7,767	1,687	4,183	10,355	0	0	feasible	
	Furnace operation improvement	INSIG	7,397		910	2,256	5,586	0	0	feasible	
(B.R.M)	Beam rolling mill productivity	INSIG	5,749	6,036	1,311	3,251	8,048	0	0	feasible	
	Furnace operation improvement	INSIG	5,749		707	1,754	4,342	0	0	feasible	
(R.M)	Rolling mill furnace operation	Kavian	2,395		295	731	1,809	0	0	feasible	
	Rolling mill productivity	Kavian	6,227	5,029	1,269	3,147	7,791	0	0	feasible	
<Modification of Facility>											
(DR. P)	Waste heat recovery	Mobarakeh	32,492		3,997	9,911	24,539	15.0	26,250	not feasible	
(R.M)	Rolling mill furnace	Kavian	7,185		884	2,192	5,426	0.5	875	feasible	
<Modification of Process>											
(P. P)	Replacement to high eff. P. P	Mobarakeh	121,562	33,767	18,329	45,455	112,539	70.0	122,500	not feasible	

Table 2.2.10-2 Economic Evaluation of Measures for Energy Conservation in the Iron & Steel Industry (Mobarakeh/Khouzestan Steel)

E. C. Case

(Natural Gas 22.4 Rial/Nm^3, Electricity 40.7 Rial/kWh, for 2000-2002)
(Natural Gas 30.0 Rial/Nm^3, Electricity 54.5 Rial/kWh, for 2000-2009)
(1,750 Rial/US$)

(1/2)

	Energy Conservation Potential	Factory	Benefit N.G. (1,000m^3/y)	Benefit Electricity (MWh/y)	Benefit (M Rial/y)	Benefit for 3 years (M Rial)	Benefit for 10 years (M Rial)	Countermeasure Cost (M US$)	Countermeasure Cost (M Rial)	Economic Evaluation	Note
<Improvement of Management>											
(P.P)	Increasing of productivity	Mobarakeh		21,240	864	2,144	7,108	0	0	feasible	
(DR. P)	Stability of DR plant operation	Mobarakeh	64,984	48,738	3,439	8,529	28,279	0	0	feasible	
(S.M.P)	Stability of EAF operation	Mobarakeh	7,672	122,752	5,168	12,816	42,490	0	0	feasible	
	Improvement of EAF heat loss	Mobarakeh		46,032	1,874	4,646	15,404	0	0	feasible	
	Stability of CC	Mobarakeh	7,376	14,752	766	1,899	6,295	0	0	feasible	
(H. R)	Increasing of productivity	Mobarakeh		54,872	2,233	5,539	18,362	0	0	feasible	
	Furnace operation improvement	Mobarakeh	20,577		461	1,143	3,790	0.5	875	feasible	
(C. R)	Increasing of productivity	Mobarakeh		12,675	516	1,279	4,241	0	0	feasible	
	Furnace operation improvement	Mobarakeh	2,535		57	141	467	0	0	feasible	
(Others)	Improvement of pump and blower operation	Mobarakeh		26,554	1,081	2,680	8,886	0.1	175	feasible	
(P. P)	Blower and pump efficiency	ASCO		47,512	1,934	4,796	15,899	0.1	175	feasible	
(DR. P)	Stop of old type DR plant	ASCO	150,782		3,378	8,376	27,774	0	0	feasible	
(S.M.P)	Productivity increase of EAF	ASCO	6,654	133,080	5,565	13,802	45,758	0	0	feasible	
	Increasing productivity of CC	ASCO	6,280	12,560	652	1,617	5,360	0	0	feasible	

(2/2)

	Energy Conservation Potential	Factory	Benefit					Countermeasure Cost		Economic Evaluation	Note
			N.G. (1,000m^3/y)	Electricity (MWh/y)	(M Rial/y)	for 3 years (M Rial)	for 10 years (M Rial)	(M US$)	(M Rial)		
(S.M.P)	Increasing of EAF productivity	INSIG		7,785	779	1,931	4,780	0	0	feasible	
	Stability of EAF	INSIG	973	7,785	339	840	2,784	0	0	feasible	
	Productivity increase of CC	INSIG	918	918	58	144	476	0	0	feasible	
(P. M)	Pipe mill productivity	INSIG	613	1,886	90	224	744	0	0	feasible	
	Furnace operation	INSIG	471		11	26	87	0	0	feasible	
(R.R.M)	Round rolling mill productivity	INSIG	7,397	7,767	482	1,195	3,962	0	0	feasible	
	Furnace operation improvement	INSIG	7,397		166	411	1,363	0	0	feasible	
(B.R.M)	Beam rolling mill productivity	INSIG	5,749	6,036	374	929	3,079	0	0	feasible	
	Furnace operation improvement	INSIG	5,749		129	319	1,059	0	0	feasible	
(R.M)	Rolling mill furnace operation	Kavian	2,395		54	133	441	0	0	feasible	
	Increasing of plate mill productivity	Kavian	6,227	5,029	344	854	2,830	0	0	feasible	
<Modification of Facility>											
(R.M)	Improvement of R. mill furnace	Kavian	7,185		161	399	1,323	0.5	875	feasible for 10 Ys.	

Feasible energy conservation potentials in Case 1

Esfahan Steel	Natural Gas	413,456 * 1,000 m^3/y (23.5 %)
	Electricity	116,650 MWh/y (69.0 %)
Mobarakeh/Khouzestan Steel	Natural Gas	311,934 * 1,000 m^3/y (16.9 %)
	Electricity	577,973 MWh/y (21.3 %)

Feasible energy conservation potentials in Case 2

Esfahan Steel	Natural Gas	372,068 * 1,000 m^3/y (21.2 %)
	Electricity	66,009 MWh/y (39.0 %)
Mobarakeh/Khouzestan Steel	Natural Gas	296,074 * 1,000 m^3/y (16.9 %)
	Electricity	565,413 MWh/y (20.9 %)

Note : Numbers in parentheses are rates of energy conservation

It should be noted that these potentials include some which have some restrictions such as the market for the products, and time for establishing operating technology.