JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

GENERAL DIRECTORATE OF ELECTRICAL POWER
RESOURCES SURVEY AND DEVELOPMENT ADMINISTRATION,
EIE
MINISTRY OF ENERGY AND NATURAL RESOURCES,
THE REPUBLIC OF TURKEY

THE STUDY ON THE RATIONAL USE OF ENERGY IN THE REPUBLIC OF TURKEY

FINAL REPORT (SUMMARY REPORT)

JANUARY 1997

TECHNO CONSULTANTS, INC.
MITSUBISHI CHEMICAL ENGINEERING CORPORATION

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Contents

List of Table & Figure

(Table)

(Figure)

List of Abbreviations

A	Ampere
AQP Regulation	Air Quality Protection Regulation
Atm	Atmosphere, a unit of pressure
BFW	Boiler Feed Water
BOTAS	Turkish Pipeline Company
CHP	Combined Heater Power System
DGO	Diesel Gas Oil
EAF	Electric Arc Furnace
ECCB	Energy Conservation Coordination Board
EIE	General Directorate of Electrical Power Resources Survey and Development Administration
EU	European Union
FDF	Forced Draft Fan
GDP	Gross Domestic Products
GWh	Giga Watt hour
Gcal	Giga calories
HHV	High Heating Value
IBF	Izmir Basma Fabrikasi
IDC	Izmir Demir Celik Sanyai
IDF	Induced Draft Fan
IEA	International Energy Agency
IRR	Internal Rate of Return
JETRO	Japan External Trade Organization
JICA	Japan International Cooperation Agency
KOSGEB	Small and Medium Industry Development Organization
KUSGET	Small Industry Development Organization
LHV	Low Heating Value
LIC	Level Indicating Controller
MENR	Ministry of Energy and Natural Resources
MITI	Ministry of International Trade and Industry of Japan
MMKcal	Million kilocalories
MTA	Mineral Exploration and Research Directorate
MWh	Thousand kilocalories

MkWh	Thousand kiloWatt hour
NECC	National Energy Conservation Center
NKK	Nippon Kokan Corporation
OECD	Organisation for Economic Co-operation and Development
PIGM	General Directorate of Petroleum Affairs
RH	Relative Humidity
RPCB	Research, Planning and Coordination Board
SEGEM	Industrial Training and Development Center
SPH	Scrap Pre-heater
SPO	State Planning Office
SUS	Stainless Steel
TEAS	Turkish Electricity Generation and Transmission Company
TEDAS	Turkish Electricity Distribution Company
TFC	Total Final Consumption of Energy
TKI	Turkish Coal Enterprise
TOE	Ton Oil Equivalent
TPAO	Turkish Petroleum Corporation
TPER	Total Primary Energy Resource
TPES	Total Primary Energy Supply
TSI	Turkish Standards Institute
TTK	Turkish Hardcoal Enterprise
TUBITAK	Scientific and Technical Research Council of Turkey
TWh	Trillion Watt hour
V	Volt
Wh	Watt hour
atm	Atmosphere, a unit of pressure
c.p.	Centipoise, a unit of viscosity
kVA	kiloVolt-Ampare
kW	kiloWatts
kgOE	kilogram Oil Equivalent
kl	kiloliter
mmHg	Head of mercury in millimeter
ppb	parts per billion
ppm	parts per million
vol%	volume percentage
wt%	weight percentage

Chapter 1 Introduction

Chapter 1 Introduction

This is the summary report version of the Final Report for the Study on the Rational Use of Energy in the Republic of Turkey. Consigned by the Japan International Cooperation Agency (JICA), a consortium of TECHNO CONSULTANTS, INC. and MITSUBISHI CHEMICAL ENGINEERING CORPORATION, an international consulting company and an international engineering company both based in Japan, has executed this study for the General Directorate of Electrical Power Resources Survey and Development Administration (EIE) of the government of the Republic of Turkey and has prepared this report. Along with this summary report, the consortium also presents a main version of the Final Report. In addition, the consortium presents five copies of four different factory versions of the main report, each binding selected chapters of the main report relevant to each of the factories mentioned below.

The consortium started the study in November 1995 and has executed it basically according to the Scope of Work agreed upon between EIE and JICA on June 30, 1995, including a major addition to the Scope of Work while the study was in progress, measurement of the operating conditions of the electric arc furnace of Izmir Demir Celik Sanayi A.S. for the purpose of developing its energy balance.

The study aims at presenting legal and administrative reforms that would permit the government to promote effective use of energy in manufacturing industries on a nation-wide scale, medium- and small-scale manufacturing industries in particular, and diagnosing selected manufacturing factories and presenting recommendations for improving their energy use, as indicated in the Scope of the Study attached. Accordingly, the study may be broken down into two aspects: policy study and technical study; the former analyzes the administrative operation and legal structure of Turkey and presents recommendations deemed effective in promoting rational use of energy in industry, and the latter presents an energy audit of the four selected factories and makes recommendations for achieving better use of energy. The four factories audited are Henkel Turyag A.S., Dev Blok A.S., Izmir Demir Celik Sanayi A.S. (IDC), and Izmir Basma Fabrikasi A.S. (IBF), manufacturers of detergent and edible oil, bricks, steel and printed cotton cloths, respectively, all located in the Izmir area.

The consortium achieved the above objectives as explained in this report. The study took 15 months, from November 1995 to January 1997, during which period four field surveys and one draft final report presentation were done in Turkey. Two seminars, one in Ankara and the other in Izmir, were done during the period of the draft final report presentation. The field surveys and the presentation of the Draft Final Report and seminars were done during the period shown below.

First field survey:	November to December 1995
Second field survey:	February 1996
Third field survey:	July 1996
Fourth field survey:	July to September 1996
Draft final report presentation and seminars:	December 1996

Throughout the entire course of this study, the study team timely presented EIE the following reports:

Report	Submission	Content of Report
Inception Report	November 1995	Plan for the study execution
Progress Report-1	December 1995	Results of the first field survey
Interim Report	February 1996	Interim results
Measurement and Modification Plans for Energy Audit	April 1996	Plan for factory energy audit
Progress Report-2	September 1996	Results of the second field survey
Draft Final Report	December 1996	Explanation of the Final Report
Final Report (Main Report and Summary Report)	January 1997	Results of the entire study

The results of the study indicate that there is room for improvement both in the policy and factory operation as enumerated in subsequent chapters. This summary report does not contain the detailed processes to arrive at the conclusion and recommendations. For details reference should be made to the main report. .

The experts engaged in this study are shown below.

	Name	Belonging	Assignment
1	Koji Tanaka	TECHNO CONSULTANTS, INC.	Team Leader
2	Akinori Hashimoto	TECHNO CONSULTANTS, INC.	Energy Policy
3	Shun-ichi Iizuka	MITSUBISHI CHEMICAL ENGINEERING CORPORATION	Medium- and Small-scale Manufacturing Industries
4	Kazumitsu Mitani	MITSUBISHI CHEMICAL ENGINEERING CORPORATION	Process A (Detergent)
5	Yukio Nishimura	TECHNO CONSULTANTS, INC.	Process B (Brick)
6	Ryo Endo	TECHNO CONSULTANTS, INC.	Process C (Textile)
7	Isamu Kawakami	NKK Corporation	Process D (Iron and Steel)
8	Hironobu Yamada	MITSUBISHI CHEMICAL ENGINEERING CORPORATION	Process E (Vegetable Oil)
9	Muneteru Yoshizawa	TECHNO CONSULTANTS, INC.	Energy Management A (Heat)
10	Hirotaka Tokano	MITSUBISHI CHEMICAL ENGINEERING CORPORATION	Energy Management B (Heat)
11	Masao Kominami	MITSUBISHI CHEMICAL ENGINEERING CORPORATION	Energy Management C (Electricity)
12	Hisaichi Inoue	NIPPON OIL ENGINEERING AND CONSTRUCTION CO., LTD.	Energy Management D (Electricity)
13	Tetsuya Nimura	MITSUBISHI CHEMICAL ENGINEERING CORPORATION	Measuring Equipment
14	Tokuyosi Kawai	KOKAN KEISOKU K.K.	Measuring Equipment A (Iron and Steel)
15	Shinya Kinoshita	KOKAN KEISOKU K.K.	Measuring Equipment B (Iron and Steel)
16	Hironobu Honda	KOKAN KEISOKU K.K.	Measuring Equipment C (Iron and Steel)
17	Hirofumi Takahashi	CHUGAI TECHNOS CO., Ltd.	Measurement

Chapter 2 Summary of Major Conclusions and Recommendations

Chapter 2 Summary of Major Conclusions and Recommendations

2-1 Laws and Regulation, Administrative Organization

2-1-1 Organizations and their Functions

(1) Problem

The government has all the necessary departments and offices required for promoting rationalization of energy use but does not have an enough budget to promote energy saving. There should be more effective interdepartmental coordination.

(2) Recommendation

EIE should cooperate with KOSGEB of the Ministry of Industry to effectively promote energy saving to the medium- and small-scale manufacturing industries.

2-1-2 Energy Conservation Laws and Regulations

(1) Problem

In order to promote energy conservation, there is a need for a law on which nation-wide energy conservation measures can be based. The existing regulation does not cover the whole range of the industrial sector nor other sectors.

(2) Recommendations

1. The scope of the Regulation should be expanded to small manufacturing industries consuming less than 500 TOE of energy. The Regulation should however limit the obligation of these small energy users to reporting their annual energy consumption.

2. An energy conservation law which, of course, covers the manufacturing sector should be formulated.

2-1-3 Preparation of Guidelines

(1) Problem

Various kinds of non-compulsory energy conservation standards, or guidelines should be prepared. They should indicate quantitative targets for measures to improve energy efficiency.

(2) Recommendation

EIE is strongly expected to take initiative in the preparation of these guidelines such as:

1. To lower the intake air ratio, and excess oxygen content in exhaust gas to improve fuel combustion in furnaces, to the extent not increasing smoke generation,
2. To raise waste heat recovery rates up to standard values for promotion of effective waste heat recovery and utilization of equipment for such purposes,
3. To reduce heat loss that occurs in the form of radiation, convection and conduction, by applying heat insulation and other appropriate measures,
4. To improve operation of combined heat and power generation and to increase efficiency in the conversion of heat to power or the reverse,
5. To prevent electricity loss due to resistance and other causes and to keep power factors at adequate levels at electricity receiving end, in cooperation with TSI and other experts concerned.

These guidelines should be reviewed periodically every 10 years to adjust to advance of technology and energy situations.

2-1-4 Incentives, Preferential Measures -- Taxation and Loan

(1) Problem

Medium- and small-scale manufacturing industries are suffering from a shortage of funds for investment in equipment for improving energy efficiency. Government programs for assisting these industries are urgently needed.

(2) Recommendation

It is recommended to raise awareness of the existing measures such as tax reduction and low interest finance with a system of endorsement for debt.

An incentive package scheme should be instituted combining the existing incentives such as tax incentives, soft loans, energy audit and training.

2-1-5 Energy Managed Factories

(1) Problems

Medium- and small-scale manufacturing industries are mostly small energy consumers and fall outside the classes responsive to the Regulation. It is necessary to obtain accurate information on trends in energy consumption and conservation patterns of these small consumers.

(2) Recommendations

To revise the applicable scope of the Regulation downward to small- and medium-scale manufacturing industries which consume 500 TOE or more energy annually so that the Regulation may cover 90 percent or more of energy consumption by the manufacturing sector.

2-1-6 Qualification of Energy Managers

(1) Problems

The system for qualifying energy managers should be a socially authoritative one. Now, not all the energy-managed factories have enough qualified energy managers. Energy managers should be appointed at every energy-managed factory within these three years.

(2) Recommendations

1. Promotion and expansion of the energy management courses conducted not only by EIE but also by the authorized organizations, to train the factory personnel to be assigned to energy managers,
2. Expediting deployment of energy managers in three years. It is advisable that a state-approved qualification system be applied to energy managers in such a way as by giving certificates to graduates of technology courses and to factory engineers with years of experiences in energy conservation.
3. Qualified energy managers should be registered after they are posted to energy-managed factories. EIE should provide them with updated information obtained by factory surveys and from foreign sources on energy conservation, as well as communicate government measures and give specialized technical education. The qualified energy managers can perform as auditors or consultants for small-scale factories which are not designated.

2-1-7 Energy Conservation Training Center

(1) Problem

Managements and engineers of medium- and small-scale manufacturing industries do not generally have good opportunities to be trained in the latest technology.

(2) Recommendation

EIE/NECC should be strengthened by having a training center equipped with a model plant to carry out practical energy conservation operations there and by developing an energy data base system capable of serving engineers at medium- and small-scale industries.

2-1-8 Organization and Role of EIE/NECC

(1) Problem

EIE and NECC's Industrial Energy Conservation Division are the main governmental organizations for promoting energy conservation in industry. EIE is not allowed to establish a new department or division in NECC. EIE/NECC are not vested with powerful authority. EIE does not operate a factory; consequently, its capability to sort out and collect valuable technical information tends to be limited.

(2) Recommendation

The officials of NECC are recommended to further continue their energy conservation activities. One option is to expand their mandate and to clearly define responsibilities of given positions.

Definition of the role of EIE/NECC as an administrative body is an important issue. One possible option is to intensify their authority by making it a management supervisory organization. It is also hoped that the current energy conservation activities, education and consulting, will be further developed and enhanced drawing upon international collaboration schemes.

2-1-9 EIE/NECC Activities, Energy Audit

(1) Problem

Analytic technology, engineers and equipment are not necessarily sufficient even in large-scale manufacturing industries. Small- and medium-scale industries are in much poorer condition. EIE should use human resources available inside and outside itself to cope with increasing needs for audits.

(2) Recommendation

1. To conduct simpler energy audits mainly at small- and medium-scale factories not designated as energy-managed factory in the regulation, in order to arouse their interest in energy conservation. In this regard, collaboration of KOSGEB is essential in selecting candidate factories worth auditing.

2. Possibility of introducing paid energy audits at large energy-managed factories should be studied, because auditing large factories would require a great deal of human resources and costly experts from outside the government including expatriate experts, if precise and high-level diagnosis and guidance service are done. The managements of the designated factories should audit their factories and identify their energy saving potentials and associated economics.

2-1-10 Dissemination of Technical Information, EIE/NECC

(1) Problem

Factory managers and engineers are not provided with sufficient information on energy conservation. Provision of the latest technical information will serve to upgrade their technical levels and to promote their energy conservation activities.

(2) Recommendation

1. To intensify their activities on small- and medium-scale industries and to seek collaboration with KOSGEB
2. To prepare a pocket-sized Energy Conservation Reference Book

2-1-11 Establishment of Energy Data Base System, EIE/NECC

(1) Problem

Accurate information is not available on energy consumption or conservation throughout the whole range of manufacturing industries, classified by the sector/subsector, and by the size groups.

(2) Recommendation

1. To establish information service outlets, such as EIE's Industrial Data Base Evaluation Book
2. To strengthen the information gathering system, especially in smaller-scale industry, by expanding the scope of the Regulation to obliging smaller energy consumers to report their annual energy consumption
3. To broaden EIE's channels for the acquisition of international technical information on energy conservation by promoting cooperative relations with overseas organizations, then to make the obtained information public
4. To install an on-line information provision and retrieval system

2-1-12 Energy Conservation Seminar, EIE/NECC

(1) Problem

There is a shortage of engineers and technology at small-and medium-scale factories. Factory managers and staff are not sufficiently aware of the need for energy conservation, because they are concerned more about production and cost.

(2) Recommendation

It is recommended to hold seminars concerning successful examples of energy conservation in real factories and to give education in energy conservation to management and engineers of medium- and small-scale manufacturing industries, which are not designated as energy-managed factories. Publication of successful examples of energy conservation will be effective in helping those engineers recognize the importance of energy conservation. Here participation by KOSGEB is essential.

2-2 Factory Audit

2-2-1 Detergent, Oil and Fats Factory, Henkel-Turyag

The study team presents the following recommendations.

1. Improvement of heat balance around boilers
   The factory should measure lignite consumption rate directly in order be able to better control and manage thermal efficiency continuously around the boiler.
2. Correction of imbalance between steam consumption and power generation
   It is necessary to increase steam consumption and decrease purchased electricity consumption.
3. Improvement of heat balance aground the spray dryer and air heater
   The heat balance should be improved by plugging the leakage points, finding relationship between the moisture content of the powder and temperature, and inlet and outlet gas temperature control.
4. Improvement of heat balance in the sulfonation process
   Heat recovery from cooling air by re-installation of the BFW pretreater, 12E8, is recommended.
5. Improvement in the steam condensate recovery system
   Isolation of the line cleaning system from the condensate system, preparation of a standard operation manual, identification of important valves by color marks are recommended.
6. Decreasing heat loss in the steam trap system
   Improvement of stream trap maintenance is recommended.
7. Decreasing heat loss in the thermal insulation system
   Some of the valves and flanges should be insulated.
8. Reduction of electricity consumption
   Unification of Transformers Nos. 1, 3, and 6 and adoption of inverter speed control system of motors should be studied.

2-2-2 Brick Factory, Dev Blok

The study team presents the following recommendations.

1. Improvement of raw material control and molding operation

Control of the black clay content is recommended.

2. Expansion of the drying process
   Addition of one drying chamber is recommended.
3. Provision of equipment needed for improving energy balance of the tunnel kiln
   Installation of a double door is recommended.
4. Addition of a cyclone separator to the powdered coal feeding system
   Installation of a cyclone separator is recommended to remove coarse particles of coal. Provision of a gas analyzer is also recommended.
5. Systematic approaches to save electricity
   Pole changes, impeller cutting, size down and other measures are recommended when problems are found with the pumps.

2-2-3 Textile Factory, IBF

IBF plans to construct a new dyeing factory in a suburb of Izmir. The study team presents recommendations to the design of the new factory and improvement of the existing one.

(1) New Factory

1. CHP system should be studied.
   The combined heat power system should be studied as a means to effectively utilize thermal energy of gas.
2. The package boiler system should be studied.
   The package boiler system could constitute an alternative for the above and should also be studied.
3. Direct heating system should be studied instead of the hot oil system.
   Direct heating system would be more thermally efficient and should be studied.
4. Computer controlled energy management system
   Systematic and real-time approach is necessary for energy management.

(2) Existing Factory

1. Heat recovery from waste water from the open width bleaching range
   Heat loss with the high-temperature waste water is the largest heat loss. Lowering of the operation temperature, installation of waste water reservoir, automatic water supply system, waste heat recovery system are recommended.
2. Automation of the Max Goller washing range
   Measurement of steam flow rate is necessary.

3. Improvement of the condensate recovery system
   Condensate is not recovered now. It should be recovered.
4. Application of insulation to valves and flanges
   High temperature valves and flanges should be insulated.
5. Installation of meters necessary for monitoring energy consumption
   This factory has very few flow meter. Each machine should have water, electricity and steam flow meters.
6. Computerized maintenance system
   Personal computers should be used for executing systematic maintenance.
7. Adjustment of the steam boiler load
   When the load is low, two instead of three boilers should be operated.

2-2-4 Steel Mill, IDC

The study team presents the following recommendations

1. Modification of the scrap preheaters to accommodate a third bucket for preheating
   Installation of additional hood, duct, and two blowers is recommended to enable the scrap preheater to accommodate a third bucket for preheating.
2. Improvement of the maintenance of oxy-fuel burners of EAF to keep the O_2/Oil ratio constant
3. Standardization of burnt lime addition into EAF
4. Decreasing of flow rate of cooling water for EAF

   Items 2,3 and 4 are solutions to the problems with the electric arc furnace operation observed by the study team.

5. Introducing billet cooling system at higher temperature in front of the reheating furnace to prevent crack generation in cast billet
   Installation of a pumping system, water piping, spray nozzles and control system should be installed.
6. Turning on power as immediately as possible to prevent the drop of hot heel temperature
7. Preheating scrap as longer as possible to raise it temperature

   Items 6 and 7 are also measures for improving thermal efficiency of the electric arc furnace.

8. Purchasing calcined burnt lime of good quality

   Poorly calcined burnt lime contains limestone which consumes heat on decomposition and thereby lowering the thermal efficiency.

Chapter 3 Background of the Study

Chapter 3 Background of the Study

The government of Turkey, being heavily dependent on import for the supply of energy, has been keenly promoting energy saving since the energy crises. EIE has been playing the central roles in this effort. In December 1992, the Energy Resources Supply Department under EIE was appointed to the National Energy Conservation Center (NECC).

The following table, which was provided to the Preparatory Study Team of JICA in 1995, shows the consumption of various types of energy and their projections. The forecast consumption has been revised since then but here the then official table is shown. This table shows that consumption of commercial energy increased very rapidly. During the three year period from 1992 to 1995 the consumption of the total commercial energy and petroleum increased at a rate of 6.29 and 4.58 percent per year, respectively.

Types of Energy	1992	1995	2000	2005	2010
Coal, thousand tons	8,841	9,498	9,272	19,708	46,824
Lignite, thousand tons	50,659	63,259	112,849	144,823	181,664
Natural asphalt, thousand tons	197	750	750	750	750
Petroleum, thousand tons	23,729	27,142	30,061	34,196	39,599
Natural gas, 10^6 cubic meters	4,612	8,501	19,988	25,879	30,594
Hydro electric power, GWh	26,568	35,841	41,633	63,852	76,365
Geothermal electric power, GWh	70	90	90	90	90
Geothermal energy, thousand tons of oil equivalent	30	285	1,540	3,570	6,500
Solar energy, thousand tons of oil equivalent	32	116	335	628	1,075
Nuclear power, GWh				7,017	14,035
Imported electricity, GWh	-125				
Total, Commercial energy, thousand tons of oil equivalent	49,161	59,041	81,948	108,395	147,180
Firewood, thousand tons	18,070	18,374	19,487	19,627	19,767
Other biomass, thousand tons (unit not shown)	10,922	10,682	9,839	9,045	8,260
Total, Non-commercial energy, thousand tons of oil equivalent	7,933	7,969	8,109	7,968	7,830
Total, thousand tons oil equivalent	57,094	67,010	90,057	116,363	155,010

This table vividly explains energy policy of the republic. The government wished to increase the consumption of lignite, a resource domestically available, and to hold down the consumption of petroleum, which is chiefly imported. By the year 2000, the consumption of lignite would have exceeded that of petroleum in calorific value, according to this table. Natural gas consumption will catch up that of petroleum; it will become comparable with petroleum in the period from 2005 to 2010.

Understandably, the government of Turkey wishes to make the most of the domestic energy resources. The rate of increase of the commercial energy consumption between 1995 and 2000 is very high at 6.8 percent. With such high growth of energy consumption, it is quite natural that the government should be quite concerned about consumption of energy.

EIE has promoted conservation of energy in various sectors, of its own and also under the cooperation of international organizations. The activities of EIE were however oriented towards large-scale industries and limited mainly to energy audits. The legal structure necessary for the promotion of energy saving was not established.

Under such circumstances, the government of Turkey has requested the government of Japan to conduct a master plan study on rational use of energy in the industrial sector. In response to the request, the government of Japan sent to Turkey two missions of JICA, once in March 1995 and again in June in 1995. On June 30, 1995, the government of Turkey and JICA agreed and signed the SCOPE OF WORK FOR THE STUDY and the MINUTES OF MEETING ON SCOPE OF WORK FOR THE STUDY; the former stipulates the scope of work, schedule and the undertakings by the government of Turkey, the latter contains appendage to the SCOPE OF WORK, list of participants in the meeting and filled-in questionnaire.

JICA has selected a consortium of TECHNO CONSULTANTS, INC. and MITSUBISHI PETROCHEMICAL ENGINEERING CO., LTD. and entered into contract with the consortium for the execution of the study. The consortium has formed a study team consisting of the members shown in Chapter 1. The consortium executed the study basically according to the agreement between the government of Turkey and JICA.

EIE has selected the four factories mentioned in Chapter 1 to be examined by the study team. A steering committee consisting of the representatives of EIE, the Ministry of Energy and Natural Resource, the State Planning Committee, the Ministry of Industry, the State Statistical Institute and the Turkish Standard Institute was formed to support this study.

Chapter 4 Energy Situation

Chapter 4 Energy Situation

The energy situation including long-term energy demand supply of Turkey are described in this chapter.

4-1 Energy Situation in Turkey

(1) General

The population, GDP, primary energy consumption, energy consumption per unit of GDP, and primary energy consumption are summarized in Table 4-1.

Table 4-1 Energy Situation in Turkey

	1985	1990	1991	1992	1993	1994
Population, (Million)	50.3	56.1	57.3	58.6	59.9	61.2
GDP, (Trillion TL)	35.1	393.1	630.1	1,093.4	1,981.9	3,883.8
GDP Constant, (Trillion TL)	63.8	83.5	84.4	89.4	96.6	91.3
TPEP, (MM TOE)	21.7	25.8	25.8	27.1	26.8	26.9
TPEC, (MM TOE)	39.2	53.3	54.6	57.0	60.6	59.5
TPEC/GDP, (TOE/MMTL)	0.61	0.64	0.65	0.64	0.63	0.65
TPEC/Capita, (kgOE)	779	951	953	973	1,013	973
Total Electric, (TWh)	29.7	46.8	49.3	54.0	59.3	61.4

Note: TPEP: Total Primary Energy Production
TPEC: Total Primary Energy Consumption

From the above table, it may be noted that:

1. Population increased at an annual average growth rate of 1.4 percent in the period 1985 - 1994.
2. GDP at a constant price of 1987 base increased at an annual average growth rate of 4.1 percent in the period 1985-1994.
3. Total energy consumption increased at the level of real GDP growth; however, energy consumption per unit GDP remained at a constant level during 1985-1994.

(2) Total Primary Energy Supply and Consumption

Total primary energy supply reached 59,489 thousand TOE in 1994, showing an annual average growth rate of 2.8 percent during 1990 - 1994. In 1994, while GDP in Turkey decreased by 5.4 percent, primary energy consumption also decreased by 1.9 percent. As much as 45 percent of the primary energy consumption was met by domestic resources. The supply increased by 6.0 percent in 1995.

Total final consumption of energy was 49,382 thousand TOE in 1995. The difference between the total primary energy supply and the total consumption of final energy consists of energy losses in the production of electricity, refinery uses, losses, etc.

(3) Import and Export

Table 4-2 gives the total energy import and export for 1995 using the unit of TOE. It should be noted that crude oil, representing 71.4 percent of the total import of energy and 23.5 million tons of crude oil, was imported from various countries and 2.9 billion dollars was spent for this purpose. Furthermore, oil products of 3.4 million tons were imported. For this importation, 674 million dollars was paid. Conversely, oil products of 1.6 million tons were exported and 164.9 million dollars of income was realized.

Table 4-2 Import and Export of Energy in 1995

Unit: 1,000 TOE

	Hard Coal	Second Coal	Petro Coal	Lignite	Oil	Natural Gas	Electricity	Total
Import	4,347	127	715	3	28,345	6,147	0	39,684
Export	0	0	0	0	1,888	0	60	1,947

(4) Energy Consumption by Sector

Sectoral energy consumption is shown in Table 4-3. The share of energy consumption in industry increased while that of residential/commercial decreased as a result of the economic development of the country in the period of 1985-1990, but the share was at the same level between 1990 and 1994.

Table 4-3 Sectoral Energy Consumption

	1985		1990		1994		1995	
	MM TOE	%	MM TOE	%	MM TOE	%	MM TOE	%
Resident/ commercial	14.21	44	15.70	37	16.74	37	17.42	35
Industry	9.78	30	14.54	35	14.97	33	17.00	34
Transport	6.20	19	8.72	21	9.91	22	11.12	23
Agriculture	1.51	5	1.96	5	2.48	5	2.50	5
Non energy	0.81	2	1.03	2	1.35	3	1.40	3
Final energy consumption	32.50	100	41.96	100	45.45	100	49.38	100

Source: MENR

4-2 Long-Term Energy Demand Supply Projections

MENR projects energy demand supply up to 2010. The projection is summarized in Table 4-4 which indicates that primary energy demand would be 90.1 million TOE in 2000, 155.6 million TOE in 2010. Indigenous production to meet the energy demand is projected to be 44 percent in 2000 and 38 percent in 2010, which shows that the share will decrease progressively. According to the projection, 95.7 million TOE of energy is required from outside which is about 2.7 times the energy import in 1994.

Sectoral energy demand projection by MENR is summarized in Table 4-5, which shows higher growth in the industrial sector.

Table 4-4 Projected Energy Demand

		1995	2000	2005	2010
Primary Energy Production (MMTOE)		26.63	39.50	48.85	59.87
Primary Energy Demand (MMTOE)		62.22	90.08	116.92	155.59
Hard Coal	(MT)	8.39	10.12	21.23	49.12
Lignite	(MT)	54.60	112.85	147.10	183.94
Asphaltite	(MT)	0.09	0.75	0.75	0.75
Oil	(MT)	26.99	29.93	34.16	39.81
N. Gas & LNG	(10^6m^3)	7.28	19.99	25.88	30.59
Hydro	(TWh)	31.73	41.93	64.99	77.56
Geothermal					
Elec.	(TWh)	0.08	0.09	0.09	0.09
Heat	(MMTOE)	0.22	1.16	2.69	4.90
Solar	(MMTOE)	0.05	0.09	0.17	0.31
Nuclear	(TWh)	-	-	7.02	14.04
Elect. Imports	(TWh)	0.39	-	-	-
Central Heating	(MMTOE)	0.07	0.24	0.46	0.77
Wood	(MMT)	18.37	19.49	19.63	19.77
Dung	(MMT)	10.68	9.84	9.05	8.26

Source: MENR

Table 4-5 Projected Sectoral Energy Demand

Unit: Million TOE

	1995	2000	2005	2010
Industry	18.18	28.68	40.76	57.49
Resident	17.48	23.90	28.24	33.19
Transportation	10.83	14.23	17.56	21.72
Agriculture	2.79	3.68	4.72	5.86
Non-Energy	1.51	1.63	1.75	1.90
Final Energy Consumption	50.79	72.11	93.04	120.15
Convers. Sector	11.44	17.97	23.89	35.44
Primary Energy Consumption	62.22	90.08	116.92	155.59

Source: MENR

4-3 Energy Saving Potential

The total energy saving potential for the end-use sectors have been identified to be approx. US 2.6 billion dollars or 13.2 million TOE annually as explained in Table 4-6.

Table 4-6 Energy Saving Potential for Three End Use Sectors (in 1993)

	Million TOE	Million US$	Percentage
Industry	5.3	1,130	30
Building	5.1	1,190	30
Transport	2.8	262	27
Total	13.2	2,582	-

Source: Turkey Energy Report 1994

4-4 Energy Consumption in Medium- and Small-scale Manufacturing Industries

After a tenacious search for information on consumption of energy by the medium- and small-scale manufacturing industries, there seems to be no printed information on this matter. EIE is establishing an energy data base as a means for monitoring energy consumption in the industrial sector through sending a questionnaire to about 1,000 establishments out of their 1,500 establishments list every two years starting from 1991. The information on the energy consumption and production of approximately 700 industrial plants are compiled, evaluated and issued.

By using the available data base received from EIE "Industrial Data Base Evaluation 1991 by EIE", the study team tried to examine the present situation of energy consumption by sectors/subsectors and energy consumption by kinds of fuel in medium- and small-scale manufacturing industries. Since the data base does not seem to represent exactly all the medium- and small-scale industries, only distribution ratios are analyzed here.

(1) Total Fuel Use by Type of Fuel

Solid fuels such as coal, lignite and petrocoke are widely used and account for about 51 percent of total fuel consumption. The second largest group is liquid fuels such as fuel oil, diesel oil and gasoline and accounts for 33 percent; gas fuel including natural gas accounts for only 16 percent. Of all kinds of fuels, hard coal accounts for 29.0 percent, followed by fuel oil at 25.6 percent and lignite at 15.1 percent.

(2) Energy Consumption by Sectors/Subsectors based on EIE Study

A large portion of fossil fuel is consumed by the iron & steel industry which accounts for 35 percent of fuel consumption by the industrial sector. The second largest is the cement industry that accounts for 19 percent, the third largest is the petrochemical industry accounting for 9 percent.

More than half of the solid fuel is consumed by the iron & steel industry, consuming mainly hard coal; the second largest consumer of solid fuel is the cement industry consuming mainly lignite-4500/3000.

Fuel oil is used mainly in the petrochemical, iron & steel and cement industries. Natural gas and LPG are the two main gaseous fuels, used mainly in fertilizers, iron & steel and cement industries.

Electricity consumption also follows a pattern similar to fossil fuel; the iron & steel industry is the first and the cement and petrochemical industries the second and third, as may be noted from Table 4-7.

Table 4-7 Energy Consumption (%) by Sectors/Subsectors

		Fossil Fuel				Electricity
Sectors	**Subsectors**	**Solid**	**Liquid**	**Gas**	**Fuel Total**	
Metal	Iron & Steel	50.26	17.85	23.76	35.18	22.35
	Aluminum	0.50	2.92	0.13	1.25	7.47
	Copper	0.02	0.36	0.06	0.14	1.19
	Others	1.39	1.20	1.35	1.32	4.47
Non-metal	Cement	26.05	10.53	13.38	18.86	15.63
	Glass	0	2.49	8.52	2.20	1.54
	Bricks/Tiles	0.81	1.44	0.20	0.92	0.38
	Ceramics	0.17	1.18	8.86	1.90	1.48
	Other	0.56	0.80	0.14	0.57	0.40
Chemicals	Fertilizers	2.22	0.94	25.42	5.50	2.44
	Petrochemicals	0	22.94	7.57	8.88	7.72
	Main Chemicals	0.53	3.74	0	1.52	0.41
	Tires	0	0.95	0	0.32	0.71
	Pharmaceuticals	0	0.39	0	0.13	0.14
	Cleaning Materials	0.16	0.32	0.23	0.22	0.20
	Dyes/Varnish	0.02	0.24	0.01	0.09	0.14
	Others	0.66	1.00	0.97	0.62	0.75
Food	Sugar	10.14	2.84	0.05	6.08	2.53
	Edible Oils	1.15	1.29	0	1.01	0.95
	Alcoholic Bev.	0.06	1.37	0	0.49	0.43
	Tea	1.25	0.09	0	0.66	0.32
	Flour & Product	0.12	0.35	0.31	0.23	0.35
	Milk & Products	0	0.24	0	0.08	0.10
	Others	0.09	2.29	0.20	0.54	0.93
Textile	Weaving	2.29	8.50	5.66	4.90	5.63
	Carpets	0.01	0.08	0.37	0.09	0.31
	Knitting & Ready	0	0.44	0	0.15	0.17
	Others	0	0.77	0.28	0.30	0.78
Paper	Paper & Pulp	0.56	9.13	0.75	3.46	6.86
	Cardboard	0.20	0.10	0.01	0.14	0.27
Metals Fabricated	Auto Spares	0.01	0.45	0.30	0.20	1.15
	Machines Products	0.15	0.38	0.01	0.21	0.24
	Automotives	0.07	0.83	0.25	0.35	5.25
	Durable Goods	0.01	0.50	0.78	0.29	0.95
	Others	0.03	0.46	0.11	0.19	0.56
Forest	Wood	0.51	0.52	0.33	0.49	0.64

(Source: EIE Industrial Data Base Evaluation 1991)

4-5 Energy Prices

All energy prices except oil product prices are determined by the Turkish government. Oil product prices have been determined by refineries, importing companies and distributing companies since 1989. Coal prices are set annually by TKI and TTK, which are state enterprises. For electricity, there also exists a two-rate tariff for peak-period and non peak-period consumption, the latter is approximately 10 percent less expensive. The energy prices on a heat equivalent basis for industry in US dollars are shown in Table 4-8.

Table 4-8 Energy Prices for Industry in US Dollars

Unit: US$/TOE

	1981	1991	1992	1993	1994
Turkey					
Natural Gas	-	151.9	149.3	173.7	156.4
Heavy Fuel Oil	292.8	186.8	171.4	159.5	125.8
Steam Coal	146.3	117.7	125.0	100.6	74.1
Electricity	715.4	971.3	1075.7	1102.8	891.0
Japan					
Natural Gas	553.2	471.9	484.6	516.6	518.0
Heavy Fuel Oil	279.8	250.5	219.1	225.9	187.3
Steam Coal	121.0	99.6	90.3	86.3	82.7
Electricity	1159.6	1538.9	1652.0	1892.7	2031.8
Germany					
Natural Gas	181.4	223.5	222.8	208.1	205.4
Heavy Fuel Oil	218.6	140.4	136.6	121.0	128.1
Steam Coal	156.8	253.1	285.9	271.4	277.7
Electricity	602.2	1019.8	1081.6	1039.0	1072.5
France					
Natural Gas	207.1	168.1	169.8	158.9	157.5
Heavy Fuel Oil	204.9	119.3	123.3	107.7	147.5
Steam Coal	110.2	131.5	141.3	133.3	135.9
Electricity	475.9	625.8	664.4	636.0	617.6
UK					
Natural Gas	186.2	180.0	175.1	143.4	140.3
Heavy Fuel Oil	225.8	124.8	115.9	100.5	118.3
Steam Coal	126.7	123.0	121.3	96.9	97.8
Electricity	733.2	830.6	887.4	787.4	794.2
USA					
Natural Gas	134.4	112.3	118.2	127.0	125.9
Heavy Fuel Oil	192.1	87.3	89.3	97.1	103.1
Steam Coal	69.0	58.6	57.4	56.9	56.9
Electricity	498.8	565.1	564.0	565.1	548.8
OECD					
Natural Gas	144.6	139.2	142.0	142.9	142.3
Heavy Fuel Oil	211.3	149.8	139.9	131.8	132.0
Steam Coal	91.9	95.4	107.7	96.9	97.5
Electricity	607.0	834.4	874.3	876.9	899.2

Source: Based on data from IEA (Energy Prices and Taxes)

Chapter 5 Energy Conservation Policy and Medium- and Small- Scale Industries

Chapter 5 Energy Conservation Policy and Medium- and Small- Scale Industries

The energy conservation policy in Turkey considering medium- and small-scale manufacturing industries is summarized in this chapter.

5-1 Concept of Government Policy on Energy

The basic energy policy of Turkey is concentrated on assurance of energy supply; reliably, sufficiently, on time, in economic terms, considering environmental impact and in a way that will support targeted growth and social development. The government has focused its efforts on improvement of domestic production by utilizing public, private and foreign investments, and increasing efficiency by rehabilitation and acceleration of existing construction programs to initiate new investments.

Energy saving is another principle in Turkish energy policy. Nevertheless Turkish energy strategy is aimed at satisfying demand without hampering economic growth. In order to meet this aim, along with enhanced recovery of domestic sources, energy management, rational utilization and conservation of energy are also adopted as other elements of the Turkish national policy to secure the supply and to protect the environment.

To ensure these policy objectives, the Turkish Government has been promoting energy conservation on a national scale and accelerating development of alternative energy resources since the early of 80's.

5-2 Organization related to Energy Conservation

Organizations in charge of energy conservation in Turkey are the Ministry of Energy and Natural Resources (MENR) and the General Directorate of the Electrical Power Resources Survey and Development Administration (EIE)/National Energy Conservation Center(NECC). There are letters of mandate to EIE, one dated March 30, 1981, to establish the new administration for energy conservation and renewable energy written by the Minister of Energy and an approval letter by SPO dated July 2, 1981. The Energy Conservation Division of EIE was nominated as National Energy Conservation Center (NECC) of Turkey by the end of 1992.

Besides MENR and EIE/NECC, several organizations such as State Institute of Statistics, Turkish Standards Institute (TSI) and the Ministry of Industry and Commerce are related to energy conservation activities.

5-3 Medium- and Small-Scale Manufacturing Industry

The importance of energy conservation in medium- and small-scale industry and energy consumption rate by size are summarized below.

(1) Importance of Energy Conservation in Medium- and Small-Scale Industry

To save energy is surely to reduce production cost. This is true especially for smaller scale plants. The importance of energy conservation shall be emphasized for them. The ratio of energy consumption including raw material to input by each size group shows this fact as summarized in Table 5-1.

Table 5-1 Ratio of Energy Consumption to Input

Size	1-9	10-49	50-99	100-199	200-499	500-999	1000 +	Total
Ratio(%)	97.6	85.5	85.2	84.9	79.9	89.7	89.1	86.9

Ratio = Energy and Raw Material Input / Total Input

(2) Energy Consumption Rate by Size

The Regulation on Energy Efficiency Improvement in Industrial Plants was issued on November 11, 1995. This regulation is applied to industrial establishments annually consuming energy equal to or more than 2,000 TOE. It would be helpful to conduct an energy conservation program in industry since the energy consumption covered by the Regulation will be more than 70 percent of the total. But the Regulation does not cover all of the industrial sector; most medium- and small-scale manufacturing industries fall outside of the Regulation coverage.

In this regard the study team, after comprehensive discussion with EIE, concludes that more effort should be made for energy conservation in smaller scale factories which consume less than 2,000 TOE annually.

(3) Bottlenecks in Energy Conservation in Industry

Bottlenecks become more pronounced when industries become smaller.

1) Lack of information

Insufficient recognition of the importance of energy conservation, ambiguity of the effect of various measures for energy saving, inadequate PR activities and lack of information appear to be major bottlenecks.

2) Lack of technology and skill

Insufficient technical knowledge and experience, and low credibility of new technologies are bottlenecks. This could be coped with partially by intensification of information collection and extension activities by EIE/NECC.

3) Lack of funds

An appropriate institutional financing system should be considered.

4) Insufficient availability of equipment for energy saving

Industries manufacturing and selling energy saving equipment are not full-fledged. Measures to stimulate their growth are important.

5) Return on investment in energy saving measures

Promotion activities are needed for evaluating returns on investment

5-4 Energy Conservation Measures

The energy conservation measures such as energy conservation laws and regulation, incentives and awareness are stated below.

5-4-1 Energy Conservation Laws and Regulation

(1) Energy Conservation Laws

In 1981 a proposal for a new law concerning energy conservation was prepared by MENR and submitted to Parliament, but was never enacted. Today, there are no laws or regulations in force except for the energy conservation regulation summarized below.

(2) Energy Conservation Regulation

1) Purpose

To provide necessary arrangements to improve efficiency in the energy intensive industrial sector

2) Scope

The private and public industrial enterprises including mining exploitation and processing enterprises, and establishments which have annual energy consumption equal to or higher than 2,000 TOE

3) Legal Basis

This regulation is prepared in accordance with the law of Organization and Duties of Ministry of Energy and Natural Resources (MENR) and shall be under the authorization of Minister of MENR, EIE is responsible for implementation of this regulation in plants on behalf of MENR.

4) Measures for Improving Energy Efficiency

The plants will take necessary measures and make efforts to improve the efficient use of energy in various areas. Furthermore, these points shall also be taken into consideration when installing new plants, increasing production capacity or modernizing of the plants.

5) Energy Audits

Energy audits for identifying energy saving potentials and monetary savings of plants shall be conducted within 3 years from the issuance date of this regulation. Results of the audits shall be submitted as a report to the NECC.

6) Preparation of Energy Conservation Plans

Plant management will prepare energy conservation plans considering energy audits for minimizing energy losses and modernization.

7) Monitoring Energy Consumption

Plants will monitor energy conservation of 3 main products monthly and annually. Plant management will ensure purchasing of measuring equipment and these equipment will be periodically controlled and calibrated by TSI (Turkish Standards Institute) for monitoring.

8) Energy Control Committees and Energy Managers

Plants shall set up Energy Manager and Energy Control Committee according to their energy consumption rate.

9) Energy Management Certificate

NECC will organize Energy Management courses for the nominated technical staff of the plants to train in Energy Management or authorize the involved organizations to organize Energy Management Courses.

10) NECC

NECC will carry out energy audit and training programs, publications and promotion programs in order to increase industrial energy efficiency. During these activities the plants will cooperate with NECC to achieve more effective results.

5-4-2 Incentives

There are legal and administrative incentives which can be applied to promoting energy conservation but they are not well known widely. The most popular legal incentives are tax credits and tax exemptions. Soft loans are available for medium- and small-scale manufacturing industries.

5-4-3 Awareness

One of the main requirement of energy conservation is the enhancement of awareness and related activities such as promotion, publication and education. These are described in the following section.

5-5 Activities related to Energy Conservation

As stated before, EIE/NECC is the main body to promote energy conservation in Turkey. The activities of EIE/NECC related energy conservation are summarized below.

(1) Awareness

EIE became involved in energy conservation as early as 1980 and established its own energy conservation team backed up by the necessary equipment and vehicles to carry out various energy conservation activities. NECC's activities include training bus programs, energy bus program, publications, energy conservation campaign, etc.

1) Training Bus Program

In 1993 a training bus program was launched. In this program, engineers of the Center visit plants and give seminars in the bus on various energy conservation topics such as energy management, insulation, combustion, efficient use of electric and steam systems, to the technical personnel of the plants. In these programs seminar notes and technical manuals are provided for the participants.

2) Energy Bus Program

Energy Audit Teams have conducted 36 energy audits in various Turkish industrial plants since 1990. The Energy Bus Programs aim to create energy conservation awareness in industry, identify the energy saving potentials and help to establish energy management in the plants.

3) Publications

Within the scope of promotion activities, approximately 60 publications have been issued. These publications have been mailed to a total of 2,500 addresses including 1,500 major industrial establishments. The Newsletter has become a periodical publication and other publications are prepared upon request from readers.

4) Energy Conservation Campaign

During Energy Week, held in the 2nd week of every January, an energy conservation campaign is held to promote the awareness of energy conservation. Activities during the energy week include exhibitions, conferences consisting of energy conservation programs, energy conservation implementation in several industries, and household and technical discussions. In addition, an awards ceremony for energy conservation among high schools is held.

(2) Policy Study and Data Base

Various studies on energy conservation are also carried out by EIE/NECC. Among them, EIE/NECC is conducting policy studies and establishment of data base system with high priority.

1) Policy Studies

The Center has been developing a national energy conservation strategy with the collaboration of EU. Within this project a computer model has been developed to forecast energy consumption in industry, residential buildings and the transport sector. The computer model developed in this project will be used as a tool to evaluate different technical options and to set up estimates of the energy benefits accruing from various energy conservation strategies.

To increase energy efficiency in industry, as a result of studies, a regulation has been issued. With this regulation, industrial establishments that have over 2,000 TOE energy consumption have to establish an energy management system in plants to increase energy efficiency.

2) Data Base

To monitor energy consumption in the industrial sector, a data base program has been established. Every two years, information on energy consumption and production of the above mentioned

1500 industrial plants is compiled, evaluated and published. The results for 1983, 1985, 1987, 1989, 1991 have been published thus far.

5-6 Plan for Rational Use of Energy

The study team devised an action plan, on a tentative basis, to promote rational use of energy in medium- and small-scale industries as illustrated in Figure 5-1. This shows the improvement of model factories on a plan-do-see cycle to achieve better use of energy along with the measures EIE and concerned government organizations can take at the right time.

5-7 Recommendations on Energy Conservation Policy and Activities

Referring to the current situation of organization, energy conservation measures and activities taken in Turkey, recommendations on energy conservation are described in Table 5-2. The tables consist of present state, problems and analysis, recommendation, responsible organizations and priority. Recommendations are divided into three sections as shown below.

1. Institutional Functions and Measures
   - 1-1 Organization and functions
   - 1-2 Energy Conservation Laws and Regulations
   - 1-3 Preparation of Guidelines
   - 1-4 Incentives
   - 1-5 Energy Managed Factories
   - 1-6 Qualification of Energy Managers
   - 1-7 Energy Conservation Training Center
2. Organization and Role of EIE/NECC
3. Activities of EIE/NECC
   - 3-1 Energy Audits
   - 3-2 Dissemination of Technical Information on Energy Conservation
   - 3-3 Establishment of Energy Data Base System
   - 3-4 Energy Conservation Seminars for Medium- and Small- Scale Factory Management and Engineers

Among above recommendations, Items 1-1, 3) Planning, 1-3 Preparation of Guidelines, 1-4 Incentives and 1-7 Energy Conservation Training Center are highlighted in detail. Reference should be made to Chapter 7 of the Main Report for the highlighted recommendations.

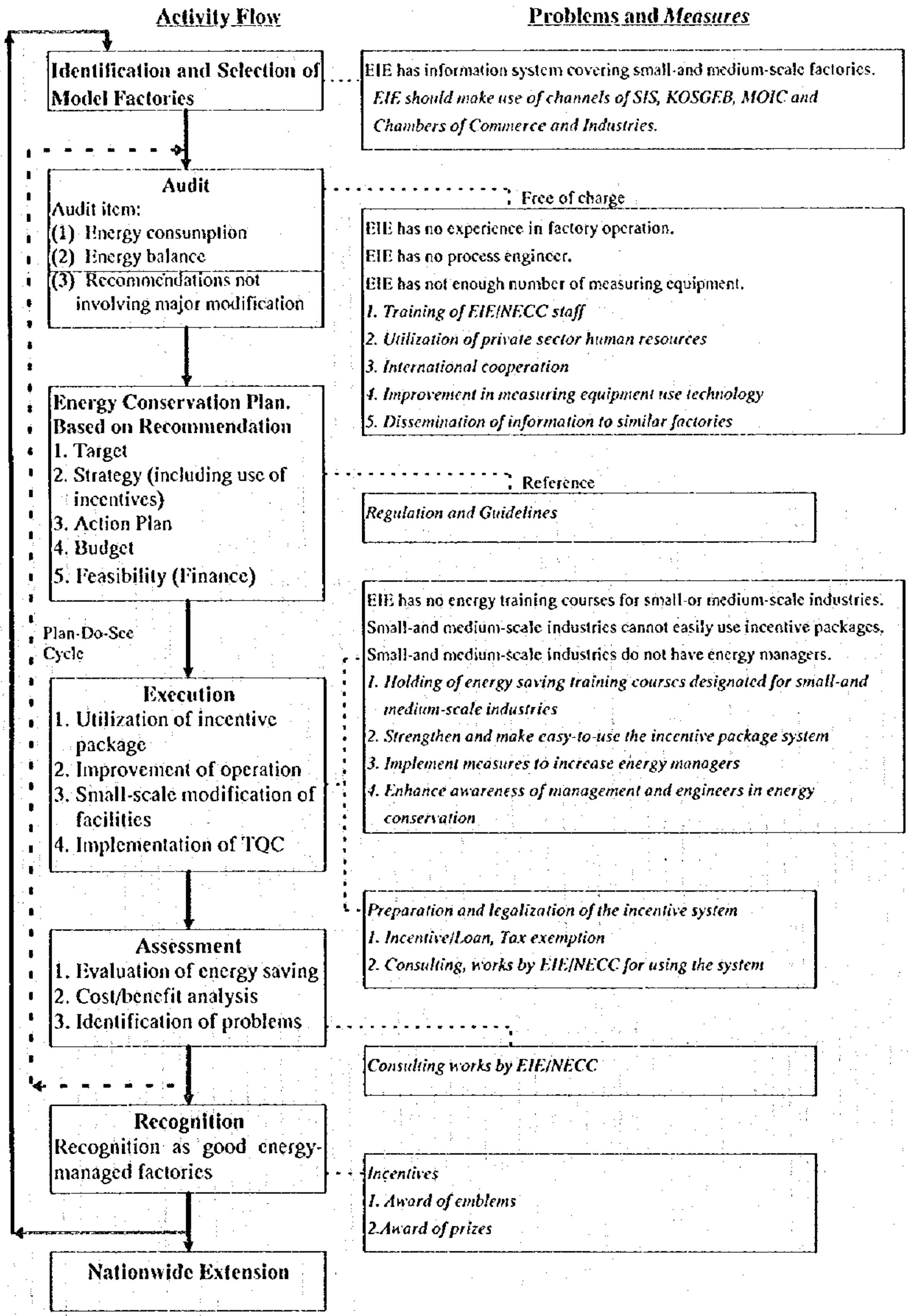


Figure 5-1 Plan for Rational Use of Energy

Table 5-2 Recommendations on Energy Conservation Promotion

(1) Institutional Functions and Measures

Itemized energy conservation measures	Present State	Problems and Analysis	Recommendations	Responsible Organization	Priority *
1-1Organization and Functions 1) Effectiveness of the Turkish Organizational Structure	EIE/NECC has taken the leadership and responsibility for energy conservation activities among ministries, agencies and institutions.	The single window system is good, but it is necessary to coordinate among governmental and private organizations to promote energy conservation. There should be effective interdepartmental coordination of conservation activities.	In the industrial sector, the Ministry of Industry and KOSGEB have functions such as access to informative means, adoption of technological developments and training. Coordination among EIE/NECC, Ministry of Industry and KOSGEB is recommended to promote smooth and effective energy conservation in the industrial sector as well as enhancing awareness through the activities of ECCB.	MENR/EIE	A
2) Government Commitmer	Financial sources for activities are needed.	In the government sector, the acquisition of extra budget for promoting an energy conservation program is difficult. For the measure to create a fund, expansion of existing scheme or creation of new monetary source is needed.	Strong political leadership and bureaucratic commitment are, however, the key to the success of government conservation activities. Strong political leadership with bureaucratic interest is expected to promote energy conservation in such a country that is highly dependent on a foreign supply of energy.	MENR	A
3) Planning	A general statement on energy conservation appeared in the seventh Five Year Development Plan (1996-2000) without specific target and priorities.	Energy conservation activities such as regulation, energy audit, energy bus program, publication have been instituted. An overall energy conservation program with well-defined quantitative targets, strategy, budget is not formulated.	An overall action program is recommended to formulate.	MENR/EIE/ NECC	A

Note: * See the attached recommendation priority table.

Itemized energy conservation measures	Present State	Problems and Analysis	Recommendations	Responsible Organization	Priority
1-2 Energy Conservation Laws and Regulations	-No Laws at present -Related Regulation has been issued for major energy consumers in manufacturing industries.	In order to promote energy conservation, there is a need for a law on which nation-wide energy conservation measures can be based. The existing regulation does not cover the whole range of the industrial sector nor other sectors.	1) The scope of the Regulation should be expanded to small manufacturing industries consuming less than 500 TOE of energy. The Regulation should however limit the obligation of these small energy users to reporting their annual energy consumption with the cooperation of SIS. (Estimated administrative cost) 9 man-months, US$6,300	MENR/EIE	B
			2) An energy conservation law which, of course, covers the manufacturing sector should be formulated. It is necessary for the government, government agencies, energy suppliers, energy equipment manufacturers and consumers to promote energy conservation from their respective standpoints, in an integrated way. Also, it is necessary for the government to express its commitment to energy conservation, and for it to formulate a law on which its various measures are to be based. (Estimated administrative cost) 12 man-months, US$96,000	MENR	C

Itemized energy conservation measures	Present State	Problems and Analysis	Recommendations	Responsible Organization	Priority
1-3 Preparation of Guidelines	TSI has standards for energy consuming equipment: - Boilers and stove - Heat insulation for buildings It is required that an energy-managed factory endeavors to improve efficiency in energy consuming equipment.	Various non-compulsory energy conservation standards, or guidelines, showing quantitative targets for energy efficiency improving measures itemized in Article 6 of the Regulation, should be prepared. The guidelines may help factory staff to conduct energy conservation measures and may help business operators to manage positive efforts for the streamlining of energy use in each factory, in such a manner as choosing better solutions adapted to the given conditions.	1) To lower the intake air ratio, and excess oxygen content in exhaust gas to improve fuel combustion in furnaces, to the extent not increasing smoke generation, 2) To raise waste heat recovery rates up to standard values for promotion of effective waste heat recovery and utilization of equipment for such purposes, 3) To reduce heat loss that occurs in the form of radiation, convection and conduction, by applying heat insulation and other appropriate measures, 4) To improve operation of combined heat and power generation and to increase efficiency in the conversion of heat to power or the reverse, 5) To prevent electricity loss due to resistance and other causes and to keep power factors at adequate levels at electricity receiving end, in cooperation with TSI and other experts concerned. These guidelines should be reviewed periodically every 10 years to adjust to the change of technology, energy situation and so on. (Estimated administrative costs is shown in the highlighted plan.)	EIE	A

Itemized energy conservation measures	Present State	Problems and Analysis	Recommendations	Responsible Organization	Priority
1-4 Incentives Preferential measures for promoting introduction of energy efficient equipment - Taxation - Loan	The existing system is not known particularly in medium- and small- scale manufacturing industries.	Medium- and small- scale manufacturing industries are suffering from a shortage of funds for investment in equipment for improving energy efficiency. Government programs for assisting these industries are urgently needed.	It is recommended to raise awareness of the existing measures such as low interest finance with a system of endorsement for debt, custom duty exemption, investment allowance, tax and duty exemption. An incentive package scheme should be instituted combining the existing incentives such as tax incentives, soft loans, energy audit and training. (Estimated administrative cost is shown in the highlighted plan.)	EIE/NECC	A

Itemized energy conservation measures	Present State	Problems and Analysis	Recommendations	Responsible Organization	Priority
1-5 Energy Managed Factories	Factories annually consuming 2,000 TOE or more are designated as energy-managed factories, and held responsible for reporting their energy consumption every year.	Medium- and small- scale manufacturing industries are mostly small energy consumers and fall outside the class responsive to the Regulation. It is necessary to obtain accurate information on trends in energy consumption and conservation patterns of these small consumers.	To revise the applicable scope of the Regulation downward to medium- and small-scale manufacturing industries which consume 500 TOE or more energy annually, so that the Regulation may cover 90% or more of energy consumption. The obligation should be limited only to reporting their annual energy consumption. At the same time, MENR will be able to analyze energy data thus made available to it, and to use these data in formulating its policy for the industrial sector. (Estimated administrative cost) The administrative costs are included in Item 1-2 Energy Consumption Laws and Regulation.	MENR/EIE	B

Itemized energy conservation measures	Present State	Problems and Analysis	Recommendations	Responsible Organization	Priority
1-6 Qualification of Energy Managers	Factories annually consuming 2,000 TOE or more energy are obligated to appoint energy managers in order to promote rational use of energy in plants.	The qualification system for an energy manager should be a socially authoritative one. Now, not all the energy-managed factories have enough qualified energy managers.	1) Promotion and expansion of the energy management courses conducted by not only EIE but also the authorized organizations, to train factory personnel to be assigned as energy managers. (Estimated administrative cost) 1 man-months x 4 courses/year x times/y, 20 man-months,US$16,000	MENR/EIE	A
	EIE regularly holds seminars on rational use of energy and energy conservation for granting qualification of energy managers to participants. A notice was issued on August 31 1996 on such seminars as a means of certifying energy managers.	Energy managers should be appointed at every energy-managed factory within 6 months to 1 year from the date of the Regulation becoming effective.	2) Expediting deployment of energy managers in 3 years, it is advisable to introduce a state approved qualification system for energy managers, in such a way as by giving certificates to graduates of technology courses and to factory engineers with years of experiences in energy conservation.	EIE	A
			3) Qualified energy managers shall be registered after they are posted to energy-managed factories and EIE shall provide them with updated information obtained by factory survey and foreign information on energy conservation, as well as to communicate government measures and to give specialized technical education. They can perform as auditors or consultants for small-scale, not designated factories. (Estimated administrative cost of items 2) and 3)) 3 men x 2 weeks x 2 times/y 3 man-months, US$2,400	EIE	B

Itemized energy conservation measures	Present State	Problems and Analysis	Recommendations	Responsible Organization	Priority
1-7 Energy Conservation Training Center	In December 1992, EIE was designated the National Energy Conservation Center (NECC) by the MENR, in the field of manufacturing industries	Management and engineers of the medium- and small-scale manufacturing industries do not generally have good opportunities to be trained in the latest technology. Energy conservation activities for medium and small- scale industries should be concentrated in EIE/NECC.	EIE/NECC, should be strengthened by having a training center equipped with a model plant to carry out practical an energy conservation operations there and by developing an energy data base system, especially for engineers at medium- and small-scale industries. EIE, through the activities of the training center, will enable the engineers to become aware of the need to use energy efficiently and educate them in energy conservation techniques. EIE should start its activities in the industrial sector since energy conservation measures can bring about quick results there. Instead of being confined to the industrial sector, the activities of the center will expand into the transportation area, consumer-related area and so on. In this way EIE can promote energy conservation on a national level in a unified way. (Estimated administrative cost is shown in the highlighted plan.)	MENR/EIE /NECC	B

(2) Organization and Role of EIE/ NECC

Itemized energy conservation measures	Present State	Problems and Analysis	Recommendations	Responsible Organization	Priority
2-1 Organization and Role of EIE/NECC	The EIE/NECC, as an organization focused on energy conservation in Turkey, carries out consulting and training activities and also proposes policies for energy conservation for the industrial, housing, and transportation sectors.	EIE and NECC's Industrial Energy Conservation Division are the main governmental organizations for energy conservation promotion to industries. EIE is not allowed to establish a new department or division in NECC. The EIE/NECC's authority is weak as an organization, and it does not operate a factory, there is a limit to the technical information that can be accumulated. On the other hand, energy conservation is carried out by the factories that actually consume the energy. Private companies tend not to open their internal information and to avoid outside intervention.	1) The officials of NECC are recommended to further continue their energy conservation activities. One option is to expand their mandate and to clearly define responsibilities of given positions. (Estimated administrative cost) 1 man-months, US$800 (Planning works only)	EIE/NECC	B
			2) Definition of the role of EIE/NECC as an administrative body is an important issue. One possible option is to intensify their authority by making it a management supervisory organization. It is also hoped that the current energy conservation activities, education and consulting, will be further developed and enhanced drawing upon international collaboration schemes. (Estimated administrative cost) 2 man-months, US$1,600 (Planning works only)	EIE	A

(3) Activities of EIE/ NECC

Itemized energy conservation measures	Present State	Problems and Analysis	Recommendations	Responsible Organization	Priority
3-1 Energy Audits	EIE has conducted, as of August 1996, free energy audits at 36 plants in industrial sectors since 1990. EIE is supposed to assist factory energy managers to carry out energy audits at their plants in line with the Regulation.	Analytic technology, engineers and equipment are not necessarily sufficient even in large-scale manufacturing industries. Medium- and small- scale industries are in much poorer condition.	1) To conduct simpler energy audits mainly at medium- and small-scale factories not designated as energy-managed factory in the regulation, in order to make these factories interested in energy conservation. In this regard, the collaboration of KOSGEB is essential in selecting candidate plants worthy of being audited.	EIE	A
		EIE should use human resources available inside and outside to cope with increasing needs for audits.	2) (Estimated administrative cost) 1 man x 3 days/time x 30 factories/year 3 man months, US$2,400		
		More budget should be allocated to implementation of the energy audits. In 1994 and 1995, only one energy audit could be carried out, mainly because of government budget saving measures.	3) Possibility of introducing paid energy audits at large energy-managed factory should also be studied where many human resources and costly experts from outside including overseas are needed for carrying out precise and high level diagnosis and guidance service. Designated plant management would be assured of energy audits for identifying energy saving potentials and monetary savings of the plant.	EIE	C

Itemized energy conservation measures	Present State	Problems and Analysis	Recommendations	Responsible Organization	Priority
3-2 Dissemination of Technical Information on Energy Conservation	EIE is conducting various consultative activities for energy conservation - energy audits - seminars - publication of technical information: magazines and papers - holding of exhibitions devoted to energy conservation - training programs	At present, sufficient information on energy conservation may not be provided to factory managers and engineers. Provision of latest technical information will serve to upgrade the technical levels of factories and to stimulate them in their energy conservation activities.	1) To continue the consulting activities of EIE/NECC and related organizations on one side, to intensify their activities on medium- and small-scale industries, on the other. To promote the latter and increase their awareness on energy conservation, collaboration of KOSGEB, with its nationwide network, should be utilized.	EIE /KOSGEB	B
			2) To prepare a pocket-sized book, 'Energy Conservation Reference Book', illustrating related regulations, statistics, standards and technical data on heat management and electricity management, in order to enable factory staff to easily access the needed information while they are conducting energy conservation activities. (Estimated administrative cost) 3 man months, US$2,400	EIE	A

Itemized energy conservation measures	Present State	Problems and Analysis	Recommendations	Responsible Organization	Priority
3-3 Establishment of Energy Data Base System	EIE has been developing an energy data base since 1990 gathering, sorting out information and publication of energy conservation data and technology. EIE started compilation of a new data base system for information of plants consuming annually 500 TOE or more energy.	The present data base system does not necessarily indicate the accurate status of energy consumption or energy conservation in the whole range of manufacturing industries, by sectors/subsectors and by size groups. It is necessary to establish proper and wide channels of information gathering, and increase public trust in it as a reliable source of information to people and enterprises.	1) To establish information service outlets, such as EIE's Industrial Data Base Evaluation Book In order to effectively provide factories with technical information on energy conservation, it is necessary to establish a system by which the present situation and future trends in technology in various areas can be accurately grasped, and with which such information can be used effectively.	EIE	A
			2) To strengthen the information gathering system, especially in smaller-scale industry, by expanding the scope of the Regulation to smaller energy consumers to report their annual energy consumption To broaden EIE's channels for the acquisition of international technical information on energy conservation by promoting cooperative relations with overseas organizations, then to make the information public	EIE	B
			3) To install an on-line information provision and retrieval system. (Estimated administrative cost) On-Going project	EIE/SIS	C

Itemized energy conservation measures	Present State	Problems and Analysis	Recommendations	Responsible Organization	Priority
3-4 Energy Conservation Seminars for Medium- and Small-Scale Factory Management and Engineers	None dedicated to factories which are not designated as energy-managed factories.	There is a shortage of engineers and technology at medium- and small- scale factories. Factory managers and staff are not sufficiently aware of the need for energy conservation, because they are concerned more about production and cost.	To hold seminars concerning successful examples of energy conservation in factories and to give education in energy conservation to management and engineers of medium- and small-scale manufacturing industries, which are not designated as energy-managed factories. Publication of successful examples of energy conservation will be effective in leading those engineers to recognize the importance of energy conservation. In this regard, the collaboration of KOSGEB is essential in holding joint seminars on energy conservation in order to improve awareness of energy saving among management and engineers. KOSGEB's Consulting and Quality Improvement Centers are responsible to provide consulting services, seminars to medium- and small-scale industries, aiming to improve their product competitiveness in such a manner as production cost reduction is realized. The joint seminars would be thus operated, EIE sponsoring and providing specialists on energy savings, KOSGEB planning the seminar program and providing the seminar hall in its Center office buildings throughout the country. (Estimated administrative cost) 3 men x 3 days/time x 2 times/year 0.6 man-months, US$480	EIE /KOSGEB	A

Recommendation Priority Table

Recommendation Item	Basic Concept	Existing or Not	Difficulty - Cost	Difficulty - Term	Importance	Urgency	TOTAL POINT	Priority Ranking
1. Institutional Functions and Measures								
Organization (1-1 1)	5	4	4	5	5	4	27	A
Government Commitment 1-1 2)	5	4	4	4	5	4	26	A
Planning 1-1 3)	5	4	4	4	5	4	26	A
Scope Expansion of the Regulation 1-2 1)	5	2	4	3	5	4	23	B
Formulation of Energy Conservation Law 1-2 2)	3	2	3	0	4	3	15	C
Preparation of non-Compulsory Guidelines 1-3	5	2	5	4	5	5	26	A
Incentive Package Scheme 1-4	5	4	3	4	5	5	26	A
Scope Expansion for Energy Managed Factory 1-5	5	2	4	3	5	4	23	B
Energy Management Course 1-6 1)	5	4	4	4	5	4	26	A
Deployment of Energy Manager 1-6 2)	5	4	4	4	5	5	27	A
Registration of Energy Managers 1-6 3)	5	2	4	3	4	3	21	B
Energy Promotion Center 1-7	4	2	3	3	4	4	20	B

Recommendation Item	Basic Concept	Existing or Not	Difficulty - Cost	Difficulty - Term	Importance	Urgency	TOTAL POINT	Priority Ranking
2. Organization and Role of EIE/NECC								
Motivation of NECC Officials 2-1 1)	5	3	4	3	4	4	23	B
Expansion of Role of EIE/NECC 2-1 2)	5	3	5	4	5	4	26	A
3. Activities of EIE/NECC								
Simple Energy Audits at Small Factory 3-1 1)	5	4	4	4	5	4	26	A
Introduction of Paid Energy Audits 3-1 2)	4	2	3	3	3	3	18	C
Information Service for Small Factory 3-2 1)	5	4	4	4	4	4	25	B
Publication of Pocket-sized Book 3-2 2)	5	3	5	4	5	4	26	A
Provision of Technical Data 3-3 1)	5	4	5	4	5	4	27	A
Strengthen the Data Gathering System 3-3 2)	4	4	4	3	5	4	24	B
On-line Information Provision, Retrieval 3-3 3)	4	3	2	3	4	2	15	C
Energy Conservation Seminars for Small Factory 3-4	5	4	4	4	5	4	26	A

Notes (1) Priority Ranking A : TOTAL POINT 30 - 25 points B : 24 - 20 points C : 19 - points

(2) Urgency Urgent, Short term : 5 - 4 points

Middle term : 3 points

Long term : 2 points

Chapter 6 Factory Audit

Chapter 6 Factory Audit

Factory audits have been conducted on the four factories as has been agreed upon from the very initial stage of this study, representing each industrial sub-sector as shown below.

Henkel-Turyag A. S.: Detergent, Edible Oil and Fats
Dev Blok A. S.: Brick
Izumir Basma Fabrikasi A. S. (IBF): Textile
Izmir Demir Celik Sanai A. S. (IDC): Steel

These factory audits have been conducted stepwise from the first field survey to the fourth period of homework in Japan. The most essential steps of actual factory audits with measurement and analysis were done in the fourth field survey, talking about 10 working days each.

This chapter reports the following items covering four factories.

1. General procedure of factory audits
2. Major items of each factory audit

6-1 General Procedure of Factory Audits

The general procedure and items of factory audits are shown in Figure 6-1, and outlines of the procedure and schedule are as follows.

(1) Recognition of Current Condition

The following items are investigated in this step, during the first field survey (November and December, 1995).

1. Outlines of factory and production facilities
2. Operating modes and conditions
3. Total and unit consumption of energy
4. Energy flowchart
5. Energy prices of fuel, electricity and others
6. Flowsheet of major products
7. Energy management and conservation
8. Major energy consuming facilities

(2) Identification of Current Problems

The following items are reviewed and scrutinized during the first field survey, the first homework period in Japan and the second field survey (November, 1995-February, 1996).

1. Problems with major energy consuming facilities
2. Problems in energy consumption already recognized
3. Items requested for factory audit
4. Major items and points of factory audit
5. Others

(3) Formulation and Preparation of Factory Audit Plan

The following items were reviewed and formulated during the second field survey and the second homework in Japan (February and March, 1996). Regarding detailed confirmation of preparations in the IDC electric furnace, special experts were dispatched during the third field survey and the third homework period in Japan, in July, 1996.

1. Review and analysis of premises for factory audit
2. Formulation of detailed plan for factory audit (measurement and analysis, field investigation, deployment of measuring equipment and others)
3. Planning of personnel allocation and schedule for factory audit
4. Necessary preparatory work and modifications of equipment for factory audit
5. Others

(4) Factory Audit

This step was conducted cooperatively with members of EIE and each factory in the fourth field survey (August and September, 1996); major items were as follows.

1. Explanation and discussion of detailed factory audit plan with the factory
2. Confirmation of preparations (points of modification, sampling and measurement)
3. Deployment of measuring and analyzing equipment
4. Installation and calibration of measuring equipment
5. Analysis of samples in temporary laboratory
6. Monitoring of operating conditions of facilities
7. Measurement and collection of records of measurements and operation
8. Confirmation of detailed data and specifications of subject facilities
9. Identification of problems by observing operating conditions

10. Collection of relevant data, information and records
11. Others

(5) Identification of Problems Requiring Countermeasures

As a result of the actual factory audit, the following items were reviewed and analyzed during the fourth field survey and the fourth homework period in Japan (August-November, 1996).

1. Review and analysis of measurement results
2. Review and analysis of results of relevant data and information
3. Identification of problems and judgment of necessity for improvement
4. Scrutiny and formulation of items for improvement
5. Others

(6) Assessment and Recommendations

As the final step of the overall factory audit framework, the following items were assessed and formulated during the fourth homework period in Japan(August-November, 1996).

1. Calculation and analysis of the effect of energy saving
2. Examination and selection of proper countermeasures
3. Cost estimation of modification for countermeasures
4. Estimation and prediction of the effect of the countermeasures
5. Overall evaluation of countermeasures for energy conservation
6. Recommendation and attention of countermeasures for energy conservation

6-2 Major Factory Audit Items

There are various kinds of factories, representing each industrial sub-sector. There are also various types of energy consumption, such as thermal and electrical energy. Detailed procedures and results of each factory audit are presented in Chapter 7 through Chapter 10; major items of each factory audit are summarized here.

(1) Henkel-Turyag

1. Energy balance around steam boilers and steam turbine generator
2. Effective utilization of heat exchangers in sulfonation unit
3. Heat balance around spray dryer and hot air furnace

4. Improvement of steam condensate recovery system
5. Improvement of steam trap system
6. Improvement of thermal insulation system
7. Reduction of electricity consumption

(2) Dev Blok

1. Evaluation of quality of raw materials
2. Improvement of quality of moulded body
3. Heat balance and performance of dryer
4. Heat balance and performance of tunnel kiln
5. Improvement of products quality
6. Improvement of electricity consumption

(3) IBF

1. Energy balance around steam boilers
2. Improvement of steam and steam condensate systems
3. Improvement of hot oil system
4. Improvement of water supply and drainage systems
5. Improvement of electricity consumption
6. Energy balance around open width bleaching machine
7. Energy balance around washing machine

(4) IDC

1. Heat input of electric arc furnace
   Electric power, fuel oil, oxygen, carbon injection and others
2. Heat output of electric arc furnace
   Exhaust gas, cooling water, surface heat loss, slag and others
3. Ambient conditions
   Outdoor/indoor temperature, atmospheric pressure and humidity

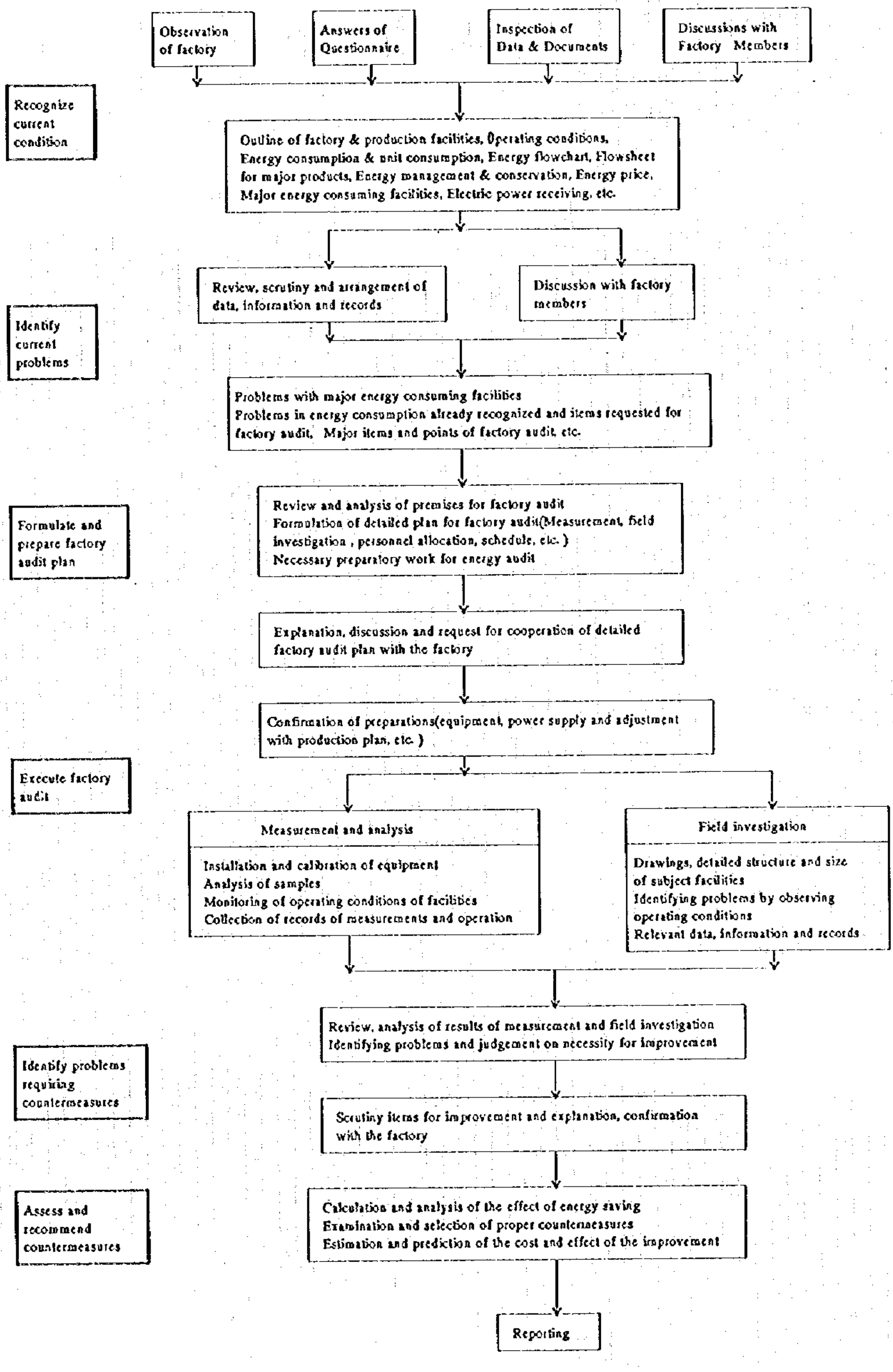


Figure 6-1 General Procedure of Factory Audit

Chapter 7 Detergent, Oil and Fats Factory

Chapter 7 Detergent, Oil and Fats Factory

This factory can be classified as a chemical industry. There are various types of energy consumption, such as utilization of fuel (lignite and fuel oil), generated steam and electricity (house generation and receiving from TEK). Thus, the JICA study team conducted an audit of most types of energy consumption.

7-1 Characteristics of Each Industrial Sub-sector

7-1-1 Liquid and Powder Detergent

The raw material of synthetic detergent is Linear Alkyl Benzene (LAB). It is sulfonated by SO_3, then neutralized by NaOH to form Linear Alkylbenzene Sulfonates (LAS), a key component of synthetic detergent. Figure 7-2 presents block flow diagram of the liquid and powder detergent producing process. Major energy consuming facilities in this process are as follows.

(1) SO_3 Generation

Sulfur melting vessel, sulfur combustion furnace,
Air drying (air compressor, refrigerator, dryer),
SO_2 cooler and SO_3 converter (exothermic reaction) with coolers.

(2) Sulfonation

Sulfonator (exothermic reaction) with jacket cooler

(3) Digestion, Hydration and Neutralization

There are not so important energy related facilities except for jacket type reactors, such as digester, hydrator and neutralizer.

(4) Liquid Detergent

There are not so important energy related facilities except for bottle filling machines.

(5) Powder Detergent

Hot air furnace, spray dryer, high pressure slurry pump, solid transfer equipment (air lift, belt conveyer, mixer) and packing machines.

7-1-2 Edible Oil and Fats

The raw materials of edible oil and fats (table margarine, kitchen & Industrial fats) are crude oil of cotton seed oil and palm oil, which are purchased from crude oil producers. The crude oil is refined through several units and processed to final products. Figure 7-3 presents a block flow diagram of the edible oil and fats producing process. Major energy consuming facilities in each unit are as follows.

(1) Neutralization

There are not significantly important energy related facilities except for steam heaters, and centrifuge and dryer.

(2) Hardening (Hydrogenation)

Water electrolysis, MP steam jacketed hydrogenator, feed oil heater, steam ejector, catalyst tank and filter press

(3) Decoloring (Bleaching)

There are not significantly important energy related facilities except for the bleaching vessel with steam coil and steam ejector.

(4) Deodorizing

Feed oil preheater, deodorizing column with steam injection and steam ejector

(5) Compounding

There are not so important energy related facilities in this unit.

(6) Plasticizing and Ripening

Plasticizer with emulsification, quick cooling and kneading, NH_3 refrigerating system for Kombinator and ripening with NH_3 compressor

(7) Oil Tank Yards

There are various kinds of oils treated and stocked in this process such as raw materials, intermediate products and final products. And steam is utilized in these tank yards as heating media.

7-1-3 Utilities

There are various kinds of utilities such as fuels, steam and electricity in this factory. When compared in terms of annual energy consumption for each source, the following figures are calculated for 1995.

Fuel oil:	14,319 MMkcal/year
Lignite:	52,736 MMkcal/year
Electricity/House generation:	2,727 MkWh/year (2,345/5,863 MMkcal/year)
Electricity/Received:	13,400 MkWh/year (11,524/28,810 MMkcal/year)
Electricity/Total:	16,127 Mkwh/year (13,869/34,673 MMKcal/year)
Generated steam:	64,500 tons/year (32,250 MMkcal/year)

Where,

Electricity converted in heat: 860 (theoretical) / 2150 (actual) kcal/kWh

Steam converted in heat: 500 kcal/kg

MM = Million, M = Thousand

As a result, steam and electricity consumption are nearly on the same level. Thus this factory has installed two steam boilers with a capacity of 10 tons/hour each and a steam turbine generator with a capacity of 16 tons/hour of steam consumption (1,600 kW/h generation).

7-2 Outline of Factory, Facilities and Flow sheet of Major Product

7-2-1 Outline of the Factory

The outline of the factory was recognized through the first field survey as follows.

1) Type of industry:	Chemical Industry (Synthetic Detergent, Edible Oils and Fats)
2) Capital:	295,000,000,000 TL (as of end of June 1995)
3) Number of employees: (as of End of Oct. 1995)	Workers 213, Employees 214, Total 427 In Production Department: 292
4) Number of engineers:	Chemical Engineers 11, Mechanical Engineers 8 Industrial Engineers 7, Environmental Engineer 1
5) Number of energy related engineers:	Electricity 2, Heat 3

6) Factory and building area: 45,000 m^2, 12,600 m^2

7) Major products:
   a) Powder Detergent
   b) Liquid Detergent
   c) Oils & Fats (Margarine & Food Industrial Oils)

8) Share and position in its industrial sub-sector:
   a) Powder Detergent (20%, third ranking place)
   b) Liquid Detergent (50 to 60%, 70 % for the softener, first ranking place)
   c) Oils & Fats (18 to 20%, second ranking place)

7-2-2 Outline of the Production Facilities

The production scheme is outlined in the following figure. There is no plan for increasing production capacity at present.

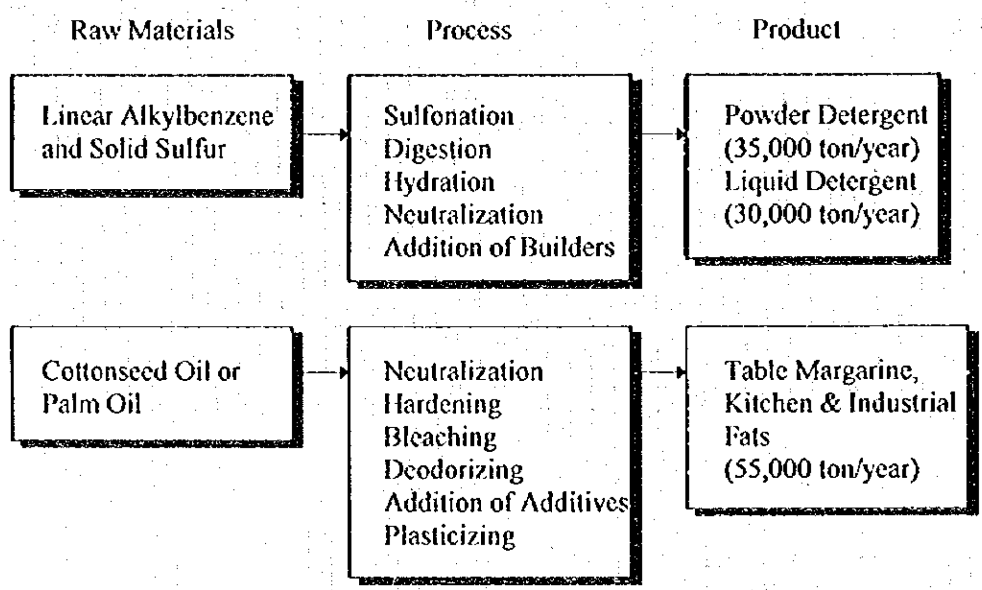


Figure 7-1 Outline of Production Facilities

7-2-3 Flow sheet for Major Products

(1) Liquid and Powder Detergent

An outline of the process flow is shown in Figure 7-2, and a short explanation of the process is given in section 7-1-1.

(2) Edible Oils and Fats

An outline of the process flow is shown in Figure 7-3, and a short explanation of the process is given in section 7-1-2.

7-3 Outline of Operating Conditions

7-3-1 Operating Mode of the Plant and Factory

(1) Operation Days in a Week

The plant is operated 6 days per week (startup Monday morning and shutdown Sunday morning except for the sulfonation unit.)

(2) Operation Modes of Plants

There are three operation modes such as batch, semi-batch and continuos operation, corresponding to the characteristics of each unit as shown in the following table.

Table 7-1 Type of Operation in the Factory

Detergent Process	Batch	Semi-batch	Continuous	Remarks
1. Sulfonator			x	
2. Powder Detergent	x	x		
3. Liquid Detergent	x			
4. Spray Dryer		x		
5. Solid Builder	x	x		
6. Blending	x			

Oils & Fats Process	Batch	Semi-batch	Continuous	Remarks
1. Neutralization		x		
2. Hardening	x			
3. Bleaching		x		
4. Deodorizing		x		
5. Compounding	x	x		
6. Plasticizing	x	x		2 kinds of train

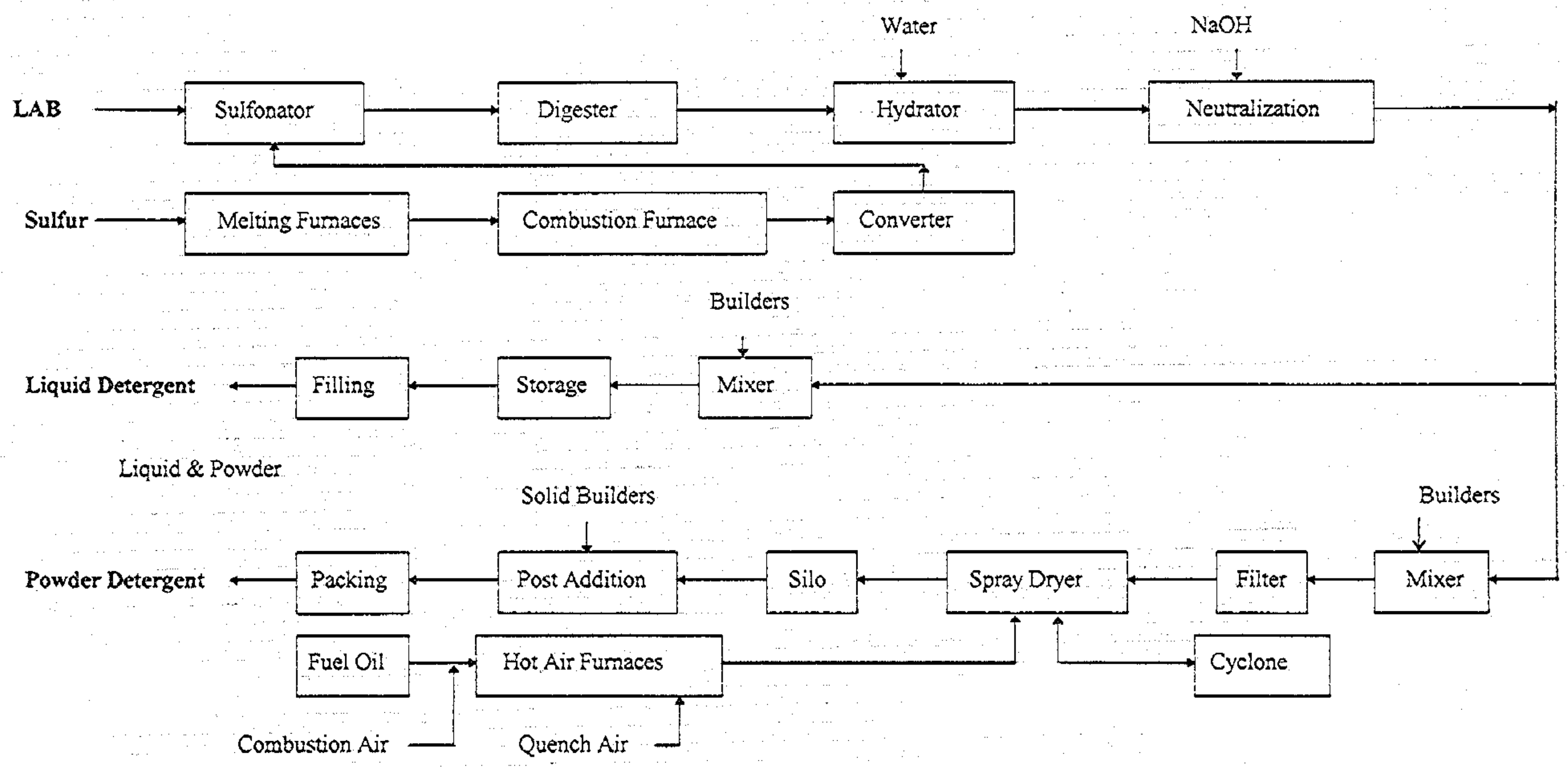


Figure 7-2 Synthetic Detergent Production Flow Sheet

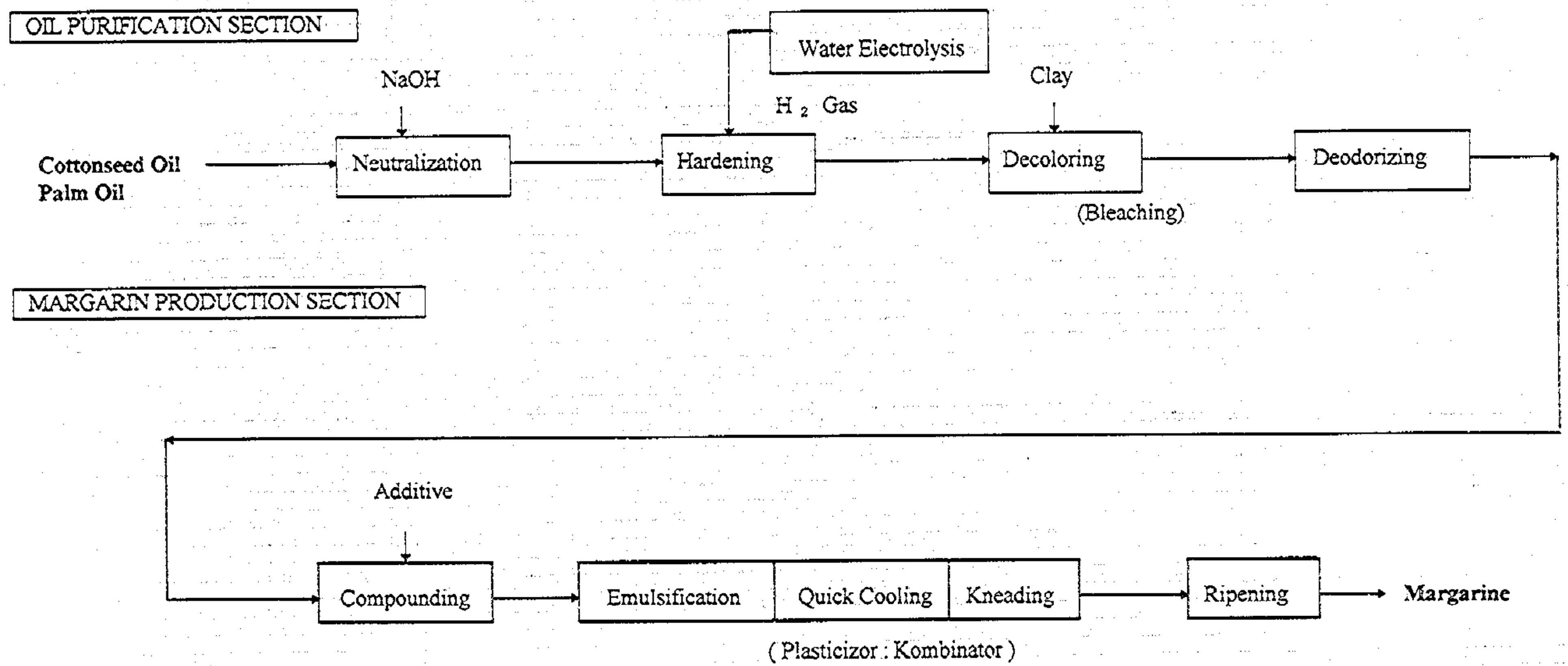


Figure 7-3 Edible Oils and Fats Production Flow Sheet

(3) Annual Operating Hours and Days

The information given here is withheld from public disclosure because of its confidential nature.

Table 7-2 Production Amount and Annual Operating Hours

The information given here is withheld from public disclosure because of its confidential nature.

7-4 Trends of Consumption and Unit Consumption of Energy

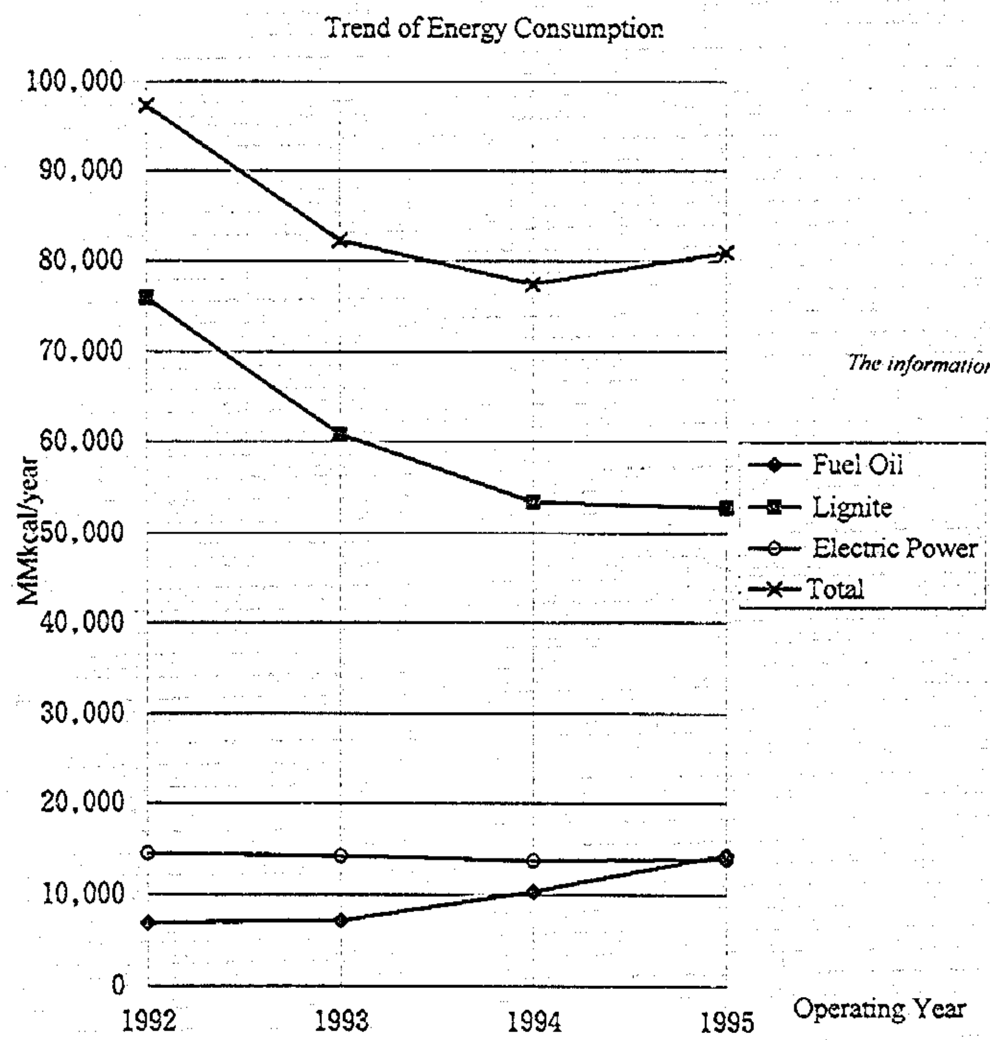
Kinds of utility and their utilization in the factory are as follows. Energy consumption trends are shown in the following table and shown in Figure 7-4.

a) Fuel Oil — Fuel for the hot air furnace in the spray drying unit in the powder detergent plant

b) Lignite — Fuel for the fluidized bed type steam boilers (2 trains), transported from the Aydin Coal Mine (125 km south of Izmir) by 25 ton trucks.

c) Diesel Oil — Fuel for starting up the steam boilers and the emergency power generators

d) Electricity — Power source for all motors and lighting



The information given here is withheld from public disclosure because of its confidential nature.

Figure 7-4 Trends of Energy Consumption and Production Amount

e) Steam Energy for steam turbine generator and heating
(There is no steam turbine driven equipment.)

Table 7-3 Trends of Energy Consumption and Unit Consumption

Name of Utility	Unit	1992	1993	1994	1995 (estimate)	1996 (plan)
a) Fuel Oil						
Consumption	kg/year	702,060	725,278	1,034,242	1,431,892	
Lower Heating Value	kcal/kg	10,000	10,000	10,000	10,000	
Consumed Total Heat	MMkcal/y	7,020	7,253	10,342	14,319	
b) Lignite						
Consumption	ton/year	23,713	19,010	16,681	16,480	
Lower Heating Value	kcal/kg	3,200	3,200	3,200	3,200	
Consumed Total Heat	MMkcal/y	75,882	60,832	53,379	52,736	
c) Well Water						
Consumption	ton/year	65,000	80,000	80,000	107,460	
d) City Water						
Consumption	ton/year	230,000	170,000	115,000		26,000
e) Electric Power						
Generated Power	MkW/y	5,833	4,023	2,448	2,727	2,500
Received Power	MkW/y	10,936	12,482	13,472	13,400	15,130
Total Consumption	MkW/y	16,769	16,505	15,920	16,127	17,630
f) Steam						
Generated Steam	ton/year	92,000	76,000	67,000	64,500	70,200

Note: All utilities are used for Detergent and Oils & Fats Plant in common without a separate measuring system.
$MM = 10^6$ and $M = 10^3$

7-5 Current Condition and Problems with Energy Management

7-5-1 Current Condition of Energy Management

(1) Establishment of Targets for Energy Conservation

At the beginning of every year, the factory's executives set targets for energy conservation and reducing of fuel, coal, electricity and water based on unit consumption figures. Then each division sets detailed targets. The results are evaluated at the end of every year.

(2) Energy Management Utilizing Data and Records

The Utility and Maintenance Department controls the operating data for the steam boilers, demineralized water treatment, electricity, etc. Other data are controlled by each production department respectively without steam and water consumption. Some production facilities such as detergent plants are operated by computer control, therefore, necessary data can be obtained from the computer records.

(3) Education and Training of Employees for Energy Management

For newly hired employees, operation training is given for a certain period inside the factory; however, energy conservation training is not included directly. On the other hand, EIE is publishing and giving some energy conservation booklet for the factory's management use.

(4) Major Energy Consuming Facilities

The main specifications of major energy consuming facilities are as follows.

1) Steam Boilers

Type	Fluidized Bed with oil burner
Fuel	Lignite (at normal operation, 2,500 kg/h consumption)
	Diesel oil (at startup only)
Feed water temp.	110 ℃
Steam flow	10,000 kg/h
Steam press. & temp.	42 bar & 470 ℃

2) Steam Turbine Generator

Inlet steam	42 bar
Extracted steam	10.5 bar & 4.5 bar
Power generation	1,600 kWh (design with 15 to 16 t/h steam consumption)
	800 kWh (winter with 10 to 11 t/h steam consumption)
	500 kWh (summer with 7 to 8 t/h steam consumption)

3) Hot Air Furnace

Type	Air direct heating
Fuel	Fuel oil (at normal operation, 400 kg/h consumption)
Feed & hot air temp.	Ambient & 300 ℃ (after mixing with quench air)

(5) Electric Power Receiving, etc.,

The electric power receiving system and its operating conditions are as follows.

1)	Receiving voltage	10,500 volt
2)	Maximum demand	2,500 kWh
3)	Power factor	95.00

4) Single-line diagram and transformer capacity per unit and number of transformers
See Figure 9-18 in Detailed Report

5) Charging system — There are three prices corresponding to daytime (6:00 to 17:00, normal price), critical time (17:00 to 22:00, highest price) and night time (22:00 to 6:00, lowest price).

6) Contract for receiving — Maximum capacity is 2,500 kWh; electric power 15 minutes' continuous excess power receiving over the contract capacity has to pay a penalty.

7) Ratio of house generation power to received power

Unit: 1,000 kWh

	1992	1993	1994	1995	1996
House Generation	5,833	4,023	2,448	2,727	3,000
	(34.8%)	(24.4%)	(15.4%)	(16.9%)	(17.0%)
Received Power	10,936	12,482	13,472	13,400	14,630
Total	16769	16,505	15.920	16,127	17,630

(6) Measures Carried out for Energy Conservation and Their Effects

A condensate recovery and energy saving project included the following measures. By installing many steam traps for return lines, stopping steam leakage, improving insulation of the steamlines and replacement of city-water with well-water, about 1.5 million DM was saved between April, 1992 and October, 1994.

7-6 Current Condition and Problems with Facilities

7-6-1 Identification of the Current Problems

(1) Problems in Major Energy Consuming Facilities

The following items are considered as problems in major energy consuming facilities.

1. Low Load Operation of Power Generator
2. Corrosion Damage in Sulfonation Unit
3. Lower Condensate Recovery
4. Steam Loss from the Steam Line
5. Insufficient Thermal Insulation
6. Loss of Electrical Consumption

(2) Problems in Promotion of Energy Conservation

In addition to the problems in energy consuming facilities, the following problems exist for the promotion of energy conservation.

1. Shortage of engineers
2. Insufficient system of research and development
3. Shortage of measuring equipment
4. No time to analyze energy consumption rate

7-6-2 Problems in Energy Consumption already Recognized and Items Requested for the Audit

These problems and items are summarized as follows.

(1) Boiler and Steam Turbine Generator

1) There is an imbalance in capacity between the steam boilers (10t/h x 2) and steam turbine generator (15t/h).
2) Steam is utilized only for heating media and an increasing of steam consumption by introducing new users is necessary to increase the house power generation.
3) There are three prices in receiving electricity as mentioned before, and the lowest price (night time) is cheaper than house power generation.

(2) Heat Exchangers in Sulfonation Unit

1) There are some interruptions which cause burn-out of tubes.
2) A corrosive material (SO_3) is treated in the heat exchangers and damages of tubes and plates have been developing troublesome shut-downs. Heat recovery by boiler feed water is not done now.

(3) Spray Dryer and Hot Air Furnace

1) Air feed for the hot air furnace is not preheated.
2) An optimum operating condition for the spray dryer is not maintained due to some leakage around it.

(4) Condensate Recovery System

1) It seems that damage of heat exchangers is causing some leakage of impurity into the condensate recovery system and water quality is not good enough to be recovered.

2) The leakage points is not certain and they are required to be detected.

(5) **Steam Trap System**

1) Some steam traps are not working correctly.

(6) **Thermal Insulation System**

1) It is not enough to evaluate the existing insulation system and it shall be improved, if necessary.

(7) **Reduction of Electricity Consumption**

1) For some motors, an adequate speed control system shall be adopted, if possible.

7-7 Method and Procedure of Energy Audit

Based on the current condition and problems with facilities, an analysis and measuring plan has been prepared as follows.

(1) Analysis and Measuring Points

Analysis and measuring points for the energy audit are investigated and listed in order to prepare a detailed plan for the energy audit.

(2) Detailed Schedule of Analysis and Measurement

A detailed schedule of analysis and measurement was planned so that actual analysis and measuring work at the factory would be finished within 10 working days. For this purpose, analysis and measuring work should be executed by cooperation of EIE and factory personnel, and a more detailed personnel allocation schedule should be adjusted at the site. Some analysis items including lignite, light oil, ash and heavy oil shall be finished within the 10 working days.

(3) Necessary Modification for Analysis and Measuring Work

It was considered that the modification work of the facility will be minimized, and the following analysis and measuring points shall be confirmed by the factory side beforehand as to whether some modification work is required or not.

1) Modification for Exhaust Gas Sampling

a) Steam boiler exhaust gas

b) Spray dryer exhaust gas

c) Air heater exhaust gas

7-8 Execution Procedure of Measurement

7-8-1 Outline of Measurement and Analysis

Measurement and analysis work were carried out in accordance with the following major items and types of energy audit in the factory.

1. Thermal efficiency of steam boiler
2. Energy balance around steam turbine generator
3. Thermal efficiency of furnace (air heater)
4. Thermal efficiency of dryer (spray dryer)
5. Thermal efficiency of heat exchangers (sulfonator)
6. Management of steam and steam condensate lines
7. Management of steam trap system
8. Management of thermal insulation system
9. Reduction of electricity consumption

7-8-2 Schedule of Energy Audit

An energy audit for the factory was carried out from 16th August to 13th September in 1996 as follows.

(1) Preparation Work

16, Aug. (Fri)	Confirmation of points of modification and sampling for measurement
21, Aug. (Wed)	Carrying back samples and transportation of measuring equipment
22, Aug. (Thur)	Final confirmation of points of modification and preparation of measuring equipment, and check flow sheet around sulfonator

(2) Measurement and Analysis Work

23, Aug. (Fri)	Discussion & confirmation of audit plan and installation of measuring equipment

24 &25, Aug. (Sat & Sun)	Analysis and preparation for audit
26 & 27, Aug. (Mon & Tue)	Audit of boilers and steam turbine generator
28 & 29, Aug. (Wed & Thur)	Audit of spray dryer and hot air heater
30, Aug. (Fri)	Audit of heat exchangers in sulfonation unit
31, Aug. & 1, Sept. (Sat & Sun.)	Analysis of results
2 & 3, Sept.(Mon &Tue)	Audit of steam and condensate recovery system
4, Sept.(Wed)	Audit of steam trap system
5, Sept, (Thur)	Audit of thermal insulation system
6, Sept (Fri)	Audit of reduction of electricity consumption
7 & 8, Sept. (Sat & Sun)	Analysis of results
9, Sept. (Mon)	Clarification of measurement and check instruments

7-8-3 Measuring Items, Points and Measuring Equipment

To calculate and evaluate the current condition of energy consumption and to determine the energy balance, the analysis and measurement work described below has been executed according to the prepared schedule and corresponding to major items for energy audit.

(1) Boilers and Steam Turbine Generator

1) Lignite: Industrial analysis and heating value
2) Light oil: Heating value
3) Boiler feed water: Flow rate, temperature, electric conductivity and pressure
4) Combustion air: Flow rate
5) Generated steam: Flow rate, temperature and pressure
6) Exhaust gas: O_2, CO_2, CO, SO_2 and temperature
7) Ash: Temperature and residual carbon
8) Steam to turbine: Flow rate, temperature and pressure
9) Extracted steam (10.5 bar): Flow rate, temperature and pressure
10) Extracted steam (4.5 bar): Flow rate, temperature and pressure
11) Extracted steam (to atm.): Flow rate, temperature and pressure
12) Generated power: kWh/h
13) Sound level around steam turbine: dB

(2) Spray Dryer and Air Heater

1) Spray dryer exhaust gas: Temperature, O_2, CO_2, CO and hydrocarbons

2) Feeding slurry: Pressure and water content

3) Powder: Moisture content and particle size distribution

4) Heavy oil to air heater: Heating value and temperature

5) Flue gas: O_2, CO_2, CO and Temperature

(3) Heat Exchangers in Sulfonation Unit

1) Air flow rate: Compressor outlet and dry air to sulfonator

2) Sulfur combustion: Sulfur flow rate

3) Raw material to sulfonator: Flow rate

4) SO_2, SO_3 temperature: Sulfur combustion, SO_2 cooler, SO_3 converter and Sulfonator

(4) Steam Lines, Steam Utilizing Facilities and Steam Condensate Recovery System

1) Outlines of steam flow chart of every pressure levels (HP, MP, LP)

2) Outlines of steam utilizing facilities in each plant

3) Outlines of condensate recovery system

4) Measurement of water quality in the condensate recovery system

(5) Steam Trap System

1) Confirmation of steam trap list

2) Check working condition of steam traps in steam center (around boiler)

(6) Thermal Insulation System

1) Steam pipe lines:
Check surface temperature with and without insulation, diameter and length of each pipeline, thickness and materials of insulation

2) Hot facilities:
Check surface temperature with and without insulation, surface area of equipment and thickness and materials of insulation

(7) Reduction of Electricity Consumption

1) Clamp test of main transformers

2) Clamp test of major electricity consuming equipment

7-9 Result of Measurement and Analysis

Results of measurement and analysis are described in this section on the following seven individual items.

7-9-1 Boilers and Steam Turbine Generator

There are some fluctuation of generated steam due to the batch operations of users. However, the typical data for this unit were as follows.

Table 7-4 Typical Measurement and Analysis Data in Steam Boiler-1

(1) Lignite		**(4) Generated Steam**	
1) Industrial Analysis		a) Flow rate (kg/h)	11,300
a) Moisture (wt%)	21.12	b) Temperature (℃)	435
b) Ash (wt%)	28.74	c) Pressure (bar)	40.9
c) Volatile matter (wt%)	48.50	**(5) Exhaust Gas**	
d) Fixed carbon (wt%)	22.76	a) O_2 content (vol%)	8.7
e) Total sulfur (wt%)	1.16	b) CO_2 content (vol%)	12.7
f) LHV (kcal/kg)	3,169	c) N_2 content (vol%)	78.6
g) HHV (kcal/kg)	3,404	d) Temperature (℃)	133
2) Elemental Analysis		**(6) Ash**	
a) Moisture (wt%)	17.10	1) Temp.(Ash Cooler Out, ℃)	75
b) Carbon (wt%)	34.50	2) Elemental Analysis	
c) Hydrogen (wt%)	3.00	a) Moisture (wt%)	0.1>
d) Nitrogen (wt%)	0.97	b) Carbon (wt%)	1.7
(2) Boiler Feed Water		c) Hydrogen (w%)	0.1
a) Flow rate (kg/h)	11,300	d) Nitrogen (w%)	0.08
b) Temperature (℃)	110	e) Specific heat at 80 ℃ (*)	0.22
c) Pressure (bar)	65.2	at 130 ℃ (*)	0.23
d)Electric conductivity (μ S/cm)	10.4	* ; cal/℃ · g	
e) pH (-)	7.4		
(3) Combustion Air			
a) Flow rate (Nm3/h)	4846/4882		

Table 7-5 Typical Measurement Data in Steam Turbine Generator

1) Inlet Steam		4) Extracted Steam to Atmosphere	
a) Flow rate (kg/h)	9,880	a) Flow rate (kg/h)	2,740
b) Temperature (℃)	461	b) Temperature (℃)	252
c) Pressure (bar)	40.9	c) Pressure (bar)	3.9
2) Extracted Steam (10.5bar)		e) pH (-)	7.4
a) Flow rate (kg/h)	3,750		
b) Temperature (℃)	325	5) Generated Power (kWh)	700
c) Pressure (bar)	10.4	6) Rotation (rpm)	1,575
3) Extracted Steam (4.5bar)		7) Sound (dB)	85-89
a) Flow rate (kg/h)	6,130		
b) Temperature (℃)	276		
c) Pressure (bar)	3.9		

7-9-2 Spray Dryer and Air Heater

Spray dryer and air heater in Powder Detergent unit can be considered as an independent facility from the viewpoint of heat balance development because its main heat source is only fuel oil for the air heater. Typical data were as follows.

Table 7-6 Typical Measurement Data in Air Heater and Spray Dryer

Air Heater		Spray Dryer	
1) Fuel oil (Heavy oil)		1) Slurry	
a) Carbon (wt%)	85.4	a) Flow rate (kg/h)	7,518
b) Hydrogen (wt%)	11.7	b) Temperature (℃)	75
c) Nitrogen (wt%)	0.5	c) Water content (wt%)	48.7
d) Sulfur (wt%)	2.26	2) Powder	
e) LHV (kcal/kg)	10,460	a) Flow rate (kg/h)	4,400
f) HHV (kcal/kg)	10,760	b) Temperature (℃)	65
g) Specific gravity (-)	0.9489	c) Water content (wt%)	48.7
h) Viscosity (mm^2/s)	219.4	b) Temperature (℃)	48.7
i) Flow rate (kg/h)	367	3) Exhaust gas	
j) Temperature (℃)	89	a) O_2 content (vol%)	19.8
k) Pressure (kg/cm^2)	2.5	b) CO_2 content (vol%)	1,6
2) Atomizing steam		c) N_2 content (vol%)	78.6
a) Temperature (℃)	150	d) Temperature (℃)	75
b) Pressure (kg/cm^2)	4.2		
3) Combustion air		Particle size distribution	
a) Flow rate (Nm^3/h)	5,830	a) >2mm (g)	4.4
b) Temperature (℃)	30	b) 2 mm> >1mm (g)	20.6
4) Quench air		c) 1mm> >0.5mm (g)	199.3
a) Flow rate (Nm^3/h)	16,310	d) 0.5mm> >0.15mm (g)	202.4
b) Temperature (℃)	30	e) 0.15mm> (g)	23.2
5) Flue gas			
a) O_2 content (vol%)	17.3		
b) CO_2 content (vol%)	4.2		
c) N_2 content (vol%)	78.5		

7-9-3 Heat Exchangers in Sulfonation Unit

There are four heat exchangers around the SO_3 Converter (12C1). Most of the heat in the sulfonation unit is mostly removed through these heat exchangers to the outside of the unit. This waste heat to the atmosphere should be utilized if possible; the heat loss was audited and calculated as described below.

Calculation of air volume

1) Average air velocity : 1,750 ft/min. = 533.4 m/min.
2) Section area of pipe : $(508 - 2 \times 10)^2 \times 0.785 = 200{,}988$ mm^2
   $= 0.201$ m^2
3) Air volume : $533.4 \times 0.201 = 107.2$ m^3/min. $= 6{,}432$ m^3/h

Calculation of heat loss

1) Air temperature : 180 °C
2) Average air enthalpy : 0.31 kcal/m^3°C
3) Heat loss : $6{,}432 \times 180 \times 0.31 = 358{,}906$ kcal/h

This heat loss is almost equivalent to the lignite consumption of 100 kg/h. Other data such as sulfur flow rate, temperature around SO_3 converter were measured at the same time in order to calculate the heat balance in the sulfonation unit.

7-9-4 Steam Lines, Steam utilizing Facilities and Condensate Recovery System

All steam lines around the steam boiler and steam turbine generator and main steam lines for production facilities were checked one by one including main condensate lines. From the result of water quality analysis, it seemed that all condensate could be recovered and reused; however, the factory explained that each condensate would not contain any oil normally, but sometimes oil may flow into the condensate line through the steam line after cleaning of each pipe by steam.

7-9-5 Steam Trap System

There are about 500 steam traps installed in steam lines. The types of steam traps are judged from estimated flow rate figures. The factory has prepared a list showing the number of steam traps, service for users, working pressures, condensate outlet pressures, size, types and makers of steam traps and renewal and checking dates of the steam traps. The arrangement of all the steam traps is checked, and working conditions in the steam center have been measured. It was founded that 14/21 (66.7%) of steam traps are in good condition; in other words, 14/18 of working steam traps are in good condition.

7-9-6 Thermal Insulation System

Thermal insulation conditions of steam lines, equipment around the steam boiler, steam turbine generator and major production facilities were also checked one by one, and heat loss from each steam line and main equipment was calculated. The calculation results are summarized in Table 7-7 and 7-8 for equipment and piping respectively.

Table 7-7 Heat loss from Main Equipment

Equipment	Inside Temp (°C)	Insulation Thick. (cm)	Surface Area (m^2)	Heat Loss (kcal/h)
Steam Boiler	434 - 900	20	128	173,150
Spray Dryer	75 - 290	20	356	125,320
Air Heater	290	20	41	22,490
Hydrogenator	200	20	30	10,680
Deodorizer	225	20	60	24,470

Table 7-8 Heat Loss from Steam Line

Name of Line	Pipe OD (mm)	Insulation Thick. (cm)	Pipe Length (m)	Heat Loss (kcal/h)
MP Steam Header (11 bar, 330 ℃) to Facilities				
Sulfonation	125	50	160	28,640
Liquid Detergent	80	57	185	22,410
Lab. & Pilot	100	63	240	31,730
Deodorizer	80	58	50	6,000
Powder Detergent	100	63	145	19,170
Oil Refinery	100	63	100	14,700
LP Steam Header (4.5 bar, 250 ℃) to Facilities				
Hydrogenation	100	56	100	10,420
Powder Detergent	100	63	145	14,060
Deodorizer	80	57	75	6,660
Liquid Detergent	100	56	240	25,000
Domestic Use	100	56	105	10,940
Sulfonation	125	50	160	21,000
Total (MP Steam + LP Steam)				210,720

7-9-7 Reduction of Electricity Consumption

(1) Measurement of Transformer Stations

This factory has six transformer stations. Electricity consumption was measured for each station. The measurement results are shown in Table 7-9.

Table 7-9 Results of Measurement for Transformer Stations

T/S No. Phase	Rated kVA	Rated Ampere	Max. Voltage	Min. Voltage	Max. Ampere	Min. Ampere	Power kW (Meas.)	Power factor	Power kW (Calc.)
1-A	1250	3125	390	380	850	750	420	0.97	479-557
1-B			390	380	800	750			
1-C			390	380	850	750			
2-A	1000	2500	390	380	900	870	510	0.92	527-578
2-B			390	380	930	920			
2-C			390	380	930	920			
3-A	1000	2500	378	378	650	560	210	0.99	336-421
3-B			370	370	640	620			
3-C			372	372	580	530			
4	1685	4212	10250	10250	70	70		0.95*	1181
5-A	1600	4000	390	390	1150	950	540-600	0.98-0.99	596-836
5-B			390	390	1250	1100			
5-C			390	390	1050	900			
6-A	750	1875	420	400	350	350	160	0.88	183-224
6-B			420	400	300	300			
6-C			420	400	350	350			

(2) Measurement of Major Motors

This factory has installed about 1,000 motors. The motors may be classified by capacity as follows.

1) Less than 10 kW: 847
2) 10 kW ≦ < 30 kW: 98
3) 30 kW ≦ < 50 kW: 26
4) 50 kW ≦ < 100 kW: 12
5) More than 100 kW: 9 (Total 992)

Among these, electric consumption of major motors was measured and shown in Table 7-10.

Table 7-10 Results of Measurements on Major Motors

Service	Rated kW	Ampere: A	Voltage: V	Power factor (Label Value)	Power:kW (Load)
FDF/Boiler	110	142	385	0.87	84.2(0,749)
IDF/Boiler	55	77	387	0.87	44.9(0.816)
IDF/Spray dryer	132	153	379	0.86*	86.4(0.655)
Air compressor	110	166	382	0.86	94.5(0.859)
NH_3 compressor	160	223-230	380	0.86	126.2(0.789) 130.2(0.814)

7-10 Energy Flowchart of Factory and Major Energy Consuming Facilities

There are following three kinds of energy source separately in the factory.

1. Lignite for steam boilers
2. Fuel oil for a air heater in powder detergent
3. Melting sulfur (SO_3 conversion heat) in Sulfonator

Therefore, energy flow charts were studied for each energy source instead of the total energy flow chart of the factory.

7-10-1 Energy Flowchart around Steam Boiler

Based on the measurement and analysis results, energy balance was determined; an energy flowchart around the steam boiler is shown in Figure 7-5.

7-10-2 Energy Flowchart around Steam Turbine Generator

Energy balance around steam turbine generator was also calculated and its energy flow chart is shown in Figure 7-6.

7-10-3 Energy Balance around Spray Dryer and Air Heater

Energy balance around spray dryer and air heater was calculated and shown in Figure 7-7.

7-10-4 Energy Balance in Sulfonator

The heat balance of the sulfonator was calculated and is shown in Figure 7-8.

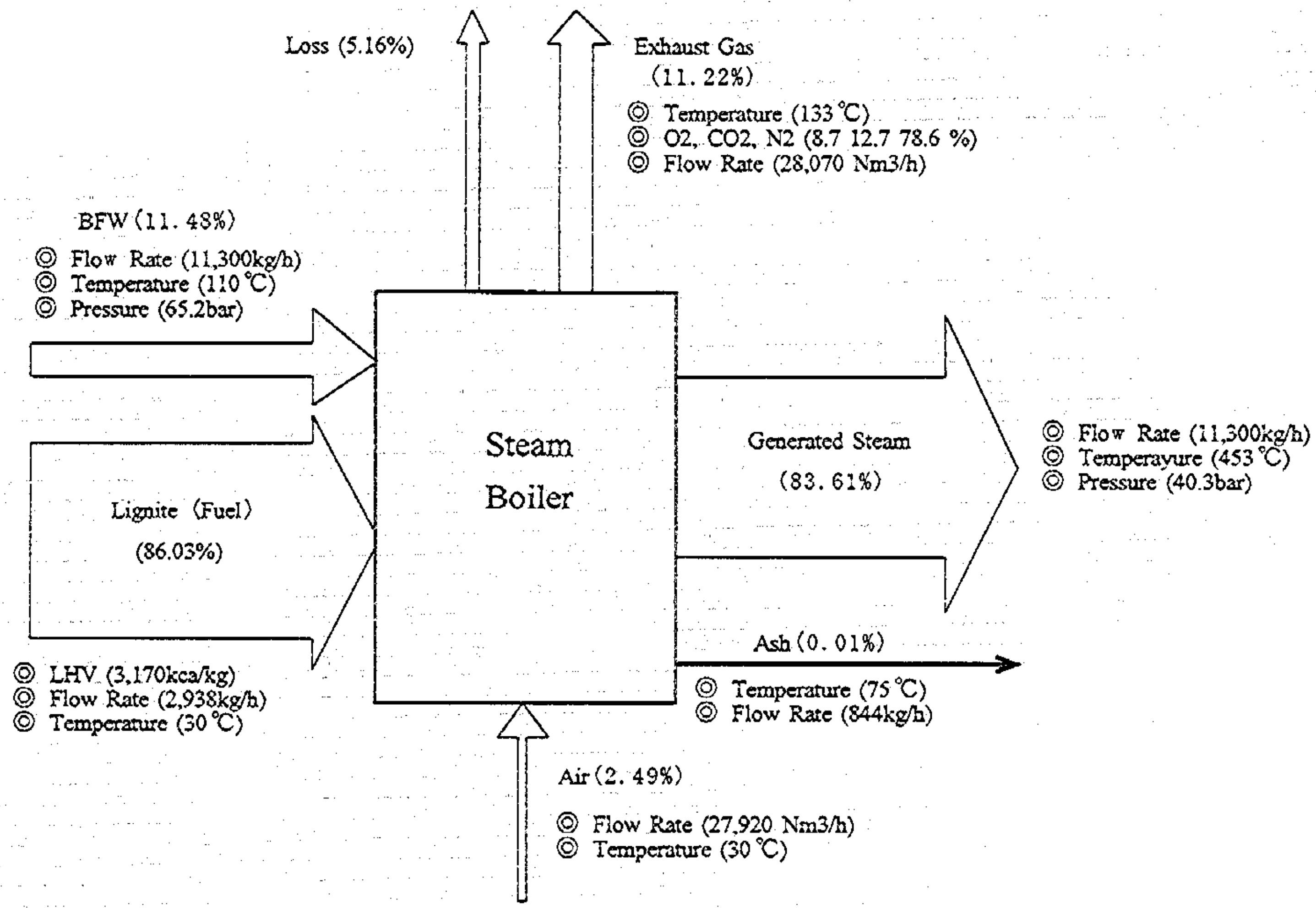


Figure 7-5 Energy Balance around Steam Boiler (Turyag A.S.)

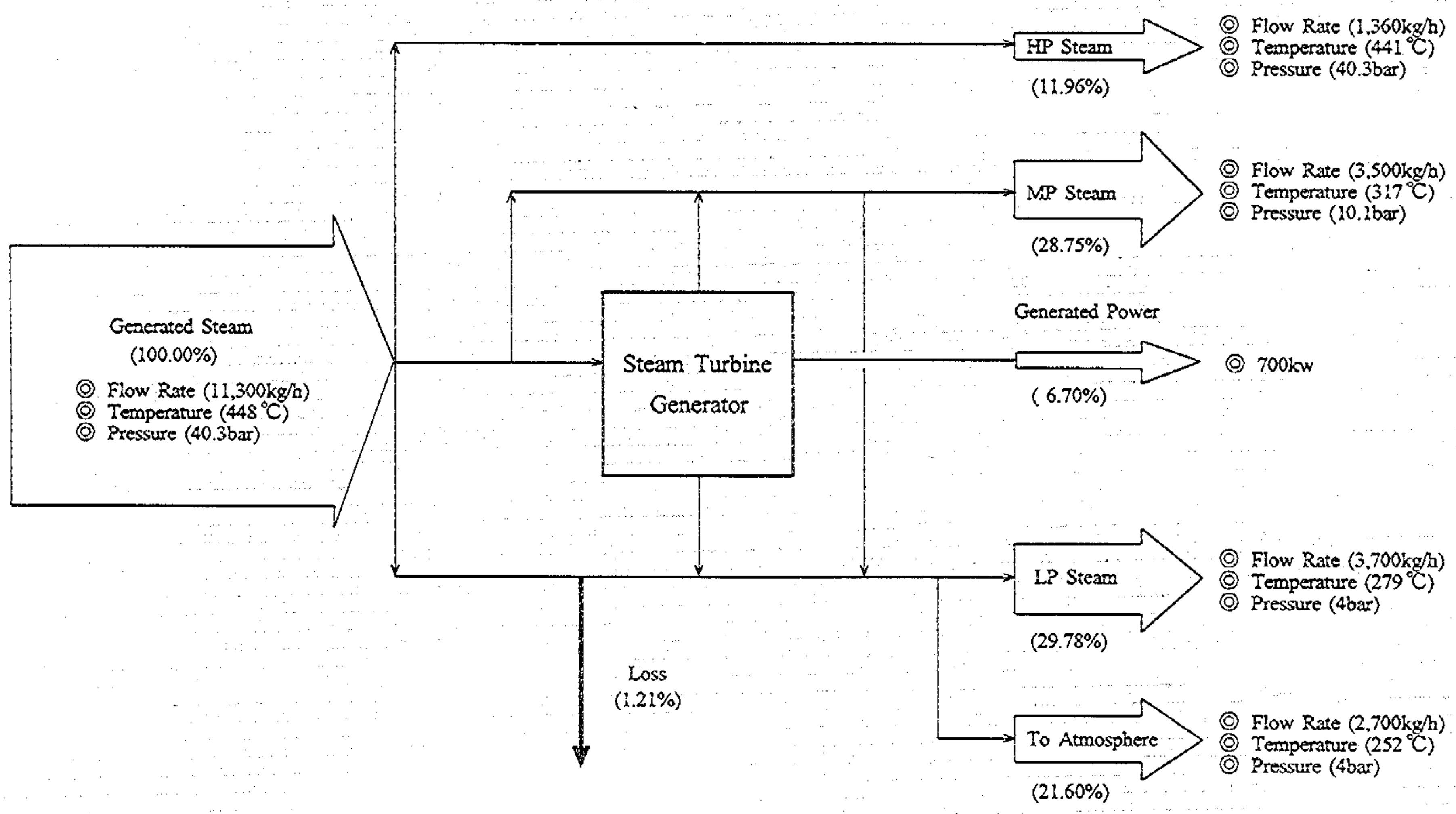


Figure 7-6 Energy Balance around Steam Turbine (Turyag A.S.)

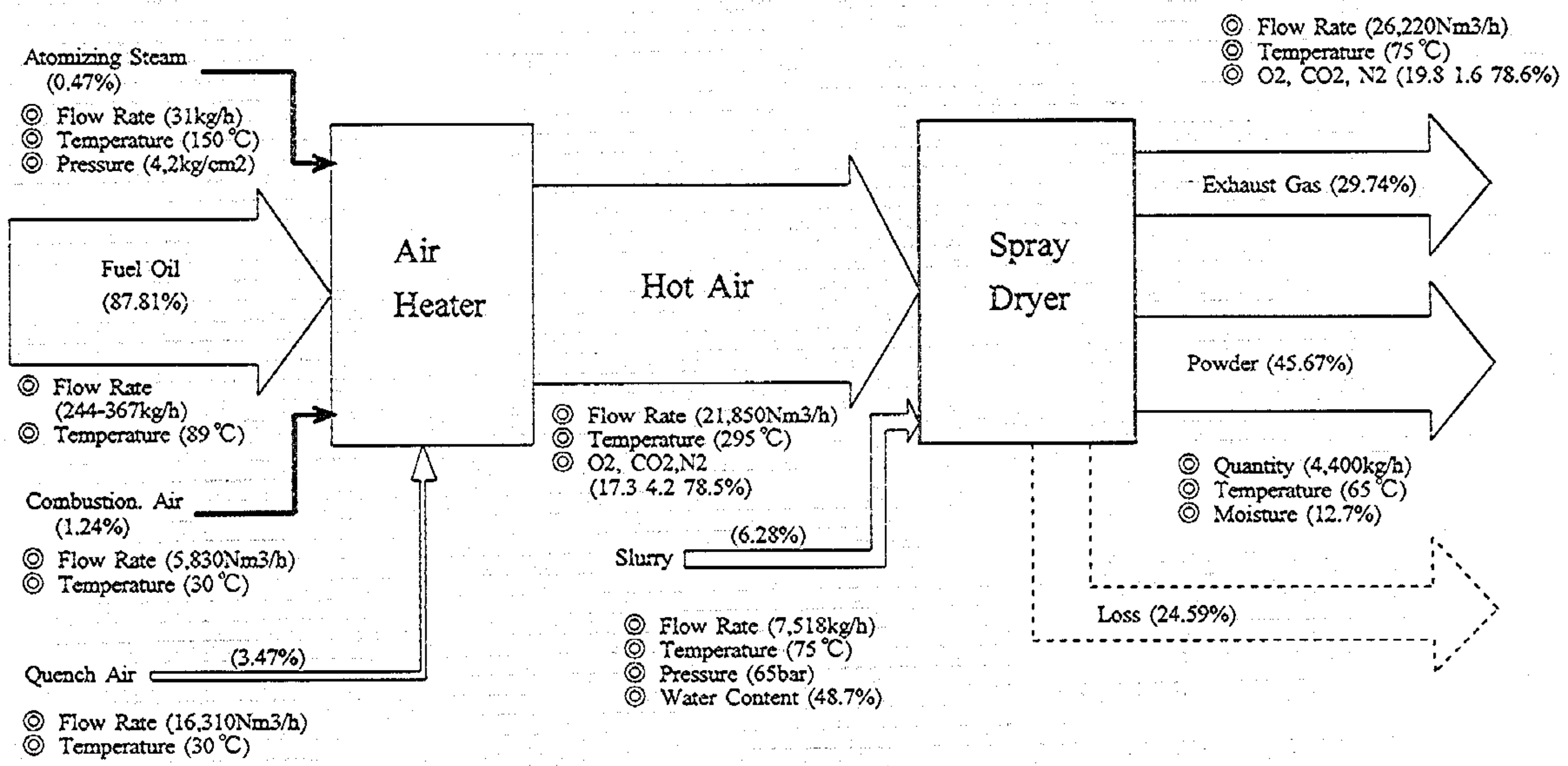


Figure 7-7 Energy Balance around Spray Dryer (Turyag A.S.)

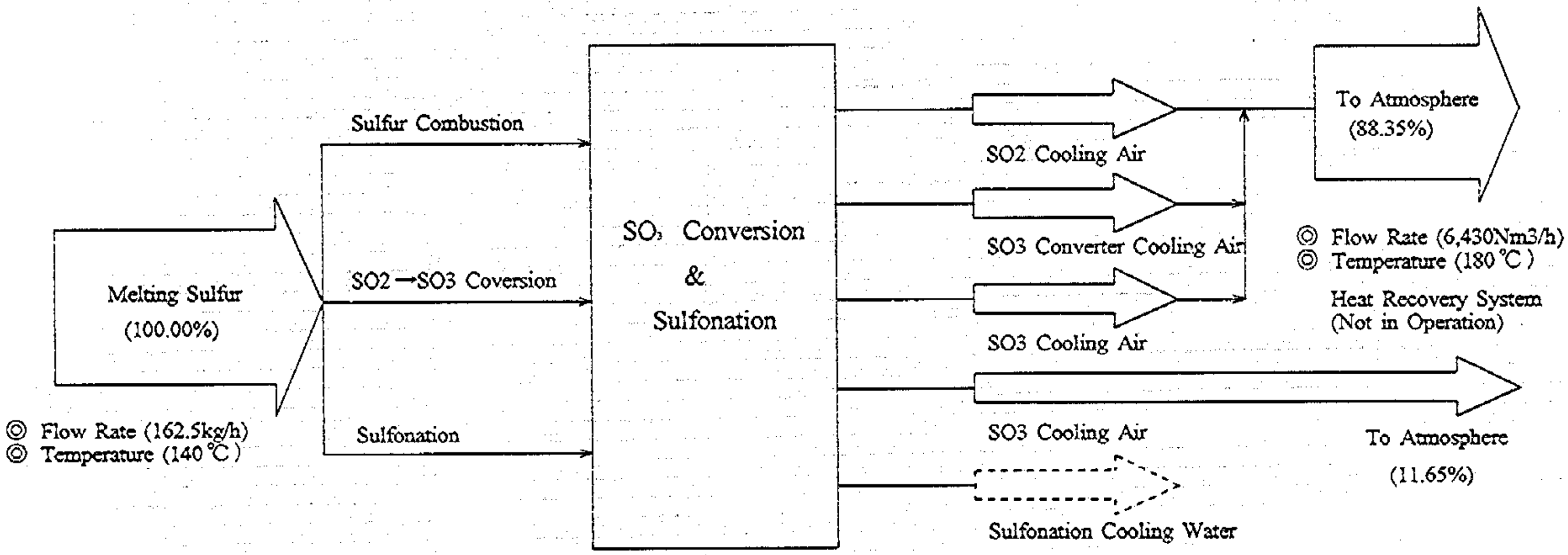


Figure 7-8 Energy Balance in Sulfonator (Turyag A.S.)

7-11 Formulation and Recommendation of Countermeasures for Energy Conservation

In accordance with the factory audit results, countermeasures for energy conservation were formulated, as described below.

7-11-1 Improvement of Energy Balance around Boilers

This factory has not been measuring the lignite consumption rate of boilers. However, it is important to measure lignite consumption rate directly, in order to control and manage thermal efficiency continuously around the boilers. This measurement shall be done by load-cell type instrumental equipment.

7-11-2 Solution for Imbalance between Steam Consumption and Necessary Power Generation

This plant has installed a steam turbine generator with a maximum steam consumption of 16 tons/h (1,600 kW) and two boilers with rated steam generation of 10 tons/h. On the other hand, steam consumption is from 7 to 8 tons/h in summer and about 11 tons/h in winter. As a result, the power generated from steam turbine generator is not enough to meet the required power of this factory; sometimes the power received from TEK exceeds the contract capacity, causing a penalty to be assessed by TEK. On such an occasion, this factory is obliged to increase power generation by means of increasing exhaust steam to the atmosphere. Moreover, there is a problem with this steam turbine generator in that the efficiency is low because of low operation load. To solve these problems, increasing of steam consumption and decreasing electricity consumption in a rational way is necessary. The following plans have been evaluated.

(1) Introducing Steam Turbine Drivers to Replace Large Motors

This countermeasure can be useful for increasing steam consumption (increasing power generation) and decreasing electricity consumption. The following motors are candidates for shift to the steam turbine drivers, utilizing MP steam (10.5 bar) extracted from steam turbine generator.

1.	Forced draft fans (FDF) of boilers:	110 kW x 2
2.	Induced draft fan (IDF) of spray dryer:	132 kW
3.	Air compressor in sulfonation process:	107 kW
4.	Screw type air compressors:	110 kW x 2

As a result of preliminary calculation of steam consumption, 100 kW's motor requires 3.5 - 3.8 tons/h of steam. This means that only one large motor can be converted to a steam turbine driver and that two-boiler operation might be necessary. One of the forced draft fans (FDF) of boilers is selected due to convenient location and operation.

(2) Introducing Condenser in Steam Turbine Generator Exhaust LP Steam Line

This countermeasure is aimed at increasing steam supply to the steam turbine generator in order to improve its efficiency and increase electricity generation. Condensed steam can be recovered as boiler feed water, but latent heat of the steam is wasted in cooling water. This means that there is not an essential difference between steam condensing and steam exhausting to the atmosphere, and this countermeasure is not recommended.

(3) Introducing Condenser in Steam Turbine Outlet of FDF of Boilers

When the steam turbine outlet of the FDF is recovered as LP steam (4.5 bar), LP steam shall be surplus and exhausted to atmosphere. Instead of this system, steam turbine outlet of the FDF shall be condensed and the condensate shall be recovered directly.

(4) Introducing Air Preheater Utilizing LP Steam for Combustion Air of Air Heater

To increase LP steam consumption and decrease fuel oil consumption, air preheater for combustion air of air heater shall be useful.

7-11-3 Improvement of Energy Balance around Spray Dryer and Air Heater

The current control points in this unit are mixing volume of raw materials, including additives, and temperature of air heater exhaust gas (drying gas). The final object of this unit is to produce proper water content of powder detergent under rational energy consumption. The relationship among the factors listed below should be determined.

1. Flow rate and water content of slurry
2. Inlet/outlet condition of drying gas (flow rate and temperature)
3. Water content of powder detergent
4. Fuel oil consumption
5. Flow rate of combustion and quench air

To control this unit for energy management, the following countermeasures should be adopted.

(1) Filling up Leakage Points of the Spray Dryer

(2) Finding the Relationship between Water Content of Powder and Maximum Temperature

(3) Inlet and Outlet Gas Temperature Control

7-11-4 Improvement of Heat Balance in Sulfonation Process

There are five heat exchangers, often damaged by SO_2 or SO_3 gas, around the SO_3 converter. Among these, the BFW preheater is currently not in use due to heavy corrosion damage. Whenever treating SO_2 and SO_3, the materials of heat exchangers should be carefully selected. The most common materials of heat exchangers in this unit are as follows.

Shell and tube type:	Shell side- Carbon steel, Tube side - SUS 316
Plate type:	SUS 304

To improve the heat balance in this process, heat recovery from cooling air by reconstruction of the BFW preheater, once named 12 E8, is important. The conceptual specification of the BFW preheater is basically the same as the original design of 12 E8 except for materials.

7-11-5 Improvement in Steam Condensate Recovery System

There are four individual vessels for steam condesate collection and the final collection vessel equipped with contamination monitoring system. Steam condensate is not recovered through this system currently, due to contamination. No condensate recovery through this system means large energy loss because of additional well water, and energy in the BFW treatment system is necessary. The duration of contamination is short. This means that contamination is not due to mechanical trouble, but to operational trouble. Typical operation trouble occurs in case of steam cleaning before and after oil transfer around the tank area.

To prevent these operation troubles, the following modification are necessary.

1. Separation of steam and condensate system from the line cleaning system
2. Introducing block and bleed valve systems in the line cleaning system
3. Introducing drain pots in the steam condensate system
4. Preparation of standard operation manual for line cleaning and education and training of

the operating procedure

5. Identification of important valves to be opened or closed with special caution, introducing color management on lines and valves

7-11-6 Decreasing Heat Loss in the Steam Trap System

There are about 500 steam traps installed in steam utilizing facilities. Their working conditions and maintenance are generally good. However, some steam traps are leaking and blowing. The steam loss and heat loss have been calculated and the result is about 3 % of loss. The service life of steam traps are usualy 3-5 years and they can be considered as consumables. Therefore scheduled management such as checking, maintenance and renewal is necessary.

7-11-7 Decreasing Heat Loss in Thermal Insulation System

As a result of calculation of heat loss from major equipment and steam pipelines, the largest heat loss is from the steam boiler, followed by the spray dryer. Total heat loss from steam pipelines is comparable to that from these units. Therefore, the first priority for improvement of thermal insulation is the boiler and the spray dryer, by increasing insulation thickness. As for steam pipelines, heat loss of each line is not so large but almost all the valves and flanges are not insulated. Therefore, thermal insulation of valves and flanges is necessary.

7-11-8 Reduction of Electricity Consumption

There are six transformer stations and 992 motors in this factory. Reduction of electricity consumption of transformers and motors is discussed below.

(1) Transformers

The rated capacity and operating load of each transformer are summarized as follows.

NO.1: 1,250 kVA, 33.6 % / 38.3-44.6 % / 26.6 %	(Boilers)
NO.2: 1,000 kVA, 51.0 % / 52.7-57.8 % / 40.3 %	(Oil & Fats)
NO.3: 1,000 kVA, 21.0 % / 33.6-42.1 % / 37.6 %	(Powder Detergent)
NO.4: 1,685 kVA, -- / 70.1 % / 20.6 %	(Elecrolysis)
NO.5: 1,600 kVA, 33.8-37.5 % / 37.3-52.3 % / 43.4 %	(Liquid Detergent)
NO.6: 750 kVA, 21.3 % / 24.4-29.9 % / 58.7 %	(Steam Turbine Generator)

Notes: The first and second operating load figures were, measured and calculated in September, 1996. The third figure is based on total electricity consumption in November, 1995.

It is difficult to evaluate the operating load of transformers from the limited data, because there are many batch and semi-batch operations in this factory. However, these data suggest low operation load of transformers. The highest efficiency of transformers is at 50-60% of operating load. Therefore, unification of transformers such as No. 1, No. 3 and No. 6 shall be studied. Especially No. 1 could be integrated with No. 6, after converting an FDF motor to a steam turbine driver and taking other countermeasures around the steam turbine generator.

(2) Motors

This factory is utilizing about a thousand motors. Among these, electricity consumption of five major motors was measured. Operating loads of these motors ranged from 65.5 % (IDF of the Spray Dryer) to 85.9 % (Screw type Air Compressor). Low operating load means that the motor has surplus capacity and it can be operated at lower rotation speed. For this purpose, adoption of an inverter speed controlling system is useful, especially for general purpose induction motors.

7-12 Cost Estimation of Countermeasures

The installation cost of the following countermeasures have been estimated by the factory.

The information given here is withheld from public disclosure because of its confidential nature.

7-13 Overall Evaluation of Countermeasures for Energy Conservation

Whenever countermeasures for energy conservation are evaluated, the cost of modification or installation for the countermeasures is necessary as the first step. The benefits of the countermeasures such as saving of energy follows as the second step. To estimate these benefits, decreasing and/or increasing quantity and prices of energy are necessary. This factory has steam boilers and steam turbine generator utilizing lignite as a fuel, generating steam and electricity in the factory. And detailed cost structures of generated steam and electricity are not available. Therefore, to evaluate energy prices of this factory is not so easy, except for Lignite, Fuel Oil and Receiving Power.

Thus, the prices of generated steam and electricity shall be estimated first, then the quantitative effect of each or integrated countermeasures for energy conservation shall be calculated. The benefits of the countermeasures are evaluated, considering both of them. After evaluation of the benefits, they are compared with the cost of the countermeasures, and overall evaluation of the countermeasures shall be conducted.

7-13-1 Estimation of Prices of Generated Steam and Electricity

(1) Trends of Consumption and Prices of Related Energy

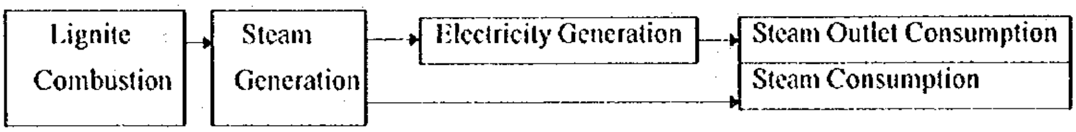
To estimate prices of generated steam and electricity, the correlation of consumption rate and prices among Lignite, Generated Steam and Electricity should be considered. Trends of these data are summarized in Table 7-11, utilizing data from 1992 to 1995.

Table 7-11 Trends of Consumption and Prices of Related Energy

Energy		1992	1993	1994	1995
Lignite	Consumption (tons/y)	23,713	19,010	16,681	16,480
	Price (TL/t)	158,000	260,000	435,000	1,200,000
Steam	Generation (tons/y)	92,000	76,000	67,000	64,500
	Price (TL/t)	116,000	198,000	340,000	869,683
Electricity	Generation (MkWh/y)	5,833	4,023	2,448	2,727
	Price (TL/kWh)	332	725	1862	3478

(2) Structural Correlation among Three Types of Energy

The structural correlation among Lignite, Generated Steam and Electricity is as follows.



From the above structure, the following correlation among Lignite, Generated Steam and Electricity is suggested.

1) Correlation between Lignite and Generated Steam

Lignite is combusted in the boiler only to generate steam, and there is a close relationship between them. Therefore, the steam generation rate can be considered as nearly proportional to the lignite combustion rate. The price of generated steam is easily calculated directly from the price of lignite. The average price ratio between them after adjusting by volumetric ratio is calculated as 0.751 kg of steam price/ kg of lignite price.

2) Correlation between Generated Steam and Electricity

To find this correlation is somewhat difficult because not all of the steam is used to generate electricity through the steam turbine generator. Moreover, the efficiency of the steam turbine generator is influenced by its operating load. Therefore, the following correlation between them is assumed. The price of generated electricity shall be calculated through the parameters, described below, and the price of lignite indirectly.

1. The volumetric ratio of generated electricity and generated steam represents the efficiency of the steam turbine generator.
2. The pricing ratio of generated electricity and generated steam reflects the volumetric ratio of them or efficiency of the steam turbine generator.

Thus, the correlation between the two parameters is useful for practical estimation of the price of the generated electricity.

Through the calculation of two parameters, the following equation can be obtained.

$Y = -0.08535X + 8.164$

Where,

Y: Price ratio of electricity/steam, X: Volumetric ratio of electricity/steam

However, to find the volumetric ratio between generated electricity and steam is still not so easy. We can use the average price of received power.

7-13-2 Quantitative Effect of Countermeasures for Energy Conservation

There are eight of countermeasures discussed in the section 7-11. The quantitative effects of the following major countermeasures among them are analyzed here. The effects are based on 7,200 (300 days/year) annual operating hours.

1. Introducing Steam Turbine Driver for FDF of a Boiler
2. Introducing Air Preheater for Combustion Air of Air Heater
3. Increasing Electricity Generation by Increasing Steam Consumption
4. Heat Recovery from Cooling Air in the Sulfonation Process

(1) Prices for Each Type of Energy

To calculate the effect of the countermeasures, the following prices for each type of energy are set as basic prices, as of August, 1996 with and exchange rate of 86,500 TL/US$.

Lignite (3200 kcal/kg):	2,771,500 TL/t (US$ 32.0/t)
Fuel Oil (10,000 kcal/kg):	23,457,700 Tl/t (US$ 271/t)
Generated Steam: (Lignite price x 0.751):	2,081,400 TL/t (US$ 24.1/t)

Increased Electricity Generation and Decreased Electricity Consumption are based on the average Price of Received Electricity from TEK: 5,678 TL/kWh (US$ 0.0656/kWh)

Source of Boiler Feed Water (Well Water): Planned for 1996 Price; 45193 TL/t (US$ 0.522/t)

(2) Introducing Steam Turbine Driver for FDF of a Boiler

By this countermeasure, electricity consumption is reduced by 110 kWh/h and generated steam is increased by 4 tons/h. However, the increase of steam consumption can be considered substitution of LP Steam now vented to atmosphere except for consumption for the air preheater. Then, decreased, increased cost and overall cost reduction are expressed as follows.

Decreased electricity:	110 x 7200 x 0.0656 = US$ 51,955/y
Increased condensate for BFW:	4 x 7200 x 0.522 = US$ 15,034/y
Increased steam:	(4 + 0.4 - 2.74) x 7200 x 24.1 = US$ 288,043/y
Overall cost reduction:	51955 + 15034 - 288043 = US$ - 221,054/y

This result means that replacement of the motor in isolation is not feasible because the latent heat of steam is not utilized in this system, so integrative countermeasures of improvement for imbalance around boilers and steam turbine generator shall be reconsidered.

(3) Introducing Air Preheater for Combustion Air of Air Heater

By this countermeasure, 204,400 kcal/h (20.44 kg/h) of fuel oil is reduced and 404 kg/h of generated steam is increased. Although increased steam is deemed as substitute of the LP Steam to atmosphere, the increased amount can be neglected. Thus, decreased cost is expressed as follows.

Decreased fuel oil: 0.02044 x 7200 x 271 = US$ 39,735/y

This single countermeasure is feasible without integrative effect of improvement for imbalance around steam boilers and steam turbine generator.

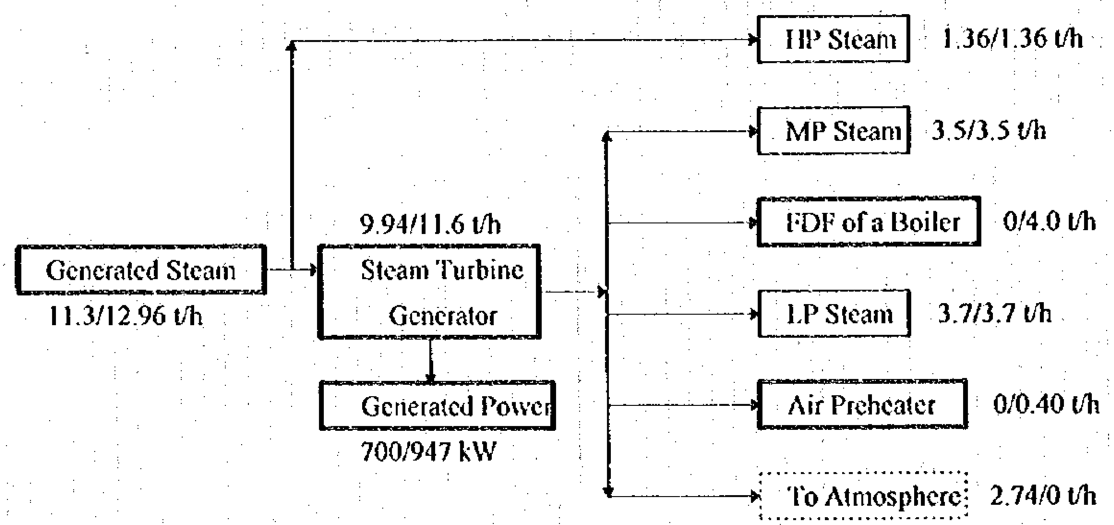
(4) Increasing Electricity Generation by Increasing Steam Consumption

This countermeasure is an integrated one, including the above two countermeasures. The objects of this integrated countermeasure are as follows.

1. To increase efficiency of the steam turbine generator by means of higher operating load
2. To increase house power generation to prevent extra charge due to over receiving
3. To utilize marginal capacity of steam boilers and turbine generator and increase house power generation

1) Steam Balance around Steam Turbine Generator

The current and estimated balance with the countermeasures around this system is shown below.



Remarks: The left figures are current and the right figure are estimated after countermeasures.

Figure 7-9 Estimated Balance of Steam and Generated Power

2) Integrative Effect of Coutermeasures around Steam Turbine Generator

There are the following five effects with these countermeasures around Steam Turbine Generator. Among them, Nos. 4 and 5 have already been discussed.

1. Increase in Generated Power:

   (Case-1) Based on price of received electricity

   Value of the increased power: (947 - 700) x 7200 x 0.0656 = US$ 116,663/y

   Increase in steam generation: (12.96 - 11.3) x 7200 x 24.1 = US$ 288,043/y

   Changes in the total cost: increase of US$ 171,380 /y

   (Case-2): Based on correlation between generated steam and electricity

   Current price of generated electricity: US$ 0.0693/kWh

   Estimated price with countermeasures: US$ 0.0464/kWh

   Benefit with coutermeasures: Current price shall be compensated with estimated price as far as the current volume concerns and receiving price shall be compensated with estimated price for increased portion. Thus, the total benefit is calculated as follows:

   (0.0693 - 0.0464) x 700 x 7200 + (0.0656 - 0.0464) x 247 x 7200 = US$ 149,561/y

   Increase in steam generation (same as the above) = US$ 288,043/y

   Changes in the total cost: increase of US$ 138,482/y

2. Increase efficiency of the steam turbine generator by means of higher operating load

   Figure 7-9 shows that the operating load of the turbine is increased from 62.2 % (9.94t/h) to 72.5 % (11.6 t/h), and efficiency should be improved. However, a detailed performance curve is not available and evaluation of this effect is not also available.

3. Increase house power generation to prevent from extra charge of over receiving

   By means of these countermeasures, electricity consumption is reduced by 110 kW and electricity generation is increased by 247 kW. Therefore, in total 357 kW of electricity receiving should be reduced and penalty for over receiving can be avoided. However, the frequency and duration of over receiving are not clear and evaluation of his effect is not also clear.

4. Introducing steam turbine driver for FDF of a boiler

5. Introducing air preheater for combustion air of air heater

3) Quantitative Effect of Integrative Countermeasures around Steam Turbine Generator

Overall quantitative effect of the above five factors, the following figure is obtained as a result.

1.	Introducing steam turbine driver for FDF of a boiler:	US$ - 221,054/y
2.	Introducing air preheater for combustion air of air heater:	US$ 39,735/y
3.	Increase in generated power by increasing steam:	US$ - 171,380/-138,482/y
	(Total):	US$ - 352,699/- 319,801/y

(4) Heat Recovery from Cooling Air in the Sulfonation Process

The inlet/outlet condition of the heat exchanger is assumed as follows.

1. Cooling Air: 180/130 ℃, 6,430 Nm3 (Q = 101,690 kcal/h)
2. Boiler Feed Water: 110/150 ℃

The Boiler Feed Water is preheated and the energy to be reduced is Lignite in the Boiler (31.8 kg/h), and benefit is calculated as below.

0.0318 x 32 x 7200 = US$ 7,327/y

7-13-3 Overall Evaluation of Countermeasures for Energy Conservation

The major contents of the eight countermeasures are formulated and recommended in 7-11. Among these, quantitative effect of the four countermeasures has been evaluated in this section. Overall evaluation of countermeasures for energy conservation in this factory is summarized below.

1. Introducing steam turbine driver for FDF of a boiler:
   This is not feasible as far as it does not concern utilizing latent heat of generated steam. And integrative effect for increasing generated power shall be investigated by the factory.

2. Introducing air preheater for combustion air of air heater:
   This can be feasible, because the installation cost of the air preheater is 4,500 DM and the effect is US$ 39,735/y. Moreover, this countermeasure is utilizing latent heat of generated steam and contributing increase in electricity generation.

3. Increasing electricity generation by increasing steam consumption:

This countermeasure is an integrated one, it is not feasible unless the following three effect are investigated in detail.

To increase efficiency of the steam turbine generator by means of higher operating load

To increase house power generation to prevent extra charge for over receiving

To seek a suitable use for latent heat of the steam

4. Improvement of heat balance in sulfonation process:

It cannot be feasible, because the installation cost of the heat exchanger is 50,000 DM and the effect is US$ 7,327/y. And other effective method of heat recovery shall be studied instead of lignite substitution.

5. Improvement of heat balance around spray dryer and air heater

This countermeasure is probably very effective, in order to reduce consumption of expensive fuel oil by filling up the leakage points. This filling up is one of the first priorities in this factory.

6. Improvement in steam condensate recovery system

This countermeasure is not expensive, but is a matter of management. Therefore, persons in charge of energy management in this factory should investigate in this detail.

7. Decreasing heat loss in the steam trap system

This countermeasure is also a matter of management. Periodical checking and replacement of steam traps are necessary.

8. Decreasing heat loss in thermal insulation system

Reinforcement in thermal insulation of the boiler and the spray dryer may be feasible, depending on the modification cost. Installation of removable boxes of insulation for flanges and valves is usually feasible; moreover, these installations shall prevent workers from injury.

9. Reduction of electricity consumption

Integration of the transformers may be effective, depending on their operating loads. And introducing inverter speed control systems may be feasible, depending on their installation cost and operating conditions.