Japan International Cooperation Agency (JICA)
The Republic of Poland
Ministry of Economy
Polish National Energy Conservation Agency (KAPE)

THE MASTER PLAN FOR ENERGY CONSERVATION IN THE REPUBLIC OF POLAND

FINAL REPORT

I. Description of the Study
II. Master Plan for Energy Conservation in the Industrial Sector

June 1999

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

Japan International Cooperation Agency (JICA)
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PREFACE

In response to a request from the Government of the Republic of Poland, the Government of Japan decided to conduct a study for energy conservation, and entrusted the study to Japan International Cooperation Agency (JICA).

JICA sent to Poland a study team headed by Dr. Yozo Takemura, The Energy Conservation Center, Japan, and organized by the Energy Conservation Center, Japan and the Institute of Energy Economics, Japan from March 1997 to March 1999.

The team held discussions with the officials concerned of the Government of Poland and conducted a field study. After its return to Japan, the team conducted further studies and compiled the results in this report.

I hope this report will contribute to the further development of energy conservation in Poland and to the enhancement of friendly relations between the two countries.

I wish to express my sincere appreciation to all those who participated in this study project for their close cooperation with the team.

June 1999

Kimio Fujita
President

I. Description of the Study

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[Abbreviations]

JICA	Japan International Cooperation Agency
KAPE	Polish National Energy Conservation Agency
NAPE	National Energy Conservation Agency
RAPE	Regional Energy Conservation Agencies
ARP	The Industrial Development Agency
NFEP & MW	The National Fund for Environmental Protection and Water Management
BOS	The Environmental Protection Bank
ECTC	Energy Conservation Technology Center
GUS	The Central Statistical Office
MTOE	Million Ton Oil Equivalent
MJ	Mega Joule
PJ	Peta Joule
TJ	Tera Joule
S.L.B.	Silica Lime Block
ENEX	Energy Conservation Exhibition
ESCO	Energy Service Company
E.C.Scenario	Energy Conservation Scenario
A.E.C. Scenario	Accelerated Energy Conservation Scenario
REF.	Reference Scenario
HOPP	Human Oriented Program for Production
OJT	On the JOB Training

I. DESCRIPTION OF THE STUDY

1. DESCRIPTION OF THE STUDY

1. DESCRIPTION OF THE STUDY

1.1 Background of the Study

During the decades of planned economy, Poland was able to purchase inexpensive primary energy from the former Soviet Union and to adopt an energy plan which assigned a high priority to the quantity. As a result the energy intensity to GDP runs twice or three times higher than that of the West European countries and America.

In conjunction with the shift from the planned economy system toward a market economy system in 1989, Poland has been in the process of liberalizing the economy. As it plans to join the EU in 2000, it is a pressing issue for Poland to improve the international competitive edge of its enterprises. Following the downfall of the former Soviet Union, the energy supply system of Poland broke down, making it difficult to acquire primary energy and materials. The prices of energy, which was made available at lower price levels through government subsidies, have been raised since January 1990. It is incumbent upon the enterprises and the people of Poland to step up efforts to promote energy conservation.

In an effort to achieve a 20 % reduction in the unit energy consumption rate to GDP by 2000, Poland has attempted a variety of energy conservation programs, which, however, have made relatively little progress.

The Government of Poland is developing an institutional arrangement to promote energy conservation, and has established KAPE (Polish National Energy Conservation Agency) as the organization responsible for promoting conservation policies. For its part, KAPE is now planning to formulate a "Master Plan EC-2001 for Energy Conservation".

Against this background a formal request was made by the Government of Poland that a fact-finding study be conducted of the present status of energy consumption in selected industries and that, based on this study, a development survey be made with a view to proposing policy recommendations to promote energy conservation. The Japan International Cooperation Agency (JICA) made a project finding survey in May 1995, conducted a preliminary survey in September 1996, and carried out a preparatory study in December 1996. JICA negotiated with its Polish counterparts about their specific requests and concluded a Scope of Work (S/W).

1.2 Objective of the Study

The objective of the study is to propose a policy recommendation for promoting energy conservation based on a fact-finding survey about the present status of energy consumption in Poland so as to help facilitate KAPE's formulation of the "Master Plan EC-2001 for Energy Conservation".

1.3 Polish Counterpart Organizations

KAPE (Polish National Energy Conservation Agency)
A Steering Committee comprised of Ministry of Economy, Ministry of Environment, Ministry of Construction and KAPE.

1.4 Japanese Organizations Responsible for the Study

The study was conducted through a partnership between The Energy Conservation Center, Japan (the principal partner) and The Institute of Energy Economics, Japan.

An Advisory Committee was formed in Japan, comprised of specialists on the Polish economy and industrial representatives, which assisted in the formulation of study guidelines and recommendations.

1.5 Scope of the Study

The following surveys were conducted based on "the Scope of Work" for the study agreed upon on November 26, 1996.
This study consists of two types of approaches: "Policy approach" for proposing recommendations for energy conservation measures and the action plans therefor, which is the ultimate purpose of this study, and "Technical approach" intended for supporting the "Policy approach" from the technical aspect.

1.5.1 Survey for the "Policy Approach"

The purpose of the policy approach is to devise a master plan for the promotion of energy conservation in the industrial field in Poland.

We defined the master plan as follows, and in line with the said master plan, collected the data and information required for the formulation of the master plan.

(1) Definition of the master plan

The master plan summarizes various measures (technical measures and methods) to be implemented by industries as well as policy measures and methods to be implemented by the government, which are to be recommended to the policy decision-maker and executor (the government) so that a given goal for energy conservation can be achieved by a given point in the time frame (including plural points in the time frame).

(2) Collection of data and information

In conjunction with the formulation of such master plans, the relevant data and information were obtained by the following sources and methods as well as through the statistical data and materials published by Central Statistic Bureau (GUS), Energy Market Agency (EMA), and other organs

a. Factory energy audit (Refer to section 1.2.3 below).
b. Survey by questionnaires (Targeted factories: around 500)
c. Interview survey (by visiting relevant ministries, organs, factories in the targeted industries)
d. Surveys consigned to specialists or specialist organs

The survey under the above item b. was consigned to a research firm(PONT). The current situation of questionnaires sent and answered are as follows.

	(No. of questionnaires sent)	(No. of questionnaires answered)	(Return rate)	(Same as the left–Ratio in terms of production capacity)
Iron and steel making industry	40	19	48	about 60
Chemical industry	30	15	50	about 60
Non-metallic materials industry (Glass)	42	21	50	about 50
Non-metallic materials industry (Brick)	136	35	26	about 50
Food processing industry (Vegetable oil)	9	3	33	about 50
Food processing industry (Meat)	147	36	25	about 50
Food processing industry (Dairy products)	71	21	30	about 40
Total	529	161	30	–

This survey through questionnaires was mainly intended for grasping the current status of energy consumption in the targeted industrial sectors and equipment (involved in each type of targeted industry). From this standpoint, the return rate in terms of the production capacity of the targeted industry is more significant than that with regard to the No. of factories. In this respect, the fact that "the return rate in terms of the production capacity" concerning each industry was as high as 50 % or over excluding that for the dairy product suggests that the result of this questionnaire survey will allow energy consumption by each industry to be estimated well enough.

The survey through interviews was made by our visit to the following organs.

- General
  Ministry of Economy, Ministry of Environmental Protection, Natural Resources and Forestry, Ministry of Finance, Ministry of Treasury, Ministry of Agriculture and Food Economy, Polish Agency for Foreign Investment (PAIZ), Institute of Foreign Trade, Business Center Club, World Bank, UNDP, UNIDO, EBRD

- Industry
  ARP, Metallurgical Chamber of Industry and Commerce, Institute for Ferrous Metallurgy, Nafta Polska, Institute for Economics of Chemical Industry, Petrochemical Plock, Pulawy Ammonia Company, URSUS tractor company, Polish chamber of Building Industry and Commerce, Institute of Glass and Ceramics, Warsaw glass company, Employers Union of Building Industry and Commerce, Autoclave Lightweight Concrete Association, Karabud brick company, Institute of Agricultural and Food Economics, Meat and Fat Research Institute, Meat Association

- Energy prices and costs
  Polish Oil and Gas Company, Polish Power Grid Company, Polish Association of Professional Heat and Power Plants, Institute of Development and Strategic Studies

Additionally, as a part of the survey under item d, we requested specialists in EMA for the preparation of the report on "Energy-related Policy and Institution in Poland", the results of which was utilized mainly for examination and review of energy price policies, the implementation status of energy conservation policies, etc.

Moreover, experts in Polish Environmental Institute offered great cooperation in our task of estimating an environmental improvement effect of energy conservation (specifically in estimation of the current situation of environmental policies, current status of air pollution, emission factors of global warming gases and air pollutants).

In addition to the foregoing, data and information in Japan and European countries (with special regard to cost-effectiveness of energy conservation measures) were collected, arranged and incorporated into the report.

(3) Coordination of the report

The data and information thus collected were used to make examination and reviews of the following items, each of which was made to constitute one chapter and incorporated into "Part II. Master Plan for Energy Conservation in Industry". For the details, please refer to each chapter in Part II.

a. Current situation of energy supply & demand and energy policy

b. Current situation of the targeted industrial sectors and equipment

<Targeted industrial sectors>
Iron and steel making, Chemicals (ammonia), Machinery (trucks and tractors), Non-metallic materials (glass, silica lime block), food (vegetable oil products, meat products, and dairy products)

<Targeted equipment>
Lighting, air compressor, motor, space heating (air conditioning), boiler, and industrial furnaces

c. Evaluating the energy conservation measures in industrial sectors and setting up scenarios for energy conservation

d. Evaluating the energy conservation measures for targeted sectors and equipment in terms of cost-benefit

e. Evaluating the future energy intensity for the targeted sectors and equipment

f. Estimating the energy potential for the targeted sectors and equipment

g. Estimating the environmental improvement effect of energy conservation

h. "Evaluation of Policy Scenarios" by analysis of energy conservation policies in terms of cost-benefit

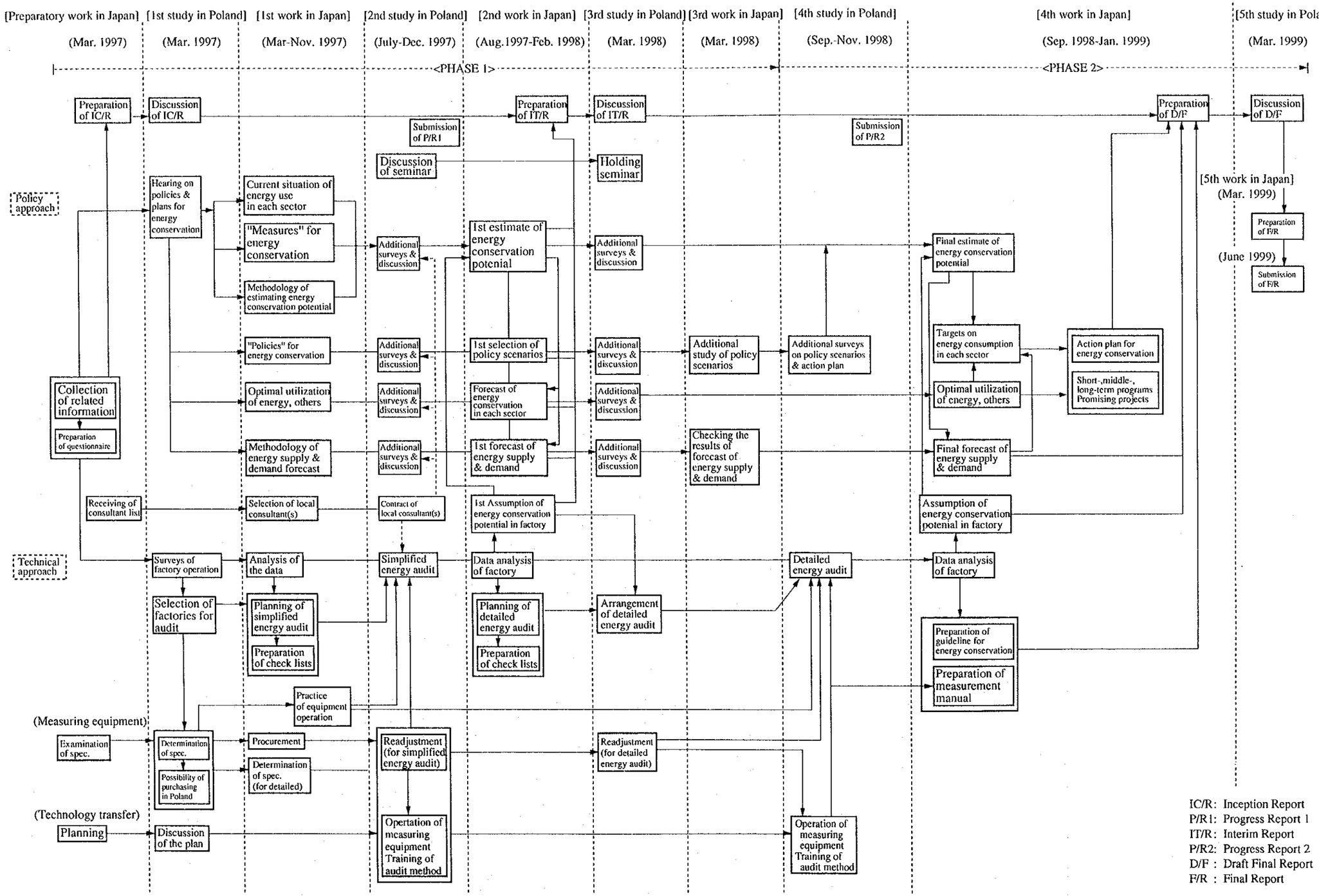
i. "Evaluation of Policy Scenarios" by macroeconomic and energy supply and demand forecasts

j. Proposing recommendations for the master plan for energy conservation and action plans and priority project

1.6 Subjects of the study

The overview of the study is schematically represented in Figure 1.1.

Figure 1.1 Overview of the Study



1.6.1 Preparatory Work in Japan (March 1997)

(1) Collection of the relevant information and data in Japan

(2) Preparation of Inception Report

1.6.2 The First Study in Poland (March 1997)

(1) Presentation and discussion of the Inception Report

(2) Hearing on the "policy approach" concerning energy conservation policy and planning

(3) Preliminary audit on candidate factories for energy audit

(4) Selection of factories for simplified and detailed energy audit

1.6.3 The First Work in Japan (May to November 1997)

(1) Analysis of current situation of energy use in targeted industries

(2) Consideration of "measures" for energy conservation in factories

(3) Methodology of estimating energy conservation potential in targeted industry sectors

(4) Consideration of energy conservation policy

(5) Consideration of "effective utilization of energy"

(6) Consideration of the methodology of forecasting energy supply and demand

(7) Analysis of the data and planning of energy audit

1.6.4 The Seconod Study in Poland (July to December 1997)

(1) Technology transfer on using of measuring equipment

(2) Technology transfer on method and important points of factory energy audit in 5 selected industries

(3) Simplified factory energy audit

(4) Additional surveys and discussions on the estimation of energy conservation potential in each sector

(5) Surveys on energy conservation policy

(6) Additional surveys and discussions on "effective utilization of energy"

(7) Additional surveys and discussions on the methodology of forecasting energy supply and demand

1.6.5 The Second Work in Japan (August to December 1997)

(1) Assumption of energy conservation potential in each factory for simplified energy audit

(2) The first estimation of energy conservation potential for the targeted industrial sectors

(3) The first selection of policy scenarios for energy conservation

(4) The first forecast of energy supply and demand

(5) Preparation of Interim Report

1.6.6 The Third Study in Poland (March 1998)

(1) Presentation and discussion of Interim Report

(2) Holding seminars

1.6.7 The Third Work in Japan (March 1998)

(1) Continued study works on policy scenarios for energy conservation

(2) Readjustment study works on forecast of energy supply and demand

1.6.8 The Fourth Study in Poland (September to November 1998)

(1) Surveys on energy conservation policy

(2) The detailed energy audit

1.6.9 The Fourth Work in Japan (September 1998 to January 1999)

(1) Estimation of energy conservation potential in each factory for detailed energy audit

(2) Final estimate of energy conservation potential in each sector

(3) Final forecast of energy supply and demand

(4) Establishing the targets of energy conservation in each sector and formulation of the "Action Plan"

(5) Preparation of a guideline for energy conservation procedure

(6) Preparation of a measurement manual for energy audit

(7) Preparation of a Draft Final Report

1.6.10 The Fifth Study in Poland (March 1999)

Presentation and discussion of the Draft Final Report

1.6.11 The Fifth Study in Japan (March 1999)

Preparation of the Final Report

1.7 Organizations and Factories to be Studied

(1) Interview survey (Ministries, industrial organization and Japanese enterprises operating in Poland)

a. Ministry of Economy, Department of Energy and Environment; Department of Economic Strategy; Departmet of Industrial Policy
b. Ministry of Finance
c. Ministry of Treasury
d. Ministry of Environmental Protection, Natural Resources and Forestry
e. Ministry of Agriculture and Food Economy
f. Central Statistical Office (GUS)
g. Energy Market Agency
h. Polish Agency for Foreign Investment (PAIZ)
i. Industrial Development Agency
j. Polish Foundation for Energy Efficiency
k. The National Fund for Environmental Protection and Water
l. Bank Ochrony Srodowiska S.A.
m. Energy Restructuring Group
n. Institute of Development and Strategic Studies
o. Institute of Foreign Trade
p. Business Center Club
q. Metallurgical Chamber of Industry and Commerce
r. Institute for Ferrous Metallurgy
s. Nafta Polska S.A.
t. Institute for Economics of Chemical Industry
u. Petrochemical Plock
v. Polish chamber of Building Industry and Commerce
w. Institute of Glass & Ceramics
x. Employers Union of Building Ceramics and Silicates Industry
y. Safe Precast Concrete Association
z. Institute of Agricultural and Food Economics
aa. Meat and Fat Research Institute
bb. Meat Association
cc. Polish Oil and Gas Company
dd. Polish Power Grid Company
ee. Polish Association of Professional Heat and Power Plants
ff. World Bank
gg. International Bank for Reconstruction
hh. BISE
ii. UNDP
jj. UNIDO
kk. European Developmet Bank
ll. Japan External Trade Office, Warsaw Office

(2) Interview survey (Factories)

Chemical	: a.	Pulawy
Machinery	: b.	Ursus
Non-metallic material	: c.	Huta Szkla
	d.	Karbud

(3) Simplified factory energy audit (at the Second Study)

Steel	: a.	Ostrowiec
	b.	Labedy
Chemical	: c.	Blachownia
	d.	Poch
Machinery	: e.	Ursus
	f.	Star
Non-metallic materials	: g.	Wolomin
	h.	Silicaty
Food	: i.	Olvit
	j.	Koscian Meat
	k.	Lubmeat
	l.	Obrzanska

(4) Detailed factory energy audit (at the Fourth study)

Steel	: Fabryka Lacznikow
Chemical	: Boruta
Machinery	: Ursus
Non-metallic materials	: Wołomin
Food	: Przetworstwe Mleka

(5) Interview survery and observation at organizations and factories in Japan

a. Asahi Denka Kogyo K.K.
b. Oji Paper, Oita Mill
c. Oji Steel Co., Ltd., Gunma plant
d. Kubota, Odawara Plant
e. Kubota, Tsukuba Plant
f. Komatsu, Oyama Plant
g. Shizuoka Nippon Ham Co., Ltd.
h. Vegetable Oil Products Assn.
i. Shin Caterpillar Mitsubishi Ltd.
j. Nippon Steel Chemical, Kyusyu Works, Oita Factory
k. Nippon Steel Chemical, Kyusyu Works, Tobata Factory
l. Japan Red Brick Assn.
m. Dynax Corp., Tomakomai Factory

n. Taiyo Oils and Fats
o. Toshiba Lightech Co., Ltd.
p. Toyo Glass Co., Ltd.
q. Toyota Motors Hokkaido KK, Tomakomai Factory
r. Nissan Motor Co., Ltd.
s. Nissan Diesel Motor Co., Ltd., Fukaya plant
t. Nihon Ytong Co., Ltd.
u. Nippon Electrode Co., Ltd, Kanbara Factory
v. Japan Brick Manufacturing Co., Ltd.
w. Hitachi Metals, Kuwana Factory
x. Hitachi Metals, Kuwabe Factory
y. Matsubo Company, Ltd.
z. Meiji Milk, Head Office
aa. Snow Brand Food Products Co., Ltd.
bb. Snow Brand Milk Products Co., Ltd. Head office, Noda, Nakashibetsu, and Bekkai plants
cc. Rinoru Oil Mills Co., Ltd., Nagoya plant

1.8 Measuring Equipment for Factory Energy Audit

Simplified factory energy auding during the second study in Poland was conducted with the measuring equipment which belongs to The Energy Conservation Center, Japan. Detailed factory energy auditing during the fourth study in Poland was carried out using the measuring equipment procured by JICA. The list of the measuring equipment is shown in "Part V. 6. Explanation of Measuring Equipment".

1.9 Members of the JICA Team

(1)	Dr. Yozo Takemura	: Leader
(2)	Mr. Toru Kimura	: Sub leader and energy conservation policy
(3)	Ms. Yukie Kawaguchi	: Energy conservation policy (in Japan)
(4)	Dr. Hisao Kibune	: Energy planning
(5)	Mr. Shigeaki Kato	: Energy planning
(6)	Mr. Zhang Ji Wei	: Energy planning
(7)	Mr. Norio Fukushima	: Leader of energy audit & Heat management
(8)	Mr. Jiro Konishi	: Heat management
(9)	Mr. Kazuo Usui	: Electricity management
(10)	Mr. Toshio Sugimoto	: Electricity management
(11)	Mr. Seiichiro Maruyama	: Iron & steel process management
(12)	Mr. Masashi Miyake	: Chemical process management
(13)	Mr. Sadao Nozawa	: Machinery process management
(14)	Mr. Masami Kato	: Non-metallic minerals process management
(15)	Mr. Shiro Honda	: Food process management
(16)	Mr. Tetsuo Oshima	: Measuring engineer
(17)	Mr. Kiyotaka Nagai	: Measuring engineer
(18)	Mr. Akihiro Koyamada	: Measuring engineer
(19)	Ms. Ayako Sato	: Coordination

1.10 Counterpart Members

(The National Energy Conservation Agency KAPE SA)

(1) Dr. Krzystof Zmijewski: President
(2) Dr. Roman Babut : Director of International Cooperation Division
(3) Mr. Ryszard Wnuk : JICA Project Manager
(4) Mr. Dariusz Koc : Manager of Energy Audit Secretary

(Local consultants)

(1) Research Center of Warsaw University of Technology
   a. Dr. Krzysztof Wojdyga : Heat management
   b. Mr. Maciey Chorzelski : Heat management
   c. Dr. Wieslaw Szadkowski: Heat management
   d. Dr. Leszek Krycki : Electricity management
   e. Mr. Wrobel Waldemar : Electricity management
   f. Mr. Staniseaw Kozinski : Electricity management

(2) POLESCO Investment SA
   a. Dr. Tadeusz Kruczek: Heat management
   b. Dr. Krzysztof Wilk : Heat management
   c. Dr. Wieslaw Goc : Electricity management
   d. Dr. Marcin Szega : Heat management
   e. Dr. Joachim Bargiel : Electricity management

(3) Baltic Energy Conservation Agency
   a. Dr. Edmund Wach : Heat management
   b. Dr. Andrzej Szajner: Heat management
   c. Dr. Pawel Bucko : Electricity management

1.11 Members of Steering Committee

(1997)

Chairman:

(1) Mr. Wielslaw Pawliotti : Adviser to Minister, Ministry of Economy

Members:

(2) Mr. Wojciech Jaworski : Director of Department of Air and Land Protection, Ministry of Environmental Protection, Natural Resources and Forestry
(3) Mr. Andrzej Pogorzelski : Department of Architecture and Building Policy, Ministry of Physical Planning and Construction
(4) Mr. Jozef Pawelec : Department of Communal Policy, Ministry of Physical Planning and Construction
(5) Dr. Krzystof Zmijewski : President, The National Energy Conservation Agency (KAPE)

(Since 1998)

Chairman

(1) Dr. Krzystof Zmijewski : President, The National Energy Conservation Agency (KAPE)

Committee members

(2) Ms. Teresa Kubacka : Department of National Economy Finance, Ministry of Finance
(3) Mr. Jozef Pawelec : Central Office of Housing and Town Development
(4) Dr. Wieslaw Pawliotti : Department of Energy and Environment, Ministry of Economy
(5) Dr. Andrzej Pogorzelski : Ministry of Internal Affairs and Administration
(6) Mr. Jan Sikora : Department of National Economy Finance, Ministry of Finance

Observers

(7) Mr. Stanisław Soja : Department of Industrial Policy, Ministry of Economy
(8) Mr. Jerzy Horodecki : Department of Industrial Policy, Ministry of Economy
(9) Mr. Ryszard Wnuk : Project Manager, KAPE

1.12 Members of Advisory Committee

Chairman:

(1) Mr. Nobuaki Mori : President, The Energy Conservation Center, Japan (ECCJ)

Members:

(2) Mr. Mitsuo Iguchi : A former Senior Technical Adviser, ECCJ
(3) Mr. Kazuya Fujime : Director, The Institute of Energy Economics, Japan (IEEJ)
(4) Mr. Kenichi Matsui : Councillor, IEEJ
(5) Mr. Ichiro Arima : A former Director, Warsaw Office, Japan External Trade Organization
(6) Mr. Noriyoshi Nagamatsu: Chief Economist, International Development Center of Japan
(7) Mr. Hiroshi Watanabe : Director, Central-Eastern European Department, Japan Association for Trade with Russia & Central-Eastern Europe
(8) Mr. Masatane Chiba : Director for International Division, Japan Productivity Center for Socio-Economic Development
(9) Mr. Kiyohiko Inoue : General Manager, Environment and Energy Department, The Japan Iron and Steel Federation
(10) Mr. Yutaka Sawada : Director, Production Technical Group, Technical Department, Japan Chemical Industry Association
(11) Mr. Ryuichi Tokunaga : General Manager, Planning and Administration Department, Japan Construction Equipment Manufacturing Association

Ⅱ. MASTER PLAN FOR ENERGY CONSERVATION IN THE INDUSTRIAL SECTOR

1. THE PAST AND PRESENT SITUATIONS OF ENERGY DEMAND AND SUPPLY AND ENERGY POLICIES

1. THE PAST AND PRESENT SITUATIONS OF ENERGY DEMAND AND SUPPLY AND ENERGY POLICIES

In this chapter, we overview the past and current situations of energy supply and demand and energy policies in Poland. Since the Polish economy started its transition to a market oriented economy in 1989, it recorded negative GDP growth until 1991, but after that it recovered and has grown steadily. Economic growth rates in recent years have been more than 5% and similar figures are expected in the future.

On the other hand, energy supply and demand showed negative growth from the second half of the 1980s to 1992 due to the stagnation of the economy. Even after 1992, the level of energy consumption is approximately the same as that of 1990, although the economic growth has a positive trend.

The reasons for the de-coupling between economic and energy trends are (1) decreasing energy loss in the energy conversion sector and (2) industrial structural change in economic circumstances of material industries such as iron & steel and chemical industry which were relatively sluggish.

Energy intensity per GDP improved. The reason for the energy intensity per GDP improvement is not only improved energy efficiency in individual industries. If the material industry, which continued to experience a slump recovers due to economy growth, energy consumption and environment pollution' might increase in the near future.

Below we survey the past and current energy supply and demand situation and the background of changes. Then we examine the energy conservation policy under the transitional economy.

This chapter discusses changes in energy supply and demand, energy policy, and the importance of the energy conservation policy for the industrial sector.

1.1 Past trends and current situations of energy supply and demand.

1.1.1 The trend of the macro - economy

In this section we overview the current economic situation in Poland from several viewpoints such as the size, trends, and driving forces of economic growth. Present GDP of Poland has soared from the peak of the planned economy. Driving forces behind its economic growth is domestic demand, although there are a few critical issues: high inflation and unemployment rates and increasing trade deficit and government fiscal deficit that will reduce the value of the currency.

(1) Size and components of GDP

The GDP (in the constant price of 1990) of Poland in 1996 was 66.3 billion PLN. When we look at this figure from three economic aspects; consumption (the private final expenditure + government consumption), investment (the private investment + the public fixed capital formation), and foreign trade balance (export-import), the ratios of each are 78%, 29%, and -6%. The foreign trade deficit (the deficit of the current balance) has continued for the last two years, 1995 and 1996.

One of the reasons for this is the expansion of capital imports, which is driven by the expansion of private investment.

(2) Characteristics of current economy

The characteristics of economic growth after 1990 and around the transitional period, are followings:

First, GDP in 1996 just exceeded that in 1989, which was the first year of the market -oriented economy. The Polish economy recorded negative growth in 1990 and in 1991 by -11.6% and -7.0%, because of the confusion caused by the transition. Since 1992, it recovered gradually, and in 1995, it achieved +6.0% economic growth and 7.0% in 1996. The present scale of GDP exceeds the peak in the socialist era (See Figure 1.1 and Table 1.1).

Second, economic growth rates in the last several years have been over 5%. It is possible to judge that the Polish economy has taken off from the economic turmoil in terms of the "depression under high inflation", which is a characteristic of transitional economies. Some economists call Poland a model of a transitional economy because it has such shown favorable economic growth in the a few years after the transition.

Third, the high rate of inflation is also showing an easing trend. Taking the consumer price index as an example, there was triple-digit inflation in 1989 and 1990. However, this declined to double-digit from 1991, and the rate went down to 19% in 1996. The figure in 1997 is about 14%. But these figures are still higher than those of Western European countries.

Fourth, the labor market has also improved. During the transitional years, the employment

environment substantially deteriorated with high unemployment. In the bad years the rate exceeded 16%, but it declined to 13% in 1996 and is expected to decline further in the future. However, double-digit unemployment is still high and the further efforts to reduce it are expected.

Fifth, a pattern of steady growth might have been prepared. Looking at the pattern of economic growth in recent years, it is clear that the driving forces of economic growth are consumption, investment, and exports, excluding coal (See Figure 1.2).

The substantial decrease of inventories was one of the major reasons for the negative growth in the period around 1990. Under the planned economic system, they needed large inventories because industrial consumers were giving warnings about the scarcity of material and feedstock supply. However, after the transition to the market economy, there were no such concerns and inventories fell. Since the adjustment of inventories around 1993, one negative factor for growth was disappeared. Conversely, the present high economic growth is supported by the expansion of consumption, investment, and exports, excluding coal. Furthermore, fixed capital formation by the government is also encouraging it.

However, it is not possible to deny that there is a pending problem that with increasing imports of capital goods due to the expansion of domestic investment and the expansion of exports, excluding coal, which promote increased exports.

Even though the Polish economy has a few controversial issues, the current economic growth is based on favorable economic forces.

Figure 1.1 Trends of GDP

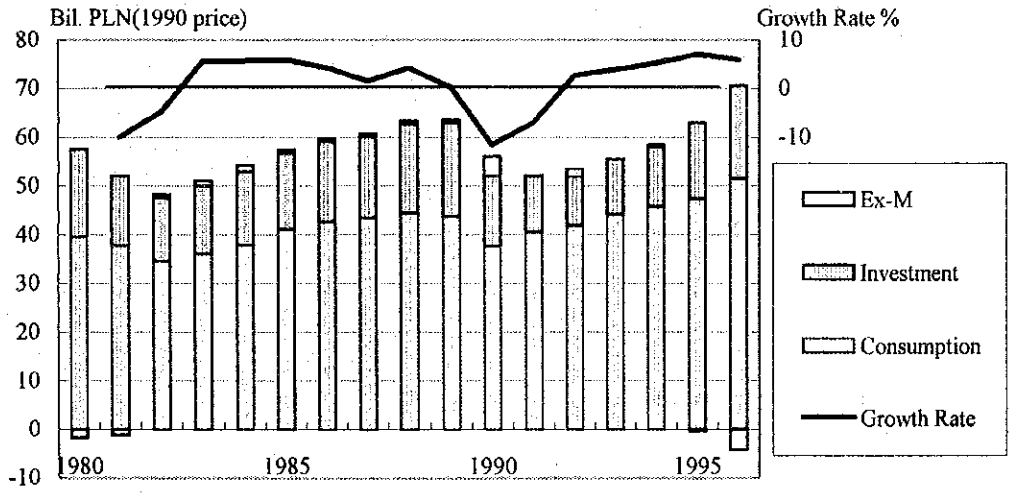
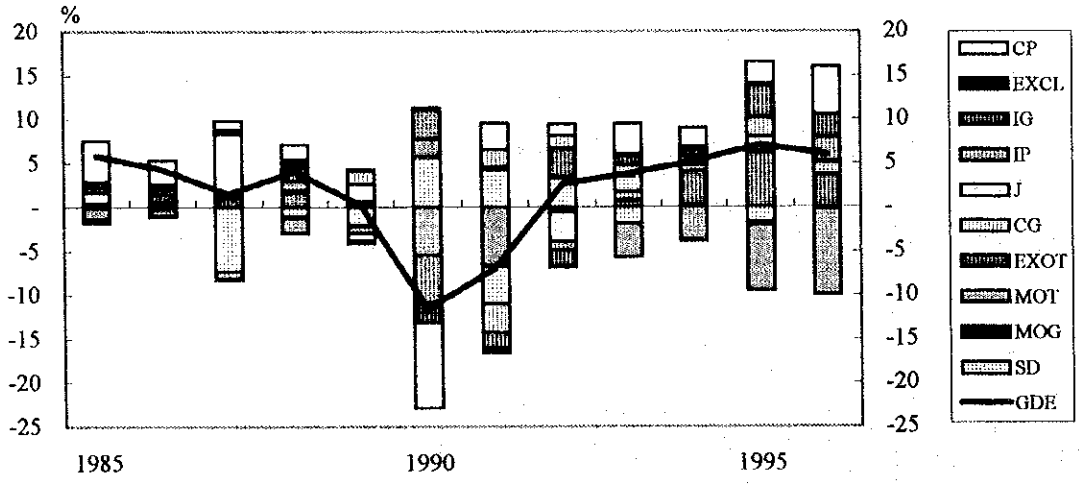


Table 1.1 GDE and Economic Indicators

(Unit, Mil. PLN, 1990 Price, and etc.)

Item \ Year	1980	1985	1988	1989	1990	1991	1992	1993	1994	1995	1996	96/'90
GDE: Gross Domestic Expenditure	56,758	57,418	63,253	63,379	56,027	52,121	53,489	55,522	58,409	62,526	66,278	2.8
Consumption	39,609	41,053	44,377	43,760	37,675	40,486	41,909	44,202	45,744	47,290	51,512	5.4
Private Expenditure	29,946	29,942	33,135	33,040	26,867	28,572	29,233	31,044	32,218	33,667	37,034	5.5
Government Consumption	9,662	11,111	11,242	10,720	10,808	11,914	12,676	13,158	13,526	13,623	14,478	5.0
Investment	17,943	15,700	18,151	19,194	14,351	11,465	9,974	11,250	12,263	15,641	19,020	4.8
Private Investment	*10,262*	*8,960*	*10,291*	*11,213*	7,774	5,905	5,392	6,084	6,647	7,874	9,575	3.5
Government Investment	*7,681*	*6,741*	*7,860*	*7,981*	6,577	5,560	4,581	5,166	5,616	7,767	9,444	6.2
Net Foreign Demand	-1,662	723	724	525	4,001	169	1,606	69	402	-405	-4,253	-
Export, Goods and Services	10,643	11,323	13,555	13,901	16,051	15,786	17,487	18,047	20,411	24,156	26,500	8.7
Coal	1,018	1,186	1,055	946	919	682	633	754	918	1,045	1,071	2.6
Others	9,625	10,138	12,500	12,955	15,132	15,103	16,854	17,293	19,493	23,111	25,428	9.0
Import, Goods and Services	12,305	10,601	12,831	13,377	12,050	15,616	15,881	17,978	20,009	24,561	30,753	16.9
Oil and Gas	1,382	1,221	1,367	1,382	1,285	1,104	1,143	1,146	1,133	1,290	1,322	0.5
Others	10,923	9,380	11,464	11,995	10,765	14,512	14,738	16,832	18,876	23,271	29,430	18.2
Gross Domestic Expenditure(Market Price)	251	1,045	2,963	11,832	56,027	80,883	114,944	155,780	210,407	286,026	359,881	36.3
Consumer Price Index(1990=100)	0.45	1.80	4.2	14.6	100.0	170.3	243.5	329.5	435.6	556.7	659.7	36.9
Wholesale Price Index(1990=100)	0.50	1.90	4.4	13.8	100.0	148.1	199.3	262.3	333.2	424.1	475.4	29.7
Exchange Rate for Exports based on BLPY(PLN/US$)	0.018	0.049	0.175	0.992	1.455	1.946	2.630	2.984	3.119	3.465	23.2
Number of Employment(1000 p)	17,325	17,144	17,023	17,002	16,280	15,326	14,677	14,330	14,475	14,735	15,139	-1.2
Unemployment Rate(%)	-	-			6.3	11.8	13.6	16.4	16.0	14.9	13.6	13.7
Population(1000 p)	35,578	37,230	37,862	37,963	38,119	38,245	38,365	38,459	38,544	38,609	*38,674*	0.2

Figure 1.2 Composition of Economic Growth



1.1.2 Trends of energy supply and demand

(1) Primary energy supply

The primary energy supply of Poland in 1996 was 108 MTOE (Million Ton Oil Equivalent). This figure is almost 22% smaller than 138 MTOE, which was the past largest consumption recorded in

1987. But, the figure in 1996 increased substantially by +9.6% compared to the previous year (See Table 1.2).

In terms of energy carrier, coal, including solid fuel, takes 74%, petroleum 17%, and natural gas 9%. There are also exports of hydro-electric power and electric power. The large dependence on coal is related to the huge quantity of domestic reserves. Poland has extensive coal reserves, which is ranked 8th in the world. According to the World Energy Conference (1996), coal reserves are 27.6 billion tons and the ratio of R/P (reserve/production) is more than 200 years based on current production of 135 million tons.

Therefore, the share of coal in the primary energy supply in the 1980s was almost 80%. However, after the transition, its share has been declining (See Figure 1.3). After switching over to the market economy and during the period when the economy recovered, energy demand in the first half of the 1990s did not increase. In particular, coal, which was a major energy carrier, was floundering.

In the demand sector, coal demand decreased, and the decrease in the conversion sector to generate heat and electric power accounted more than half of the decrease. In final energy consumption, coal demand is decreasing.

However, excluding the industrial sector, coal demand is recovering.

The main reason for the decrease in the conversion sector is the improvement of conversion efficiency (conversion loss's decrease) and the decrease of heat demand in the residential and commercial sector (See Figure 1.4).

Table 1.2 Trend of Primary Energy Supply

(Unit: 1000 TOE, and etc.)

Item / Year	1980	1985	1990	1991	1992	1993	1994	1995	1996	'95/'90	'96/'95
Primary Energy Requirement	128,814	130,841	101,220	99,634	98,653	100,131	95,700	98,637	108,130	-0.5	9.6
Coal	101,778	105,176	78,520	78,530	76,861	77,776	72,782	74,205	79,787	-1.1	7.5
	(79)	(80)	(78)	(79)	(78)	(78)	(76)	(75)	(74)		
Oil	17,910	16,054	13,592	13,092	14,017	14,216	14,782	15,515	18,800	2.7	21.2
	(14)	(12)	(13)	(13)	(14)	(14)	(15)	(16)	(17)		
Gas	8,866	9,459	8,915	7,944	7,817	8,219	8,218	8,995	9,645	0.2	7.2
	(7)	(7)	(9)	(8)	(8)	(8)	(9)	(9)	(9)		
Hydro	281	334	283	292	305	127	149	163	166	-10.5	2.0
Electricity	-20	-182	-89	-225	-346	-207	-230	-241	-269	22.0	11.5
GDP(Mil.PNL,1990)	56,758	57,418	56,027	52,121	53,489	55,522	58,409	62,526	66,278	2.2	6.0
GDP Intensity(kg/PLN)	2.27	2.28	1.81	1.91	1.84	1.80	1.64	1.58	1.63	-2.7	3.4
CO2 Emission (Mil. ton-C)	133,325	135,748	103,965	102,912	101,837	103,274	98,311	101,023	110,519	-0.6	9.4

(Note) Figures in parentheses are share in the total.

(Source) GUS, Poland Energy Information Center

Figure 1.3 Trend of Primary Energy Requirement

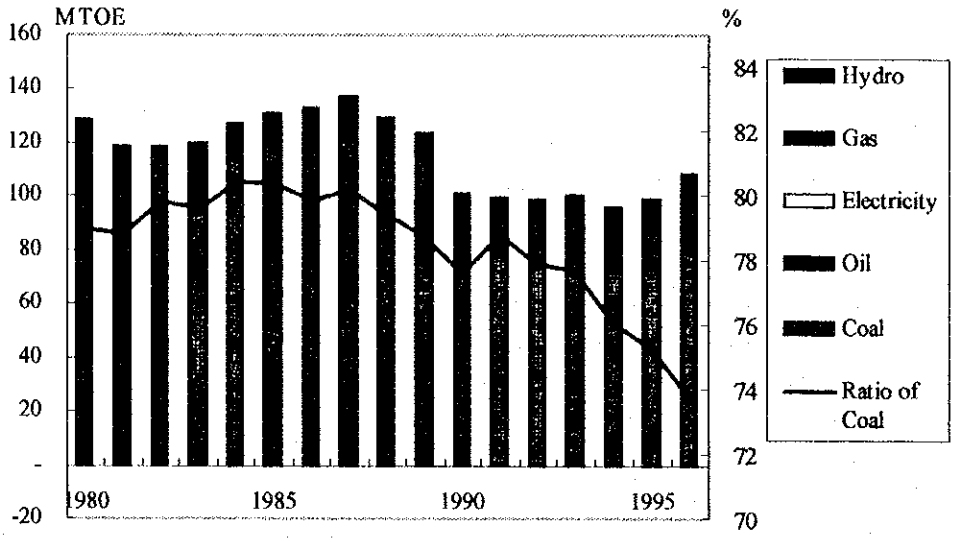
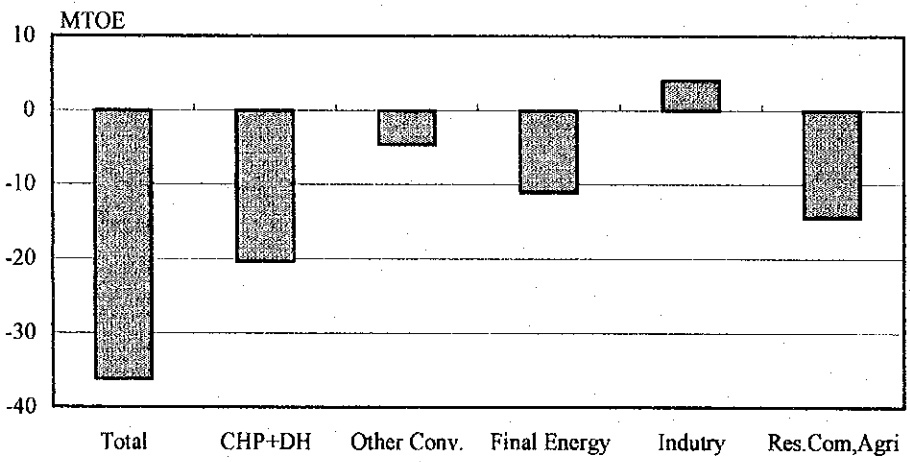


Figure 1.4 Decline of Coal Consumption between 1987 to 1995



Let us attempt to analyze the decrease of the primary energy supply during the past decade with three factors: (1) population, (2) economy growth, and (3) energy intensity per GDP. The analysis shows that in the first half of the 1990s the overwhelmingly factor for the decline of energy demand was the decline of (1) energy intensity per GDP, accompanying (2) the negative factor of the economic recession. The energy intensity per GDP represents the energy volume required to produce a certain amount the value added. It declined to 79 in 1990 and to 65 in 1995 from 100 in 1985.

Moreover, we will examine which demand sector triggered the decline of intensity.

The biggest contribution is shown by the conversion sector, like the case of the decrease of coal demand. The analysis is illustrated by the charts that follow (See Figure 1.5 and Figure 1.6).

Figure 1.5 Factors behind the Decline of the Primary Energy Requirement

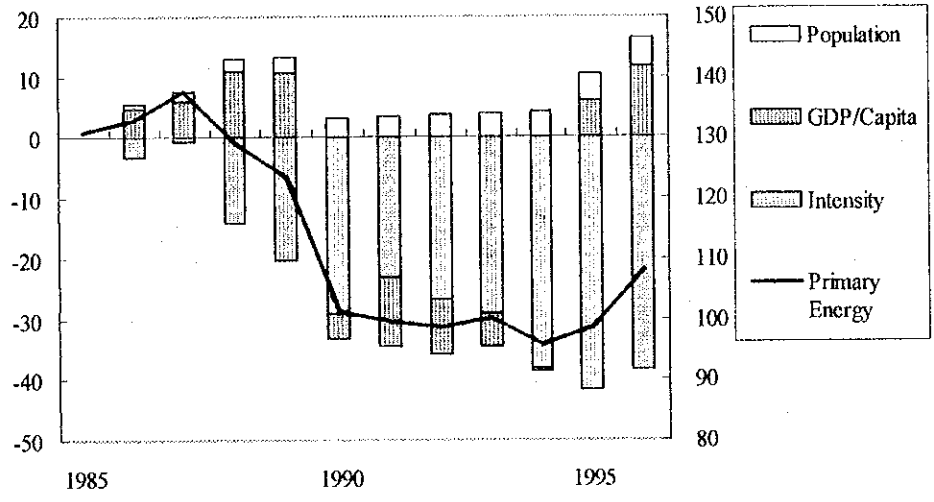
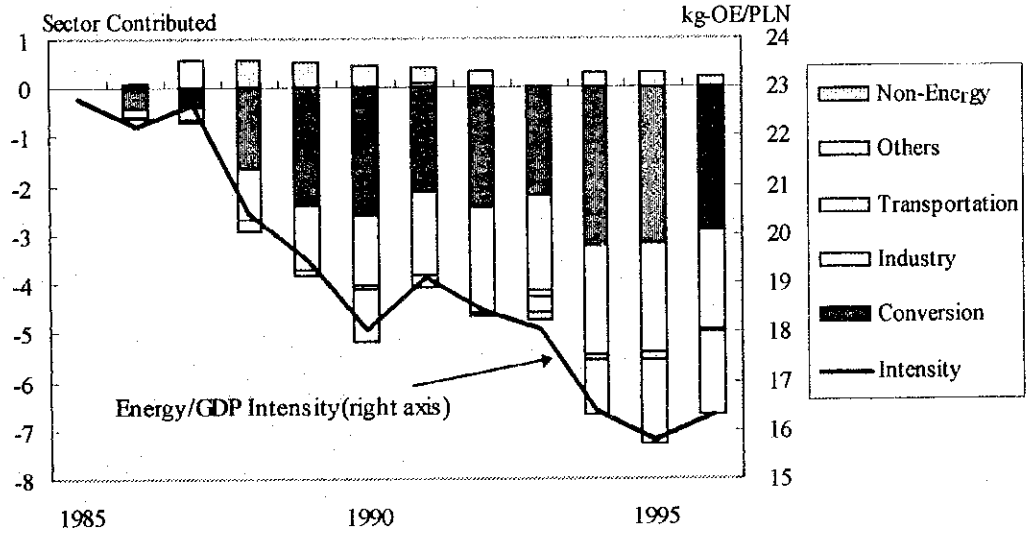


Figure 1.6 Decline of Energy/GDP Intensity and its Contribution by Sector



(2) Trend and the present situation of final energy consumption

Sixty-eight percent of the primary energy supply, which is 67 MTOE, was given to consumer as the final energy consumption in 1995. The composition ratios of final energy consumption by energy in the same year are as followed: coal is the biggest with 42%, with 20% for petroleum, 14% for heat, 12% for gas, and 12% for electric power.

By demand sectors, "the other sector (agriculture + residential + commercial)" accounts for 48%, for 34% of the industrial sector, 13% for transportation, and the remains 5% for non-energy use (See Table 1.3).

When we see the trend of demand, the current consumption level still does not exceed its peak in 1987. The average annual increase during the period from 1990 to 1995 is minus 0.7%. The figure in 1996 was slightly larger than the 1990 level, although demand in 1996 increased drastically by 9.1% over the previous year. This was caused by the substantial decrease of heat demand in terms of energy carrier and by the decrease of use by industry and "the others" sectors in terms of demand sector (See Figure 1.7).

Table 1.3 Final Energy Consumption

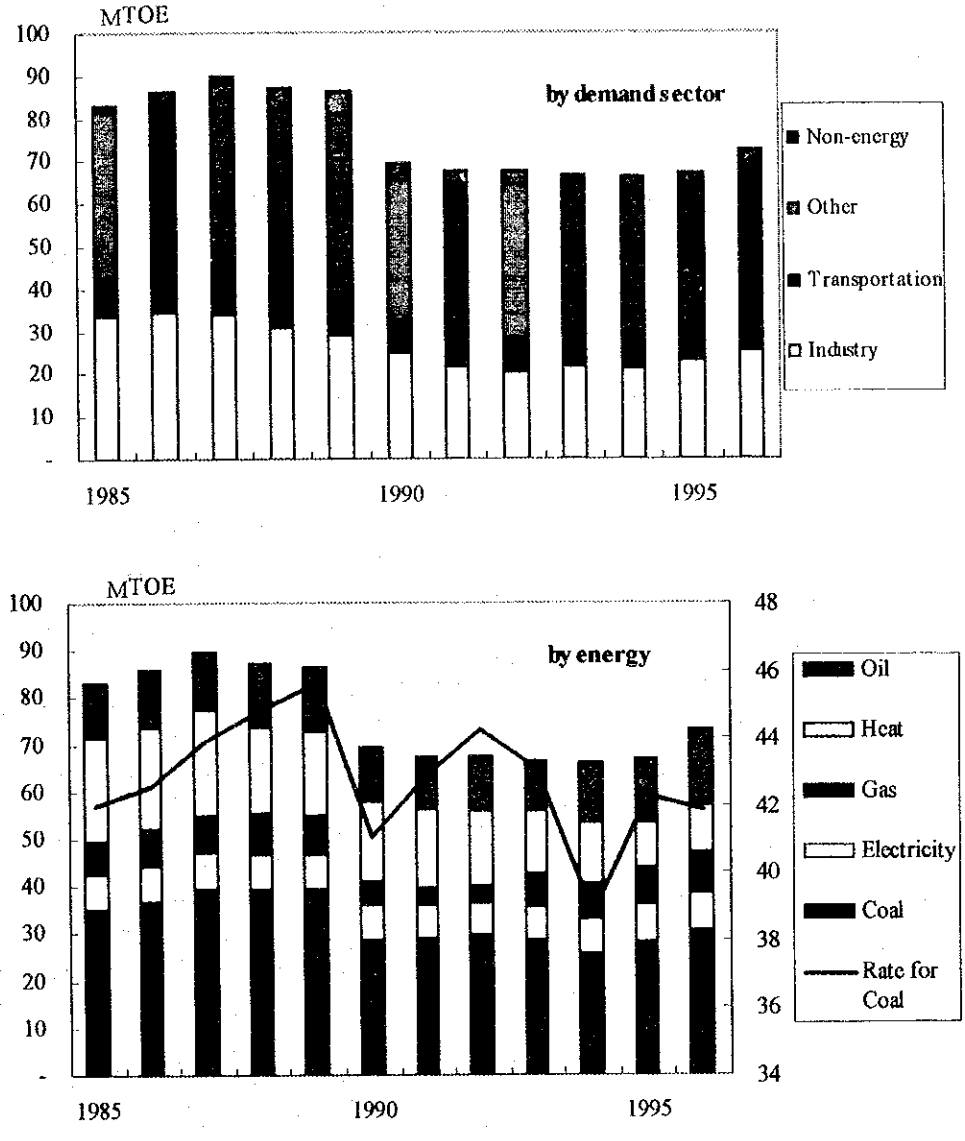
(Unit: 1000 TOE, and etc.)

Item / Year	1980	1985	1990	1991	1992	1993	1994	1995	1996	'95/'90	'96/'95
Final Energy Consumption	86,505	83247	69,319	67,497	67,376	66,416	66,214	66,933	73,009	-0.7	9.1
	(100)	*(100)*	*(100)*	*(100)*	*(100)*	*(100)*	*(100)*	*(100)*	*(100)*		
Coal	38,360	34944	28,462	28,949	29,802	28,630	25,697	28,291	30,564	-0.1	8.0
	(44)	*(42)*	*(41)*	*(43)*	*(44)*	*(43)*	*(39)*	*(42)*	*(42)*		
Oil	12,647	11,870	11,336	11,100	11,605	10,739	13,004	13,454	15,928	3.5	18.4
	(15)	*(14)*	*(16)*	*(16)*	*(17)*	*(16)*	*(20)*	*(20)*	*(22)*		
Gas	6,772	6,914	4,971	3,964	3,597	7,004	7,350	7,862	8,454	9.6	7.5
	(8)	*(8)*	*(7)*	*(6)*	*(5)*	*(11)*	*(11)*	*(12)*	*(12)*		
Electricity	7,320	7,708	7,323	6,845	6,630	6,995	7,326	7,703	8,035	1.0	4.3
	(8)	*(9)*	*(11)*	*(10)*	*(10)*	*(11)*	*(11)*	*(12)*	*(11)*		
Heat	21,406	21,811	17,227	16,638	15,741	13,048	12,838	9,623	10,028	-11.0	4.2
	(25)	*(26)*	*(25)*	*(25)*	*(23)*	*(20)*	*(19)*	*(14)*	*(14)*		
Industry	38,124	33,692	24,708	21,752	19,955	21,778	21,230	22,958	25,325	-1.5	10.3
	(44)	*(40)*	*(36)*	*(32)*	*(30)*	*(33)*	*(32)*	*(34)*	*(35)*		
Transportation	9,804	8,719	8,063	8,295	8,171	7,842	8,330	8,423	9,920	0.9	17.8
	(11)	*(10)*	*(12)*	*(12)*	*(12)*	*(12)*	*(13)*	*(13)*	*(14)*		
Others	36,675	39,068	32,322	34,086	35,951	35,895	33,127	31,929	33,881	-0.2	6.1
	(42)	*(47)*	*(47)*	*(50)*	*(53)*	*(54)*	*(50)*	*(48)*	*(46)*		
Agriculture	4,284	3,978	5,114	4,690	4,487	4,659	5,000	4,770	5,166	-1.4	8.3
Residential	31,302	32,912	20,236	22,387	24,417	24,252	23,253	22,890	24,062	2.5	5.1
Commercial	1,089	2,179	6,971	7,009	7,047	6,984	4,874	4,269	4,654	-9.3	9.0
Non-energy	1,903	1,767	4,227	3,364	3,299	901	3,528	3,623	3,882	-3.0	7.2
	(2)	*(2)*	*(6)*	*(5)*	*(5)*	*(1)*	*(5)*	*(5)*	*(5)*		

(Note) Figures in parentheses are shares in the total.

(Source) GUS, Poland Energy Information Center

Figure 1.7 Trends of Final Energy Consumption



(3) Energy consumption in the industrial sector

a. Scale and trend of demand

Energy consumption in the industrial sector is 25 MTOE, or 35% of the total final energy consumption in 1996. Coal accounts for 57%, electric power 16%, heat 10%, gas 10%, and petroleum 7% in the same year (See Table 1.4 and Figure 1.8). Its trend shows that the demand recorded a peak in 1986 and decreased sharply to reach bottom in 1992. After that, a gradual increase was shown and in 1996 a 10% increase was recorded.

The trend of a decline until 1992 was derived from the substantial reduction of energy

consumption by energy intensive industries, such as iron and steel, chemicals, mineral extraction and machinery.

Conversely, the increase trend in recent years is due to the expansion of energy consumption by material industries. In the background of the upward tendency, we can recognize revived production levels in those industries.

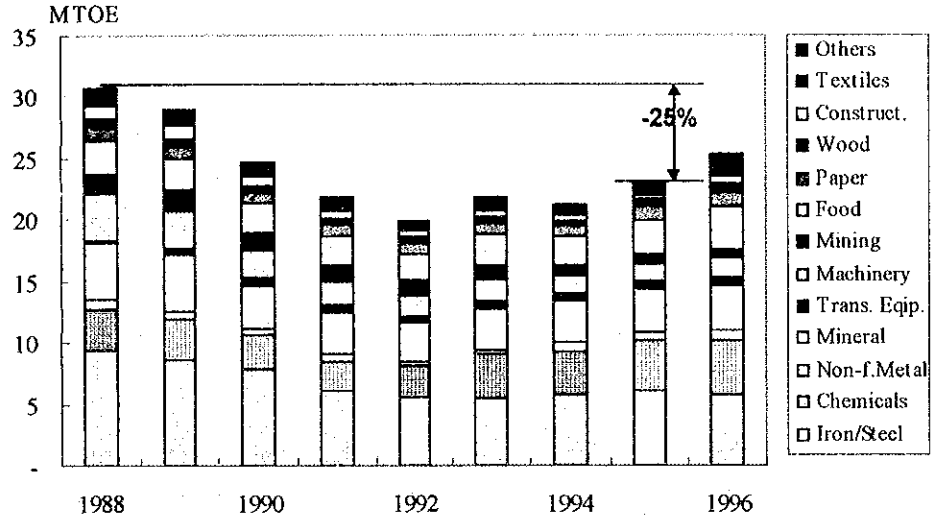
Table 1.4 Energy Demand in the Industrial Sector

(Unit: 1000 TOE, etc.)

	1980	1985	1990	1991	1992	1993	1994	1995	1996	95/90	96/95
Total	38,124	33,692	24,708	21,752	19,955	21,778	21,230	22,958	25,325	-1.5	10.3
Coal	11,799	9,472	8,518	7,477	7,124	10,049	10,014	13,459	14,463	9.6	7.5
	(31)	*(28)*	*(34)*	*(34)*	*(36)*	*(46)*	*(47)*	*(59)*	*(57)*		
Oil	2,574	2,110	784	623	585	780	679	1,326	1,823	11.1	37.5
	(7)	*(6)*	*(3)*	*(3)*	*(3)*	*(4)*	*(3)*	*(6)*	*(7)*		
Gas	4,868	4,413	2,438	1,836	1,498	2,685	1,971	1,949	2,552	-4.4	31.0
	(13)	*(13)*	*(10)*	*(8)*	*(8)*	*(12)*	*(9)*	*(8)*	*(10)*		
Electricity	4,269	3,991	3,234	2,867	2,710	3,027	3,390	3,612	3,971	2.2	9.9
	(11)	*(12)*	*(13)*	*(13)*	*(14)*	*(14)*	*(16)*	*(16)*	*(16)*		
Heat	14,615	13,706	9,734	8,950	8,039	5,238	5,177	2,612	2,526	-23.1	-3.3
	(38)	*(41)*	*(39)*	*(41)*	*(40)*	*(24)*	*(24)*	*(11)*	*(10)*		
Iron and Steel	12,248	10,344	7,816	5,999	5,600	5,428	5,742	6,070	5,681	-4.9	-6.4
	(32)	*(31)*	*(32)*	*(28)*	*(28)*	*(25)*	*(27)*	*(26)*	*(22)*		
Chemical	5,236	5,087	2,790	2,495	2,478	3,607	3,547	4,037	4,432	7.7	9.8
	(14)	*(15)*	*(11)*	*(11)*	*(12)*	*(17)*	*(17)*	*(18)*	*(18)*		
Non-ferrous Metal	1,574	1,252	571	555	338	372	684	708	828	4.4	16.9
	(4)	*(4)*	*(2)*	*(3)*	*(2)*	*(2)*	*(3)*	*(3)*	*(3)*		
Non-metallic Mineral	6,232	5,158	3,514	3,339	3,184	3,249	3,325	3,501	3,646	-0.1	4.1
	(16)	*(15)*	*(14)*	*(15)*	*(16)*	*(15)*	*(16)*	*(15)*	*(14)*		
Transportation Equipment	0	0	603	672	569	672	660	619	709	0.5	14.6
	( )	*( )*	*(2)*	*(3)*	*(3)*	*(3)*	*(3)*	*(3)*	*(3)*		
Machinery	4,670	3,998	2,231	1,921	1,662	1,782	1,481	1,480	1,535	-7.9	3.8
	(12)	*(12)*	*(9)*	*(9)*	*(8)*	*(8)*	*(7)*	*(6)*	*(6)*		
Mining and Quarrying	0	0	1,452	1,265	1,205	1,052	734	819	694	-10.8	-15.2
	( )	*( )*	*(6)*	*(6)*	*(6)*	*(5)*	*(3)*	*(4)*	*(3)*		
Food and Tobacco	2,826	2,976	2,363	2,393	2,156	2,570	2,390	2,684	3,485	2.6	29.8
	(7)	*(9)*	*(10)*	*(11)*	*(11)*	*(12)*	*(11)*	*(12)*	*(14)*		
Paper and Pulp	1,123	1,069	1,008	1,039	969	1,006	956	1,231	1,250	4.1	1.5
	(3)	*(3)*	*(4)*	*(5)*	*(5)*	*(5)*	*(5)*	*(5)*	*(5)*		
Wood and Wood Products	649	597	446	425	427	446	440	507	654	2.6	29.0
	(2)	*(2)*	*(2)*	*(2)*	*(2)*	*(2)*	*(2)*	*(2)*	*(3)*		
Construction	1,481	1,506	763	620	456	532	381	306	575	-16.7	87.9
	(4)	*(4)*	*(3)*	*(3)*	*(2)*	*(2)*	*(2)*	*(1)*	*(2)*		
Textile	1,630	1,432	1,043	919	824	973	731	900	1,134	-2.9	25.9
	(4)	*(4)*	*(4)*	*(4)*	*(4)*	*(4)*	*(3)*	*(4)*	*(4)*		
Other Industries	455	275	108	111	86	90	160	97	702	-2.1	626.7
	(1)	*(1)*	*( )*	*(1)*	*( )*	*( )*	*(1)*	*( )*	*(3)*		

(Note) Figures in parentheses are shares of the total.
(Source) GUS, Poland Energy Information Center

Figure 1.8 Trend of Energy Consumption in the Industrial Sector



Factor analysis of consumption changes

Now we examine the factors that caused the changes in energy consumption in the industrial sector before and after the transitional period, detailed data for 1988-1995.

The scale of energy consumption for industry in 1995 was almost 25% smaller than in 1988. We dis-aggregate this into three factors: (1) change of energy intensity in each manufacturing industry, (2) change of industrial structure, and (3) change of economic activity level.

1) Methodology

The formula for the analysis is:

$$E=\Sigma Ei=\Sigma\ (Ei/Ni)\cdot(Vi/GDP)\cdot GDP \qquad (1)$$

Here, Ei means energy consumption in the 'i' industry and Vi is production level of 'i' industry. When we replace (Ei/Vi) with $\alpha\ i$ and (Vi/GDP) with $\beta\ i$, then $\alpha\ i$ represents the energy intensity for 'i' industry and $\beta\ i$ shows the relative position of industry 'i' in GDP and aggregation of $\beta\ i$, of which ΣEi, represents the industrial structure.

$$E=\Sigma Ei=\Sigma\ \alpha\ i\cdot\beta\ i\cdot GDP \qquad (2)$$

Then, the change of energy consumption between t and $t-1$ periods is calculated as follows;.

$$E=E_{t}-E_{t-1}=\Sigma\Delta E_{i}=\Sigma\ \Delta\alpha_{i}\cdot\beta_{i}\cdot GDP + \alpha_{i}\cdot\Delta\beta_{i}\cdot GDP + \alpha_{i}\cdot\beta_{i}\cdot\Delta GDP + \text{other residuals} \quad (3)$$

The first variables "$\Delta\alpha_{i}\cdot\beta_{i}\cdot$GDP" in the equation (3) show the factor of the energy intensity changes, the second variable "$\alpha_{i}\cdot\Delta\beta_{i}\cdot$GDP" explains the factor of industrial structural changes, and the third variable "$\alpha_{i}\cdot\beta_{i}\cdot\Delta$GDP" represents the factor of all economic activity.

2) Results

The following interesting characteristics are clearly revealed, based on the analysis (See Figure 1.9 and Figure 1.10).

The major findings of the analysis tell us that almost half of the decline of energy consumption occurred due to the change of industrial structure. Concretely, depressed production levels in the material industries, which are energy insensitive, was the biggest factor.

On the other hand, the energy intensity of individual industries falls in the transitional period, although energy intensity per GDP is improved on a macro basis. It is supposed that the decline of production pushed up energy consumption for certain products due to the fixed energy consumption for maintaining the production complex.

Also, for industrial activity, the production levels of individual industries in 1995 were catching up with those in 1988.

The above analysis implies the following:

The reduction of energy consumption in the past years was not originated by the improvement of energy intensity representing energy savings in each industry, but by the industrial structural changes. It shows that there was a relative stagnation of production among the energy intensive, heavy and material industries, compared to the whole economy.

Therefore, if the production of the material industries rises along with economic growth without any energy saving measures, energy consumption in the industrial sector will increase in the future.

We can see the trend of energy intensity in individual industries not improving but worsening, when we look carefully at data for individual industries. Therefore, if Poland needs to maintain energy consumption at the current level in the future, it becomes more and more important to promote energy conservation measures for individual industries.

Figure 1.9 Factor Analysis of Demand Changes in the Industrial Sector

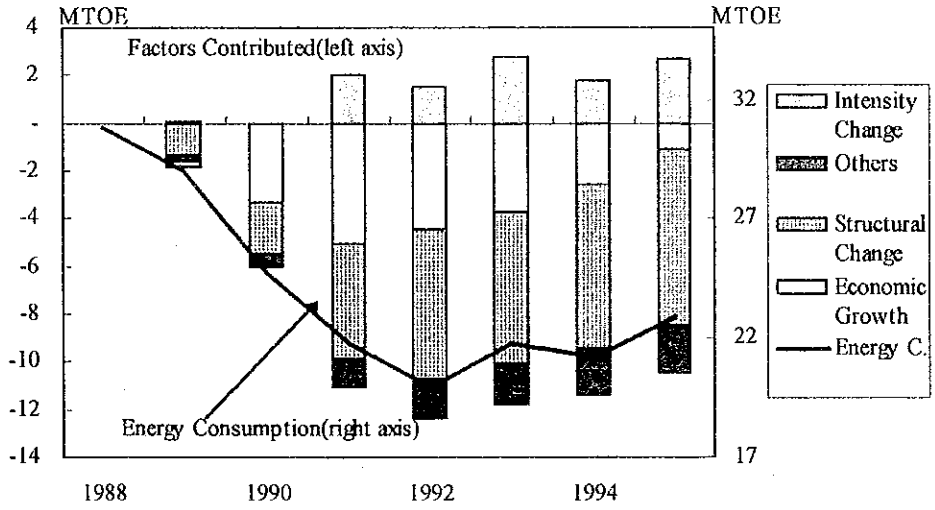
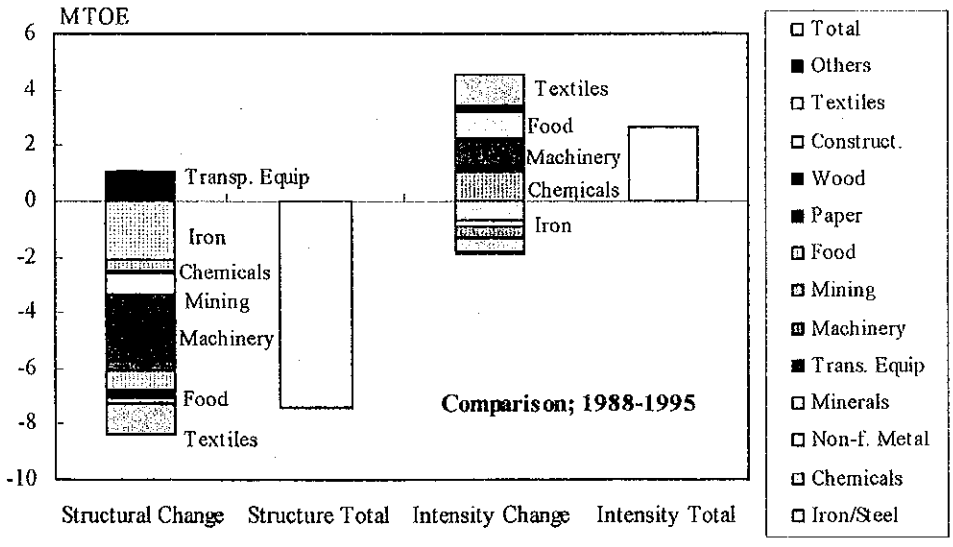


Figure 1.10 Composition of Factors of Demand Changes in the Industrial Sector



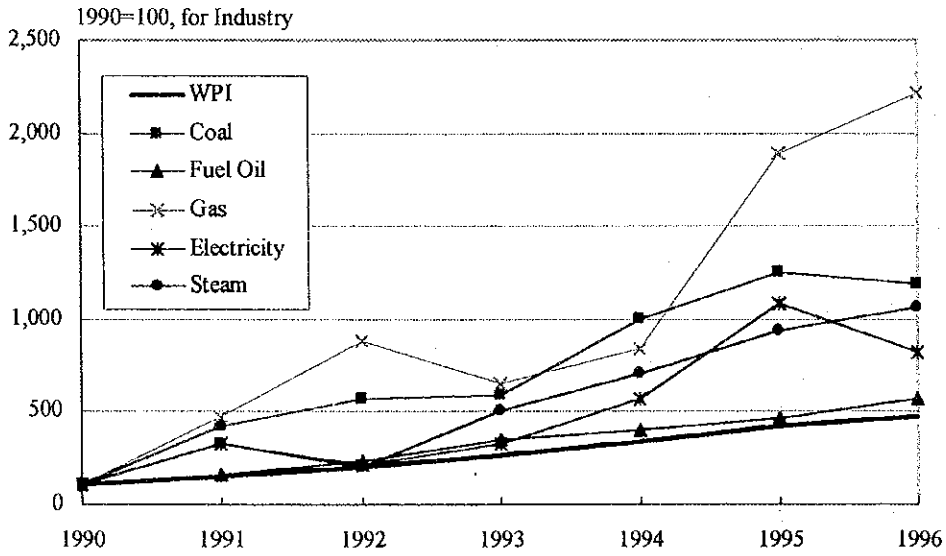
1.2 Domestic energy price

Before the economic structure changed to a market economy, domestic energy prices had been kept lower than the supply cost by the government with subsidies. However, prices have been raised gradually to ameliorate the government budget and market efficiency, since switching over to a market economy.

For example, the coal price for the industry was 130.1 PLN/ton in 1995, which is about three times that in 1991, and the gas price for industry in 1995 was 566.1 PLN/m^3, which is four times the figure in 1991. The prices of petroleum products, electricity, and heat have also been raised in the same way.

Because the wholesale price index in the same period increased 2.9 times, energy prices were raised. In the future, energy prices are expected to increase to reduce the subsidies and to mitigate energy consumption (See Figure 1.11).

Figure 1.11 Trends of Domestic Energy Prices for Industry



1.3 CO_2 emissions

CO_2 emissions from energy consumption in 1995 were 101million ton-C, which accounts for about 30% less than the peak recorded in 1987. However, in 1996 it increased by 9.4% to 110 million tons-C. This is 6% more than the value in 1990, although it is 17% smaller than the value in 1988, which is the benchmark year for reducing CO2 emissions in Poland under the Kyoto protocol.

When we use the next formula to separate the factors contributing to the decline of past CO_2 emissions, some information is revealed.

$$CO_2=(CO_2/\text{Energy}) \cdot (\text{Energy/GDP}) \cdot (\text{GDP/Population}) \cdot \text{Population} \quad (1)$$

Here, we can recognize the first variable (CO_2/Energy) as fuel switching, the second (Energy/GDP) as energy intensity, the third (GDP/Population) as the per capita GDP, and the last one as population. If we use the linear homogeneous function, the change of CO_2 Emission is expressed as follows;

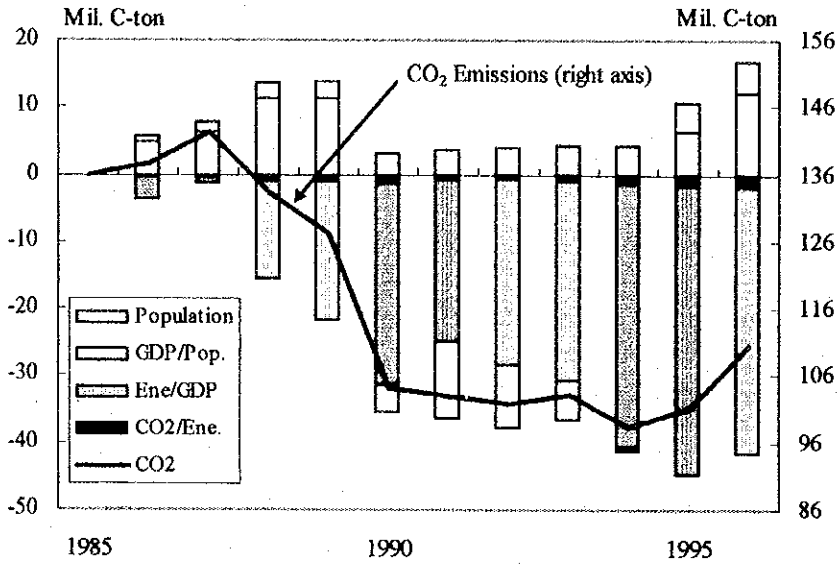
$$\begin{aligned}
&\triangle CO_2 = CO_2\, t - CO_2\, t\text{-}1 \\
&=\triangle(CO_2/\text{Energy}) \cdot (\text{Energy/GDP}) \cdot (\text{GDP/Population}) \cdot \text{Population} \\
&+(CO_2/\text{Energy}) \cdot \triangle(\text{Energy/GDP}) \cdot (\text{GDP/Population}) \cdot \text{Population} \\
&+(CO_2/\text{Energy}) \cdot (\text{Energy/GDP}) \cdot \triangle(\text{GDP/Population}) \cdot \text{Population} \\
&+(CO_2/\text{Energy}) \cdot (\text{Energy/GDP}) \cdot (\text{GDP/Population}) \cdot \triangle\text{Population} \\
&+\text{other residuals} \qquad (2)
\end{aligned}$$

The main reason for the reduction of CO_2 emissions is the improvement of energy intensity (the energy consumption per GDP) based on the above macro analysis (See Figure 1.12). That is similar to the analysis of the primary energy supply (See the previous Figure 1.5).

As mentioned before, the improvement of energy intensity was in the energy conversion sector and the industrial sector. However, in the industrial sector, the past improvement of energy intensity on a macro basis resulted not in an improvement of energy efficiency in individual industries, but in industrial structure changes; with relatively stagnant production in the energy intensive industries.

Therefore, whether CO_2 emissions decline along with this trend or not in the future depends on how much energy savings progress in the conversion sector and in the industrial sector.

Figure 1.12 Trends of CO_2 Emissions and Contributing Factors



1.4 Energy Conservation Policies Since 1989

1.4.1 Economic/other policies and energy conservation policies

Energy conservation policies are among the most important elements of economic policies in Poland.

According to the "Energy Policy Guidelines for Poland until 2010," which are among the most important governmental documents on energy policies and were prepared by the Ministry of Industry and Trade and accepted as government documents by the Council of Ministers on October 17, 1995, the following items are determinants of the range and character of energy policies and strategies in Poland:

a. Change of economic rules from a centrally planned to a market economy
b. Ending of system of budget subsidies for enterprises
c. Privatization plans

Additionally, the "Guidelines" state that international obligations are to be taken into consideration in formulating energy policies. These obligations include those resulting from agreements with EU, the World Bank, UN, and others. Poland signed the "Framework Convention on Climate Change" in 1992.

More concretely on energy conservation policies, the "Guidelines" state that the three items below are important guidelines when considering energy conservation policies. This statement was based upon the "Strategy for Poland", as well as the "Program of Industrial Policy," both of which are important documents on the basic direction of Polish economic policy after 1989. In other words, the "Guidelines" aim at supplementing and establishing the details of these two documents.

a. Reduction of social reform costs and improvement of nation's living standards
b. Improvement of international economic competitiveness of Poland and aspiration to integrate quickly with the European Union
c. Minimize damage to the environment

Items a. and b. require lower cost of energy use, which can be achieved by reducing energy consumption. In addition, with regard to item c., a major part of the damage to the environment can be recovered by energy conservation.

Thus, we can conclude that energy conservation policies explicitly have a close relation with economic policies in Poland.

1.4.2 Development of energy conservation policies

Since 1989, the government to achieve "energy efficiency" or "rationalization of energy use" has adopted several policy measures.

a. Increase in energy prices ---- Prices of energy carriers have been increased significantly since 1989 from lower levels that did not fully reflect supply costs (See Fig.1.11). Such price increases have influenced companies and people to be more concerned about energy conservation, although energy conservation has not necessarily been the target of the price increases.

b. Modernization and rationalization of equipment and management----The government has prepared policy measures for accepting foreign investment in many industrial sectors, as well as for proceeding with privatization or restructuring of Polish companies. These policy measures have played and will play an important role for companies to implement modernization and rationalization of equipment and management, which can contribute to energy conservation in factories.

c. Environmental protection policies----The government has been promoting environmental protection, especially taking into account early accession to the EU. As one policy measure, the government established the National Fund for Environmental Protection and Water Management (NFEP&WM) Funds at the levels of Province and Communes, and Environmental Protection Bank (BOS) for the purpose of providing loans and subsidies to accelerate investments on environmental protection.

NFEP&WM, which was established in 1989, is funded mainly by environmental "fees" and "fines" and mineral rights. The Fund provides ecological loans at 50-95% of commercial bank interest rates. In addition, subsidies are provided for environmental protection projects.

There were 49 Funds for Environmental Protection at the level of regional or local governments. These funds have supported conversion of many small district heating boilers and boilers serving public sector premises, which are increasingly available for energy efficiency investments.

Environment Protection Bank was set up in 1991 specifically to invest in projects and provide loans to improve the environment. The bank provided finance at a range of preferential rates: 20-60% of commercial base rates for municipalities, 40-80% manufacturers of equipment to improve the environment, and 60-100% to other borrowers for environmental projects.

These organizations have contributed to energy conservation by improving the efficiency of whole facilities in factories, which are resulted by favorable loans for investment on de-sulphurization

units in heat supply plants, for instance. In addition, the Funds mentioned above have been able to provide loans directly for energy conservation measures since loan procedures were revised in 1997.

d. The "Energy Law" and regulations on energy conservation----The government has promulgated the "Energy Law," which stipulates policy measures for "rational and efficient use of fuels and energy," as well as to establishes standard for the energy efficiency of equipment and facilities in factories. The government is now studying specific standards.

e. Establishing agencies for promoting energy conservation and international cooperation---- KAPE (National Energy Conservation Agency) and other organizations related to energy conservation were established directly or indirectly by the government. They have been carrying out such activities as researches and studies, public relations, education and training, energy audits, and others (Note).

(Note) Descriptions below are according to the following report: International Institute for Energy Conservation, "The Market for Energy Efficiency in Poland," 1997.

The Polish government in 1994 to develop the energy efficiency sector using private capital created KAPE. KAPE is a joint-stock company owned by several government ministries. It has begun to establish a national network of regional energy agencies. There are now 12 regional agencies, typically owned by municipalities.

The Polish Development Bank originally funded the Foundation for Energy Conservation in 1992 as a non-profit arm to develop energy conservation programs. Its main focus so far has been on training and energy audits. A new joint-stock company has been created called the National Agency for Energy Conservation (NAPE in Polish) in association with the Foundation for Energy Conservation. The NAPE's main objective is said to develop an ESCO (Energy Service Company) business, using energy audits as a source of clients.

The Polish Foundation for Energy Efficiency (FEWE in Polish) was initially established in 1990 with the aid of core funding from the US Government, although it is now essentially independent and effectively derives much of its income from consulting works.

These agencies and organizations act as counterparts in technical cooperation projects for energy conservation, which the government has agreed with foreign countries (Japan, Holland, Denmark, U.S.A., and others) and international organizations (EU, UN, and others). KAPE, the counterpart of this study, has been involved in many other projects including those with Holland and EU, for instance, to promote energy conservation in various sectors.

2. ESTIMATION OF THE CURRENT STATUS OF ENERGY CONSUMPTION IN TARGETED INDUSTRIES AND EQUIPMENT

2. ESTIMATION OF THE CURRENT STATUS OF ENERGY CONSUMPTION IN TARGETED INDUSTRIES AND EQUIPMENT

2.1 Introduction

In this chapter, we will estimate the current status of energy consumption in targeted industries and equipment.

The objective of this study is to formulate an "Energy Conservation Master Plan in the Industrial Sector in Poland," as explained in detail in Chapter 3. For this objective, first,

a. We will estimate the current status of energy consumption in targeted industries and equipment (in this chapter).

And then, based on this estimation,

b. Technical measures for energy consumption will be selected and their cost-effectiveness evaluated (in Chapter 4).

Finally,

c. The energy conservation potential will also be estimated (in Chapter 5 and 6).

2.2 Estimation of energy consumption in targeted industries

In principle, industries with factories that have undergone factory energy audits were selected as the target of this study. The targets of the factory energy audits in the chemical sector included coal chemical, industrial medicines, and dye factories; but the ratio of energy consumption in these types of industries is very low. Therefore, the chemicals sector was considered inappropriate as a target of the "policy study." As a result, we decided to survey the ammonia production sub-sector, which is the largest energy consumer in this sector.

The targets of this study include the sectors and sub-sectors listed below. (Rough classification of industries such as iron and steel, chemicals, machinery, non-metallic minerals, and food -- types of industry defined in the "scope of work" of this study -- are referred to as sectors, while small industry types included within each sector are called sub-sectors.)

(1) Iron and steel
(2) Chemicals
    (2)-1 Ammonia
(3) Machinery
    (3)-1 Trucks
    (3)-2 Tractors
(4) Non-metallic minerals
    (4)-1 Glass
    (4)-2 Silica lime block (SLB)
(5) Food
    (5)-1 Vegetable oil products
    (5)-2 Meat products
    (5)-3 Dairy products

These types of industries account for approximately 30% of the entire energy consumption in the manufacturing industry in Poland (Table 2.1). Energy consumption is particularly large in iron and steel, which occupies 18% of the total, followed by ammonia at 6%. On the other hand, the ratio of trucks, tractors, SLB, and vegetable oil products do not even reach 1% each of the entire manufacturing industry.

Table 2.1 Energy Consumption and Energy Intensities in Targeted Industries in 1997

Name of industries	Production (1000t/y or 1000pcs/y)	Energy consumption		Energy Intensity		
		(TJ/y)	(%)	Fuel (MJ/t or pcs)	Electricity (MJ/t or pcs)	Total (MJ/t or pcs)
Iron & steel	11,590	218,803	17.54	17,925	1,897	19,822
Ammonia	2,252	73,931	5.93	31,406	1,811	33,217
Truck	58	2,002	0.16	25,150	9,830	34,980
Tractor	23	1,423	0.11	43,075	19,078	62,153
Glass	1,422	25,241	2.02	15,984	1,904	17,888
Silica Lime Block	1,496	1,256	0.10	810	30	840
Vegetable Oil	602	4,754	0.38	8,105	945	9,050
Meat Products	1,241	21,566	1.73	11,644	2,616	14,260
Dairy Products	2,615	28,256	2.27	7,880	1,260	9,140
Sub-total		377,232	30.24			
Manufacturing Total		1,247,423	100.00			

(Note) "pcs" means pieces which are used for truck and tractor.

(Source) Central Statistical Office(GUS) ; JICA Team' estimates.

Energy consumption and energy intensity (EI) of each industry shown in Table 2.1 are estimated as follows.

First, with regard to energy consumption,

a. Polish statistical data was used for the industries whose energy consumption is listed.

b. For industries whose energy consumption is not listed, the E.I. was estimated using the following method. Energy consumption was calculated using the estimated E.I. and manufacturing volume of products. Among the nine targeted industries, this method was used for four industries including ammonia, trucks, tractors, and SLB.

Second, on the E.I. estimation,

a. When the E.I. is listed in Polish statistical data, the validity of E.I. was inspected and then used. (The ammonia sub-sector is based on the statistical data of the Energy Market Agency, the former

Energy Information Center.)

b. Although the E.I. is not listed in the statistics, the E.I. was estimated using the related data listed, after considering the manufacturing structure of products based on the process and total energy consumption volume (iron and steel sector).

c. Except for these two industries, we independently estimated the E.I. in the truck, tractor and SLB sub-sectors based on the factory energy audit, questionnaire survey, and data and information in Japan and other countries.

Finally,

d. With regard to the remaining four sub-sectors (glass, vegetable oil, meat products, and dairy products), the value that divides the total energy consumption of each industry as listed in statistics, by the manufacturing volume of each product, is considered to be the E.I. in each industry. However, when estimating the E.I. of the major products of each industry, data and information similar to c. were used.

The reasons for using the existing statistical data when estimating the E.I. in each industry are as follows: when estimating the future energy consumption of targeted industries and the energy conservation potential, continuity with conventional Polish statistical values is attained. Based on this continuity, it is desirable to be able to compare the predicted values and the estimated values with past figures. This is also the same for the iron and steel industry

As such, the E.I in these industries also includes energy other than the energy directly used to manufacture products (i.e., transportation-related energy for factories). Generally speaking, it is often impossible to estimate the E.I. for each product based only on regular energy consumption statistics and manufacturing statistics in Japan as well as in western countries.)

It should be advised that simply comparing the E.I. estimated in this chapter with the E.I. at excellent factories in Japan and other countries is inappropriate.

2.2.1 Iron and Steel

(1) General situation of the iron steel sector

Poland produces approximately 11 mt of crude steel annually, and the production volume based on production process in 1996 was as follows.

Converter steel: 6,758,000t

Electric furnace steel: 2,554,000t

Open-hearth furnace steel: 1,121,000t

Total: 10,432,000t

Converter steel is produced using the blast furnace/converter method at two major steelworks, Katowice and Sendzimira, and as shown above, converter steel represents approximately two-thirds of all crude steel produced in Poland.

Czestochowa has a blast furnace but produces steel by electric furnace. Six factories along with Czestochowa also produce crude steel by electric furnace, while seven factories operate open-hearth furnaces.

Besides these factories, there are a fairly large number of factories that only process steel, but the exact number is unclear. The data of 27 iron and steel companies was listed in the energy statistics in 1997.

Since 1993 a "restructuring" plan (1993 to 2002) had been implemented in the iron and steel sector, and the following efforts have been implemented: a) reduction in the crude steel production capacity, b) shift to electric furnaces from open-hearth furnaces, c) increase in the heat rolled steel plate production capacity, and d) reduction in the number of workers. For example, the "ratio of continuous casting" increased from 9% in 1990 to 37% in 1996 and to 49% in 1997.

The revised restructuring plan (1998 to 2005) was announced in June 1998 based on the EU agreement reached in December 1997. In this plan, modernization of the facilities mentioned above will be implemented on a continuous basis. As the 2005 goal, 11.8 mt and 13.2 mt are listed as the crude steel production and crude steel production capacities respectively.

The total funds required for this plan are estimated to be 12.2 billion PLN, of which 8.4 billion PLN will be invested in modernization, with another 300 million PLN earmarked for environmental preservation. Funds required for modernization are expected to be raised by companies, and this includes seeking investment by foreign companies.

Present direct investment by foreign companies is limited to a small-scale investment in Lucchini (by an Italian company). However, Katowice and Sendzimira, which are both large companies, are said to be negotiating investment by companies in the U.K., and Austria / Holland.

(2) Present situation of energy consumption

As mentioned above, the iron and steel sector consumes the largest amount of energy in Poland, consuming 218,803 TJ in 1997.

Based on this figure, when estimating the E.I., the energy consumption/1t of crude steel is 19.8

GJ. When comparing this E.I. figure with the E.I. (14.5 GJ) of an excellent factory of the model that corresponds to iron and steel production in Poland, it is understood this E.I. is much higher than the E.I. in the iron and steel sector. This means that the energy conservation potential of the iron and steel sector in Poland is close to 30%.

The E.I. of two Labedy and Ostrowiec factories, which were targeted for the factory energy audit, is 1.6 (4.2 GJ/2.6 GJ) and 1.7 times higher (15.4GJ /9.2 GJ) than the E.I. of an excellent factory of the model that corresponds to each factory.

2.2.2 Ammonia

(1) General situation of the ammonia sub-sector

In Poland, five factories produce ammonia from natural gas, and these factories produce all of the ammonia in Poland. The production volume was approximately 2.25 mt in 1997, and the volume has remained on the same level since 1995.

Among these five factories, Pulawy is the largest and accounts for approximately 45% of the total ammonia production volume, followed by Police (approx. 20%), Kedzierzyn-Kozle (approx. 15%), Tarnow (approx. 10%), and Wloclawek (approx. 10%).

As in the iron and steel sector, a modernization and restructuring plan is being implemented in the ammonia sub-sector (as part of the fertilizer industry) with the target year 2005. The goal of this "Great Chemical Synthesis" plan is a 30% reduction in energy consumption on average.

Direct investment by foreign companies in the ammonia sub-sector is not seen as yet.

(2) Present situation of energy consumption

In Poland, a total of 73,931 TJ of natural gas and electricity was consumed to produce ammonia in 1997. Needless to say, this figure includes the raw material natural gas. Energy consumption in the chemical sector was 208,698 TJ in 1997, and ammonia production occupied 35% of the total energy consumption.

According to statistics in Poland, the E.I. of ammonia production factories is 33 GJ/t, and the difference with the E.I. of an excellent factory (31GJ/t) is very small.

According to the questionnaire survey response, this is believed to be the result of measures taken at several factories, including "modernization of the ammonia synthetic process" and "recovery of hydrogen from purge gases in the synthetic process."

2.2.3 Trucks

(1) General situation of the truck sector

There are approximately 15 truck companies in Poland, of which two companies operate a system of integrated manufacturing from manufacturing parts to vehicle assembly, although they do not have casting and forging processes. One company is STAR, for which a factory energy audit was conducted, and the other company is JELCZ, and both are under the umbrella of ZASADA, which is a rising new company in Poland.

Some of the other factories seem to manufacture engines independently, but many of the companies are knockdown producers that assemble finished products with parts procured domestically and internationally.

The number of trucks manufactured in 1997 was 57,300 units. The above two companies with integrated manufacturing systems are estimated to manufacture approximately 5,000 units, with the remaining companies manufacturing 52,300 units. Foreign companies are already operating in the knockdown sector. An expert at the Ministry of Economy predicts that these companies will gradually increase the ratio of domestic parts manufacturing in Poland.

(2) Present situation of energy consumption

Energy consumption in the truck manufacturing sector was 2,002 TJ in 1997, which was only 0.2% of the overall manufacturing industry.

Based on the factory energy audit, the E.I. of STAR is very high compared with an excellent factory, in other words, 6 to 7 times higher (221.4 GJ/30.6-38.6 GJ).

Based on this energy audit result, and other data and information, we assumed the following and estimated that the average E.I./truck of the overall truck manufacturing sector is approximately 34.4 GJ/truck.

a. We divided the truck factories into two groups: the two parts manufacturing and assembling factories of STAR and JELCZ, and the knockdown factories that assemble finished parts procured domestically and internationally.
b. We estimated that the manufacturing of the STAR/JELCZ group in 1997 was 5,000 units, while the knockdown group produced 52,300 units.
c. We further estimated that the E.I. of the STAR/JELCZ group was approximately 207 GJ/truck and 18 GJ/truck for the knockdown group.

2.2.4 Tractors

(1) General situation of the tractor sector

As in the truck manufacturing sector, there are approximately 15 tractor (for agriculture) manufacturing companies in Poland, of which only the state company URSUS operates integrated manufacturing from parts to the final assembly.

The number of tractors manufactured in 1997 was 22,800 units, of which 14,5000 units, or more than 50% of the total, were manufactured by URSUS. However, this number decreased from 16,518 units in 1995 and 16,717 in 1996, and overall manufacturing is moving laterally. In this situation, the market share of URSUS is decreasing (manufacturing of URSUS in 1998 is estimated to be as low as 11,000 units).

The background of these figures is the delay in privatization of the company, as well as the delay in overall rationalization. (However, as the factory energy audit shows, it is worth noting that rationalization and management improvements are progressing at their tool factory.)

Despite the sluggish tractor market, foreign companies are already operating as knockdown producers based on their evaluation of the domestic and international market in the future.

(2) Present situation of energy consumption

Energy consumption in the tractor manufacturing sector was 1,423 TJ in 1997, which was only 0.1% of the overall manufacturing industry.

According to the factory energy audit, the E.I. of URSUS is 1.7 to 2 times higher (76.2 GJ/38.4-46.4 GJ) than an excellent factory.

Based on this energy audit result and other data, we estimated that the average E.I. of the tractor manufacturing sector including other factories is 62.4 GJ/tractor. In the estimation, we made the following assumption:

a. As shown above, tractor factories in Poland can be divided into two groups: URSUS and knockdown factories.
b. The ratio of manufacturing of URSUS and knockdown factories is shown above.
c. The E.I. of URSUS is 87.92 GJ/tractor and the E.I. of the knockdown group is 18.28 GJ/tractor.

2.2.5 Glass

(1) Present situation of the glass sector

The glass sector in Poland produces all kinds of glass products. These products can be categorized as a) sheet----or flat----glass, b) bottle glass----called "glass container/packaging" in

Poland----, and c) glass for tableware and lighting----called "consumer and technical glass" in Poland-----. The production volume in 1997 was as follows.

- Sheet glass: 426,000t
- Bottle glass; 873,000t
- Glass for tableware/lighting: 122,000 t
- Total: 1,421,000t

Eight companies manufacture sheet glass. Two companies, HSO Sandomierz and HSO Szczakowa, are prominent glass producers, with the latter already operating a float-type molding process, which is the latest technology of Pilkington in the U. K. As well, Saint Gobain in France has recently begun to manufacture sheet glass.

There are 14 companies manufacturing bottle glass, and HSO Jaroslow is the largest with a 31% market share. Together with two other companies, HS Ujscie and Wielkopolska HS, which have approximately a 10% share each, the top three companies account for more than 50% of the overall market share.

Fourteen companies manufacture glass for tableware and lighting. Further subdividing this sector into crystal glass and other sub-sectors, many companies are led by 1 or 2 leading companies in the sub-sectors including the world-renown Krosno Glasswork SA.

(2) Present situation of energy consumption

Energy consumption in the glass sector was 21,860 TJ in 1997, which was 2% of the overall manufacturing industry.

According to the factory energy audit, among the targeted bottle glass factories and glass factories for tableware and lighting, the E.I. of the former ranges from almost the same level (135.6 GJ/131.6 GJ) of an excellent factory to more than twice the level (289.9 GJG/131.6 GJ) depending on the manufacturing line. The E.I. of the latter is more than 2 times higher (25.6 GJ/11.2 GJ) than an excellent factory.

Furthermore, for the sheet glass factories, it was estimated that approximately 1.5 times more energy (15.9GJ/10.5GJ) than an excellent factory was used.

Based on these survey and estimation results, and Polish statistical data, we estimated that the E.I. in the glass manufacturing sector in 1997 was 17.9 GJ/t.

We made the following assumptions for this estimation.

a. Glass factories can be divided into three groups ---- sheet glass, bottle glass, and glass for

tableware and lighting.

b. The volume of product manufacturing in each group is shown in (1).

c. The E.I. of each group in 1997 was 14.564 GJ/t for sheet glass (10.5 GJ/t), 12.883 GJ/t for bottle glass (7.5 GJ/t), and 65.059 GJ/t for glass for tableware and lighting (39.04 GJ/t). (Figures in the bracket are the estimated values of the E.I. of an excellent factory.)

2.2.6 Silica lime block (SLB)

(1) General situation of the SLB sub-sector

The production of SLB, which is used as a building material for walls and flooring, dropped to 3.79 million units in 1997 from 4.29 million units in 1995 because of recent sluggish home construction and relatively high growth in autoclaved light concrete production, which is a competitive product. According to the estimate of relevant parties in the industry, the share of SLB lags significantly behind other competitive products in the wall and flooring material market, as shown below. (Figures represent market share <%>.)

- Autoclaved light concrete	40
- Bricks	33
- SLB	7
- Other concrete products	7
- Other products	13

Approximately 24 major companies operating 34 factories manufacture this product, and all of these are Polish companies. Reflecting the market situation as mentioned above, foreign companies are not investing in this field.

(2) Present situation of energy consumption

The total volume of energy used to manufacture SLB was 1,256 TJ in 1997, which was only 0.1% of the overall manufacturing industry.

According to the factory energy audit, the E.I. of the SILIKATY factory is 2.3 times higher (1.68 GJ/0.72 GJ) than an excellent factory.

Based on data and information such as the questionnaire survey, we estimated that the E.I. to manufacture SLB in Poland is 0.8 GJ/t.

2.2.7 Vegetable oil

(1) General situation of the vegetable oil sub-sector

There are approximately 15 factories in the vegetable oil sub-sector (oil and margarine for

cooking), of which eight factories are manufacturing finished products. Four of these companies are large and occupy approximately 80% of the overall finished product volume. Foreign companies own three factories.
The remaining 7 to 8 companies produce raw oil extracted from raw materials, not finished products.

When looking at the flow from raw materials to finished products, the above eight companies can be divided into two groups: factories that produce raw oil from raw materials and manufacture finished products, and factories that purchase raw oil domestically and internationally to manufacture products. The purchase volume from domestic supplies for the latter group is unclear, but raw oil imported from foreign countries is estimated at approximately one-third of the total processing volume of the raw oil.

The production of vegetable oil has increased over the past several years and reached 602,000t in 1997. The ratio of final products by combining the "flow from raw materials to the finished products" (mentioned above) and "small and large companies" was estimated as follows.

- Large companies using domestic raw materials	50%
- Large companies using imported raw materials	30%
- Small- and medium-sized companies using domestic raw materials	15%
- Small- and medium-sized companies using imported raw materials	5%

(2) Present situation of energy consumption

The volume of energy used to manufacture vegetable oil was 5,457 TJ in 1997, which was only 0.4% of the overall manufacturing industry.

According to the factory energy audit, the E.I. of the OLVIT factory is 1.9 times higher (5.1 GJ/2.7 GJ) than an excellent factory. However, as this factory does not have the process to press and extract oil from raw material, this E.I. is fairly low compared with factories with this process.

Based on the energy and manufacturing statistics in Poland, we estimated the E.I. of this sub-sector was 9.050 GI/t (fuel 8.105 GJ/t, electricity 0.945 GJ/t) in 1997. As seen from above, the average E.I. is much higher than at OLVIT7s factory, and more than three times higher than an excellent factory.

2.2.8 Meat products

(1) General situation of the meat products sub-sector

The meat products sub-sector includes a) slaughtering cows, pigs, chickens and others, b)

processing raw meat and poultry, and c) manufacturing ham, bacon, sausage and others.

Meat and poultry products sold to end consumers in 1997 (consumed at homes and at restaurants) were 1,241,000 t, mostly accounted for by meat at 1,086,000t. However, the increase in demand for poultry has been significant over the past several years. Meat products sold to the end consumers in 1997 were as follows.

Cured meat	945,000 t
Cured poultry	120,000 t
Meat preserves	141,000 t
Poultry preserves	36,000 t
Total	1,241,000 t

The number of factories manufacturing processed meat in Poland is estimated between 5,000 to 6,000. Among these factories, factories belonging to the three large groups of ANIMEX, Sokolow, and Farm Foods are estimated to account for 20% of the market. Besides the above, two national companies of Lukuw and Bjalystok are also large companies.

As well, 400 to 500 companies are said to process poultry, of which factories under the umbrella of the four corporate groups of ANIMEX, DROBIMEX, DROSET, and INDYKPOL are estimated to occupy approximately 35% of the market.

In addition to the various groups of Polish companies, many foreign companies have entered this market.

(2) Present situation of energy consumption

The volume of energy used in the meat and poultry products sub-sector was 17,679 TJ in 1997, which was 1.7% of the overall manufacturing industry.

According to the factory energy audit, the E.I. of the two Kosian and Lubmeat factories is 1.9 (8.4 GJ/4.2 GJ) and 2.4 times higher (14.45 GJ/5.9 GJ), respectively, than an excellent factory, and both figures are very high.

Based on these results and other data and information, we estimated that the E.I. of the meat processing sub-sector in Poland is 14.3 GJ/t. At the same time, the following assumptions were made.

a. The amount sold to end consumers is shown above.
b. The total volume of energy used to manufacture meat and poultry products is 17,679 TJ (according to statistics by EMA).

2.2.9 Dairy products

(1) General situation of the dairy products sub-sector

Dairy products production decreased from 3,213,000 t in 1990 to 2,558,000 t in 1996. In terms of energy consumption, major dairy products are processed milk (for drinking and others), powdered milk, butter, and cheese. Processed milk production recorded a significant decrease at the beginning of 1990's, but has increased in recent years. Production of powdered milk and butter seems to show a small increase, although a declining tendency has been seen over the long term since the beginning of 1990's. Cheese production decreased in the first half of the 1990's, but has shown a steady increase in recent years.

In this sub-sector, there are approximately 300 companies and corporations (as of the end of 1996), of which 260 are cooperative unions operating approximately 700 factories. The remaining 40 companies are believed to be private companies. In addition to the factories that manufacture milk, powdered milk, butter, and cheese, seven large companies produce mainly ice cream.

Compare with the other two sub-sectors in the food processing industry, investment by foreign companies and mergers by large domestic companies are not active. Nevertheless, it is worth noting that companies in Germany, France, Holland, and Denmark are operating.

(2) Present situation of energy consumption

The volume of energy used in the dairy products sub-sector was 23,895 TJ in 1997, which was 2.3% of the overall manufacturing industry. The dairy products sub-sector is the largest energy consumer among the three food sub-sectors targeted by this study.

Based on the factory energy audit result, the E.I. of the Obrzanska factory is 1.2 times higher (4.1 GJ/3.4 GJ) than an excellent factory. Compared with targeted factories in other sub-sectors, the difference with an excellent factory is fairly small.

When estimating the E.I. of major dairy products such as processed milk, powdered milk, butter, and cheese based on sub-sector statistics in Poland (energy consumption and product production volume) and comparing the E.I. with the estimated value in Japan, the difference is very large (Table 2.2).

For example, the E.I. to manufacture processed milk is estimated to be 7.51 GJ/t in Poland, and 2.38 GJ/t in Japan; and when looking at powdered milk, which has the highest E.I. among dairy products, the E.I. is 35.14 GJ/t in Poland and 17.52 GJ/t in Japan.

Table 2.2 Comparison of Estimated Energy Intensities for Manufacturing Dairy Products in Poland and Japan in 1997

	Poland			Japan		
	Fuel (MJ/t)	Electricity (MJ/t)	Total (MJ/t)	Fuel (MJ/t)	Electricity (MJ/t)	Total (MJ/t)
Processed milk	6,300	1,208	7,508	388 <1,552>	576 <828>	964 <2,380>
Powdered milk	32,470	2,673	35,143	11,627 <15,502>	1,512 <2,016>	13,139 <17,518>
Butter	6,335	904	7,239	1,550 <3,100>	540 <684>	2,090 <3,784>
Cheese & others	6,365	1,311	7,676	1,938 <2,713>	1,044 <1,620>	2,982 <4,333>

(Note) Figures with < > and without < > for Japan show the maximum and minimum estimated by the JICA Team , respecively.

2.3 Estimation of energy consumption of targeted equipment

In addition to the estimation of the current total energy consumption in target industries, the current energy consumption was estimated for the following seven types of energy-related equipment in targeted industries.

(1) Lighting
(2) Air compressor
(3) Motor
(4) Transformer
(5) Heating (Air conditioning)
(6) Boiler
(7) Industrial furnace

The present situation of energy consumption was estimated based primarily on the factory energy audits and questionnaire survey. Statistics on these types of equipment, such as their number and energy consumption in each industry, do not exist. The ratio of equipment in energy consumption in each sector and sub-sector was estimated, and the energy consumption of each equipment was estimated based on this result.

Table 2.3 Energy Consumption in Seven Types of Equipment in Targeted Industries in 1997

	Steel	Ammonia	Truck	Tractor	Glass	S.L.B.	Veget.	Meat	Dairy	Total
[Share in Total(%)]										
Lighting	4.0	0.2	5.9	3.4	1.0	2.0	2.0	5.6	2.0	3.3
Compressor	4.5	9.0	10.2	19.5	29.5	11.0	9.0	3.3	10.0	7.6
Motor	24.0	20.0	29.6	44.6	49.1	7.0	15.0	54.1	24.0	28.2
Transformer	7.4	2.0	15	18.2	3.5	7.0	3.0	4.9	7.0	6.4
Total Electricity	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Heating	10.9	37.0	33.1	28.1	6.5	33.0	45.0	19.9	6.0	16.8
Boiler	17.4	50.0	66.0	42.7	15.9	93.0	70.0	94.4	85.0	32.5
Heating Furnace	5.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.4
Total Fuel	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
[Energy Intensity(MJ/t or pcs)]										
Lighting	76	4	581	642	26	1	19	146	25	
Compressor	86	163	1,000	3,728	562	3	85	86	126	
Motor	455	362	2,906	8,514	934	2	142	1,416	302	
Transformer	140	36	1,475	3,468	66	2	28	127	88	
Total Electricity	1,897	1,811	9,830	19,078	1,904	30	945	2,616	1,260	
Heating	1,954	11,620	8,335	12,101	1,045	267	3,647	2,318	473	
Boiler	3,115	15,703	16,599	18,373	2,541	753	5,674	10,995	6,698	
Heating Furnace	1,009	0	0	0	0	0	0	0	0	
Total Fuel	17,925	31,406	25,150	43,075	15,984	810	8,105	11,644	7,880	
[Energy Consumption(TJ/y)]										
Lighting	881	9	34	15	37	1	11	181	65	1,235
Compressor	997	367	58	86	799	4	51	107	329	2,798
Motor	5,273	815	168	196	1,328	3	85	1,757	790	10,416
Transformer	1,623	81	85	80	94	3	17	158	230	2,370
Total Electricity	21,986	4,078	569	439	2,707	45	569	3,246	3,295	36,935
Heating	22,647	26,168	483	278	1,486	399	2,195	2,877	1,237	57,770
Boiler	36,103	35,363	961	423	3,613	1,126	3,416	13,645	17,515	112,165
Heating Furnace	11,694	0	0	0	0	0	0	0	0	11,694
Total Fuel	207,751	70,726	1,456	991	22,729	1,212	4,879	14,450	20,606	344,801

Table 2.3 shows the "ratio" of energy consumption of each type of equipment, energy intensity (E.I.), and energy consumption volume in each industry. The E.I. and the energy consumption shown in this table are included in the E.I. and energy consumption in each industry stated in 2.2.

2.3.1 Lighting

With regard to lighting, together with compressors, motors, and transformers to be mentioned later, the ratio of each equipment in the overall electricity consumption in each sector and sub-sector was estimated.

The results show that the ratio of lighting in the nine sectors and sub-sectors was 3.3% in 1997, and that the electricity consumption for lighting was 1,235 TJ (343 GWh).

2.3.2 Compressors

Electricity consumption by compressors accounted for 7.6% of the total in 1997 at 2,798 TJ (777 GWh).

2.3.3 Motors

Electricity consumption by motors accounted for 28.2% of the total in 1997 at 10,416 TJ (2,893 GWh). This figure also includes motors used by the above compressors.

2.3.4 Transformers

Electricity consumption by transformers accounted for 6.4% of the total in 1997 at 2,370 TJ (658 GWh).

2.3.5 Heating (air conditioning)

Fuel consumption in heating (air conditioning) accounted for 16.8% of the total fuel consumption (344,801 TJ) of nine industries in 1997 at 57,927 TJ.

2.3.6 Boilers

Energy consumption by boilers accounted for 32.5% of the total energy consumption in 1997 at 112,165 TJ. This figure includes energy used in heating above.

2.3.7 Industrial furnaces

This study did not include furnaces, which play a major role in the manufacturing process (examined in 2.2), such as blast furnaces, converter, and electric furnaces in the iron and steel sector, as well as melting furnaces in the glass manufacturing sector. This study selected only heating furnaces in the iron and steel sector. As a result, among the target sectors, fuel consumption by industrial furnaces was not calculated except in the iron and steel sector.

Fuel consumption by "industrial furnaces" in the iron and steel sector was 5.6% of the total fuel consumption, or 3.4% of the targeted sector at 11,694 TJ.