3. GOVERNMENTAL MEASURES AND POLICY SCENARIOS FOR ENERGY CONSERVATION

3. GOVERNMENTAL MEASURES AND POLICY SCENARIOS FOR ENERGY CONSERVATION

3.1 Introduction

Beginning in this chapter, we will consider the central part of this study on "the master plan for energy conservation in the industrial sector in Poland," based upon,

First, having reviewed energy demand/supply and energy policies in the past in Poland in Chapter 1, and

Second, having estimated current energy consumption for targeted industries and equipment in Chapter 2.

Here, we define this master plan as:

---- technical measures that should be implemented in the industrial sector, and

---- governmental measures, including the establishment of institutions / organizations, that should be executed for the sector by the government,

---- for the purpose of achieving a certain target for energy conservation in the industrial sector by a certain time (or times) in the future,

---- to be presented to decision makers on energy conservation policies in Poland.

To formulate such a master plan, we think we need to answer the following questions:

a. What kind of technical measures and instruments are needed for energy conservation ?

b. What kind of governmental measures, including institutions / organizations, are needed to support and accelerate the technical measures?

c. And then, the three basic questions below:

c-1. What is the theoretical basis for energy conservation policies?

c-2. What policy alternatives for energy conservation are formulated based upon these?

c-3. How is the most desirable alternative evaluated and selected?

Item b. above should be proposed on the basis of such basic considerations as that for sub-items of c-1., c-2., and c-3 shown above.

In this Chapter 3, first, we give basic consideration to item a., b., and c. above in the section 3.2 below.

Next, we consider item a., taking into account reality in Poland in section 3.3.

Furthermore, in section of 3.4, we consider item b. as was done for item a..

Finally, in section 3.5, we establish policy scenarios, which are the "alternatives" mentioned in c-2. above, to be used for estimating energy conservation potential and its effects on environmental improvement in the industrial sector, based upon the considerations in sections 3.2, 3.3, and 3.4.

In addition, we show the results of our study on sub-item c-1. in detail in the Appendix to this Chapter, and detailed evaluations of policy scenarios (c-3.) in Chapter 8 and 9.

3.2 Technical Measures and Governmental Measures for Energy Conservation

3.2.1 What are the technical measures ?

(1) Three steps for technical measures associated with energy conservation

Usually, technical measures for energy conservation in factories are divided into three steps.

The first step is to improve energy management in factories.

The second step is to improve equipment and facilities related to energy in factories.

The third step is to improve production processes.

(2) Direct and Indirect Measures

On the other hand, if we look at technical measures for energy conservation from the viewpoint of what is the main purpose or target of the measures, we can divide them into two categories: direct and indirect.

The latter is investment for the modernization or the rationalization of factories, mainly aiming at strengthening competitiveness by expanding production, improving product quality, reducing costs, etc.

It is indispensable for us to pay attention to this side of investment in estimating future potential for energy conservation in Poland where direct investment by foreign firms as well as privatization and restructuring of state enterprises are underway.

In addition, the indirect measures here roughly correspond to the measures in step 3 mentioned in (1) above.

3.2.2 What are the governmental measures ?

(1) Basic approach to governmental measures for energy conservation

We define the energy conservation policy as a set of governmental measures for supporting and accelerating technical measures ---- "direct" measures in particular ---- mentioned above.

According to our detailed study on the theoretical basis for the energy conservation policy, which is presented in the Appendix to this Chapter, we think that the basic approach should be the follows:

First, in general, even in a market economy, to which Polish economy is now transforming itself, there are failures, whether they are called market failures or coordination failures. Accordingly, any economic system needs government's intervention to remedy the failures in general, which can be said to be the energy conservation policy. Such a necessity for government intervention should be emphasized for transitional economies and economies in developing countries.

Then, one of the most important failures to be considered in formulating energy conservation policies is "imperfect information" and asymmetric information. We think that comprehensive and fine-tuned policy measures should be taken for remedying such failures.

Another important "failure" is environmental pollution. To remedy this "failure," policy measures for energy conservation which are harmonized (or do not contradict) with environmental policies are justified, while comprehensive measures in the environmental policy need to be implemented, including financial support to companies.

Second, in formulating concrete governmental measures, we should fully take into consideration the following:

a. Effectiveness of executing favorable governmental measures for companies, including financial support, which are provided on certain subjective conditions.
b. Importance of implementing governmental measures necessary for accelerating or encouraging "community-level" cooperation between workers at production sites, to make technical measures for energy conservation more effective and efficient.
c. Effectiveness of coordination by exchanging views and information between the government and companies in "deliberative councils (or advisory committees)," which have been evaluated to be effective in Japan, for instance.

Finally, we think that economic policies including energy conservation policies have many objectives. This is very important especially in evaluating alternative energy conservation policies, as mentioned in (2) below.

(2) How to formulate energy conservation policies

Following the basic approach mentioned above, we examine governmental measures and instruments for energy conservation here.

First, governmental measures and instruments with which the government provides to companies are categorized into information and funds.

Information is further divided into data and that on what to do. The former includes figures and documents on the energy efficiency of equipment, and the latter includes education and training for employees in factories on energy conservation.

Funds are provided to companies in many ways including favorable loans, subsidies, favorable treatments on taxation, guarantees for borrowings, and rebates.

Second, these policy measures can be divided into two categories from the viewpoint of whether they urge or invite companies to act voluntarily or not voluntarily (compulsorily).

For instance, signals of energy prices, such as when prices are changed by the government, suggest companies take actions they think are appropriate. Labeling equipment also urges companies to act voluntarily. Establishing standards on the energy efficiency of equipment, however, compels them to use only those which satisfy the standards. On the other hand, reporting energy consumption in energy intensive factories to the government, or allocating energy managers in factories can be executed either as voluntary ones or compulsory measures.

Incidentally, these governmental measures naturally need institutions and organizations which are in charge of executing them. In general, existing ones may be modified to take charge of new governmental measures, or new ones can be established for new governmental measures.

Organizations or institutions which might have to be newly established in Poland include a Center for promoting energy conservation, banks or funds in charge of financing investment costs for energy conservation, the "deliberative councils (advisory committees)," and cooperative systems for labor union. Bodies carrying out technical and economic cooperation with foreign countries and international organizations are also among the most important institutions.

Finally, governmental measures are provided to achieve targets for two aspects of corporate management, which are improving the management of operation and maintenance of equipment and facilities in factories. Organizations and institutions need to be modified or established to make the improvements.

(3) Evaluation of alternatives on governmental measures for energy conservation

As already mentioned, economic policies include plural objectives. Usually, they are effective allocation of resources, equitable allocation of income, and stabilization of economy. Among these, governmental measures for energy conservation relate directly to the effective allocation of resources, although we also have to pay attention to the degree of their contribution to stabilization of economy. Relations between energy conservation policies with "equitable allocation of income," however, are generally negligible.

Furthermore, energy conservation policies are closely related to environmental protection policies, as already mentioned.

Thus, if energy conservation policies have plural objectives, alternatives in the master plan for energy conservation have to be evaluated comprehensively taking into account all of the objectives. Accordingly, we will make their evaluations at the two levels of "micro" and "macro."

As mentioned later, two policy scenarios ---- "Energy Conservation (E.C.) Scenario" and "Accelerated Energy Conservation (A.E.C.) Scenario" ---- will be established to promote energy conservation in the industrial sector in this study, the performance of which will be evaluated quantitatively.

At the "micro" level, two scenarios will be evaluated through a cost / benefit analysis. In the evaluation, we will target, as a benefit, reducing energy consumption through energy conservation (This indicator will be used as one representing an "equitable allocation of resources") and environmental improvement through energy conservation (Improvement itself is an objective or a criterion). We will then target the costs necessary for executing governmental measures and preparing institutions / organizations, as well as the investment costs for taking technical measures in factories (For more details, see Chapter 8).

Then, at the macro level, we will compare two Scenarios, with the objective of "stabilizing the economy" in mind, for the following indicators (For more details, see Chapter 9):

a. Macro-economic indicators
   ---- economic growth rate
   ---- income per capita
   ---- increase rate of prices
b. Energy-related indicators
   ---- increase rate of demand
   ---- energy supply mix
c. Global environmental indicators
   ---- Emissions of green house gases

We will evaluate two scenarios at these two levels to provide Polish decision makers on energy conservation policies for the industrial sector with materials for them to make final conclusions (For more details, see Chapter 10).

3.3 Considerations on Energy Conservation Measures in Factories

In section 3.3, we consider concrete and realistic technical measures for energy conservation that can be implemented in Polish factories, based upon a general consideration of the "technical measures" and the "governmental measures" for energy conservation in section 3.2 above. Such a consideration is made in advance for considering concrete and realistic "governmental measures" for energy conservation in Polish factories in section 3.4 below.

3.3.1 Current status of technical measures for energy conservation in Polish factories

(1) From the questionnaire survey

We have undertaken a questionnaire survey on energy consumption in factories in targeted sectors and sub-sectors, as of December 1997. The survey consists of two parts, one of which is titled the "Factory survey" and deals with production processes, products production, energy consumption, and energy conservation measures in factories, and the other is titled the "Equipment survey," which focuses on energy consumption of main energy-consuming equipment including lighting, air compressor, motor, transformer, heating (air conditioning), boiler, and furnace.

More than five hundred factories in the industries targeted in this study were targeted by the Questionnaire Survey, which received a 30% response rate in each industry. This rate for means that the Survey reached the target set the minimum response rate. In discussions with our counterparts and consulting firm to which we commissioned the Survey, we concluded that around 30% would be the minimum satisfactory level if we took into account the following current situation of Polish firms:

First, many Polish firms are not willing to answer questions from outsiders, mainly because they are now in the process of privatization, have been under the control of foreign companies, or are negotiating with foreign companies on their investments.

Second, the government or its related organizations are restricted to collecting data from companies, unlike during the communist era. If they keep such data, a third party cannot get them, including data on production by company, for instance.

The survey includes, factories in industries other than those targeted in Chapter 2. They are factories other than Ammonia manufacturing in the chemical industry and other than Silica Lime Block (S.L.B.) manufacturing in the brick industry. We, however, present our analyses of the Survey including these industries to grasp current energy use in Polish factories as widely as possible.

The results of the "Factory survey" show that some factories have already executed measures for energy conservation, including training for employees and managers and introducing economic incentive systems. There are also some factories already implementing measures that belong to the second and third categories.

In the iron and steel industry, for instance, two factories have already implemented energy conservation measures belonging to the second and/or third steps and are planning to implement additional measures in the same steps. In addition, a S.L.B. factory has already implemented the following technical measures----a) recovery of waste heat for autoclaves, b) exchange of steam for autoclaves, and c) automatic operation of facilities.

On the other hand, the Survey also shows that many factories have not yet made any earnest measures for energy conservation, although some of them have started training for employees (We call them the NY group of factories). If we calculate the share of the NY group of factories in total number of factories in a sector or sub-sector which answered to the questionnaire, we can get the numbers of 30% in the chemical industry and 100 % in the vegetable oil industry (Table 3.1). In the table, we call factories that have already implemented technical measures for energy conservation the "AI" group.

Table 3.1 Grouping of Factories into NY* and AI*

Sector (sub-sector)	No. of factories (answered)	NY* group of factories (% of total)	AI* group of factories (% of total)
Iron & steel	14	50	50
Chemicals	15	30	70
Machinery	11	50	50
Glass	19	50	50
Bricks	34	65	35
Vegetable oil	3	100	0
Meat	37	50	50
Dairy products	20	40 - 50	50 - 60

(Note) Number of percentage are around ones.

NY ---- Factories which have not yet implemented energy conservation measures, including those executing only training.
AI ---- Factories which have already implemented the measures.

(Source) The Questionnaire Survey

These figures show that more than half of factories have not yet implemented earnest measures in nearly all sectors and sub-sectors targeted in this study.

(2) Obstacles to promoting energy conservation

The questionnaire included a question on "Obstacles promoting energy conservation" to factories. Among the following factories were asked to circle as many as necessary as obstacles to energy conservation promotion.

a. Uncertainty of prospects for energy situation.
b. Uncertainty of prospects for product demand and factory operation.
c. Minor impact of energy cost to the total cost of the product.
d. Uncertainty about return on investment for energy conservation.
e. Small possibility of energy shortage.
f. Little room for additional energy conservation.
g. Shortage of engineers.
h. Difficulty in obtaining good energy conservation equipment.
i. Unreliable performance of energy conservation equipment.
j. Difficulty in obtaining enough information for taking measures.
k. Insufficient system of research and development.
l. Shortage of funds for facility improvement.
m. Superannuated facilities.
n. Low consciousness of employees about energy conservation.
o. Lack of staff who can educate employees.
p. Shortage of measuring equipment.
q. No time to analyze energy consumption rate.
r. Shortage of information on government's policy measures.
s. Insufficient measures of the government for promoting energy conservation.
t. Others (   )

According to their answers, the following are the main obstacles for them to take technical measures for energy conservation (For other items, see Table 3.2):

< Items >	< Number of answers >
l.	90
m.	69
s.	58
d.	53
r.	51
b.	39
p.	38
n.	36

Table 3.2 Obstacles to Promoting Energy Conservation in Factories

Obstacles (Item No.)	Iron & steel	Chemical	Truck & Tractor	Glass	Bricks	Veget. oil	Meat products	Dairy products	Total
a	1	2	2	3	4	1	4	3	20
b	9	3	2	4	9	1	9	2	39
c	1	2	3	0	4	0	3	3	16
d	5	8	2	5	11	1	14	7	53
e	2	4	1	3	0	2	1	0	13
f	1	0	0	3	2	0	4	1	11
g	1	0	1	2	0	0	7	2	13
h	6	1	1	0	4	1	5	2	20
I	1	2	1	1	4	0	6	2	17
j	1	1	0	1	7	2	13	1	26
k	1	0	0	0	2	0	1	0	4
l	7	10	3	12	22	1	23	12	90
m	8	6	2	8	21	1	13	10	69
n	2	1	1	4	9	0	17	2	36
o	0	0	0	0	0	0	4	1	5
p	4	3	0	6	7	0	9	9	38
q	1	0	1	1	2	0	14	1	20
r	4	3	2	7	11	2	16	6	51
s	3	7	4	8	14	2	12	8	58
t	1	0	0	0	0	0	0	1	2

(Source) The questionnaire survey.

From these answers, we think we can conclude the following:

First, factories are facing the problems of operating old, obsolete facilities and equipment and the "shortage of measuring equipment."

Second, however, they cannot finance new facilities or equipment.

Third, on the other hand, they are also suffering from "uncertainties about return on investment for energy conservation" and "uncertainties of prospects for product demand and factory operation."

Fourth, they will have to solve the problem of "low consciousness of employees about energy conservation" (A Polish expert on energy conservation commented that "low consciousness of managers on energy conservation" should be added as an important item).

Finally, accordingly, they are requesting the government to prepare additional policy measures including economic incentives for implementing measures, providing and education or training for energy conservation.

3.3.2 Two focuses for considering energy conservation measures in Polish factories ----"Improved management of operation and maintenance" and "Improvement of machines and equipment"----

As mentioned above, more than half of the factories in targeted industries had not implemented earnest measures for energy conservation as of December in 1997. More concretely, we can say the following:

a. We suppose that at least around half of the factories in the industries has not implemented even basic or primary measures (in the first step). This was also observed in the factory energy audits.

b. In addition, old and obsolete equipment and facilities have not been replaced in the factories mainly because of a lack of funds.

Accordingly, we think that, in considering technical measures in factories for the purpose of formulating "policy measures" for energy conservation, we should focus on "improved management of operations and maintenance in factories," basic and primary measures among them in particular.

Second, we should focus on how to recover investment costs, mainly for "Improvement of machines and equipment."

Therefore, we introduce the experiences on the most basic measures for "Improved management" in Japan to Poland for a full understanding of its importance. In addition, we will also introduce recent theoretical studies on the basis of "Improved management" in Japan as well as studies in Poland.

We present the necessity for an economic evaluation of "Improvements to machines and equipment" in section of 3.3.3.

For more details on technical measures for energy conservation in factories, refer to "Guideline for Energy Conservation" in this study.

(1) Proper management of energy (Example A)

Taking the experiences of Japanese petroleum refineries as an example, the measure of "Checking and adjusting fuel/air ratio in heating furnaces or boilers" was implemented as follows:

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

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

The third step was to prevent air leakage. To stop holes, materials such as aluminum tape and asbestos yarn are used. Installation of stopcocks on burners as well as improvement of check-windows is also necessary.

After taking the measures mainly in the first category, low O2 burners, automatic damper control system, and others devices, which are measures in the second category, were introduced.

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

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

In addition, the measures in the first category are not the only ones for which the ideas of operators or workers were effective for energy conservation, but they played a very important role in all categories, particularly in the first and second categories.

(2) Proper management of energy (Example B)

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

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

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

Second, "groups" or "circles" were often organized by workers executing energy conservation measures to play a big role in the execution of proposals.

In particular, we should pay attention to an example in which a "combustion management group" in a power plant was successful in persuading operators to improve management, acting as a core group for all operators.

(3) Basis for proper management of energy

What motivated the behavior of such operators? In other words, what was the basis of company management for basic energy conservation policies, or for middle management and workers in factories in originating technical measures?

We think that we need to carefully consider institutions in factories (firms)----including a coordination system in which decisions on factories' operations are made or senior management, middle management, and workers in factories exchange information with each other, and an incentive mechanism through which wages and other rewards are determined----to answer this question.

First, let us look at the general relationship between these systems and mechanisms and the efficiency of operations in factories.

According to studies done by the Comparative Institutional Analysis school, which originated at Stanford University in California in the United States in early 1990s, the following differences in the Coordination System can be found between the automobile industries in the U.S. and Japan:

In the Japanese industry, workers are requested to have common knowledge of the whole production system. They are qualified to stop production lines, and are also requested to respond to emergency including machine failures, for instance.

Such a production system is in contrast to that in the U.S. automobile industry during the period from around 1970 to 1980. Duties were distributed more strictly with production lines under the control of centralized management and emergencies were dealt with by staff who had specialized knowledge.

The Comparative Institutional Analysis insists that workers' behavior is determined not only by the Coordination System but also by the Incentive Mechanism. In Japan, the Incentive Mechanism, of which permanent employment, seniority pay, and seniority promotion were characteristics, supported the behavior of workers.

We think that it is very important for the Poles, in relation to energy conservation in factories, to pay attention to the current status of the Polish system and mechanism as one of the most basic problems, and to consider how to improve them, and not to superficially follow examples of technical measures in foreign countries.

In such a consideration, they should take into account the following:

a. Energy conservation is an activity common to all industries including those mentioned above. The Japanese System, however, may be appropriate for promoting energy conservation, mainly because energy conservation in the industrial sector has been very successful in Japan.

b. The Coordination System in a country is formulated during the historical development of the country. Therefore, its simple transfer from one country to another is impossible.

   Nevertheless, if we look at the U.S. automobile industry which has recovered its competitive strength by learning from the Japanese system, it can be said that industries in Poland will be successful upon adopting some parts of the Japanese system.

c. In parallel, some parts of the U.S. System and others----German, for example----may be able to be transferred to Polish industries partly and selectively.

d. A similar consideration can be made for the Incentive Mechanism, also taking into account the characteristics of the Polish Mechanism. Taking an example from the automobile industry again, a GM factory in Nashville in the US has provided workers with more incentives than those in Japanese factories.

Next, let us look at Polish characteristics of the coordination system and the incentive mechanism.

A study report prepared by the World Bank in 1993 has presented key deficiencies in the Coordination System and Incentive Mechanism in Polish industries. We suppose the Bank's following comments are very suggestive in considering how to improve management in Polish factories, although they were directed at the energy sector (Reference 6):

a. Much decision making is generally at a quite senior level, so operational decisions are often referred upwards when responsibility could be delegated to a lower level of management;

b. No formal performance management review and improvement processes, or development system or incentives exist for employees;

c. Job descriptions, where they exist, do not focus on individual accountability and responsibilities, nor are they part of an overall organization plan;

d. Salaries are often based on complex formula, and pay differentials are low.

The Bank concluded that the management of companies need to be given clear, unambiguous objectives, and all employees need to be rewarded according to their contributions and responsibilities.

We assume that, even if some of these deficiencies might have already been overcome in resent years, it will take some additional years to resolve all of them.

A study by Marta Juchnowicz, a Polish expert on corporate management, shows that what has been resolved is still very marginal (Reference 7). This study focuses on the motivation system of Polish companies in the transition period, and points out the following:

a. Generally, in Polish companies, the motivation system has never received emphasis and has constituted the weakest element of the management system.

b. On the "Coordination system":
----The management is generally technocratic, and tends to treat employees as a uniform mass. Or, the management tends to treat the relation with employees and the trade union in the category of domination and subordination, not in the category of partnership, negotiation, and cooperation.
----The middle management is rarely engaged in managing employees. It is usually highly educated in engineering or technology, but not on sociology, psychology, and management in universities. In addition, it is hardly trained on employee management in companies.
----The lower level of management is usually not authorized to make decisions on any task.

c. On the Incentive mechanism:
----Usually, promotion criteria are not described and disclosed to employees, although a system for performance evaluation has been established.
----Most managers treats wages as the method by which employees meet material needs. They do not understand that wages can also be the source of employees' satisfaction, i.e. a way of expressing managers' appreciation of employees and compensating them.

3.3.3 Necessity for Economic Evaluation of Energy Conservation Measures

As mentioned in section 3.3.1 above, many Polish companies are suffering from a lack of funds for energy conservation measures.

Such a situation shows, from the viewpoint of formulating governmental measures, the necessity for estimating the total amount of the government's economic support to energy conservation, and for considering conditions including interest rates and loan periods.

In chapter 4 of this study report, we make an economic evaluation of technical measures for energy conservation, which can be adopted for targeted industries and equipment, according to two policy scenarios established in section 3.5 below. We will also evaluate which technical measures can be economically feasible if the government economic incentives are provided.

In chapter 8, we estimate the total investment costs of technical measures that are evaluated economically feasible, as well as on those that can be implemented by the economic incentive, based upon the economic evaluation in chapter 4.

3.4 Basic Consideration of Policy Measures for Energy Conservation

3.4.1 Consideration of technical measures, governmental measures, and institutions / organizations for each level of factories' energy conservation efforts

We can divide Polish factories into the following three groups, according to the levels of their conservation efforts, based upon the results of the factory energy audit, the questionnaire survey, and others :

The first is factories at the level of having just become concerned about energy conservation. The second is the level of having started to consider energy conservation measures and decision-making on their implementation. The third is the level of having already implemented measures (Table 3.3).

If a factory is at the level of being concerned about energy conservation (Level-1), one of the basic actions necessary for it to do is to collect and organize data on energy conservation inside and outside the factory. Technical measures for monitoring or measuring energy consumption are necessary for collecting data inside it. For such purposes, the factory has to install devices for monitoring and measuring, and to prepare staff who are well trained to analyze and evaluate the data collected by them.

Governmental measures which the government should adopt for factories at this level are to provide information on necessary devices, for instance, and, if possible and necessary, may be to assist them financially to invest in such devices. Another important governmental measure is to provide factories' director and senior officials with information on energy in general and on the government's policies and guidelines.

For the government to provide these governmental measures requires institutions / organizations. In addition, for factories to implement their technical measures for energy conservation institutions / organizations inside them need to be prepared or improved.

Needless to say, there are also relations basic actions, technical measures, governmental measures, and institutions / organizations in factories at the other two levels.

Concrete relations in levels 2 and 3 are shown in Table 3.3 which has been prepared taking into account the current situations in Poland. For instance, it shows that an organization such as a Center for energy conservation is necessary for promoting factories at level 2 to undertake self-audits on energy.

It also shows that to introduce the institution of designating energy intensive factories it is necessary for factories at level 3 to improve operations and management in factories as one of the purposes of such an institution.

Table 3.3 Technical and Governmental Measures for Promoting Energy Conservation in Factories by Level

Levels for implementing measures in factories	Basic actions necessary for each step in factories	Measures for energy conservation in factories	Measures to be provided by the Government	Institutions or organizations necessary for the technical and governmetal measures
(Level-1) Concern for energy conservation	Collection of data & infor mation	Monitoring & mesurement	Basic direction of the Gov.'s policy (EU accession ; global environment)	Ministries and gov. agencies responsible for energy conservation
(Level-2) Consideration and decision making	Examining advantages of energy savings (Financial evaluation of technical measures)	Self energy auditing	Data & information (D.I.) on successful cases (Prepared by factory audits, model factories, general surveys, etc.) D.I. on the most efficient technologies	Cooperation with foreign countries (f.c.) and international organizations (i.o.) "Energy Conservation Techn.Center" (ECTC) "Energy Service Company" (ESCO)
(Level-3) Implementation of e. c. measures	< Formulating energy conserv. program > Establishing targets for e. c. Establishing manage. systems for e. c. (Including coordination systems and incentive mechanisms) Technical measures (Soft and hard) Steps or courses for the implementation	< Management > Improvement of coordination systems Improvement of incentive mechanisms (Incentive schemes--salary & bonus ; by group of workers) (Awarding schemes including proposal schemes) < Equipment & facilities > Conversion of existing equipment Replacement of in-efficient equipment Introduction of efficient equipment	< Management > D.I. on the energy conservation programs including guideline for ene. conserv. Regulations on energy management Information on improving coordination systems and incentive mechanisms Human resource development (Training) < Equipment & facilities > Labeling of energy efficiency Setting energy efficiency standard Economic incentive (subsidy; tax credit; favorable loan; loan guarantee; etc.) Energy pricing Supply of energy efficient technologies(Intro of foreign tech.; joint prodction of energy eff. tech.; own develop. and production)	Cooperation with f.c. and i. c. ECTC ESCO Ministries and government agencies Cooperation with labor union Cooperation at business associations Deliberative councils (advisory boards) Designating energy intensive factories* Energy managers *(including environment & quality) Industrial Development Agency (ARP) National Fund for Environmental Protection & Water Management (NFEP&WM) Local funds for environmental protection Environment Protection Bank (BOS) Ecofund Cooperation with f. c. and i. o.

(Note) These governmental measures are executed not only for factories at the level-3 but also for those at other levels.

In sections 3.4.2 and 3.4.3 below, we will consider the basic directions of governmental measures for promoting energy conservation in factories. In such a consideration, we categorize governmental measures / instruments according to the two focuses mentioned in section 3.3 above and the levels mentioned in this section, which act as vertical and horizontal axes, respectively (As we have already mentioned relations or correspondences at level 1 in this section, we will concentrate on those at levels 2 and 3, the latter in particular, below).

3.4.2 Basic Policy Directions for Proper Management in Factories

(1) General consideration on governmental measures and institutions / organizations

The basic actions necessary for the level in factories should contain the following (Table 3.3):

a. Establishing targets for energy conservation.
b. Establishing management schemes for energy conservation, including the coordinating systems and the incentive mechanism.
c. Determining technical measures, including software and hardware.
d. Setting steps or courses for implementing the technical measures.

For supporting and promoting these technical measures, the following are the main items to be executed as governmental measures (Table 3.3):

a. To provide data necessary for the energy conservation program
b. Any regulations for improving energy management in factories (Obligatory reporting of energy consumption, for example)
c. To provide information for improving coordination system and incentive mechanism mentioned above
d. Assistance with education and training of management and employees (Including those on improving the capability to undertake a factory energy audit)

Furthermore, the following institutions / organizations are necessary for the government to provide these governmental measures:

On a., c., and d. ---- To provide these governmental measures, it is necessary for the government to establish a Center for promoting energy conservation and to agree on cooperation with foreign countries and international organization

On c. ---- To cooperate with the labor union and business associations, as well as to establish deliberative councils (advisory committees)

Among these institutions / organizations, cooperation with business associations and establishment of deliberative councils will also contribute to considering and implementing item b. above (Any regulations for improving energy management in factories)

(2) Proposing concrete governmental measures and institutions / organizations

Based upon the general consideration of governmental measures and institutions / organizations, we propose the following concrete governmental measures and institutions / organizations:

a. Training of corporate executives and energy managers

From the standpoint of the large proportion of total production costs occupied by energy, corporate executives and energy managers should be trained to recognize the importance of energy conservation within their management strategies, and thus to set up management systems in their companies, that will allow the PDCA (Plan, Do, Check, and Action) circle method to function smoothly.

b. Training of energy-related engineers and factory auditing experts

Engineers involved in energy matters, i.e., heat and electricity, should be trained to fully understand the most efficient methods of energy conservation and means of promoting them. Additionally, an organization (ECTC mentioned later) should be established to develop experts capable of energy auditing their companies, and thereby allow individual companies to set up a system for promoting of energy conservation.

c. Providing information relating to energy conservation policies, technologies, equipment, and successful cases of energy conservation

For the purpose of promoting energy conservation measures, the relevant authorities should establish an organization (ECTC) that will provide company executives and staff involved in energy matters with information on government energy policies and systems, energy conservation technologies and leading equipment in use both domestically and abroad, and examples of their successful application by companies.

d. Setting up energy conservation model factories

The government will set up energy conservation model factories for each industrial sector, and arrange for energy conservation technical and management specialists to observe the results of such model factories so that methods will be applied to lines and equipment.

e. Providing incentives for the promotion of energy conservation

With the aim of providing incentives for tackling the task of energy conservation, both the government and the companies will award prizes and certificates for successful cases of energy conservation, excellent energy-saving equipment, and companies, and individuals who have made outstanding contributions to the promotion of energy conservation.

f. Support for the introduction of ESCO scheme and for setting up ESCOs

In the U.S., considerable growth has been achieved by companies involved in comprehensive energy-related work intended for energy conservation in buildings and factories, thus contributing significantly to the promotion of energy conservation movement in that country. These companies cover a wide range of tasks, including auditing of buildings / factories, remodeling, operation improvement, and maintenance / servicing of equipment, as well as funding for the implementation of such measures.

The Polish government should attract such companies coming to operate in Poland, to introduce similar systems, offer financial assistance for the development of wholly Polish ESCO companies and efficiently promote the adoption of energy conservation methods. The development of ESCO companies that can raise funds for improving energy conservation by themselves will be a very important means of minimizing governmental financial assistance for investment in energy conservation equipment.

g. Establishment of central Energy Conservation Technical Center(ECTC)

To comprehensively promote the above-listed measures, the government will establish an energy conservation promotion body.

In addition to the policy measures above, we propose the following, which have been executed in Japan, to further improve energy management in factories:

h. Designating energy-intensive factories

The government will list factories consuming large amounts of energy as such and require them, as a legal obligation, to set standards for the rational use of energy, to meet the said standards, to notify the authorities of the state of their energy utilization and to assign persons qualified in energy management. Energy conservation should thus be further promoted in factories.

i. Implementation of detailed factory audits

ECTC will conduct energy audits of the same sort as those implemented by the JICA Team, and will provide the support necessary for a large number of companies to speedily take appropriate energy conservation measures.

3.4.3. Governmental Measures for Promoting the Recovery of Investments

As shown in Table 3.3, the main governmental measures to be provided by the government for improving equipment and facilities in factories are:

a. Recommending or making mandatory the labeling of energy efficiency at equipment and facilities,
b. Setting energy efficiency standard for equipment and facilities,
c. Providing factories with economic incentives for converting or replacing equipment and facilities,
d. Reasonable energy pricing, and
e. Supporting supplies of energy-efficient equipment and facilities to factories, including their development and production in Poland.

We deal with items c. and d. in this section (3.4.3) and others in 3.4.4 below.

(1) Energy pricing

Prices of energy carriers have increased significantly since the transition to a market-economy in 1989.

Looking at current pricing of energy carriers, prices of petroleum products have been, in principle, liberalized.

Prices of electricity, gas, and heat ---- all of which are delivered directly from suppliers to consumers through transmission / distribution lines or pipe lines ---- are stipulated by the Energy Law of 1997 to be set at the full costs of supply. According to our estimate, these prices have already been increased to a level very near their supply costs through significant increases since 1989. In addition, electricity tariffs are to be determined by the direct negotiations between suppliers and consumers after the beginning of 1999 ---- The Poles have called it liberalization of electricity tariffs ----, although the tariffs should be approved finally by the government in accordance with the Law.

Finally, the prices of coal will be maintained at nearly the current levels until 2002 according to the revised plan for restructuring the coal industry published in June 1998, which aimed at reducing the production costs of coal through large decreases of workers and production for the purpose of recovering the industry's international competitiveness. The plan has been reported to and approved by Parliament.

Such current pricing of energy carriers means that the government has already been adopting a policy, in which the prices are determined rationally in a way reflecting supply costs or approaching international prices. Accordingly, we think that it is desirable for the policy to be maintained in the future from the viewpoint of promoting energy conservation.

(2) Economic incentives

In general, subsidies, tax credits, and favorable loans are called economic incentives for promoting or accelerating companies' activities to improve efficiency. As we have already mentioned, there has been no such powerful and effective policy measure for energy conservation in Poland.

We propose that the government prepare a system of long-term, low-interest rate loans for promoting energy conservation in factories. The reason why we do not propose other methods including direct subsidies----although long-term, low-interest rate loans we propose are a kind of indirect subsidy because they have more favorable conditions in terms of loan periods and interest rates than usual commercial loans----, or tax credits and others, is that we think it is more desirable for the government to expand the current system for providing loans and subsidies for environmental protection, as mentioned in chapter 1, to cover loans on energy conservation, than to create a new system.

We have fully understood that the Polish government has been making big efforts to reduce or abolish budget subsidies since 1989. As we have presented in section 3.2 of this Chapter and in the Appendix to this Chapter in more detail, however, governmental intervention including economic incentives for energy conservation do not contradict the general direction of economic policies, if they can satisfy certain conditions, because energy conservation is one of the most important policies on which the government has put priority.

Certain conditions here mean fulfilling an objective criterion, based on which the economic incentives are provided. The objective criterion is the fact that energy conservation is actually accelerated by the incentives, in other words, that a technical measure for energy conservation gains economic feasibility by being given incentives.

Finally, we think the government should select an organization or organizations responsible for providing the incentives from among existing ones that are providing loans and / or subsidies for environmental protection, as mentioned above. They include the following:

---- National Fund for Environmental Protection and Water Management (NFEP&WM)

---- Regional and local funds for environmental protection

---- Environment Protection Bank (BOS)

Cooperation with other countries and international organizations may be considered to be one of alternatives for financing at least a part of the funds for providing incentives. In such case, additional candidate organizations include

---- Industrial Development Agency (ARP)

---- State-owned banks

(Note) For reference, we show economic incentives currently provided to companies in Japan below.

1. Tax exemption
   a. Objective: Energy efficient equipment specified by law and regulation.
   b. Tax exemption: Either of the following;
   (1) Tax exemption equivalent to 7% of the equipment acquisition cost (which should be not more than 20% of the income tax or corporate tax payable),
   (2) Special depreciation of 30% of the acquisition cost in the year of acquisition, in addition to ordinary depreciation.

2. Loan
   a. Objective: Energy efficient equipment specified by law and regulation.
   b. Financing ratio: Within 40%.
   c. Interest rate: 1.3 % (As of December 16, 1998)

3. Subsidies
   a. Objective: Photo-voltaic power generation system for household.
   b. Amount of subsidy (As of fiscal year 1995): A * B
      A: Lower one of the following
         ---- 850 thousand yen plus consumption tax
         ---- 1/2 of the system cost per 1kW
      B: Maximum output of solar battery module (kW)(5kW is the upper limit)

3.4.4 Governmental Measures for Providing Information and Promoting Research / Development on Energy Efficient Equipment and Facilities

Polish experts on energy conservation have pointed out, as one of the important obstacles to promoting energy conservation in factories, the lack of information on energy efficient equipment and facilities, although the questionnaire survey has not necessarily received many answers on this item.

In addition, it is necessary for us to take into consideration that not only technical measures with high investment costs in step 2 but also those in step 3 will need to be taken if we look at a little longer into the future.

We think that, to respond to such necessities, the government should assist companies to introduce equipment and facilities in the way of a) providing information on them from a broader context (including the government establishing the standard for energy consumption on equipment as well as compelling factories to use such equipment, for instance), and b) cooperating with companies on research and development of energy efficient equipment and facilities.

Accordingly, we propose the following governmental measures:

(1) Setting standards for energy-related equipment

Under the Energy Law, the government has already announced its basic policy relating to the establishment of equipment standards. This should be followed up by immediate consideration of the establishment of a system of specific standards for efficiency of energy utilization equipment.

(2) Introduction and development of high-efficiency energy-related equipment

One important point regarding the promotion of the wider use of highly energy-efficient equipment by Polish companies, particularly in the short term, is the need to keep companies precisely and promptly informed about new developments in those types of equipment available abroad, as well as about newly developed technologies.

Over the short-to-medium term, the introduction of advanced equipment and techniques through various forms of business tie-ups with foreign companies would also make a valuable contribution to the energy conservation movement. For this purpose, too, the ECTC, which will act as a pivotal organization for the promotion of energy conservation, and other such organizations, would play an important role.

In addition, over the long term, it is most advisable for Polish companies to make efforts to develop more energy-efficient equipment and new technologies themselves. It is therefore recommended that the government examine the possibility of providing some sort of support for companies' own efforts towards this end during the period of transition to a market economy (Such support could consist of, for example, the examination of development methods by advisory committees composed of experts, and an assistance for the systematic organization by companies of joint research and development bodies).

3.5 Policy Scenarios for Promoting Energy Conservation

3.5.1 Selection of components for scenarios

In section 3.5, we establish policy scenarios for promoting energy conservation in factories, based upon the examinations in sections of 3.3 and 3.4 above. Components (governmental measures) incorporated in the scenarios have to be suitable for quantitative analyses (on future energy consumption and environmental effect), which are main purposes of establishing them.

They are the following four:

a. Governmental measures for improved energy management ---- They correspond to the direct ones and those in step 1, which are mentioned in section 3.2.

b. Policy of pricing energy carriers (Governmental measures on recovering investment costs for energy conservation) ---- They correspond to the direct ones and those in step 2.

c. Governmental measures for the modernization and rationalization of equipment and management ---- They correspond to the indirect ones and those in step 3.

d. Providing economic incentives (Governmental measures for accelerating the recovery of investment costs) ---- They correspond to the direct ones and those in step 2.

3.5.2 Two Policy Scenarios and their Components

In addition to the Reference Scenario, which is one in which no technical and governmental measures for energy conservation will be implemented, or the Business-as-Usual Scenario, we establish the following two policy scenarios:

---- Energy Conservation Scenario (E.C.)

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

They are composed of the four components below, (2) and (3) are common to each Scenario.

Table 3.4 shows the components of each Scenario.

Table 3.4 Scenarios for Promoting Energy Conservation in Targeted Sectors

Scenarios Terms	Energy Conservation Scenario (E.C.)	Accelerated Energy Conservation Scenario (A.E.C.)
Short term (1999 - 2000)	< Improved management > (1)Training of experts for self-audits (2)Nominating model factories (3)Preparing incentives for energy conserv. (4)Establishing E.C.T.C.	< Improved management > (1)Training of experts for self-audits (2)Nominating model factories (3)Preparing incentives for energy conserv. (4)Establishing E.C.T.C. (5)Designating energy intensive factories (6)Allocating energy managers at factories
	< Energy pricing > (1) Prices of coals will be maintained in the real term. (2) Prices of electricity, heat, and gas will be increased nearly to cost levels by 2000 (around 0.9 of costs in the cases of heat and gas and around 0.8 in electricity).	< Energy pricing > Same as left
	< Modernization & rationalizations > Energy savings will be accomplished by modernization and rationalizations of factories in targeted sectors.	< Modernization & rationalizations > Same as left.
	< Economic incentives > None	< Economic incentives > Favorable loans with interest rate of 3% per annum for ten years will be made to factories. (Note) 3% is in the real term, which can be compared to the commercial rate of 10% for five years in "E.C." Scenario.
Middle term (2001 - 2003)	< Improved management > Same as above	< Improved management > Same as above
	< Energy pricing > (1) Prices of coals will be maintained in the real term. (2) Prices of electricity, heat, and gas will be increased to cost levels by 2003	< Energy pricing > Same as left.
	< Modernization & rationalizations > Same as above	< Modernization & rationalizations > Same as left.
	< Economic incentives > None	< Economic incentives > Favorable loan with the interest rate of 2% per annum for ten years will be made to factories. (Note) 2% is in the real term, which can be compared to the commercial rate of 7% for five years in "E.C." Scenario.

(1) Governmental measures for improved energy management

< E.C. >
Governmental measures of item a. to g. mentioned in sub-section 3.4.2-(2) will be implemented in this Scenario.

< A.E.C.>
In addition to the governmental measures above, items h. and i. will be implemented in this Scenario.

(2) Policy of pricing energy carriers

The influence of the government on pricing energy carriers has never been negligible. Therefore, taking into account its basic policy on energy pricing, we assume that prices of energy carriers which are dealt with in the Scenarios will be as follows:

First, the prices of coking and steaming coals will be maintained at the level of those in 1998 (In real terms; same hereinafter), according to the government's plan for restructuring the coal industry announced in June 1998. The price of coke will follow the same trend as coal.

Second, the prices of electricity, gas, and heat will be liberalized, according to the government's basic guidelines, to approach the level of their estimated supply costs in 2000 (around 0.9 of the cost in the case of heat and gas and 0.8 in the case of electricity). The prices will reach the level of their supply costs in 2003.

(3) Governmental measures for modernization and rationalization

The government's current policy will be maintained for direct investment by foreign companies and privatization and restructuring of state-owned companies. This will contribute to a certain degree of modernization and rationalization in companies and factories.

(4) Economic incentives

< E.C.>
No incentive will be provided.

<A.E.C.>
Long term, low interest rate loans will be provided to companies investing in energy conservation. The conditions are assumed to be:

---- 3% interest rate and 10-year loan period in 2000, and
---- 2% interest rate and 10-year loan period in 2003.

Table 3.5 Scenarios on Prices of Energy Carriers

	Coking coal (PLN/t)	Coke (PLN/t)	Steaming coal (PLN/t)					Gas (PLN/1000m^3)				Electricity (PLN/MWh)						
			Average	Truck	Tractor	S.L.B.	Food	Average	Steel	Chemical	Glass	Average	Steel	Chemica	Truck	Tractor	Glass	Food
1998	220	400	170	160	180	170	195	470	525	415	489	140	128	125	149	161	134	165
2000	220	400	170	160	180	170	195	498	556	439	518	165	151	148	175	190	158	195
2001	220	400	170	160	180	170	195	515	576	455	537	175	160	156	185	201	167	206
2002	220	400	170	160	180	170	195	534	597	471	556	184	169	165	195	212	177	218
2003	220	400	170	160	180	170	195	553	618	488	576	195	178	174	206	224	186	230
2004	220	400	170	160	180	170	195	553	618	488	576	195	178	174	206	224	186	230
2005	220	400	170	160	180	170	195	553	618	488	576	195	178	174	206	224	186	230
2006	220	400	170	160	180	170	195	553	618	488	576	195	178	174	206	224	186	230
2007	220	400	170	160	180	170	195	553	618	488	576	195	178	174	206	224	186	230
2008	220	400	170	160	180	170	195	553	618	488	576	195	178	174	206	224	186	230
2009	220	400	170	160	180	170	195	553	618	488	576	195	178	174	206	224	186	230
2010	220	400	170	160	180	170	195	553	618	488	576	195	178	174	206	224	186	230
2011	220	400	170	160	180	170	195	553	618	488	576	195	178	174	206	224	186	230
2012	220	400	170	160	180	170	195	553	618	488	576	195	178	174	206	224	186	230

(Note) Prices are in the real term of 1998 price, which are those of energy carriers delivered to factories. Prices in 1998 are from the statistics of the Energy Market Agency.

On the other hand, usual, not favorable, conditions are assumed to be

---- 10% interest rate and 5-years loan period in 2000, and
---- 7 % interest rate and 5-years loan period in 2003.

The following are the reasons why we assume the conditions mentioned above:

First, in assuming the loan period under the usual conditions, we have taken into account information and reports that a major part of current commercial loans are medium-term loans with a loan period of three to five years, which will not be changed in the near future. Then, we adopted five years for our estimation.

Second, with regard to interest rates under the usual conditions, based upon reports and information that the current rates of commercial loans are around 24 to 25% per annum, we have assumed the following to calculate the real interest rates:

---- Commercial rates per annum will be lowered to around 18% in 2000 and around 14% in 2003.
---- Annual increase rate of producer prices (wholesale prices) will be lowered to around 8%in 2000 and around 7% in 2003.

Next, in assuming the loan period under favorable conditions, we have assumed 10 years based upon the following:

---- The period of this kind of loan should be longer than the usual ones.
---- The depreciation periods of equipment and machines are eight to 12 years in Poland.

With regard to interest rates under favorable conditions, we have assumed 3% in 2000 and 2 % in 2003, based upon the following facts:

---- The interest rates of NFEP&WM as of 1995 were determined to be 30% to 80% of the rediscount rate (the so-called official discount rate)(Note).
---- The interest rates of commercial loans have been almost the same as the rediscount rates at their lower levels.

(Note) As of March 1999, the interest rates were determined to be 50% to 95% of the rediscount rate. We, however, assumed 3% and 2%, which are 30% of the commercial rates in 2000 and 2003, respectively, considering that an economic incentive should be large enough to accelerate energy conservation.

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< Appendix >

A Consideration of Theoretical Basis for Energy Conservation Policies

1. Questions to be answered

We think that we have to clarify the basis for energy conservation policies in considering policy measures for energy conservation in the industrial sector in Poland. There are two reasons.

First, in general, we can say that a set of policy measures adopted by the government of a country is aimed at bringing people positive effects in terms of objectives established for an area (or a field) - Being affluent, useful lives, or economic welfare, for instance -. We think that we need to clarify the positive effects in an area (or a field) which are brought to people through the execution of energy conservation policies.

Second, more concretely, we have to answer the question of whether policy measures for energy conservation, which we propose the Polish government to take in this study mainly based upon experiences in Japan, are suitable or desirable for Poland. We have to answer the same question if we base upon experiences in the U.S. or Germany to propose policy measures.

Next, we think that it is appropriate for us to grasp an area (or a field) mentioned above as the economic system in a country for the following reasons:

In many countries, governments have established and executed the policies below as those they should adopt for some areas (or fields). They include

- Economic policies (Including those for finance, banking, and industries),
- Science and technology policies,
- National security policies (Defense policies),
- Education policies,
- Social security policies, and
- Environmental protection policies.

We can define these policies as those which are sets of policy measures executed by the governments to improve the performance of systems in the areas (or fields)- the economic system and the environmental system, for instance - aiming at achieving objectives set in each area (or field).

Usually, the objectives of economic policies are said to be the following three: a) effective allocation of resources, b) equitable allocation of income, and c) stabilization of economy.

The government uses the following measures or instruments to achieve these objectives: a) collection of taxes and transfer expenditure, b) government's expenditures, c) government's regulations (laws, administrative guidance, and others), d) management of state or public enterprises, and e) others (changing official discount rate, issuing government bonds, and others)(Reference 1, for instance).

On the other hand, as we have mentioned in the text of this Chapter, technical measures for energy conservation mean those implemented for improving energy management and equipment and facilities in factories, while governmental measures for energy conservation mean those which are executed by the government for supporting and accelerating technical measures.

Accordingly, we can say that the policy measures are executed aiming at improving production efficiency - more concretely reduction of costs - in companies, which are the main components in the economic system. If this is the case, it is very clear that such an aim is closely related to one of the objectives of the government's economic policies mentioned above, which is a) the effective allocation of resources, and thus, we think it is reasonable for us to grasp energy conservation policies from the side of economic policies.

If we grasp energy conservation policies as such, we can situate the policies in economic policies as follows:

Needless to say, the government of a country executes energy conservation policies for the purpose of bringing its economy as a whole to objectives it has established, by promoting energy conservation in factories. Therefore, the government should adopt policy measures and instruments that can be thought to bring the whole economy to the objectives. In other words, it should not adopt measures that are foreseen to bring the whole economy far from the objectives, even if they can promote energy conservation in a factory or in an industry. That is, the energy conservation policies subordinate to the economic policies in a country.

By the way, what we should consider here are energy conservation policies as environmental policies.

Promoting energy conservation can contribute to environmental improvement, especially to a reduction of air pollution. In particular, since global environmental problems have received serious attention, energy conservation has been thought to be one of the most effective solutions in environmental policies. Such a situation worldwide has made energy conservation policies closely linked to environmental policies.

Assuming the following two conditions, however, we can conclude that the objectives of environmental policies – improving global and local environment - will be achieved at the same time as the energy conservation policies will be executed as part of economic policies.

First, emissions of air pollutants and green-house gases, including SOx, NOx, dust and CO_2, as well as combustion residues of fuels, especially coal, can be reduced by the government executing energy conservation policies.

Second, emissions of pollutants other than those mentioned above will not be increased - no negative effects in other areas - by the government implementing the policy measures.

We have mentioned above that it is necessary for us to consider the basis for energy conservation policies, and that it is reasonable to consider policy measures from the viewpoint of economic policies. Then, we will seek a basis through reviews of current economic theories below.

Although we present conclusive comments at the beginning, we have to say that, unfortunately, none of the current economic theories, at least as an independent one, can necessarily provide us such a comprehensive system that allows us to formulate and execute economic policies - the energy conservation policies in this particular case - based upon it.

Therefore, we have decided to consider the basis in the following order:

First, we draw useful suggestions through a review of several important economic theories.

Second, we will make up our own guidelines for formulating energy conservation policies, following the suggestions.

Third, we will select desirable measures and instruments to compose energy conservation policies, according to the guidelines (References 2 and 3 are those which express similar views to ours on formulating economic policies).

2. Traditional and standard economics = Neo-classical economics and other economic theories

2.1 Neo-classical economics

2.1.1 Its theories on economic policies

Neo-classical economics insists that the government is justified to intervene in the market only in case there is a market failure to achieve the effective allocation of resources which is among the objectives of economic policies mentioned in 1. above. We can call market failures conditions in which the market fails to allocate resources effectively, and they include the following:

First, there should be markets for all goods and services which an individual takes into account in considering the allocation of his or her own resources. In other words, the market fails for goods or services which will appear in the future, due to uncertainly or risk, because there is no market.

Second, the market fails when, for instance, a company does not compensate (or receive payment) for damage (or an advantage), although its activities have done damage (or given an advantage) to another company. The economic theory calls this a case in which there exists externality. An example of positive externalities is that a company's beautiful garden gives people peace of mind, while negative externalities include the environmental pollution.

Third, the market fails for goods that have the "non-rivalness - consumption of a goods by a consumer does not decrease its supply to other consumers - and the "non-excludability" - consumers are not prevented from consuming the goods, both of which are called public goods. They will not pay the price set, therefore, private suppliers are not interested in supplying such goods. These include national defense, police, and fire-fighting. For such goods, the government needs to intervene in the market to supplement for its failure.

Fourth, the market fails when firms are not carrying out production using technologies characterized by constant or decreasing returns of scale. In such cases, the condition of prices being equal to marginal costs is not realized and the market does not reach stable equilibrium.

Fifth, the market fails when the conditions of perfect competition are not satisfied so that prices are not fully elastic and the market is unstable.

Sixth, the market fails when there is imperfect information, as well as asymmetric information. For instance, the free choice of a goods by consumers is prevented when information on the goods is imperfect in the whole market, and excessive demand, which is advantageous to suppliers, may be generated on a goods when the suppliers have more information than consumers on the goods. Then, government intervention is required to improve imperfect and asymmetric information.

2.1.2 Views of critics to energy conservation programs in the U.S.

In recent disputes on energy conservation programs in the U.S., A. B. Jaffe and R. Stavins insist that policy measures corresponding to market failures should be clearly discriminated from those not corresponding to them, presenting their basic stand-points as follows (Reference 6):

a. The standard economic approach defines good public policy to be that which maximizes the appropriately weighted sum of goods and services (including, of course, intangibles) enjoyed by society throughout time.

b. Thus, we do not consider energy efficiency as a goal in itself, but only as a mean to the end of overall efficient (and equitable) resource allocation.

R. T. Sutherland, based upon the same stand-points as Jaffe and Stavins, insists that a market failure test, as shown below, is necessary for proposing appropriate policies, following D. F. Spulber's study (Reference 7):

The test first determines whether a market failure has occurred. In the presence of a market failure, the second step is to define a government action that may correct the cause of the market failure. The third step is to determine if the benefits of government intervention exceed the costs.

In addition, he presents the following on concrete policy measures:

a. With regard to limited access to capital and the characteristic of cash-constrained business, capital markets certainly constrain the allocation of capital, particularly to riskier borrowers, but this allocation is a source of efficiency not inefficiency.

b. Lack of information or limited information on energy conservation equipment is not thought to be a major obstacle to implementing energy conservation, although energy conservation proponents insist it is.

c. Energy efficiency labeling of appliances is desirable, but energy efficiency standards are not desirable.

2.2 Theories on economic policies in other economics

2.2.1 Comparative Institutional Analysis

The Comparative Institutional Analysis insists that the government should intervene in the market to correct coordination failures. Such a conclusion is generated from the view of the C. I. Analysis which grasps the market and the government differently from neo-classical economics.

We summarize the views of the C. I. Analysis, from the viewpoint of formulating energy conservation policies, as follows:

First, the C. I. Analysis is the same as traditional economics in assuming that individual economic entities behave according to self interest, but is different in acknowledging that they are only boundedly rational. It also emphasizes that it is difficult for each economic entity to achieve socially effective results through mutual cooperation and coordination of behavior, because of imperfect and asymmetric information.

Second, it thinks that each society faces almost the same problems which its members generate by behaving according to their self-interest, but that there are multiple ways for the society to solve them. This is because the economic system of each society has its own path dependence and institutional complementarily.

Third, the C. I. Analysis regards as important various institutions - the government, firms, laws, voluntary devices including organizations, engagements, and customs in addition to market - of which economic systems are composed, as well as their interactions.

In this way, the C. I. Analysis is trying to look into the institutional composition of economic systems, which had been dealt with only as a black box. For instance, neo-classical economics has regarded the firm as a purely technical entity, which inputs production elements to produce goods or services for sale in the market. The contents of the firm have been assumed to be determined by engineering, which is outside economics, and has been dealt with as a black box.

The firm's activities, however, usually generate various, different results, depending on the different ways information is processed by people involved in it. In other words, the different approaches to coordination inside a firm is one of the most important factors which results in the differences among economic systems.

Among the institutions picked up in this context, the coordination system and the incentive mechanism, which we described in detail in the text in this Chapter, are what we would like to regard as important ones in relation to energy conservation policies in factories. The former, for instance, is what determines the role of each operator on production lines in factories, and the latter is the monetary and other incentive mechanism on the performance of employees. Both receive attention as important factors which determine production efficiency in factories.

Based upon such analyses, the C. I. Analysis regards the relation between the government and the market as follows:

The market and the government are not in confrontation, according to the C. I. Analysis. It is not the government's responsibility to solve the coordination problem. Rather, the government's role is to facilitate the development of private-sector institutions that can overcome these failures. In other words, one possible role of government may be to complement and foster private-order coordination rather than to substitute for it.

Finally, the C. I. Analysis states that criteria for comparing multiple systems - that is, objectives which an economic system should achieve - are plural, and may include, besides productive efficiency, relative equality, incentive compatibility, the provision of a safety net(Reference 9).

2.2.2 Views of proponents of energy conservation programs in the U.S.

In recent disputes on energy conservation policies in the U.S., proponents of energy conservation programs present their discussions from the viewpoint of imperfect and asymmetric information. They do not belong to the C. I. Analysis school, but their views are in the same orbit as the school's.

A. H. Sanstad and R. B. Howarth argue that recent developments in microeconomic theory - in particular, the economics of information - suggest that many of the 'market barriers' to energy efficiency discussed in the literature may be understood as market failures properly construed. And they insist that problems of imperfect information and bounded rationality on the part of consumers, for example, may lead real-world outcomes to deviate from the dictates of efficient resource allocation. In conclusion, they state that the mere presentation of factual information that is technically accurate may be insufficient to induce consumers to make substantively rational decisions, and that both the interpretation of factual information and the use of that information in decision making need to be taken into account.

With regard to concrete policy measures, they state the following: particular policies must be judged on a case by case basis, and the mere existence of a market failure does not imply that government intervention can improve the efficiency of resource allocation (Reference 10).

In addition, on concrete policy measures, J. G. Koomy and A. H. Sanstad have concluded, based upon empirical evidence, that such policy measures as providing rebates, demonstration projects, and national efficiency standards may be justified (Reference 11).

Finally, S. J. DeCanio proposes such non-regulatory policy measures mainly for the information below (Reference 12):

a. The government should act as a clearinghouse for information on energy conservation.
b. The government should act as a management consultant for energy conservation.
c. The government should communicate directly with top management on the importance of energy conservation (For instance, the government's attention on the environmental protection has made all levels of the management of most firms support it).

2.3 Theoretical bases for Japanese industrial policies

M. Miyata, who had been involved in formulating and executing industrial policies in Japan for many years, points out that the following important economic and social objectives, which are other than the market failures, cannot be attained by the market mechanism, and insists that the government has been requested to cope with these market limits, which include the market failures:

a. To ensure economic equity; in other words, to protect against economic weakness.
b. To exclude economic and social friction (For instance, to solve social problems caused by some industries declining).
c. To maintain national security (For instance, to maintain and develop the defense industries, or to build oil stock-piles for the stable supply of energy).
d. To develop the national land in a balanced way.

3. Desirable economic policies in developing countries and transitional economies

3.1 Market-enhancing view

There have been several approaches to desirable economic policies in developing countries and transitional economies. They are categorized into the following three, according to the C. I. Analysis (Reference 9):

a. Market-friendly view
b. Development-state view
c. Market-enhancing view

Item a. is based upon neo-classical economics, partly supplemented by the view of item b. And item b. insists that the government should lead economic development. Finally, item c. is what the C. I. Analysis is proposing, and we think it is very suggestive to our consideration on energy conservation policies.

According to the C. I. Analysis, the market-friendly view emphasizes the role of private-sector institutions, the development-state view emphasizes government intervention, whereas the market-enhancing view emphasizes the role of government policy in promoting private-sector coordination.

As already mentioned, the C. I. Analysis does not regard the market and the government as rivals. The role of the government is to improve the institutions for the coordination in the market to be done well. In other words, it insists that economic policies should be hammered out for the purpose of enhancing the market's function of coordination (market-enhancing).

From such considerations, the following proposals are generated:

First, it proposes contingent rents, which are defined to be policy measures provided favorably to firms on the condition of fulfillment of an objective criterion. The C. I. Analysis considers that such rents would urge firms to improve their management (production) efficiencies and result in improving the efficiency of the whole economic system. Concretely, providing export subsidies, establishing a patent system, and a policy of financial restraint are proposed.

For instance, the C. I. Analysis states that export subsidies may induce private agents to supply more goods that are undersupplied in the competitive process, if they are provided on the condition mentioned above.

Such views justify that we will consider economic incentives (favorable treatments on taxation, loans, and others) for accelerating energy conservation in Poland.

Second, it proposes to utilize rural entrepreneurship or town-village enterprises as important agents for improving the efficiency of the economic system, mainly according to experiences in China. This means to support and accelerate the activities of small-to-medium size enterprises which are led by able, active management results in the efficiency of the whole economic system.

Such views are also very advisable when considering economic policy measures, especially those for privatizing small-to-medium size enterprises in Poland.

3.2 The World Bank's "East Asian Miracles"

This study report examines economic policies in eight countries and areas in East Asia to assess their effectiveness (Reference 13). It categorizes the views of economic policies into the following:

a. Neo-classical economics
b. Revisionist view (Development-state view in 3.1 above)
c. Market-friendly view (Same as above)
d. Functional approach (The World Bank's view in this report)

Following the functional approach which focuses on the accumulation of human and material capital, allocation of economic resources, and changes in productivity, the Bank assess fundamental policies and selective intervention policies which were adopted in these countries and areas. As the results, the following concrete policy measures are appreciated as justifiable ones (Note that the degrees of the appreciation are different in countries and areas):

- Some selective intervention policies

- Policies for accelerating corporate competitions by the contest mechanism

- Policies for promoting exchanges of views and information in deliberation councils, which are forums between government officials and representatives of the private sector, as can be seen in Japan.

Looking at these assessments, we may conclude that the Bank's functional approach has supported at least a certain part of what the market-enhancing view is insisting. In fact, this report has suggested an idea similar to contingent rents, using the phrase performance-indexed reward, in addition to having justified the contest mechanism, as mentioned above, stating: a wide range of government assistance in the form of subsidies, access to rationed credits and foreign exchanges, tax exemptions, etc., was provided to business in East Asia on the basis of export contests.

We, however, have to remember that this report has not justified policies for individual industries adopted in these countries and areas.

3.3 Necessity for regarding cooperation in the community as important

The development economics formulated in Japan have similarities to the C. I. Analysis as follows:

- It assumes multiple economic evolution in various countries, the basis of which is thought to be differences in initial conditions for development including the existence of economic resources, the rigidity of institutions, economic and social situations, etc.
- It regards government intervention is important.
- It insists that policies for growing the market economy should be executed according to the country's development stage.

We, however, do not consider each item above in detail, only focusing on the importance of cooperation in the community, which the development economics is arguing.

Y. Hayami emphasizes that cooperation in the community should be regarded as important, which, we think, corresponds to the coordination system argued by the C. I. Analysis.

He states that the market plays the role of coordinating the division of labor into appropriate cooperative relations through competition caused by self interest, the government through instructions based upon power, whereas the community does the same through cooperation based upon agreement. The community is an organization where people can generate cooperative relations, based upon a relationship of mutual trust caused by human interchanges, and we can regard the

relationship as one of local public goods, according to his view.
And, he argues that, as can be seen from experiences in Japan, community-like organizations can lead the division of labor in modern corporations, which has been highly complicated, to appropriate cooperative activities, and contribute to improving productivity and product quality, which we can see in successful QC (Quality Control) activities in many corporations.

In addition, M. Sano points out that, based upon his studies on economic development in Argentina, past technical cooperation by the Japanese government have been inclined to elemental production technologies in a narrower meaning, and that we should systematically tackle providing such technical cooperation as that related closely to social relations (Reference 2). This view is in the same orbit as Hayami's, which will have to be considered very seriously in the future.

4. Summary

We can get important suggestions from reviewing some economic theories in section 2 and 3.

First, we can get the following suggestions from the review in section 2:

In general, even in a market economy, to which Polish economy is now transforming itself, there are failures, whether they are called market failures or coordination failures. Accordingly, any economic system needs government's intervention to remedy the failures in general, which can be said to the energy conservation policy. Such a necessity for government intervention should be emphasized for transitional economies and economies in developing countries.

Then, one of the most important failures to be considered in formulating energy conservation policies is imperfect information and asymmetric information. Neo-classical economics are rather even negative to acknowledge the importance of this kind of failures, but we should follow the suggestions made by the C. I. Analysis. We think that comprehensive and fine-tuned policy measures should be taken for remedying such failures.

Another important "failure" is environmental pollution. To remedy this "failure," policy measures for energy conservation which are harmonized (or do not contradict) with environmental policies are justified, while comprehensive measures in the environmental policy need to be implemented, including financial support to companies.

In addition, it is necessary for us to consider policies for inducing companies to implement technical measures for solving global environmental problems from different dimensions. We, however, will have to tackle this problem in another opportunity.

Second, we can get the following suggestions from the review in section 3:

In formulating concrete policy measures, we should fully take into consideration the following:

a. Effectiveness of executing favorable policy measures for companies, including financial support, which are provided on certain subjective conditions.

b. Importance of implementing policy measures necessary for accelerating or encouraging "community-level" cooperation between workers at production sites, to make technical measures for energy conservation more effective and efficient.

c. Effectiveness of coordination by exchanging views and information between the government and companies in "deliberative councils (or advisory committees)," which have been evaluated to be effective in Japan, for instance.

Finally, from the review in both sections 2 and 3, we can draw a suggestion that economic policies including energy conservation policies contain many objectives. This is very important especially in evaluating alternative energy conservation policies.

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4. ECONOMIC EVALUATION OF TECHNICAL MEASURES FOR ENERGY CONSERVATION

4. ECONOMIC EVALUATION OF TECHNICAL MEASURES FOR ENERGY CONSERVATION

4.1 Evaluation Method

This chapter discusses the economic evaluation of energy conservation measures at the factory level, applying the following methodology:

When

C = Cost of investment for an energy conservation measure at the time of investment
(We assume that an investment is made at a certain point of time.)

B = Effect of the measure
(Present value of energy saved by the measure for a certain length of period)

And if

B>C

Then, we conclude that the measure is evaluated as being economically feasible.

We make the evaluation for the years 2000 and 2003.

The costs and the value of the effects of the measures are calculated using real prices in 1998.

We collected and analyzed the data and information on costs based on our past results and experience in Japan (including the results of the factory energy audits). These costs were converted to PLN equivalents using a "location factor" and exchange rates. If the original data were for years preceding 1997, the figures were converted to 1998 prices using an "escalation factor."

The effects of the measures were calculated by energy carrier on the basis of future energy prices in Poland.

The following describes the figures and the other items used in the calculation.

4.1.1 Costs of investment.

a. Escalation factor: This factor was used for converting the figures in the original data, for example, those from 1980 into 1998 prices (Reference 1). Incidentally, we assumed that 1998 prices are equivalent to 1.5 times the 1980 prices.

b. Location factor: This factor was used to convert the figures in the original data into prices in Poland. That is, we assumed that if the cost of investment in Japan is one (including cost of designing, engineering, and construction), then the equivalent for Poland is 0.7 (based on an estimate as of December 1996 as shown in Reference 1).

c. Exchange rates: In Poland, the so-called 'crawling peg' has been used since 1991. This is a method of controlling exchange rates by allowing them to fluctuate slowly between lower and upper limits set by the government. The PLN has been systematically depreciating under this crawling peg system. That is, the benchmark for fluctuations is lowered on a monthly basis by a predetermined rate against a currency basket composed of the US dollar, British pound, French franc, German mark, and Swiss franc, which are combined at a certain ratio.

To be more specific, the rate of reduction of the benchmark, which was 1% until the end of 1997, has decreased since the beginning of 1998, and currently stands at 0.85%. In line with a decline of the official discount rate from 24% to 22% at the end of October 1998, the control range of fluctuations was widened from 10% upward and downward from the benchmark (compared to 7% until the end of 1997).

According to an estimate included in the government budget draft for fiscal 1999 (January-December) made public on October 30, 1998, the depreciation rate of the PLN against the US dollar dropped from 21.7% in 1997 to a predicted 7.5% in 1998. The depreciation rate is likely to further decrease to about 5% in 1999 (this is the median of the estimates).

In light of these developments, we assume that the PLN will be depreciated annually against the US dollar by 5% in 1999 and 2000, by 4% in 2001 and 2002, and by 3% in 2003. As a result, the exchange rate will be $1=PLN 3.89 in 2000 and $1=PLN 4.34 in 2003.

Meanwhile, the yen was stronger against the dollar at the beginning of 1999 than it is at present due to the establishment of the Euro currency and other transient factors. However, considering the relative growth of the US and European economies, the yen is forecast to depreciate to a small extent from that level in the near future. Based on this projection, we predict that during the applicable period the yen will be ¥120 against the dollar, almost the same as at present (in April 1999). The following show our assumptions:

US$1=¥120=PLN3.89 (2000)
=PLN4.34 (2003)

That is, PLN1=¥30.85 (2000)
=¥27.65 (2003)

4.1.2 Effects of energy conservation measures

(1) E. C. Scenario

a. Applicable period for evaluating of effects: five years. Based on information and reports that the majority of commercial loans extended for plant investment are mid-term loans of three to five years, we assume that this lending practice will remain unchanged into the near future, adopting fine years as the period.

b. Discount rate (annual rate in the real term) used for calculating present values: 10% (2000) and 7% (2003). Interest rates on mid-term loans mentioned above are reported to be 24-25% to 27-28%. Assuming that these rates will drop to about 18% in 2000 and to 14% in 2003, and that the rate of increase in consumer prices will decline to about 8% in 2000 and to 7% in 2003, we calculate the discount rate for each year as shown above.

c. Energy prices: Have been assumed in the policy scenarios. For details, refer to Chapter 3.

(2) A. E. C. Scenario

In the E. C. scenario, the evaluation period and the discount rate based on commercial loans are used, whereas, in the A.E.C scenario, long-term loans with low interest rates are presumed as an economic incentive. In the latter scenario, the loan period is 10 years with an interest rate of 3% (2000) and 2% (2003).

The assumed loan period of 10 years reflects two factors: a) the period of the loans as in the latter scenario ought to be longer than that of commercial loans, and b) equipment and machinery at factories in Poland are depreciated over eight to twelve years.

The interest rates of 3% for 2000 and 2% for 2003 are set at 30% of the market rate on the grounds that a) as of 1995, interest rates on NFEP&WM loans were set at 30% to 80% of official discount rates (rediscount rates), and b) since 1995, the lowest market interest rate has been as low as the official discount rate (Note)

(Note) As of March 1999, the interest rates were determined to be 50% to 95% of the rediscount rate. We, however, assumed 3% and 2%, which are 30% of the commercial rates in 2000 and 2003, respectively, considering that an economic incentive should be large enough to accelerate energy conservation.

Energy prices are the same as in the E. C. Scenario.

4.2 Economic Evaluation of Energy Conservation Measures at the Factory Level

4.2.1 Iron & steel

(1) Production process and energy consumption

Generally, iron and steel products are manufactured in three steps: iron-making process, steel-making process, and rolling process.

In the iron-making process, iron ore is transformed into iron through deoxidization by means of coal (coke), natural gas, and others including pulverized coal and fuel oil in a blast furnace. In the steel-making process, pig iron or iron scraps discharged from the blast furnace are turned into steel in a converter, electric furnace, or open-hearth furnace. In the rolling process, the steel is made into final products after undergoing a number of operations including hot rolling, cold rolling, and surface treatment.

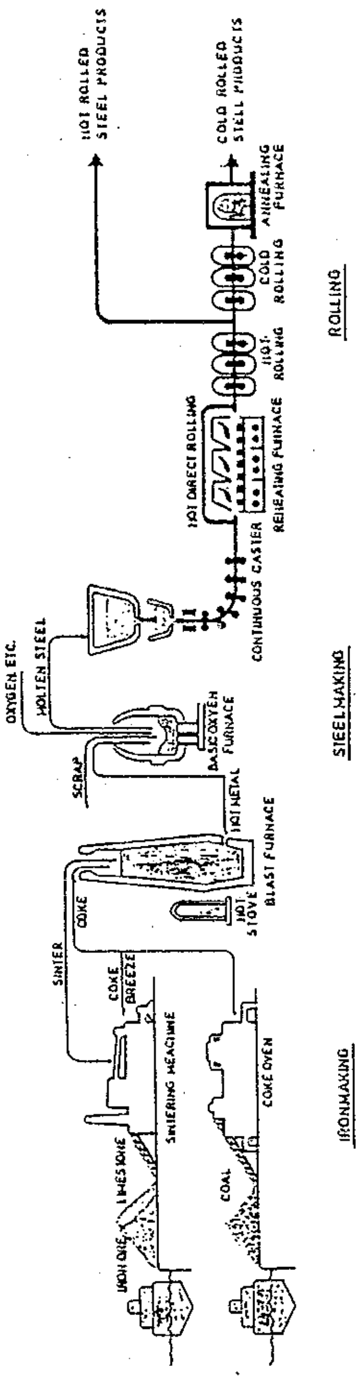
In integrated steelworks in Japan, based on the blast furnace-converter system, the iron-making process is reported to account for two-thirds to three-quarters of the total energy consumed by plants as a whole (Figure 4.1). In particular, blast furnaces are estimated to represent as much as 60% of the total energy use in a plant.

In the steel-making process, fuel accounts for only a minor portion of the total amount of heat used in plants, although carbon-rich fuels are sometimes used as a heat source for converter (In a typical process in Japan, it is estimated to be about 2%).

Electric furnaces use electricity as a heat source. When scraps and other materials are provided externally for steel material, electricity comprises a substantially larger portion of the steel mill's total energy consumption.

It is worth noting that when converting coal into coke in a coke oven, when burning coke in a blast furnace, and when making steel in a converter, coke oven gas, blast furnace gas, and converter gas are produced respectively, which are then used as fuel for the steel mill. In Poland, however, these gases are not used effectively in steel mills based on the blast furnace-converter system. Instead, they purchase natural gas for fuel.

Figure 4.1 Typical "Blast Furnace Process" in Japan



(Source) Japan Iron and Steel Federation

Lastly, in the rolling process, fuel is used for heating the heating furnace, and electricity is used for supplying power.

In addition, electricity is used as a power source in blowers, fans, and compressors. As with other industries, it is also used for lighting.

When examining energy conservation measures at the factory level, it is essential to pay attention to technical measures by process and their effect for energy conservation mentioned above.

For details of production processes and energy consumption for each process, refer to "The Guidelines," the fourth volume of the Study Reports.

(2) Economic evaluation

Table 4.1 provides the results of the economic evaluation. The energy conservation measures are arranged in line with the steps from 1 through 3 described in Chapter 3. Selected on the basis of the factory energy audit, statistics available in Poland, and experiences in Japan, these measures are considered feasible.

The effects of such measures are provided in terms of fuel (coke and gas) and electricity, and represented as MJ and kWh per ton of crude steel. The costs of investment are expressed in PLN per ton of crude steel. The ratio of effects to costs is provided in the rightmost column. As is widely the practice, if the ratio exceeds one (that is, if the effects accumulated for five years exceed the initial amount of investment), the energy conservation measure is judged to be economically feasible.

The following list technical measures judged to be economically feasible in 2000.

a. Coke oven:
   ---- Revision of the steam utilization method.
   ---- Reinforcement of the control of heat reduction time.
   ---- Optimization of the air/fuel ratio
   ---- Improving pumps and blowers

b. Sintering plant:
   ---- Prevention of air leakage and improvement of ventilation.
   ---- Enhancing the efficiency of operation by such an improvement as replacement of fan impellers.

c. Blast furnace:
   ---- Stabilizing operations.
   ---- Improvement of the air/fuel ratio of the hot blast stove.
   ---- Reduction of the coke ratio by improving the performance of pumps and blowers.
   ---- Reinforced control of air volume of dust collectors.
   ---- Installation of top pressure turbines.
   ---- Injection of pulverized coal.

d. Converter:
---- Performance improvement of pumps and blowers.
---- Reinforced control of air volume of dust collectors.

e. Electric furnace:
---- Reduction of the tap-to-tap interval.
---- Preheating of scraps.
---- Improvement of dust collection blowers.

f. Hot rolling:
---- Improvement of the air/fuel ratio of heating furnaces.
---- Reinforcement of heating furnace seals.
---- Enhancement of rolling efficiency.
---- Performance improvement of pumps and blowers.

g. Cold rolling:
---- Performance improvement of pumps and blowers.

Table 4.1 Economic Evaluation of Technical Measures for Energy Conservation in the Iron & Steel Industry

Technical Measures	Production	Investment cost*			Saved Energy and Benefit* Coke			2000	2003	Natural gas			2000	2003	Electricity			2000	2003	Total *	2000	2003	Evaluation (Benefit / cost)	
	(Th. t/y)	1998 (MillYen)	2000 (PLN/t)	2003 (PLN/t)	(TJ/y)	(MJ/t)	(t/t)	(PLN/t)	(PLN/t)	(TJ/y)	(MJ/t)	(Thm3/t)	(PLN/t)	(PLN/t)	(GWh/y)	(MWh/t)	(MJ/t)	(PLN/t)	(PLN/t)	(MJ/t)	(PLN/t)	(PLN/t)	2000	2003
< STEP 1 >																								
(IS-1)Coke plant(General improvement)	2,400	96	0.2	0.2	0	0	0	0	0	1,293.6	123	0.004	0.9	1.0	0.0	0.0000	0.0	0.0	0.0	123.1	0.9	1.0	4.2	4.1
(IS-2)Sintering plant(Same as above)	8,016	120	0.3	0.3	0	0	0	0	0.0	0.0	0	0.000	0.0	0.0	96.2	0.0092	33.0	6.3	7.1	33.0	6.3	7.1	24.4	24.7
(IS-3)Blast furnace(Same as above)	6,534	18	0.0	0.0	2,041	194	6.9E-03	11.6	12.2	548.9	52	0.001	0.4	0.4	9.3	0.0009	3.2	0.6	0.7	249.6	12.5	13.3	322.8	306.0
(IS-4)Converter (Yield iprovement)	6,750	0	0.0	0.0	0	0	0	0	0	100.0	10	0.000	0.1	0.1	9.6	0.0009	3.3	0.6	0.7	12.8	0.7	0.8	-	-
(IS-5)Converter (Other iprovement)	6,750	0	0.0	0.0	0	0	0	0	0	1,329.8	127	0.004	0.9	1.0	33.8	0.0032	11.6	2.2	2.5	138.1	3.1	3.5	-	-
(IS-6)EAF(Reduction of "tap to tap" time)	2,700	2,160	4.7	5.2	0	0	0	0	0	-961.0	-91	-0.003	-0.6	-0.7	313.2	0.0298	107.3	20.6	23.3	15.8	20.0	22.6	4.3	4.3
(IS-7)Hot rolling (Hot charge rolling)	8,526	2,984	6.4	7.2	0	0	0	0	0	2,856.2	272	0.008	1.9	2.1	0.0	0.0000	0.0	0.0	0.0	271.8	1.9	2.1	0.3	0.3
(IS-8)Hot rolling (Yield impronvement)	8,526	0	0.0	0.0	0	0	0	0	0	1,202.2	114	0.003	0.8	0.9	50.3	0.0048	17.2	3.3	3.7	131.6	4.1	4.6	-	-
(IS-9)Hot rolling (Other improvement)	8,526	307	0.7	0.7	0	0	0	0	0	4,384.2	417	0.012	2.9	3.2	42.6	0.0041	14.6	2.8	3.2	431.7	5.7	6.4	8.7	8.6
(IS-10)Cold rolling(General improve.)	1,103	0	0.0	0.0	0	0	0	0	0	0.0	0	0.000	0.0	0.0	28.7	0.0027	9.8	1.9	2.1	9.8	1.9	2.1	-	-
(IS-11)Piping mill(General improve.)	511	0	0.0	0.0	0	0	0	0	0	681.0	65	0.002	0.5	0.5	34.6	0.0033	11.9	2.3	2.6	76.6	2.7	3.1	-	-
(IS-12)Effects of yield improve.																								
Steel making by rolling	10,510	0	0.0	0.0	0	0	0	0	0	602.7	57	0.002	0.4	0.4	0.0	0.0000	0.0	0.0	0.0	57.3	0.4	0.4	-	-
Blast furnace by rolling	6,534	0	0.0	0.0	4,938	470	0.017	28.0	29.4	0.0	0	0.000	0.0	0.0	0.0	0.0000	0.0	0.0	0.0	469.8	28.0	29.4	-	-
Sinter plant by rolling	8,016	0	0.0	0.0	591	56	0.002	3.3	3.5	0.0	0	0.000	0.0	0.0	0.0	0.0000	0.0	0.0	0.0	56.2	3.3	3.5	-	-
Blast furnace by converter	6,534	0	0.0	0.0	1,800	171	0.006	10.2	10.7	0.0	0	0.000	0.0	0.0	0.0	0.0000	0.0	0.0	0.0	171.3	10.2	10.7	-	-
Sinter plant by converter	8,016	0	0.0	0.0	216	21	0.001	1.2	1.3	0.0	0	0.000	0.0	0.0	0.0	0.0000	0.0	0.0	0.0	20.5	1.2	1.3	-	-
< STEP 2 >																								
(IS-13)Coke plant (pump, blower)	2,400	120	0.3	0.3	0	0	0	0.0	0.0	0.0	0	0.000	0.0	0.0	12.0	0.0011	4.1	0.8	0.9	4.1	0.8	0.9	3.0	3.1
(IS-14)Sinter plant (exhaust blower)	8,016	180	0.4	0.4	0	0	0	0.0	0.0	0.0	0	0.000	0.0	0.0	80.0	0.0076	27.4	5.3	5.9	27.4	5.3	5.9	13.6	13.7
(IS-15)Blast furnace (coke rate)	6,534	1,000	2.2	2.4	4,674	445	0.016	26.5	27.9	0.0	0	0.000	0.0	0.0	0.0	0.0000	0.0	0.0	0.0	444.7	26.5	27.9	12.3	11.6
(IS-16)Blast furnace (blast blower)	6,534	400	0.9	1.0	0	0	0	0	0	548.9	52	0.001	0.4	0.4	0.0	0.0000	0.0	0.0	0.0	52.2	0.4	0.4	0.4	0.4
(IS-17)Blast furnace (pump,blower)	6,534	773	1.7	1.9	0	0	0	0	0	0.0	0	0.000	0.0	0.0	104.6	0.0100	35.8	6.9	7.8	35.8	6.9	7.8	4.1	4.2
(IS-18)Blast furnace (hot stove)	6,534	1,000	2.2	2.4	0	0	0	0	0	548.9	52	0.001	0.4	0.4	0.0	0.0000	0.0	0.0	0.0	52.2	0.4	0.4	0.2	0.2
(IS-19)Converter(pump, blower)	6,750	675	1.5	1.6	0	0	0	0	0	0.0	0	0.000	0.0	0.0	67.5	0.0064	23.1	4.4	5.0	23.1	4.4	5.0	3.0	3.1
(IS-20)Converter(dust collecting system)	6,750	250	0.5	0.6	0	0	0	0	0	0.0	0	0.000	0.0	0.0	33.7	0.0032	11.5	2.2	2.5	11.5	2.2	2.5	4.1	4.2
(IS-21)EAF (scrap heating)	2,700	378	0.8	0.9	0	0	0	0	0	0.0	0	0.000	0.0	0.0	67.5	0.0064	23.1	4.4	5.0	23.1	4.4	5.0	5.4	5.5
(IS-22)EAF (dust collecting system)	2,700	55	0.1	0.1	0	0	0	0	0	0.0	0	0.000	0.0	0.0	10.8	0.0010	3.7	0.7	0.8	3.7	0.7	0.8	6.0	6.1
(IS-23)Hot rolling(dust collecting system)	8,526	5,798	12.5	14.0	0	0	0	0	0	3,563.9	339	0.010	2.4	2.6	0.0	0.0000	0.0	0.0	0.0	339.1	2.4	2.6	0.2	0.2
(IS-24)Hot rolling (refractory)	8,526	767	1.7	1.8	0	0	0	0	0	1,023.1	97	0.003	0.7	0.8	0.0	0.0000	0.0	0.0	0.0	97.3	0.7	0.8	0.4	0.4
(IS-25)Hot rolling (pump, blower)	8,526	426	0.9	1.0	0	0	0	0	0	0.0	0	0.000	0.0	0.0	42.6	0.0041	14.6	2.8	3.2	14.6	2.8	3.2	3.0	3.1
(IS-26)Cold rolling (heat recovery)	1,103	200	0.4	0.5	0	0	0	0	0	621.0	59	0.002	0.4	0.5	0.0	0.0000	0.0	0.0	0.0	59.1	0.4	0.5	0.96	0.95
(IS-27)Cold rolling (pump, blower)	1,103	287	0.6	0.7	0	0	0	0	0	0.0	0	0.000	0.0	0.0	28.7	0.0027	9.8	1.9	2.1	9.8	1.9	2.1	3.0	3.1
< STEP 3 >																								
(IS-28)OHF (replacement to EAF)**	1,060	N.E.	N.E.	N.E.	0	0	0	0	0	4,770.0	454	0.013	3.2	3.5	-412.3	-0.0392	-141.2	-27	-31	313	-24.0	-27.1	N.E.	N.E.
(IS-29)CC rate up (37.3% to 95%)**	8,526	N.E.	N.E.	N.E.	3,527	336	0.0120	20.0	21.0	7,091.9	675	0.019	4.7	5.2	340.1	0.0324	116.5	22.4	25.3	1,126.9	47.1	51.5	N.E.	N.E.
(IS-30)Hot rolling (plate mill)**	1,200	N.E.	N.E.	N.E.	0	0	0	0	0	753.6	72	0.002	0.5	0.6	12.0	0.0011	4.1	0.8	0.9	75.8	1.3	1.4	N.E.	N.E.
(IS-31)Cold rolling (cold mill)**	550	N.E.	N.E.	N.E.	0	0	0	0	0	229.9	22	0.001	0.2	0.2	11.0	0.0010	3.8	0.7	0.8	25.6	0.9	1.0	N.E.	N.E.
(IS-32)Piping mill(pipe mill)**	250	N.E.	N.E.	N.E.	0	0	0	0	0	209.0	20	0.001	0.1	0.2	2.5	0.0002	0.9	0.2	0.2	20.7	0.3	0.3	N.E.	N.E.
(IS-33)Coke plant (CDQ)	800	4,000	8.6	9.6	0	0	0	0	0	920.8	88	0.003	0.6	0.7	0.0	0.0000	0.0	0.0	0.0	87.6	0.6	0.7	0.1	0.1
(IS-34)Coke plant (coal moisture control)	2,400	2,000	4.3	4.8	0	0	0	0	0	328.8	31	0.001	0.2	0.2	-6.0	-0.0006	-2.1	-0.4	-0.4	29.2	-0.2	-0.2	0.0	0.0
(IS-35)Sinter plant (heat recovery boiler)	4,008	3,500	7.6	8.4	0	0	0	0	0	3,476.3	331	0.009	2.3	2.6	0.0	0.0000	0.0	0.0	0.0	330.8	2.3	2.6	0.3	0.3
(IS-36)Blast furnace (PCI)	5,820	7,000	15.1	16.9	***	215	N.A.	92.5	97.2	0.0	0	0.000	0.0	0.0	0.0	0.0000	0.0	0.0	0.0	215.0	92.5	97.2	6.1	5.8
(IS-37)Blast furnace (top pressure turbine)	5,820	3,000	6.5	7.2	0	0	0	0	0	0.0	0	0.000	0.0	0.0	174.6	0.0166	59.8	11.5	13.0	59.8	11.5	13.0	1.8	1.8
(IS-38)Converter (gas recovery system)	6,750	14,000	30.2	33.7	0	0	0	0	0	561.1	53	0.002	0.4	0.4	67.5	0.0064	23.1	4.4	5.0	76.5	4.8	5.4	0.2	0.2

(Note) * PLN/t, MJ/t, GWh/t, and MWh/t are those devided by crude steel production (10,510,000 ton) per year, not by production shown in the column of each technical measure.

** According to the restructuring plan titled "The study of the restructuring of the Polish iron and steel industry by the year 2002."

*** Benefit from the conversion of coke (611,100t/y) to pulverized steaming coal (675,100t/y).

N.E. ---- Not estimated. N.A. ---- Not applied.

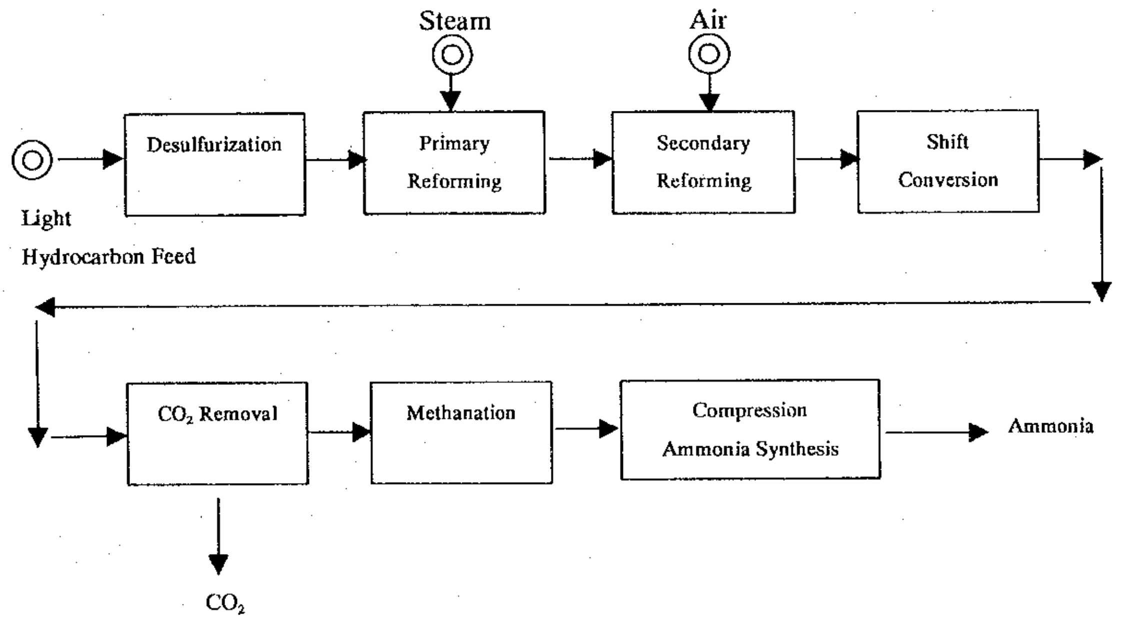
4. Ammonia

(1) Production process and energy consumption

In principle, ammonia is produced by synthesizing hydrogen and nitrogen under high pressure. Nitrogen is available from the air. Hydrogen is obtained by reforming natural gas or light hydrocarbon (such as naphtha) with hydrogen at a high temperature.

Figure 4.2 presents a process for producing ammonia from natural gas or light hydrocarbon (Reference 2). A large amount of energy is consumed in the reforming and synthesis processes. Thus, energy conservation measures center on the two processes.

Figure 4.2 Typical Ammonia Process via Steam Reforming



(Source) Oak Ridge Associated Universities (1985), "Industrial Energy Use Data Book"

(2) Economic evaluation

The following are among the energy conservation measures generally considered essential:

a. Reforming process:

---- Providing an efficient mechanism for heat exchanges between air and gas during combustion to reduce heat loss during the discharge of gas used for combustion.

b. Synthesis process:

---- Switching the basket in the reactor to a low differential pressure type to enhance efficiency of synthesis and installing a device to recover hydrogen in purge gas, thus reducing hydrogen losses.

Table 4.2 shows the results of the economic evaluation of these measures. It indicates that all measures except for the installation of a heat exchanger-type primary reformer are economically feasible.

In addition to these measures, this Table also indicates that it is feasible to control motor rotation and improve lighting (replacement of electric lumps) based on the results of the questionnaire survey on equipment (further details will be provided in 4.3 below).

4.2.2 Trucks

(1) Production process and energy consumption

The truck production process is composed of the manufacturing process for engines, chassis, and other components and the assembly process for them. If these two processes are to be incorporated into a single plant, the molding and forging processes must be added. The latter processes require large amounts of energy.

STAR's plant, where a factory energy audit was conducted, is run without the molding and forging processes. Instead, it purchases all necessary components. Thus, its main energy consumers are engine assembly (manufacturing), chassis assembly process, and coating process.

As described in Chapter 2, no official statistics are available regarding the truck sector to help in the E.I analysis. Therefore, we estimated E.I. for this sector mainly on the basis of the results of the factory energy audit. For the reason just stated, our estimate does not include data on the molding and forging processes. Accordingly, these processes are not addressed in our discussion of energy conservation measures.

(2) Economic evaluation

Table 4.3 presents the results of our economic evaluation of the energy conservation measures for truck assembly plants, mainly based on the results of a factory energy audit at STAR's plant.

According to the results, all measures studied are evaluated as economically feasible with the exception of the modernization of manufacturing lines.

Assuming all these measures are implemented, it is estimated that energy conservation potential will be 28.5 GJ/pcs for fuel and 600 kWh/pcs (2.159 GJ/pcs) for electricity.

As explained in Chapter 2, STAR's plant is six to seven times higher in the E.I. than plants rated as "excellent," demonstrating outstandingly large possibilities for energy conservation.

Table 4.2 Economic Evaluation of Technical Measures for Energy Conservation in the Ammonia Industry

Technical Measures for Energy Conservation	Production	Investment costs				Saved Energy and Benefit (Gas)					Saved Energy and Benefit (Electricity)					Total			Evaluation (Benefit / costs)	
		Total costs		Unit cost		Saved Energy			Benefit		Saved energy			Benefit		Saved Energy	Benefit			
	(t/y)	1998 (Mill. PLN)	1998 (Mill. yen)	2000 (PLN/t)	2003 (PLN/t)	(10^6kcal/t)	(MJ/t)	(t/t)	2000 (PLN/t)	2003 (PLN/t)	(MWh/y)	(MWh/t)	(MJ/t)	2000 (PLN/t)	2003 (PLN/t)	(MJ/t)	2000 (PLN/t)	2003 (PLN/t)	2000	2003
Improving lighting*	-	-	-	0.06	0.06	0	0.0	-	0.0	0.0	-	0.1	0.2	0.08	0.07	0.1	0.2	0.1	1.43	1.14
Controlling motor by inverter*	-	-	-	21	23	0	0.0	-	0.0	0.0	-	20	72	14	15	20.0	72	14	0.66	0.66
Heat exchanger type primary reformer	135,000	17.1	600.0	144	161	0.15	628.5	-	35	38	0.0	0.0	0.0	0	0	628.5	35	38	0.24	0.24
Combustion air preheater	300,000	5.1	180.0	19	22	0.19	796.1	-	44	49	0.0	0.0	0.0	0	0	796.1	44	49	2.27	2.24
High conversion rate synthetic reactor	300,000	4.3	150.0	16	18	0.14	586.6	-	33	36	0.0	0.0	0.0	0	0	586.6	33	36	2.01	1.98
Low pressure different synthetic reactor	300,000	2.6	90.0	10	11	0.17	712.3	-	39	44	0.0	0.0	0.0	0	0	712.3	39	44	4.06	4.01
Hydrogen recovery unit (Cryogenic process)	300,000	7.3	255.0	28	31	0.14	586.6	-	33	36	0.0	0.0	0.0	0	0	586.6	33	36	1.18	1.17
Hydrogen recovery unit (Membrane process)	300,000	6.6	230.0	25	28	0.14	586.6	-	33	36	0.0	0.0	0.0	0	0	586.6	33	36	1.31	1.29

(Source) New Energy and Industrial Technology Development Organization (NEDO), "Energy Saving Technology in Japan," December 25, 1995.
(*) From the Questionnaire Survey.

Table 4.3 Economic Evaluation of Technical Measures for Energy Conservation in the Truck Industry

	Production	Investment costs				Saved Energy and Benefit (Steam coal)					Saved Energy and Benefit (Electricity)					Total			Evaluation (Benefit / costs)	
		Total costs		Unit cost		Saved Energy			Benefit		Saved energy			Benefit		Saved Energy	Benefit			
	(pcs/y)	1998 (1000 PLN)	1998 (1000 yen)	2000 (PLN/pcs)	2003 (PLN/pcs)	(GJ/y)	(MJ/pcs)	(t/pcs)	2000 (PLN/pcs)	2003 (PLN/pcs)	(MWh/y)	(MWh/pcs)	(MJ/pcs)	2000 (PLN/pcs)	2003 (PLN/pcs)	(MJ/pcs)	2000 (PLN/pcs)	2003 (PLN/pcs)	2000	2003
<Step 1>																				
Enhancing management	3,200	486.0	17,010	121	135	24,000	7,500	0.341	227	239	1,180	0.369	1,328	295	333	8,828	522	573	4.3	4.3
Steamlining transformer	3,200	0	0	0	0	0	0	0	0	0	46	0.014	52	12	13	52	12	13	-	-
<Step 2>																				
Reducing heating energy	3,200	371.0	12,985	92	103	15,400	4,813	0.219	146	154	0	0	0	0	0	4,813	146	154	1.6	1.5
Controlling drying furnaces	3,200	186.0	6,510	46	52	52,000	16,250	0.739	493	519	0	0	0	0	0	16,250	493	519	10.7	10.1
Improving compressors	3,200	143.0	5,005	36	40	0	0	0	0	0	600	0.188	675	150	170	675	150	170	4.2	4.3
Changing air pressure	3,200	20.0	700	5	6	0	0	0	0	0	140	0.044	158	35	40	158	35	40	7.0	7.1
<Step 3>																				
Improving the yield	3,200	0	0	0	0	0	0	0	0	0	66	0.021	74	17	19	74	17	19	-	-
Modernizing machine lines	3,200	100,000.0	3,500,000	24,826	27,690	33,000	10,313	0.469	313	329	10,400	3.250	11,700	2,600	2,938	22,013	2,913	3,267	0.1	0.1

4.2.4 Tractors

(1) Production process and energy consumption

As with trucks, the tractor production process consists of manufacturing and assembly of a variety of components. URSUS's plant, audited for this study, employs both the molding and forging processes. Therefore, the entire production system for tractors, including these two processes, is applicable in our analysis of energy conservation measures.

The results of the factory energy audit at URSUS indicate that about 40% of energy used per tractor produced is consumed during the molding and forging processes. For factories rated as "excellent," on the other hand, the figure is estimated to be about 40%, assuming the higher level of energy consumption for heating, and nearly 50%, assuming its lower level. At any rate, it is clear that these two processes represent a sizable portion of E.I. in tractor production.

In conclusion, when reviewing energy conservation measures for tractor production plants operated as an integrated system, close attention must be paid to the molding and forging processes.

(2) Economic evaluation

Table 4.4 shows the results of our economic evaluation of the energy conservation measures for tractor plants on the basis of the results of the factory energy audits. From this, we can conclude that the majority of the measures are economically feasible.

There are not many applicable measures indicated for the molding and forging processes. We should note that the improvement to casting ladles is judged to be feasible, although its effects are not considered sufficient. As for other measures, halting the equipment at every cycle and streamlining the production process are among the feasible measures.

Further, regarding equipment, preventing air leakage from air compressors and adjusting their air pressure are also feasible. Details are provided in 4.3 below.

4.2.5 Glass

(1) Production process and energy consumption

As described in Chapter 2, the products manufactured at glass plants in Poland can be classified into sheet glass, bottle glass, and glass for tableware and lighting. Most of energy required in the glass production process is consumed by melting furnaces.

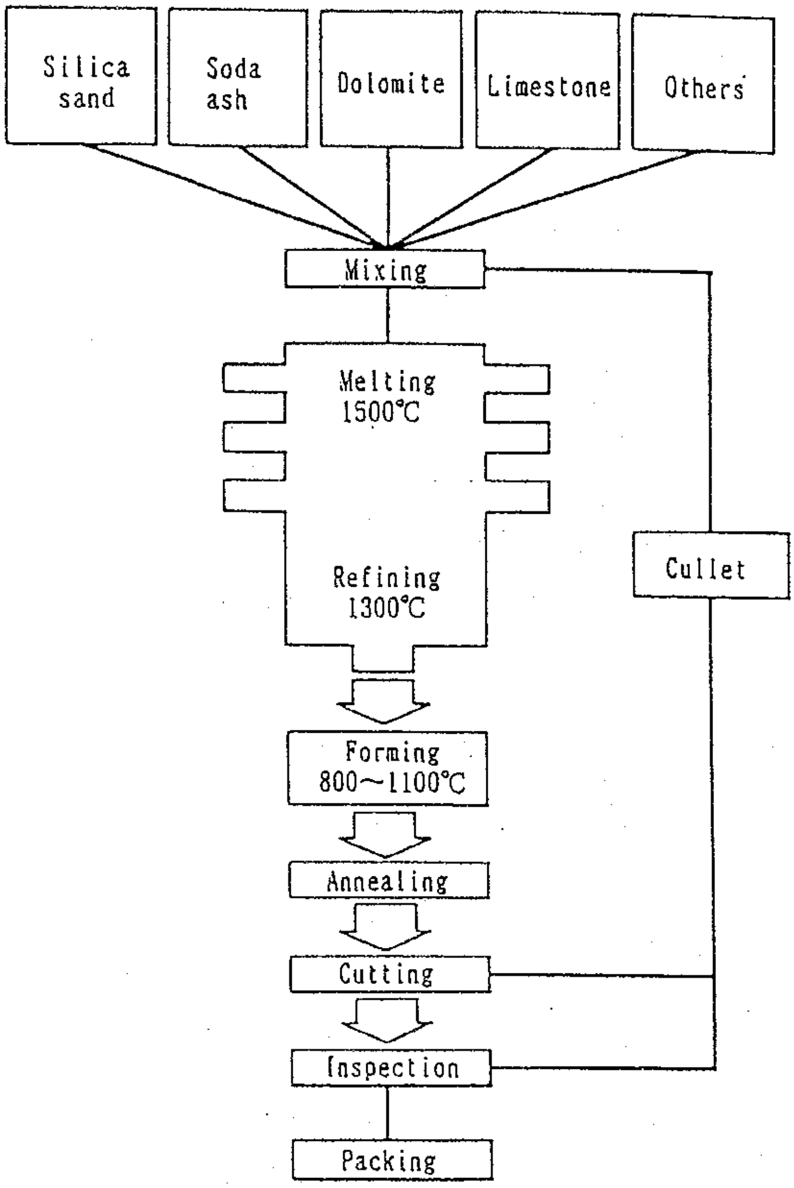
As illustrated in Figure 4.3, the production of sheet glass starts with material preparation and then proceeds through the melting-refining, forming, annealing, and cutting processes before producing the final product. Looking at energy consumption at sheet glass factories by process, about 90% of a factory's total heat energy is consumed in the melting process, where raw materials are melted at 1,500 to 1,600℃. On the whole, the ratio of electric energy to heat energy consumed at sheet glass factories is small, or 5% to 7%.

Table 4.4 Economic Evaluation of Technical Measures for Energy Conservation in the Tractor Industry

	Production	Investment costs				Saved Energy and Benefit (Steam coal)					Saved Energy and Benefit (Electricity)					Total			Evaluation (Benefit / costs)	
		Total costs		Unit cost		Saved Energy			Benefit		Saved energy			Benefit		Saved Energy	Benefit			
	(t/pcs)	1998	1998	2000	2003				2000	2003				2000	2003		2000	2003	2000	2003
		(1000 PLN)	(1000 yen)	(PLN/pcs)	(PLN/pcs)	(GJ/y)	(MJ/pcs)	(t/pcs)	(PLN/pcs)	(PLN/pcs)	(MWh/y)	(MWh/pcs)	(MJ/pcs)	(PLN/pcs)	(PLN/pcs)	(MJ/pcs)	(PLN/pcs)	(PLN/pcs)		
<STEP 1>																				
Casting:Improving cupora operation	16,716	0.0	0	0	0.0	3,000	179	0.008	6.1	6.4	0	0	0	0	0	179	6.1	6.4	-	-
Improving air ratio in boilers	16,716	0.0	0	0	0.0	55,739	3,334	0.152	113.7	119.7	0	0	0	0	0	3,334	113.7	119.7	-	-
Forging:Improving purchasing system	16,716	0.0	0	0	0.0	1,200	72	0.003	2.4	2.6	0	0	0	0	0	72	2.4	2.6	-	-
Machining and assemblying:Reducing air leakage	16,716	429.0	15,015	20.4	22.7	0	0	0.000	0.0	0.0	2,200	0.1316	473.8	114.4	129.4	474	114.4	129.4	5.6	5.7
Others:Reducing air leakage	16,716	0.0	0	0.0	0.0	0	0	0.000	0.0	0.0	3,830	0.2291	824.8	199.1	225.2	825	199.1	225.2	-	-
<STEP 2 >																				
Casting:Improving casting ladle	16,716	4.3	151	0.2	0.2	350	21	0.001	0.7	0.8	0	0.0000	0.0	0.0	0.0	21	0.7	0.8	3.5	3.3
Casting: Utilizing waste heat from cupora	16,716	571.0	19,985	27.1	30.3	5,800	347	0.016	11.8	12.5	0	0.0000	0.0	0.0	0.0	347	11.8	12.5	0.4	0.4
Ma. and ass.:Centralization of production process	16,716	2,857.0	99,995	135.8	151.4	105,000	6,281	0.286	214.1	225.6	4,200	0.2513	904.5	218.3	247.0	7,186	432.5	472.5	3.2	3.1
Ma. and ass.:Changing compressed air prssure	16,716	43.0	1,505	2.0	2.3	0	0	0.000	0.0	0.0	1,170	0.0700	252.0	60.8	68.8	252	60.8	68.8	29.8	30.2
Forging:Changing lighting to sodium lamps	16,716	140.0	4,900	6.7	7.4	0	0	0.000	0.0	0.0	108	0.0065	23.3	5.6	6.4	23	5.6	6.4	0.8	0.9
Assembly:Changing lighting to Hf fluorscent la.	16,716	252.0	8,820	12.0	13.4	0	0	0.000	0.0	0.0	76	0.0045	16.4	4.0	4.5	16	4.0	4.5	0.3	0.3
One cycle stopping of equipment	16,716	109.0	3,815	5.2	5.8	0	0	0.000	0.0	0.0	300	0.0179	64.6	15.6	17.6	65	15.6	17.6	3.0	3.1
Controlling motor revolution	16,716	4,286.0	150,010	203.7	227.2	0	0	0.000	0.0	0.0	3,300	0.1974	710.7	171.6	194.1	711	171.6	194.1	0.8	0.9
<STEP 3>																				
Forging:Introducing hot blast cupora	16,716	0.0	0	0.0	0.0	23,200	1,388	0.063	47.3	49.8	0	0.0000	0.0	0.0	0.0	1,388	47.3	49.8	-	-
Ma. and ass.:Improving machine lines	16,716	71,429.0	2,500,015	3,394.6	3,786.3	0	0	0.000	0.0	0.0	8,200	0.4905	1766.0	426.3	482.2	1,766	426.3	482.2	0.1	0.1
Improving the yield	16,716	0.0	0	0.0	0.0	5,600	335	0.015	11.4	12.0	1,170	0.0700	252.0	60.8	68.8	587	72.2	80.8	-	-

(Source) Factory Energy Audit report made by the JICA Team

Figure 4.3 Production Process of Sheet Glass



Bottle glass and glass for tableware/lighting undergo almost the same melting-refining process as sheet glass. In the succeeding processes, such as forming, annealing, and finishing, the ratio of electricity is relatively high, compared to sheet glass, although different products are manufactured in the processes. The melting furnace, however, consumes the majority of energy required for manufacturing such products, as in the case of sheet glass.

(2) Economic evaluation.

We reviewed the energy conservation measures for producing bottle glass and glass for tableware/lighting, using the results of factory energy audits. The measures for producing sheet glass were examined on the basis of general data and information. The results of the evaluation are as follows:

Table 4.5 evaluates the energy conservation measures for producing bottle glass and glass for tableware/lighting in terms of economic feasibility that may be applicable to glass factories in Poland. From this we can conclude that "reinforcing insulation for melting furnaces" (with an energy conservation potential of 1,178 MJ/t) and "reducing excess air for melting furnaces" (similarly, 969 MJ/t) will be economically feasible in 2000 for bottle glass.

As for glass for tableware/lighting, these same two measures are evaluated to be similarly feasible in economic terms (with an energy conservation potential of 16,258 MJ/t and 12,640 MJ/t for "reinforcing insulation and reducing excess air"). Concerning converting melting furnaces to "the oxygen combustion method" or "the electric melting method," these measures are also judged to be feasible. Nevertheless, their energy conservation potentials of 59,459 MJ/t and 115,472 MJ/t, respectively, are so large that there will not be many factories that apply these measures across Poland. Therefore, these two measures will not be discussed in E.I. estimation in Chapter 5.

Sheet glass is not listed on Table 4.5. "Improving burners in the melting furnace" is considered to be an economically feasible measure for sheet glass (energy conservation potential of 4.32 GJ/t and the effect to cost ratio of 1.28), the effect of which is used in estimating E.I..

4.2.6 Silica lime block (S.L.B.)

(1) Production process and energy conservation

The production of S.L.B. is composed of the following processes:

a. Preparation of raw materials
b. Molding of prepared raw materials
c. Primary processing and cutting of molded materials
d. Autoclaving (hardening materials under high pressure and temperature)
e. Final processing of products

Among the above processes, the autoclave is the greatest consumer of heat energy, normally utilizing 90% of it. Electric energy, on the other hand, is used to mill, mix, and mold raw materials.

Table 4.5 Economic Evaluation of Technical Measures for Energy Conservation in the Glass Industry

(1) Glass--A (Bottle)

	Production	Investment costs				Saved Energy and Benefit (Steam coal)					Saved Energy and Benefit (Electricity)					Total			Evaluation (Benefit / costs)	
		Total costs		Unit cost		Saved Energy			Benefit		Saved energy			Benefit		Saved Energy	Benefit			
	(Th.t/y)	1998 (1000 PLN)	1998 (1000 yen)	2000 (PLN/t)	2003 (PLN/t)	(GJ/y)	(MJ/t)	(t/t)	2000 (PLN/t)	2003 (PLN/t)	(MWh/y)	(MWh/t)	(MJ/t)	2000 (PLN/t)	2003 (PLN/t)	(MJ/t)	2000 (PLN/t)	2003 (PLN/t)	2000	2003
<STEP 1>																				
Reducing excess air	20,320	250	8,750	9.8	10.9	19,693	969	0.0277	63.4	70.0	0	0	0	0	0	969	63.4	70.0	6.49	6.42
Blocking openings	20,320	0	0	0.0	0.0	2,382	117	0.0033	7.7	8.5	0	0	0	0	0	117	7.7	8.5	-	-
Controlling air compresor pressure	20,320	0	0	0.0	0.0	0	0	0.0000	0.0	0.0	236	0.0116	41.8	8.4	9.4	42	8.4	9.4	-	-
<STEP 2>																				
Reinforcing insulation	20,320	1,070	37,450	41.8	46.7	23,932	1,178	0.0337	77.1	85.0	0	0.0000	0.0	0.0	0.0	1,178	77.1	85.0	1.84	1.82
Increasing recoveered heat	20,320	1,746	61,110	68.3	76.1	12,172	599	0.0171	39.2	43.2	0	0.0000	0.0	0.0	0.0	599	39.2	43.2	0.57	0.57
Controlling motor revolution by inverter	20,320	377	13,195	14.7	16.4	0	0	0.0000	0.0	0.0	289	0.0142	51.2	10.3	11.5	51	10.3	11.5	0.70	0.70
Lighting:changing to sodium lamps	20,320	47	1,645	1.8	2.0	0	0	0.0000	0.0	0.0	18	0.0009	3.2	0.6	0.7	3	0.6	0.7	0.35	0.35
<STEP 3>																				
Improving operation rate	20,320	2,286	80,010	89.4	99.7	13,646	672	0.0192	44.0	48.5		0.0000	0.0	0.0	0.0	672	44.0	48.5	0.49	0.49

(2)--Glass B (Table ware and lighting)

	Production	Investment costs				Saved Energy and Benefit (Steam coal)					Saved Energy and Benefit (Electricity)					Total			Evaluation (Benefit / costs)	
		Total costs		Unit cost		Saved Energy			Benefit		Saved energy			Benefit		Saved Energy	Benefit			
	(t/y)	1998 (1000 PLN)	1998 (1000 yen)	2000 (PLN/t)	2003 (PLN/t)	(GJ/y)	(MJ/t)	(t/t)	2000 (PLN/t)	2003 (PLN/t)	(MWh/y)	(MWh/t)	(MJ/t)	2000 (PLN/t)	2003 (PLN/t)	(MJ/t)	2000 (PLN/t)	2003 (PLN/t)	2000	2003
<STEP 1>																				
Reducing excess air	2,689	250	8,750	73.9	82.4	33,989	12,640	0.3611	827.4	912.6	0	0.0000	0.0	0.0	0.0	12,640	827	913	11.20	11.08
Blocking openings	2,689	0	0	0.0	0.0	3,847	1,431	0.0409	93.6	103.3	0	0.0000	0.0	0.0	0.0	1,431	94	103	-	-
Controlling compessor pressure	2,689	0	0	0.0	0.0	0	0	0.0000	0.0	0.0	11	0.0041	14.7	3.0	3.3	15	3	3	-	-
<STEP 2>																				
Reinforcing heat insulation	2,689	1,750	61,250	517.0	576.7	43,718	16,258	0.4645	1064.2	1173.8	0	0.0000	0.0	0.0	0.0	16,258	1,064	1,174	2.06	2.04
Increasing recovered heat	2,689	1,784	62,440	527.1	587.9	6,657	2,476	0.0707	162.0	178.7	0	0.0000	0.0	0.0	0.0	2,476	162	179	0.31	0.30
Replacing motor	2,689	2	70	0.6	0.7	0	0	0.0000	0.0	0.0	2	0.0007	2.7	0.5	0.6	3	1	1	0.91	0.91
<STEP 3>																				
Conversion to oxygen	2,689	5,650	197,750	1,669.2	1,861.8	159,884	59,459	1.6988	3892.0	4292.9	-685	-0.2547	-917.1	-184.2	-206.3	58,541	3,708	4,087	2.22	2.19
Conversion to electric melting	2,689	2,310	80,850	682.5	761.2	310,503	115,472	3.2992	7558.4	8337.0	-1596	-0.5935	-2136.7	-429.1	-480.8	113,335	7,129	7,856	10.45	10.32
Improving yield	2,689	2,286	80,010	675.4	753.3	7,504	2,791	0.0797	182.7	201.5		0.0000	0.0	0.0	0.0	2,791	183	201	0.27	0.27

(Source) The Factory Energy Audit report made by the JICA Team

Table 4.6 Economic Evaluation of Technical Measures for Energy Conservation in the Silica Lime Block Industry

	Production	Investment costs				Saved Energy and Benefit (Steam coal)					Saved Energy and Benefit (Electricity)					Total			Evaluation (Benefit / costs)	
		Total costs		Unit cost		Saved Energy			Benefit		Saved energy			Benefit		Saved Energy	Benefit			
	(Th.t/y)	1998 (1000 PLN)	1998 (1000 yen)	2000 (PLN/t)	2003 (PLN/t)	(GJ/t)	(MJ/t)	(t/t)	2000 (PLN/t)	2003 (PLN/t)	(MWh/y)	(MWh/t)	(MJ/t)	2000 (PLN/t)	2003 (PLN/t)	(MJ/t)	2000 (PLN/t)	2003 (PLN/t)	2000	2003
Modifying measuring and mixing machines	49,306	150.0	5,250	2.4	2.7	8,332	169	0.008	5.4	5.7	0	0	0	0	0	169	5.4	5.7	2.3	2.1
Improving operation pattern	49,306	43.0	1,500	0.7	0.8	6,854	139	0.006	4.5	4.7	0	0	0	0	0	139	4.5	4.7	6.5	6.1
Implementing heat recovery	49,306	64.0	2,240	1.0	1.2	7,840	159	0.007	5.1	5.4	0	0	0	0	0	159	5.1	5.4	5.0	4.7
Improving lighting	49,306	9.0	315	0.1	0.2	0	0	0.000	0.0	0.0	4	8.11E-05	0.3	0.1	0.1	0	0.1	0.1	0.4	0.4

(Source) The Factory Energy Audit report made by the JICA Team

(2) Economic evaluation

Energy conservation measures for S.L.B. factories should center on the autoclave, as follows:

a. Utilizing steam (for heat energy):
---- Improving operation pattern for autoclaves.
---- Automation of autoclave operation.

b. Recovering steam:
---- Installation of a steam accumulator to recover heat from raw materials.

c. Preventing heat loss:.
---- Reinforcement of insulation (which is proposed in the factory energy audit).

Furthermore, if steam is generated within the factory concerned, some measures will have to be taken, including "a reduction of excess air in boilers," "recovery of heat," and "improvement of burners" (the former two measures are proposed in the factory energy audit).

Measures for electricity include "reduction of peak load through adjustments during operation," "optimization of motor voltage," and "improvements to lighting."

Table 4.6 presents the results of our evaluation of the measures among those described above that allow quantitative assessment. They indicate that "modifying measuring and mixing machines for raw materials," as well as "improving the operation pattern of autoclaves" and "heat recovery," are regarded as economically feasible. The energy conservation potential of these measures is about 0.47 GJ/t.

4.2.7 Vegetable oil

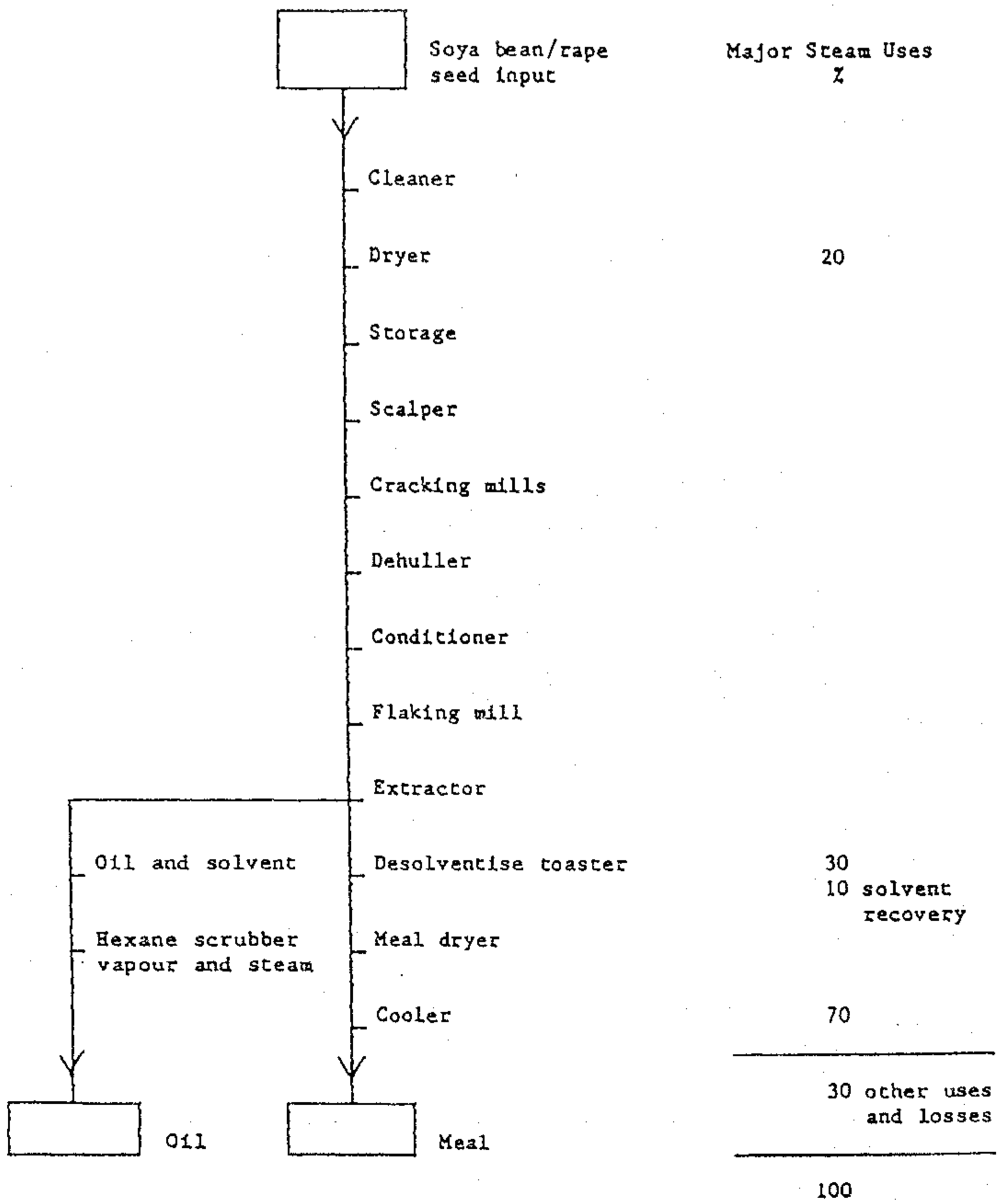
(1) Production process and energy consumption

Vegetable oils are produced by the following processes (For details, refer to "The Guidelines." Figure 4.4 illustrates the oil extraction process for soybeans and the ratio by process of steam consumption. Figure 4.5 presents an example of the oil refining and margarine production processes) (Reference 3)

a. Exploitation of raw oil ---- pressing and extraction (solvent extraction)

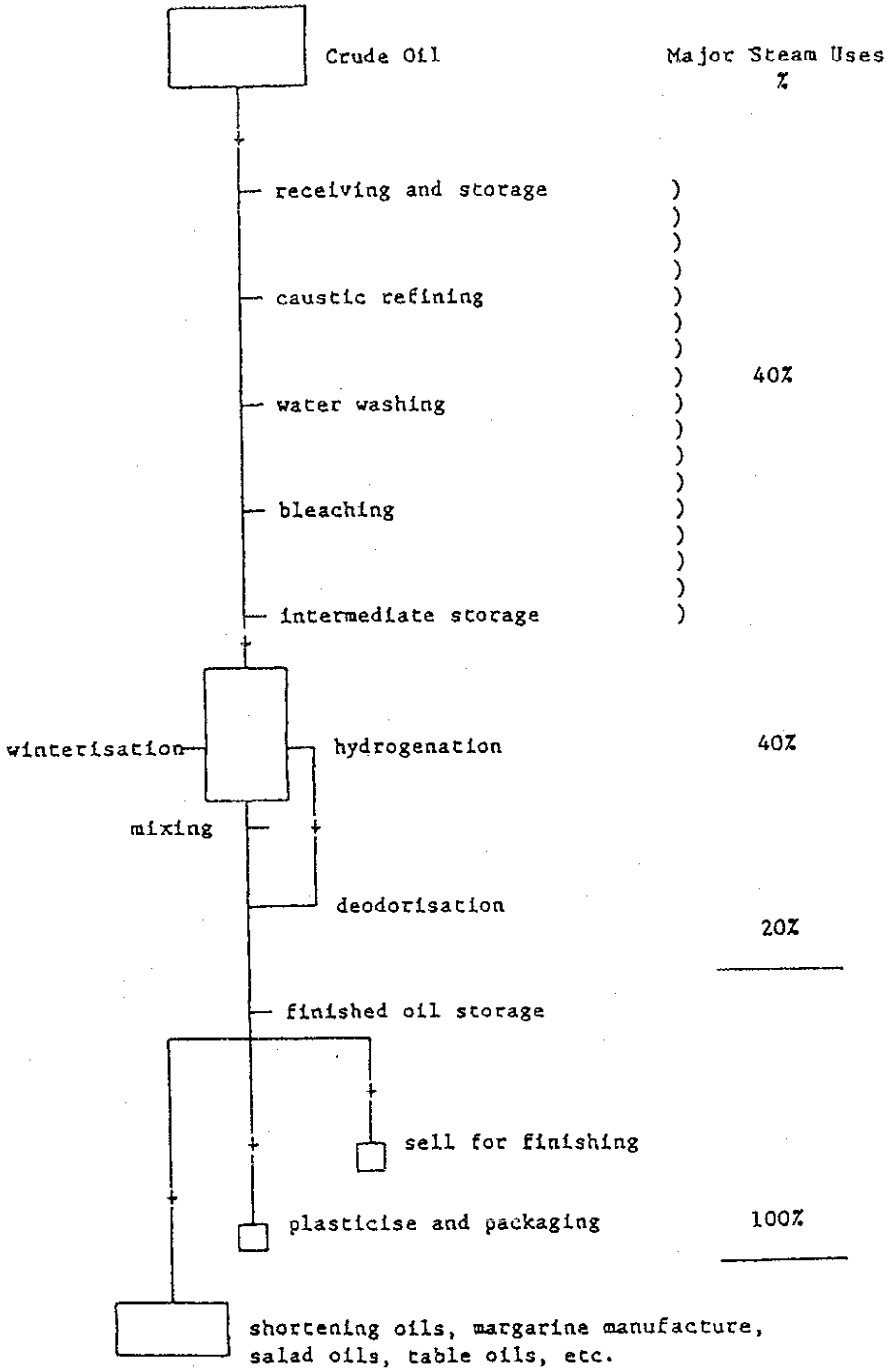
b. Refining of raw oil
b-1. Degumming: removal of phospholipids, proteins, and resins in raw oils.
b-2. Deoxidization: removal of free fatty acids in oils and fats.
b-3. Decolorization: removal of pigments in oils and fats.
b-4. Dewaxing: removal of solid greases, which causes turbidity in oils and fats.

Figure 4.4 The Main Processes of Soya Bean Extraction



(Source) UK Department of Energy, "Energy Use and Energy Efficiency in UK Manufacturing Industries up to the Year 2000," Her Majesty's Stationary Office

Figure 4.5 Usual Processes in Oil Refining, and Production of Shortening Oils and Margarine



(Source) Same as Figure 4.4

Table 4.7 Economic Evaluation of Technical Measures for Energy Conservation in the Vegetable Oil Industry

	Production	Investment costs				Saved Energy and Benefit (Steam coal)					Saved Energy and Benefit (Electricity)					Total			Evaluation (Benefit / costs)	
		Total costs		Unit cost		Saved Energy			Benefit		Saved energy			Benefit		Saved Energy	Benefit			
	(t/y)	1998 (1000 PLN)	1998 (1000 yen)	2000 (PLN/t)	2003 (PLN/t)	(st-kg+/t)	(MJ/t)	(t/t)	2000 (PLN/t)	2003 (PLN/t)	(MWh/y)	(MWh/t)	(MJ/t)	2000 (PLN/t)	2003 (PLN/t)	(MJ/t)	2000 (PLN/t)	2003 (PLN/t)	2000	2003
Prelminary De-solvent *	9,720	205,000	307,500	718.1	800.9	60	180	0.008	6.6	7.0	0	0	0	0	0	180	6.6	7.0	0.01	0.01
De-solvent vapor:Heat recovery(continuous)*	46,800	15,000	22,500	10.9	12.2	46	138	0.006	5.1	5.4	0	0	0	0	0	138	5.1	5.4	0.5	0.4
De-solventvapor:Heat recovery(batch)*	18,000	5,540	8,310	10.5	11.7	175	524	0.024	19.4	20.4	0	0	0	0	0	524	19.4	20.4	1.8	1.7
De-colorization:heat recovery(A):	36,000	4,000	6,000	3.8	4.2	55	165	0.007	6.1	6.4	0	0	0	0	0	165	6.1	6.4	1.6	1.5
De-colorization:heat recovery(B)*	40,000	2,700	4,050	2.3	2.6	33	99	0.004	3.6	3.8	0	0	0	0	0	99	3.6	3.8	1.6	1.5
De-odorization:heat exchange(A)*	50,000	7,000	10,500	4.8	5.3	176	527	0.024	19.5	20.5	0	0	0	0	0	527	19.5	20.5	4.1	3.9
De-odorization:heat exchange(B)*	54,000	24,000	36,000	15.1	16.9	104	311	0.014	11.5	12.1	0	0	0	0	0	311	11.5	12.1	0.8	0.7
De-odorization:heat exchange(C)*	72,000	32,500	48,750	15.4	17.1	55	165	0.007	6.1	6.4	0	0	0	0	0	165	6.1	6.4	0.4	0.4
Hummer mill*	300,000	1,000	1,500	0.1	0.1	0	0	0.000	0.0	0.0	18	0.0001	0.216	0.054	0.061	0	0.1	0.1	0.5	0.5
De-odorization:heat exchange**	53,858	314	10,990	4.6	5.2	(GJ/t) 6,463	120	0.005	4.4	4.7	0	0	0	0	0	120	4.4	4.7	1.0	0.9
Heat insulation:steam valve**	53,858	208	7,280	3.1	3.4	4,511	84	0.004	3.1	3.3	0	0	0	0	0	84	3.1	3.3	1.0	1.0
Peak demand**	53,858	13	455	0.2	0.2	0	0	0.000	0.0	0.0	0	0	0	0	0	0	0.0	0.0	0.0	0.0
Reacter of hydrogenation**	53,858	429	15,015	6.3	7.0579	10,018	186	0.008	6.9	7.2	0	0	0	0	0	186	6.9	7.2	1.1	1.0

(Note) + ---- "st-kg" means "steam-kg."

(Source) *----From examples in Japanese vegetable oil manufacturing factories. **----From the Factory Energy Audit report.

b-5. Hydrogenation (hardening): transforming liquid oils into solid ones by hydrogenation to manufacture margarine (Hardening is not performed when making liquid oils such as salad oil).

b-6. Deodorization: removal of odor-causing volatile substances.

As for energy consumption by process, the process for exploiting raw oil represents the amount of fuel consumed, at 50 to 60%, with 20 to 25% being consumed for the refining process (excluding the hardening process) and the other processes (including hardening), respectively.

(2) Economic evaluation

Table 4.7 presents the results of our evaluation of energy conservation measures for vegetable oil factories based on the results of the factory energy audits and our experience at oil extraction factories in Japan (for early 1980s).

From these results, we can conclude that "heat recovery from solvent vapor with the batch solvent extraction method" is economically feasible.

As regards the oil refining process, "heat recovery in decolorization" is evaluated as economically feasible. For "heat recovery in deodorization," one of four cases is judged to be economically feasible, while other three fail to reach the effect-to-cost ratio of one. However, the ratio for two of the three cases is close to one. This suggests that these two measures will be feasible if any economic incentives are provided.

Further, "the reduction of reaction time in the hydrogenation process" and "the reinforcement of insulation for steam valves" are evaluated economically feasible.

4.2.8 Meat products

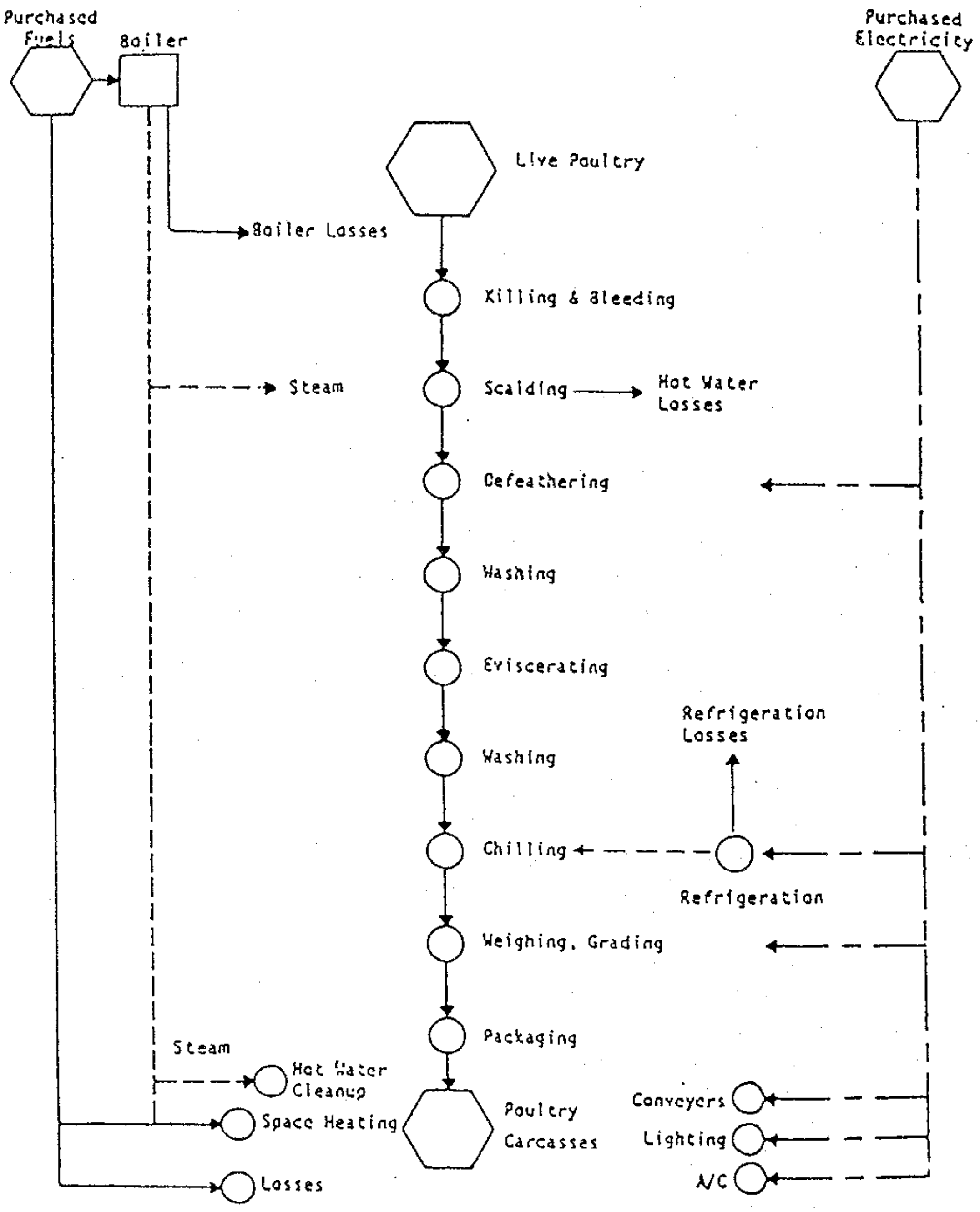
(1) Production process and energy consumption

Meat product production includes the following processes:

a. Slaughter of animals and birds
b. Processing of slaughtered animals and birds, including freezing
c. Curing of raw meat and poultry
d. Soaking of cured meat and poultry
e. Drying and smoking
f. Cooking (Boiling)

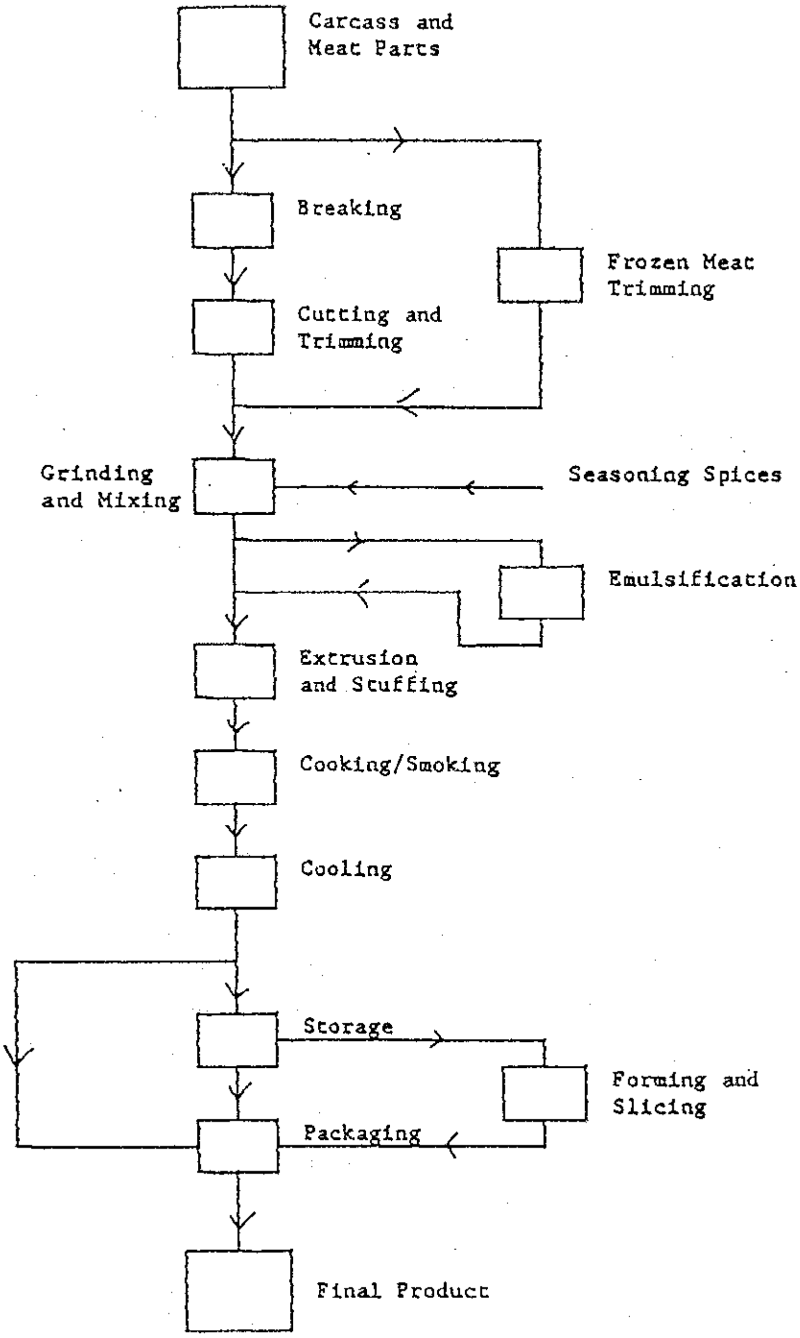
Ham, sausage, bacon, and other meat products usually undergo these processes. (Figure 4.6 and 4.7)

Figure 4.6 Schematic material and Energy Flow of Typical Poultry Processing Plant



(Source) Same as Fig.4.4

Figure 4.7 An Example of Industrial Processes for Meat Products



(Source) Same as Fig.4.4

No satisfactory data are available concerning energy consumption by process. However, it is estimated that 40% of total electricity is consumed for freezing in the processes a. and b. above (according to data and information in the U. K. in the 1980s). By comparison, the processes c. and beyond are said to consume only a little energy. In these processes, especially in process f., a certain amount of steam is used. In addition, electricity is used for freezing and cooling.

These findings indicate that in meat-processing factories, energy conservation measures should focus on boilers for steam (and electricity) generation and refrigerators for cooling and freezing.

(2) Economic evaluation

Table 4.8 shows the results of our economic evaluation of energy conservation measures based on data obtained in the factory energy audit. From these, "the recovery of drain" is considered to be economically feasible as an energy conservation measure for the production process in the meat processing industry. Other feasible measures include "the installation of curtains at the entrance and exit of factory buildings," "the introduction of external air into factories," and "performance enhancement of compressors."

As for "the reinforcement of insulation for steam valves" and "the improvements to lighting," they are judged to be feasible on the condition that the economic incentives are provided.

4.2.9 Dairy products

(1) Production process and energy consumption

Dairy products are made through the processes as presented in Figures 4.8 and 4.9. "Pasteurized milk," "homogenized milk," "sterilized milk" and " UHT milk" shown in Figure 4.8 are among a milk product called the "processed milk." Figure 4.9 shows a process producing only cheese although, in practice, there are a large number of factories producing both cheese and powdered milk.

Among these products, the greatest energy consumer is the powdered milk. Large amounts of steam are used in the vaporization and drying processes in its production. For dairy products as a whole, a great deal of energy is consumed by boilers for steam (and electricity) generation and refrigerators for freezing and cooling.

In conclusion, energy conservation measures for dairy product factories should center on processes mentioned above, or machines and equipment related to the processes.

(2) Economic evaluation

According to the factory energy audit and experiences in Japanese factories, the following technical measures can be listed by product.

a. For powdered milk factories (including those producing also batter or cheese):
---- Recovery of drain in drying and other processes.

Table 4.8 Economic Evaluation of Technical Measures for Energy Conservation in the Meat Products Industry

(1)—Meat A

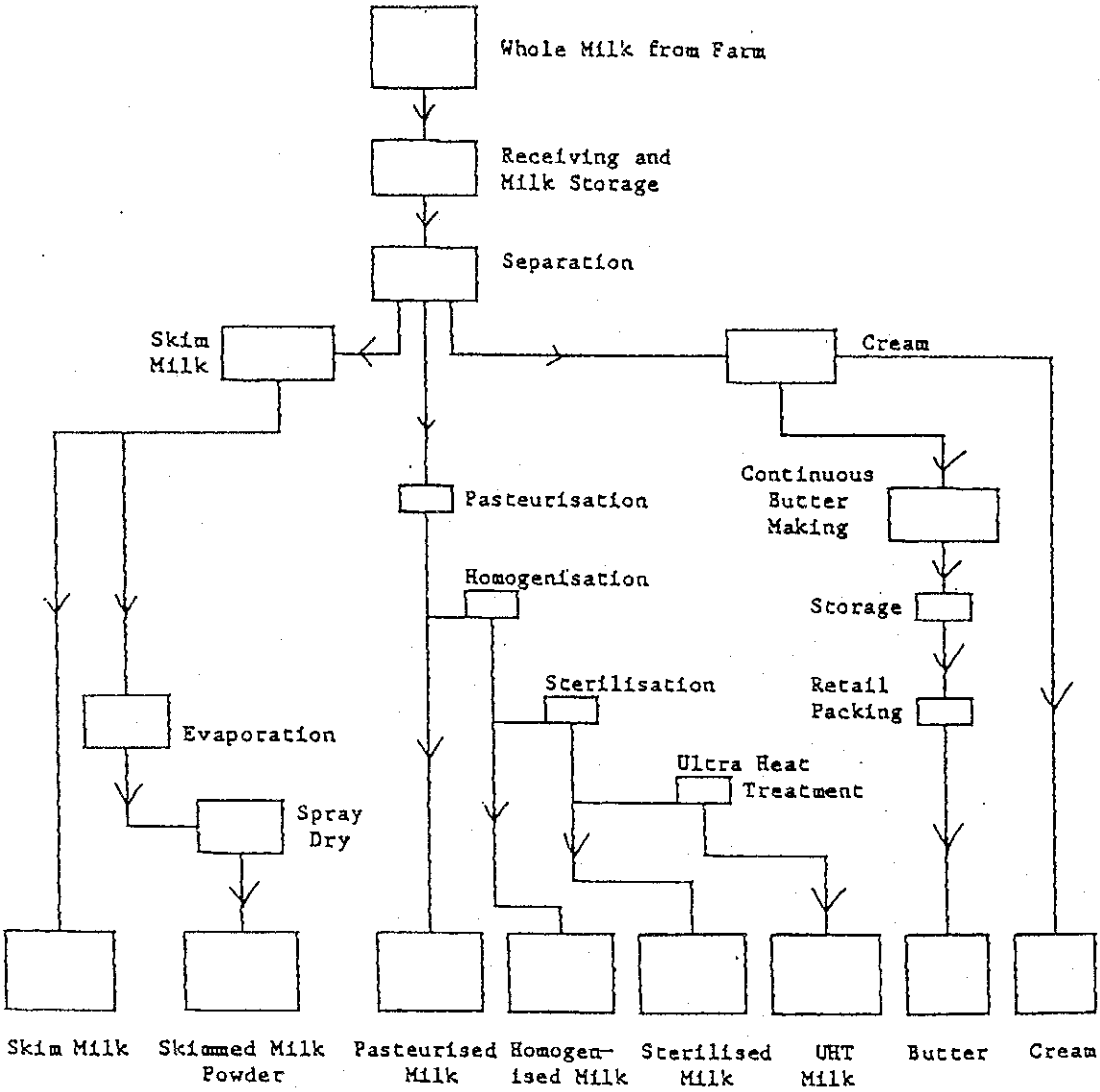
	Production (t/y)	Investment costs: Total costs 1998 (1000 PLN)	Investment costs: Total costs 1998 (1000 yen)	Investment costs: Unit cost 2000 (PLN/t)	Investment costs: Unit cost 2003 (PLN/t)	Saved Energy and Benefit (Steam coal): Saved Energy (GJ/y)	Saved Energy (MJ/t)	Saved Energy (t/t)	Benefit 2000 (PLN/t)	Benefit 2003 (PLN/t)	Saved Energy and Benefit (Electricity): Saved energy (MWh/y)	Saved energy (MWh/t)	Saved energy (MJ/t)	Benefit 2000 (PLN/t)	Benefit 2003 (PLN/t)	Total: Saved Energy (MJ/t)	Total: Benefit 2000 (PLN/t)	Total: Benefit 2003 (PLN/t)	Evaluation (Benefit / costs) 2000	Evaluation (Benefit / costs) 2003
Heat recovery	7,096	2,057.0	71,995	230.3	256.9	8,409	1,185	0.054	43.8	46.1	0	0	0	0	0	1,185	43.8	46.1	0.2	0.2
Recovery of drain	7,096	1,029.0	36,015	115.2	128.5	5,606	790	0.036	29.2	30.7	0	0	0	0	0	790	29.2	30.7	0.3	0.2
Intoducing external air intofactories	7,096	257.0	8,995	28.8	32.1	0	0	0.000	0.0	0.0	67	0.0094	34.0	8.4	9.5	34	8.4	9.5	0.3	0.3
Installing Curtain at the enterances	7,096	103.0	3,605	11.5	12.9	561	79	0.004	2.9	3.1	45	0.0063	22.8	5.7	6.4	102	8.6	9.5	0.7	0.7
Heat insulation of steam valve	7,096	201.0	7,035	22.5	25.1	2,071	292	0.013	10.8	11.4	0	0.0000	0.0	0.0	0.0	292	10.8	11.4	0.5	0.5

(2)--Meat B

	Production (t/y)	Investment costs: Total costs 1998 (1000 PLN)	Investment costs: Total costs 1998 (1000 yen)	Investment costs: Unit cost 2000 (PLN/t)	Investment costs: Unit cost 2003 (PLN/t)	Saved Energy and Benefit (Steam coal): Saved Energy (GJ/y)	Saved Energy (MJ/t)	Saved Energy (t/t)	Benefit 2000 (PLN/t)	Benefit 2003 (PLN/t)	Saved Energy and Benefit (Electricity): Saved energy (MWh/y)	Saved energy (MWh/t)	Saved energy (MJ/t)	Benefit 2000 (PLN/t)	Benefit 2003 (PLN/t)	Total: Saved Energy (MJ/t)	Total: Benefit 2000 (PLN/t)	Total: Benefit 2003 (PLN/t)	Evaluation (Benefit / costs) 2000	Evaluation (Benefit / costs) 2003
Recovery of drain	9,190	206.0	7,210	17.8	19.9	5,008	545	0.025	20.1	21.2	0	0.0000	0.0	0.0	0.0	545	20.1	21.2	1.1	1.1
Improving performance of compressor for freezing	9,190	8.0	280	0.7	0.8	0	0	0.000	0.0	0.0	13	0.0014	5.1	1.3	1.4	5	1.3	1.4	1.8	1.9
Intoduction of external air into factories	9,190	103.0	3,605	8.9	9.9	0	0	0.000	0.0	0.0	215	0.0234	84.2	20.9	23.6	84	20.9	23.6	2.3	2.4
Installing curtain at the entrances and doors	9,190	51.0	1,785	4.4	4.9	505	55	0.002	2.0	2.1	27	0.0029	10.6	2.6	3.0	66	4.7	5.1	1.1	1.0
Improvements to lighting	9,190	15.0	525	1.3	1.4	0	0	0.000	0.0	0.0	7	0.0008	2.7	0.7	0.8	3	0.7	0.8	0.5	0.5
Heat insulation of steam valve	9,190	120.0	4,200	10.4	11.6	2,517	274	0.012	10.1	10.7	0	0	0	0	0.0	274	10.1	10.7	1.0	0.9

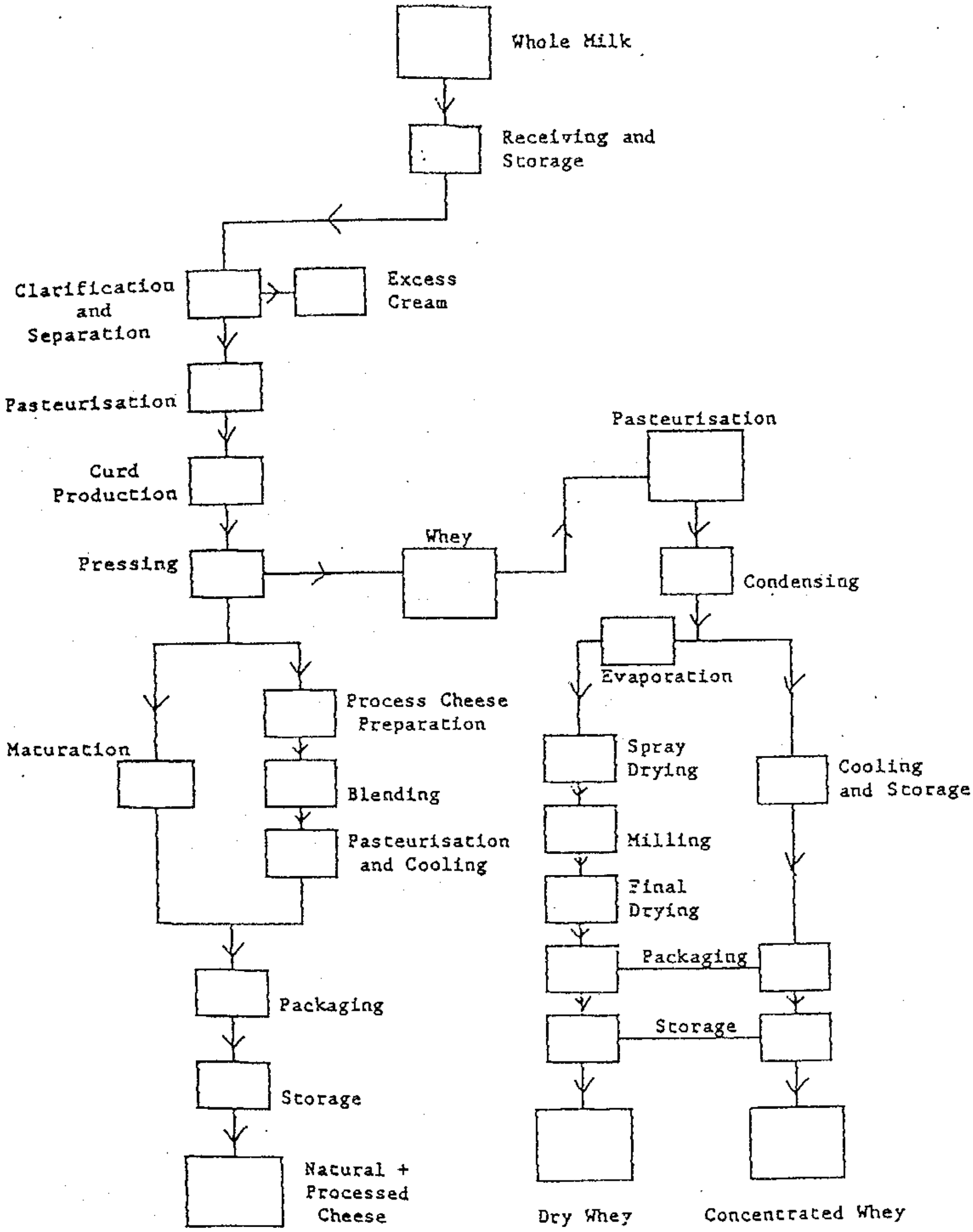
(Source) The Factory Energy Audit report made by the JICA Team

Figure 4.8 Liquid Milk Processes : Milk, Butter, Milk Powder



(Source) Same as Fig.4.4

Figure 4.9 Cheese-making Processes



(Source) Same as Fig.4.4

---- Recovery of waste heat.
---- Improved operation of freezing machines.
---- Installation of economizers in boilers.
---- Installation of inverters for fans (Control of fan rotation).

b. For processed milk factories (including those producing also ice-cream.):
---- Recovery of drain.
---- Improved use of hot water for equipment cleaning.
---- Recovery of waste heat from continuous blowers.
---- Improved operation of freezing machines.
---- Installation of economizers in boilers.

c. For cheese factories:
---- Recovery of waste heat from continuous blowers
---- Improved operation of freezing machines

Table 4.9 shows a result of the economic evaluation of various technical measures described above on the basis of experiences at dairy product factories in Japan. The following are considered to be economically feasible:

a. Installation of inverters for fans (in all factories).
b. Improved operation of freezing machines in factories producing powdered milk, processed milk, margarine, and cheese.
c. Higher degree of vaporization in the powered milk production process.
d. Reinforcing heat insulation for steam valves.

Further, "the recovery of drain in the dryer" and "the recovery of waste heat in the continuous blowers" are among the measures that require the economic incentives to be feasible.

Table 4.9 Economic Evaluation of Techaical Measures for Energy Conservation in the Dairy Products Industry

	Raw Material Input	Investment costs				Saved Energy and Benefit (Steam coal)					Saved Energy and Benefit (Electricity)					Total			Evaluation (Benefit / costs)	
		Total costs		Unit cost		Saved Energy			Benefit		Saved energy			Benefit		Saved Energy	Benefit			
		1980	1998	2000	2003				2000	2003				2000	2003		2000	2003	2000	2003
	(t/y)	(1000 yen)	(1000 yen)	(PLN/t)	(PLN/t)	(oil**-l/y)	(MJ/t)	(t/t)	(PLN/t)	(PLN/t)	(kWh/y)	(kWh/t)	(MJ/t)	(PLN/t)	(PLN/t)	(MJ/t)	(PLN/t)	(PLN/t)		
<Factories : Powder milk with butter or cheese>																				
Dryer: recovery of drain(1)	91,600	6,500	9,750	2.4	2.7	85,500	36	0.002	1.3	1.4	0	0	0	0	0	36	1.3	1.4	0.6	0.5
Dryer: recovery of drain(2)	120,600	6,500	9,750	1.8	2.0	179,400	58	0.003	2.1	2.2	0	0	0	0	0	58	2.1	2.2	1.2	1.1
Dryer: recovery of drain(3)	137,800	6,500	9,750	1.6	1.8	58,400	16	0.001	0.6	0.6	0	0	0	0	0	16	0.6	0.6	0.4	0.4
Dryer: recovery of drain(4)	49,900	6,500	9,750	4.4	4.9	83,200	65	0.003	2.4	2.5	0	0	0	0	0	65	2.4	2.5	0.5	0.5
Dryer: recovery of drain(5)	33,400	6,500	9,750	6.6	7.4	78,400	91	0.004	3.4	3.5	0	0	0	0	0	91	3.4	3.5	0.5	0.5
Other processes: recovery of drain(1)	22,700	600	900	0.9	1.0	57,700	99	0.004	3.6	3.8	-3,000	-0.132	-0.5	-0.1	-0.1	98	3.5	3.7	3.9	3.7
Other processes: recovery of drain(2)	59,000	5,600	8,400	3.2	3.6	55,900	37	0.002	1.4	1.4	0	0.000	0.0	0.0	0.0	37	1.4	1.4	0.4	0.4
Recovery of waste heat from continuous blower	59,000	3,900	5,850	2.3	2.5	31,700	21	0.001	0.8	0.8	0	0.000	0.0	0.0	0.0	21	0.8	0.8	0.3	0.3
Improved operation of freezing machines(1)	120,000	3,400	5,100	1.0	1.1	0	0	0.000	0.0	0.0	221,500	1.846	6.6	1.6	1.9	7	1.6	1.9	1.7	1.7
Improved operation of freezing machines(2)	49,900	3,000	4,500	2.0	2.3	0	0	0.000	0.0	0.0	341,609	6.846	24.6	6.1	6.9	25	6.1	6.9	3.0	3.0
Dryer; inverter for fans*	1,062,912	9,200	13,800	0.3	0.3	0	0	0.000	0.0	0.0	1,111,000	1.045	3.8	0.9	1.1	4	0.9	1.1	3.2	3.2
Higher degree of vaporization(1)	120,000	18,700	28,050	5.3	5.9	315,500	102	0.005	3.8	4.0	-25,700	-0.214	-0.8	-0.2	-0.2	101	3.6	3.7	0.7	0.6
Higher degree of vaporization(2)	27,600	4,000	6,000	4.9	5.5	108,800	153	0.007	5.6	5.9	0	0.000	0.0	0.0	0.0	153	5.6	5.9	1.1	1.1
Higher degree of vaporization(3)	92,100	4,000	6,000	1.5	1.6	121,000	51	0.002	1.9	2.0	0	0.000	0.0	0.0	0.0	51	1.9	2.0	1.3	1.2
Boiler; installing economizers	59,000	17,400	26,100	10.0	11.2	196,100	129	0.006	4.8	5.0	-14,100	-0.239	-0.9	-0.2	-0.2	128	4.5	4.8	0.5	0.4
<Factories : Processed milk with or without ice cream>																				
Recovery of drain(1)	6,400	400	600	2.1	2.4	3,600	22	0.001	0.8	0.8	-500	-0.078	-0.3	-0.1	-0.1	22	0.7	0.8	0.3	0.3
Recovery of drain(2)	25,600	300	450	0.4	0.4	4,700	7	0.000	0.3	0.3		0.000	0.0	0.0	0.0	7	0.3	0.3	0.7	0.6
Recovery of drain(3)	17,700	2,000	3,000	3.8	4.3	21,100	46	0.002	1.7	1.8	-3,600	-0.203	-0.7	-0.2	-0.2	45	1.5	1.6	0.4	0.4
Recovery of drain(4)	67,400	500	750	0.3	0.3	6,300	4	0.000	0.1	0.1	-400	-0.006	0.0	0.0	0.0	4	0.1	0.1	0.5	0.5
Recovery of drain(5)	76,800	4,000	6,000	1.8	2.0	35,300	18	0.001	0.7	0.7	12,200	0.159	0.6	0.1	0.2	18	0.8	0.9	0.5	0.4
Recovery of drain(6)	77,100	2,300	3,450	1.0	1.1	19,700	10	0.000	0.4	0.4	-4,700	-0.061	-0.2	-0.1	-0.1	10	0.3	0.3	0.3	0.3
Improved use of hot water for cleaning(1)	61,600	13,000	19,500	7.2	8.0	136,000	86	0.004	3.2	3.3	0	0.000	0.0	0.0	0.0	86	3.2	3.3	0.4	0.4
Improved use of hot water for cleaning(2)	25,600	700	1,050	0.9	1.0	5,400	8	0.000	0.3	0.3	0	0.000	0.0	0.0	0.0	8	0.3	0.3	0.3	0.3
Improved use of hot water for cleaning(3)	55,400	17,600	26,400	10.8	12.1	197,800	138	0.006	5.1	5.4	-38,200	-0.690	-2.5	-0.6	-0.7	136	4.5	4.7	0.4	0.4
Improved use of hot water for cleaning(4)	15,900	5,000	7,500	10.7	11.9	36,200	83	0.004	3.3	3.4	-7,100	-0.447	-1.6	-0.4	-0.5	87	2.9	3.0	0.3	0.2
Improved use of hot water for cleaning(5)	11,400	400	600	1.2	1.3	1,500	5	0.000	0.2	0.2	0	0.000	0.0	0.0	0.0	5	0.2	0.2	0.2	0.1
Recovery of waste heat from continuous blowing(1)	13,800	1,600	2,400	3.9	4.4	13,700	38	0.002	1.4	1.5	0	0.000	0.0	0.0	0.0	38	1.4	1.5	0.4	0.3
Recovery of waste heat from continuous blowing(2)	76,800	4,600	6,900	2.0	2.3	69,200	35	0.002	1.3	1.4	0	0.000	0.0	0.0	0.0	35	1.3	1.4	0.6	0.6
Recovery of waste heat from continuous blowing(3)	55,400	2,000	3,000	1.2	1.4	18,200	13	0.001	0.5	0.5	0	0.000	0.0	0.0	0.0	13	0.5	0.5	0.4	0.4
Improved operation of freezing machines(1)	13,800	200	300	0.5	0.6	0	0	0.000	0.0	0.0	25,700	1.862	6.7	1.7	1.9	7	1.7	1.9	3.4	3.4
Improved operation of freezing machines(2)	76,800	1,200	1,800	0.5	0.6	0	0	0.000	0.0	0.0	91,200	1.188	4.3	1.1	1.2	4	1.1	1.2	2.0	2.0
Improved operation of freezing machines(3)	2,600	1,500	2,250	19.6	21.9	0	0	0.000	0.0	0.0	72,989	28.073	101.1	25.0	28.3	101	25.0	28.3	1.3	1.3
Boiler; installing economisers(1)	76,800	12,900	19,350	5.7	6.4	121,200	61	0.003	2.3	2.4	-37,400	-0.487	-1.8	-0.4	-0.5	59	1.8	1.9	0.3	0.3
Boiler; installing economisers(2)	55,400	14,000	21,000	8.6	9.6	103,800	73	0.003	2.7	2.8	0	0.000	0.0	0.0	0.0	73	2.7	2.8	0.3	0.3
Boiler; installing economisers(3)	19,700	6,500	9,750	11.2	12.5	50,700	100	0.005	3.7	3.9	0	0.000	0.0	0.0	0.0	100	3.7	3.9	0.3	0.3
Boiler; installing economisers(4)	32,700	3,500	5,250	3.6	4.1	22,000	26	0.001	1.0	1.0	-2,000	-0.061	-0.2	-0.1	-0.1	26	0.9	1.0	0.2	0.2
Boiler; installing economisers(5)	55,200	6,000	9,000	3.7	4.1	57,300	40	0.002	1.5	1.6	0	0.000	0.0	0.0	0.0	40	1.5	1.6	0.4	0.4
<Factories:Cheese>																				
Recovery of waste heat from continuous blowing	17,400	4,500	6,750	8.8	9.6	57,900	129	0.006	4.8	5.0	1,900	0.109	0.4	0.1	0.1	129	4.9	5.1	0.6	0.5
Improved operation of freezing machines	100,500	1,000	1,500	0.3	0.4		0	0.000	0.0	0.0	40,300	0.401	1.4	0.4	0.4	1	0.4	0.4	1.1	1.1
<From the Factory Energy Audit>																				
Improved operation of freezing machines	23,000	0	1,785	1.8	2.0	0	0	0.000	0.0	0.0	170,000	7.3913	26.6	6.6	7.5	27	6.6	7.5	3.7	3.8
Steam valve; improved heat insulation	23,000	0	1,015	1.0	1.1	18,912	32	0.001	1.2	1.2	0	0	0.0	0.0	0	32	1.2	1.2	1.2	1.1

(Note) (1),(2),(3)----mean case (1), case(2), case(3)----. The same numbers do not mean the same factories.
* For all Japanese factories. ** crude oil equivalent.
(Source) From examples in Japanese dairy products factories, except for "From the Factory Energy Audit."