

**REPORT OF THE STUDY  
ON  
ENERGY CONSERVATION PROJECT  
IN  
THE KINGDOM OF THAILAND  
— SUMMARY —**

**DECEMBER, 1984**

**JAPAN INTERNATIONAL COOPERATION AGENCY**



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## I. Outline of the Study, Energy Situation

### 1. Introduction

In March 1981 the Japan International Cooperation Agency (JICA), sent its first energy conservation survey mission to Thailand to discuss with the Thai government the possibility of cooperation in the field of energy conservation and details of such cooperation.

The government of Thailand requested Japan's cooperation in order to promote and strengthen the energy conservation program in the manufacturing industry on the basis of the discussions.

JICA, in accordance with the request, dispatched a preliminary survey team to Thailand in March 1982 to discuss with Thailand's National Energy Administration (NEA) the outline of the study project. Consequently, NEA and JICA signed "the Scope of Work for the Study on Energy Conservation Project in the Kingdom of Thailand" (Scope of Work) to proceed to the study project.

JICA pushed for the Study by sending study teams to Thailand on four occasions starting in August 1982.

This report was prepared in accordance with the Scope of Work and on the basis of the results of the past surveys.

### 2. Background of the Study—Energy Situation in Thailand

#### (1) Energy demand and supply

Thai economy has attained remarkable development over the past 20 years. Both expansion of infrastructural investment, diversification of agricultural production and industrialization mainly in the field of import substitutive industries, progressed rapidly.

In consequence of such economic development and changes in the industrial structure, the demand for primary energy made a 10-fold increase from 1961 through 1982. But after the oil crisis broke out in 1973, the rate of increase in the demand for energy dwindled to half or less than that before.

There has also been a major change over the past decade in the energy supply structure. Petroleum remains to be the biggest source of primary energy. But, since 1973 dependence on petroleum and on imported energy have decreased sharply.

However, even now, the energy dependence on oil and dependence on imported energy in Thailand still remains at a high level of 60 percent. Therefore, the energy supply structure in Thailand is still apt to be affected by changes in the energy situation abroad. Also, the ratio of Thailand's energy import value to total import value, which had stood at 10.4 percent in 1973, nearly trebled to 29.8 percent in 1982. The country spends 37 percent of the valuable foreign currency earned from exports on purchasing oil from abroad, and this is seemed to be the main cause for Thailand's chronic trade deficits.

Considering the final domestic demand for energy, the transport sector is the largest consumer of energy, but the share of this sector in final energy consumption has been decreasing in recent years. Instead, the shares of industrial sector, household

commercial and other sectors have been increasing.

(2) Energy strategies

The basic strategies in the energy field in the Fifth National Economic and Social Development Plan (1982-1986) of Thailand lies in lowering the external trade deficit and reduction of energy dependence on imported energy (imported oil).

Under these strategies, the following energy targets are set forth:

- A) To reduce the average annual growth rate of total energy consumption to 4.8 percent by promoting efficient use of energy and energy conservation particularly in the transport and industrial sectors;
- B) To reduce the amount of imported oil by 3 percent per year during the Fifth Plan period.
- C) To decrease the ratio of oil imports to total energy consumption from 75 percent in 1980 to 46 percent in 1986.
- D) To increase, by 1986, the oil refining capacity to 280,000 bbl. a day;
- E) To increase the rate of electrification of rural communities from 36 percent in 1980 to 92 percent in 1986.
- F) To increase the amount of oil reserve to 60 days, by 1986.

(3) Energy conservation measures

In order to improve the energy utilization efficiency in the transport and industrial sectors, various measures are laid down in the Fifth Plan, and some of those have already been put into practice:

Also, in 1981 the Energy Conservation Center was established within NEA. This center is engaged in the following activities at present:

- A) Providing technical service to industrial factories regarding energy audits;
- B) Distributing information concerning energy conservation technologies;
- C) Training in energy conservation (seminars and conferences);
- D) Energy conservation demonstration programs

Furthermore, aside from the said Energy Conservation Center, a plan to establish a new private organization to promote energy conservation under the financial aid of the government is being pushed at present.

As stated in the foregoing, energy conservation is ranked as one of the most important problems in the energy policy system of the Kingdom of Thailand. In fact, the future progress of industrialization and improvement of people's living standards in the country will run parallel with a more energy intensive pattern. Hence, it is believed that more efficient use of energy will further increase in importance within the country.

3. Process of the Study

(Framework of the survey is shown in Fig. 1)

- (1) In order to precisely grasp the energy utilization situation in the field of the manufacturing industry in Thailand, the study teams were sent to Bangkok three



times. These study teams visited 55 factories of the following 6 types of industry and surveyed the energy utilization situation as well as the possibilities of energy conservation, and made suggestions on what to do for more efficient use of energy:

Type of industry	Ceramics and glass	Paper	Textile	Metal	Chemical and plastic	Food
Number of factory	10	9	9	9	9	9

- (2) During the factory surveys, the study teams extended to Thai counterparts technical staffers who accompanied the teams, technical guidance on how to handle measuring instruments, and how to make energy audit, and thus transferred technologies to them.
- (3) Parallel to the factory surveys, data and information regarding the energy situation in Thailand were collected.
- (4) Following the factory surveys, JICA dispatched a review team to Thailand to discuss how to proceed with future surveys. Then a fourth study team visited Thailand to investigate energy conservation measures and systems enforced in the industrial sectors of the country.
- (5) Based on the results of the aforementioned surveys, the draft of the guideline for rationalization of energy use, classified by type of industry, and the recommendation of measures to promote energy conservation in the field of manufacturing industry were formulated.
- (6) The Study was conducted with the following points in mind.
  - A) Rationalization of fuel combustion
  - B) Prevention of heat loss by radiation and conduction
  - C) Recovery and reutilization of waste heat
  - D) Prevention of electricity loss by resistance, etc.
  - E) Rationalization of conversion of electricity into power, heat, etc.

## II. Results of the Factory Energy Audit

### I. Factories Surveyed

#### (1) Item manufactured and capital group

No. of factory	Joint venture with foreign co (S)	Belonging to Group	Others	Total
Items manufactured				
Ceramic/ Glass Glass bottle, glass Tile Sanitary ware/ Insulator, others	2	0	8	10
Paper Paper Corrugated carboard	0	3	6	9
Textile Spinning/ Cloth weaving Nylon polymerization/ Spinning Socks	4	2	3	9
Metall Steel bar for concrete PC Wire, Wire Foundry Tractor parts Nail, screw, bolt/nut	3	4	2	9
Chemical/ Plastic Organic chemicals Inorganic chemicals Gas separation Plastic moulding	2	2	5	9
Food Marine product canning Oil and fat, Feed Alcoholic drinks	1	4	4	9
Total	12	15	28	55

- (2) Fuel oil consumption per factory (Lignite is converted in heavy oil equivalent. Excludes LPG and fuel for power generation)

Consumption	Ratio
1,000 kl/year or less	49%
1,000 ~ 3,000 kl/year	36%
3,000 kl/year and more	15%

- (3) Electric power consumption per factory

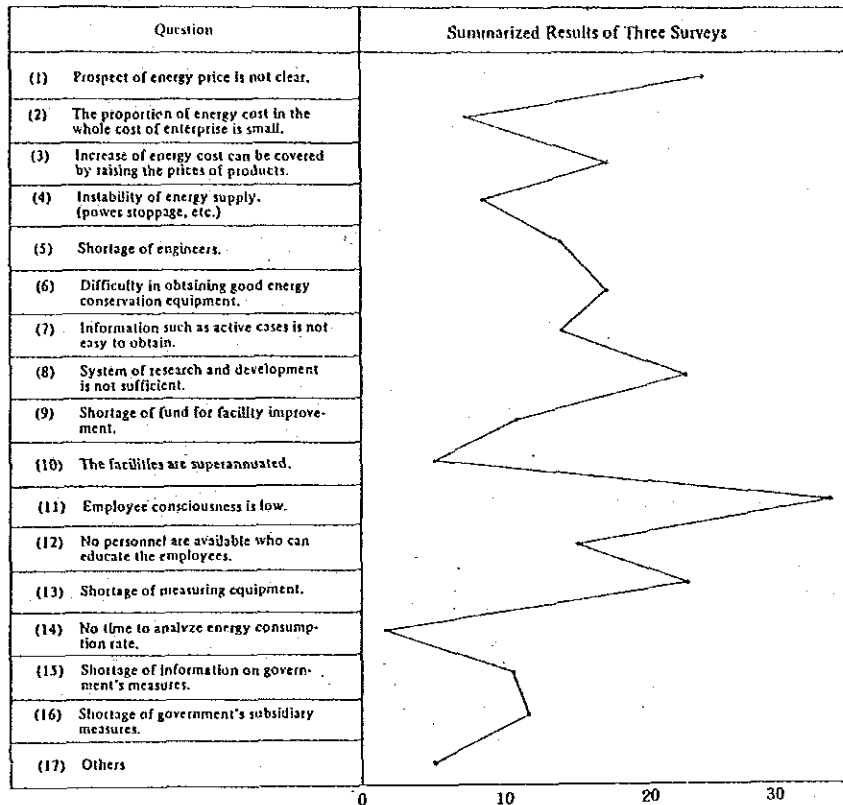
Consumption	Ratio
$10 \times 10^6$ kWh/year or less	80%
$10 \sim 20 \times 10^6$ kWh/year	9%
$20 \times 10^6$ kWh/year and more	11%

## 2. State of Energy Management

- (1) Generally, the management is highly concerned about energy conservation. However, only a few factories establish and notify definite policies of the enterprise and concrete target values.
- (2) The factories which have some energy conservation measures enforced have reached 2/3 of the total number.
- (3) The factories which provide an opportunity for discussion of energy problems have reached approx. 40% of the total number. The majority of these factories make use of general staff meetings for the discussion. Only three factories have a specialized ad hoc committee for energy conservation. One factory once had a committee devoted toward energy conservation, but abolished it because of its lack of know-how for the operation of the committee.
- (4) At 9 factories, the QC circles are already off the ground centering around the staff. These circles are also being prepared at one other factory. Nevertheless, they have not reached a stage that their QC circle's activities are successful with favorable results for energy conservation.
- (5) The suggestion system is established at factories equivalent to approx. 1/4 of the total number, but it is basically not operated.
- (6) Energy consumption is being recorded by factories equivalent to approx. 60% of the total number.
- However, any appropriate measures taken whenever necessary through calculation of the energy consumption rate, preparation of a control chart, and analysis of causes of demand variation, that is, management through data, are not fully implemented. The same is true about quality and yield.
- (7) Staff are often sent to external seminars. However, internal "transfer education" by the staff who have participated in the external seminars is basically not carried through.

Item	Ceramic/ Glass	Paper	Textile	Metal	Chemical/ Plastic	Food	Total
Company policy							
• Establishment and notification of target values	—	—	2	2	2	4	10
• Measures hitherto taken	5	6	9	5	7	5	37
Participation of all personnel							
• Setting up of committees	3	2	7	4	4	2	22
• Project team	—	2	—	—	—	1	3
• QC circle	1	—	2	4	1	1	9
• Suggestion System	2	2	2	1	1	6	14
• Appeal to employees	5	2	4	4	4	6	25
Management through data							
• Grasping of daily consumption	8	4	6	3	4	8	33
• Grasping of consumption by process	6	2	6	2	5	6	27
• Calculation of energy consumption rate	5	5	3	4	4	3	24
• Preparation of control chart	1	1	1	1	1	2	7
• Analysis of causes of demand variation	1	1	2	—	2	3	9
Technological leveling-up of employees							
• Participation of staff in external training courses	6	5	6	7	6	9	39
• Education of operators	1	—	3	1	1	—	6
• Information exchange within the same industry	—	—	1	—	—	1	2
Total no. of factories	10	9	9	9	9	9	55

3. Answers to Questionnaire "Problems Encountered in the Promotion of Energy Conservation."



#### 4. Problems of Heat Control

- (1) Rationalization of Fuel combustion
  - A) Incorrect air ratio
  - B) Incorrect flame direction because of the wrong installation of the burners
  - C) Oil leakage from the burners
  - D) Shortage of control instruments
  - E) No concern about the quality of fuel oil
- (2) Rationalization of Heating, Cooling and Heat Transfer
  - A) Insufficient cleaning of the heat transfer surface
  - B) Large heat capacity of objects other than those for heating
  - C) Exceedingly high steam pressure
  - D) Inappropriate furnace design and capacity
  - E) Defective charging of objects to be heated
  - F) Insufficient utilization of heat obtained through the preceding process
  - G) Faulty air purge during steam heating
  - H) Room for higher-efficiency equipment for the evaporator, furnace and other equipment
  - I) Necessity of reducing dehydrating heat energy through mechanical separation of higher efficiency
  - J) High rejection rate of products
  - K) Defective boiler feed water treatment  
Insufficient water blow-down for the boiler
- (3) Prevention of Heat Loss by Radiation and Conduction, etc.
  - A) Considerable heat radiation from the furnace wall
  - B) Uninsulated steam-using facilities and piping and deteriorated insulation
  - C) No installation of cover on the hot water of tank
  - D) Inadequate provision of enclosures, hoods and lids for drying equipment and melting furnace
  - E) Necessity of reinforcement of insulation of the upper surface of a tunnel kiln truck
  - F) Unsuitable color of the heat radiation surface
  - G) Steam leakage from valves
  - H) Inadequate maintenance of steam traps
  - I) Inappropriate blow-down quantity of boiler water
- (4) Recovery and Utilization of Waste Heat
  - A) Room for the recovery of waste heat
  - B) Room for the recovery of waste pressure
  - C) Room for the recovery of condensate
  - D) Insufficient utilization of flash steam
  - E) Inadequate handling of recovered waste heat

5. Problems of Electric Power Control
- (1) Rationalization of Conversion of Heat to Power  
Insufficient use of heat of diesel generator for emergency
  - (2) Prevention of Electric Power Loss by Resistance, etc.
    - A) Room for the improvement of power factor
    - B) Insufficient efforts to suppress peak demand
    - C) Room for the reduction of loss in the transformer
    - D) Inbalance of 3-phase current
    - E) Insufficient maintenance and shortage of control instruments
  - (3) Rationalization of Conversion of Electricity to Power and Heat, etc.
    - A) Room for the reduction of power for fluid transport
    - B) Excess capacity of some of electric motors
    - C) Inadequate maintenance of power transmission belts
    - D) Room for the rationalization of lighting
    - E) Reinforcement of insulation of electroheating equipment
    - F) Recovery of fluid pressure

6. Targets for Improvement and Projected Effects

( ) means ratio in % to consumption.

Classification	Item	Targets for Improvement	Projected Effects of Improvement Heavy oil equiv. kℓ/y							Total
			Ceramic /Glass	Paper	Textile	Metal	Chemical /Plastic	Food		
Rationalization of fuel combustion	Improvement of air ratio.	Air ratio 1.3 max.	1,088 (4.5)	1,668 (5.7)	209 (1.6)	165 (2.0)	44 (0.6)	1,026 (7.6)	4,200 (4.4)	
	Lowering temperature of exhaust gas.	Exhaust gas temperature 250°C max.	-	2,724 (9.3)	3 (-)	1,495 (18.0)	-	213 (1.6)	4,435 (4.6)	
Rationalization of heating, cooling, heat transfer	Improvement of production process and heating method.	-	-	-	-	-	-	-	-	
Prevention of heat loss by radiation, convection, and conduction.	Reinforcement of insulation of furnace and carriage.	Surface temperature	1,221	419	440	180	-	-	1,841	
	Reinforcement of insulation of facilities using steam.	Newly built glass-melting furnace <200°C	-	371	-	10	344	364	1,137	
Recovery and utilization of waste heat	Installation of cover and hood.	Upper surface of firing zone of newly built tunnel kiln. <100°C	-	-	31	20	68	6	465	
	Lowering surface emissivity.	Facilities using steam <60°C	-	11	-	-	3	8	19	
Recovery and utilization of waste heat	Optimization of blow water quantity.	-	-	-	-	-	-	-	-	
	Prevention of steam leakage.	-	-	-	-	-	-	-	-	
Recovery and utilization of waste heat	Smaller radiation area.	-	-	-	-	-	-	-	-	
	Recovery and utilization of waste heat of exhaust gas.	-	-	-	-	-	-	-	-	
Recovery and utilization of waste heat	Recovery and utilization of waste heat of waste water.	-	-	-	-	-	-	-	-	
	Heat exchange of process fluid.	-	-	-	-	-	-	-	-	
Recovery and utilization of waste heat	Recovery of condensate and utilization of flash steam.	-	-	-	-	-	-	-	-	
	Subtotal	-	648 (2.7)	1,022 (3.5)	689 (5.1)	-	343 (4.8)	372 (2.8)	3,074 (3.2)	
Recovery and utilization of waste heat	Subtotal	-	2,957 (12.2)	6,215 (21.1)	1,372 (10.2)	1,870 (22.5)	802 (11.1)	2,008 (15.0)	15,224 (15.8)	
	Total	-	24,319	29,397	13,460	8,310	7,201	13,420	96,107	
Fuel consumption	Heavy oil equiv. kℓ/year	-	-	-	-	-	-	-	-	



Classification	Item	Targets for Improvement	Projected Effects of Improvement 10 <sup>3</sup> kWh/y							Total		
			Ceramic /Glass	Paper	Textile	Metal	Chemical /Plastic	Food				
Rationalization of conversion of heat to power, etc.	Improvement of power factor. Reduction of transformer loss. Improvement of frequency converter efficiency.	Receiving power factor 85% minimum	87	11	52	169	73	32	424			
			37	209	181	514	44	76	1,061			
						39			39			
	Subtotal		124 (0.4)	220 (0.3)	233 (0.1)	722 (1.0)	117 (0.4)	108 (0.4)	1,524 (0.3)			
Rationalization of conversion of electricity to power, heat, etc.	Reduction of power for fluid transportation. compressor / refrigerator pump air-conditioning load Improvement of conduction belt/ Change of gear ratio. Change of motor capacity / Optimization of motor voltage. Reduction of heat loss of electric heating equipment. Rationalization of lighting. Recovery of waste energy. Application of high efficiency equipment.		227	9		17	93	287	624			
			7		4,908				9			
					470				4,915			
			46		147	2	74	473	742			
			57		250	338	119		764			
			9	15	664	49	22	26	785			
					525		964		964			
									525			
				Subtotal		346 (1.1)	24 (-)	6,964 (3.2)	555 (0.8)	1,272 (4.0)	786 (2.7)	9,947 (2.1)
				Total		470 (1.5)	244 (0.3)	7,197 (3.3)	1,277 (1.7)	1,389 (4.4)	894 (3.1)	11,471 (2.5)
	Electric power consumption 10 <sup>3</sup> kWh/year		30,578	79,919	219,610	73,292	31,874	28,877	464,150			

Effects as extended to Thailand's respective entire industries

	Fuel	Electric Power
	kℓ/year	Mwh/year
Ceramic / Glass	6,500 (46%)	1,080 (35%)
Paper	18,600 (33%)	510 (33%)
Textile	10,600 (13%)	55,400 (13%)
Metal	7,500 (25%)	5,100 (25%)
Chemical / Plastic	21,100 ( 4%)	36,500 ( 4%)
Food	32,400 ( 6%)	52,500 ( 2%)
Total	96,700	151,090

( ) Coverage rate (%)

Calory of the above ( A )	kcal/year $0.94 \times 10^{12}$	kcal/year $0.13 \times 10^{12}$
Total consumption by Thailand's manufacturing industry ( B )	$30,557 \times 10^{12}$	$7,709 \times 10^{12}$
A/B	3.1%	1.7%

Note : (B) Thailand Energy Situation 1981~82

### III. Guideline for Rationalization of Energy Use

#### 1. Composition

The guideline has been prepared for the six industries of:

Ceramic and Glassware,

Paper,

Textile,

Metal,

Chemical and Plastic, and

Food;

and in addition, the technical measures common to all industries above have been extracted and summarized as:

Boilers,

Utilization of Steam,

Electricity, and

Process Measurement,

Guidelines by industries are composed of chapters of:

Character of Guideline,

Characteristics of Energy Consumption,

How to manage Energy,

Rationalization of the Utilization of Energy.

#### 2. Character

The guideline has been made of the following characteristics:

##### (1) Purpose of Application

A) Reference for Plant Engineers conducting Energy Conservation Measures.

B) Manual for Energy Audit.

C) Criteria for Judging Progress of Rationalization.

D) Text for Seminars.

##### (2) Level of Description

The Level of Description has been made to have the engineers, from 4 to 5 years after graduating from universities and not engaged in a specific industry, understand.

##### (3) Scope of Description

In order to cope with the status quo of the Thai Kingdom, the description has been limited to processes and facilities existing in the factories surveyed.

##### (4) Contents

The description ranged over the basic technical items, referential numerical values, energy conservation techniques, referential improvement instances and records, and improvement target values.

##### (5) Future Treatment

There are many factories in the Kingdom of Thailand apart from those visited during the Study, where varied products are made by various processes. Energy

conservation technology is also in progress year after year, and new knowledge is born there. Accordingly, we expect that Thailand would integrate for itself the information obtained by the future factory energy audit, etc., one by one, on the basis of the present guideline, supplementing and expanding its technical prestige.

### 3. Characteristic of Energy Consumption by Industries

Here the description covered the manufacturing processes and major facilities and equipment for what are common to several factories surveyed. The writing level is tailored to fit the understanding of engineers not engaged in a specific industry, added, if necessary, with the basic matters, like theories, etc. For chemical industries, however, the process is varied combinations of unit equipment, inability to point out typical manufacturing processes, and explanations of each unit equipment could be found in later chapters.

Subsequently, as energy application state, energy consumption states of industries by power/thermal or by processes are described, and the points to emphatically be dealt are shown. In addition the actual record data in Japan are supplemented as much as possible, for comparing to the states in Thailand.

### 4. How to manage Energy

Energy conservation in the manufacturing industry could not obtain a sufficient results by facilities improvement only. All managers, technical staffs and operators are called essentially for grappling it with volitions.

Energy control is defined to be a systematic effort in achieving energy conservation. Major energy control items count the following four.

#### (1) Clarification of Management Policy

It is necessary first of all that the management indicate concrete targets and policies, and ask for the collaboration of its employees. Then its departments and sections plan execution programs corresponding to their respective roles, and start the practical activities going.

#### (2) Rearrangement of System for Promotion

As energy conservation activities involve a number of persons, appointment of a coordinator who deals with the entire progress as a core, as well as creation of a committee who conducts communication coordination and examination of problems within the plant, would be effective for promotion of energy conservation.

On the other hand, the QC circle involving operators is expected to contribute to energy conservation indirectly through not only energy conservation directly but also improvement of production and quality.

#### (3) Scientific and Systematic Activities

A scientific control, not limited to energy conservation in order to promote improvement in the plant, measures necessary operation data, analyzes the data and looks for the clue to solve problems, is indispensable.

Further, systematic activities for elevating the technical level gradually are necessary, by cycling so called "Deming Circle"—(1) to plan improvement counter-

measure based on data, (2) to execute, (3) to follow the results, (4) to conduct necessary modification and to execute again.

(4) Furnishing Education and Information

As the employees become to be able to point out not only problematical points, but also to propose improvement measures, the intentions to participate would further be elevated, so it will be necessary to reinforce the intra-company education by means of seminars and guidebooks.

Furthermore, in order to stimulate the desire for improvement, an activation of information exchanges among people of the same trade or with users is expected.

5. Rationalization of Energy Use

Significant energy conservation measures were selected from among those for every industry, taking notes of concrete methods, theories and evaluation methods, and include as many as possible successful instances in Japan.

Among major countermeasures, those which could be expressed quantitatively the degree of execution, for example air ratio, outer wall temperature of furnaces and equipment, combustion exhaust gas temperature, etc., have been quoted with judgement criteria showing desired execution levels.

Standard for energy consumption rate by industries vary greatly with manufacturing conditions and product specifications, rendering uniform displays nonsensical, but some products with relatively small differences in conditions or specification, e.g., writing paper, craft paper, center core and board, have been shown with unit targets. Also, some facilities with a relatively stable or constant manner of application, that is, induction melter, arc furnace and ceramic oven, have been indicated with unit values and instances of the results of heat balances by scales as references.

#### IV. Recommendation of Measures to promote Energy Conservation

##### 1. Introduction

- (1) Here, the word "energy conservation" means rationalization of energy use. So energy conservation is not to restrict energy consumption compulsorily, it is compatible with economic development and improvement in living standard.
- (2) Promotion of energy consumption in the Thai manufacturing industry has a great significance. It is, however, not appropriate to see changes in industrial structure as a means of attaining energy conservation. Regarding industrial structural changes as a postulate, energy conservation should be aimed at on the individual enterprise level.
- (3) Energy conservation is carried out by individual enterprises. The role that the government is expected to play is to motivate, support and encourage enterprises. The government's role is discussed here.
- (4) The objectives the government seeks to attain through energy conservation, and the priority given to energy conservation by the government, are not always the same as those of enterprise. In order to fill up such a perception gap, close communication and cooperation between the government and enterprises are indispensable.  
Here, the word "government" is used in a broad sense to include semi-governmental organs.
- (5) Though energy conservation is rather an unattractive task, it brings about unexpectedly substantial results which pay fully a considerable amount of funds and manpower.
- (6) The following are the immediate targets of the government's measures in the field of manufacturing industry.
  - Motivating entrepreneurs to carry out energy conservation
  - Improvement in energy conservation technical level of enterprises
  - Providing conditions for investment in energy saving equipment
  - Establishment of the Energy Conservation Center

##### 2. Motivating Entrepreneurs to carry out Energy Conservation

- (1) To develop energy conservation campaigns powerfully focusing on entrepreneurs.
- (2) To put the recording/reporting scheme on factory energy use situation into practice at the earliest possible date.
- (3) To adopt a commendation system where the government commends factories (workshop groups) excellent in energy conservation regularly.
- (4) The government's intervention in energy prices must be decided on with utmost prudence not only from the viewpoint of energy conservation but after an overall comparative study of the priorities of many policies which the Thai government now confronts.

3. Improvement in Energy Conservation Technical Level
  - (1) To train engineers who can play the central role in promoting energy conservation, by encouraging or obligating the appointment of energy manager for factories where more than a given amount of energy is used.
  - (2) To reinforce seminars on energy conservation technology and to hold them on a planned and systematic basis.
  - (3) As for distribution of printed matters on energy conservation technology, to lay emphasis on the following:
    - Fostering an all-around energy conservation technology monthly magazine
    - Collecting and introducing successful (unsuccessful) energy conservation cases
    - Promoting cooperation among the organs concerned
  - (4) To secure sources of energy conservation technical information by the following methods:
    - Creating a system to collect, accumulate and provide both foreign and domestic energy conservation technology information on a centralized and systematic basis.
    - Establishing constant information channels by permanent cooperative relations with overseas energy conservation promotion agencies
    - Organizing circles of experts on energy conservation technology, and applying their expertise to the government's information services.
  - (5) To support energy conservation exhibitions sponsored by makers and to disseminate, making use of the opportunity of exhibition, information.
 

Also, to hold regularly a dissemination convention of successful cases attained by small group activities.
  - (6) To elevate the technical level of the consultants as well as to expedite utilizing their expertise, by installing a system to officially qualify the consultants.
  - (7) To develop the existing and planned factory energy audit services favorably.
  
4. Providing Conditions for Investment in Energy Saving Equipment
  - (1) To reinforce the preferential tax systems for investment in energy saving equipment (tax deduction, accelerated depreciation).
 

Above all, specifying the subject equipments clearly, as well as making them known widely, is absolutely necessary.
  - (2) To install a system where the third-party organizations certify the competence of the equipment covered by the preferential tax system.
  - (3) To arrange and expand the financing system for investment in energy saving equipment, in accordance with the progress of energy conservation measures taken by the industries.
  - (4) To install a system where public organs offer guarantees to smaller enterprises.
  - (5) To increase the subject factories and industry types of the energy conservation demonstration program.
  - (6) To install a system where the government leases meters and universal equipment useful for energy conservation.

- (7) To give aids (subsidy, tax deduction, special depreciation, low-interest loan) to activate R&D of manufacturer, etc. of energy saving equipment and materials.
- (8) To expedite improvement of performance and spread of energy saving equipment and materials, by installing a system where the government approves equipment and materials fulfilling a certain standard of performance.
- (9) For the government to commend excellent energy saving equipment and materials.

5. Points to be kept in mind in operating an Energy Conservation Center

(1) The viability of the Center wholly depends on the confidence it acquires from the enterprises. In order to acquire the confidence, the Center must keep close relation with the enterprises, by

- Taking a measure (working rules and others) for not letting out any secrecy it gained from enterprises,

- Establishing a planning committee consisting of influential engineers from the industry,

- Providing chances of technical exchange through organizing study circles of corporate engineers,

- Keeping close relations with companies by sending useful information periodically to member companies,

- Sending useful information periodically to member companies.

Also, it must win a good appraisal among the industry through accumulating accomplishments useful for energy conservation in industry, by

- Employing capable engineers and sending them to overseas training. Salaries of almost the same level as private companies should be offered for getting them to stay longer.

- Organizing a brain trust consisting of private engineers, consultants and university professors for getting their advice.

- Arranging a system to accumulate and quickly provide much information. Introduction of overseas technologies is also important.

- Playing the role of go-between between the government and companies.

(2) In order for the Center to attain the long-term and stable evolution of its business, sound financial health must be maintained. Because of its characteristic dependence on software (technical information) for a source of income, a considerable amount of effort is required. To maintain sound finance, the Center must ensure the stable income, by

- Increasing the member companies (membership fee) through provision of useful service and special benefits to them,

- Encouraging the enterprises strongly to undergo factory energy audit periodically and to send their engineers to the seminar held by the Center,

- Taking charge of boiler inspection on behalf of the government.

Also, it must curtail the fixed expenses, by



- Reducing full-time employee and entrusting the business in executive phase (research, energy audit, technical guidance and seminar, etc.) to the outsiders as much as possible.

And also, it must diversify its business, by

- Developing active sales activities and training engineers who are competent for elaborate energy audit services that requires advanced technology, so that the Center may secure the client factories which are its major income sources,
- Directing its efforts also to the training and publishing business.

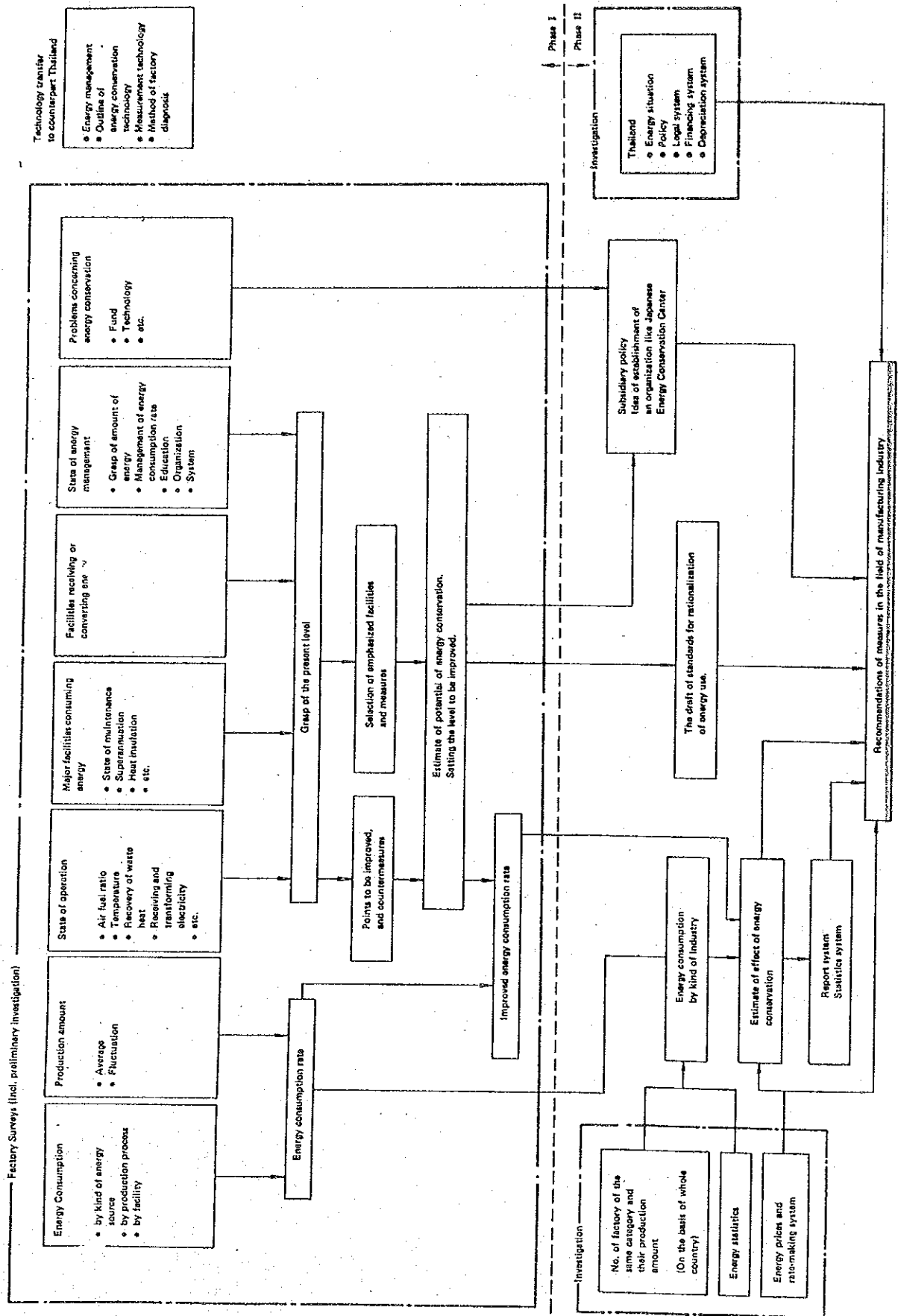
In addition, the center should,

- Coordinate with the other organs pursuing the same kind of business, so that competition may not arise,
- Ensure that the Center may be indemnified from any results ensuing from advice given at the time of energy audit.
- Insure against injury to any person or damage involved in energy audit.

## 6. Conclusion

It is only the first step for promotion of energy conservation to institute various systems and organizations. Until noticeable achievements are made, many years will be needed. What is particularly required is the government's lasting zeal and concern on energy conservation.

Fig. 1 Framework of Thailand's Manufacturing Industry Energy Conservation Investigation





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