Chapter 1 Outline of the Project

Section 1 Outline

1-1 Introduction

When we consider the high levels of economic growth in the Asian region, and the rapidly increasing consumption of energy mainly in the form of fossil fuels, the importance of this project is obvious. To survey various energy conservation technologies currently employed throughout Japanese industries, collate the relevant information, and present it as a database in an easily understandable format is an activity of fundamental importance in terms of providing technical information for the promotion of energy conservation in the developing countries.

Energy conservation in industrial processes is achieved through operational technology comprising a combination of measures covering manufacturing methods, functions of machinery and equipment, and operation and management technology.

This work updates “Energy Efficiency Technology in Japan (1995),” which is named “Energy Conservation Directory” for short and introduces the energy conservation technology adopted in energy-intensive industries in Japan. This work revises the directory format as necessary. Editing incorporates the opinions of specialists in the relevant fields.

1-2 Work Outline

(1) Updating the Previous Directory

Additions and deletions are made to the previous directory in order to incorporate recent developments. To do so, the survey was carried out as follows.

- To select energy-intensive industries appropriate for introducing to developing countries.
- To re-investigate energy conservation technology widely applied in Japan.
- To incorporate in the directory the information on the current status of implementation of each energy conservation technology in Japan, and its benefits on energy conservation.

(2) Revision of the Directory Format

On a data sheet for each technology, information on the amount of investment, contact points for inqury, and sites in Japan in which the technology has been implemented are added as far as possible, and its energy saving effects are expressed in a unified format.

(3) Revision of Editing Procedures

An energy conservation map is included, which shows the outline diagram of the process flow for each energy-intensive industry. Technologies considered to be representative of each industrial process are preferentially presented.

1-3 Committee Personnel

In addition to a comprehensive survey of existing energy conservation technologies, verification by specialists from each industry was considered necessary to ensure the reliability of the results of the survey. Spe-

cialists from each industry were therefore enlisted as members of the editing committee. See the list of committee members involved in revision of the directory.

Members of the Energy Saving Directory Revision Committee

Title&Industry represented	Name	Organization
Chairman	Takeshi Usami	Former Head of Resources and Environmental Technology General Research Institute Special Techinical Advisor, Japan International Cooperation Agency
Vice-chairman Iron and steel industry	Youichi Hanji	Chairman of Energy Policy Committee, Japan Iron and Steel Federation; Chief Engineer of Energy, Environmental Control & Energy Dept., Steel Technology Center, NKK Corporation
Pulp, paper, paper products manufacturing	Sadao Hori	Senior Technical Engineer, Japan Paper Association
Chemical industry	Yutaka Sawada	Director, Production Technology Group, Technical Affairs Department, Japan Chemical Industry Association
Petroleum and coal products manufacturing (Petrochemical industry)	Kenichi Toguchi	Chairman of Energy Saving Committee, Japan Petrochemical Industry Association; Manager, Facility Planning, Research and Technology Division, Tonen Chemical Corp.
Petroleum and coal products manufacturing (Oil refining industry)	Takeshi Ohsugi	Principal Engineer, Project Group, Refining Department, Japan Energy Corporation
Ceramic, earthen and stone products manufacturing	Motohiko Masunaga	Assistant General Manager, Production Control Department., Cement & Construction Materials Division, Mitsubishi Materials Corporation
Electricity generation	Toshio Manabe	General Manager, Engineering Department, The Federation of Electric Power Companies
Electrical machinery industry	Teruo Fukuda	Director & General Manager, Environment Department, The Japan Electrical Manufacturers' Association
Industrial machinery industry	Tsutomu Tanaka	Manager, Gvernment Affairs & Strategic Policy Develpment Office, JGC Corporation

Observer	Name	Organization
New Energy and Industrial Technology Development Organization	Kazushige Yokoyama	Deputy Director, First Cooperation Project Management Div., International Cooperation Center
	Takaya Ohto	Chief Researcher

Secretariat	Name	Organization
Energy Conservation Center, Japan	Yozo Takemura	Managing Director
	Kazuki Tanabe	General Manger, International Cooperation Department
	Yousuke Natori	Manager, International Cooperation Department
	Yasunori Serizawa	General Manager, International Engineering Department
	Taichiro Kawase	General Manager, International Engineering Department

Section 2 Project Plan

2-1 Project Objectives

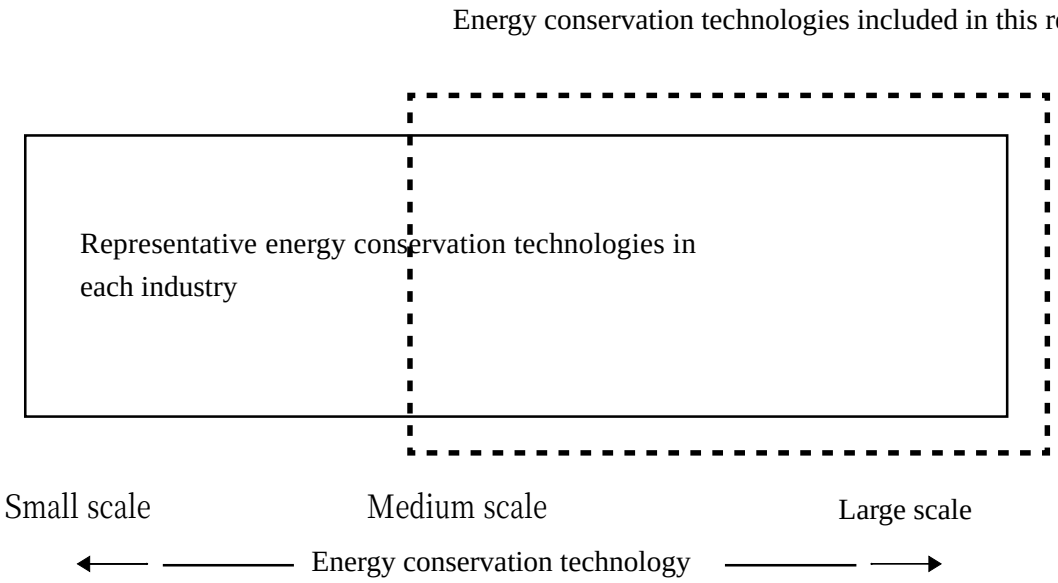
The fundamental objective of this project is to produce a directory covering representative energy conservation technologies proven in Japan for use in promoting energy conservation in the developing countries (primarily Southeast Asia). A further objective is to cover energy conservation technologies which could be candidates for being implemented as model projects under the support of NEDO as part of future Japan's international contributions.

2-2 Items Requiring Revision

The following points were considered by the directory revision committee.

2-2-1 Scale of Technologies to be Covered

The criteria for selecting the technologies to be covered in the current revision differs slightly depending upon the industry in which they are applied, but basically it covers energy conservation technologies of medium to large scale.



2-2-2 Industry Classification and Arrangement

Emphasis are placed on energy conservation technologies in the energy-intensive industries such as iron and steel, cement, pulp and paper, and chemical industries, however fields such as the electric furnace process in the iron and steel industry, food processing, and textiles are also included in consideration of the situation prevailing in the developing countries.

When wide varieties of processes are employed in a singe industry sector such as the chemical, food processing, and textile industries, they are classified into sub-sectors within each industry.

As for the order of the arrangement of industries, there is a variety of methods. A typical one is the JIS Industrial Classification which was compiled based on the survey by the Japan Standard Survey Association. In this directory, however, they are generally arranged in the order of intensity of energy consumption in each industry. The need for an easily understandable classification required slight modifications: for

example, the non-ferrous metal industry follow the iron and steel industry in listing.

2-2-3 Technology Classification and Selection of Technology Items

Both technologies used in the production processes for a specific industry and commonly applicable to many industries are handled as follows.

- To clarify the criteria used to select technology for inclusion.
- To examine technologies previously included for removal or inclusion.
- To add new items.
- New items proposed by committee members and specialists from each industry
- Technologies implemented in NEDO energy conservation model projects
- Appropriate technologies employed in energy conservation machinery and equipment designated by the energy investment tax credit system.
- Other representative and universally applicable energy conservation technologies, taking into consideration the level of promulgation and penetration within industries
- To classify technology items.
- Technology specific to a certain industry
- Technology commonly applicable to many industries

2-2-4 Directory Format

The directory format includes the following.

- Serial number, industry and technology classifications expressed in an easily understandable manner
- Appropriate technology title
- Economics, scale of investment, efficiency of investment (investment payback period, etc.).
- Effect of improvement (in crude oil equivalent, etc.).
- Contact point for further information
- Example sites where a certain technology was verified or installed
- Conceptual diagram of the equipment before and after improvement

2-2-5 Editing Procedure

The directory are edited in accordance with the following, and importance is placed on ease of understanding and use, and effectiveness in terms of visual impact.

- Improvement effects are summarized in list format.
- Applications of a technology across multiple industries are also described in list format.
- Basic production process diagrams are added for each industry.
- Points at which energy conservation technologies are employed are indicated in the process diagrams.
- Each technology is described on one sheet, with conceptual technical diagrams to ensure easy understanding.
- Colors are partially used for indicating the improved sections, etc.

2-3 Project Organization

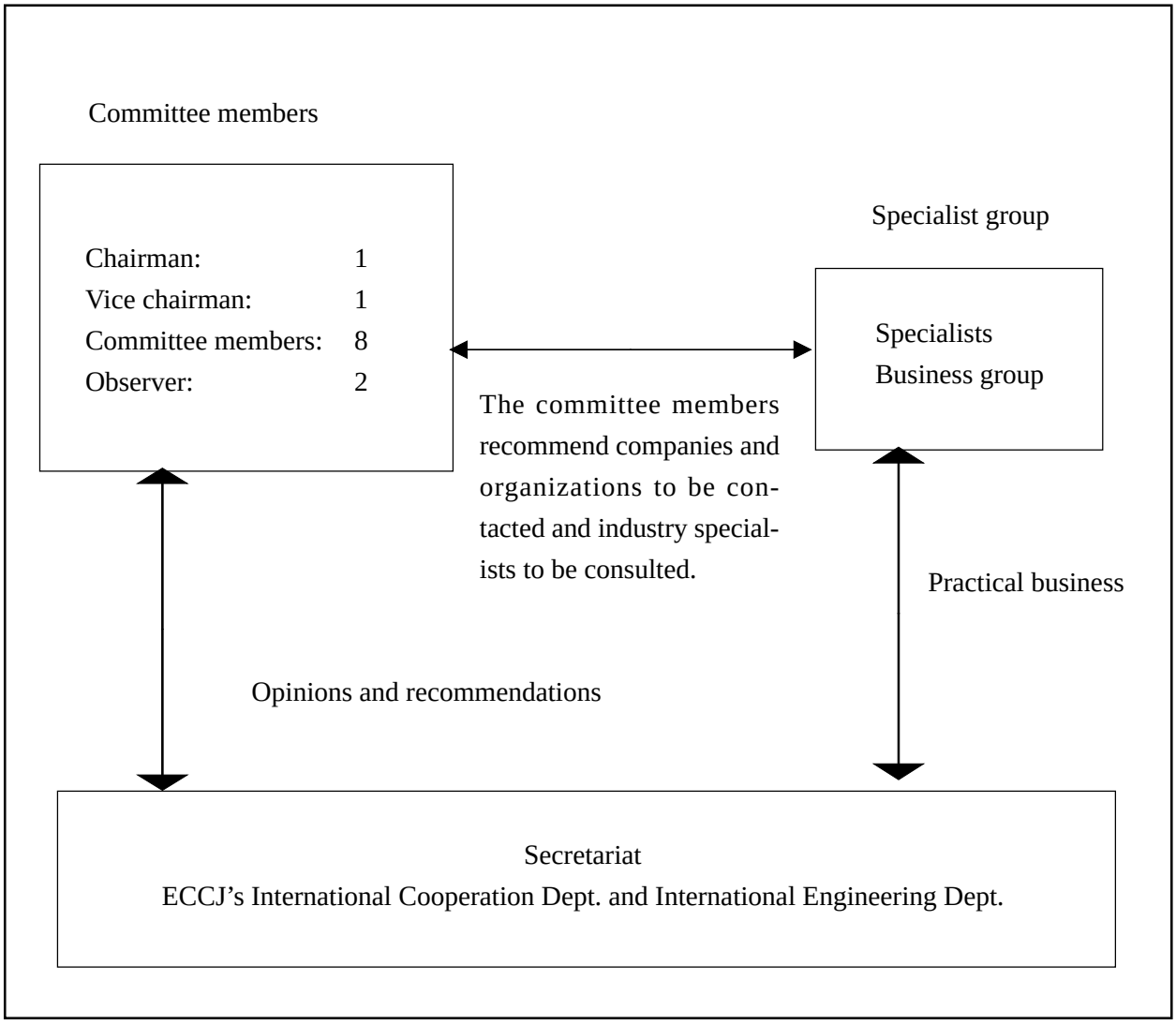
The project was promoted by a committee organization encompassing industry representatives, secretariat personnel, and specialists. Participation of industry representatives and specialists was required to ensure the reliability of content.

2-3-1 Committee and Work Organization

The organization to promote this project was as follows.

Committee and Work Organization

[Committee]



2-3-2 Work Content

The work was carried out through cooperation among committee members from energy-intensive industries, the specialist group, the business group for database development, etc., the secretariat office, and other related industry organizations contacted by the specialist group and secretariat office. The primary work is as follows.

(1) Committee

- To deliberate on the contents of the revised Energy Conservation Directory.
- To submit technical information and data related with respective industries.
- To recommend companies and organizations to be contacted and specialists to be consulted in each industry surveyed.

(2) Specialist group

- To contact specialists in target industries.
- To collect information and data on energy conservation technology from specialists in target industries and published materials.
- To analyze technical data and collect additional information when necessary.
- To collate the information into technical data sheets.

(3) Business group

- To produce the text and data sheets for Japanese edition.
- To produce the text and data sheet for English edition.
- To produce CD-ROM edition.

(4) Secretariat Office

- To coordinate overall activities.
- To share the work with the specialist group.
- To conduct committee meetings and editing conferences.

An outline of the project activities is shown below.

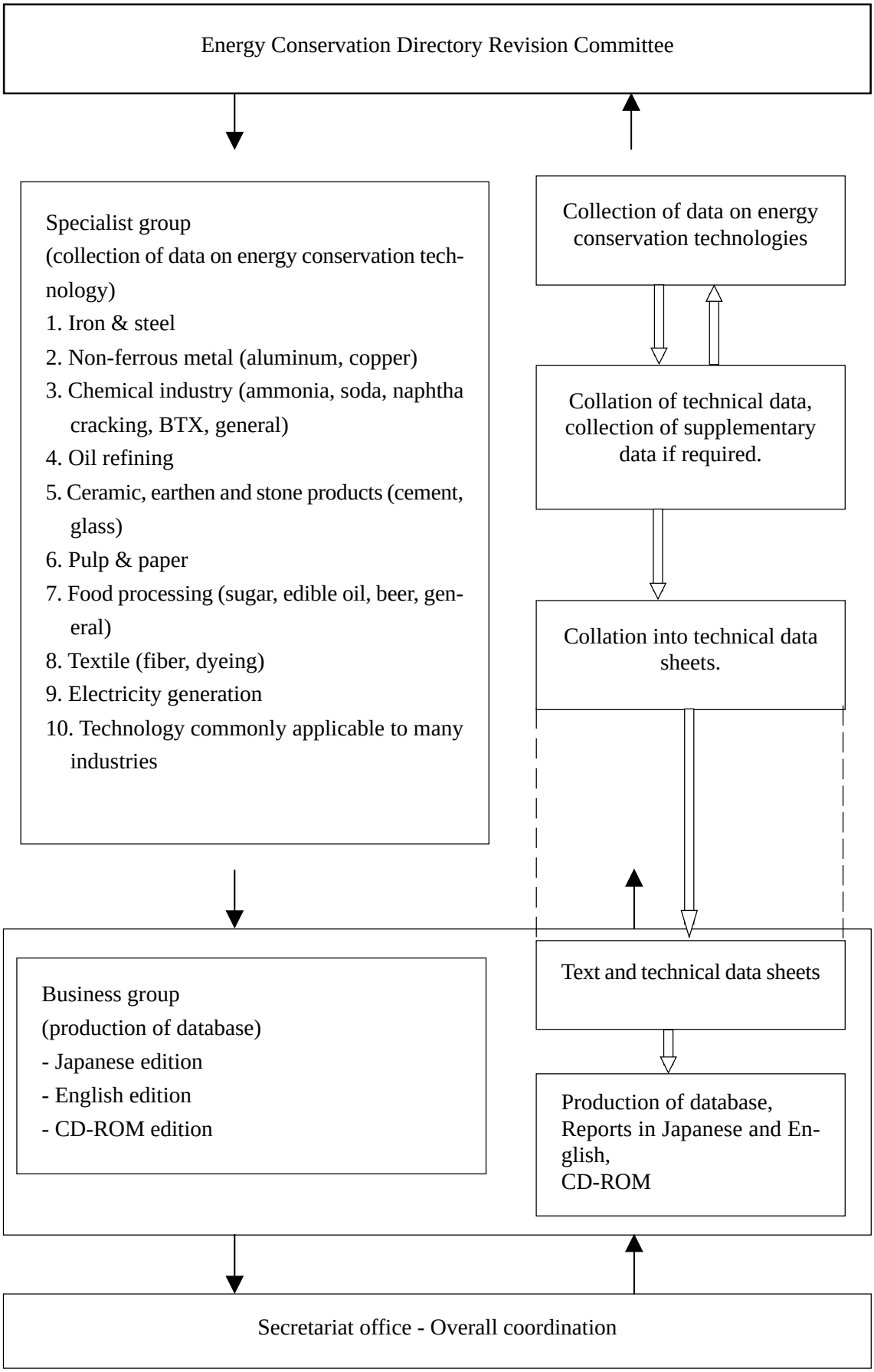
2-4 Work Schedule

The work was conducted between July 21, 1998 and February 26, 1999, during which time three meetings of the committee were held.

• September 2, 1998	First committee meeting	Deliberations on, and verification of, business direction.
• October 7, 1998	Second committee meeting	Deliberations on, and verification of, mid-term progress.
• November 18, 1998	Third committee meeting	Final deliberations and verification.

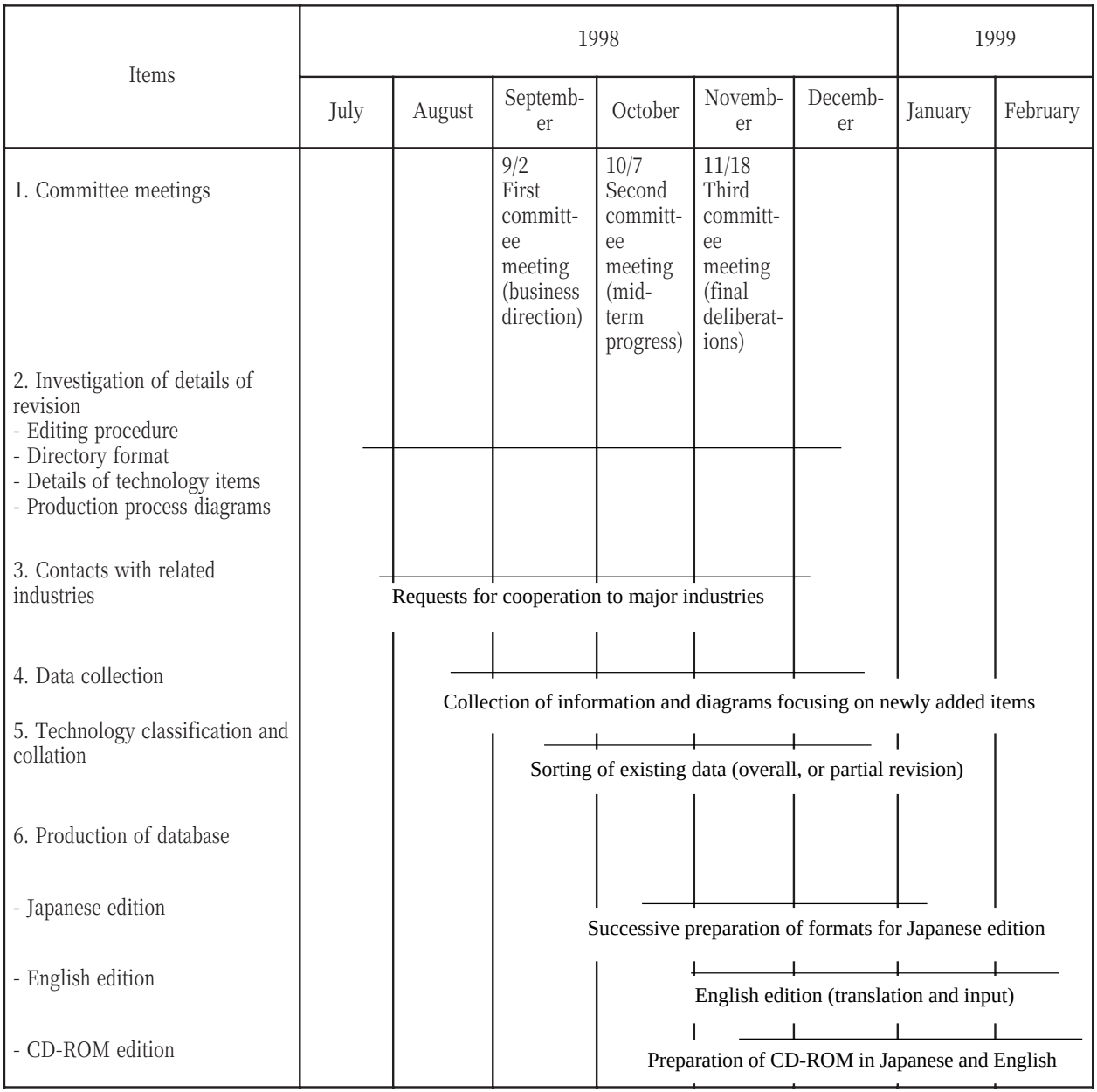
The overall work schedule is shown in the following pages.

Project activities



Business Implementation Schedule

(Implementation period: July 21, 1998 - February 26, 1999)



Note : The previous directory was prepared between October 1993 and December 1994.

2-5 Industries Covered in Directory

Energy conservation technology is often developed in a close relationship with production systems in each industry. These production systems are very similar within the same industry, and it is therefore appropriate that the Energy Conservation Directory be classified by industry.

The representative industries covered in this revision are the five major energy-intensive industries (iron and steel, pulp and paper, chemical, oil refining, cement). Other industries are added, which deems to be relevant to the situation of developing countries.

General-purpose machinery and equipment such as blowers, compressors, and pumps are widely used in many industries, and a category named “Many Industries” is therefore introduced.

Waste treatment is classified into either energy recovery or materials recovery. Since a focus on energy recovery contributes to energy conservation, it is considered appropriate to include waste treatment in the “Many Industries” category.

2-5-1 Industry Classification

Industry classification and names are basically in accordance with the JIS Industrial Classification, however slight modifications are introduced to ensure familiarity and ease of understanding. The industry classification employed in the directory is as follows. The numbers are from the JIS classification.

12. Food manufacturing industry
14. Textile industry
16. Timber and wood products manufacturing industry
18. Pulp and paper, and paper products manufacturing industry
20. Chemical industry
21. Petroleum and coal products manufacturing industry
25. Ceramic, earthen and stone products manufacturing industry
26. Iron and steel industry
27. Non-ferrous metals manufacturing industry
28. Metal products manufacturing industry
29. General machinery and tools manufacturing industry
30. Electrical machinery and tools manufacturing industry
31. Transport machinery and tools manufacturing industry

Electricity generation
Many industries (including waste treatment)

The relationship between the industries covered in the directory and the JIS Industrial Classification is as follows.

Relationship Between Industries Covered in the Directory and the JIS Industrial Classification

Ministry of International Trade and Industryד s Industrial Classifications (JIS)	Directory prior to revision (number of listed items)	Directory (proposed revision) (including NEDO energy conservation projects)	Remarks	Energy consumption *
				(in crude oil equivalent)
12. Food manufacturing industry	Sugar (10)	Sugar, etc	Addition of technical items under consideration	4,904,000kl
13. Drinks, tobacco, and animal feeds manufacturing industry				1,337,000kl
14. Textile industry (except for clothing and other textile products)	Textiles, spinning (25)	Textiles, spinning, etc	Addition of dyeing under consideration	2,355,000kl
15. Clothing and other textile products industry				311,000kl
16. Timber and of wood products manufacturing industry (except for furniture)	Plywood (9)	Plywood, etc		289,000kl
17. Furniture and fittings manufacturing industry				156,000kl
18. Pulp and paper, and paper products manufacturing industry	Pulp and paper (33)	Pulp and paper		14,733,000kl
19. Publishing, printing, printed products manufacturing industry				658,000kl
20. Chemical industry	Chemical (synthetic ammonia) (30)	Chemical (synthetic ammonia etc) *	Addition of technical items under consideration	58,143,000kl
		Petrochemical		
	Caustic soda (6)	Caustic soda		
21. Petroleum and coal products manufacturing industry	Oil refining (15)	Oil refining *		37,280,000kl
22. Plastic products manufacturing industry				2,213,000kl
23. Rubber products manufacturing industry				838,000kl
24. Tanning, leather products, and fur products manufacturing industry				37,000kl
25. Ceramic, earthen and stone products manufacturing industry	Cement (25)	Cement *		
	Glass (8)	Glass		
26. Iron and steel industry	Steel (45)	Steel *		89,497,000kl
27. Non-ferrous metals manufacturing industry		Non-ferrous metals		3,507,000kl
28. Metal product manufacturing industry				2,007,000kl
29. General machinery and tools manufacturing industry				2,007,000kl
30. Electrical machinery and tools manufacturing industry				4,568,000kl
31. Transport machinery and tools manufacturing industry				4,719,000kl
32. Precision machinery and tools manufacturing industry				306,000kl
34. Other manufacturing industries				227,000kl
	Electricity generation (coal-fired) (31)	Electricity generation (coal-fired) *		
	Many industries (70)	Many industries		
		Waste treatment		
			* Including 16 NEDO energy conservation model projects. ** Machinery and equipment designated by the energy investment tax credit system are considered.	

* Source : Ministry of International Trade and Industry – Research and Statistical Department (published 1996 March) “Statistical Tables for the Structure of Petroleum Consumption - 1996 (commerce, mining, and industry)”

2-5-2 Contacts with Industries Covered

The following contacts were made in order to obtain information and data on energy conservation technology in the relevant industries.

(1) Searches and investigation of materials

- Searches of reference materials held by the Energy Conservation Center, Japan.
- Investigations using database search facilities for specific technologies.
- Observations of committee members and specialists.

(2) Contacts with related industries

- Visits to, and question-and-answer sessions with, associations of the major industries represented by committee members.
- Visits to, and question-and-answer sessions with, other industry associations and relevant companies.
- Investigation of industry publications, directories, and technical reports, etc., on the advice of the industry associations.

(3) Others

- Understanding in accordance with suggestions of individual specialists.

The contact points in the following pages were approached for each industry.

Contact Points in Each Industry
for Editing “Directory of Energy Conservation Technology in Japan” 1/3

Industry Classification		Related Industries
(intermediate classification)	(minor classification)	
12. Food manufacturing industry	- Sugar	Sugar Manufacturing Industry Association
	- Edible oil	
	- Fermentation and tea processing	Bio Industry Association
	- Beer	
	- Canning and bottling	Canning Association
	- General foods (instant and others)	
14. Textile industry	- Textiles and spinning	Textile Association
	- Dyeing	Japan Dyeing Association
16. Timber and wood products manufacturing industry	- Plywood and structural timber	Wood Information Center Wood Drying Facility Association
18. Pulp and paper, and paper products manufacturing industry	- Pulp and paper	Japan Paper Association Pulp and Paper Association
20. Chemical industry	- Synthetic ammonia	Japan Chemical Industry Association Japan Ammonia Association
	- Caustic soda	Japan Soda Industry Association
	- Organic	
	* Petrochemicals	Japan Petrochemical Industry Association
	* Plastic	
	* Synthetic rubber (rubber products)	Japan Rubber Industry Association
	* Paints	Japan Paint Industry Association
	* Surfactants	Japan Chemical Industry Association Japan Soap and Detergent Industry Association
	* Dyes	Japan Chemical Product Industry Association
21. Petroleum and coal products manufacturing industry	- Oil refining	Petroleum Association of Japan
	- Coal related * Coal briquettes * Bio-coal	NEDO, CCT, Coal, Coal Utilization Center
22. Plastic products manufacturing industry	- Plastic products * Melting * Extrusion and injection * Cooling	Japan Plastics Machinery Industry Association

Contact Points in Each Industry
for Editing “Directory of Energy Conservation Technology in Japan” 2/3

Industry Classification		Related Industries
(intermediate classification)	(minor classification)	
25. Ceramic, earthen and stone products manufacturing industry	- Cement	Cement Association
	- Glass	Plate Glass Association
	- Refractories	Refractory Association
	- Pottery * Tiles * Ceramics * Earthenware	Japan Ceramics Association
26. Iron and steel industry	- Iron and steel	Japan Iron and Steel Federation
27. Non-ferrous metals manufacturing industry	- Aluminum * Melting * Rolling * Die-casting	Japan Aluminum Federation
	- Copper refining	Japan Brass Makers Association
	- Processing	Semi-formed Materials Center
28. Metal products manufacturing industry 29. General machinery and tools manufacturing industry 30. Electrical machinery and tools manufacturing industry 31. Transport machinery and tools manufacturing industry	* Can manufacturing * Machinery and tools * Press equipment * Domestic electrical appliances * Motor vehicles * Paints * Heat treatment	Japan Machinery Federation Electric Enterprise Federation Japan Industrial Machinery Association
Electricity generation	* On-site power generation (coal) * Utility (coal-fired) * Gas turbine * Combined * Re-powering * NEDO energy conservation model projects	Japan Electrical Machinery Association Electric Enterprise Federation Japan Gas Association

Contact Points in Each Industry
for Editing “Directory of Energy Conservation Technology in Japan” 3/3

Industry Classification		Related Industries
(intermediate classification)	(minor classification)	
Many industries	* Drying * Plant air-conditioning and refrigerating * Co-generation * Waste water treatment * Steam generation and use * Combustion equipment * Waste heat recovery * Heat exchange * High pressure air * Electricity * Measurement * Distillation * Reaction (catalysts) * Solid substance handling technology (petroleum related)	Wood Drying Facility Association Japan Refrigeration and Air-conditioning Association Japan Cogeneration Center
	* Industrial furnaces * Sintering furnaces * Waste products	Industrial Furnace Association Clean Japan Center

* Note :

1. Intermediate classification numbers are in accordance with JIS industrial classification numbers.

2. Information on those industries for which related industry associations and companies are not listed above was obtained from reference materials.

Related industry associations

Section 3 Industry and Technology Classifications and Descriptions

3-1 Industry Classification

(1) Industry Names

- Names employed for JIS industrial classification were abbreviated following common understandings in industries.

Examples :

12. Food manufacturing industry	- Food
14. Textile industry	- Textile
18. Pulp and paper, and paper products manufacturing industry	- Pulp & paper
20. Chemical industry	- Chemical
21. Petroleum and coal products manufacturing industry	- Oil refining
25. Ceramic, earthen and stone products manufacturing industry	- Ceramic
26. Iron and steel industry	- Iron & steel
27. Non-ferrous metals manufacturing industry	- Non-ferrous metal

(2) Industry codes

- Each industry (including those with sub-sector classifications) is generally expressed by a 2-letter code.

Examples :

Iron & steel industry	: IS
Chemical industry: Ammonia	: CA

- For ‘Ceramics, earthen and stone products’, C for Ceramics should be used, however to prevent confusion with the chemical industry the letter Y from the term Yougyou (Ceramic industry in Japanese) is employed.

(3) Order of Arrangement of Industries

The order of arrangement of industries in this directory is as follows to ensure ease of understanding.

- Industries are generally listed in the order of decreasing energy-intensity.
- Non-ferrous metal industry is listed immediately after the iron and steel industry.
- Intermediate classifications (sub-sectors) are introduced for the non-ferrous metal, chemical, ceramic, food, and textile industries.

  Naming in (1) above also applies to intermediate classifications (sub-sectors).

  Example : Non-ferrous metal industry Aluminum
  Copper
- Energy conversion and distribution sectors such as the supply of electricity, gas, and heat, are covered under electricity generation, and are listed after the industries consuming energy.
- Waste treatment is covered under service industry in the JIS classifications. As it cannot be realistically placed in the energy conversion sector, it is included under the “Many Industries” category. Co-generation is considered as an utility and is therefore also included under the “Many Industries” category.
- General and electrical machinery and equipment have a particularly close link with those employed in the electricity generation sector and were therefore considered to be included there. However after much consideration they are distributed among other industrial sectors and “Many Industries.”

Notation for industry classifications, and the relevant industry codes are listed below.

Industry classification and codes

Classification		Code
Iron & Steel		IS
Non-ferrous		N
	Aluminum	NA
	Copper	NC
Chemical		C
	Ammonia	CA
	Soda	CS
	Naphtha cracking	CN
	BTX	CB
	General	CG
Oil refining		OR
Ceramic		Y
	Cement	YC
	Glass	YG
Pulp & Paper		PP
Food		F
	Sugar	FS
	Beer	FB
	Edible oil	FO
	General	FG
Textile		T
	Fiber	TF
	Dyeing	TD
Electricity Generation		EG
Technologies commonly applicable to many industries		MI

3-2 Technology Classification

(1) Factors to be considered in introducing energy conservation technology

The cost to produce a certain product is basically composed of three elements: the material cost, labor cost, and depreciation cost.

As the energy cost is included in the material cost, it is apparent that to reduce the energy consumption through the use of energy conservation technology results in a reduction in the production cost.

On the other hand, the use of energy conservation technology naturally requires investment in machinery and equipment, and depreciation of that investment must also be considered as it is a factor to increase the production cost. When introducing energy conservation technology, it is therefore extremely important to consider the mutual relationship between the reduction in the energy cost and the increase in the depreciation cost.

(2) Definition of energy conservation technology

Energy conservation technology for industries is defined as technology which allows the efficient use of energy (including energy conservation) within the current situation prevailing in a particular country.

The rate of energy conservation by various technologies varies considerably from a level of 1-2% to more than 20-30%. Some energy conservation technologies are characterized by a low rate of energy conservation but can generate a large amount of energy saving when the production volume or scale of operation is large. It is therefore necessary to determine the criterion both in the rate and volume of energy saving when investigating a particular technology, and to consider it to be energy conservation technology only if its performance exceeds these criterion.

We have generally used the following criterion for inclusion in the directory, based on the current situation in Japan.

- Rate of energy conservation : more than 10%
- Energy saving: more than 10 million yen per year (approximately 500kl/year in crude oil equivalent)

3-2-1 Technology Classification and Codes

Energy conservation technology employed in industries can be classified in various manners as follows.

- Energy conservation technology by energy-efficient function
  - * Highly energy-efficient technology (improved efficiency of equipment)
  - * Waste energy recovery technology (waste heat recovery, etc.)
- Energy conservation technology by process
  - * Energy conservation technology by production process in each industry

  Production processes in a certain industry may divided into a number of branches by the products they produce as is the case in the chemical industry (e.g., ammonia, naphtha cracking, BTX), or follow a linear series of different processes as is the case in the iron and steel industry (e.g., coke-making, sintering, iron-making, steel-making).
- Energy conservation technology by machinery and equipment, and operation
  - * Machinery and equipment which effectively use energy

* Machinery and equipment which conserve energy
* Improvements in operation management and control method

In this directory, when primary processes in an industry (e.g., sintering in iron and steel making) are needed to be described for ease of understanding, they are referred to in the column of the technology title on the technology data sheet, and energy conservation technology in each industry and its primary production processes is recorded under the following technology classification.

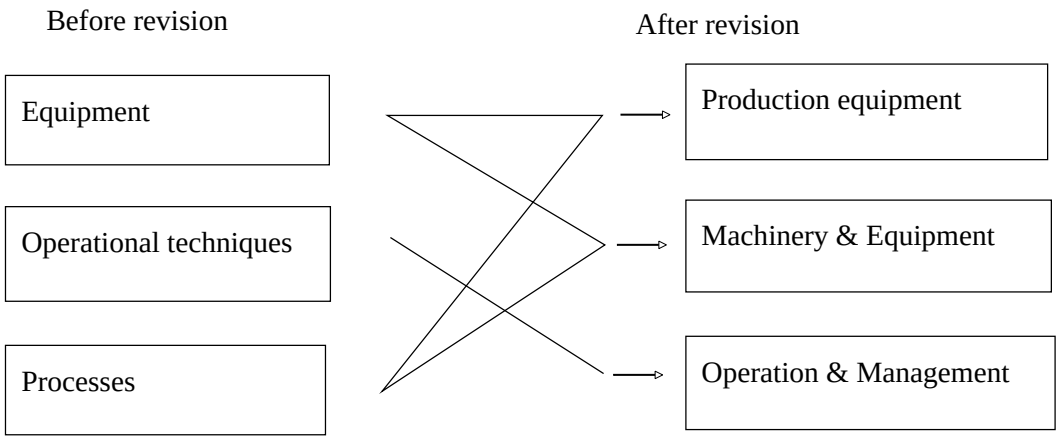
(1) Production Equipment
This category includes production equipment which makes possible conservation of energy through integration of two or more consecutive processes, elimination of part of processes, or increased process speed, and which provides the energy saving of more than 10% or a short investment payback period of less than 3 years.
A continuous casting machine (CC) and direct rolling equipment are examples in the iron and steel industry.

(2) Machinery & Equipment
This category includes auxiliary machinery and equipment (e.g., blowers) required to be used in association with the primary production equipment, or energy-conserving machinery and equipment (e.g., waste heat recovery equipment for an industrial furnace) to be added to the production equipment, which provide the energy saving of more than 10% in comparison with conventional equipment. Energy-conserving machinery and equipment which are currently used only to a limited extent are also included in this category if they are expected to be used to a greater extent in the future due to their potentiality or expected support from various quarters (e.g., equipment covered by the energy investment tax credit system of Japan).
Examples in the iron and steel industry are: waste heat recovery from main exhaust or cooler exhaust of a sintering machine, and coal drying and moisture-control equipment for coke ovens. The latter is covered by the energy investment tax credit system.

(3) Operation & Management
This category includes improvements of a limited extent in operation and management methods for existing machinery and equipment which allow operation with a fewer number of machines, over a shorter time, or at a better distribution of load, etc, and optimize the production system. They need to provide the energy saving of more than 10% in comparison with conventional operation and management methods.
Examples in the iron and steel industry are automatic combustion control for coke ovens, and blast air valve control.

Remarks :

Comparison of technology classification before and after the revision is as follows.



(4) Technology classification codes

Technology classification in this directory generally employs 2-letter codes as follows.

Technology Classification	Code
Production Equipment	PE
Machinery & Equipment	ME
Operation & Management	OM

3-2-2 Classification and Code for Technologies Commonly Applicable Many Industries

Technologies commonly applicable to many industries or many primary processes are recorded in the “Many Industries” category. However, for example, in the food industry, common technologies are frequently employed such as drying equipment and co-generation equipment. When it is difficult to accurately classify these technologies as unique to a specific industry or as commonly applicable to many industries, they are classified in accordance with the general understandings.

(1) Classification of common technologies

Common technologies can be classified into many categories as follows.

Technical category	Heat equipment	Electrical equipment	Heat & electrical equipment
Pumps and compressors		○	
Fans and blowers		○	
Power transmission and gearboxes		○	
Combustion equipment	○		
Heat exchangers	○		
Steam generating and using equipment	○		
Thermal insulation and refractories	○		
Co-generation	○	○	
Electrical equipment		○	
Plant air-conditioning		○	
Instrumentation and control		○	
Energy management systems		○	
Waste recovery			○

Common technologies cover a wide variety of categories which are classified as heat equipment, electrical equipment, etc. They are further classified into improvements in equipment and operation in terms of energy conservation technology.

(2) Codes for common technologies

While it is possible to classify the common technologies as described above, this results in classification into categories which are too fine. To simplify matters, common technologies are treated as one of the industry classifications. Also in the same manner as in industry classification, they are classified into production equipment, machinery & equipment, and operation & management.

While not noted specifically, various common technologies are listed in the order of heat-related equipment, electricity-related equipment, and waste recovery equipment.

Technology Classification	Code
Technologies commonly applicable to many industries (Many Industries)	MI
Remark The above is further classified into PE, ME, and OM.	

(3) Criteria for listing common technologies

Common technologies are widely applied for a general purpose while being small in scale in comparison with energy conservation technologies in the primary production processes of each industry. Therefore, common technologies comparatively small in the scale of investment are also listed. The criteria for listing common technologies is as follows.

- Energy saving of more than 10% in relation to conventional machinery, equipment, and operation.
- Energy saving of more than 100kl/year.in crude oil equivalent.
- Investment of more than 5,000,000 yen per unit of energy conservation machinery and equipment.
- Representative examples of similar technology are listed. Reference examples are listed in the Remarks column if necessary.
- Systems constructed to realize energy conservation with integrated instrumentation.
- Independent instrumentation and control devises are not included (e.g., oxygen meters, heat flow meters).
- Devises which increase the overall energy efficiency of a plant when installed in a large number, but one unit is very small in scale are not listed.

  Examples: steam drain traps, individual burners, lighting equipment, and minor modifications in equipment associated with activities for operational improvements (small damper-control devises, trimming of pump impellers, etc.).
- Air-conditioning equipment, lighting equipment, and other domestic appliances used in households are not listed.
- Some items are included at the discretion of specialists and committee members from the various industries.

3-3 Outline of Technology Item Codes

The code for each technology item is constructed by combining the industry classification code, technology classification code, and series number, in this order.

Example 1

Technology item: Improvement in segregated charging of sintering materials

* Industrial classification	: Iron & steel	(code)	IS
* Technology classification	: Production Equipment	(code)	PE
* Series number.	: 1		

The technology item code is therefore IS-PE-1.

Example 2

Technology item: Immersion-melting plating furnace

* Industrial classification	: Non-ferrous metal: Aluminum	(code)	NA
* Technology classification	: Production Equipment	(code)	PE
* Series number.	: 1		

The technology item code is therefore NA-PE-1.

There is a system of allocating series numbers in the 100s for one series of processes, in the 200s for another series, etc. However in this directory each technology classification begins from 1 to simplify matters.

Section 4 Configuration of the Directory

Numbers of items listed in the directory are shown below.

Total by Technology Classification

Classification		Production Equipment	Machinery & Equipment	Operation & Management	Total by Industry Classification
Iron & Steel		12	14	7	33
Non-ferrous	Aluminum	-	5	3	8
	Copper	-	2	1	3
Chemical	Ammonia	6	5	3	14
	Soda	3	2	2	7
	Naphtha	-	5	4	9
	BTX	-	4	4	8
	General	2	6	-	8
Oil refining		-	6	17	23
Ceramic	Cement	8	5	-	13
	Glass	2	1	1	4
Pulp & Paper		6	15	3	24
Food	Sugar	5	1	1	7
	Beer	1	1	-	2
	Edible oil	-	-	2	2
	General	3	3	-	6
Textile	Fiber	7	1	-	8
	Dyeing	4	1	-	5
Electricity Generation		6	9	6	21
Many industries		-	31	8	39
Total by Industry Classification		65	117	62	244

Energy saving effects and applicable industries are listed as follows for each technology item.

4-1 Summary of Energy Saving Effects

Energy saving effects for technology items in each industry are listed.
Following is an example of the list.

Page	Serial No.	Item No.	Technology Item/Title	Outline	Energy saving effect
86	1	IS-PE-1	Improvement in segregated charging of sintering materials	By improving segregated charging of sintering materials, return ores are reduced.	Specific coke consumption 2.8% reduced, coal addition rate 0.54% reduced.

4-2 Summary of Applicable Industries

Industries to which each energy conservation technology is applicable are listed as follows.

Page	Serial No.	Item No.	Iron & Steel	Non-ferrous	Chemical	Oil Refining	Ceramic	Pulp & Paper	Food	Textile	Electricity Generation	Many Industries
86	1	IS-PE-1	◎									
118	33	IS-OM-7	◎	○	○	○	○	○	○		○	○

Note
IS-OM-8 : Technology item Centralized Energy Management and Control.
◎ : Listed as a technology item for this industry.
○ : Applicable to those other industries, but not listed in this directory as such.

4-3 Primary Process Diagrams for Each Industry

Primary process diagrams which provide outlines of the process flows and equipment employed there are included for each industry, and each technology item introduced in this directory is indicated approximately at a point where it is implemented for ease of understanding.

4-4 Technology Data Sheets for Each Technology

A data sheet for each technology item generally contains following information.

- Technology item code : As per “3-3 Outline of Technology Item Codes”
- Industry classification : As per “3-1 Notation for Industry Classifications”.
- Technology classification : As per “3-2-1 Technology Classification and Codes”.
- Title: A title which accurately indicates the content of the technology. When ease of understanding requires that a process be noted, the name of the process was included in the title.
- Energy Source : Primary energy sources subject to conservation are indicated.
- Practical Use:The common understanding within the industry on the timing with which this technology was first put in general use or implemented as a practical technology is indicated.
- Outline: An outline of the energy conservation technology is indicated.
- Principle & Mechanism: The principle and operation mechanism which make this an energy conservation technology are briefly explained. If the “Outline” and the “Principle and Mechanism” cannot be readily separated, both may be described together.
- Description: Generally the situations before and after improvement are described, with appropriate diagrams explaining the structure of the machinery and equipment, their shapes, a system diagram, and other technical details. When the improved section is needed to be clearly indicated in the diagram after improvement for ease of understanding, it is enclosed within a red dotted line.
- Energy saving effects: The effects or benefits of the improvements are generally expressed in crude oil equivalent. If this method presents difficulties, it is noted.
- Economics, Equipment: It is very difficult to exactly indicate the economic effect of an energy saving technology. The values indicated here are, therefore, gross approximations based on the knowledge and general understanding of industrial experts, and are included here only as a rough guide for reference purpose. In cases where it is not possible to indicate values due to requests from industries and other reasons, the columns are left blank.

  1) Investment amount: The investment amount indicated is generally for the machinery and equipment with a capacity and specifications referred to in the data sheet. An approximate amount is indicated in the unit of a million yen. Principally, the amount covers only the cost of machinery and equipment. Material, labor, and utility costs for foundation work, equipment installation, and adjustment with neighboring equipment, that is, so-called installation costs, widely vary depending on various conditions such as countries, sites, and economic conditions. Therefore they are not included in the investment amount. However, when the cost of equipment such as energy-saving production equipment is closely related with the installation cost and the two are not separable, an investment amount that includes the installation cost is indicated.

  2) Improvement effect: Basically, the effect of energy saving is indicated in the approximate monetary value in the unit of a million yen. When there are effects such as quality and yield improvements in addition to energy saving, they are indicated; with monetary values when possible. Calorific values of various types of energy used for calculating an energy-saving effect, for example 9,250 kcal/L for crude oil, are from the Comprehensive Energy Statistics of the Agency of Natural Resources and Energy. Values in crude oil equivalent are from the Article 11 of the Law for Rationalization of Energy Use. When converting an energy-saving effect

into a monetary value, the wholesale price of heavy oil is used, as the energy consumed in industrial facilities is mostly heavy oil, and it has the same level of calorific value as crude oil (9,300 kcal/L of A-class heavy oil vs. 9,250 kcal/L of crude oil). The wholesale price of heavy oil differs (currently 18,000 to 25,000 yen/kL) depending on areas, transportation methods, and transaction scales.

3) Investment payback: This is an approximate number of years required for the initial investment to be fully paid back by the improvement effect (cost saving). Investments for energy-saving machinery and equipment are mostly paid back by energy saving. However, in some cases for energy-saving production equipment, production yield enhancement and other operational improvements are also incorporated in the investment payback calculation.

- Remarks : Related items and examples of applications in other industries are indicated.
- Example sites: Major sites and companies where the technology is implemented are listed. When the technology is widely used and there are many such sites, expressions such as ‘Adopted at many sites’ are used.
- References: Reference materials are listed as far as possible.
- Inquiry : Contact points for inquiry on the technology are listed in the order of related industry, the Energy Conservation Center Japan (ECCJ), and NEDO.

The following is a technology data sheet (or format) for each technology employed in this directory.

Energy Conservation Directory

[Industry Classification]	Technology item / Title	[Energy Source]
[Technology Classification]		[Practical Use]

Outline		
Principle & Mechanism		
[Description] Structure explanation, Shape, and/or System diagram	Before improvement	After improvement
	Note: When the improved section is needed to be clearly indicated in the diagram after improvement for ease of understanding, it is enclosed within a red dotted line.	
Energy saving effects		
[Economics] Equipment cost		
Remarks		

[Example sites]	[References]	[Inquiry]

Section 5 Concluding Remarks

5-1 Conclusion

Prior to its revision, the Energy Conservation Directory included 307 technologies, of which 126 was removed in the revision. All of the remainder were reviewed and updated, and 63 new technologies were added, so that the current edition contains a total of 244 technologies.

This edition focuses on technologies which provide energy saving of more than 10%, and which were selected by committee members and specialists from the various industries. A huge number of energy conservation technologies are currently available, although their energy conservation benefits varies over a wide range, from a very low level to a high level. The range of applicable energy conservation technologies varies considerably in both Japan and the developing countries in accordance with local energy costs and other economic conditions. However, we hope that descriptions of the technologies in this directory will prove useful to all readers.

5-2 Future Developments

- Further developments of energy conservation technology are expected in future, and it is expected that this directory will require revision as these new technologies are implemented.

- It is hoped that the comparatively small-scale technologies which were deleted from this edition will be covered by a separate version of this directory if the opportunity presents itself.

- This directory lists one technology per sheet. Due to space and other limitations, each technology is not explained in detail. It is expected that the readers will obtain supplemental information through contacting appropriate sources.

- In promoting energy conservation, it is essential that energy conservation technology be applied to production machinery, equipment, and operation. However in order to fully understand the effects of application of the technology, instrumentation to measure these effects, and measurement with the appropriate timing, are of major importance.

  We are of the opinion that the production of a directory summarizing the necessary instrumentation and systems, and representative examples of their application, would be of considerable use in conjunction with this directory. This will be realized if the appropriate opportunity presents itself.