NEDO－IC－02－ED－02

Infrastructure Improvement Project for Rationalization of International Energy Use (Feasibility Study on Energy Conservation in Major Industries in ASEAN Countries)

March, 2003

New Energy and Industrial Technology
Development Organization (NEDO)
Entrusted to The Energy Conservation Center, Japan

Infrastructure Improvement Project for Rationalization of International Energy Use
(Feasibility Study on Energy Conservation in Major Industries in ASEAN Countries)

The Energy Conservation Center, Japan

March, 2003

Study purpose:

This survey is intended to carry out energy audits for typical factories and business establishments involved in major industries jointly with experts the from ASEAN side and thereby grasp an understanding of the actual state of energy consumption by the factories concerned, with a view to providing appropriate advice on their energy conservation measures and at the same time establishing typical energy auditing methodology in those countries.

Preface

In recent years, proper actions for effective utilization and demand stabilization of increasingly limited energy resources and against global warming problems have been emphasized and necessity of sustainable economic development has been discussed in many ways.

Japan as an advanced nation in terms of economy and technology is strongly demanded to provide positive international cooperation for developing countries.

In order to contribute to well-balanced development of economy and environment in developing countries, the actual status and issues on the energy use and environmental protection measures in each of these countries should be fully surveyed. Preparation of an appropriate and acceptable plan and support matching the conditions in each country would be necessary.

Under such circumstances, the planned and established energy audits in major industries and technical transfer for ASEAN countries seems very timely because these countries are continuing remarkable development and will show a steep increase in energy consumption.

This project includes not only transfer of energy conservation technology but also transfer of factory audit technology to allow autonomous energy conservation audit in these countries in future, so this project will be very useful for these countries in terms of assisting in independent development.

We hope that this project will contribute to energy conservation and environmental protection in ASEAN countries and these counties will sustain economic development being harmonized with environment, and expect that this project will be a bridge for technical exchange and friendship between Japan and these countries.

March 2003
The Energy Conservation Center, Japan

Summary

The ASEAN economies are continuing to grow at a brisk pace, and accordingly their energy consumption is also anticipated to increase rapidly from now on. In this context, it will be vital to use energy more efficiently, as well as to give due consideration to global warming.
This project has entered its third year, and the ASEAN Center for Energy (ACE), our ASEAN counterpart, is engaged in increasingly full-fledged and substantial energy conservation activities, thereby contributing to the spread of awareness of the need for energy conservation among the people in ASEAN countries.

Especially, it is notable that the results of the project were summed up and the future action policy was discussed intensely with Japanese experts.
In details, creation of a database, benchmark, guideline for energy management was started in order to share the accomplishments of these 3 years within ASEAN countries. This theme was discussed at the Inception Workshop, which was held just after the start of the project of this fiscal year and at the Post Workshop after the close of the business on site.
Formation of a working group by a representative from each ASEAN country was resolved at the workshop of end of February 2003, which means that a practical framework to back up the database, benchmark and guideline was built.

Specific details of activities through this project for this year are as follows:

Nov. 25-26, 2002;
Participate in “Inception Workshop of The SOME-METI Project on PROMEEC - Buildings and PROMEEC - Industries” (Singapore).
(1) Policies for energy conservation promotion for building & industry sections, and energy management & typical energy conservation technologies
(2) Explanation and discussion of Action Plan for 2002FY project (building & main industry sections)
(3) Determination of a rough schedule for the building and main industry survey
(4) Exchange of views on benchmarks for energy consumption in buildings
(5) Exchange of views of the future project development

Dec. 10-19, 2002;
Energy audit of the garment industry in Cambodia and iron & steel industry in Philippines (first survey)
(1) Introduction of energy conservation of garment industry in Japan (Cambodia)
(2) Audit of 2 garment factories in Cambodia
(3) Preparation of audit of iron & steel industry in Philippines

Feb. 10-21, 2003;

Energy audit of the garment industry in Cambodia and iron & steel industry in Philippines (second survey)

(1) Introduction of energy conservation of iron & steel industry in Japan (Philippines)
(2) Audit of 2 iron & steel factories in Philippines, explanation of results and discussion
(3) Audit of 2 garment factories in Cambodia, explanation of results, discussion and additional audit

Feb. 28-Mar. 1, 2003;

Participate in “Workshop of The Working Group for Benchmarking and Audit Guideline Development Projects, SOME-METI Work Program” (Yangon, Myanmar)

(1) Report of results and discussion of audit of building (Vietnam & Myanmar)
(2) Report of results and discussion of factory audit (garment industry in Cambodia and iron & steel industry in Philippines)
(3) Introduction and discussion of development of a database, benchmark, and guideline for building in Japan
(4) Case study of development of a database, benchmark, and guideline for building in Vietnam & Myanmar
(5) Introduction and discussion of implementation and concept of the development of bench mark in ASEAN
(6) Discussion of future policy and plan of PROMEEC Project (building & main industries)

Considerable cooperation was provided from Cambodia and Philippines, which were subjects of survey, this fiscal year.

At Cambodia, audit was carried out twice at M&V International Manufacturing Ltd. and June Textiles Co., Ltd. (Cambodia) at Phnom Penh.

Cambodia is just at its start point of development, and electrification is limited to urban areas. We had full support from the related organizations on selecting the 2 companies. Garment industry is a representative industry of Cambodia, and many administration officials attended the workshops and the first audit with enthusiasm, to absorb experience and information from Japanese experts.

Philippines is on the way of further development, as for iron & steel industry, because of the import of cheap slabs and billets and appreciation of scrap (raw material) caused by the robust economy of China, the management of steel manufacturers by electric furnace is in a difficult situation.

A large number of companies are suspending the operation of electric furnace, and the furnace operating companies are diminished to only 5 companies in these days.

The Target Company could not be determined at the first audit. We visited Philippines Iron & steel Manufacturers Association and 3 iron & steel manufacturers, and made a request to make coordination for the second audit.

By the second audit, the slabs and billets price run up. 2 companies, almost at full-operation, accepted our audit, and audit was carried out at an electric furnace factory of billet production and factory of rolling only. A large number of engineers, more over the attendants from the Ministry of Energy, participated the workshop to acquire Japan's energy conservation experience and knowledge.

However, we could have fruitful results for both parties thanks to the cooperation of administration officials and ACE persons. We believe that the proposed measures for energy conservation are significant points to improve the current situation concerned.
We would very much like to see these proposals put into practice at the earliest opportunity, and the reference materials and actual experiences are utilized effectively, disseminated in ASEAN countries and become the base of future activities, thereby enabling us to contribute to the conservation of energy and presentation of the environment in the ASEAN countries.

Finally, we would like to thank all those at ACE along with the organizations and factories involved in each country for their cooperation.

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Participants for the workshop, audit and survey of energy conservation in major industries of ASEAN countries
(Staffs from MIME, ACE and ECCJ)
At the entrance of MIME, Phnom Penh, Cambodia, (Dec. 9, 2002)

I. Garment Industry

1. Project Summary

Aiming at contributing to energy conservation, environmental protection, and persistent economic development in ASEAN countries showing remarkable economic growths, this project was established as a part of the Infrastructure Improvement for Rationalization of International Energy Use.
With ACE (ASEAN Center for Energy) as a core organization, this project attempts to promote energy conservation relating to major industries under cooperation of ASEAN countries. As the country and industry to be surveyed in this fiscal year, Cambodia and its garment industry were selected. Thereafter, an audit plan was created based on discussions with persons in charge in this country. In four days of December 9 through 13, 2002 and February 17 through 21, 2003, audits attended by persons in charge from MIME (the Ministry of Industry, Mines and Energy) were implemented at the sites of two companies in the garment industry.
Reported below is the survey result including the political and economic status of this country.

1.1 Subjects of Study and Organizations Involved

(1) Country and companies surveyed

Country : The Kingdom of Cambodia
Companies : M&V International Manufacturing Ltd. and June Textiles Co. Ltd.

(2) Organization

1) Cambodia

Ministry of Industry, Mines and Energy: MIME

Mr. Khlaut Randy	Under Secretary of State MIME
Dr. Sat Samy	Director of Energy Technique Dept.
Mr. Chan Socheat	Manager of Electric of Energy Technique
Mr. Lieng Vuthy	Deputy Head of Energy Efficiency and Standard Office
Mr. Toch Sovanna	Deputy Head of Renewable Energy Office
Mr. Khlainia Amradararith	Technical Energy Dept
Mr. Ouk Theary	Technical Energy Dept
Mr. Nong Chhavyvann	Technical Energy Dept
Mr. Yem Chandararith	Dept. of Energy Development
Mr. Ly Chamroeurn	Technical Energy Dept
Mr. Heang Bora	Staff of Energy Efficiency and Standard Office

Mr. Choun Thea	Staff of Energy Efficiency and Standard Office
Mr. Hing Kunthap	Consultant, Energy & Environment Advisor of Dr. SAT SAMY
Mr. Soeung Vandoeun	Technical Energy Dept
Mr. So Veasna	Technical Energy Dept
Mr. Chhay Khan	Technical Energy Dept
Mr. Chhim Thearith	Electrical Engineer, Technical Energy Dept.
Mr. Thach Sovannreasey	Dept. of Energy Development
Mr. Chum Sopha	Technical Energy Dept
Mr. Anderson WILLIAMSON	(From Australia: Sustainable Energy Development Authority (SEDA))

2) M&V International Manufacturing Ltd.

Mr. WENY Wei	Administration Dept. Officer for all M&V
Mr. SU Chin Pha	Manager of Energy Sect.

3) June Textiles Co., Ltd.

Mr. William ONG	General Manager
Mr. YI Sokhom	Shipping Manager

4) ACE (ASEAN Center for Energy):
Mr. Christopher ZAMORA

5) The Energy Conservation Center, Japan

Hiroshi Shibuya	Department Manager of the International Engineering Department
Ichiro Matsuura	Technical expert of the International Engineering Department
Hideyuki Tanaka	Technical expert of the International Engineering Department

1.2 Political and Economic Conditions in Cambodia

(1) Political and economic conditions in Cambodia

1) National indicators

Country name	:	The Kingdom of Cambodia
Area	:	181,000 km^2 (less than about the half area of Japan)
Population	:	12.2 million (as of 2000)
Capital	:	Phnom Penh
Language	:	Cambodian (Official language)
Religions	:	Buddhism (Hinayana)

2) Basic economic indicators

Gross domestic production (GDP): Approx. 3.09 billion US$ (source: Ministry of Economy and Finance; 2000)

Trade values (source: data for 2000 from National Bank)

(1) Exports : 1,050 million US$ (of which 110 million US$ represents re-export)

(2) Imports : 1,430 million US$

(3) Trade balance : 280 million US$

Major items in trade

(1) Exports : Garment products, timber, rubber, fish and shell, agricultural products (soybean, corn)

(2) Imports : Petroleum products, tobacco, gold, construction materials, automobiles, electrical products

Currency and exchange rate: Riels (1 US$ = 3,880 riels as of 2000)

3) Political system

Form of government : Constitutional monarchy

Head of state : His Majesty King Norodom Sihanouk (Enthroned on Sep. 24, 1993)

National assembly : Bicameral system (National Assembly and Upper House)

Major ministries : Ministry of Foreign Affairs and International Cooperation, Ministry of National Defense, Ministry of Interior and National Security, Ministry of Economy and Finance, Ministry of Information, Ministry of Public Works and Transport, Ministry of Justice

4) Political situation

In November 1998 the People's Party and the FU Party formed a coalition government, and at the end of November a new administration was set up with former Second Prime Minister Hun Sen, deputy leader of the People's Party, as the Prime Minister.

The coalition was heavily dominated by the People's Part: members of the party were awarded the most influential cabinet posts, including those of Prime Minister, Chief Cabinet secretary, and all the main ministerial posts relating to economic matters. As in the previous administration, the posts of Minister of Defense and Minister of Interior are co-lateral ministers system (2 ministers/ministry).

Meanwhile, each of the two governing parties provided chief secretaries under the ministers at each government department.

The new administration from the start announced that its priority would be the rehabilitation of the economy, thus naming itself “Economy Administration”. Recognizing that the healthy economic development of the country required an efficient administrative and fiscal system, the government put forward and energetically promoted five main reform policies, covering financial reform, the management of forest resources, the reduction of the number of military personnel, administrative reform, and social reform.

Subsequently, the government succeeded in raising its revenue through the introduction of a value added tax of 10%. In addition, a decrease was observed in the incidence of illegal logging. Thus, some of the initial targets of the reform policy are being gradually realized. At the 6th meeting of donor countries and organizations, held in Phnom Penh in June 2002, all the donor nation governments and donor organizations recorded their favorable impressions of the reforms undertaken by the Cambodian government and prompted further efforts.

5) Economic trend

As a result of the political change in July 1997 as well as the economic crisis that affected most of Asia, Cambodia suffered a severe deterioration in its economy in 1998 (GDP growth slowed from 3.5% in 1996 to 1.5% in 1998) owing to declines in aid and investment from overseas, plus a fall off in revenue from tourism. The newly established administration, in line with its professed top priority on economic recovery, set to work seriously to implement reform in the field of finance, the management of forest resources, the reduction of the number of military personnel, administrative reform, and social reform. At the same time, the Cambodian government held regular monitoring sessions with representatives of donor countries to keep them informed on the progress being made in the various reform plans. In 1999, political stability returned to the country, and the economy also followed a favorable trend, with GDP growth reaching 6.7%. The trend remained strong with Cambodia recording GDP growth of 7.7% in 2000 and 6.3% in 2001 in spite of heavy damage from flooding.

6) Economic conditions

Table I-1-1 shows the major economic indicators in Cambodia.

Table I-1-1 Basic Economic Data

		1997	1998	1999	2000	2001
Population (million)		10.7	11.4	11.7	12.2	
Real economic growth rate (%)		4.3	2.1	6.9	7.7	6.3
GDP (million US$)		3269	3011	3300	3351	3404
GDP per capita (US$)		281	247	264	261	259
National budget (million US$)		424.6	412.9	480.3	546.7	
GDP share by sector (%)	Agriculture, forestry and fisheries	46	45.8	42.8	38.2	36.9
	Industries	15.2	16.1	17.1	20.8	21.9
	Service industry	34.6	34	34.5	35.5	35.3
Consumer price inflation rate (%)		5.5	13.8	3.7	-4.6	-2.8
Exchange rate (Riel/US$)		2946	3744	3808	3845	3922
Exports (re-export) (million US$)		862 (327)	900 (296)	884 (172)	1261 (170)	1375 (176)
Imports (million US$)		1092	1073	1159	1524	1600
Trade balance (million US$)		-230	-173	-275	-263	-226

(2) Major export/import items to/from Japan

1) Trade with Japan

(a) Exports to Japan (for 2000; unit: 1 million Japanese yen)

Imports from Japan : 4,146

Exports to Japan : 5,573

(b) Major items in trade

Imports from Japan : Motorcycles, machines, etc.

Exports to Japan : Footwear, fish (frozen), etc.

2) Direct investment from Japan

Lumber factories, galvanized steel sheet factories, automobile service factories, etc.

1.3 Energy Status in Cambodia

The Ministry of Industry, Mines and Energy (MIME) is responsible for energy policies in Cambodia. The results of its activities seem to appear gradually but the steps are slow because of fund shortage, etc.

Most of energy resources in Cambodia is still firewood. Although deposits of petroleum, natural gas, and coal have been expected, they are not confirmed yet. This country has a lot of water but the expected waterpower is approximately 10,000 MW because flat fields cover the most areas of the country and mountains are limited very much.

For the energy demand, petroleum products occupy nearly 95%, which is all imported. They are mainly used for traffic organizations and power generation plants (public and private power generation plants). Gasoline, Kerosene, diesel oil, and fuel oil are used approximately evenly.

The main constituent of industrial energy in Cambodia is of course electricity. Presently, the rate of electrification is still lower than 20%. Electrification is limited to Phnom Penh, major local cities, and surrounding areas. In most areas, people are forced to live on without electricity. Therefore, the top priority for Cambodia is to propagate electrification throughout the country.

According to the MIME's plan and policy, EDC (Electricite du Cambodge, Electricity of Combodia) under MIME is mainly promoting the nationwide electrification project. Supported by new development and imports from adjacent countries, a project of increasing electricity supply from approximately 150 MW at present to 750 MW in 2016 is being carried forward. Figure I-1-1 shows the master plan of power generation/distribution by 2012 presented by MIME, Cambodia.

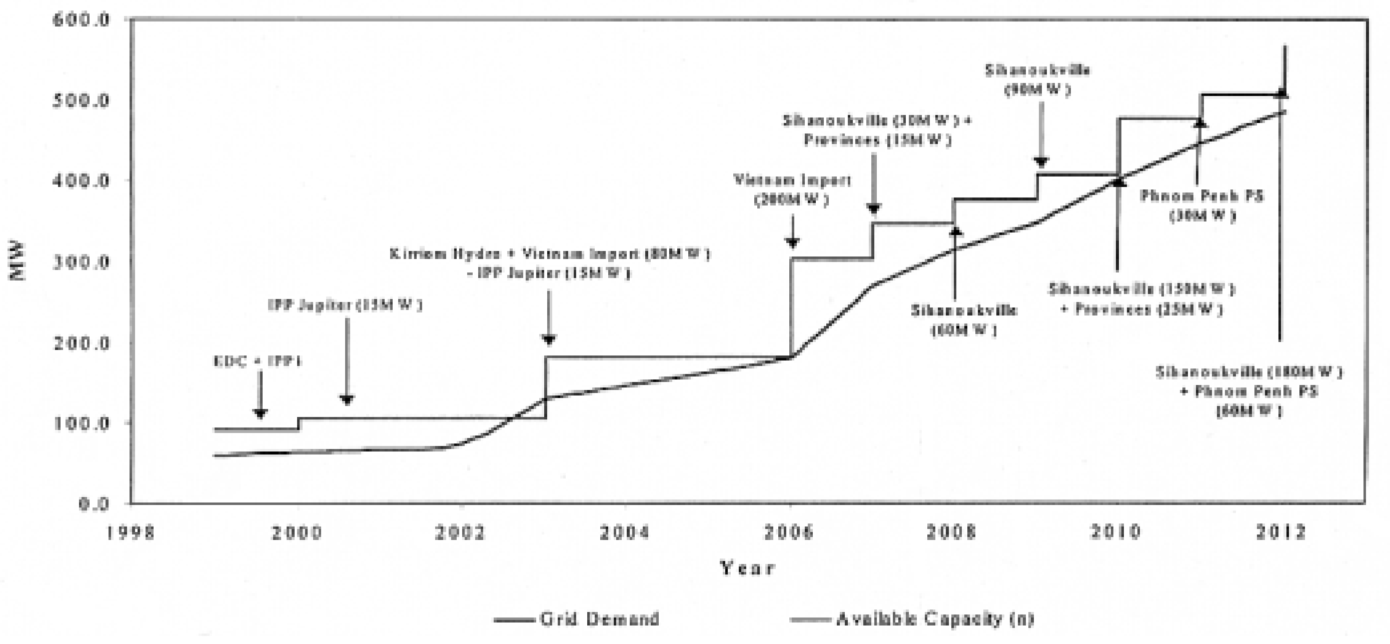


Figure I-1-1 Master Plan of Power Generation/Distribution in Cambodia

1.4 Overview of Garment Industry in Cambodia

To allow recognition of the Cambodia's current status, information from documents disclosed is given below.

1) Foreign relations of Cambodia

Regarding the relations with adjacent countries, the issue of the border that should be determined remains. Skirmishes often occur near the border. These incidents were caused by the fact that the border is not clear. Diplomatic negotiations for settlement are being continued.

For China, Cambodia has declared that it would support the policy of "One China" and the relationship between these two countries is closely tight.

However, it can be mentioned that the influence of the United States to Cambodia is very large presently.

First, the United States exists as a country of supplying aid. Although Japan supplies the largest and prominent aid to Cambodia, the amount of implementation by the United States was 230 million dollars in 1999 alone, as the runner-up. For the cumulative amount in 1992 to 1999, the United States was also the runner-up slightly above France. Since the "political change in July 1997", however, the United States has adopted a policy that aid for Cambodia is limited to humane aid only and the United States does not use the central government as a counterpart.

2) Economy in Cambodia and garment industry

In recent years, almost no price increase has been seen. The rate of Riel to US dollar was 3800 to 3900 riel per dollar in 2000 and 3900 to 3950 riel in 2002. In Cambodia, US dollars as well as the domestic currency are generally in use.

Direct investments from foreign countries were decreasing around 2000. However, investments for tourism (including hotel construction) have drastically increased. Investments to the garment sector do not show a significant drop and the number of investments increases. Among investments by manufacturing sector in 2000, the garment sector occupied approximately 60% and the energy sector occupied approximately 16%. Presently, it is said the number of garment companies is more than 200.

The influence of the United States to the garment industry is considerably great. In 1999, exports of garment products occupied more than 80% of domestic product exports from Cambodia and most of them were bound for the United States. Although the garment industry in Cambodia is being led and developed by investments from Chinese capitals in China and Hong Kong, it is considered that import volume assignment authorized by the United States for Cambodia is working fairly strongly as the motive for such investments. Further, the general preferential trade system is applied to the garment products exported except for very few items. On the other hand, the United States seems to be not so positive for increase in volume assignment to Cambodia. Rather, the United States has been reluctant to assigning an incremental bonus for the reason that the labor conditions in Cambodia are poor. In other words, the trade policy of the United States for Cambodia dominates development of the only one and largest export industry in Cambodia and therefore it is related to deepening and growth of industrialization for the entire national economy of Cambodia.

2. Overview of Garment Factories Audited

To implement energy conservation audit and survey for the garment industry in Cambodia, ECCJ asked ACE to select two garment factories in Phnom Penh and its surrounding area. The responsible department in the Cambodian government selected the two garment factories listed above according to the request from ACE.

The overview of two selected garment factories is as follows:

2.1 Overview of Garment Factory 1 – M&V International Manufacturing Ltd.

Company name	:	M&V International Manufacturing Ltd.
Factory name	:	M&V No. 3 factory (MV3 factory)
Location	:	No. 1623 Chac Angre Kraum, Phnom Penh, Cambodia TEL: (855) 23-425 041
Products	:	Knit wear (sweaters)
Production volume	:	5,102,531 pieces (2001)
Employees	:	Approximately 3,000 (staff: 80 to 90)
Working system	:	8-hour work (7:00 to 11:00 and 12:30 to 16:30), 1-shift system
Organization	:	Figure I-2-1 shows the organization of the MV3 factory. The headquarters is located in Macao (China). One factory is located in Macao, and four factories in Cambodia.

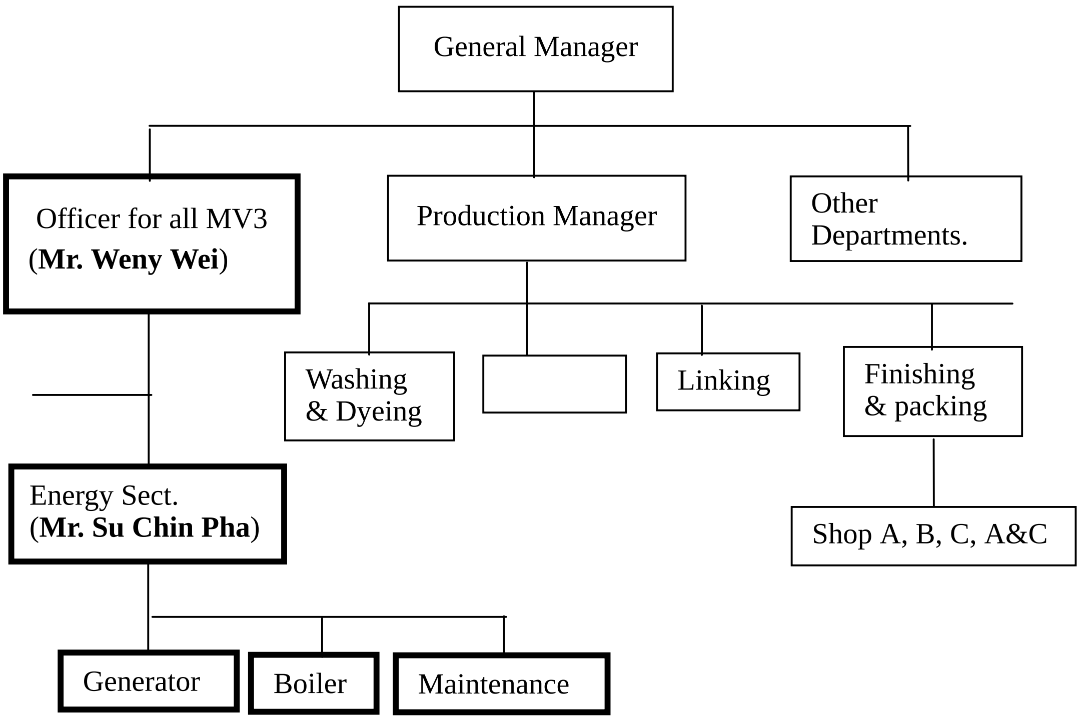


Figure I-2-1 Organization of MV3 Factory

Operation overview : This factory manufactures sweaters only under control of the headquarters located in Macao. Our impression was that the headquarters in Macao totally grasped production organization/management and the role of MV3 was to achieve the production duty according to instructions from the headquarters.

This company was established in 1994 and operation in MV3 was started in 1997. The annual production volume is more than 5 million pieces, all of which are exported to the United States, EU, etc.

Since sweaters are produced before the season, the production peak time is July and August and the time with the smallest production is February every year. This pattern is repeated. Upon the audit and survey in February, the factory was almost deserted, the number of employees was smaller, and the production volume was approximately 1/3 of that in the peak time.

Energy sources are electricity and petroleum. The electricity mainly relies on private power generation by a diesel power generation but electricity for nighttime lighting, etc. is purchased from EDC.

For boilers, river water and heavy oil are in use.

2.2 Facilities and Capacities of M&V – MV3 Factory

(1) Facilities

Boilers :	No. 1 boiler --- horizontal fire-tube boiler	4,200 kg/h
	No. 2 boiler --- vertical through flow boiler	1,560 kg/h
	No. 3 boiler --- vertical through flow boiler	783 kg/h
	No. 4 boiler --- horizontal fire-tube boiler	6,000 kg/h

Electricity receiving equipment : 380 V (without transformer)

As the equipment in the garment factory, the dyeing unit, washing machine, drying machine, sewing machine, knitting machine, flat-iron, lighting, air conditioner, etc. are available.

(2) Factory layout

Figure I-2-2 shows the layout of the M&V – MV3 factory.

(3) Organization for operation

1-shift operation system with 3,000 to 4,000 workers (approximately 1,000 temporary workers assumed)

The working time is 7:00 to 11:00 and 12:30 to 16:30 (8 hours).

An organization of 16 members is responsible for energy equipment.

(4) Energy consumption

Table I-2-1 lists energy consumption by energy source type in 2002. The data was obtained from M&V.

Table I-2-1 Energy Consumption (2002)

(1US$ = 3,950 Riels)

Energy source type	Consumption	Unit price	Consumption amount (US$)
Heavy oil (kL/y)	927.6	US$0.25/L	231,900
Diesel oil (kL/y)	480	US$0.35/L	168,000
Electricity (MWh/y)	214	600 Riel/kWh = US$0.152/kWh	32,545
		Total	432,455

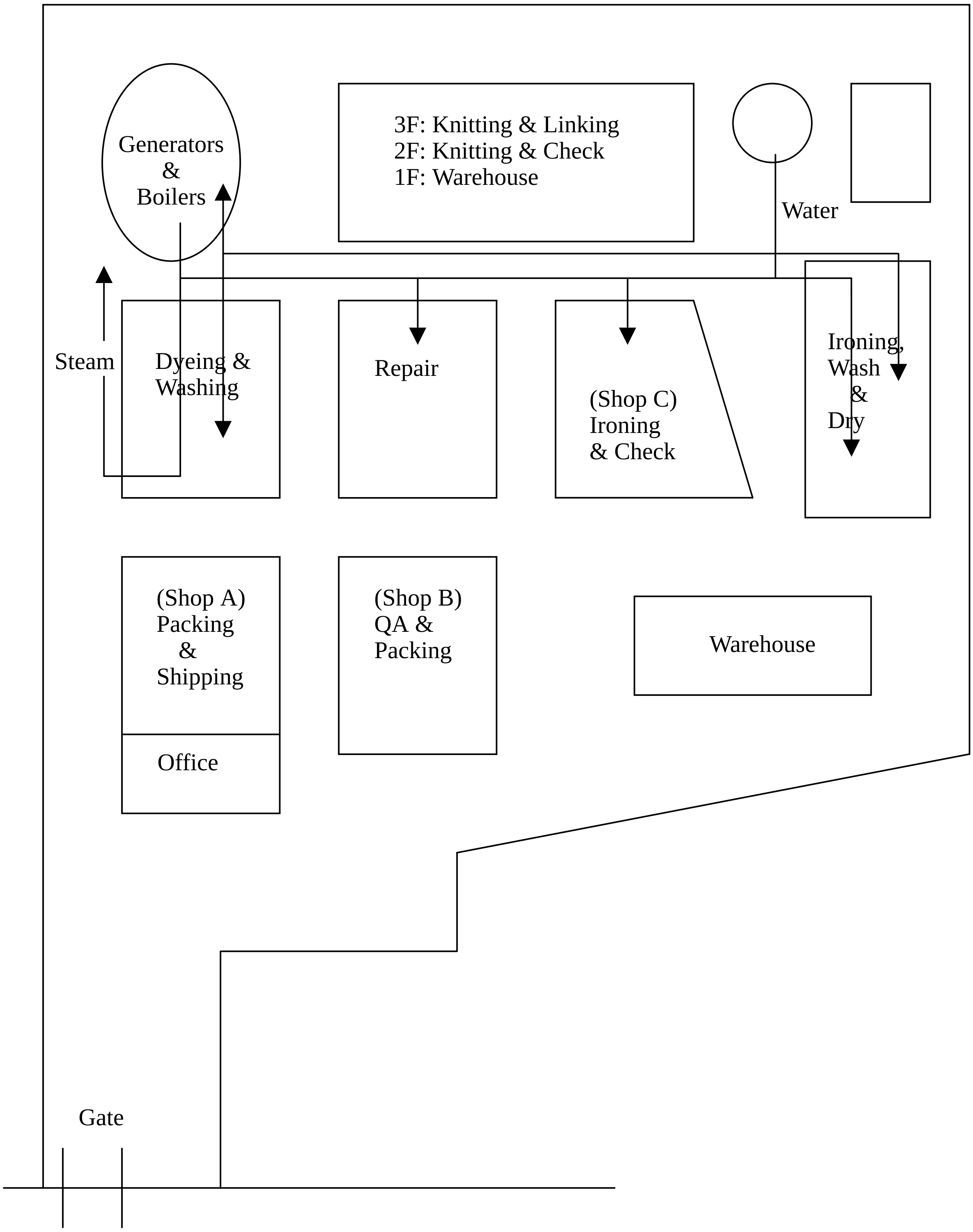


Figure I-2-2 M&V International Manufacturing Ltd. – MV3 Factory Layout

2.3 Overview of Garment Factory 2 – June Textiles Co., Ltd.

Company name	:	GIMMILL Industrial (Pte) Ltd. (RAMATEX/GIMMILL Group) June Textiles Co., Ltd. (Cambodia)
Factory name	:	June Textiles Co., Ltd. (Cambodia)
Location	:	Russian Blvd., Borei 100 Khnong, Sangkat Tek Thla, Khan Russei Keo, Phnom Penh Tel: 023-883-338
Products	:	Casual wear (main product: T-shirts)
Production volume	:	1.17 million dozens (2001)
Employees	:	4,393 (as of November 30, 2002) (30 skilled workers included)
Working system	:	7.5-hour system with 2 shifts (6:15 to 14:15 (7.5 hours), 14:15 to 22:15 (7.5 hours))
Organization	:	Figure I-2-3 shows the organization of June Textiles Co., Ltd. (Cambodia). The headquarters is located in Singapore.

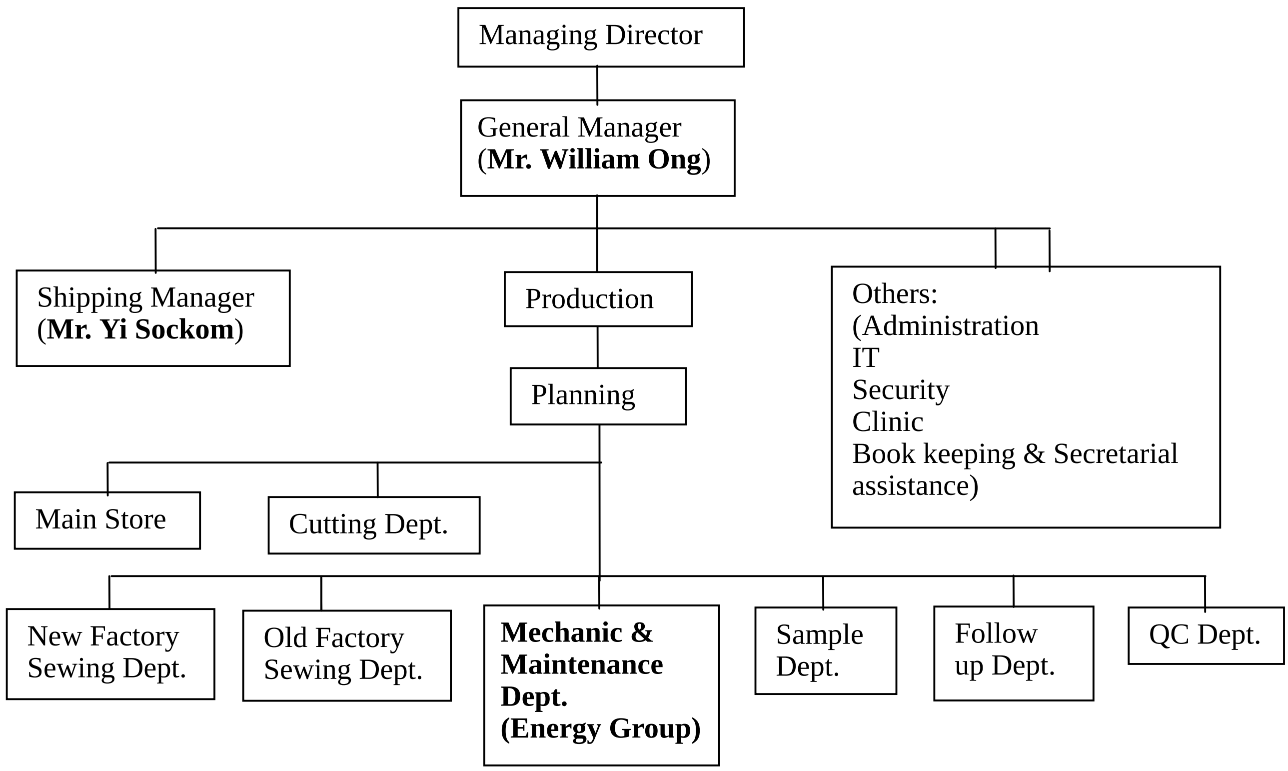


Figure I-2-3 Factory Organization of June Textiles Co., Ltd.

Operation overview : This factory manufactures casual products including T-shirts mainly under control of the headquarters located in Singapore. This company was established in 1992 and operation was started in 1994. In 1997, a new building was constructed beside the existing building. Presently, the annual production volume is 1.17 million dozens (in 2001). All of the products are exported to the United States and EU.

Energy sources are electricity and petroleum products. Electricity from the diesel power generator in IPP (Independent Power Producer) installed in its own factory has been purchased but electricity has also been purchased since 2011 from EDC (Electricite du Cambodge). In the time zone of 14:15 to 22:15, electricity from IPP is used. In other time zones, electricity from EDC is used.

For boilers, service water and diesel oil are in use.

2.4 Facilities and Capacities of June Textiles Co., Ltd.

(1) Facilities

Boilers : No. 1 boiler --- vertical through flow boiler 783 kg/h
No. 2 boiler --- vertical through flow boiler 500 kg/h
No. 3 boiler --- vertical through flow boiler 300 kg/h
No. 4 boiler --- vertical through flow boiler (second-hand equipment being installed)

Electricity receiving equipment : 22 kV (a transformer (22 kV/400 to 230 V, 1500 kVA) provided)

Air compressors:
No. 1 air compressor --- 12.95m^3/min×85.9 kW + Reservoir tank 1 m^3
No. 2 air compressor --- 37 kW + Reservoir tank 1 m^3 (also used for No. 3 air compressor)
No. 3 air compressor --- 37 kW

As equipment in the garment factory, the cutting machine, sewing machine, flat-iron, air conditioners, etc. are available.

(2) Factory layout

Figure I-2-4 shows the factory layout of June Textiles Co., Ltd.

(3) Organization for operation

4,393 workers with 2 shifts
The operating time is 7.5 hours in 6:15 to 14:15 and 7.5 hours in 14:15 to 22:15 (totally 15 hours).

(4) Energy consumption

Table I-2-2 lists energy consumption by energy source type in 2002. The data was obtained from June Textiles.

Table I-2-2 Energy Consumption (December 2001 to November 2002)

(1US$ = 3,950 Riels)

Energy source type	Consumption	Unit price	Consumption amount
Electricity from IPP (MWh/y)	1,676	480 Riel/kWh = US$0.122/kWh	205,168
Electricity from EDC (MWh/y)	2,170	480 Riel/kWh = US$0.122/kWh	265,165
Diesel oil (kL/y)	198	US$0.35/L	67,747
		Total	538,080

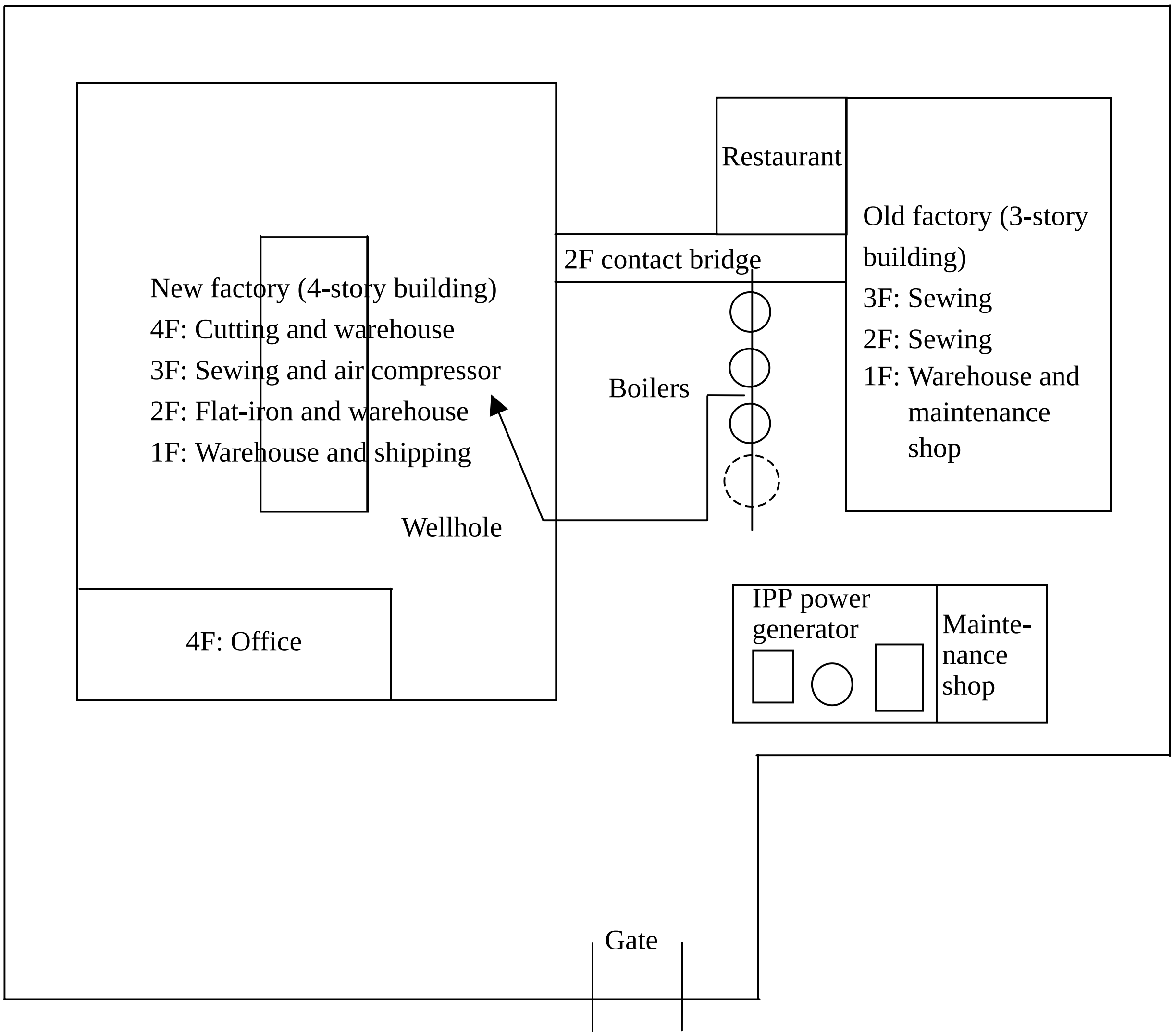


Figure I-2-4 Factory Organization of June Textiles Co., Ltd.

3. Audit Plan

The purpose of audit and survey by visiting Cambodia was to grasp the production processes, energy consumption, and actual status of utilizing exhaust heat in two selected garment factories, propose an improvement plan for promotion of energy conservation, and attempt to improve and propagate energy conservation consciousness for enlightenment through convening a workshop on the site to introduce the energy conservation technologies and activities in Japan. Further, it was intended to support the persons responsible for promotion of energy conservation on the ASEAN side so that they would be able to establish the standard energy conservation audit method, by taking into account the actual status of similar industries, energy conservation audit technical level, etc. in ASEAN countries after energy conservation audit was implemented.

Upon implementation, survey was carried out two times.
In the first field survey, the first workshop was convened. Efforts were made so that points of energy audit in the garment industry and energy conservation technologies realized in the Japanese garment industry would be introduced and understood.
For audit, it had been planned that the local audit group arranged by ACE would perform measurement and implement audit under supervision of the delegated experts with regard to check with the questionnaire sent in advance and survey in the actual factories. However, factory selection was delayed as described above, we were obliged to conduct check with the questionnaire and audit survey concurrently.

In the second field survey, based on the energy conservation improvement plan revealed as a result of the first audit, explanation was given to the person in charge in the Ministry of Industry, Mines and Energy (MIME) of the Cambodian government and the manager from these two companies. Further, field audit survey was performed again to confirm the contents of the improvement plan.

3.1 Audit Proceeding

For 2 companies that accepted energy conservation audit survey, one-day visit was made to each company for both the first and second field surveys.
In the first audit survey, MIME and ECCJ explained how this audit survey was planned and its significance to the plant managers of both companies. Since the response to the questionnaire had not been given, all members took a plant tour first. Then, the members were divided into two teams. One team was to check the response to the questionnaire and the other was to implement audit by visiting the field again.
The measuring instruments used by the auditing team were the radiation thermometer, illuminometer, clamp type ammeter, and clamp type watt-meter.

In addition, the photo shoots were forbidden strictly by two companies, therefore there are no pictures showing the factory situations.

3.2 Selection of Equipment to be Audited and Checking Response to Questionnaire

Energy used in the garment factories is limited to:

Electricity (private power generation and purchased electricity):

Sewing machine, washing machine, drying machine, dyeing machine, pump, fan/air conditioner operation, lighting, etc.

Steam : Flat-iron, water temperature control of the washing machine and dyeing machine, etc.

Therefore, if a power generator was provided, it was determined that audit would focus on the power generator's operation and exhaust heat recovery status; boiler operation, piping equipment, and steam utilization status; and the air compressor and lighting equipment that would use more energy.

Although two companies already received the questionnaire from ECCJ when audit was started, nothing was prepared as the response. Therefore, we decided to get each answer by checking one by one.

The attached table shows the questionnaire and responses.

Both companies had not performed field measurement and daily data collection but they had simply checked the monthly payment bills.

Actions against failures could not be taken and countermeasures would be late unless meters are attached to the equipment and management with these meters is enabled. Further, someone may notice a failure several months after it occurred.

3.3 Audit Schedule

Two factories where we conducted audit survey were located in Phnom Penh. We were able to move around very easily because of MIME's help.

We visited two factories twice each. For individual reasons of each factory, one-day audit survey was performed for both first and second field surveys. In the M&V – MV3 factory, it took time because two interpreters were necessary among English, Cambodian, and Chinese.

The audit schedule is shown below.

First survey: Implemented in December 2002

December 9 (Mon.)	Convention of a workshop on energy efficiency and energy conservation (participated by MME, ACE, and ECCJ)
December 10 (Tue.)	Preparation and discussion on audit survey at MIME

December 11 (Wed.)	M&V MV3 factory visit Introduction of participants, explanation of the purpose for audit survey, plant tour, audit implementation, and acquisition of the response to the questionnaire
December 12 (Thu.)	June Textiles Co., Ltd. Factory visit Introduction of participants, explanation of the purpose for audit survey, plant tour, audit implementation, and acquisition of the response to the questionnaire
December 13 (Fri)	Summary of audit survey and implementation of the wrap-up meeting at MIME

Second survey: Implemented in February 2003

February 17 (Mon.)	Explanation and discussion on the result of the first audit survey (energy conservation improvement plan) at MIME
February 18 (Tue.)	June Textiles Co., Ltd. Factory visit Explanation of the result of the first audit survey (energy conservation improvement plan) and re-implementation of audit and information acquisition
February 19 (Wed.)	M&V MV3 factory visit Explanation of the result of the first audit survey (energy conservation improvement plan) and re-implementation of audit and information acquisition
February 20 (Thu.)	Summary of audit survey and correction of the improvement plan at MIME and reporting to the energy department manager of MIME
February 21 (Fri.)	Summary of audit survey at MIME and reporting the energy conservation improvement plant to the vice minister of MIME

4. Equipment Audited

4.1 Audit Survey of M&V International Manufacturing Ltd.

(1) Diesel power generator equipment specifications and operating method

1) Equipment capacities

No. 1 power generator :	500 kVA, 400 kW	–
No. 2 power generator :	720 kVA, 576 kW	JUBILEE GENERATING SET, UK
No. 3 power generator :	720 kVA, 576 kW	JUBILEE GENERATING SET, UK

2) Operating method

From AM7:30 to 11:30 and PM1:00 to 5:00, the No. 2 and 3 power generators are run to support the factory load.

In the nighttime, electricity is purchased from EDC to support the factory load.

On the day of audit. No. 1 generated 250 kW and No. 2 generated 230 kW. Total electricity output (factory load) was approximately 480 kW.

(2) Electricity receiving/transforming equipment

1) Equipment capacity

The 3-phase 400 V power is purchased from EDC.

2) Operating method

Mainly in the nighttime, electricity is purchased from EDC.

The time zone and the frame of purchased electricity are determined according to the discussion with EDC. Electric energy purchased is approximately 13,000 kWh/m.

(3) Boiler equipment specifications and operating method

1) Equipment capacities

Boiler A : Evaporation volume 4,200 kg/h × 10 kg/cm^2: horizontal fire tube boiler
LAI CHEN WORKS CO., LTD., TAIWAN

Boiler B : Evaporation volume 3,450 LBS/h × 10 kg/cm^2: vertical through flow boiler
FULTON BOILER WORKS, INC., NY

Boiler C : Evaporation volume 1,725 LBS/h × 10 kg/cm^2: vertical through flow boiler
FULTON BOILER WORKS, INC., NY

Boiler D : Evaporation volume 6,000 kg/h × 10 kg/cm^2: horizontal fire tube boiler
FULTON BOILER WORKS, INC., NY

2) Operating method

Boiler D mainly supplies steam of 7 kg/cm^2 to the dyeing, dryer, and ironing processes.

(4) Lighting equipment

1) Equipment capacities

Shop A : Uses many local lights and ceiling (general) lighting with 36 lamps.

Shop B : Uses many local lights and ceiling (general) lighting with 18 lamps. However, ceiling (general) lighting is turned off.

Shop C : Uses many local lights and ceiling (general) lighting with 266 lamps.

Washing and dyeing : Ceiling (general) lighting

Shop A & B : Uses many local lights and ceiling (general) lighting.

2) Operating method

Ceiling (general) lighting and local lights are turned off for the equipment that has been shut down.

For the equipment in service, many local lights and ceiling (general) lighting are used.

4.2 Audit Survey of June Textiles Co., Ltd.

(1) Diesel power generator equipment specifications and operating method

1) Equipment capacities

No. 1 power generator : 350 kVA/280 kW
PERKINGS ENGINES LTD, UK

No. 2 power generator : 500 kVA/400 kW
PERKINGS ENGINES LTD, UK

2) Operating method

The power generators are operated by IPP, from which this company purchases electricity.

From PM 2:00 to 10:00, electricity is purchased from these two power generators for the factory load of approximately 700 kW.

(2) Electricity receiving/transforming equipment specifications and operating method

1) Equipment capacity

Electricity of 22 kV is received from EDC. The capacity of the main transformer is 22 kV/400-230 V, 1500 kVA.

2) Operating method

Presently, electricity is purchased from EDC in a time zone of AM6:00 to PM2:00. The time zone and the frame of electricity purchased are determined according to the discussion with EDC.

(3) Boiler equipment specifications and operating method

1) Equipment capacities

No. 1 boiler :	Evaporation volume	1,725 LBS/h × 10 kg/cm^2
	FULTON BOILER WORKS INC, NY	
No. 2 boiler :	Evaporation volume	500 kg/h × 10 kg/cm^2
	MIURA BOILER CO. LTD, JAPAN	
No. 3 boiler :	Evaporation volume	300 kg/h × 10 kg/cm^2
No. 4 boiler :	Under installation	

2) Operating method

Presently the No. 1 boiler mainly supplies steam to the ironing process at a boiler outlet steam pressure of approximately 3.3 kg/cm^2.

(4) Air compressor equipment specifications and operating method

1) Equipment capacities

No. 1 air compressor	:	12.95 m^3/min × 85.9 kW (INPUT)
		BKOOM WADE, UK
No. 2 air compressor	:	37 kW OSP-37S5AR
		HITACHI, JAPAN
No. 3 air compressor	:	37 kW OSP-37S5AR
		HITACHI, JAPAN
No. 1 air compressor reservoir tank	:	1 m^3

No. 2 & 3 air compressor reservoir tank: 0.3 m^3

2) Operating method

Since compressed air is required for sewing machine in new and old factories, air compressors are started at AM6:00 every day and stopped at PM10:00 when the work ends. Three air compressors are connected via piping. Presently, the No. 1 air compressor supplies compressed air to the factories.

(5) Lighting equipment specifications and operating method

1) New factory

The product warehouse is located on the first floor, the ironing, inspection, and packing workshop on the second floor, the sewing workshop on the third floor, and the material and cutting room on the fourth floor. Generally, the positions of lighting apparatuses are high.

2) Old factory

The knit product warehouse is located on the first floor, and the sewing workshops on the second and third floors. Generally, the positions of lighting apparatuses are high.

5. Energy Conservation Survey and Measurement Results

5.1 Survey and Measurement Results of M&V International Manufacturing Ltd.

(1) Diesel power generators

Although the No. 2 and 3 power generators are in service, exhaust gas from the diesel engine is not efficiently used.
Heat of exhaust gas from the No. 2 and 3 power generators should be recovered to generate steam of 3 kg/cm^2.

(2) Boiler equipment

Some parts of the steam piping and valves in the dryer and ironing processes were not covered with the heat insulator.

1) Dryer process : 25 A steam valve : 10 positions
   25 A steam piping : 3 m/position × 10 positions = 30 m
2) Ironing process : 25 A steam valve : 8 positions
   25 A steam piping : 2 m/position × 8 positions = 16 m

(3) Lighting equipment

In Shop A, Shop C, and Shop A & B, ceiling (general) lighting does not efficiently work. These lights should be turned off for energy conservation.

1) Result of illumination measurement through ceiling lighting ON/OFF in Shop A (Figure I-5-1)

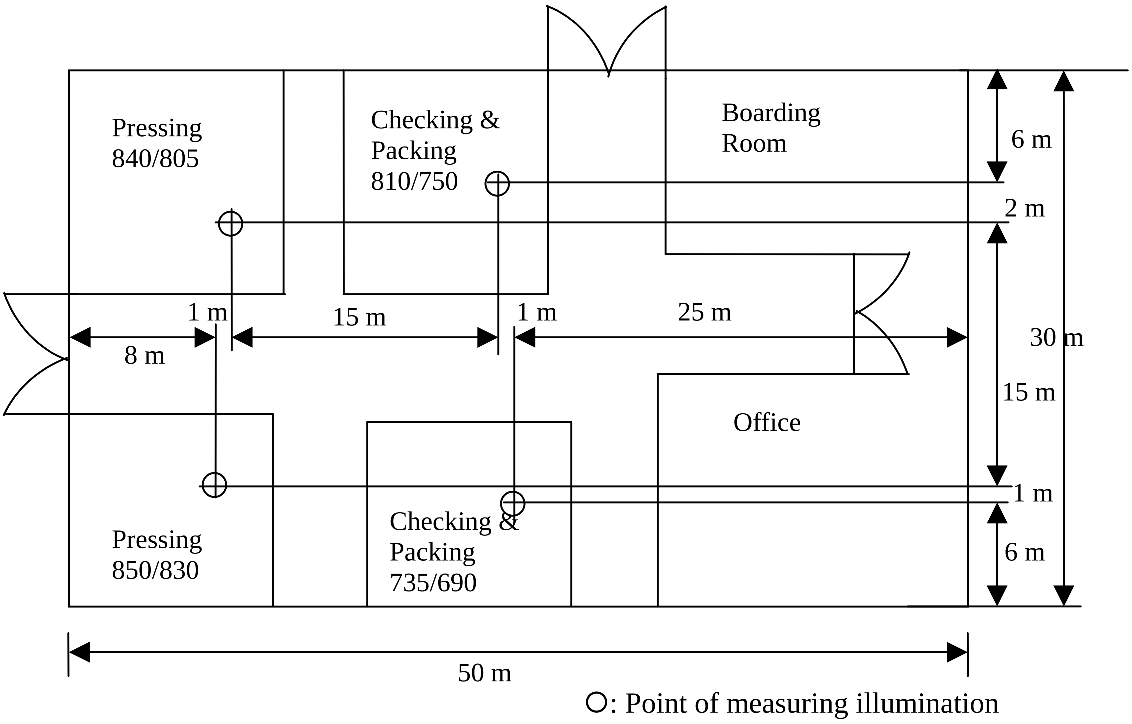


Figure I-5-1　Illumination through Ceiling Lighting ON/OFF in Shop A

(Example) 840/805　840: Illumination (Lx) provided when both ceiling lighting and local lights are turned on

805: Illumination (Lx) provided when ceiling lighting is turned off

2) Result of illumination measurement through ceiling lighting ON/OFF in Shop C (Figure I-5-2)

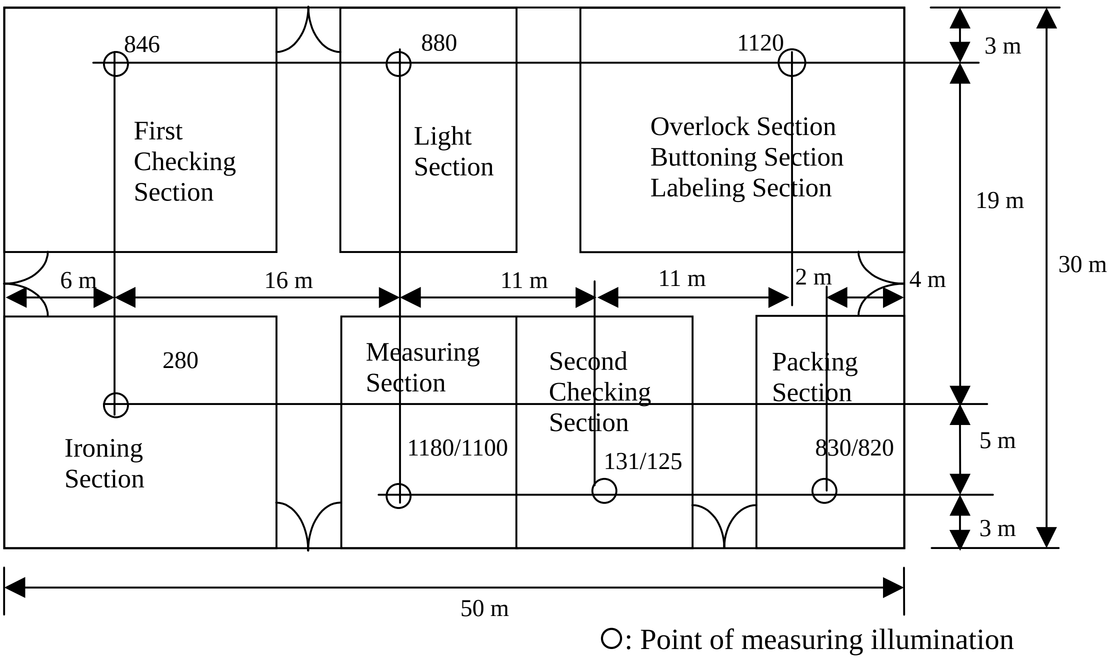


Figure I-5-2　Illumination through Ceiling Lighting ON/OFF in Shop C

3) Result of illumination measurement through ceiling lighting ON/OFF in Shop A & B (Figure I-5-3)

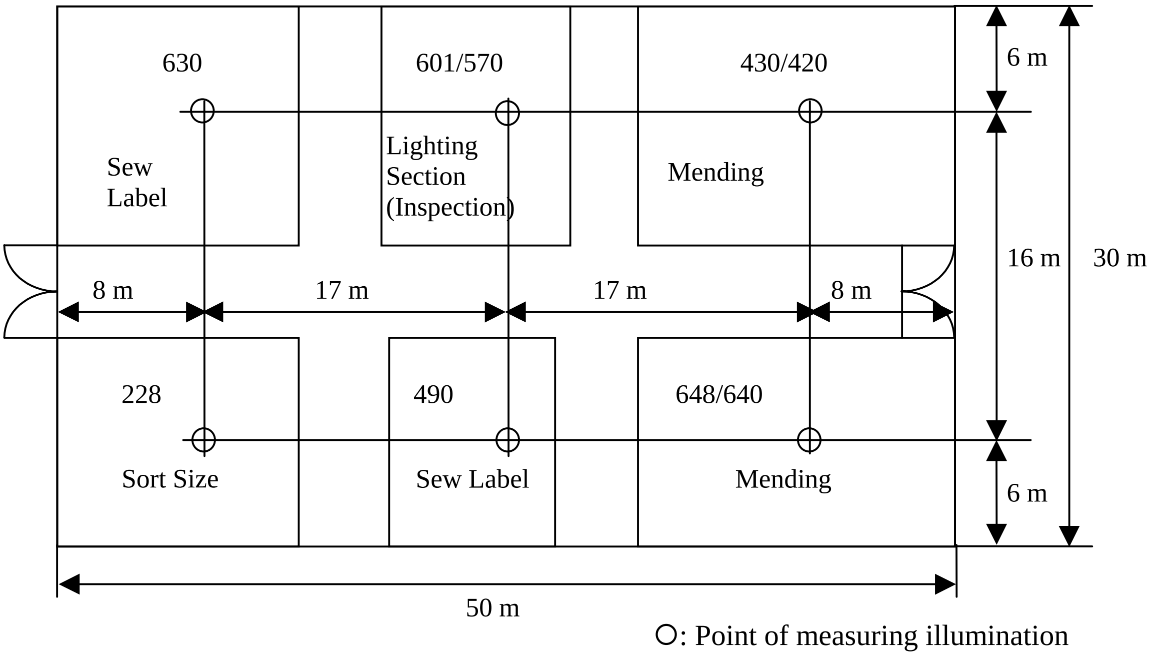


Figure I-5-3 Illumination through Ceiling Lighting ON/OFF in Shop A & B

5.2 Survey and Measurement Results of June Textiles Co., Ltd.

(1) Boiler equipment

1) Most of drain from the ironing process is emitted to the air.
Heat of the drain should be recovered and used as water supplied to the boiler.

2) The steam piping between the boiler, steam header, and factory is not insulated (surface temperature: 135°C). Figure I-5-4 shows the boiler piping schematic diagram.
Heat insulation should be applied to the bare piping for energy conservation.

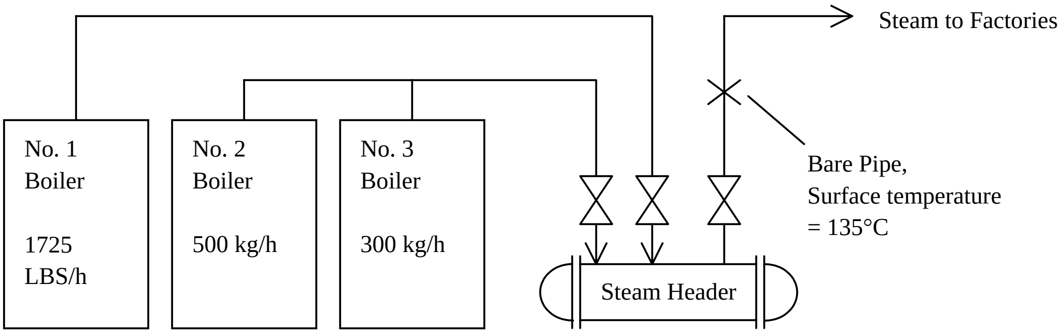


Figure I-5-4 Boiler Piping Schematic Diagram

(2) Air compressor equipment

On the day of audit, the No. 1 air compressor was running and repeating loading/unloading.
A 2 m^3 reservoir tank should be installed and controlling the number of air compressors in service should be applied to three air compressors for energy conservation.

(3) Lighting equipment

The mounting position of the fluorescent lamp apparatus for the cutting machine on the fourth floor in the new factory is high. By lowering the apparatus position by approximately 50 cm, illumination on the working surface can be greatly improved. Finally, the number of lighting apparatuses can be reduced and significant energy conservation effects can be expected.
Similarly, the position of the fluorescent lamp apparatus for the sewing machine on the second floor in the old factory should be lowered.

6. Recommendation of Energy Conservation and Expected Effects

6.1 Recommendation and Expected Effects for M&V International Manufacturing Ltd.

(1) Heat recovery of exhaust gas from diesel engine

1) Exhaust gas heat recovery method

Heat exchangers should be newly installed on the exhaust gas ducts from the No. 2 and 3 diesel engines for exhaust gas heat recovery. With energy resulting from exhaust gas heat recovery, steam of 3 kg/cm^2 is generated and used along with existing boilers. Consequently, reduction of fuel used by boilers is attempted.

Figure I-6-1 shows heat recovery method of the exhaust gas from diesel engines.

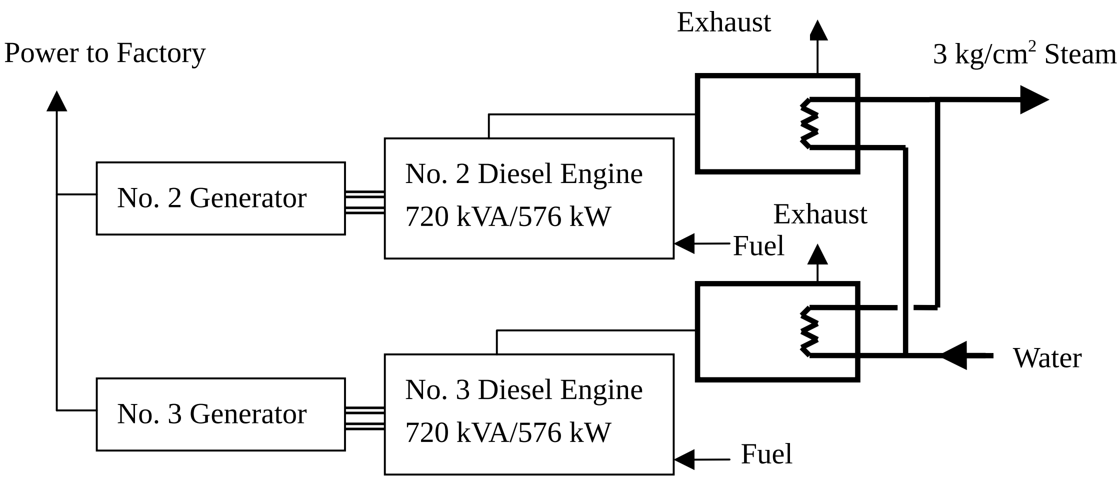


Figure I-6-1 Heat Recovery Method of the Exhaust Gas from Diesel Engines

2) Effects expected as a result of exhaust gas heat recovery

Operating conditions :	Power generation output	:	250 kW × 2 sets (equipment capacity = 576 kW/set)
	Recovered steam pressure	:	3 kg/cm^2
	Exhaust gas recovery heat value	:	45 Mcal/h at 250 kW (Data of the same equivalent size in Japan)
	Fuel heat generation	:	10,200 kcal/kg
	Fuel specific gravity	:	0.85 kg/L
	Fuel price (heavy oil)	:	US$ 0.25/L in 2002
	Boiler efficiency	:	85%
	Steam enthalpy	:	664 kcal/kg

Supplied water temperature	:	60°C
Running time	:	2,296 h/y
Steam recovery	:	45000 × 2/(664-60) = 149 kg/h
Merit of heat recovery	:	(45000 × 2 × 2296 × 0.25) /(10200 × 0.85 × 0.85) =US$7010/y (= Δ28 kL/y /saved fuel volume)

3) Equipment investment amount US$98600 (Japan-based investment amount)

a. Exhaust gas boiler	2 sets	US$33000 × 2 =	66000
b. Pump, piping material	2 sets	US$3300 × 2 =	6600
c. Electrical components	1 set	US$	10000
d. Installation cost	1 set	US$	16000
	Total	US$	98600

(2) Heat insulation for steam piping in the dryer and ironing processes

1) Parts to which heat insulation is to be applied

a. Parts in the dryer process to which heat insulation has not been applied
25A steam valve : 10 parts
25A steam pipe : 3 m/part × 10 parts = 30 m

b. Parts in the ironing process to which heat insulation has not been applied
25A steam valve : 8 parts
25A steam pipe : 2 m/part × 8 parts = 16 m

Table I-6-1 shows the heat loss by radiation in the non-heat insulation points.

Table I-6-1 Radiation in the Non-heat Insulation Points

Process (Location)	Operation Period (h/d)	Present Situation (None-heat insulation points)	Heat Loss by Radiation
Dryer	10 h/d	25A Steam Valve 10 valves	155 kcal/mh × 1 m × 10 × 10h = 15500 kcal/d
		25A Steam Pipe 30 m	155 kcal/mh × 30 m × 10h = 46500 kcal/d
Ironing	10 h/d	25A Steam Valve 8 valves	155 kcal/mh × 1 m × 8 × 10h = 12400 kcal/d
		25A Steam Pipe 16 m	155 kcal/mh × 16 m × 10h = 24800 kcal/d
Total			99200 kcal/d

2) Expected effect

The energy conservation effect is:

Radiation heat value × Heat insulation efficiency × Annual running days × Fuel unit price/(Fuel calorific value × Boiler efficiency)

= 99200 kcal/d × 0.8 × 287d × US$0.25/(10200 kcal/kg × 0.85 kg/L × 0.85)

= US$772/y (= Δ3.1 kL/y saved fuel volume)

3) Equipment investment amount US$2,850 (Japan-based investment amount)

a. Heat insulation material	1 set	US$ 1600
b. Heat insulation application cost	1 set	US$ 1250
	Total	US$ 2850

(3) Turning off the ceiling (general) lighting in Shops A, C, and A & B

1) Effects expected from turning off the lighting in Shop A

Illumination provided after turning off the ceiling lighting is almost the same as that provided when the ceiling lighting is turned on. In other words, the ceiling (general) lighting does not work efficiently. Therefore, the lighting should be OFF during the daytime for energy conservation.

Since the energy conservation effect is the total capacity of the ceiling lighting apparatuses (4.3 kW (40 W × 3 pieces × 36 sets)):

Total capacity of lighting apparatuses × Annual running time × Operation rate × Electricity charge unit price

= 4.3 kW × 287d ×8 h/d × 0.8 × US$0.152/kWh

= US$1200/y

2) Effects expected from turning off the lighting in Shop C

Since the energy conservation effect is the total capacity of the ceiling lighting apparatuses (9.6 kW (40 W × 3 pieces × 80 sets)):

Total capacity of lighting apparatuses × Annual running time × Operation rate × Electricity charge unit price

= 9.6 kW × 287d × 8 h/d × 0.8 × US$0.152/kWh

= US$2680/y

3) Effects expected from turning off the lighting in Shop A & B

Since the energy conservation effect is the total capacity of the ceiling lighting apparatuses (3.6 kW (40 W × 3 pieces × 30 sets)):

Total capacity of lighting apparatuses × Annual running time × Operation rate x Electricity charge unit price

= 3.6 kW × 287d × 8 h/d × 0.8 × US$0.152/kWh

= US$1005/y

4) Equipment investment amount: 0 (not required)

6.2 Recommendation and Expected Effects for June Textiles Co., Ltd.

(1) Drain recovery from the ironing process

1) Drain recovery method

Figure I-6-2 shows drain recovery method from the ironing process. Drain should be utilized for boiler feed water and the heating.

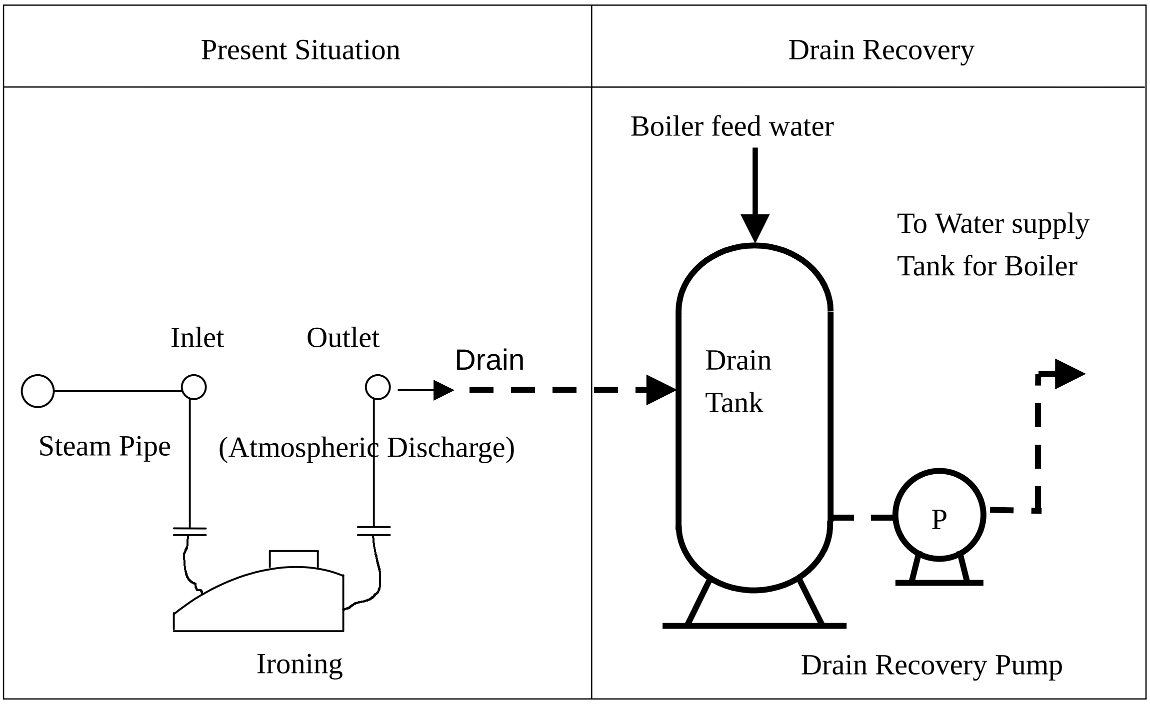


Figure I-6-2 Drain Recovery Method from the Ironing Process

2) Effects expected from drain recovery

Drain from indirect heating (heat exchange type) in the ironing process is used as water supplied to the boiler.

A drain recovery pump should be installed to recover the saturated water of approximately 1.2 kg/cm^2 at 120°C into the boiler water supply tank.

a. Operating conditions:

Boiler capacity	:	500 kg/h
Boiler load rate	:	60%
Steam consumption rate in the ironing process	:	20%
Drain recovery rate	:	50%
Boiler efficiency	:	85%
Boiler water supply temperature	:	30°C
Fuel unit price (diesel oil)	:	US$0.35/L

b. The fuel unit consumption (i.e. fuel volume required to generate steam of 1 kg) is obtained.
If the water supply temperature is 30°C (at present),
(664-30) kcal/kg/10200 × 0.85 = 0.073 kg/kg
If the water supply temperature is 120°C (drain recovery),
(664-120) kcal/kg/10200 × 0.85 = 0.0627 kg/kg

c. The energy conservation effect is:
Drain recovery volume kg/y × Fuel unit consumption difference × Fuel unit price/Fuel specific gravity
= 500 kg/h × 0.6 × 0.8 × 0.5 × 4800 h/y × (0.073-0.0627) kg/kg
× US$0.35/L/0.85kg/L
= US$2443/y (= Δ7 kL/y saved fuel volume)

3) Equipment investment amount US$27,000 (Japan-based investment amount)

a. Drain tank 5 m^3	1 set	US$ 15000
b. Pump and piping	1 set	US$ 5000
c. Installation cost	1 set	US$ 7000
	Total	US$ 27000

(2) Heat insulation for bare piping between the boiler, steam header, and factory

1) Parts to which heat insulator is to be applied
All piping is bare (i.e. heat keeping not applied), as shown in Figure I-6-3, Boiler piping schematic diagram.
As a measure, heat insulation (heat insulator thickness of 30 mm) should be applied to the full length (60 m) of the bare piping.

2) Effects expected from heat insulation
(Heat insulation conditions) 40A piping × 60 m
Running condition : 16 h/d × 300 d/y
Heat insulation effect : 80%
(Expected effect)
= 230 kcal/mh × 60 m × 16 h/d × 300 d/y × 0.8/(10200 kcal/L × 0.85 × 0.85)
× US$0.35/L = US$2516/y (= Δ7.2 kL/y saved fuel volume)

3) Equipment investment amount US$3,800 (Japan-based investment amount)

a. Heat insulation material	1 set	US$ 1500
b. Heat insulation application cost	1 set	US$ 2300
	Total	US$ 3800

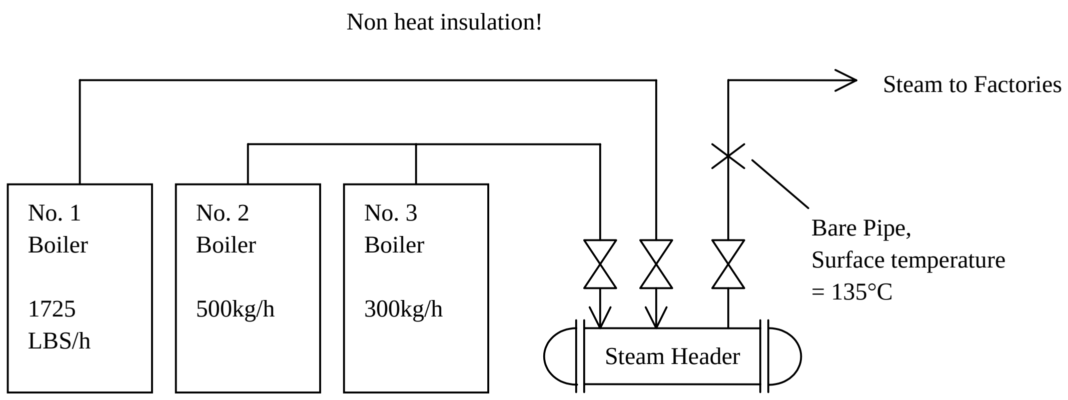


Figure I-6-3 Boiler Piping Schematic Diagram

(3) Energy conservation achieved by introducing of controlling the number of air compressors in service

1) Introduction of controlling the number of air compressors in service
Figure I-6-4 shows the method of installing a new reservoir tank and controlling the number by three air compressors.

2) Effects expected from introduction of controlling the number of air compressors in service
Presently, the No. 1 air compressor is repeating loading/unloading in a cycle of 5 seconds. The unloading state is the standby state of the air compressor not delivering compressed air. Air is accumulated in the newly installed reservoir tank. The status of air accumulation is indicated by the tank pressure, with which the system controls air compressor ON/OFF. By stopping the operation after the unloading operation, energy conservation can be achieved.

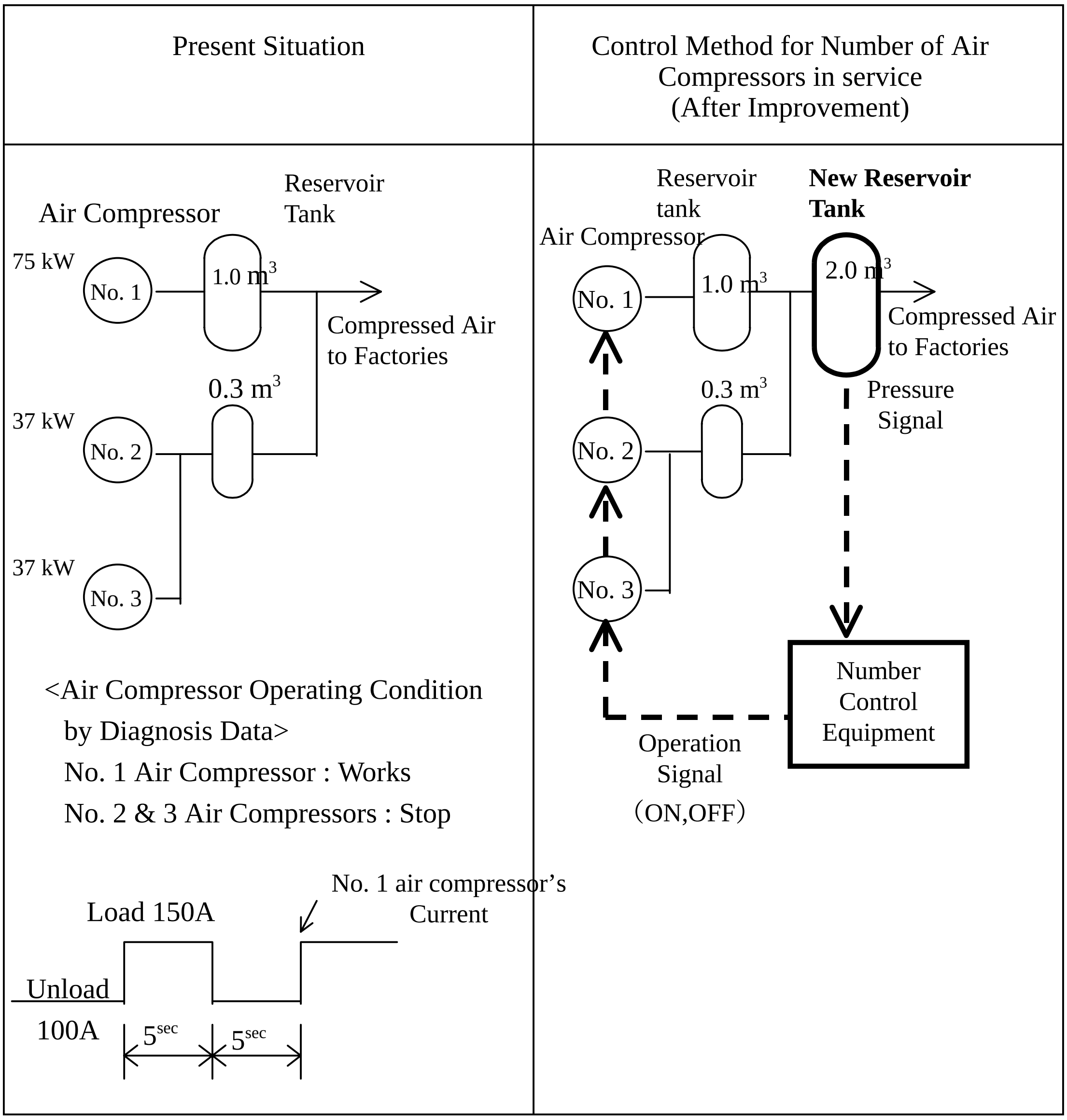


Figure I-6-4　Control Method for Numbers of Air Compressors in Service

(Expected effects)

Electricity for unloading = $\sqrt{3} \times 0.4 \times 100 \times 0.85 = 58.9$ kW

Annual electricity for unloading = 58.9 kW × 16 h/d × 300 d/y × 0.8 × 1/2

= 113088 kWh (air compressor load rate assumed to be 0.8)

The energy conservation effect is:

113088 kWh/y × US$0.122/kWh = US$13797/y

3) Equipment investment amount US$23,500 (Japan-based investment amount)

a. Unit for controlling the number of air compressors in service	1 set	US$ 12500
b. Reservoir tank 2 m^3	1 set	US$ 6000
c. Installation cost	1 set	US$ 5000
	Total	US$ 3800

(4) Energy conservation achieved by changing the position of the lighting apparatus

1) Places requiring apparatus position change (improvement)

Following two places are large and wide room, and there are many local lamps. This method is applied to anywhere in the rooms.

a. Changing the position of the fluorescent lamp for the cutting machine on the fourth floor in the new factory (Figure I-6-5)

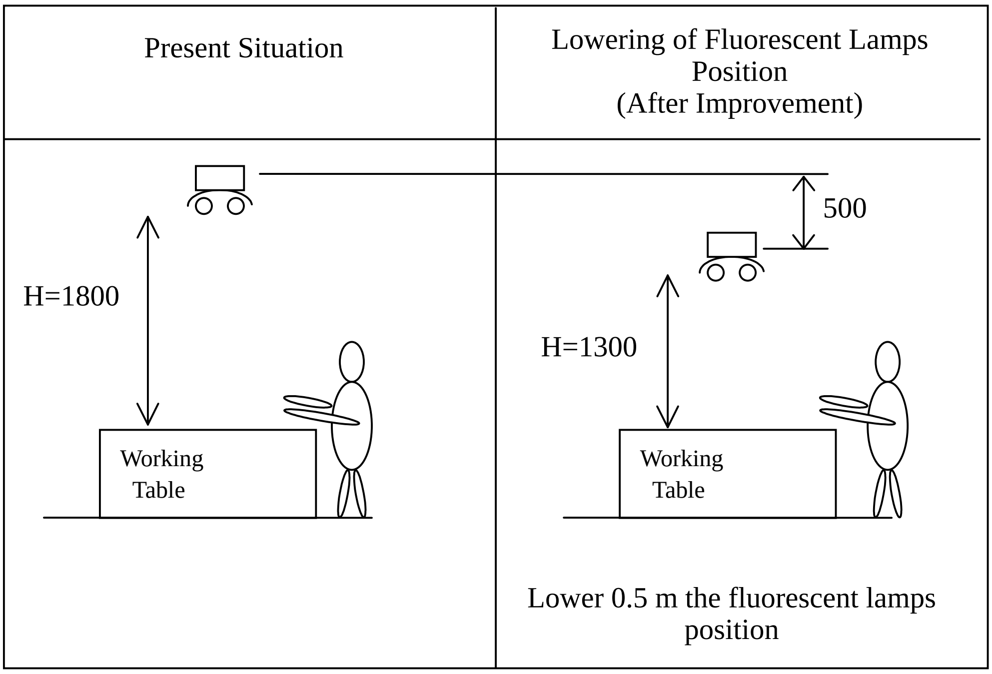


Figure I-6-5 Changing the Position of the Fluorescent Lamp on the Fourth Floor in the New Factory

b. Changing the position of the fluorescent lamp for the sewing machine on the second floor in the old factory (Figure I-6-6)

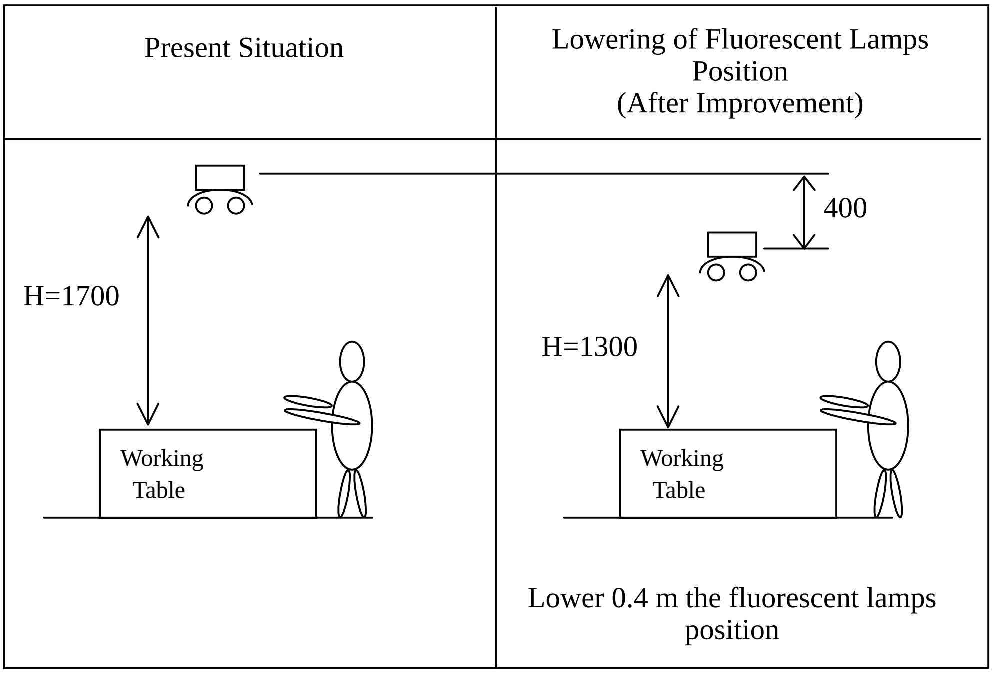


Figure I-6-6 Changing the Position of the Fluorescent Lamp on the Second Floor in the Old Factory

2) Expected effects

Illumination on the working table is closely related with the distance H between the lighting apparatus and working surface. In other words, if H is reduced to a half, illumination becomes 4 times larger.

By lowering the position of the lighting apparatus, illumination is greatly improved. Consequently, the number of apparatuses can be reduced and therefore energy conservation can be achieved.

a. Expected effects for the cutting machine on the fourth floor in the new factory

a) Number of lighting apparatuses at present: 40 W × 2 pieces × 208 lamps

b) Number of lighting apparatuses required to obtain the same illumination when the position of the apparatus is lowered:

$$208 \text{ lamps} \times (1300/1800)^2 = 109 \text{ lamps}$$

c) Number of apparatuses reduced : 208 – 109 = 99 lamps

d) Energy conservation : 7.92 kW (40 W × 2 pieces × 99 lamps)

e) The energy conservation effect is :

7.92 kW × 16 h/d × 300 d/y × 0.8 × US$0.122/kWh = US$3710/y

(lighting load rate assumed to be 0.8)

b. Expected effects for the sewing machine on the second floor in the old factory

a) Number of lighting apparatuses at present: 40 W × 2 pieces × 128 lamps

b) Number of lighting apparatuses required to obtain the same illumination when the position of the apparatus is lowered:

$$128 \text{ lamps} \times (1300/1700)^2 = 75 \text{ lamps}$$

c) Number of apparatuses reduced : 128 – 75 = 53 lamps

d) Energy conservation : 4.24 kW (40 W × 2 pieces × 53 lamps)

e) The energy conservation effect is :

4.24 kW × 16 h/d × 300 d/y × 0.8 × US$0.122/kWh = US$1986/y

(lighting load rate assumed to be 0.8)

3) Equipment investment amount US$6,000 (Japan-based investment amount)

a. Cost for changing the apparatus position on the fourth floor in the new factory	US$ 3000
b. Cost for changing the apparatus position on the second floor in the old factory	US$ 3000
Total	US$ 6000

6.3 Summary of Energy Conservation Effects

Table I-6-2 shows the summary of energy conservation effects

Table I-6-2 Summary of Energy Conservation Effects

Company name / Item	M&V International Manufacturing Ltd.		June Textiles Co., Ltd.	
	US$/y Expected effect	US$ Equipment investment amount	US$/y Expected effect	US$ Equipment investment amount
1. Heat recovery from diesel engine exhaust gas	7010	98600	–	–
2. Heat insulation for steam piping	772	2850	2516	3800
3. Drain heat recovery in the ironing process	–	–	2443	27000
4. Controlling the number of air compressors in service	–	–	13797	23500
5. Making the lighting equipment’s efficiency higher	4885	–	5696	6000
Total	12667	101450	24452	60300

7. Guideline for Promotion of Energy Conservation

7.1 Overview of Processes in the Garment Industry

The manufacturing processes are shown in Figure I-7-1. Which process uses utilities such as electricity, water, steam, compressed air, etc. how should be grasped first.

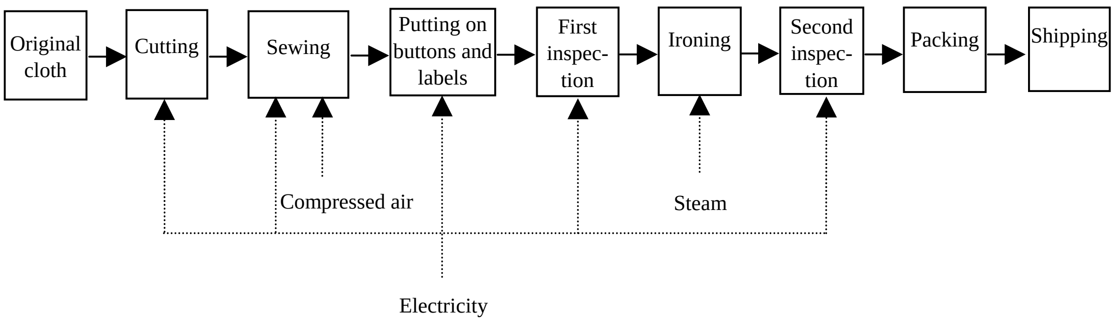


Figure I-7-1 Manufacturing Processes in the Garment Industry

7.2 Grasping the Actual Status of Energy Consumption

(1) Data collection in advance

Data should be collected in advance and filled in Factory Energy Use Status Table (i.e. enter the production volume and used quantities of electricity, fuel, steam, water, and compressed air).

(2) Prepare a graph showing the amount of energy used.

For example, a graph showing the power volume used in the factory is prepared in Figure I-7-2.

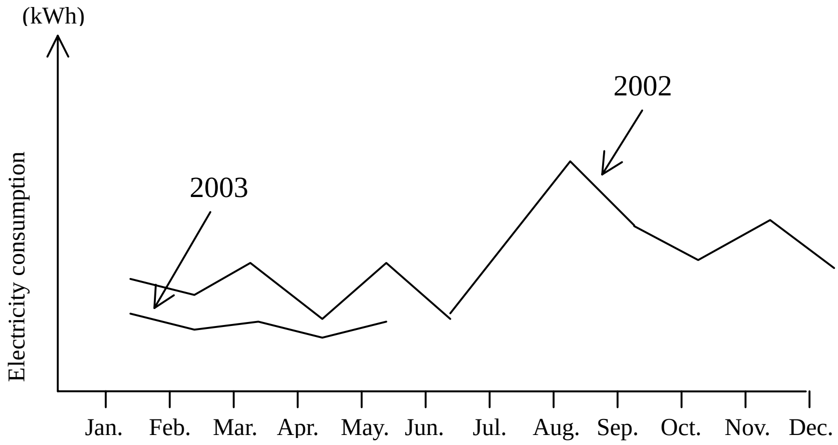


Figure I-7-2 The Power Volume Used in the Factory (Example)

(3) Prepare a graph showing the production volume and energy intensity in the factory.

For example, a graph showing the sweater production volume and power consumption is prepared in Figure I-7-3.

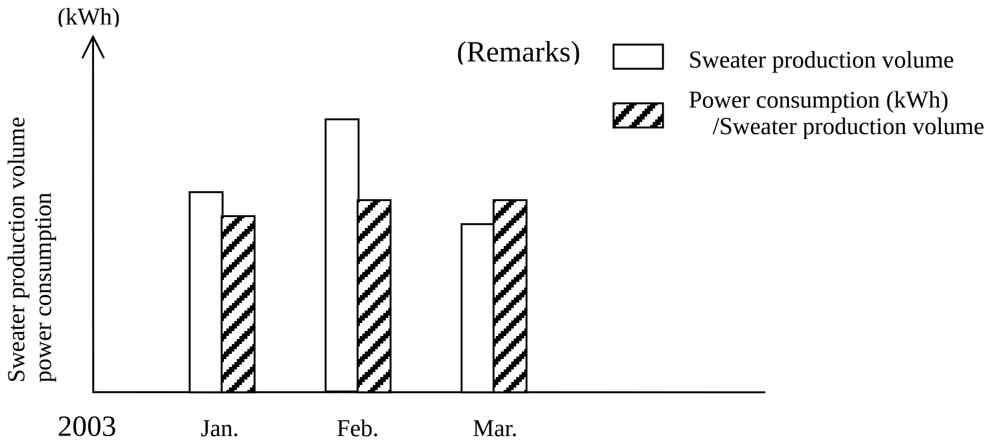


Figure I-7-3 The Sweater Production and Power Consumption (Example)

(4) Enhancement of energy management

Measuring instrument should be installed for respective utilities so that periodic measurement, data collection, and management of the energy volume used in the factory will be possible.

1) Electricity : Installing a meter for electrical energy generated by each diesel power generator
Installing a meter for electrical energy in each process
2) Steam : Installing a meter for the fuel volume used for each boiler
Installing a flow rate meter for water supply to each boiler
3) Compressed air : Installing a flow rate meter for each process
4) Lighting : Installing a meter for electrical energy in each process

7.3 Extraction of Problems with Energy Conservation Check List

When graphs of the energy consumption data collected, production volume, and energy volume used and intensity are available, check should be made according to the check list given below to extract problems in energy conservation.

1) Electricity management
   a. How to determine the contracted electricity and the system of the electricity charge should be understood.
   b. The contracted electricity and maximum demand electricity as well as the electricity volume used should be reduced.
   c. Isn’t wasted electricity found in comparison between months and with the previous year when the graph showing the used electricity volume is checked?
   d. Is electricity consumption being improved?

2) Energy Conservation Check Points for Major Equipment
   a. Electricity receiving/transforming equipment
      - Isn’t there any transformer that can be shut down in the nighttime or on holidays?
      - Is the power factor being improved?

   b. Air compressor equipment
      - Isn’t there leak from piping?
      - What about ventilation? Isn’t the air compressor intake temperature high?
      - Can’t the delivery pressure of the air compressor be dropped?
      - What is the air compressor’s capacity adjusting system?
      - Is the air compressor shut down when it is not used?
      - What operation is performed against variation of the used volume?
      - Has introduction of controlling the number of air compressors in service been studied?

   c. Blower and pump
      - Are they shut down when they are not necessary?
      - Doesn’t the flow rate or pressure have a too large margin?
      - Is the flow rate adjusted, and by what?
      - Was changing the number of revolutions or impeller cutting studied?
      - Was controlling the number of revolutions studied?

   d. Boiler equipment
      - Is the air-fuel ratio for combustion adequate?
      - Is heat insulator applied to the boiler furnace wall?
      - Is heat insulator applied to steam piping?
      - Is drain recovered efficiently after the use in the process?

e. Lighting
- Is lighting turned off when or where it is not required?
- Is daylight used and is lighting turned off?
- Is spot lighting also used?
- Is illumination adequate and is it measured?
- Was adoption of high-efficiency lighting apparatuses studied?

f. Air-conditioning equipment
- Can’t the heat load generated from components and outer air load be reduced?
- Can’t heat insulation for the building and daylight shielding be improved?
- Is the set value for room temperature adequate?
- Can’t the air conditioner running time be reduced?
- Isn’t air conditioning run in unnecessary spaces?
- Is the filter cleaned periodically?
- Upon renewal, new installation, or expansion, was adoption of the ice heat storage type studied?

7.4 Energy Conservation Approaches

After problems are extracted according to 7.3 Extraction of Problems with Energy Conservation Check List, approaches for solving the problems are required.
Following are the energy conservation approaches for problem solution.
Energy conservation should be studied according to these approaches. The result of studying energy conservation should be forwarded to the energy conservation actions based on the considerations of the energy conservation effects and equipment investment.

Examples of approaches:

Approach 1 :	Reduction of Maximum Electricity with a Demand Controller
Approach 2 :	Power Factor Improvement Method
Approach 3 :	Energy Conservation Technique for Air Compressors
Approach 4 :	Energy Conservation and Cost Reduction through Control of the Number of Air Compressors in Service
Approach 5 :	Control of the Number of Revolutions for Blowers and Pumps
Approach 6 :	Making Efficiency Energy Supply Higher by Co-generation System
Approach 7 :	Application of High-efficiency Lighting Apparatuses

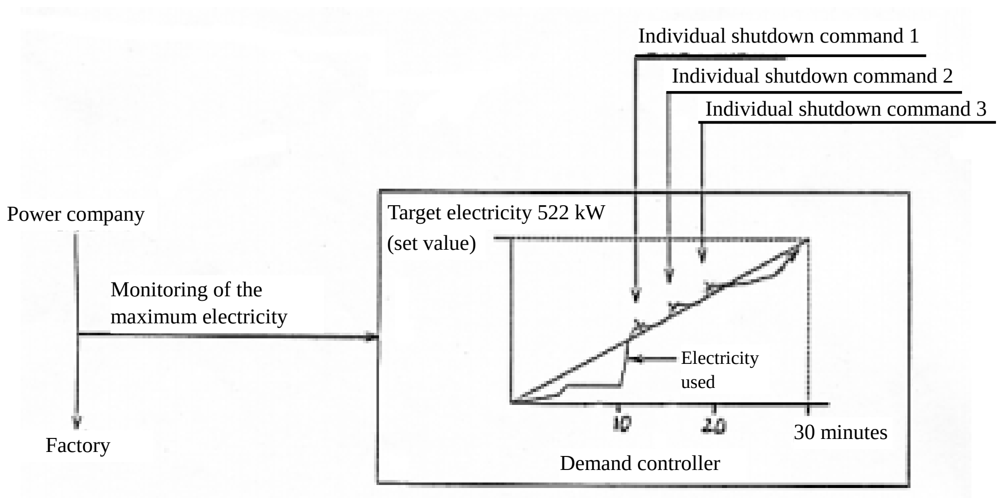
Approach 1: Reduction of Maximum Electricity with a Demand Controller

1. Operation of Demand Controller

The demand contract is a contract system based on the maximum electricity. Consumption once a large value occurs, this value is the contracted electricity for coming one year. Reduction of the contracted electricity from 612 kW to 522 kW by suppressing the maximum electricity is described below.

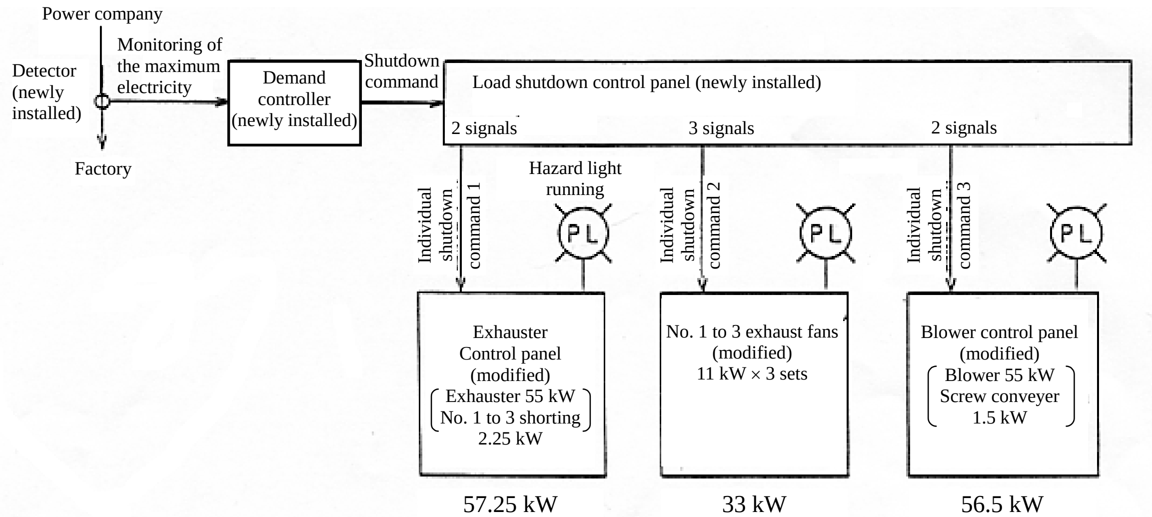
If it is estimated that the actual electricity used is likely to exceed the target electricity of 522 kW, individual shutdown commands 1 to 3 are sequentially issued to shut down non-important loads in the factory and suppress the value below the target electricity.

After 30 minutes, power-on is performed (sequentially by timers) automatically to achieve demand control and operation in unmanned and automatic mode.



2. Schematic Diagram of Demand Controller

The factory receives electricity from the power company. This system monitors the maximum electricity at the electricity receiving point as shown below and shuts down the non-important loads in the factory with the shutdown signals from the load shutdown control panel to suppress the peak electricity. By suppressing the maximum electricity (peak), the contracted electricity can be maintained low and a significant amount of electricity charge can be reduced.



3. Investment Effect by the Demand Controller

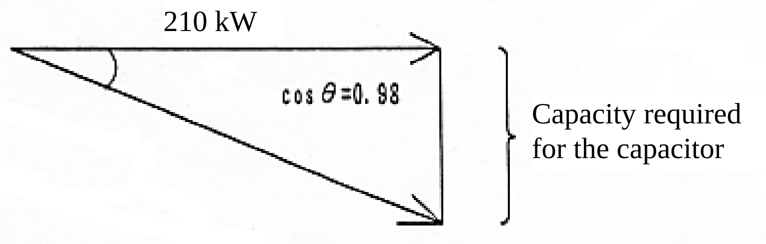
If it is assumed that the present contracted electricity of 612 kW is suppressed to 522 kW by execution individual shutdown commands 1 and 2 in the table below, the amount of introduction merit is 1.45 million yen annually.
Since a peak may occur any time in the present status (blind state), it is recommended to introduce the demand controller.
Once the demand controller is introduced, the maximum electricity can be easily managed and therefore it is easy to implement energy conservation measures.

	Equipment to be shut down	Saved electricity	Investment effect/year	Total investment effect
Individual shutdown command 1	Exhauster	57.25 kW	57.25 kW × 1575 yen/kW × 0.85 × 12 = 919,721 yen	919,721 yen
Individual shutdown command 2	Exhaust fan	33 kW	33 kW × 1575 yen/kW × 0.85 × 12 = 530,145 yen	1,449,866 yen
Individual shutdown command 3	Blower	56.5 kW	56.5 kW × 1575 yen/kW × 0.85 × 12 = 907,762 yen	2,357,538 yen

If up to individual shutdown command 3 is implemented, the effect is approximately 2.3 million yen annually.

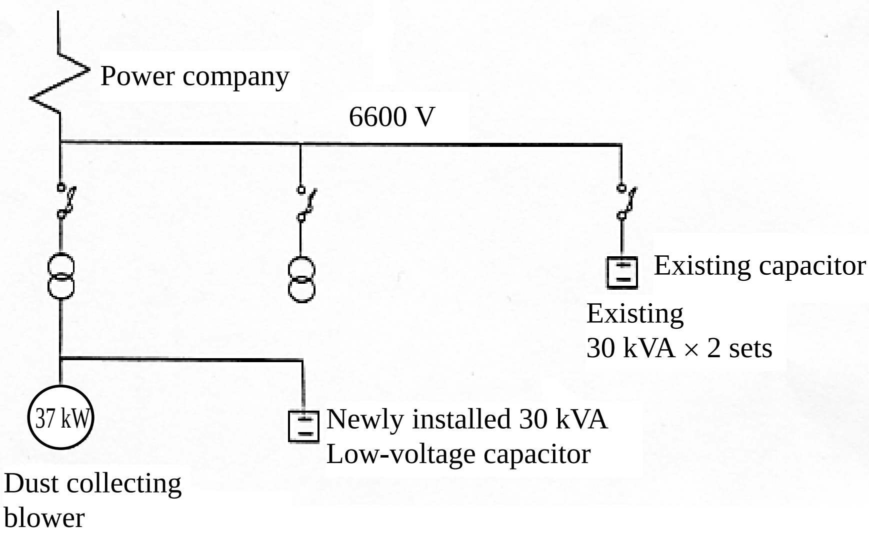
Approach 2: Power Factor Improvement Method

1. If the present maximum electricity is 210 kW and the power factor is 98%, the capacity required for the capacitor for improvement to a power factor of 100% is as follows:

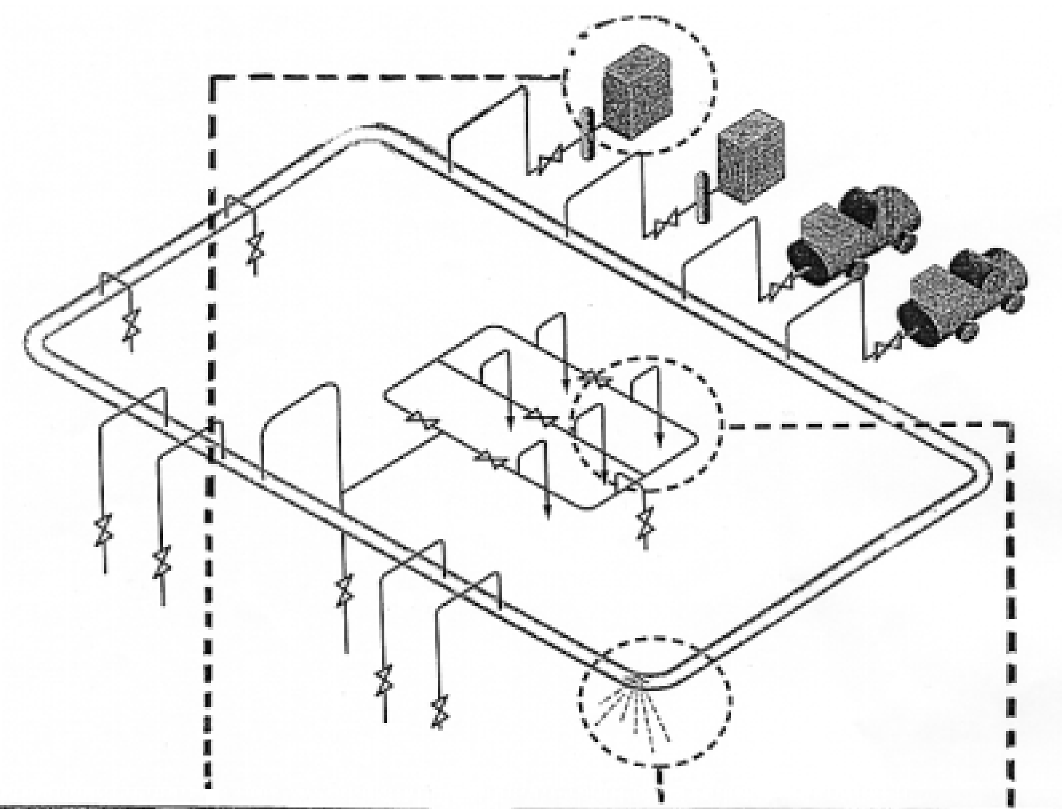


Capacity required for the capacitor $= 210 \times \tan\theta = 210 \times 0.2 \fallingdotseq 42$KVA

2. Installation of the power factor improving capacitor



Approach 3: Energy Conservation Technique for Air Compressors



(1) Renewal to a new machine (high-efficiency air compressor)

<Expected effect> Energy conservation of 7 to 15% (per air compressor)

(2) Adoption of the system controlling the number of air compressors in service

<Expected effect> Realization of the minimum necessary air compressors in service

(3) Improvement of installation (intake) condition

- Lowering the intake air temperature
- Reduction of the intake resistance

<Expected effect> Realization of operation with optimum energy conservation

Improvement measures
- a. Review of the intake port and exhaust port
- b. Optimization of the ventilation fan capacity

(4) Reduction of the delivered air pressure and use-end pressure

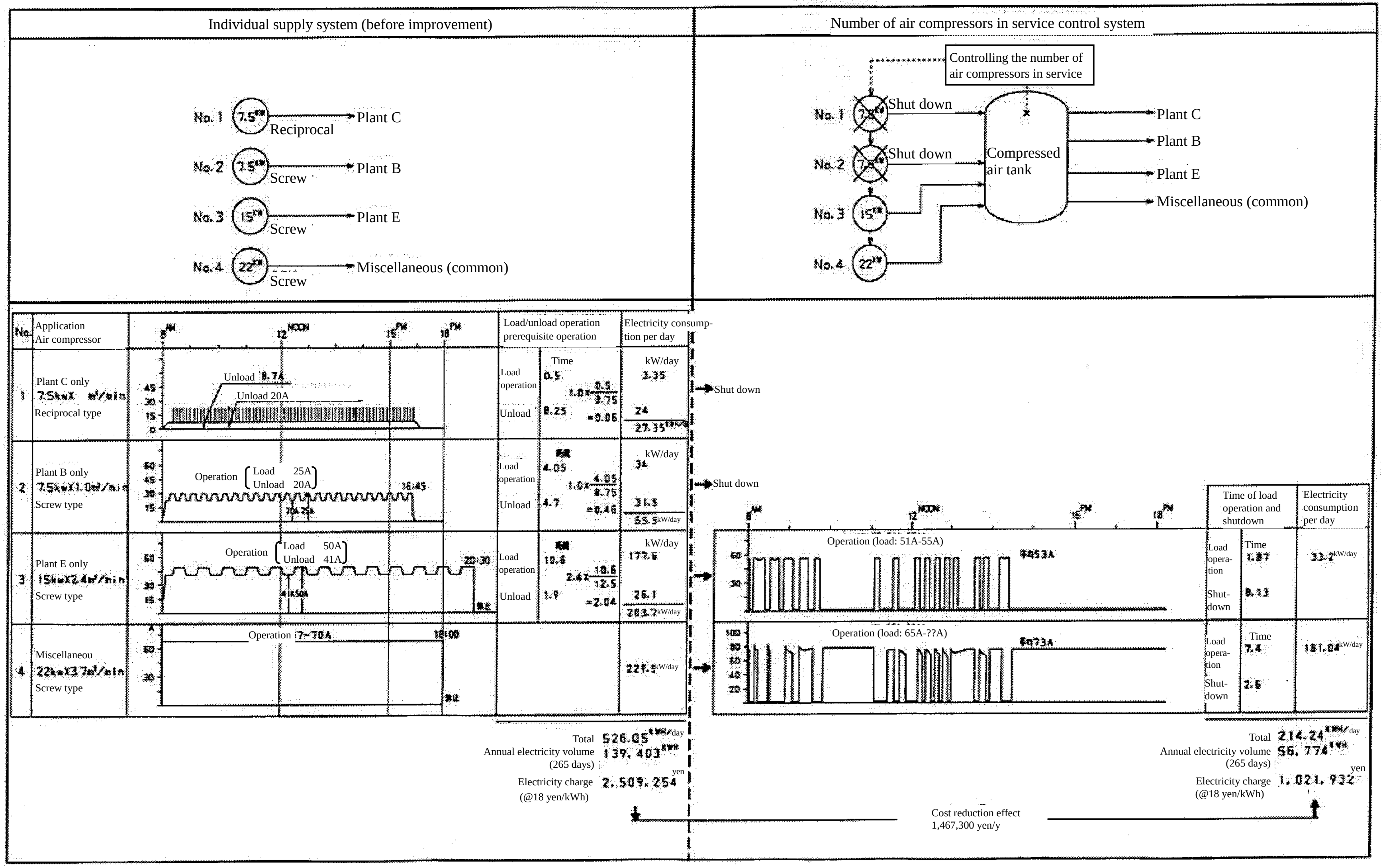
<Expected effect> If a delivery gauge pressure of 0.69 MPa (7 kgf/cm^2) is dropped to 0.59 MPa (6 kgf/cm^2), energy conservation is approximately 9%.

Measures for reduction of pressure losses
- a. Periodic maintenance of supplementary equipment (filters, etc.)
- b. Loop piping and review of pipe diameter

(5) Repair of air leak from piping

<Expected effect> If 10 positions of 1 mm dia. hole are repaired, energy conservation corresponds to a 5.5 kW air compressor.

Approach 4: Energy Conservation and Cost Reduction through Control of the Number of Air Compressors in Service



Approach 5: Revolution Control for Blowers and Pumps

If the intake air flow rate is Q m^3/min, the pressure is H mmAq, and the efficiency is η, the required electricity P kW for the blower is:

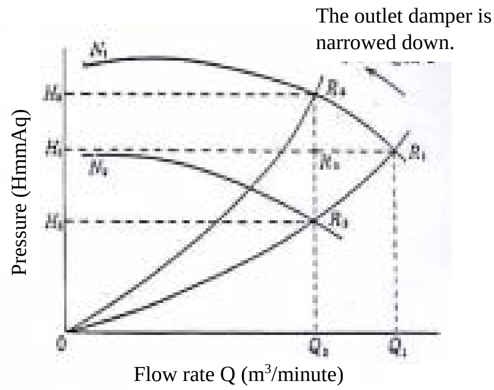
$P = QH/6120\eta$.

If the number of revolutions is N rpm and the constant is k, the relationship between the number of revolutions and power is as follows:

$Q = k_1N$, $H = k_2N^2$

$P = k_3N^3$

In the figure at right, if the outlet damper is narrowed down to reduce the air flow rate of the blower that is running at the number of revolutions N_1 and air flow rate Q_1 to Q_2, the resistance curve of piping changes from OR_1 to OR_2, power changes from rectangle $OH_1R_1Q_1$ to $OH_2R_2Q_2$. Power does not decrease very much when the air flow rate is reduced by narrowing down the damper.



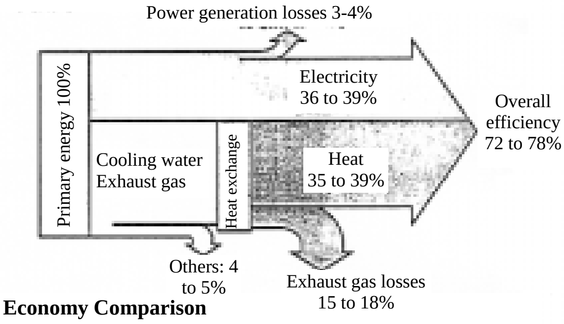
In contrast, N_1 is reduced to N_2 by controlling the number of revolutions, power reduces from the area of rectangle $OH_1R_1Q_1$ to the area of $OH_3R_2Q_2$.

As you see, controlling the number of revolutions is more advantageous that controlling the outlet damper in energy conservation.

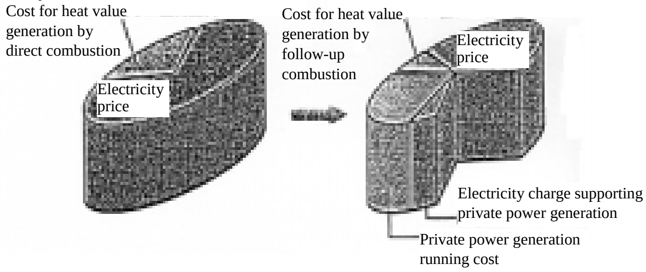
Generally, an inverter unit (VVVF) is adopted for controlling the number of revolutions.

Approach 6: Making Energy Supply Efficiency Higher by Co-generation System

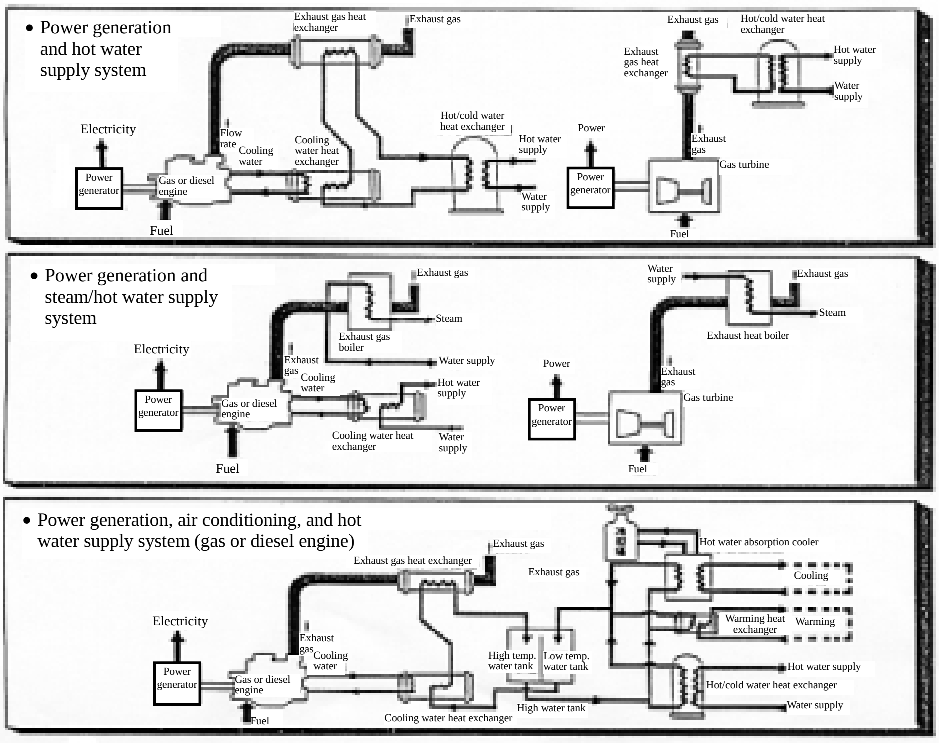
1. **High-efficiency Power Generation and High-efficiency Exhaust Heat Recovery**
   Adoption of a diesel engine enabling high-efficiency shaft power.
   Stable and high-efficiency exhaust heat utilization through operation of collaborating lines.
2. **Easy Fuel Supply**
   Adoption of a diesel engine enabling each fuel supply (A heavy oil)
3. **Low-pollution Diesel Pack**
   Low noise by adopting the sound-proof cubicle [75 dB(A)].
   Low NOX in exhaust gas by the (optional) denitration unit.
4. **Compact unit**
   Adoption of a diesel engine (1500/1800 rpm).
5. **High economy**
   Reduction of the energy cost with the inexpensive electricity unit price and through high-efficiency exhaust heat utilization.
   Reduction of the equipment cost through introduction of the system matching the electricity and heat demands.
   Reservation of electricity against disasters.
6. **Energy Efficiency**
   High-efficiency system that suppresses the losses of primary energy (100%) to 22 to 28%.



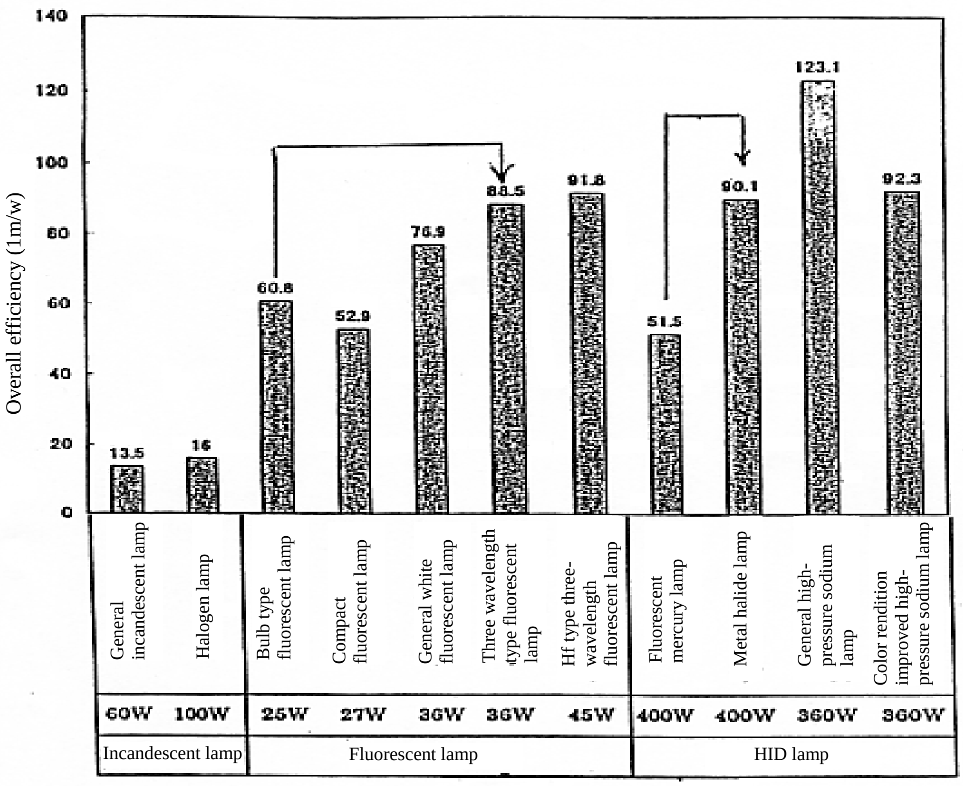
7. **Economy Comparison**
   With the economic merit, the equipment cost for introducing the co-generation system can be recovered in 3 to 5 years (simple investment recovery period).



Heat recovery system flow chart (typical example)



Approach 7: Application of High-efficiency Lighting Apparatuses



	Type of light source	Lamp Power [W]	Input Power [W]	Total luminous flux (1) [lm]	Overall efficiency (2) [lm/W]	Color temperature [K]	Average color rendering index [Ra]	Rated life [h]
Incandescent lamp	Incandescent lamp							
	General lighting	60	60	810	13.5	2850	100	1000
	Ball bulb	57	57	705	12.4	2850	100	2000
	Crypton lamp	60	60	840	14.0	2850	100	2000
	Halogen lamp							
	Single-ended mold	100	100	1600	16.0	2900	100	1500
	With infrared rediation reflection film	85	85	1680	19.8	2900	100	2000
	Small type (low-voltage type)	50	50	1000	20.0	3000	100	2000
	Double-ended mold	500	500	10500	21.0	3000	100	2000
Fluorescent lamp	Bulb type fluorescent lamp							
	Electronic lighting – bulb color	25	25	1520	60.8	2800	84	6000
	Electronic lighting – daylight white color	25	25	1460	58.4	5000	88	6000
	4-tube type – daylight white color	23	23	1550	67.4	5000	84	8000
	General fluorescent lamp							
	White	40	43	3000	69.8	4200	61	12000
	Same as above (power saving type)	36	39	3000	76.9	4200	61	12000
	Three-wavelength type – daylight white color	40	43	3450	80.2	5000	88	12000
	Same as above (power saving type)	36	39	3450	88.6	5000	88	12000
	High-frequency Hf) type							
	32W lighting – daylight white color	32	35	3200	91.4	5000	88	12000
	45W lighting – daylight white color	45	49	4500	91.8	5000	88	12000
	Compact type							
	27W type – daylight white color	27	34	1800	52.9	5000	88	7500
	36W type – daylight white color	36	40	2900	72.5	5000	88	9000
HID lamp	Fluorescent mercury lamp	400	427	22000	51.5	3900	40	12000
	Metal halide lamp	400	444	40000	90.1	3800	70	9000
	Same as above (Double-ended mold)	250	263	20000	76.0	4300	85	6000
	High-pressure sodium lamp	360	386	47500	123.1	2050	25	12000
	Same as above (improved rendering type)	360	390	36000	92.3	2100	60	12000

List of Attachments

KINGDOM OF CAMBODIA
NATION RELIGION KING
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COUNTRY REPORT

ON

ECONOMIC AND ENERGY SITUATION IN CAMBODIA

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ECONOMIC SITUATION
COUNTRY OVERVIEW

Cambodia located in South East Asia borders by Thailand and Laos to the north Vietnam to the east, gulf of Thailand and Vietnam to the South and the west part border by Thailand gulf of Thailand. Cambodia has a total area of 181,035 Km^2 divided into 24 provinces and one municipality according to the final census results of 1998 shows the total population of 11,437,656 and 85% of the people live in rural areas and mostly based on agriculture. The GDP per capita is varies between $240-$290 with an average growth rate of 1-4% (1997 - 1999). Literacy and education shows adult literacy as 68.8%, literacy rate are highest in Phnom Penh with rate of 90.9%, 74.8% and 82.2% for both sexes (see table 1) when compared with these rates, the rural sector rates were substantially lower and the male, female and both sexes literacy rates were 77.9%, 54.7% and 65.2%respectovely, as expected, male rate were higher than female rate in all sectors. Adult literacy rates appear to have increase by approximately 2.5% during the past few years.

Table 1 : Adult literacy rates by sex and Status, Cambodia

Type/ Sex	Cambodia	Phnom Penh	Other Urban	Rural
Both sexes	67.8	82.2	72.9	65.2
Male	80.0	90.9	84.0	77.9
Female	57.7	74.8	63.7	54.7

In common with other countries on the region, Cambodia possesses unique cultural and natural assets that have considerable international appeal. The most well known place in Cambodia is the temple city Angkor situated about 300Km North of Phnom Penh in the province Siem Reap, just a few Km from Siem Reap town. 95% of the population practice Buddhism as their religion the remaining Moslem and Christian.

1 Geographic condition including land use pattern and ownership

The tropical climate varies between 20°C-35°C throughout the year fully one-forth of the total land and of the country is appropriate for cultivation by geography condition the country divided into 4 regions: Plain region, Tonle Sap region, Coastal region and Plateau mountain region

2 Demographic condition including rural urban migrate

The final population of Cambodia as on March, 1998 according to the 1998 census is 11,437,656, the population of Cambodia by sex and urban rural residence is given in Table 2.

Table 2. Population of Cambodia by sex and urban rural residence

Total/Urban/Rural	Both Sexes	Males	Females
Total	11,437,656	5,511,408	5,926,248
Urban	1,795,575	878,186	917,389
Rural	9,642,081	4,633,222	5,008,859

Refer to the 1998 census 4/5 of the population live in the Central plains, which are dominated by the Mekong River and Tonle Sap Lake. Cambodia's population density was 63 inhabitants/Km^2 in 1998 in comparison to that was the density of population 37 inhabitant/Km^2 in 1981 and 54 inhabitant/Km^2 in 1993. In 1998 the Plain Region showed the highest density of population (235 inhabitants/Km^2) the Province Kandal with 300 persons/Km^2; with the Capital Phnom Penh 3,744.5 persons/Km^2, followed by Takeo with

222, Prey Veng with 194, Svay Rieng 161 and Kampong Cham with 164 inhabitants/Km^2. The lowest density of population was found in the Plateau and Mountain Region (17.5 Persons/Km^2) Mondulkiri with 2.2 Persons/Km^2, Stung Treng 7.3 Persons/Km^2, Ratanakiri and Preah Vihear each with 8.7 Persons/Km^2 Kampong Speu with 85 inhabitants/Km^2. The Coastal Region shows identity of 49 inhabitants/Km^2 and the Tonle Sap Region shows 51.8 Persons/Km^2.

Compared to other countries in this region the density of population of Vietnam's Red River Dilta is more than one thousand in habitant per Km^2.

3 Administration

Cambodia is a constitutional Monarchy King Norodom Sihanouk is the head of state. Prime Minister head a government The National Assembly has 122 members. The Administration of Government is through 24 provinces and a capital Phnom Penh is the Political cultural and economic center.

4 Economic and Social Situation

The Cambodia economy was devastated during the war in 1970's and 1980's. Since that time some progress has been made in rebuilding the economy most of the labor force are engaged in agriculture while rubber, fisheries, gem mining and food processing are the main industries. Last two year some same cement jute and cotton factories has been re-established and the clothing manufacture and tourist industries have expanded. Private investors from France, Malaysia, Singapore, Thailand. South Korea have established themselves in recent Nears. Cambodian main import are petroleum, automobiles, motorcycles, machinery equipment and construction materials. The gross domestic product (GDP) and the GDP percent from 1994 to 1999 shown in the Table below.

	1994	1995	1996	1997	1998	1999
Gross domestic product GDP (in MUS$)	2,385	2,923	3, I I3	3,033	2,868	3,182
GDP per capita (USS)	241	284	291	27-1	251	271
GDP (%in crease)	4%	7.60% °	7.0%	1.0%	I.0%	4.0%

Transportation and communications there are six national highways which emanate from Phnom Penh of those, except for the highway to Sihanouk Ville and to Kompong Cham, all other highways are in poor repair some of the small roads are impassable. While there is some public transport in the capital and some provincial cities, many Cambodians use bicycles and motorcycles for travel. Walking and buffalo drawn casts are commonplace. Railway services are available from Phnom Penh to Battambang, the Thailand border and to Sihanouk Ville.

There are several private companies participate in the Telecommunication System such as : Mobitel, SAMART Shinawatra etc. Development in this sector became better compared to the past two years.

Health and welfare Adequate medical care is not available to the large past of the population. The Government is implementing a basic health care system and International relief organisation are working with hospitals to improve the system. The sanitation is poor. Potable water is not read available, the life expectancy in 1995 was 53yrs for females and 50yrs for males.

Situation in the Past and at Present

1. Cambodia's power sector was severely damaged by years of war and neglect. In spite of the Government's efforts, its institutions remain weak and power supply is unreliable, costly, and mostly limited to urban areas. Consequently, only 12 percent of the households have access to electricity: the lowest electrification ratio among East Asian countries. In most cities, deficiencies in the power supply remain due to weak management and poor conditions of generation and distribution facilities. Further, the lack of a transmission system prevents a more efficient use of power supply options resulting in one of the highest electricity costs in the world.

2. After a two-year economic slowdown caused by a long political stalemate and East Asia's financial crisis, political stability is emerging and Cambodia appears to be ready to resume a sustained economic growth. GDP growth for 1999 is expected to reach 4% (as opposed to 1% in 1998) and gradually increase to 6% in 2001while Cambodia initiates a new era as a member of the ASEAN. Important part of this growth will be associated to industrial expansion stemming from regional trade opportunities and located mostly in the Phnom Penh – Sihanouk ville area. Therefore, the next 4 to 5 years will be characterized by an increasing demand for infrastructure in this area. However, while macro economic stability and growth are expected to be achieved progress has yet to be made in addressing fundamental fiscal problems, including a weak domestic revenue mobilization and inefficient public expenditure management. The efficient development of the power sector, open to private participation, will be critical to support Cambodia's goal for sustainable economic growth and social development due to the following reasons (a) the reliable provision of electricity services at lower costs is an essential condition for the growth of a competitive industry, and (b) power investments for the period 1999-2003 are expected to reach I1% of domestic investment and 2-2.5% of GDP, hence, a power sector successful in attracting direct private investment will minimize the use of public resources thus reducing the pressure on fiscal management problems and releasing public fluids for social objectives.

3. Cambodia's power sector is today at a crossroads. After a period of emergency rehabilitation and reconstruction, *the sector is ready to face development objectives aimed at: (a) improving sector efficiency and reducing electricity costs; (b) consolidating the ongoing reform; and (c) addressing the sector's social concerns, particularly the extension of electricity services to rural areas.* It is therefore necessary to formulate and implement a power sector strategy addressing the most salient problems of the sector:

- lack of a legal and regulatory framework, including the lack of transparency and competition in the current process for private sector entry;
- an entrenched public-oriented approach towards the management of public utilities;
- poor technical, commercial and financial performance of the sector;
- weak investment planning;
- lack of resources and strategy to provide electricity services to rural areas; and
- a weak human resource base.

1.3.1 Energy resources

The energy situation in Cambodia is characterized by its very low conventional by its very low conventional energy consumption as compared to other Asian countries. The major sources of energy for Cambodia are biomass and imported petroleum products. Biomass energy sources account for an overwhelming share; total woodfuel consumption during 1994 was estimated to be 1617 ktoe (FAO, 1997).

Cambodia's sources of energy consist primarily of indigenous supplies of wood, which together with other forms of biomass represented 83% of the total energy supply in 1995, while the remaining 17% consisted of imported petroleum products

Diesel oil and gasoline account for the bulk of petroleum product imports.

Table Estimated Energy Supplies, 1995

Energy Source	Tones	Terajoules	1000TOE	% of Total
Wood	5,621,035	81,505	1,941	80.5 %
Other Biomass & Dung	113,300	1,645	39	1.6 %
Petroleum Products	419,475	1,8107	431	17.9 %
Fuel Oil	50,553	2,056	49	2.0 %
Diesel Oil	183,431	7,835	187	7.7 %
Kerosene	25,015	1,112	26	1.1 %
Kerosene Jet Fuel	10,748	468	11	0.5 %
Motor Gasoline	145,983	6,467	154	6.4 %
LP Gas	3,745	170	4	0.2 %
Total		**101,257**	**2,411**	**100 %**

Tones of Oil Equivalent Source: MIME, Energy Department

Electricity in Cambodia is generated in 22 isolated systems, mostly from diesel generators. Total installed capacity of electricity generation in Cambodia is estimated to be 122MW, of which 85MW are in Phnom Penh. As a result of the small size of generation units (300KW to 5MW unit size), dependence on oil-based generation, and large distribution losses, the unit cost of electricity in Cambodia is among the highest in the region.

1.3.2 Demand and Supply Forecasts

Table 2 Energy Demand Scenario *, 1995-2020

Terajoules	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2,005**	**2,010**	**1995-05% / Yr**
Total	**94,148**	**94,583**	**99,123**	**102,848**	**106,797**	**1,110,861**	**115,104**	**138,463**	**152,244**	**3.9%**
Wood	77,721	77,721	79,980	82,288	84,662	87,103	89,616	103,552	106,344	2.9%
Charcoal	1,097	1,097	1,121	1,143	1,167	1,189	1,213	1,367	1,357	2.2%
Other Bio.	1,754	1,642	1,633	1,625	1,616	1,608	1,600	1,559	1,351	-0.5%
LP Gas	103	170	212	257	310	362	421	729	1,050	15.7%
Kerosene	1,323	1,112	1,420	1,481	1,549	1,607	1,678	2,081	2,430	6.5%
Jet Fuel	725	468	725	761	799	389	881	1,125	1,435	9.2%
Gasoline	6,002	6,089	7,301	8,073	8,939	9,836	10,766	15,288	20,284	9.6%
Diesel	4,580	5,393	5,751	6,149	6,576	7,031	7,521	10,539	14,783	6.9%
Fuel Oil	65	64	73	79	86	93	102	158	249	9.4%
Electricity	777	827	907	991	1,093	1,191	1,308	2,066	2,962	9.6%
Households	81,530	81,395	83,830	86,224	88,685	91,215	93,819	108,240	110,608	2.9%
Wood	77,329	77,329	79,536	81,804	84,134	86,527	88,985	102,546	104,730	2.9%
Charcoal	935	935	957	979	1,002	1,026	1,050	1,179	1,135	2.3%
Kerosene	1,046	879	1,117	1,155	1,190	1,226	1,263	1,468	1,512	5.3%
LP Gas	35	57	88	120	153	187	222	416	546	22.1%
Diesel	80	176	84	86	88	91	93	106	107	-4.9%
Electricity	352	378	415	45	501	551	607	967	1,229	9.8%
Other	1,754	1,642	1,633	1,625	1,616	1,608	1,600	1,559	1,351	-0.5%
Service Sector	918	989	1,057	1,129	1,231	1,310	1,420	2,104	3,189	7.8%
Wood	23	23	18	16	13	11	10	5	3	
Charcoal	149	149	149	147	146	143	142	152	165	0.2%
Kerosene	278	233	303	325	359	381	415	614	918	10.2%
LP Gas	69	113	124	138	158	175	199	313	504	10.7%

Diesel	33	80	36	39	43	46	50	75	114	-0.6%
Electricity	367	391	426	464	512	553	605	945	1,486	9.2%
Industry	405	405	465	512	564	619	681	1,096	1,764	10.5%
Wood	307	370	425	468	515	565	622	1,001	1,611	10.5%
Charcoal	13	13	15	17	18	20	22	36	58	10.5%
Diesel Oil	22	22	25	28	30	33	37	59	95	10.5%
Fuel Oil	63	63	72	78	85	92	101	157	248	9.5%
Electricity	58	57	66	72	80	87	96	154	247	10.4%
Transport	11,174	11,674	13,633	14,832	16,154	17,537	18,988	26,712	36,188	8.6%
Gasoline	6,002	6,089	7,031	8,073	8,939	9,836	10,765	15,288	20,284	9.6%
Diesel	4,445	5,116	5,606	5,997	6,414	6,861	7,341	10,299	14,468	7.2%
Jet Fuel	725	468	725	761	799	839	881	1,125	1,435	9.2%
Fuel Oil	2	1	1	1	1	1	1	1	1	0.0%

*Demand by final consumers, not including fuel for electricity generation or wood for charcoal

Cambodia's energy supplies forecasting 1990-2010 has not yet been estimated

ELECTRICITY SECTOR

A. Ministry of Industry, Mines and Energy (MIME)

MIME is responsible for policy and planning of the electricity sector and also for management of supplies in 19 provinces of Cambodia.

One of MIME's important activities is its leading rule in Renewable Energy activities throughout the rural area. This includes Solar Energy, Biomass and Biogas, Hydropower. The potential for wind energy in Cambodia has not yet been assessed.

B. Electricity Authority of Cambodia (EAC)

The ElectricityAuthority of Cambodia is being enacted under the proposed Electricity Law and will be responsible for regulating the provision of electricity power services. The responsibilities of EAC are expected to include:

- Licensing of companies for generation, transmission, distribution and retailing of electricity, including consolidated and subcontractor arrangements
- Review and approval of tariffs
- Monitoring of investments and power acquisitions by license,
- Development and monitoring of performance, technical, safety and environmental related standards
- Certification and inspection of metering
- Establishment of accounting standards
- Enforcement of electricity law

C. Electricity du Cambodge (EDC)

EDC is a public sector utility that has the non-exclusive responsibility for generation, transmission, distribution and retail of electricity throughout Cambodia. It presently provides the supplies to the nation's capital Phnom Penh and through grid extension to Kandal province and also the provincial cities of Sihanouk ville, Steam Reap and Kompong Cham. EDC is also expected to assume responsibility, for the fist three to five years, of the network rehabilitation and expansion being funded by the ADB in seven main provincial towns

Phnom Penh has the largest power system in the country. It serves about 80,000 customers with a peak demand of 85MW Key data 2 as 31 December 1999 for EDC include:

- Total installed generation capacity 115 MW
- Maximum generation output 97MW
- Energy Generation 387 GWh
- Energy Sales (excludes own usage) 284 GWh
- System Losses 24.05 %
- 115 kV Network 23 circuit-km
- 22 kV Network 341.04 circuit-km

D. Demand/Supply Forecasts 1999-2016 key issue

Over the past several years, the demand for electricity has been growing along with the economic growth. The demand growth has averaged 30-40MW per year. The production of electricity in Cambodia has not respected to the demand The present role of EDC is to improve the efficiency of generation, transmission and distribution on electric power in Cambodia.

Electricity Demand

The demand and energy forecasting is important for the electric power system planning The forecasting of electricity for Cambodia has been formulated by several institutions, such as EDC (Corporate Planning Department), in 1994, Worley International Corporation in 1994, which was funded by World Bank project, the NEWJEC Inc. (German Company) funded by Asian Development Bank in 1998, and Nippon Koei in 1996 under the project of Japan International Cooperation Agency (JICA)

Table 3 Expected Power Generation output for Cambodia (MW)-Base Case

Year	1998	2000	2002	2004	2006	2008	2010	2012	2014	2016
Banteay Meanchey	4.0	5.9	8.0	10.0	12.0	14.5	17.3	20	24	26
Battambang	3.5	5.7	8.6	12.0	15.0	18.5	22.4	27	31	33
Kampong Cham	4.9	7.8	10.5	13.0	15.2	17.9	20.5	23	26	29
Kampong Chhnang	1.1	1.6	2.2	2.8	3.4	4.0	4.7	5	6	7
Kampong Speu	1.0	2.0	2.9	3.8	4.7	5.9	7.2	9	12	16
Kampong Thom	1.5	2.4	3.4	4.5	5.3	6.4	7.5	9	10	11
Kampot	2.7	4.8	8.1	10.1	13.9	16.3	18.9	25	28	33
Kandal	2.2	3.9	5.5	6.7	7.9	9.2	10.6	12	13	15
Koh Kong	0.7	0.9	1.2	1.4	1.7	2.0	2.3	3	3	4
Kratie	1.9	3.2	4.4	5.7	6.8	8.0	9.4	11	12	14
Mondul Kiri	0.1	0.2	0.3	0.4	0.5	0.6	0.7	1	1	1
Phnom Penh	60	93	131	170	207	256	304	356	418	484
Preach Vihear	0.3	0.5	0.7	1.0	1.1	1.4	1.6	2	2	2
Prey Veng	1.7	3.0	4.4	5.5	60.6	7.8	9.0	10	11	13
Pursat	1.3	2.3	3.2	4.2	5.0	5.9	6.9	8	9	11
Ratanak Kiri	0.9	1.1	1.3	1.5	1.7	1.9	2.2	2	3	3
Siem Reap	3.0	4.2	5.6	7.1	8.4	10.0	11.5	13	15	17
Sihanouk Ville	2.9	3.4	4.1	4.8	5.5	6.3	7.3	8	10	11
Stung Treng	0.2	0.5	0.7	0.9	1.1	1.3	1.5	2	2	2
Svay Reing	1.0	1.6	2.2	2.8	3.2	3.9	4.4	5	6	6
Takeo	1.5	2.4	3.4	4.2	4.9	5.8	6.7	8	8	9
Total	**97**	**150**	**212**	**273**	**331**	**404**	**477**	**558**	**651**	**746**

Source: Government of Cambodia, MIME Nov. 1998

RENEWABLE ENERGY SECTOR

a) Institutional Setting

In 1995, a working group called " Solar Energy Application (SFA) " was formed by Technical Energy Department of Ministry of Industry Mines and Energy SEA takes responsible in renewable energy and plays the role such as follow:

- cooperation and coordination with Ministries, agencies concerning and donor,
- data collection basically for study,
- research, setting up the solar energy system I pilot project), training local people. promoting and disseminating of this field,
- report to MIME the results of the study.

b) Present use Potential and Direction for Development

Since a beginning of the oil crisis 1973, which remarkably influenced power development programs all over the world massive technological and research offers arc borne concentrated in the field of Renewable Energy resources. In solar sector for electricity generation, the conversion process via solar cells is being more and more attractive and u is becoming the most promising.

Refer to technological development of the world time by time. day by day and according to the situation in Cambodia that technological development in all field are very slightly development such as energy sector of this renewable energy which is very slowly developed compared with the neighboring countries. Even through the royal government's offer improving and developing of all sectors same priority sector has been promoted day by day.

The Royal Government also pushed all ministries takes more attention for rural and remote areas development.

Solar Energy

Cambodia has a tropical climate with favorable condition for the utilization of solar energy. This is reflected in the annual mean temperature in the low-lying plain, which is about 26ºC. Measurement during 1981-1988 at Phnom Penh indicate that the average sunshine duration varied between 6.1 and 9.7 hours per day in August and December respectively.

The total PV capacity about 204,586 Wp was installed in Cambodia since 1997. The PV installation use for private rural houses, schools, health center, orphans, pagodas telecommunication, etc..

The most recently under the financing of New Energy and Industrial Technology Development Organization (NEDO), we have installed the PV battery, charging system in Phnom Chino and PV water pumping in school at Kompong Chnaing province. We hope that the out put of projects will:

- increase the economic condition of people of those
- areas increase the knowledge of the people
- as a bridge for transfer the civilization and technology (people will get information through the radio and TV)

Hydropower

Cambodia is the one of the South-East Asian country rich in water resources and has the second largest hydropower potential in the lower Mekong Basin According to the latest preliminary study the total hydropower potential of the country is estimated at 10,000MW, which 50% is in the Mekong, 40% in its tributaries and the remaining 10% in the south-western coastal area outside the Mekong river basin

Cambodia's future demand is projected at 175MW in 2000, 380MW in 2010 and 760MW in 2020, due to the improving situation this increase in demand cannot be satisfied by the existing power station, The most urgent action for the utilities lies in the rehabilitation and upgrading of existing power plants, This is considered critical as a continued shortage in the electricity supply will seriously restrain the ongoing reconstruction and socio-economic development of the country.

The need for Cambodia will be to use Cambodia's Hydropower potential in order to meet future electricity demand and to reduce the dependence upon imported fuel and to exchange of hydropower with neighboring countries.

Before the civil war, the Kirirom I Hydropower station was running with an installed capacity of 10MW, and energy was delivered to Phnom Penh through a 110 kV transmission line over a distance of 120Km. This Hydropower Plant was completed in 1968 as the first hydropower station in Cambodia, but it was completely destroyed during the war after only 13 months of operation. However the facilities have been started to restore by Austrian and Swedish Aid projects. The Prek Thnot project with an installed capacity of 18MW was implemented near the Kirirom I Hydropower station, but the construction was interrupted in 1970 due to the war In 1992 one small Hydropower Station at Present in Cambodia, and all of the operating generator; now are diesel and okil-fired engines depending on imported oil

Wind Energy

Up to present the generation of electricity from wind still yet implemented even. We have the potential of this resource especially at the coast and the mountainous regions which tile wind velocity generally is about l0m/s Measurements during 1981-1990 at Phnom Penh indicate that the average wind velocity varied between 4.8 and l4.8 m/s in January and July respectively. There are some installation of wind energy for water pumping implemented by the NGO, (Christian Outreach) for irrigation in some place of Prey Veng Province about 5 unit:

Biomass

As in almost all Asian countries, biomass energy plays a major role in satisfying the rural energy elements of Cambodia. According to an estimate by the FAQ, wood fuel consumption in 1994 was 1,618 ktoe, and accounted for 84% of the total energy consumption in the country. The total potential available wood fuels during the same year was 24.5 million toe. Besides, and estimated amount of 167 ktoe of agro-industrial processing residues were also available as fuel in 1994 (FAO 1997). Due to lacking of modern technology in this field the development of the biomass system still very low. In Cambodia the biomas system are basically from Agriculture wastes and generally used for cooking and small handicrafts in rural areas.

Biomass is also used in the industrial sector for copra drying and steam generation. However, no reliable estimates of the amount of Biomass energy consumption for these purposes are available.

Biogas

The Biogas system in Cambodia mostly base on the domestic animal wastes such as cows, buffaloes, pigs, etc...

The systems were implement by Christian Outreach, Food Agriculture Organization, Padex,;;; in some Provinces : Prey Veng, Kandal, Kompong Speu, Svay Rieng, Ta Keo, Kom Pot, and Siem Riep, There seems to be considerable potential for biogas development in Cambodia. The energy potential of biogas from recoverable animal wastes in the country has been estimated to be about 228 ktoe/year (Bhattacharya et al., 1997).

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- Report on the Cambodia Social-Economic Survey 1999
  National Institute of Statistics, Ministry of Planning, Phnom Penh
  Sponsored by : United Nations development Programme, Swedish International Development Cooperation Agency and Executed by the World Bank
- Report on Energy Policy and Conservation in Cambodia
  Ministry of Industry Mines and Energy (MIME), Technical Energy Department
  Sponsored by : New Energy and Industrial Technology Development Organization (NEDO), Japan

The Energy Conservation Technology Realized in Japanese Garment Industry

Presentation Slide List

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3		Steps for Power Saving Promotion	
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		a. Check & improvement of daily load (example)	
5		b. Execute approximate demand management by demand controller	
6		Power Factor Improvement	
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The Energy Conservation Technology Realized in Japanese Garment Industry

December, 2002 at Cambodia

February, 2003 at Philippine

The Energy Conservation Center, Japan
〔ECCJ〕

ECCJ 1

Electric Power Management

(1) Priority Efforts for Energy Conservation
① Understand the structure of electricity rates
② Grasp the current status of electricity usage

(2) Reduce the contract demand & maximum demand of electricity as well as electricity consumption volume

ECCJ 2

Steps for Power Saving Promotion

* First step: appropriate usage & management of existing facilities
* Second step: introduction of energy conservation equipment
* Third step: radical modification of production facilities & process, etc.

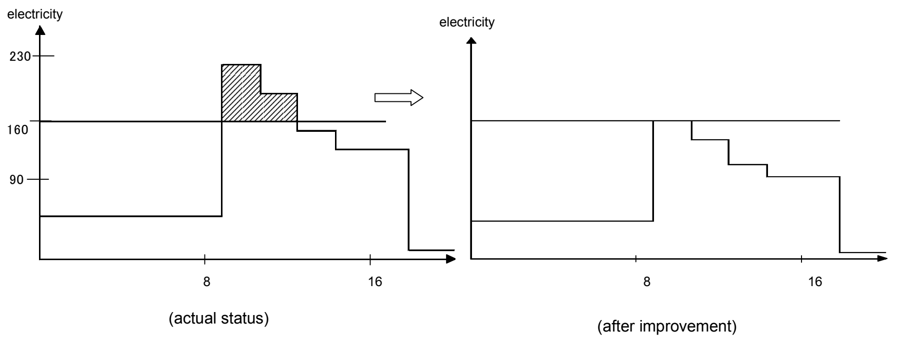
Start from small-scale investment of the first & second steps, going on to the next step

ECCJ

3

Peak Cut by Demand Controller

a. Check & improvement of daily load (example)

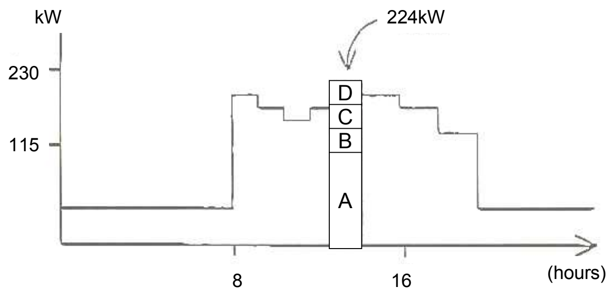


ECCJ

4

b. Execute appropriate demand management by demand controller

Analyze the daily load curve of the day when the maximum electricity was recorded

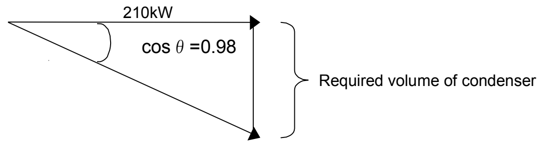


Load diagnosis (example)
A …. power capacity of vulcaniztion press & oil pressure: 100KW
B …. power capacity of mixing roll: 50kW
C …. power capacity of air-conditioner: 50kW
D …. power capacity of compressor & lightening: 50kW

ECCJ

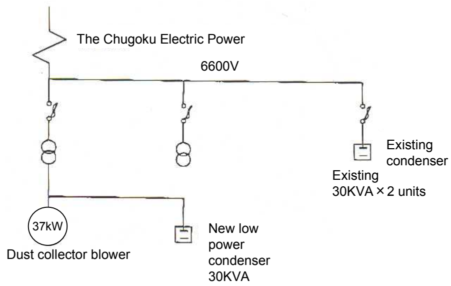
Power Factor Impovement

a. When the required volume of condenser is calculated to improve the power rate from 98% (the actual maximum electric power 210kW) to 100%,, the results would be as below.



Required volume of condenser= 210 × tan θ =210 × 0.2=42KVA

b. location method of condenser for power rate improvement



c. comparison of investment & merit
・investment 30KVA condenser … 50,000 yen (Instrument cost only. Setting work cost excluded.)
・merit … cost reduced by approximately 20,000 yen/y

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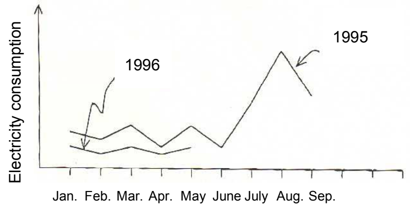
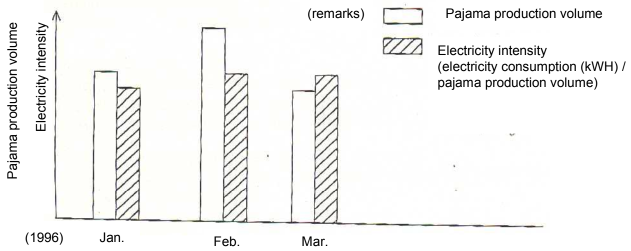
Guidance for Management (example)

Present a graph to the employees so that they would be aware of electricity consumption.



Make a graph of electricity Present a graph to the employees so that they would be aware of electricity consumption of pajama production to promote awareness of energy conservation.



ECCJ

7

Energy conservation guidance for illumination facilities (example)

1. Automatic blink switch (pattern control by time zone) & adjustment of lightening by natural light for window-sides.

2. Turn off the lights of vacant rooms.

3. Take off lamps which are not used, and use natural light for effective energy conservation.

4. Change wide area illumination to local illumination.

5. Usage of too many fluorescent lamps causes elevation of temperature, and would be a load to the air-conditioner.
Improve the situation by changing ceiling illumination to local illumination.

ECCJ

8

Illumination Standard of Factories & Offices

illumination LX	factory: work	factory: location	office: location
3,000 – 2,000 – 1,500	production of precision instrument & electronic components, fine optical works at printing factories ・assembling(a), –audit(a), –test(a) ・sorting(a), –planning, –designing	dashbord & control board at control room etc.	
1,500 – 1,000 – 750	sorting, audit at fabric factories, typesetting & calibration at printing factories, fine opticas works at chemical factories such as diagnosis ・assembling(b), –audit(b), –test(b) ・sorting(b)	design room, drawing room	office room (a), business room, design room, drawing room, entrance hall (daytime)
750 – 500 – 300	normal optical works of regular production processes ・assembling(c), –audit(c), –test(c) ・sorting(b), –packaging(a), –desk work at warehouses	control room	– (750–500) meeting room, reception office, waiting room, dining hall, kitchen, recreation room, training room, janitor's room, entrance hall(nighttime), elevator hall (500–200) office room (b), executive room, meeting room, printing room, TEL exchange room, computer room, control room, clinic ●power distribution panel, dashboard at electricity room & machinery room ●reception
300 – 200 – 150	rough optical works ・specific duties ・packaging(b), –packing(b)(c)	electricity room air–conditioning room	– (200–150) storeroom, work room, vault, electricity room, auditorium, machinery room, elevator washroom, bathroom, corridor, stair, lavatory, rest room (200–100)
150 – 100 – 75	rough optical works ・specific duties ・packaging(b), –packing(b)(c)	entrance, corridor, passage, warehouse, stair, rest room, lavatory	
75 – 50	works such as loading, unloading & removing	indoor escape stair, warehouse, indoor power equipment	indoor escape stair
50 – 30 – 20 – 10		outdoor(passage for premise security)	

Remarks: 1. (a) in the chart indicates those which are fine and weak in contrast, which require high accuracy. (b): interim of (a) & (c). (c): rough ones, which are strong in contrast

2. (office room): for optical work or when you feel the interior of the room dark, due to the bright sunshine outdoor, (a) should be applied.

ECCJ

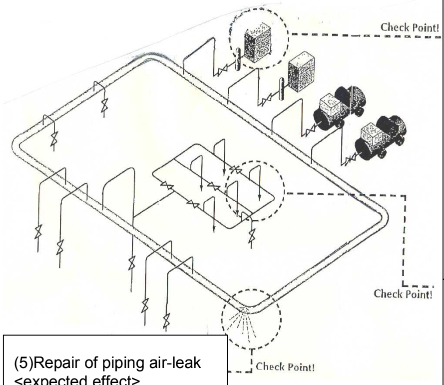
Energy conservation by introduction of high-efficiency lighting apparatus

		lamp power (W)	input power (W)	total luminous flux (1) (lm)	overall efficiency (2) (lm/W)	color temperature (K)	average color rendering index (Ra)	life (h)
incandescent lamps	incandescent lamps							
	for general use	60	60	810	13.5	2850	100	1000
	ball lamp	67	57	705	12.4	2850	100	2000
	krypton lamp	60	60	840	14	2850	100	2000
	halogen lamp							
	single–ended mold	100	100	1600	16	2900	100	1500
	with infrared radiation reflexion film	85	85	1680	19.8	2900	100	2000
	small type (low pressure type)	50	50	1000	20	3000	100	2000
	double–ended mold	500	500	10500	21	3000	100	2000
fluorescent lamp	bulb type fluorescent lamp							
	electric lighting bulb color	25	25	1520	60	2800	84	6000
	electric lighting neutral white color	25	25	1460	58.4	5000	88	6000
	4 pipe tube neutral white color	23	23	1550	67.4	5000	84	8000
	general fluorescent lamp							
	white	40	43	3000	69.8	4200	61	12000
	ditto (electricity–saving type)	36	39	3000	76.9	4200	61	12000
	3–wavelength type – neutral white color	40	43	3450	80.2	5000	88	12000
	ditto (electricity–saving type)	36	39	3450	88.5	5000	88	12000
	HF type							
	32W lighting – neutral white color	32	35	3200	91.4	5000	88	12000
	45W lighting – neutral white color	45	49	4500	91.8	5000	88	12000
	compact type							
	27W lighting – neutral white color	27	34	1800	62.9	5000	88	7500
	36W lighting – neutral white color	36	40	2900	72.5	5000	88	9000
HID lamp	fluorescent mercury lamp	400	427	22000	51.5	3900	40	12000
	metal halide lamp	400	444	40000	90.1	3800	70	9000
	ditto (double–ended mold)	250	269	20000	76	4300	85	6000
	high–pressure sodium lamp	360	386	47500	123.1	2050	25	12000
	ditto (improved rendering type)	360	390	36000	92.3	2100	60	12000

remarks:
1. incandescent lamp is 0 hour index. Others are 100 hours total luminous flux. Index.
2 Total luminous flux. divided by input power. Indicates the brightness per input power.

ECCJ

Check points of compressors for energy conservation



(1)Renewal to new type (high-efficiency compressor)
<expected effect> energy conservation at 7-15%

(2)Introduction of control system of number of machines
<expected effect> realization of minimum operating machines

(3)Improvement of locating (intake air) conditions
●decline of intake air temperature
●reduction of intake air temperature resistance
<expected effect> realization of optimized energy conservation operation

Improvement measures:
a. revision of inlet & exhaust outlet
b. optimization of ventilation fan volume

(4)Reduction of discharge pressure & terminal in use
<expected effect>discharge gauge pressure: 0.69MPa (7kgf/cm²) to 0.59MPa
If pressure is reduced to (6kgf/cm²), energy conservation is at appr. 9%.

Measures for pressure loss reduction:
a. regular maintenance of peripherals(filter, etc.)
b. looping of pipelaying, revision of pipe diameter

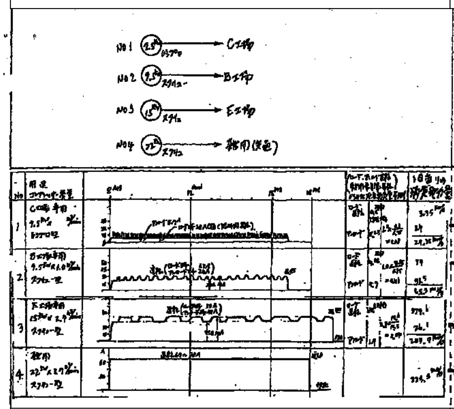
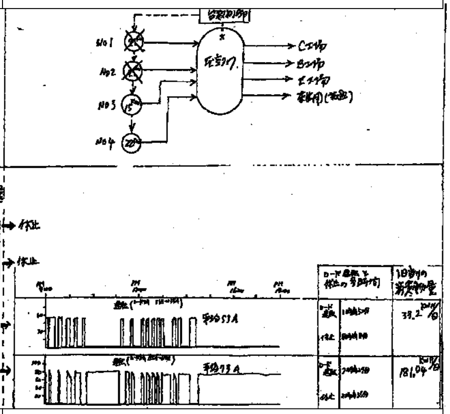
(5)Repair of piping air-leak
<expected effect>
improvement of
1mm ϕ hole × 10 points
- energy conservation equivalent to 5.5kW compressor

*Expected effect data differ due to use conditions & environment.
Confirm to the manufacturer about the measures & effect .

ECCJ 11

Energy conservation cost-down by control system of number of compressors (example)

<calculated by compressor current measurement>

Individual supply method (before improvement)	compressor number control method (after improvement)
	
Total 526.05kWH/day annual electricity volume (265days): 139,403kWH electricity rate (@18yen/kWH): 2,509,254 yen	Total 214.24kWH/day annual electricity volume (265days): 56,774kWH electricity rate (@18yen/kWH): 1,021,932 yen

Cost-down effect
1,487,300 yen/year

ECCJ 12

Guidance for air-conditioning electric power (example)

(e.g.1) Energy conservation of air-conditioning (cooling)
*reinforce the emission fan of the ceiling to exhaust hot air of the ceiling.
*curtains for windows are preferable.

(e.g.2) Energy conservation of air-conditioning (cooling)
*set the temperature at 28℃.
(by setting the temperature 1℃ higher, energy conservation at appr.10% could be expected for air-conditining heat source.)

(e.g.3) Consideration of introduction of eco-ice
peak difference between daytime & nighttime is large, due to air-conditioning load (cooling) in the summer.
Eco-ice is a system to restrain the electricity usage by storing the electricity to heat source, and supply heat source in the daytime

ECCJ

13

Guidance for energy conservation of boiler

(e.g.1) Prevention of diffuse heat loss from vapor piping
reinforce the thermal insulation of vapor piping of factories to prevent diffuse heat loss

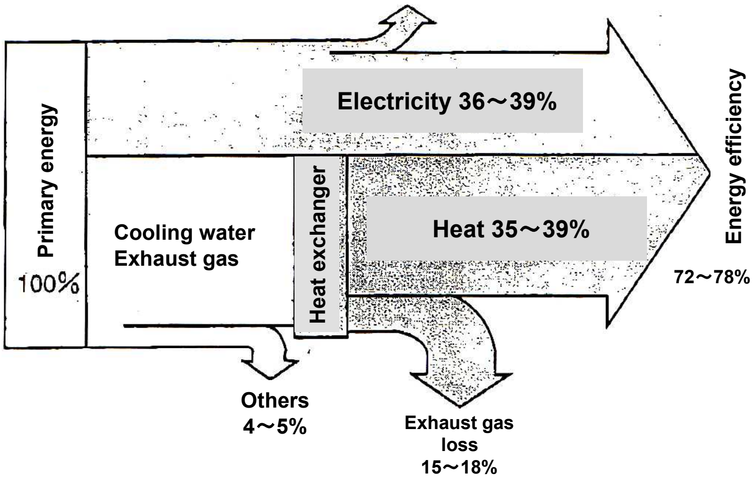
(e.g.2) renovation of degradation & efficiency improvement of decrepit boiler
*merit calculation was done and degradation renovation plan was proposed for the factory
*the vapor header part was not kept warm, causing heat loss. Reinforcement of the thermal insulation of vapor piping would prevent diffuse heat loss

ECCJ

14

Diesel Engine Generator Energy Conservation

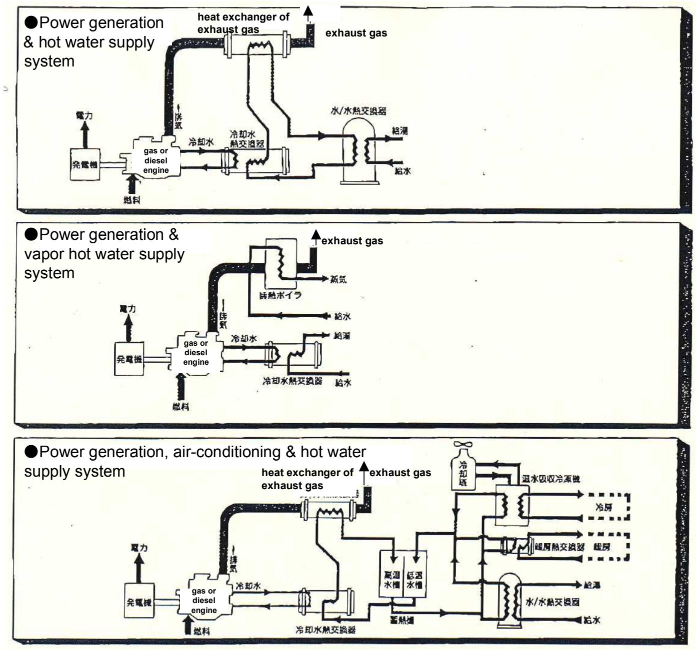
Diesel Engine Energy efficiency



ECCJ

15

Heat recovery system flow (example)



ECCJ

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More Information

- You can find information regarding ECCJ's activities as well as trends of energy efficiency and conservation in Japan through accessing ECCJ's Internet Home Page:

- URL: http://www.eccj.or.jp/index_e.html

ECCJ

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[A] Information Required for ASEAN Industry Audit (Garment Industry)

[I] Necessary information （Answers to Questionnaire） before audit execution

(We want following information by November 29, 2002)

1. Company general information for factory energy consumption:
2. Production of major products
3. Utility consumption data
   3-1~3 Garment-making process including generator power plant if you have (Daily, Monthly and Annual)
4. Electric power receiving
5. Boiler

[II] Necessary information during the audit execution

6. Necessary drawings and documents including energy intensity
7. Energy conservation plan
8. Energy conservation items in the past (including results)
9. Energy conservation items undergoing (including expected results)

10 Problem items if you have.

[III] Item as requirement for garment maker selection

Two factories in the area of Phnom Penh

[IV] Necessary measuring instruments

Please prepare following measuring instruments for audit execution.

Temperature gauge, (Non-touch radiance type)
Illuminant meter,
Clamp type Ammeter (0~300A or 500A),
Clamp type Wattmeter
Etc.

表Ｉ－３－２　Company Information for Factory Energy Conservation / Questionnaire

[Garment Industry]

Company Name	*M & V International Manufacturing Ltd.*
Replied by	*Mr. WENY Wei,　　　　　　Mr. SU Chin Pha*
Division	*Admin. Dept. officer,　　　　　　Maintenance Manager*
Date	*December 11 2002*

1. General

1	Name of Factory		***V3 Factory*** *of M & V international Manufacturing Ltd.*
2	Address		*No.1623 CHAK ANGRE KRAUM, Phnom Penh, Cambodia Tel: 855-23-425041*
3	President		*(Headquarter In MACAO)*
	Factory Manager		*Mr. WENY Wei*
	Energy Manager		*Mr. SU Chin Pha*
4	Type of Industry		*Garment (Sweater Production)*
5	Capital		*No reply*
6	Annual Sales Amount		*No reply*
7	Number of Employees		*Staffs: 80 - 90,　Workers Approx. 3,000　[MIME Data: 3,958]* *(Work time: 7:00 = 11:00, 12:30 - 16:30 + Over time)*
8	Number of Engineers		*Job of Headquarter (MACAO)*
		Electrical Engineers	
		Mechanical (Heat) Engineers	
9	Organization Chart		*Refer to ANNEX 4* *Total 5 factories　(4 in Cambodia, 1 in MACAO, China)*
10	Brief Company History		*V3: Established in 1994, and V3 Factory started operation in 1997*
11	Meteorological		Tropical Climate

2. Production of Major Products

No.	Name of Production	Production Capacity	1999			2000			2001			2002		
			Annual Operating Hour	Production Volume (Pieces)	Sales Amount (Pieces)	Annual Operating Hour	Production Volume (Pieces)	Sales Amount (Pieces)	Annual Operating Hour	Production Volume (Pieces)	Sales Amount (Pieces)	Annual Operating Hour	Production Volume (Pieces)	Sales Amount (Pieces)
1	Garment Factory		*2288*			*2288*			*2288*			*2288*		
	- Sweater -									*5,102,531*	*5102531*			

Total Production = 5,102,531Pcs/year

Max. 677,000Pcs/month

Max 30,000Pcs/day

*365 * 6/7 - 26 = 286 days/year*

*286 * 8 = 2288 hours/year*

MIME data (at Nov. 2002)
Total Employee = 3,958
Product = 33,500~33,600 Pcs/day

3A-1. Daily Utility Consumption

Garment-making process

No.	Name of Utility	Month / Date																															Total
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	
1	Electricity (kWh)				*Ave. 430kWh/Month for Lighting at night・・・・(30kW)　from EDC, 30.4days/Month*																												
2	Fuel Oil (kL)	for Boilers			*2,800 ~ 3,000L/day (9h/day)*						*Oil from SOKIMEX (Singapore) & CALTEX (Cambodia)*																						
3	Diesel Oil (kL)	for Generators			*1,800 ~ 2,000L/day (9h/day)*						*Oil from SOKIMEX (Singapore) & CALTEX (Cambodia)*																						
4	~~LPG (t)~~																																
5	~~Compressed Air (m^3)~~																																
6	Steam (t)				*No meters*																												
7	River Water (m^3)				*800m^3/day (Tank capacity, Pump working time = 60m^3/h * 15hours/day), Max. 900 ~ 1,000m3/day, Min. 700m3/day. No meters*																												
8	~~Well Water (t)~~																																
9	~~City Water (t)~~																																
10																																	
11																																	
12																																	
13																																	
14																																	
15	Power plant generation (kWh)			*Average = 3,000 ~ 3,500kWh/day*													*Gene. #2 = 252kW, #3 = 228kW　Total = 480kW (At 14:00 of December 12 2002)*																
16					*(9h/day)*												*Capacity:*		*#1= 500KVA/400kW*														
17																			*#2= 720KVA/576kW*														
18																			*#3= 720KVA/576kW*														
19																																	
20																																	

3A-2 Monthly Utility Consumption

Garment-making process

No.	Name of Utility	Lower Heat Value	2002												Total
			January	February	March	April	May	June	July	August	September	October	November	December	
1	Electricity (kWh)		*From EDC*										*13,000kWh*		
2	Fuel Oil (kL)												*67 ~ 72kL*		
3	Diesel Oil (kL)												*43 ~ 48kL*		
4	~~LPG (t)~~														
5	~~Compressed Air (m^3)~~														
6	Steam (t)		*No meters*												
7	River Water (m^3)												*800*23.9=19,120m3*		
8	~~Well Water (t)~~														
9	~~City Water (t)~~														
10															
11															
12															
13															
14															
15	Power plant generation (kWh)												*71,700~83,650kWh*		
16															
17															
18			*(365*6/7-26)/12 = 23.9days/Month*												
19															
20															

3A-3 Annual Utility Consumption

Garment-making process

*: US$ or Reils

No.	Name of Utility	Lower Heat Value	1999			2000			2001			2002		
			Consumption (kWh,kL,t,m^3)	Unit Price (*)	Purchase Amount (*)	Consumption (kWh,kL,t,m^3)	Unit Price (*)	Purchase Amount (*)	Consumption (kWh,kL,t,m^3)	Unit Price (*)	Purchase Amount (*)	Consumption (kWh,kL,t,m^3)	Unit Price (*)	Purchase Amount (*)
1	Electricity (kWh)											156,000	R600	
2	Fuel Oil (kL)											804 ~ 864	US$0.25	
3	Diesel Oil (kL)											516 ~ 576	US$0.35	
4	~~LPG (t)~~													
5	~~Compressed Air (m^3)~~													
6	Steam (t)		*No meters*											
7	River Water (m^3)											229,440		
8	~~Well Water (t)~~													
9	~~City Water (t)~~													
10														
11														
12														
13														
14														
15	Power plant generation (kWh)											860,400 ~ 1,003,800		
16														
17			*8 ~ 9hours/day, 23.9days/Month, 12 months/year*											
18														
19													(US$1 = 3,950R)	
20														

4. Electric Power Receiving

No.	Items	Unit	1999	2000	2001	2002	Note
1	Receiving Voltage	kV				0.38	
2	Maximum Demand	MW					
3	Annual Electricity Consumption	MWh				1,020 ~ 1,160	
4	Paid Amount of Electricity	US$ or Reils					
5	Power Factor						
6	Annual Operating Hour	h/y				8,760	
7	Average Electricity	kW				30	
8	Maximum Electricity	kW					
9	Transformer Capacity per Unit	kW					No Transformer
10	Number of Transformers						
11	In-house Generation Capacity	kW				1,552	

5. Boiler

No.	Boiler No.	1	2	3	4		
1	Type	Lateral type	Vertical typ	Vertical typ	Lateral type		Flue Boiler
2	Built Year	1998	1996	1996	2000		N0.1: '97, No.2: '92 made
3	Nominal Capacity (Steam)						
	Steam Pressure (kg/cm^2G)	10	10	10	10		Actual ope.: $7kg/cm^2$
	Steam Temperature (℃)						
	Evaporating Volume (kg/h)	4,200	1,560	780	6,000		
4	Nominal Capacity (Electricity)						
	Generated Electricity (kWh)						
	Generated Voltage (kV)						
	Power Factor						
5	Kind of Fuel	Bunker oil	Bunker oil	Bunker oil	Bunker oil		
	Fuel Consumption						No meters
6	Operating Period **(Hours/Day)**						No Data
	1999						
	2000						
	2001						
	2002						
7	Operating Period **(Hours/Year)**						
	1999						
	2000						
	2001						
	2002						

6. Necessary Drawings and Documents

No.	Items	
1	Plant Layout: *Layout is displayed as the Firebreak Chart.*	
2	Process Flowchart of Major Products	*No drawings*
3	Energy Flowchart	
4	Electric Skeleton Diagram	
5	Structural Drawing of Major Equipment	
	Measuring Points and Name of Instruments for Energy Consumption	
6	Specification and Structural Drawings of Boiler	

7	Energy Intensity : Energy Consumption / Output of Products						
No.	Kind of Product	Kind of Energy	Unit	1999	2000	**2001**	**2002**
a	(Example)	Production	pcs/y	300,000	320,000	320,000	350,000
	Garment	Fuel Oil	kL/y	3,000	3,200	3,100	3,300
		Electricity	MWh/y	3,000	3,200	3,200	3,300
b	*Garment*	*Production*	*Sweater*			*5,102,531*	
		Electricity (EDC)	*MWh/y*				*156*
		Fuel Oil	*kL/y*				*804 ~ 864*
		Diesel Oil	*kL/y*				*516 ~ 576*
						Max. 677,000Pcs/Month	
						Max. 30,000Pcs/day	
c		Production					
d		Production					
e		Production					

7. Energy Conservation Plan

Nothing!

M & V wants to know or learn the methods how to do the energy conservation activities.

8. Energy Conservation Items in the Past (including results)

Lighting: *When a fluorescent tube is blow-out, new one is exchanged from 40W to 36W.*

9. Energy Conservation Items Undergoing (including expected results)

Nothing!

10. In case you have any problem(s) in your course of promotion of energy conservation, please circle the number(s) of applicable item(s) among the following.

1	Uncertainty of energy prospect
2	Less impact of energy cost to the whole cost of the enterprise
3	The increasing energy cost can be covered by rising the price of products
4	Little possibility of energy shortage: *M & V can receive oil soon or anytime.*
5	Little potential for promoting further energy conservation
6	Shortage of engineers: *Especially pertaining to the generator (Engine) engineer(s)*
7	Difficulty in obtaining good energy efficient equipment
8	Unreliable results from energy efficient equipment
9	Uncertainty about return of investment in energy conservation facilities
10	Difficulty in obtaining good information such as successful case of energy saving activities
11	Insufficient system of research and development
12	Shortage of fund for facility improvement and modification
13	Out-of-date facilities
14	Low consciousness of employees
15	Lack of personnel who can educate the employees
16	Shortage of measuring equipment
17	No time to analyze energy consumption rate
18	Shortage of information on government's measures
19	Shortage of government's subsidiary measures
20	Others (Please add comments):
	Insufficient of information exchange between government and companies, and education

表Ｉ－３－３ **Company Information for Factory Energy Conservation / Questionnaire [Garment Industry]**

Company Name	*June Textiles Co., Ltd (Cambodia)*	
Replied by	*Mr. William ONG*	*Mr. YI Sokham*
Division	*General Manager*	*Shipping Manager*
Date	*12-Dec-02*	

1. General

1	Name of Factory		*June Textiles Co., Ltd (Cambodia)*
2	Address		*Russian Blvd., Borei 100 Khnong, Songkat Tek Thla, Khan Russei Keo, Phnom Penh, Cambodia Tel: 023-883-338*
3	President		
	Factory Manager		*Mr. Lee Thai Khit (Managing Director)*
	Energy Manager		*Mr. Chung Yit FANG (Mechanic and Maintenance Dept.)*
4	Type of Industry		*Garment*
5	Capital		*250,000,000Riels (=12MUS$)*
6	Annual Sales Amount		*49MUS$ (2001)*
7	Number of Employees		*4,393 (Staff 170) at 30/11/2002*
8	Number of Engineers		*Experts only ~30 people*
		Electrical Engineers	
		Mechanical (Heat) Engineers	
9	Organization Chart		*Refer to ANNEX 5*
10	Brief Company History		*License: 1992, Production start: 1993 at other factory,* Old Factory: 1994 ~ , New Factory: 1998 ~ Refer to ANNEX 7
11	Meteorological		Tropical Climate

2. Production of Major Products

No.	Name of Production	Production Capacity	1999			2000			2001			2002		
			Annual Operating Hour	Production Volume (*Dozens*)	Sales Amount (*Dozens*)	Annual Operating Hour	Production Volume (*Dozens*)	Sales Amount (*Dozens*)	Annual Operating Hour	Production Volume (*Dozens*)	Sales Amount (*Dozens*)	Annual Operating Hour	Production Volume (*Dozens*)	Sales Amount (*Dozens*)
1	Garment Factory		*4,290*			*4,290*			*4,290*			*4,290*		
	(Casual wear)			*812,000*	*812000*		*942,000*	*942,000*		*1,169,869*	*1,169,869*		*(1,286,850)*	*(1,286,850)*

MIME data (at Nov. 2002)
Total Employee = 4,041
Product = 3,100~3,800 Dozens/day

*365 * 6/7 - 26 = 287 days/year*
*287 * 15 = 4,305 hours/year*
(2 Shifts/day, 7.5 hours each = 15h/d)

3A-1. Daily Utility Consumption
Garment-making process

No.	Name of Utility	Month / Date																															Total
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	
1	Electricity (kWh)																																
2	~~Fuel Oil (kL)~~																																
3	Diesel Oil (kL)																																
4	~~LPG (t)~~																																
5	Compressed Air (m^3)																																
6	Steam (t)																																
7	~~River Water (m^3)~~																																
8	Well Water (m^3)				*No meters, No data.*																												
9	City Water (m^3)				*Monthly data only*																												
10																																	
11																																	
12																																	
13																																	
14																																	
15	Power plant generation (kWh)																																
16																																	
17																																	
18																																	
19																																	
20																																	

3A-2 Monthly Utility Consumption

Garment-making process

No.	Name of Utility	Lower Heat Value	2001	2002											
			December	January	February	March	April	May	June	July	August	September	October	November	Total
1	Electricity (kWh)	*(EDC)*	130,970	*137,400*	*141,200*	*130,890*	*163,420*	*155,260*	*248,680*	*255,510*	237,710	175,570	199,870	193,160	2,169,640
2	~~Fuel Oil (kL)~~														
3	Diesel Oil (kL)	*for Boilers*	*18*	*20*	*16*	*8*	*12*	*20*	*20*	*18*	*18*	*22*	*14*	*16*	202
4	~~LPG (t)~~														
5	Compressed Air (m^3)														
6	Steam (t)														
7	~~River Water (m^3)~~														
8	Well Water (m^3)														
9	City Water (m^3)	*for Boilers*												*7,286*	*87,430*
10															
11															
12															
13															
14															
15	Power plant generation (kWh)	(IPP)	*140,940*	*143,520*	*146,670*	*146,700*	*125,970*	*133,770*	*138,870*	*142,350*	*138,270*	*138,690*	*140,210*	*139,680*	1,675,640
16															
e	(For Reference)														
18	Production in 2001 (Dozens)		109,461	107,233	85,760	125,457	115,981	98,354	86,026	93,298	83,173	95,579	75,305	94,242	1,169,869
19															
20															

3A-3 Annual Utility Consumption

Garment-making process

*: US$ or Reils

No.	Name of Utility	Lower Heat Value	1999			2000			2001			2002		
			Consumption (kWh,kL,t,m^3)	Unit Price (*)	Purchase Amount (*)	Consumption (kWh,kL,t,m^3)	Unit Price (*)	Purchase Amount (*)	Consumption (kWh,kL,t,m^3)	Unit Price (*)	Purchase Amount (*)	Consumption (kWh,kL,t,m^3)	Unit Price (*)	Purchase Amount (*)
1	Electricity (kWh)	(EDC)										*2169460kWh*	*480R/kWh*	*$265,165/y*
2	~~Fuel Oil (kL)~~													
3	Diesel Oil (kL)	for Boilers										*202kL*	*0.3426$/L*	*69205/y*
4	~~LPG (t)~~												*(10% Tax included)*	
5	Compressed Air (m^3)													
6	Steam (t)													
7	~~River Water (m^3)~~													
8	Well Water (m^3)													
9	City Water (m^3)	for Boilers										*87,430*	***0.35$/m³***	*30,600*
10														
11														
12													*US$ = 3,950Riels*	
13														
14														
15	Power plant generation (kWh)	(IPP)										*1,675,640*	*480R*	*$205,177/y*
16														
17														
18														
19												*(US$ = 3,950Riels at the end of 2002)*		
20														

4. Electric Power Receiving

No.	Items	Unit	1999	2000	2001	2002	Note
1	Receiving Voltage	kV				22kV	*From EDC 2001 ~*
2	Maximum Demand						
3	Annual Electricity Consumption	kWh				216,940	
4	Paid Amount of Electricity	US$ or Reils				*$470,432*	
5	Power Factor						
6	Annual Operating Hour	h/y				8,760	
7	Average Electricity	MW					
8	Maximum Electricity	MW					
9	Transformer Capacity per Unit	MVA				1.5	
10	Number of Transformers					1	
11	In-house Generation Capacity	kW				680	*From IPP 1993 ~*

5. Boiler

No.	Boiler No.	1	2	3	4		
1	Type						
2	Built Year	*1993*	*1993*	*1993*	*(2003)*		
3	Nominal Capacity (Steam)						
	Steam Pressure (kg/cm^2G)						
	Steam Temperature (℃)						
	Evaporating Volume (kg/h)	782	500	300			
4	Nominal Capacity (Electricity)						
	Generated Electricity (kWh)						
	Generated Voltage (kV)						
	Power Factor						
5	Kind of Fuel	Diesel oil	Diesel oil	Diesel oil	Diesel oil		Total data only
	Fuel Consumption						Refer to Page 34
6	Operating Period **(Hours/Day)**						
	1999						
	2000						
	2001						
	2002		No data				
7	Operating Period **(Hours/Year)**						
	1999						
	2000						
	2001						
	2002						

6. Necessary Drawings and Documents

No.	Items	
1	Plant Layout:	*Refer to ANNEX 7*
2	Process Flowchart of Major Products	*Refer to ANNEX 6*
3	Energy Flowchart	*No drawings*
4	Electric Skeleton Diagram	
5	Structural Drawing of Major Equipment	
	Measuring Points and Name of Instruments for Energy Consumption	
6	Specification and Structural Drawings of Boiler	

7	Energy Intensity : Energy Consumption / Output of Products						
No.	Kind of Product	Kind of Energy	Unit	1999	2000	**2001**	**2002**
a	(Example)	Production	pcs/y	300,000	320,000	320,000	350,000
	Garment	Fuel Oil	kL/y	3,000	3,200	3,100	3,300
		Electricity	MWh/y	3,000	3,200	3,200	3,300
b	*Garment*	*Production*	*Dozens*	*812,000*	*942,000*	*1,169,869*	*1,280,000*
		Electricity (EDC)	*kWh/y*				*2,169,460*
		Electricity (IPP)	*kWh/y*				*1,675,640*
		Diesel Oil	*kL/y*				*202*
	Casual wear						
c		Production					
d		Production					
e		Production					

7. Energy Conservation Plan

Nothing!

June Textiles Co., Ltd wants to reduce the energy cost, but there are no targets or policy for reduction of energy cost.

Cost composition:

Raw materials:	*65%*
Energy cost:	*12%*
Labor cost:	*10%*
Maintenance:	*5%*
Ohters:	*8%*

8. Energy Conservation Items in the Past (including results)

Nothing!

9. Energy Conservation Items Undergoing (including expected results)

Nothing!

10. In case you have any problem(s) in your course of promotion of energy conservation, please circle the number(s) of applicable item(s) among the following.

①	Uncertainty of energy prospect
②	Less impact of energy cost to the whole cost of the enterprise
③	The increasing energy cost can be covered by rising the price of products
4	Little possibility of energy shortage
5	Little potential for promoting further energy conservation
6	Shortage of engineers
7	Difficulty in obtaining good energy efficient equipment
8	Unreliable results from energy efficient equipment
9	Uncertainty about return of investment in energy conservation facilities
⑩	Difficulty in obtaining good information such as successful case of energy saving activities
⑪	Insufficient system of research and development
12	Shortage of fund for facility improvement and modification
13	Out-of-date facilities
⑭	Low consciousness of employees
15	Lack of personnel who can educate the employees
⑯	Shortage of measuring equipment
⑰	No time to analyze energy consumption rate
⑱	Shortage of information on government's measures
19	Shortage of government's subsidiary measures
20	Others (Please add comments):

KINGDOM OF CAMBODIA
NATION RELIGION KING
****

COUNTRY REPORT

ON

ECONOMIC AND ENERGY SITUATION IN CAMBODIA

Ministry of Industry Mines and Energy (MIME)
Department of Energy Technique (DET)
#47 Norodom Blvd., Phnom Penh, Cambodia.
Fax : (855) 23 428 263
E-mail : samy@forum.org.kh

ECONOMIC SITUATION
COUNTRY OVERVIEW

Cambodia is a member of the Association of Southeast Asian Nations (ASEAN). It has a total land area of 181,035 km^2 divided into 24 provinces and one municipality. According to the 1998 final census, the total population was 11,437,656, of which, 85 percent live in rural areas with agriculture as the main source of income. In 1999, the GDP per capita is about USD 271. The national adult literacy rate was 68.8 percent. Adult literacy rates appear to have increased by approximately 2.5% during the past few years (Table 1).

Table 1: Adult literacy rates by sex and Status, Cambodia

Type/ Sex	Cambodia	Phnom Penh	Other Urban	Rural
Both sexes	67.8	82.2	72.9	65.2
Male	80.0	90.9	84.0	77.9
Female	57.7	74.8	63.7	54.7

Cambodia possesses unique cultural and natural assets that have considerable international appeal. The most well known place in Cambodia is the temple city Angkor situated about 300 kilometers North of Phnom Penh in the province of Siem Reap, just a few km from Siem Reap town. About 95 percent of the population practice Buddhism as their religion, and the remaining 5 percent is shared by Islam and Christianity.

1. Geographic condition including land use pattern and ownership

The climate of Cambodia is tropical. Temperatures range between 20°C to 35°C throughout the year. About one-fourth of the country's total land area is appropriate for cultivation. The country has four (4) geographical regions, namely: 1) Plain region, 2) Tonle Sap region, 3) Coastal region, and 4) Plateau mountain region

2. Demographic condition including rural-urban migratation

As of March, 1998, the total population of Cambodia was 11,437,656 people. The breakdown of population, by area and sexes is shown in Table 2.

Table 2. Population of Cambodia by Sex and Urban-Rural Distribution

Total/Urban/Rural	Both Sexes	Males	Females
Total	11,437,656	5,511,408	5,926,248
Urban	1,795,575	878,186	917,389
Rural	9,642,081	4,633,222	5,008,859

About 4/5 of the population live in the Central plains, which included the area of Mekong River and Tonle Sap Lake. Cambodia's population density more than doubled in 1998 to 63 inhabitants per km^2 compared to 37 inhabitants per km^2 in 1981. In 1998, the Plain Region showed the highest population density about 235 inhabitants/km^2, Kandal Province 300, Capital Phnom Penh 3,744.5, Takeo 222, Prey Veng 194, Svay Rieng 161, and Kampong Cham 164. The low population density areas were: Plateau and Mountain Region (17.5 persons/km^2), Mondulkiri (2.2 persons/km^2), Stung Treng (7.3 persons/mm^2), Ratanakiri and

Preah Vihear (8.7 persons/km^2), Kampong Speu (85 inhabitants/km^2). The Coastal Region has a density of of 49 inhabitants/km^2, and Tonle Sap Region is 51.8 persons/km^2.

3. Administration

Cambodia is a constitutional monarchy. King Norodom Sihanouk is the head of state. Prime Minister Hun Sen is the head of the government. It has a National Assembly consisting of 122 members elected by the people from various regions. The Administration of the Government covers 24 provinces; with the seat of political, cultural, and economic activities located in Phnom Penh.

4. Economic and Social Situation

Since the 1980's, Cambodia has achieved some progress in economic development. Majoirty of the labor force is engaged in agriculture. Main industries include: rubber, fisheries, gem mining and food processing. For the past two years, cement and cotton factories have been re-established; while garment and tourist industries have been expanded. Private investors, mainly from France, Malaysia, Singapore, Thailand, and South Korea have established commercial activities in recent years that provided boost to the economy. Cambodia's main imports are petroleum, automobiles, motorcycles, machinery equipment and construction materials. The gross domestic product (GDP) and GDP in percent from 1994 to 1999 are shown in Table 3.

Table 3. Total GDP, GDP per Capita, and Growth Rate 1994-1999

	1994	1995	1996	1997	1998	1999
Gross domestic product GDP (in MUS$)	2,385	2,923	3, I I3	3,033	2,868	3,182
GDP per capita (USS)	241	284	291	27-1	251	271
GDP (% increase)	4%	7.60% °	7.0%	1.0%	I.0%	4.0%

Transportation and communications. There are six national highways linking Phnom Penh with other areas, except the highway to Sihanouk Ville and to Kompong Cham, all other highways are in poor conditions while some others are not passable. Public transport in the capital and some provincial cities are few. Bicycles and motorcycles are dominantly used by commuters. Walking and buffalo drawn casts are common sights. Railway services are available from Phnom Penh to Battambang (at the border of Thailand) and to Sihanouk Ville.

There are several private companies engaged in telecommunication business such as: Mobitel, SAMART Shinawatra etc. Development in this sector has greatly improved for the past two years.

Health and Welfare. Adequate medical care is not available to the large portion of the population. The Government is implementing a basic health care system and International relief organisations are working with hospitals to improve the system. The sanitation is poor. Potable water is not readily available. Life expectancy in 1995 was 53 years for females and 50 years for males.

Situation in the Past and at Present

1. Cambodia's power sector was severely damaged by years of war and neglect. In spite of the Government's efforts, its institutions remain weak and power supply is unreliable, costly, and mostly limited to urban areas. Consequently, only 12 percent of the households have access to electricity: the lowest electrification ratio among South East Asian countries. In most cities, deficiencies in the power supply remain due to weak management and poor conditions of generation and distribution facilities. Further, the lack of a transmission system prevents a more efficient use of power supply options resulting in one of the highest electricity costs in the world.

2. After a two-year economic slowdown caused by a long political stalemate and East Asia's financial crisis, political stability is emerging and Cambodia appears to be ready to resume a sustained economic growth. GDP growth for 1999 is expected to reach 4% (as opposed to 1% in 1998) and gradually increase to 6% in 2001 while Cambodia initiates a new era as a member of the ASEAN. Important part of this growth will be associated to industrial expansion stemming from regional trade opportunities and located mostly in the Phnom Penh – Sihanouk ville area. Therefore, the next 4 to 5 years will be characterised by an increasing demand for infrastructure in this area. However, while macro economic stability and growth are expected to be achieved, progress has yet to be made in addressing fundamental fiscal problems, including a weak domestic revenue mobilisation and inefficient public expenditure management. The efficient development of the power sector, open to private participation, will be critical to support Cambodia's goal for sustainable economic growth and social development due to the following reasons (a) the reliable provision of electricity services at lower costs is an essential condition for the growth of a competitive industry, and (b) power investments for the period 1999-2003 are expected to reach 11% of domestic investment and 2-2.5% of GDP, hence, a power sector successful in attracting direct private investment will minimise the use of public resources, thus reducing the pressure on fiscal management problems and releasing public funds for social objectives.

3. Cambodia's power sector is today at a crossroads. After a period of emergency rehabilitation and reconstruction, *the sector is ready to face development objectives aimed at: (a) improving sector efficiency and reducing electricity costs; (b) consolidating the ongoing reform; and (c) addressing the sector's social concerns, particularly the extension of electricity services to rural areas.* It is therefore necessary to formulate and implement a power sector strategy addressing the most salient problems of the sector:

- lack of a legal and regulatory framework, including the lack of transparency and competition in the current process for private sector entry;
- an entrenched public-oriented approach towards the management of public utilities;
- poor technical, commercial and financial performance of the sector;
- weak investment planning;
- lack of resources and strategy to provide electricity services to rural areas; and
- a weak human resource base.

1.3.1 Energy resources

The energy situation in Cambodia is characterized by its very low conventional energy consumption as compared to other Asian countries. The major sources of energy for Cambodia are biomass and imported petroleum products. Biomass energy sources account for an overwhelming share; total woodfuel consumption in 1994 was estimated to be 1,617 ktoe (FAO, 1997).

Cambodia's sources of energy consist primarily of indigenous supplies of wood, which together with other forms of biomass represented 83 percent of the total energy supply in 1995, while the remaining 17 percent consisted of imported petroleum products (Table 4).

Diesel oil and gasoline account for the bulk of petroleum product imports.

Table 4. Estimated Energy Supplies, 1995

Energy Source	Tones	Terajoules	1000TOE	% of Total
Wood	5,621,035	81,505	1,941	80.5 %
Other Biomass & Dung	113,300	1,645	39	1.6 %
Petroleum Products	419,475	1,8107	431	17.9 %
Fuel Oil	50,553	2,056	49	2.0 %
Diesel Oil	183,431	7,835	187	7.7 %
Kerosene	25,015	1,112	26	1.1 %
Kerosene Jet Fuel	10,748	468	11	0.5 %
Motor Gasoline	145,983	6,467	154	6.4 %
LP Gas	3,745	170	4	0.2 %
Total		**101,257**	**2,411**	**100 %**

Note : TOE -Tons of Oil Equivalent
Source: MIME, Energy Department

Electricity in Cambodia is generated in 22 isolated systems, mostly from diesel generators. Total installed capacity of electricity generation in Cambodia is estimated at about 122MW, of which 85 MW are in Phnom Penh. As a result of the small size of generation units (300KW to 5MW unit size), dependence on oil-based generation, and large distribution losses, the unit cost of electricity in Cambodia is among the highest in the region.

1.3.2 Demand and Supply Forecasts

Table 2 Energy Demand Scenario *, 1995-2020

Terajoules	1994	1995	1996	1997	1998	1999	2000	2,005	2,010	1995-05% / Yr
Total	**94,148**	**94,583**	**99,123**	**102,848**	**106,797**	**1,110,861**	**115,104**	**138,463**	**152,244**	**3.9%**
Wood	77,721	77,721	79,980	82,288	84,662	87,103	89,616	103,552	106,344	2.9%
Charcoal	1,097	1,097	1,121	1,143	1,167	1,189	1,213	1,367	1,357	2.2%
Other Bio.	1,754	1,642	1,633	1,625	1,616	1,608	1,600	1,559	1,351	-0.5%
LP Gas	103	170	212	257	310	362	421	729	1,050	15.7%
Kerosene	1,323	1,112	1,420	1,481	1,549	1,607	1,678	2,081	2,430	6.5%
Jet Fuel	725	468	725	761	799	389	881	1,125	1,435	9.2%
Gasoline	6,002	6,089	7,301	8,073	8,939	9,836	10,766	15,288	20,284	9.6%
Diesel	4,580	5,393	5,751	6,149	6,576	7,031	7,521	10,539	14,783	6.9%
Fuel Oil	65	64	73	79	86	93	102	158	249	9.4%
Electricity	777	827	907	991	1,093	1,191	1,308	2,066	2,962	9.6%
Households	81,530	81,395	83,830	86,224	88,685	91,215	93,819	108,240	110,608	2.9%
Wood	77,329	77,329	79,536	81,804	84,134	86,527	88,985	102,546	104,730	2.9%
Charcoal	935	935	957	979	1,002	1,026	1,050	1,179	1,135	2.3%
Kerosene	1,046	879	1,117	1,155	1,190	1,226	1,263	1,468	1,512	5.3%
LP Gas	35	57	88	120	153	187	222	416	546	22.1%
Diesel	80	176	84	86	88	91	93	106	107	-4.9%
Electricity	352	378	415	45	501	551	607	967	1,229	9.8%
Other	1,754	1,642	1,633	1,625	1,616	1,608	1,600	1,559	1,351	-0.5%
Service Sector	918	989	1,057	1,129	1,231	1,310	1,420	2,104	3,189	7.8%

Wood	23	23	18	16	13	11	10	5	3	
Charcoal	149	149	149	147	146	143	142	152	165	0.2%
Kerosene	278	233	303	325	359	381	415	614	918	10.2%
LP Gas	69	113	124	138	158	175	199	313	504	10.7%
Diesel	33	80	36	39	43	46	50	75	114	-0.6%
Electricity	367	391	426	464	512	553	605	945	1,486	9.2%
Industry	405	405	465	512	564	619	681	1,096	1,764	10.5%
Wood	307	370	425	468	515	565	622	1,001	1,611	10.5%
Charcoal	13	13	15	17	18	20	22	36	58	10.5%
Diesel Oil	22	22	25	28	30	33	37	59	95	10.5%
Fuel Oil	63	63	72	78	85	92	101	157	248	9.5%
Electricity	58	57	66	72	80	87	96	154	247	10.4%
Transport	11,174	11,674	13,633	14,832	16,154	17,537	18,988	26,712	36,188	8.6%
Gasoline	6,002	6,089	7,031	8,073	8,939	9,836	10,765	15,288	20,284	9.6%
Diesel	4,445	5,116	5,606	5,997	6,414	6,861	7,341	10,299	14,468	7.2%
Jet Fuel	725	468	725	761	799	839	881	1,125	1,435	9.2%
Fuel Oil	2	1	1	1	1	1	1	1	1	0.0%

*Demand by final consumers, not including fuel for electricity generation or wood for charcoal
Cambodia's energy supplies forecasting 1990-2010 has not yet been estimated

ELECTRICITY SECTOR

A. Ministry of Industry, Mines and Energy (MIME)

MIME is responsible for policy and planning of the electricity sector and also for management of supplies in 19 provinces of Cambodia.

One of MIME's important activities is its leading role in Renewable Energy activities throughout the rural areas. This includes solar, biomass, biogas, and hydropower. The potential for wind energy in Cambodia has not yet been assessed.

B. Electricity Authority of Cambodia (EAC)

The ElectricityAuthority of Cambodia was established by virtue of the new Electricity Law. The EAC will be responsible for regulating the provision of electric power services. The responsibilities of EAC include:

- Licensing of companies for generation, transmission, distribution and retailing of electricity, including consolidated and subcontractor arrangements
- Review and approval of tariffs
- Monitoring of investments and power acquisitions by license,
- Development and monitoring of performance, technical, safety and environmental related standards
- Certification and inspection of metering
- Establishment of accounting standards
- Enforcement of electricity law

C. Electricity du Cambodge (EDC)

EDC is a public sector utility that has the non-exclusive responsibility for generation, transmission, distribution and retail of electricity throughout Cambodia. It presently provides the supplies to the nation's capital Phnom Penh and through grid extension to Kandal province and also the provincial cities of Sihanouk ville, Steam Reap and Kompong Cham. EDC is also expected to assume responsibility, for the fist three to five years, of the network rehabilitation and expansion being funded by the ADB in seven main provincial towns

Phnom Penh has the largest power system in the country. It serves about 80,000 customers with a peak demand of 85 MW. EDC's key electricity data as of 31 December 1999 include:

• Total installed generation capacity	115 MW
• Maximum generation output	97MW
• Energy Generation	387 GWh
• Energy Sales (excludes own usage)	284 GWh
• System Losses	24.05 %
• 115 kV Network	23 circuit-km
• 22 kV Network	341.04 circuit-km

D. Demand/Supply Forecasts 1999-2016 and Key issues

Over the past several years, the demand for electricity has been growing along with the economic growth. The demand growth has averaged 30-40 MW per year. The production of electricity is not adequate to meet demand. The present role of EDC is to improve the efficiency of generation, transmission and distribution on electric power in Cambodia.

Electricity Demand

Table 4. Expected Power Generation output for Cambodia (MW)-Base Case

Year	1998	2000	2002	2004	2006	2008	2010	2012	2014	2016
Banteay Meanchey	4.0	5.9	8.0	10.0	12.0	14.5	17.3	20	24	26
Battambang	3.5	5.7	8.6	12.0	15.0	18.5	22.4	27	31	33
Kampong Cham	4.9	7.8	10.5	13.0	15.2	17.9	20.5	23	26	29
Kampong Chhnang	1.1	1.6	2.2	2.8	3.4	4.0	4.7	5	6	7
Kampong Speu	1.0	2.0	2.9	3.8	4.7	5.9	7.2	9	12	16
Kampong Thom	1.5	2.4	3.4	4.5	5.3	6.4	7.5	9	10	11
Kampot	2.7	4.8	8.1	10.1	13.9	16.3	18.9	25	28	33
Kandal	2.2	3.9	5.5	6.7	7.9	9.2	10.6	12	13	15
Koh Kong	0.7	0.9	1.2	1.4	1.7	2.0	2.3	3	3	4
Kratie	1.9	3.2	4.4	5.7	6.8	8.0	9.4	11	12	14
Mondul Kiri	0.1	0.2	0.3	0.4	0.5	0.6	0.7	1	1	1
Phnom Penh	60	93	131	170	207	256	304	356	418	484
Preach Vihear	0.3	0.5	0.7	1.0	1.1	1.4	1.6	2	2	2
Prey Veng	1.7	3.0	4.4	5.5	60.6	7.8	9.0	10	11	13
Pursat	1.3	2.3	3.2	4.2	5.0	5.9	6.9	8	9	11
Ratanak Kiri	0.9	1.1	1.3	1.5	1.7	1.9	2.2	2	3	3
Siem Reap	3.0	4.2	5.6	7.1	8.4	10.0	11.5	13	15	17
Sihanouk Ville	2.9	3.4	4.1	4.8	5.5	6.3	7.3	8	10	11
Stung Treng	0.2	0.5	0.7	0.9	1.1	1.3	1.5	2	2	2
Svay Reing	1.0	1.6	2.2	2.8	3.2	3.9	4.4	5	6	6
Takeo	1.5	2.4	3.4	4.2	4.9	5.8	6.7	8	8	9
Total	**97**	**150**	**212**	**273**	**331**	**404**	**477**	**558**	**651**	**746**

Source: Government of Cambodia, MIME Nov. 1998

RENEWABLE ENERGY SECTOR

a) Institutional Setting

In 1995, a working group called "Solar Energy Application (SFA)" was formed by Technical Energy Department of Ministry of Industry Mines and Energy. SEA is responsible in renewable energy and performs the following activities:

- cooperation and coordination with Ministries, agencies concerning and donor,
- data collection basically for study,
- research, setting up the solar energy system I pilot project), training local people. promoting and disseminating of this field,
- report to MIME the results of the study.

b) Present Use, Potential, and Direction for Development

Solar Energy

Cambodia's tropical climate is favorable for the utilisation of solar energy. This is reflected in the annual mean temperature in the low-lying plain, which is about 26ºC. Measurements during the periods of 1981-1988 at Phnom Penh indicate that the average sunshine duration varied between 6.1 and 9.7 hours per day in August and December respectively.

The total installed PV capacity was about 204,586 Wp in Cambodia. PV installations include private rural houses, schools, health center, orphans, pagodas telecommunication, etc.

Recently, the New Energy and Industrial Technology Development Organization (NEDO), has installed PV battery charging system in Phnom Chino and PV water pumping in school at Kompong Chnaing province. The projects are expected to: increase the economic condition of rural people, increase the knowledge of the people, and to transfer information and technology.

Hydropower

Cambodia is the one of the South-East Asian countries that is rich in water resources. It has the second largest hydropower potential in the lower Mekong Basin. According to the latest preliminary study, the total hydropower potential of the country is estimated at 10,000 MW, of which, 50 percent is in the Mekong, 40 percent in its tributaries and the remaining 10 percent in the south-western coastal area outside the Mekong river basin.

Cambodia's demand is projected at 175 MW in 2000, 380 MW in 2010 and 760 MW in 2020. Due to improvement in economy, the increase in power demand cannot be met by existing power supply capacities. The most urgent action for the utilities are to rehabilitate and upgrade existing power plants. This is considered critical as a continued shortage in the electricity supply will seriously restrain the ongoing reconstruction and socio-economic development of the country.

The need for Cambodia will be to use Cambodia's Hydropower potential in order to meet future electricity demand and to reduce the dependence upon imported fuel and to exchange of hydropower with neighboring countries.

Before the civil war, the Kirirom I Hydropower station was running with an installed capacity of 10MW, and energy was delivered to Phnom Penh through a 110 kV transmission line over a distance of 120Km. This Hydropower Plant was completed in 1968 as the first hydropower station in Cambodia, but it was completely destroyed during the war after only 13 months of operation. However the facilities have been started to restore by Austrian and Swedish Aid projects. The Prek Thnot project with an installed capacity of 18MW was implemented near the Kirirom I Hydropower station, but the construction was interrupted in 1970 due to the war In 1992 one small Hydropower Station at Present in Cambodia, and all of the operating generator; now are diesel and okil-fired engines depending on imported oil

Wind Energy

At present, wind energy has not been used for power generation. Wind resource, especially in coastal and mountainous regions, is about l0 m/s. Measurements during 1981-1990 at Phnom Penh indicate that the average wind velocity varied between 4.8 and l4.8 m/s in January and July respectively. There are some installations of wind energy for water pumping implemented by an NGO, (Christian Outreach) for irrigation in Prey Veng Province.

Biomass

As in almost all Asian countries, biomass energy plays a major role in satisfying the rural energy requirements of Cambodia. According to FAO estimate, wood fuel consumption in 1994 was 1,618 ktoe, and accounted for 84% of the total energy consumption in the country. The total available wood fuels during the same year was 24.5 million toe. In addition, an estimated amount of 167 ktoe of agro-industrial processing residues was also available as fuel in 1994 (FAO 1997). Due to the lack of modern technology, the development of biomass system still very low. In Cambodia, biomass systems generally use agricultural wastes for cooking and small handicrafts in rural areas.

Biomass is also used in the industrial sector for copra drying and steam generation. However, no reliable estimates of the amount of biomass energy consumption for these purposes are available.

Biogas

Biogas system in Cambodia used animal wastes for energy. The systems were implemented by Christian Outreach, Food Agriculture Organization, and Padex. In some provinces. Prey Veng, Kandal, Kompong Speu, Svay Rieng, Ta Keo, Kom Pot, and Siem Riep, there seems to be considerable potential for biogas development. The energy potential of biogas from recoverable animal wastes in the country has been estimated to be about 228 ktoe/year (Bhattacharya et al., 1997).

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Sponsored by : New Energy and Industrial Technology Development Organization (NEDO), Japan

II. Iron and Steel Industry

Participants for audit and survey of energy conservation in major industries of ASEAN countries (Staff members from DOE, Iron and steel companies, ACE and ECCJ)
At a meeting room of company A, Manila, Philippines (Feb. 11, 2003)

II. Iron and Steel Industry

1. Project Summary

This project was intended to contribute to energy conservation, environmental protection, and persistent economic development of ASEAN countries showing remarkable economic growth and established as a part of the Infrastructure Improvement for Rationalization of International Energy Use.

With ACE (ASEAN Center for Energy) as the core organization, this project attempts to promote energy conservation relating to major industries under cooperation of ASEAN countries. As the country and industry to be surveyed in this fiscal year, Philippines and its iron and steel industry were chosen. Then, an audit plan was prepared based on the discussion with responsible persons in this country. For four days on December 16 through 19, 2002 and February 10 through 14, 2003, audit was implemented at the sites of two companies in the iron and steel industry with the presence of responsible persons of the Department of Energy (DOE) in Philippines.

The survey report including the Philippines' political and economic status is discribed below. However, we promised PSA (Philippine Steel-makers Association) and these companies according to their request that the company names would not be disclosed. Therefore, these companies are represented by e.g. "Company A", etc.

1.1 Subjects of Study and Organizations Involved

(1) Country and companies surveyed

Country : The Republic of Philippines

Companies :

Company A (electric arc furnace factory)	:	Visit in the first visit and audit survey in the second visit implemented
Company C (electric arc furnace factory/rolling mill)	:	Visit in the first visit
Company D (electric arc furnace factory)	:	Visit in the first visit
Company B (rolling mill)	:	Visit and audit survey in the second visit

Although four factories were visited, Company A with electric arc furnace (hereinafter reffered to as "EAF") factory (totally 1.5 days) and Company B with rolling mill (1.5 days) were actually audited and surveyed.

(2) Organization

1) Philippines

a. DOE (Department of Energy):

Ms. Teresita M. BORRA	Director EUMA
Ms. Lilian C. FERNANDEZ	Division Chief
Mr. Jesus C. AUUNCIACION	Chief Science Research Specialist, Energy Efficiency Division
Mr. Artemio P. HABITAN	Supervisor, Science Research, Monitoring & Evaluation Section, Energy Efficiency Division
Mr. Michel ESTRADA	Energy Efficiency Division
Mr. Marlon R. N. DOMINGO	Energy Efficiency Division
Mr. Antonio BASCO	Monitoring
Mr. Simon LEONOR	Energy Audit

b. BOI (Board of Investments):

Mr. Ramon L. ROSALES	Director, Industry Planning Dept. 3
Ms. Amelia P. CABALLERO	Officer of Construction Materials, Metal-works & Machinery Division

c. PSA (Philippine Steel-makers Association) :

Mr. Antonio P. ARROBIO	Secretary of the Philippine Steel-makers Association (Vice President of Cathay Pacific Steel Co.)

d. Company A (EAF factory) : 6 persons

e. Company C (EAF/rolling mill factory) : 3 persons

f. Company D (EAF factory) : 1 person

g. Company B (roll factory) : 4 persons

h. Other companies participated in the workshop : 6 persons from 2 companies

2) ACE:

Mr. Christopher ZAMORA

3) ECCJ:

Hiroshi Shibuya	Department Manager of International Engineering Department
Ichiro Matsuura	Technical Expert of International Engineering Department
Hideyuki Tanaka	Technical Expert of International Engineering Department

1.2 Political and Economic Conditions of Philippines

(1) National indicators

Country name : The Republic of the Philippines
Area : 294,554 km^2
Population : 76,499 million (census value as of May 1, 2000)
Capital : Manila (population: 1.58 million)
Language : Many languages including Filipino, English, and Ilocano
Religions : Catholicism (84%), Philippines Independent Church/ Protestant (11%), and Islam (5%)

(2) Basic economic indicators

Table II-1-1 shows the basic economic data of Philippines.

Table II-1-1 Basic Economic Data of Philippines

		1998	1999	2000	2001
GNP (100 million US$)		685	802	790	757
GNP per capita (US$)		912	1045	1007	945
Economic growth rate (%)		-0.6	3.4	4.0	3.4
Inflation rate (%)		9.8	6.7	4.4	6.0
Unemployment rate (%)		10.0	9.8	11.2	11.1
Total trade value (100 million US$)	Exports	295.0	350.4	380.8	321.5
	Imports	296.6	307.4	313.9	295.5

Substantial GDP growth rate : 3.4% (2001)
Nominal GDP total amount : 3,642,820 million pesos (2001)
71,438,068,586 US$ (1 US$ = 50.9927 peso on an annual average)
Current balance (on an international balance basis) : 4,504 million US$ (2001)
Trade balance (on an international balance basis) : 2,598 million US$ (2001)
Foreign currency reserves : 134,42.6 million US$ (2001)
Foreign liabilities balance : 520,60 million US$ (2001)
Exchange rate (term average) vs. US$ rate : 50.9927 (2001)
Exchange rate (term-end value) vs. US$ rate : 51.404 (2001)
Exports to Japan : 5,055 million US$ (2001) FOB
Imports from Japan : 6,097 million US$ (2001) FOB

(3) Political system

System of government : Constitutional republic system
Head of state : Gloria Macapagal Arroyo
Assumption of office : Promoted to President from Vice-president on January 20, 2001
Parliament : Bicameral
Outline of parliament (number of seats, date of founding, term of office):
Regular members of upper house 24 (national constituency), lower house 262 (by both proportional representation and single-member constituencies);
Term of office: upper house 6 year (half the seats being reelected every 3 years); lower house 3 years
Major ministries : Department of Finance, Department of National Defense, Department of Trade and Industry, Department of Justice, Department of Tourism, Department of National Economic Development Authority, Department of Transportation and Communications, and Department of Budget and Management

(4) Political developments

- May 1998: Josef Estrada is elected to be a president of the Philippines, largely thanks to the support of the population's lower income brackets
- October 2000: President Estrada suffers a steep fall in popularity as a result of widespread allegations of illegal gambling, misappropriation of public funds, and so on. On October 12, Vice-president Gloria Macapagal Arroyo resigns her cabinet post, and on November 2 Secretary of Trade and Industry Roxas also resigns. Messers chairmen and many members of both houses of Congress leave the ruling coalition, known as LAMP, and the situation moves toward impeachment of the President.
- January 16, 2001: The refusal – at the impeachment hearings – to disclose important evidence regarding accusations of illegal amassing of personal wealth by the president, leads to mounting demonstrations by the general public. President Estrada successively loses the support of his cabinet members, and Ms. Arroyo is proclaimed president.
- May 1, 2001: Police clash with a huge crowd of supporters of former president Estrada, protesting against plans for his arrest. On the same day, President Arroyo declares a state of emergency, allowing the arrest of the former president without a court warrant.

- In the interim elections on May 14, 2001, 8 out of 13 seats up for re-election in the upper house are captured by the ruling party coalition led by President Arroyo. Together with those seats that the coalition held that were not up for re-election, this gives the coalition a majority in the upper chamber.
- August 7, 2001: A cease fire is agreed between the government and the Moro Islamic Liberation Front (MILF) following President Arroyo's rejection of former president Estrada's hard-line stance against the MILF.
- November 19, 2001: An armed group supporting Misuari, honorary chairman of the MILF and governor of the Mindanao Islamic Autonomous Region (MRMM) attacks an army post on the island of Jolo in Sulu Province. Mr. Misuari requests postponement of the gubernatorial election set for November 26, and the suspicion is widespread that the attack was made for the purpose of putting off the election. On November 24, Mr. Misuari is arrested in Malaysia on suspicion of illegal entry: he is subsequently returned to the Philippines.
- November 26, 2001: Husin wins the MNLF deputy chairman The MRMM election. The Arroyo administration officially recognizes him as the new governor.
- July 22, 2002: President Arroyo makes the second policy speech after the assumption of office and announces the statuses of achieving poverty eradication, modernization of the agricultural sector, peace preservation, and macro economy development as the pledges made in the preceding year and indicates the goal of the future policies. She focuses on employment securing and investment invitation – and among them – shows a positive stance for solution of labor problems for investment invitation.

(5) Economic trend

Under the administration of President Ramos (1992-1998), a high growth was achieved through introduction of foreign capitals and under the control of exports by promoting economic structure reforms including reform of the government's finances and deregulation. The substantial GDP growth rate rose steeply from a mere 0.3% in 1993 to 5.7% in 1996 and 5.2% in 1997.

The Philippine peso, too, was affected by the East Asian currency crisis, which was sparked by a steep fall in the exchange rate of the Thai currency, the baht, in July 1997. On top of a rising inflation rate and the government's deteriorating financial balance, bad weather caused by the El Ninho phenomenon led to poor harvests, and as a result, the Philippines in 1998 recorded its first negative GDP growth figure since 1991, at minus 0.6%.

In 1999, the output of farm crops such as rice and corn recovered thanks to improved weather, while the manufacturing sector also held firm. Therefore, the GDP growth rate recovered to 3.4% and the GNP growth rate to 3.7% (0.4% rise in 1998) and the trade balance registered its first surplus in 11 years, at US$4300 million.

In 2000, although the farming sector experienced a slowdown, manufacturing industry enjoyed sharp growth, and, supported by strong consumer demand and vigorous exports, the GDP growth rate showed a 4.0% increase, the GNP growth rate showed a 4.5% increase, and the trade surplus was US$6700 million.

In 2001, the GDP growth rate maintained a 3.4% increase, topping the government's target of 3.3%, supported by firm faming and service sectors and personal consumption in good condition, although exports and the mining and manufacturing industries declined as a result of worldwide stagnation.

By the third quarter in 2002, the substantial GDP growth rate was 4.1 (3.0% in the preceding year) and the substantial GNP growth rate was 4.2% (3.6% in the preceding year). In the fourth quarter, the government's goal for GDP 4.0% and GNP 4.5% may be achieved because a demand increase by remittance of a large amount by workers in overseas in Christmas season is expected.

(6) Trades and investments between Philippines and Japan

Although Japan is a second large trade partner for Philippines, following the United States, Philippines shows a deficit constantly. In past years, the major items of export to Japan were primary products such as fishery products and banana. Recently, processed products such as semiconductors and wire harnesses have increased. Most items imported from Japan are industrial products, among which electronic/electrical parts and automobile parts rank higher. The trade amount between Japan and Philippines in 2001 (exports + imports) is simply 2.1% from the standpoint of Japan but it is 16.7% from the standpoint of Philippines (the United States: 24%).

Japan is one of the major countries investing to Philippines and many investments are being made to the manufacturing sector in the economic special district. For the types of industry, major investments are made to electronics, followed by transporting components and processed metal items.

1.3 Energy Status in Philippines

The following description is based on "Philippine Energy Plan 2002-2011" announced in November 2001.

(1) Primary energy consumption

Primary energy consumption in Philippines had increased 3.5% on an annual average between 1995 and 2000. Since the GDP growth rate on an annual average in this period was 3.5%, the energy elasticity rate to GDP was 1.0. In 2000, energy consumption was 249.5 million barrels of fuel oil equivalent. Although the percentage of petroleum in total primary energy consumption reduces year by year, it is still high (45.5%) and almost 100% of petroleum depends on imports. For energy sources produced domestically, the recycle type (bagasse, agricultural waste, timber, etc.) is 30.1%, hydraulic power is 5.1%, and geothermal energy is 8.2%.

Table II-1-2 Transition of Primary Energy Consumption (Assuming a Big Volume Consumption of Domestic Energy)

Unit: Barrels of fuel oil equivalent (MMBFOE)

	1995 (actual)		2000 (actual)		2006 (forecast)		2011 (forecast)	
	Demand	Compo-sition %	Demand	Compo-sition %	Demand	Compo-sition %	Demand	Compo-sition %
Domestic production	92.2	44.0	111.9	44.9	191.5	58.2	254.2	55.7
Petroleum	0.03	0.02	0.3	0.1	13.1	4.0	7.2	1.6
Gas	0.0	0.0	0.04	0.01	31.0	9.4	57.5	12.6
Coal	6.1	2.9	4.4	1.8	7.4	2.2	14.4	3.2
Hydraulic power	10.7	5.1	12.3	5.1	20.1	6.1	30.1	6.6
Geothermal	10.6	5.0	19.7	8.2	30.9	9.4	42.1	9.2
Recycle type	64.8	30.9	75.1	30.1	89.1	27.1	102.8	22.6
Imports	117.5	56.0	137.6	55.1	137.6	41.8	200.2	43.9
Petroleum	114.0	54.3	113.3	45.4	117.6	35.7	175.4	38.5
Coal	3.5	1.7	24.3	9.7	20.0	6.1	24.8	5.4
Others	0.0	0.0	0.0	0.0	0.0	0.0	1.7	0.4
Total	209.7	100.0	249.5	100.0	329.1	100.0	456.1	100.0

Source: PEP 2002-2011

(2) Electricity

For electricity generated in Philippines, 45.3 TWh was produced in 2000 and exceeded 41.4 TWh in the preceding year by 9.3%. For the demand by application in 2000, 36.1% was for the industrial sector, 35.3% was for the residential sector, 26.0% was for the commercial sector, and 2.6% was for the transportation and other sectors. For the electricity demand in 10 years from 2001 to 2011 based on the estimated economic growth rate of 6% on an annual average, an increase of 9.3% on an annual average is expected and 45.1 TWh in 2001 will increase to 110.2 TWh in 2011.

Table II-1-3 Actual/Forecast Transition of Electricity Generation

Unit: TWh

	2000 (actual)		2001 (forecast)		2011 (forecast)		Growth rate on an annual average between 2001 and 2011%
	Electricity generation	Compo-sition %	Electricity generation	Compo-sition %	Electricity generation	Compo-sition %	
Luzon Grid	35.0	77.2	35.0	77.6	82.3	74.7	8.9
Visaya Grid	4.2	9.2	4.7	10.4	12.6	11.4	10.4
Mindanao Grid	6.1	13.6	5.4	12.0	15.3	13.9	11.0
Total in Philippines	45.3	100.0	45.1	100.0	110.2	100.0	9.3

Source: PEP 2002-2011

The system of electricity industry in Philippines is characterized by the fact that the system is divided by clear sections that are electricity generating/transmitting companies and electricity distributing companies. National Power Corporation (NPC) and Manila Electric Company (MERALCO), both of which are national corporations, monopolize the electricity market. NPC performs consistent operation of electricity generation and transmission. MERALCO distributes electricity to Manila and adjacent areas and electricity distribution to other areas is sold wholesale to local electrification cooperatives and NPC also sells electricity to major industrial demands. However, since the electricity enterprise is monopolized, the NPC’s business is not streamlined and its debt increases. Additionally, the electricity charge increases due to electricity distribution losses, etc., so the electricity charge in Philippines is second higher, following Japan in Asia. As an action plan, “Electric Power Industry Reform Act (Republic Act No.9136)” containing the action of selling NPC and putting it under private management as a core was established in the congress in June 2001 to make the electricity sector more efficient through entry of private capitals and introduction of the principle of competition. The Electric Power Industry Reform Act also expresses that local electrification should be proceeded with. For rural villages, villages of approximately 25% still cannot access the electricity transmission network. The government’s plan aims at achieving electrification of 95%

barangays (minimum administrative units) by 2004 and full electrification by 2006.

Because of the geographical features of Philippines as a country of islands, the NPC’s electricity transmission network consists of three grids; Luzon, Visaya, and Mindanao. Electricity is distributed by MERALCO in Manila, by electricity distribution companies such as VECO in Visaya, and by approximately 120 local electrification cooperatives in rural areas. The largest electricity distribution company is MERALCO. Promotion of local electrification is under control of National Electrification Administration (NEA), which is responsible for constructing local electricity distribution equipment, organizing and supervising local electrification cooperatives as electricity distribution organizations, and implementing staff training, etc. but does not distribute electricity directly. For electricity generation equipment (NPC) by grid, the Luzon grid uses thermal power, the Visaya grid uses geothermal power, and the Mindanao grid uses hydraulic power as major sources.

Table II-1-4 Electricity Source Constitution of Philippine (NPC) Electricity Generation by Grid (2000)

Unit: TWh

	Luzon Grid		Visaya Grid		Mindanao Grid		Total	
	Electricity generation	Constitu-tion %	Electricity generation	Constitu-tion %	Electricity generation	Constitu-tion %	Electricity generation	Constitu-tion %
Thermal power	20.29	65.5	0.64	17.4	0.49	9.0	21.90	54.0
Petroleum	4.97	16.0	0.36	9.8	0.49	9.0	6.30	15.5
Coal	15.32	49.5	0.28	7.6	0.00	0.0	15.60	38.5
Hydraulic power	3.16	10.2	0.01	0.3	4.19	76.7	7.36	18.1
Geothermal power	7.51	24.3	3.02	82.3	0.78	14.3	11.31	27.9
Total	30.96	100.0	3.67	100.0	5.46	100.0	40.58	100.0

Source: NPC 2000 Annual Report

(3) Energy price

For the NPC’s electrical charge by area, the energy price is approximately 2 peso/kWh in local areas (5.6 yen/kWh if 1 peso = 2.8 yen) and approximately 3 peso/kWh in urban areas (8.4 yen/kWh). Therefore, the price in urban areas is higher.

Table II-1-5　NPC's Electricity Charge

Peso/kWh

	1999	2000
Luzon Grid	2.84	3.34
Visaya Grid	2.52	3.23
Mindanao Grid	1.67	1.93
Philippines	2.65	3.12

Source:　2000 Annual Report "National Power Corporation (NPC)"

The fuel prices (according to the data from the Energy Industry Administration Bureau of the Department of Energy; as of September 2000) is as follows:

Gasoline (lead-free)　16.85 to 17.36 peso/L
Diesel oil　13.04
Kerosene　12.59

(4) Government offices responsible for energy conservation and promoting organizations

1) Department of Energy (DOE)

This department aims at streamlining, integration, and adjustment of various programs of the government in the field of energy resources in Philippines, by conducting total and integrated mining, production, management, development, preservation, recycling, efficient utilization, continuous, adequate, and economical reservation of supply; and considerations to the environment.

Since DOE was established in 1992, it developed the Philippine Energy Plan (PEP) every year and announced the future prospect and plan on the energy supply and demand status, prospect, and governmental policy in coming 10 years. As auxiliary organizations relating to energy, Philippine National Oil Company (PNOC), National Power Corporation (NPC), and National Electrification Administration (NEA) are under supervision of this department.

2) Energy Regulatory Commission (ERC)

The former name was Energy Regulatory Board, which was renamed to Energy Regulatory Commission (ERC) in June 2001. This commission is responsible for establishing standards for the energy demand side consumption efficiency improvement plan (DSM Program) in connection with the energy conservation policy. This commission has jurisdiction over the DSM framework program.

3) National Power Corporation (NPC)
   This national organization is under supervision of DOE and it is responsible for consistent operation of electricity generation and transmission throughout Philippine and electricity distribution to major industrial demands.

4) Manila Electric Company (MERALCO)
   This national organization is under supervision of DOE and it is responsible for electricity distribution to Manila and adjacent areas.

5) National Electrification Administration (NEA)
   This national organization is under supervision of DOE and it is responsible for electricity distribution to rural areas and electrification of farming villages.

6) Philippine National Oil Company (PNOC)
   This company is responsible as the leader of R&D for energy in Philippines.

1.4 Iron and Steel Industry in Philippines

Description below is based on the material by Philippines BOI (Board of investments).

(1) Supply and demand of iron and steel in Philippines

The maximum iron and steel consumption in the past in Philippines was approximately 4 million tons in 1960. Then, the consumption has decreased. In 2000, the demand of iron and steel was 3.136 million tons, which was 5.2% smaller than that in the preceding year. This was caused by reduction of public enterprises due to budget shortage. In 2001, the level in 1999 was restored. In 2002, the demand will increase by 3.2% to 6.5% compared with that in 2001. (See Tables II-1-6 and II-1-7.)

Facilities in National Steel Co. (NASCO) that had supplied more than 50% of steel sheets, etc. was shut down in November 1999. Now, all steel sheets, etc. are imported.

Table II-1-6 Demand of Iron and Steel in Philippines

(Unit: 1,000 tons)

Year		1999	2000	2001	Sem 1 2001	Sem 1 2002	2002 Forecast	
							Low	High
Flat Products	Local Prod'n	144	--	--	--	--	--	--
	Imports	1,443	1,386	1,483	734	815	1,550	1,600
		1,587	**1,386**	**1,483**	**734**	**815**	**1,550**	**1,600**
Long Products	Local Prod'n	1,286	1,350	1,386	711	752	1,450	1,485
	Imports	434	400	474	226	256	450	475
		1,720	**1,750**	**1,860**	**937**	**1,008**	**1,900**	**1,960**
Total Steel	Local Prod'n	1,430	1,350	1,386	711	752	1,450	1,485
	Imports	1,877	1,786	1,957	962	1,071	2,000	2,075
		3,307	**3,136**	**3,343**	**1,671**	**1823**	**3,450**	**3,560**

Table II-1-7 Demand of Iron and Steel in Philippines (by Kind of Product)

(Unit: ton)

Kind of Products		Sem 1, 2001	Sem 1, 2002	Increase/Decrease
Hot rolling products		366,200	420,000	+14.7%
Cold rolling products		177,200	218,200	+23.1%
Coating products		152,200	165,000	+8.4%
	Tin plate	92,400	110,000	+19.0%
	Zinc coated	31,500	47,100	+49.5%
Pipe & tube		23,000	11,700	- 49.1%
Billet		**590,000**	**635,800**	**+7.8%**
Long finish		224,000	265,600	+18.6%

The import in the first half of 2002 reached 59.3% of the total import in 2001. According to the tables shown above, the volume of imported billets is large and approximately 80% of material for producing bar steel in Philippines relies on import.

(2) Development and problems of iron and steel industry

Iron and steel manufacturers, foundries, and scrap traders petitioned the government to inhibit or at least regulate scrap export through the policy statement submitted to the trade industry committee in the congress, to save the iron and steel manufacturers and foundries that were facing a crisis. Since 80% of their raw materials are scrap and iron and steel products, they mentioned that the domestic iron and steel industry would surely be collapsed unless scrap export is inhibited or regulated.

This industry consists of 250 companies, to which capitals of more than 10 billion peso and more than 500 thousand employees are committed, directly or indirectly. This industry pays taxes of hundreds of million pesos to the government, has economic connections with other industries and saves foreign currencies that are important to the country. In Philippines, 13 melting companies using EAFs in the past are reduced to 5 companies and the others changed to single rolling mills.

1) Billet production sector

For billet production, the EAF – continuous casting system is employed. Types of steel are plain carbon steel (structural steel), intermedium-class steel, and high-strength steel.

Billet production in 2001 was 420,000 tons, which was 36% of the manufacturing capacity (1,160,000 tons).

Two companies with a capacity of 300,000 tons/year are not currently operating.

2) Rolling sector

Rolling mills produce reinforcing steel bars for civil engineering and construction, wire rods, and shapes and sections steel. Reinforcing steel bars are categorized into two types; structural steel and intermediate/high-strength steel. There are about 25 manufacturers of structural steel. The number of manufactures of intermediate steel/high-strength steel is 4. For wire rods, inexpensive products are mainly imported from Russia and Ukraine. Mills in this sector are changing to produce reinforcing steel bars.

Shapes and sections steel is produced by mainly two companies. The capacity of overall mills is approximately 3.6 million t/y.

3) Company management structure

These companies are mostly family corporations. However, three companies are stockholding companies to which foreign countries are committed.

4) Technology

- Field of melting

  Most companies performing melting have new excellent equipment with high-productivity for which auxiliary equipment and productivity have been enhanced and processes have been improved.

  The cost of production with the equipment is fully competitive against foreign countries, thanks to convenience of transportation, minimum depreciation, and inexpensive personnel expenses.

- Field of rolling

  Rolling mills are divided into three types; the continuous type, the semi-continuous type, and the non-continuous type, namely cross country. The continuous type has a rolling stand with full tandem arrangement and has a heating furnace with high-speed operation, computer control, and high fuel efficiency. There are 3 companies, each of which has a capacity of at least 300 thousand t/y.

  The semi-continuous type has a reverse type roughing mill stand or a loop type with semi-tandem arrangement. There are 12 companies and the average capacity is 150 thousand t/y.

  The non-continuous type mills has a minimum scale that meets at least the economic requirements and it is operating with high fuel consumption and depending man-hours mostly. Most mills belong to this category.

(3) Present situation of iron and steel industry

1) High electricity cost: Electricity from MERALCO = US$0.11/kWh
2) High transportation and handling costs. Equipment improvement is necessary.
3) Financing problem. Financing organizations are very careful because of the currency crisis in 1997 through 1998.
4) Ineffective and unnecessarily high-quality standards are forced. As a result, cost reduction is difficult.
5) New investors as well as existing manufacturers should be encouraged to make investment so that the operation cost will be cut down through enhancement of equipment and technology and improvement of operation.

   New investments depend on how efficiently the problems 1) to 4) are handled.

(4) Issues of customs duties

Regarding the iron and steel industry, some developments were noticed in the past one year.

1) A new damping act was enforced according to the WTO's instruction.
2) A safeguard action act protecting domestic industries against the increase of imports was approved. In 2001 through 2004, the government approved a new customs duties structure for cutting down customs duties to materials and products. For semi-products, customs duties will be cut down from 3%. For final products (bars, coated steel, and pipes), customs duties will be gradually cut down from 10% to 5%.

As these situations indicate, the iron and steel industry in Philippines is presently in a very tough status.

In 2003, the price of imported billets has steeply increased. The price was 160 to 170 US$/t last year and the price increase is approximately 100US$/t. Therefore, manufacturers with EAF are in the condition of full production now. Since production might be obstructed, some companies visited in the first survey turned down the audit at the second survey.

2. Overview of Factories with Electrical Arc Furnace and Rolling Mill Audited

For implementation of audit and survey for iron and steel industry in Philippines, ECCJ requested ACE to select two factories with EAF in Manila or adjacent areas.

ECCJ visited the factories of three companies and explained the purpose of audit and survey, and learned the factory overview, etc. ECCJ picked up two out of these three companies as candidates and requested DOE to realize re-visit for audit and survey at the second visit.

By the second visit (February 2003), making a confidentiality protection duty agreement to two companies, ECCJ carried out the audit and survey.

Overview of each iron and steel company selected is described below.

2.1 Overview of Company A (Factory with EAF)

Location	:	Metro Manila
Product	:	Billet
Number of employees	:	160 (including 7 engineers)
Working system	:	8-hour work with 3 shifts
Organization	:	Figure II-2-1 shows the organization of Company A. The headquarters is located in Metro Manila.

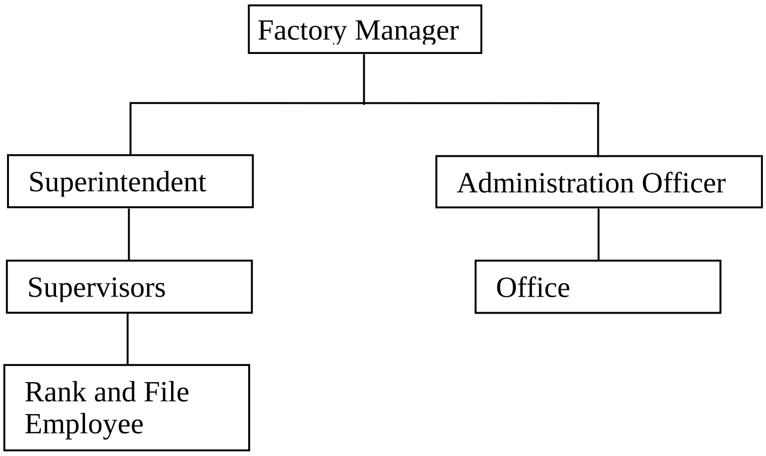


Figure I-2-1　Organization of Company A

Operation overview: This factory produces billets with a small AC EAF and a continuous casting machine. The company was founded about 30 years ago and continues a pattern of operation for 11 months a year. The full volume of produced billets is delivered to a rolling mill company that is several kilometers away.

The energy sources are electricity and petroleum. The full volume of electricity is purchased from Manila Electric Company (MERALCO). For emergency use, this factory has a private diesel power generator for lighting and cooling water supply. A special fuel oil (mixture of diesel oil 60% and bunker oil 40%) for the ladle heating burner.
In addition, coke and oxygen (purchased oxygen and oxygen privately generated by PSA) are used to run the EAF. For continuous casting, LPG is purchased to cut billets.

2.2 Equipment and Capacity of Company A

(1) Equipment

EAF:	AC furnace Rated capacity: X t/heat, Maximum capacity: 1.4X t/heat	1 set
Continuous casting machine:	2-strands billet continuous casting machine	1 set

Dust collector:	Push-in type bag filter	1 set

PSA (oxygen producing) equipment:	1 set
Air compressor:	3 sets
Overhead traveling crane:	9 sets
Scrap/slag carrying car:	2 sets
Cooling water supplying/treatment equipment:	1 set
Electricity receiving equipment:	1 set
Emergency power supply equipment (diesel power generator):	1 set

In addition, there are lightings and air conditioners.

(2) Factory layout

Figure II-2-2 shows the factory layout of Company A.
This layout shows that the EAF and continuous casting machine are installed in the same yard.

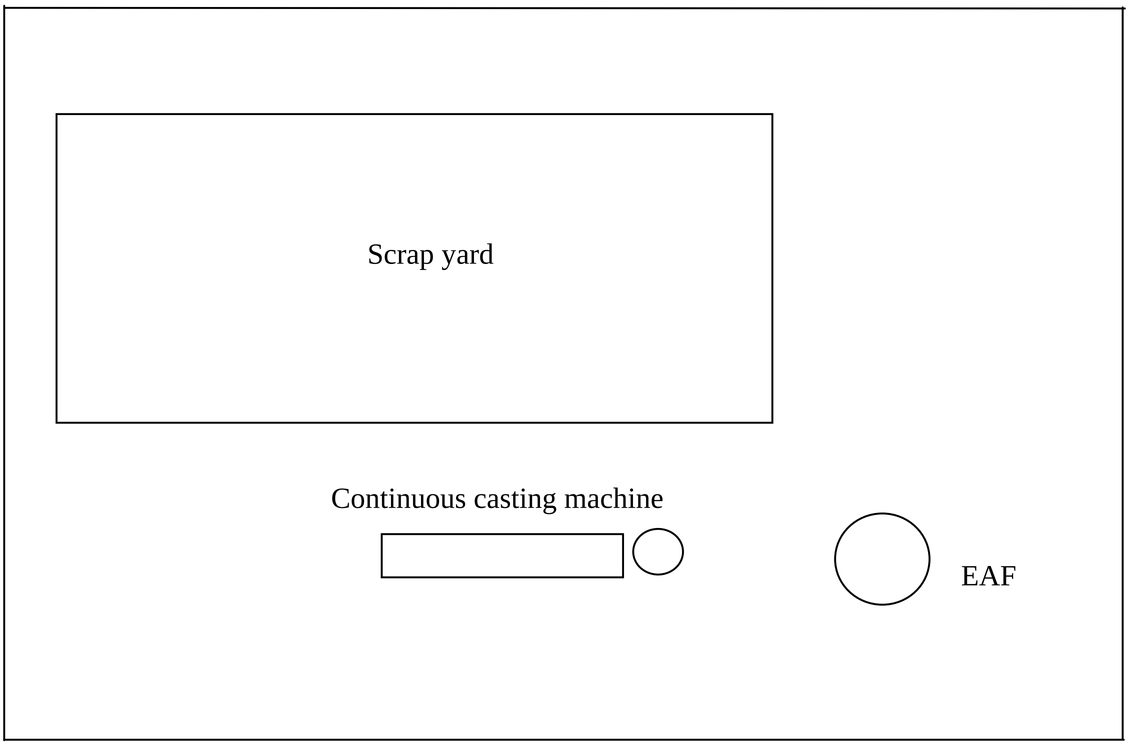


Figure II-2-2 Factory Layout of Company A

(3) Operating system

About 140 workers with 3 shifts, 11-month operation a year
The shutdown period for maintenance is 8 hours every week and 1 month including the year end and new year.

(4) Energy in use

Table I-2-1 shows types of energy used in the factory.

Table I-2-1 Types of Energy in Use

Type	Application	Remarks
Special fuel oil	Ladle heating	Diesel oil 60%, bunker oil 40%
Diesel oil	Truck	
LPG	Continuously casting; billet cutting	
Coke	EAF injection	
Electricity	EAF, etc.	Emergency power is privately generated.
Purchased oxygen	EAF injection	Privately generated and purchased

2.3 Overview of Company B (Factory with Rolling Mill)

Location	:	About 1 hour by car from Metro Manila
Product		Reinforcing steel bar
Number of employees	:	450 (including 56 engineers)
Working system	:	8-hour work with 3 shifts
Organization	:	Figure II-2-3 shows the organization of Company B. The headquarters is located in Metro Manila.
Operation overview	:	This factory imports all billets (material) from foreign countries and rolls them to produce reinforcing steel bars. The production capacity is more than 300 thousand t/y. The company is likely to be affected by economic situations of foreign countries and seems to be making efforts in procurement of material. When we visited for audit and survey, operation was shut down for a weak because of material shortage, and equipment maintenance was being implemented.

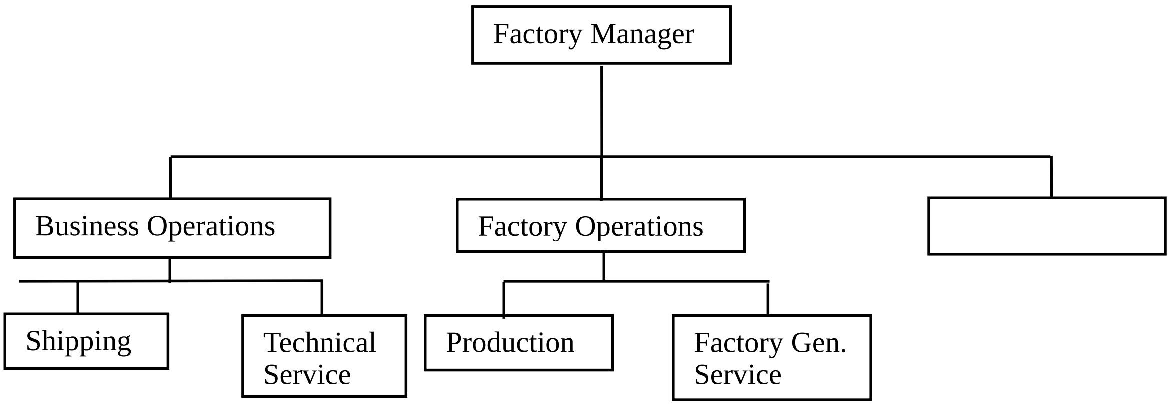


Figure I-2-3 Organization of Company B

2.4 Equipment and Capacity of Company B

(1) Equipment

Heating furnace for rolling	:	Walking beam type heating furnace using bunker oil Capacity of heating furnace: Maximum 65 t/h or more, long billets heatable Burner layout: set on both sides Exhaust heat recovery recuperator provided

Rolling machine : Tandem horizontal/vertical type, linear layout
Continuous quenching machine provided
Cooling bed

Electricity receiving/transformer equipment:	4 sets
Air compressor:	6 sets
Cooling water supply and water treatment equipment:	1 set

In addition, there are emergency power supply equipment, lighting, and air conditioner as the equipment in the rolling mill.

(2) Factory layout

Figure I-2-4 shows factory layout of Company B.

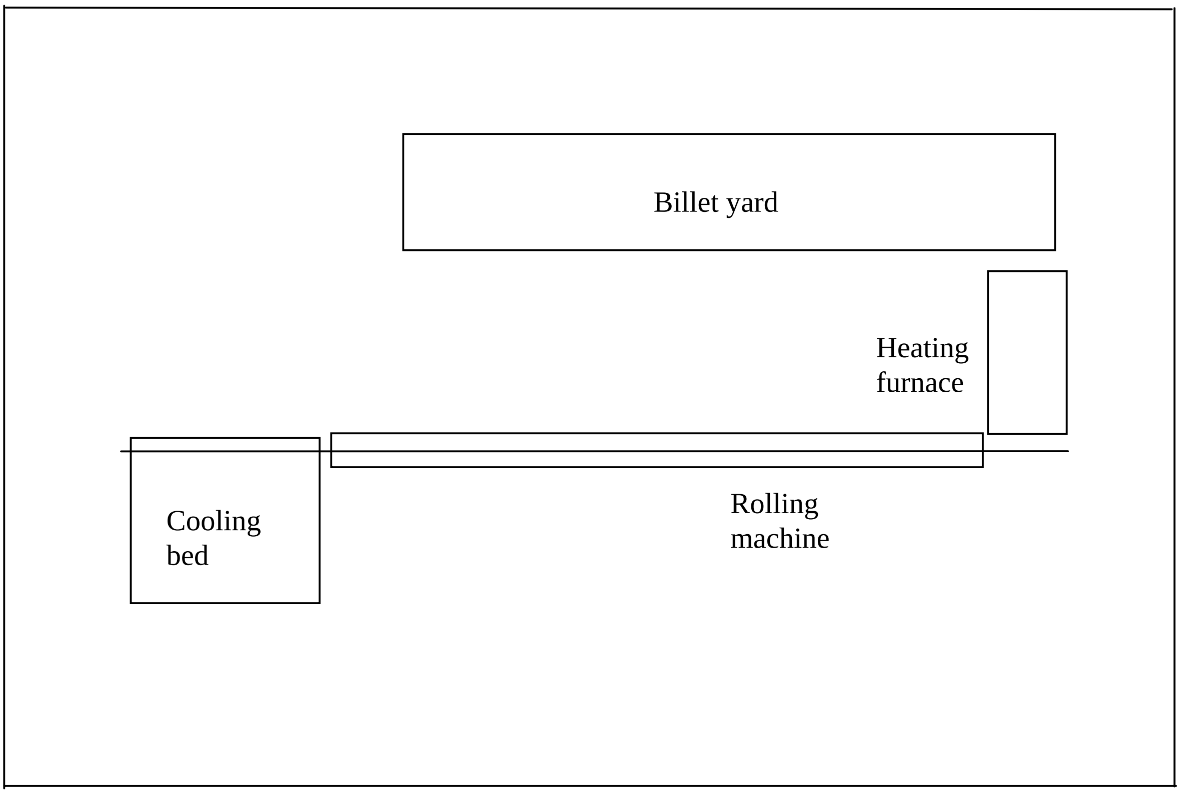


Figure I-2-4 Factory layout of Company B

(3) Operating system

3 shifts, 24-hour operation

(4) Energy consumption

Table I-2-2 lists types of energy used in the rolling mill.

Table I-2-2 Types of Energy Used in the Rolling Mill

Type	Application	Remarks
Heavy oil	Heating furnace	Bunker oil S: 2.5 to 2.9%
LPG	Billet cutting	
Oxygen	Billet cutting	
Electricity	Machine operation, lighting, etc.	Emergency power is privately generated.

3. Audit Plan

The situation at the first visit was described in the preceding section.
The purpose of audit and survey by visiting Philippines was to grasp the product manufacturing processes, energy consumption, and actual status of exhaust heat utilization of the selected factory with EAF, offer an improvement plan for promotion of energy conservation, and convene a workshop to introduce the energy conservation technologies and activities in Japan and enhance and propagate consciousness on energy conservation for enlightenment. Further, it was intended to provide support so that persons of ASEAN promoting energy conservation can establish the standard energy conservation audit method, based on the status of similar industries and the technical levels of energy conservation audit in ASEAN countries, after implementation of the energy conservation audit.
Audit and survey were implemented during the second visit.
First, the energy conservation workshop was convened. Following the explanation on these activities by ACE and DOE, ECCJ introduced the energy conservation technology being implemented for the iron and steel industry in Japan to develop understanding.
Audit was implemented in two factories. Confirmation with the questionnaire sent in advance and actual survey in the factories were performed. In the first factory, particularly, a wrap-up meeting was held to propose the improvement plan.

3.1 Audit Proceeding

(1) Company A

Company A that accepted energy conservation audit and survey owns the factory visited in the first visit. The Factory Manager was very much concerned about cost reduction and therefore he was very cooperative with the audit and survey.
The response to the questionnaire had been prepared. The response was checked, factory tour was made, and then the site was re-visited to implement audit.
The meters used by the audit team were the radiation thermometer, illuminance meter, and clamp type ammeter brought from Japan.

(2) Company B

We first brought the questionnaire and gave explanation. The actual audit and survey were performed on the following day only but audit itself was impossible because factory had been shut down as described before. We checked the response to the questionnaire, acquired information on operation, and made a factory tour to see the equipment under maintenance.

Taking photographs at the site was strictly forbidden by the both companies, therefore visual information couldn’t obtained at all.

3.2 Selection of Equipment to be Audited and Checking the Response to the Questionnaire

Energy used in the factory with EAF is mostly electricity (purchased electricity) used for the EAF, motor drive to run equipment, etc. Energy conservation should be applied to and focused on electricity.

Although the questionnaire from ECCJ was handed to these companies one day before the audit, responses in a satisfactory level were prepared. We gained a good understanding and cooperation, and were able to check the contents smoothly.

The questionnaire is attached.

3.3 Audit Schedule

During the first visit, three factories with EAF were visited but they did not accept audit and survey. As a result, we simply learned the operation status. Company A was about 1 hour away by car from the Manila city center. Companies C and D were 80 km away from the Manila city center and it took more than 2 hours to visit these sites because of traffic jam.

Actual audit and survey were performed during the second visit. It took 2 days for audit and survey in Company A including the meeting, and 1.5 days for Company B that determined acceptance upon the second visit.

First survey: Implemented in December 2002

December 16 (Mon.)	Meeting with DOE and ACE to discuss about audit implementation. Visited BOI to learn the current status of the iron and steel industry in Philippines. Visited PSA to discuss a way out of the current difficulty in finding the factories to be audited, explain the factories to be visited, and request for introduction.
December 17 (Tue.)	Visited Company A to learn the operation status.
December 18 (Wed.)	Visited Company C to learn the operation status. Visited Company D to learn the operation status.
December 19 (Thu.)	Visited DOE to request for arrangement of the factories to be visited during the second visit.

Second survey: Implemented in February 2003

February 10 (Mon.)	Workshop on making energy more efficient and energy conservation convened (DOE, ACE, engineers from three iron and steel manufacturers, and ECCJ)

February 11 (Tue.)	Visited Company A to implement audit and survey (Acceptance by Company B determined.)
February 12 (Wed.)	Visited the persons concerned in DOE Visited the chief secretary of PSA and acquired iron and steel production information. Visited Company B and explained about the questionnaire on audit.
February 13 (Thu.)	Visited Company B and implemented audit and survey.
February 14 (Fri.)	Visited Company A and has a wrap-up meeting with DOE and ACE. Reported the energy conservation improvement plans.

4. Equipment Audited

4.1 Audit and Survey in Company A

(1) AC EAF

1) Equipment capacities
   EAF : small type AC EAF 1 set
   Rated capacity : X t/heat, Maximum capacity: 1.4X t/heat

2) Operating method
   Scrap is charged 7 times/heat on average.
   For melting, the schedule is managed; the first and second times are 14 minutes, the third time is 9 minutes, four to seven times are 6 minutes each.
   The tap-to-tap time is approximately 135 minutes.
   As the sub-materials for melting, oxygen and coke are injected.

(2) Continuous casting (CC) equipment

1) Equipment specifications
   Continuous casting equipment : 2-stands billet CC
   Casting time : 50 to 55 minutes/heat

2) Current operation
   Continuous operation is performed for 11 months. For one month from the middle of December to the middle of January, the equipment is shut down and maintenance is implemented. The products are mostly 100□ billet.
   Annual operation time: 7920 h (11 m × 30 d/m × 24 h/d)

(3) Power receiving/transforming equipment

1) Capacities of major equipment (Table II-4-1)

Table II-4-1 Quantity of Major Equipment in Company A

No.	Name	Quantity	Remarks
1	EAF	1	
2	Continuous casting equipment	1	
3	Dust collector	1	
4	PSA equipment for oxygen generation	1	
5	Air compressor	3	
6	Over head traveling crane	9	
7	Cooling water equipment (pump, fan)	15	
8	Deep-well pump	2	
9	Lighting equipment (shop, office)	1	

2) Emergency power supply equipment (Table II-4-2)

Table II-4-2 Emergency Power Supply Equipment in Company A

No.	Name	Equipment capacity	Quantity
1	Emergency diesel power generation equipment	1000 kVA	1

3) Operating method

Power from MERALCO is always received via the electricity receiving/transforming equipment. Comparing with the maximum electricity, approximately 55% on average is always received.

Upon the failure of power from MERALCO, the emergency power supply equipment supplies electricity to cooling water equipment and lighting equipment.

(4) Dust collector

1) Equipment components

The equipment of the dust collector is shown below.

a. Main fan : 1 set
b. Booster fan : 1 set
c. Reverse fan : 1 set
d. Other components : 1 set

2) Operating method

During operation of the EAF, the main fan sucking dirty air from the building and the booster fan to suck directly from the furnace run continuously.

The reverse fan always runs for dust cleaning of the bag filter.

(5) PSA equipment

1) Equipment components

The equipment components are shown below.

a. Vacuum pump : 1 set

b. Air blower : 1 set

c. Oxygen compressor : 1 set

d. Other components : 1 set

2) Operating method

PSA runs during the operation of furnace. Insufficient oxygen is covered by purchase of liquid oxygen.

(6) Air compressor equipment

1) Equipment capacities

a. No. 1 reciprocal air compressor 30 kW: 1 set

b. No. 2 reciprocal air compressor 30 kW: 1 set

c. No. 3 reciprocal air compressor 30 kW: 1 set

2) Operating method

The operating method is shown in Figure II-4-1.

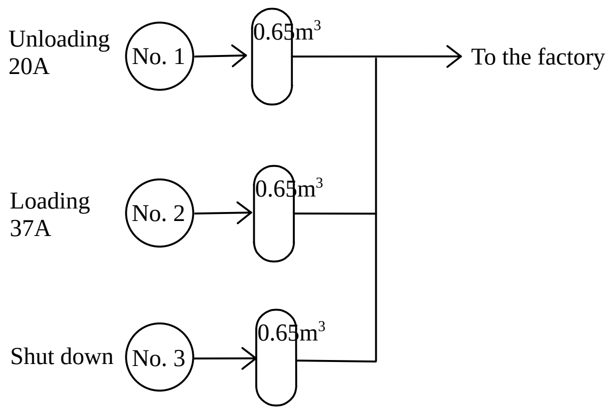


Figure II-4-1 Operating Method of Air Compressor

(7) Cooling water equipment

1) Operating method of the cooling water equipment for the EAF

For the pump and fan, one set is in service and a reserved set is in standby mode.

2) Operating method of the deep-well pump and cooling water equipment for auxiliary equipment

   For the pump, one set is in service and another set is in standby mode.

4.2 Audit and Survey in Company B

On the day of February 12, 2003 for audit and survey, the factory was shut down (audit and was survey scheduled on February 11 though 13). Therefore, survey and audit on energy conservation during factory operation were impossible. The visit to the site and the contents that we learned are outlined below.

(1) Heating furnace for rolling, rolling machine --- 1 line

This factory purchases 130 □ × 12000 mm L billets, heats in the heating furnace, produces steel bars with a rolloing mill, and ships.
The products are reinforcing bars of 10 – 50 mm in diameter.

(2) Power receiving/transforming equipment

1) Outline of major equipment (Table II-4-3)

Table II-4-3 Major Equipment in Company B

No.	Name	Quantity	Remarks
1	Heating furnace fuel pump	2	
	Push-in blower for combustion	1	
	Exhaust gas fan	1	
2	Rolling machine	1	
3	Tempcore machine	1	Quenching equipment
4	Cutting machine	1	
5	Cooling water equipment for rolling machine	1	
6	Cooling water equipment for tempcore box	1	
7	Cooling water equipment for auxiliary equipment	1	
8	Cooling water equipment for heating furnace	1	
9	Air compressor		
	(1) 100 kW × 14.15 m^3/min	2	
	(2) 200 kW × 28.3 m^3/min	4	
10	Lighting equipment	1	

2) Emergency power supply equipment (Table II-4-4)

Table II-4-4 Emergency Power Supply Equipment in Company B

No.	Name	Equipment capacity	Quantity
1	Emergency diesel power generator equipment	500 kVA	1

3) Operating method

Electricity from MERALCO is always received via the electric power receiving/transforming equipment. About 70% of the contracted capacity is always received.

Upon the failure of electric power from MERALCO, the emergency power supply equipment supplies electricity to cooling water equipment and lighting equipment.

(3) Air compressor equipment

1) The following air compressors are installed in this factory as shown in Table II-4-5.

Table II-4-5 Air compressor Equipment in Company B

Air compressor	Capacity
No. 1 air compressor	14.15 m^3/min × 100 kW
No. 2 air compressor	28.3 m^3/min × 200 kW
No. 3 air compressor	28.3 m^3/min × 200 kW
No. 4 air compressor	14.15 m^3/min × 100 kW
No. 5 air compressor	28.3 m^3/min × 200 kW
No. 6 air compressor	28.3 m^3/min × 200 kW

2) Air receiver tank capacity

A tank with a capacity of 20.52 m^3 is provided as a common receiver tank on the outlet side of No. 1 to 6 air compressors.

3) Operating method

There are enough capacities of compressed air to supply to the both big and small factories, but small one has been shut down. The volume of compressed air used during operation of the big factory is approximately 40 m^3/min.

Therefore, two or three air compressors are run for operation of the big factory to supply compressed air.

(4) Cooling water equipment

1) Cooling water equipment for rolling mill

Only the required number of cooling water pumps and cooling tower fans are run with standby reserved machines.

2) Cooling water equipment for tempcore box (bar quenching equipment)
Only the required number of cooling water pumps and cooling tower fans are run with standby reserved machines.

3) Cooling water equipment for auxiliary equipment
Only the required number of cooling water pumps and cooling tower fans are run with standby reserved machines.

4) Cooling water equipment for heating furnace
For the cooling water pump and cooling tower fan, one set is in service and there is no reserved equipment.

5. Results of Survey and Measurement on Energy Conservation

5.1 Results of Survey and Measurement in Company A

(1) AC EAF

1) EAF operation

Company A consumes approximately 600 kWh/t (i.e. electric power consumption of the overall factory divided by the billet production volume) for billet production. Since there is no data indicating power consumption at each location, clear judgment is impossible. However, electricity unit consumption seems to be more than 500 kWh/t if it is assumed that electricity consumption for auxiliary equipment other than the EAF is 100 kWh/t.

For energy loaded into the EAF, electrical energy from electrodes and reaction heat by coke and oxygen injection are mainly used. Generally, scrap preheating and the additional heating for the furnace by heavy oil burners are used. However, this factory does not adopt these means. Since a considerable amount of equipment investment is required to implement them, it was determined to direct attention to the operating method.

2) Problems in operating the EAF

For operation of the EAF, 1 cycle (tap-to-tap time) requires about 2.3 hours (about 10 heats a day). The reason is that the frequency of scrap charge is 7 times on average (maximum 11 times) and much time is required for other than the actual scrap melting time.

Two possible causes are considered:

a. The bulk density of scrap seems to be small. Therefore, cutting long scrap materials, pressing scrap with much air gaps, and so on should increase the bulk density of scrap.
b. The inner volume of the furnace should be increased as much as possible.

The heat loss can be reduced and, consequently, the energy consumption can be cut down by increasing the bulk density of scrap and melting efficiency, then shortening the cycle time (tap-to-tap time).

(2) Power receiving/transforming equipment

1) Electricity charge system

Electricity charge system provided by MERALCO is as follows:

① Basic charge	:	Monthly demand electricity kW × 20 pesos/kW
② Metered charge	:	Monthly used electrical energy kWh × 1.85 pesos/kWh
③ Power factor discount rate	:	(Actual power factor (%) – 85) × 0.3
④ Power factor discount	:	(① + ②) × ③/100
⑤ Primary discount	:	(① + ②) × 3/100
⑥ Exchange rate adjustment	:	(① + ② – ④ – ⑤) × 7.04/100
⑦ Purchased power adjustment (PPA)	:	Monthly used electrical energy kWh × 2.45

Electricity charge to be paid = ① + ② – ④ – ⑤ + ⑥ + ⑦

2) Problems in using electricity in this factory

a. The maximum electricity is too large against the average electricity in normal use (double of the rated capacity). The maximum electricity (peak) should be reduced.

b. Presently, the power factor is approximately 98%. The power factor should be improved.

(3) Dust collector equipment

During operation of the EAF, the main fan and the booster fan are continuously running. Particularly, the booster fan is the dust collecting fan for the EAF only and it is continuously run even though the EAF is in standby mode.

According to the operation status of the EAF and the dust load, the volume of exhaust gas from the dust collecting fan should be adjusted through the revolution control to achieve energy conservation.

(4) Air compressor

Three air compressors have been installed.

Two air compressors are on load state but the other is run in almost unloaded state.

It is recommended to install a 1 m^3 air receiver tank and to control the number of air compressors in service operating two air compressors for energy conservation.

5.2 Results of Survey and Measurement in Company B

(1) Heating furnace for rolling

1) Operation of the heating furnace for rolling

Company B imports cold billets, heats them to up to 1240°C in a heating furnace for rolling, rolls them to reinforcing steel bars (D-bars), and ships them.

As a measure for energy conservation, the metal tube type recuperator is used for preheating combustion air with the exhaust gas heat.

The fuel for the heating furnace is bunker oil (S: 2.5 to 2.9%). Fuel consumption is slightly more than 30 L/t approximately.

2) Measure for further improving exhaust heat recovery

Although fuel consumption is in a satisfactory level presently, the metal tube type of recuperator may be changed into the regenerative burner type using ceramics for further improved heating element.

(2) Power receiving/transforming equipment

1) Electricity charge system (Same as company A)

Electricity charge system provided by MERALCO is as follows:

① Basic charge	:	Monthly demand electricity kW × 220 pesos/kW
② Metered charge	:	Monthly used electrical energy kWh × 1.85 pesos/kWh
③ Power factor discount rate	:	(Actual power factor (%) – 85) × 0.3
④ Power factor discount	:	(① + ②) × ③/100
⑤ Primary discount	:	(① + ②) × 3/100
⑥ Exchange rate adjustment	:	(① + ② – ④ – ⑤) × 7.04/100
⑦ Purchased power adjustment (PPA):		Monthly used electrical energy kWh × 2.45

Electricity charge to be paid = ① + ② – ④ – ⑤ + ⑥ + ⑦

2) Problems in using electricity in this factory

a. The maximum electricity is too large against the average electricity in normal use (1.5 times of the rated capacity). The maximum electricity (peak) should be reduced.

b. Presently, the power factor is approximately 94.25%. The power factor should be improved.

(3) Air compressor equipment

Presently, the M-1 factory only is operating. Depending on the operation status, two or three air compressors are run to supply compressed air.

By using the existing common air reservoir tank, controlling the number of air compressors in service should be adopted with three air compressors to achieve energy conservation.

6. Recommendation for Energy Conservation and Expected Effects

Calculation of the expected effects is shown in the recommendations given below. These are assumed values and may not match the values upon audit and survey. Please understand that these values represent the degree of energy conservation effects.

6.1 Recommendation and Expected Effects in Company A

(1) Energy conservation through reduction in the AC EAF's tap-to-tap time

1) Reduction of the tap-to-tap time

a. Reduction of the number of scrap charge

Increasing the inner volume of the EAF and increasing the bulk density of scrap can reduce the number of scrap charge. Figure II-6-1 shows the current standard operation pattern of the EAF in Company A.

To increase the bulk density of scrap, long scrap material should be cut or scrap with a small density should be pressed as a pre-treatment. As a result, if the current average number of scrap charging times of 7 can be reduced to 6 or 5, then the melting time is reduced by 4 minutes or 8 minutes. Assuming that the bulk density of the scrap currently charged is low (not measured yet) and it comes close to 0.74 t/m^3 by 0.03 t/m^3, the melting time can be reduced by 1 minute. With the effect of oxygen injection additionally, the time will be shortened further.

b. Reduction of the refining time

The refining time required is 30 to 45 minutes. The time can be reduced by making oxygen and coke injection more efficient and changing the power supply method.

2) Effects expected by reduction of the tap-to-tap time

Regarding the relationship between the scrap's bulk density and melting time, it is said that melting is fastest when the bulk specific gravity is 0.74 t/m^3 according to experiences in Japan. (See Figure II-6-2, example in Japan.)

Heat emission from the EAF and heat extraction from the cooling water for furnace body are in proportion to time. In the site, meters were not provided and no data was available, so it was impossible to check the heat balance of the EAF. This heat loss is approximately 10% according to experiences in Japan.

If the overall tap-to-tap time is reduced by 10%, then the total heat loss reduces by 1%. Further, 1% more can be reduced through efficiency improvement, etc. This is totally 2%, that is, it is estimated that 10 kWh/t can be reduced.

The effect can be calculated by multiplying electricity expenses and yearly production.

In the future, the tap-to-tap time for the plain carbon steel can be reduced to 100 minutes and power consumption can be reduced to 450 kWh/t as a result of operation improvement and so on.

3) Amount of investment to increase the inner volume of the EAF

If space increase is possible by modifying the upper part of furnace walls in the EAF, the volume of scrap increase by 0.7 m^3, that is approximately 0.5 t/charge, is possible when the upper part of the furnace walls in the EAF is raised. Furthermore, increase of 1.4 m^3 will make 1 t/charge increase of scrap increase. Such modification should be considered to decrease charging of scrap 1-2 times.

Cost of construction for raising the upper body of furnace:

The steel materials of approximately 4 t and machining cost:	US$40000
Cost of field modification and installation:	US$30000
Total:	US$70000

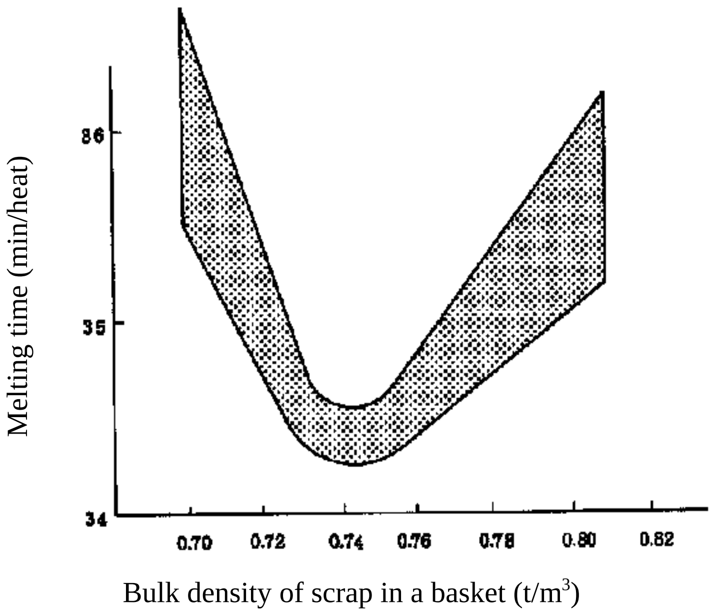


Figure II-6-2 Relationship Between the Scrap's Bulk Density and Melting Time

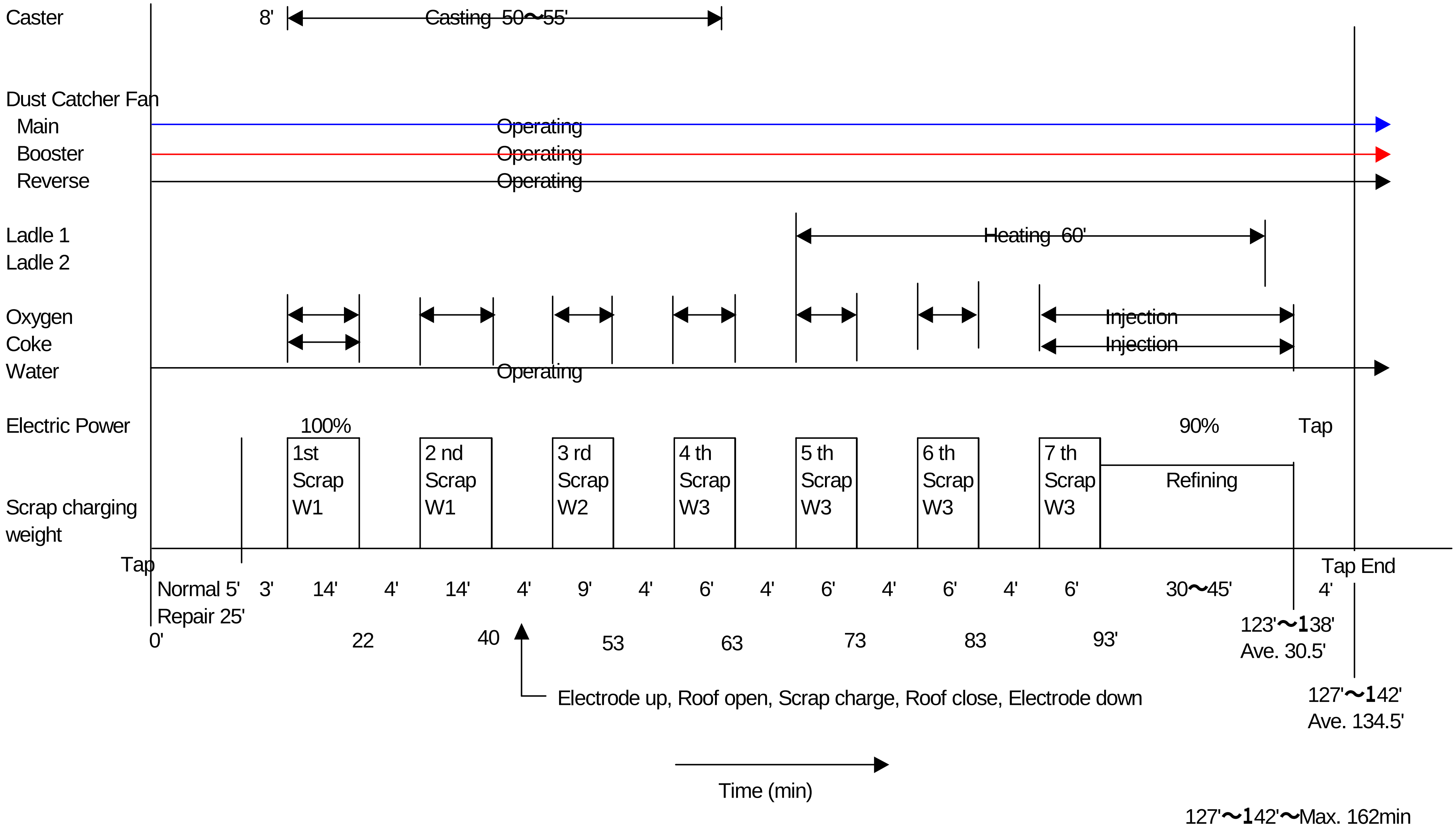


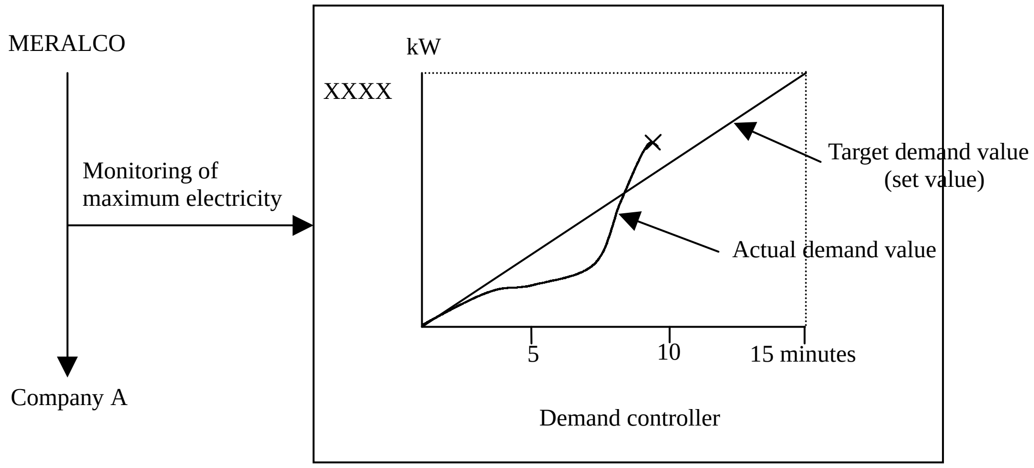
Figure II-6-1 EAF Operation Pattern in Company A

(2) Power receiving/transforming equipment

1) Reduction of the basic charge through reduction of the demand electric power (peak)

a. Operation by introducing the demand controller

① If the actual maximum electric power (15-minute demand value) is likely to exceed the target demand value, this system suppresses the load of the EAF or automatically shuts down part of the dust collecting equipment and PSA equipment to maintain the value below the target demand. (Figure II-6-3)



X: Since the target demand is likely to be exceeded, the load of the factory is partly limited or automatically shut down.

Figure II-6-3 Demand Controller Method

② Equipment to be limited or shut down automatically (Assumed value)

Load to be limited	Limitation of the EAF load	Δ500 kW
Load to be shut down automatically	Shutdown of part of PSA equipment	Δ350 kW
	Shutdown of part of dust collecting fans	Δ150 kW
	Total	Δ1000 kW

b. Effect expected from demand cutting (Δ1000 kW)

Operation is performed for 11 months a year. However, since the basic charge and so on are paid, the annual consumption is divided by 12 for calculation of the value per month. Then, the value should be multiplied by 12 as the annual cost. The same calculation method should be applied to 2) below.

The annual merit is US$52620/y... See Table II-6-1.

c. Equipment investment amount (Calculated as equipment equivalent of the assumption in Table II-6-1.)

(Breakdown)

Demand controller	1 set:	US$15000
Installation cost	1 set:	US$10000
Total		US$25000

2) Power factor discount through improvement of the power factor of electricity receiving from MERALCO

a. Power factor improvement (98 $\rightarrow$ 100%)
The Power Factor Capacitor should be enhanced.
The required capacity is 1.5 Mvar.

b. Effect expected from power factor improvement (98 $\rightarrow$ 100%)
Annual merit is US$1106/y. ...See Table II-6-2.

c. Equipment investment amount: (Calculated as equipment equivalent of the assumption in Table II-6-2.)

(Breakdown)

Vacuum switchgear	1 set:	US$25000
Capacitor	1 set:	US$70000
Installation cost	1 set:	US$5000
Total		US$100000

For 1) and 2) above, expected effects through reduction of electricity charge paid to MERALCO were summarized. Implementation of 1) and 2) above can contribute to energy conservation and resource conservation surrounding the power company and this factory on a macro basis.

(3) Energy conservation through controlling revolutions of dust collecting fan

1) Method of controlling revolutions of dust collecting fan
With the EAF operation status and dust load as control signals, energy conservation should be attempted through controlling revolution of the dust collecting fan by the inverter unit. (Figure II-6-4)

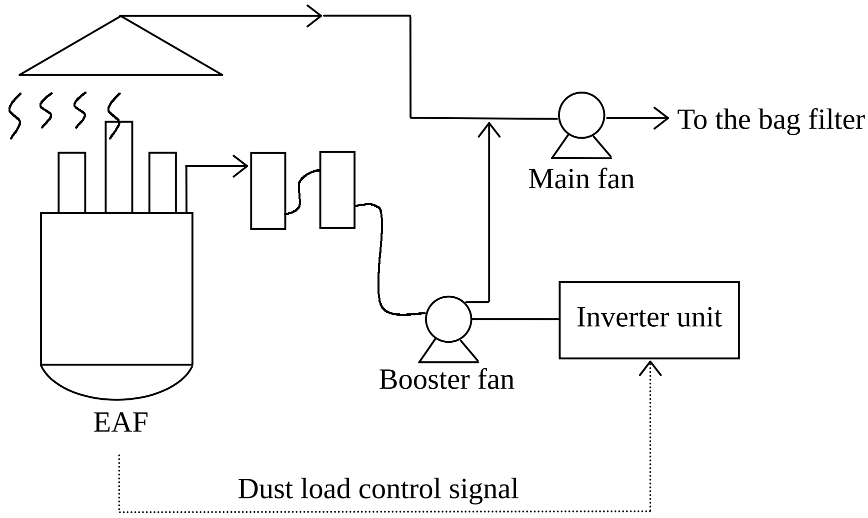


Figure II-6-4　Method of Controlling Revolutions of Dust collecting fan

2) Effects expected through controlling revolutions
(Prerequisites)

- While the arc of the EAF is running, revolutions of the booster fan are 100%.
- While the arc of the EAF stops (in standby mode), revolutions of the booster fan are 50%.
- The tap-to-tap time is 135 minutes as a cycle, and the arc running time is 98.5 minutes as a cycle. Ten cycles are performed a day. Operation days are 330; 11 months.
- The time in which the arc stops (in standby mode) :

  $(1440 - 98.5 \times 10)$ min/d = 455min/d = 7.58h/d

  Annual expected effect = (Motor output: X) $\times$ $[1 - (1/2)^3]$ $\times$ 7.58h/d $\times$ 330d/y $\times$ (Unit price of electricity charge: Y) Peso/kWh

  = 2190・X・Y Peso/y

  US$43.8・X・Y/y with an exchange rate of 1US$ = 50 peso

3) Equipment investment amount: US$50000
(Breakdown)

Inverter unit:	US$38000
Installation cost:	US$12000

(4) Energy conservation through introduction of controlling the number of air compressors in service

1) Introduction of controlling the number of air compressors in service
The number of air compressors corresponding to the compressed air volume required by the factory should be run.
The number of air compressors in service is controlled by detecting the pressure of the newly installed tank ($1 \rightarrow 2 \rightarrow 1 \rightarrow 0 \rightarrow 1$...). (Figure II-6-5)

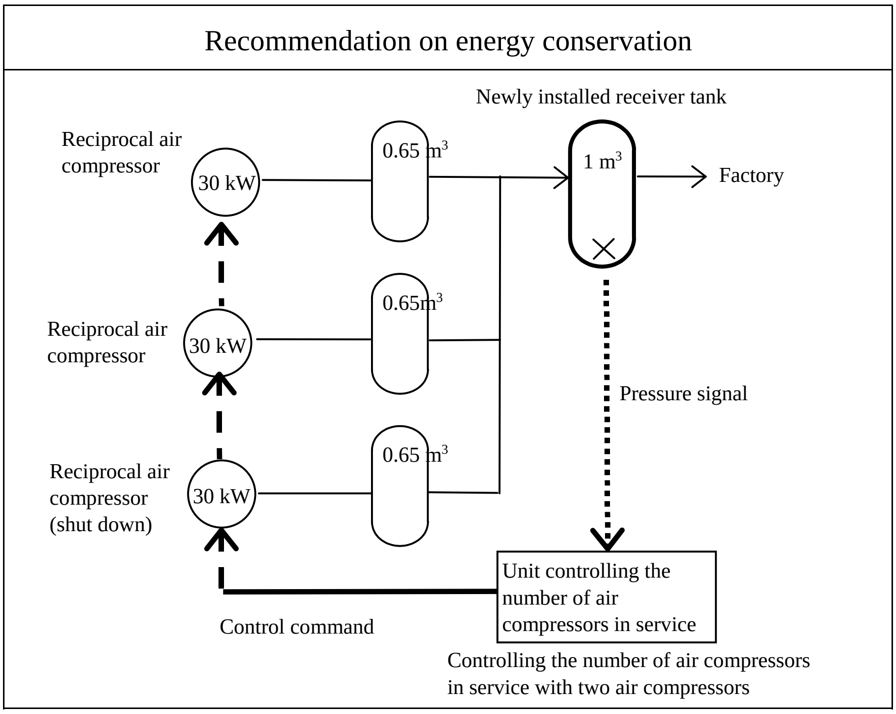


Figure II-6-5 Method of Controlling the Number of Air Compressors

2) Effects expected through introduction of controlling the number of air compressors in service
Unloading electricity = $\sqrt{3} \times 0.4$ kV $\times 20 \times 0.85 \times 0.8$ (unloading rate) = 9.42 kW
Annual expected effect = 9.42 kW $\times$ 7920 h/y $\times$ 4.78 Peso/kWh = 356619 Peso/year
US$7130/y with an exchange rate of 1 US$ = 50 pesos

3) Equipment investment amount: US$23000
(Breakdown)

Unit controlling the number of air compressors in service:	US$15000
Air receiver tank 1 m^3:	US$3000
Installation cost:	US$5000

<Assumptions for merit calculation>

Contracted electricity : 10000 kW → 9000 kW (10% reduced)
Power factor : 98%
Electricity used : 3000000 kWh/m

Table II-6-1 Table of Electricity Charge Through Contracted Electricity Reduction in Company A

No.	Item	Current charge (Peso) (Electricity contracted = 10000 kW)	Improved charge (Peso) (Electricity contracted = 9000 kW)
①	Basic charge kW × 220 Peso/kW	2200000	1980000
②	Metered charge kWh × 1.85 Peso/kWh	5550000	5550000
③	Power factor discount rate (Actual power factor rate (%) – 85) × 0.3	3.9	3.9
④	Power factor discount (① + ②) × ③/100	302250	293670
⑤	Primary discount (① + ②) × 3/100	232500	225900
⑥	Exchange rate adjustment (① + ② – ④ – ⑤) × 7.04/100	507954	493534
⑦	Purchased power adjustment (PPA) kWh × 2.45	7350000	7350000
⑧	Monthly electricity charge to be paid ① + ② – ④ – ⑤ + ⑥ + ⑦	15073204	14853964

Merit by reduction in the contracted electricity (10000 → 9000 kW): 219240 peso/m
US$ 4385/y with an exchange rate of 1 US$ = 50 peso
The annual merit is US$ 52620/y.

<Assumptions for merit calculation>

Contracted electricity : 10000 kW
Power factor : 98 → 100%
Electricity use : 3000000 kWh/m

Table II-6-2 Table of Electricity Charge Through Power Factor Improvement in Company A

No.	Item	Current charge (Peso) (P.F = 98%)	Improved charge (Peso) (P.F = 100%)
①	Basic charge kW × 220Peso/kW	2200000	2200000
②	Metered charge kWh × 1.85Peso/kWh	5550000	5550000
③	Power factor discount rate (Actual power factor rate (%) – 85) × 0.3	3.9	4.5
④	Power factor discount (① + ②) × ③/100	302250	348750
⑤	Primary discount (① + ②) × 3/100	232500	232500
⑥	Exchange rate adjustment (① + ② – ④ – ⑤) × 7.04/100	507954	504680
⑦	Purchased power adjustment (PPA) kWh × 2.45	7350000	7350000
⑧	Monthly electricity charge to be paid ① + ② – ④ – ⑤ + ⑥ + ⑦	15073204	15023430

Merit through power factor improvement (98 → 100%): 49774 peso/m
US$ 995/m with an exchange rate of 1 US$=50 peso
The annual merit is US$11940/y.

6.2 Recommendation and Expected Effects in Company B

(1) Heating furnace for rolling

1) Adoption of the regenerative burner for the heating furnace for rolling

Although a metal tube type recuperator for heating combustion air is used for exhaust gas heat recovery, a regenerative burner can be adopted for further reduction of fuel consumption.

Since bunker oil (S: 2.5 to 2.9%) is used as the fuel, effects of sulfur to ceramics should be considered but fuel consumption can be improved by at least 10%.

Although fuel consumption is relatively good at present, we recommend changing to the regenerative burner system using ceramic shown below.

For introduction, clearance with surrounding equipment should be checked and whether a sufficient space for modification is provided should be studied.

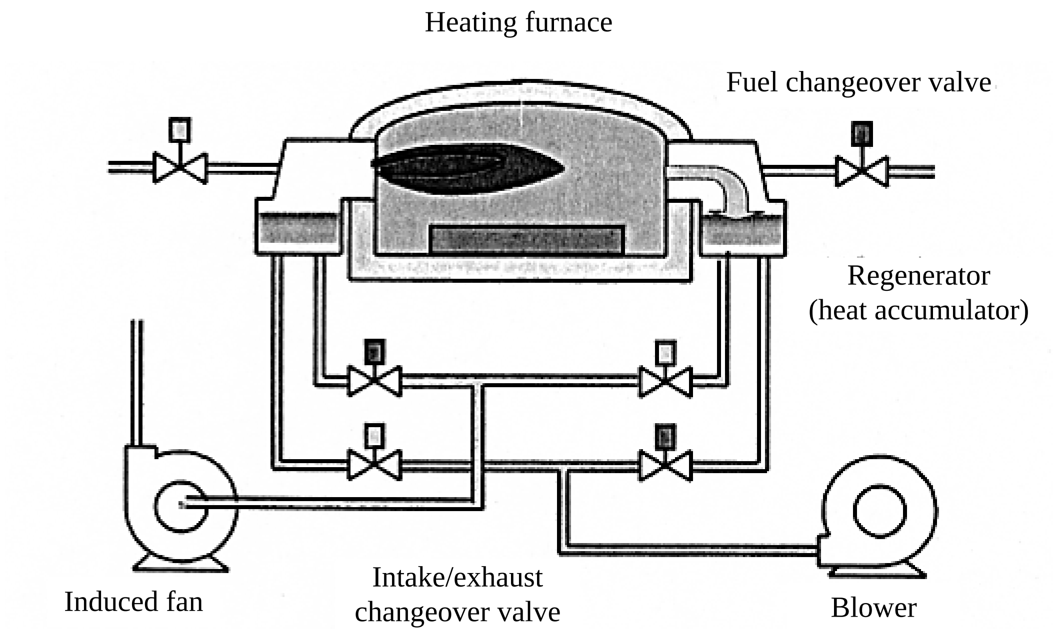


Figure II-6-6 Schematic Diagram of Heating Furnace Using Regenerative Burner

This burner mechanism is depicted in section 7 and allows you to acquire preheated air at a high temperature. The temperature effectiveness is more than 85%.

Figure II-6-7 shows the relationship between the preheated air temperature and energy conservation rate (result in Japan).

The regenerator allows you to obtain preheated air at a temperature higher than that obtained by the recuperator and the energy conservation rate is 10 to 20% higher.

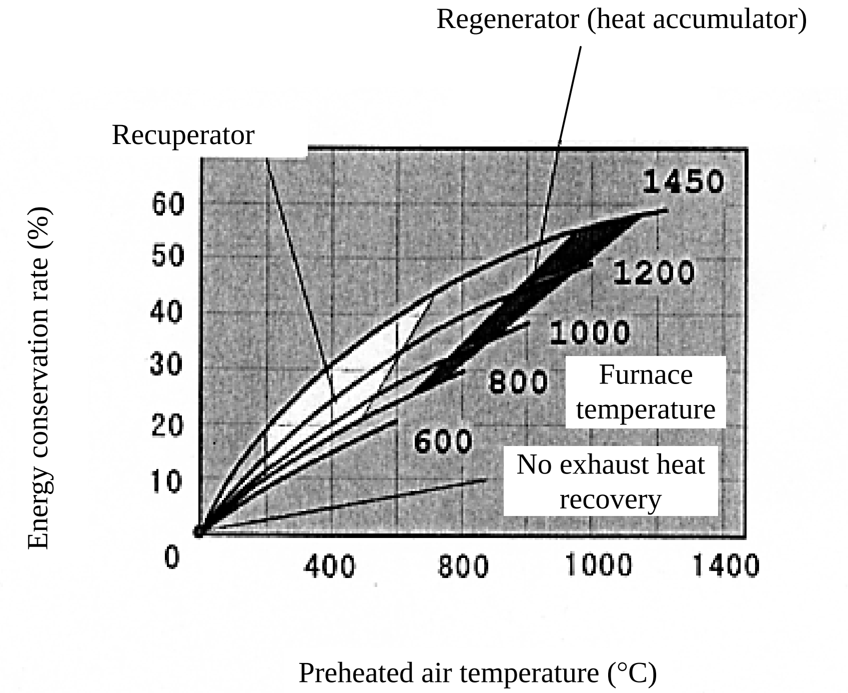


Figure II-6-7 Heating Furnace for Rolling with a Regenerative Burner Containing a Ceramics Heat Accumulating Element

2) Effects expected through introduction of the regenerative burner
If it is assumed that fuel consumption is reduced by 10%, the volume is 3 L/t. Annual savings of fuel is calculated by multiplying the annual production to the consumption.

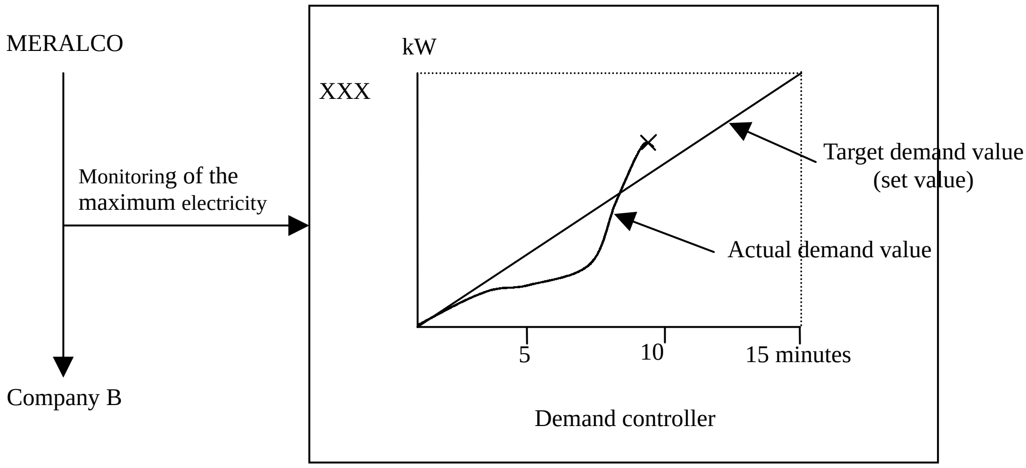
3) Investment for introduction of the regenerative burner
For example, installing a regenerator as an equivalent of 2 Mcal/h burner costs about US$25000, including installation cost, estimated by Japan. When multiplying a unit number, total installation cost can be calculated, not including reconstruction cost. Engineering a reconstruction and equipment shutdown period should be necessary.

(2) Power receiving/transforming equipment

1) Reduction of the basic charge through reduction of the demand electric power (peak)

a. Operation by introducing the demand controller

① If the actual maximum electric power (15-minute demand value) is likely to exceed the target demand value, this system issues an alarm with a hazard light for autonomous load limitation and suppresses the maximum electric power below the targeted demand value. (Figure II-6-8)



X: Since the target demand is likely to be exceeded, the hazard light issues an alarm at this point. With this alarm, the load is limited to the value that the production activities are not obstructed and the maximum electricity is suppressed below the targeted demand value.

Figure II-6-8 Method of Demand Controller

② Equipment to be limited or shut down automatically
Since the load status on the day of audit was unknown, the object cannot be identified.

b. Effects expected through demand cutting (∆500 kW)
If peak cutting of 500 kW is possible with the load limitation described above, the effect is as follows:
Annually US$ 26630/y...See Table II-6-3.

c. Equipment investment amount: (Calculated as equipment equivalent of the assumption in Table II-6-3.)

(Breakdown)

Demand controller	1 set:	US$ 15000
Installation cost	1 set:	US$ 10000
Total		US$ 25000

2) Power factor discount through improvement of power factor for electricity received from MERALCO

The average electricity receiving power factor in 2002 is 94.25%. Based on this fact, the following study was implemented:

a. Power factor improvement (94.25 → 100%)

The power factor capacitor should be enhanced.

b. Effect expected through power factor improvement (94.25 → 100%)

Annually US$ 22560/y...See Table II-6-4.

c. Equipment investment amount: (Calculated as equipment equivalent of the assumption in Table II-6-4.)

(Breakdown)

Vacuum switchgear	1 set :	US$ 25000
Capacitor	1 set :	US$ 75000
Installation cost	1 set :	US$ 5000
Total		US$ 105000

(3) Energy conservation through introduction of controlling the number of air compressors in service

1) Introduction of controlling the number of air compressors in service

The number of air compressors corresponding to the compressed air volume required by the factory should be run.

The number of air compressors in service is controlled by detecting the pressure of the newly installed tank (1 → 2 → 3 → 2 → 1...). (Figure II-6-9)

Recommendation on energy conservation

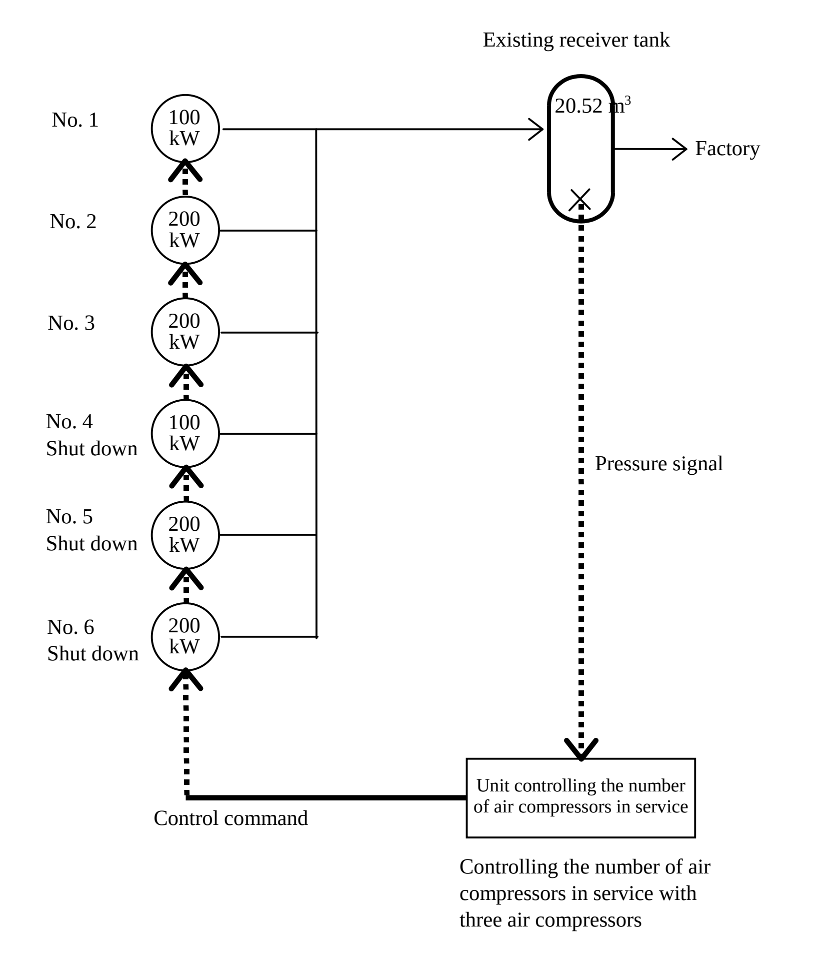


Figure II-6-9 Method of Controlling the Number of Air compressors

b. Effect expected through introduction of controlling the number of air compressors in service

Since the factory was shut down on the day of audit, it was impossible to grasp the running status of air compressors, particularly each air compressor's loading/unloading status.

Calculation of the expected effect was impossible.

c. Equipment investment amount: US$ 25000

(Breakdown)

Unit controlling the number of air compressors in service:	US$ 15000
Installation cost:	US$ 10000
Total	US$ 25000

<Assumptions for merit calculation>

Contracted electricity : 8000kW → 7500kW
Power factor : 94.25%
Electricity used : 1800000 kWh/y

Table II-6-3 Table of Electricity Charge Through Contracted Electricity Reduction in Company B

No.	Item	Current charge (Peso) (Electricity contracted = 8000 kW)	Improved charge (Peso) (Electricity contracted = 7500 kW)
①	Basic charge kW × 220Peso/kW	1760000	1650000
②	Metered charge kWh × 1.85Peso/kWh	3330000	3330000
③	Power factor discount rate (Actual power factor rate (%) – 85) × 0.3	2.775	2.775
④	Power factor discount (① + ②) × ③/100	141248	138195
⑤	Primary discount (① + ②) × 3/100	152700	149400
⑥	Exchange rate adjustment (① + ② – ④ – ⑤) × 7.04/100	337642	330345
⑦	Purchased power adjustment (PPA) kWh × 2.45	4410000	4410000
⑧	Monthly electricity charge to be paid ① + ② – ④ – ⑤ + ⑥ + ⑦	9543694	9432750

Merit by reduction of the contracted electricity (8000 → 7500 kW): 110944 peso/m
US$ 2219/y with an exchange rate of 1 US$ = 50 peso
The annual merit is US$ 26630/y.

<Assumptions for merit calculation>

Contracted electricity : 8000 kW
Power factor : 94.25 → 100%
Electricity used : 1800000 kWh/y

Table II-6-4 Table of Electricity Charge Through Power Factor Improvement in Company B

No.	Item	Current charge (Peso) (P.F. = 98%)	Improved charge (Peso) (P.F. = 100%)
①	Basic charge kW × 220Peso/kW	1760000	1760000
②	Metered charge kWh × 1.85Peso/kWh	3330000	3330000
③	Power factor discount rate (Actual power factor rate (%) – 85) × 0.3	2.775	4.5
④	Power factor discount (① + ②) × ③/100	141248	229050
⑤	Primary discount (① + ②) × 3/100	152700	152700
⑥	Exchange rate adjustment (① + ② – ④ – ⑤) × 7.04/100	337642	331461
⑦	Purchased power adjustment (PPA) kWh × 2.45	4410000	4410000
⑧	Monthly electricity charge to be paid ① + ② – ④ – ⑤ + ⑥ + ⑦	9543694	9449711

Merit through power factor improvement (94.25 → 100%): 93983 peso/m
US$ 1880/m with an exchange rate of 1 US$=50 peso
The annual merit is US$ 22560/y.

6.3 Summary of Energy Savings

The figures below are based on assumption mentioned above and presented for reference.

Item / Company	Company A		Company B	
	US$/y Expected effect	US$ Equipment investment amount	US$/y Expected effect	US$ Equipment investment amount
1. Shortening the tap-to-tap time of the EAF	Δ10kWh/t	70000	—	—
2. Heat recovery from the heating furnace exhaust gas	—	—	Fuel Δ10%	25000 × No. of burners
3. Controlling revolutions of the dust collecting fan	Δ43.8XY X: Motor (kW) Y: Electricity rate (Peso/kWh) (Equivalent to approx. Δ3.6 kWh/t)	50000	—	—
4. Demand control for the electricity receiving/ transforming equipment	52620	25000	26630	25000
5. Power factor improvement	11940	100000	22560	105000
6. Controlling the number of air compressors in service	7130	23000	—	25000

7. Guideline for Promotion of Energy Conservation and Audit Manual

7.1 Manufacturing Process Overview

The factory with EAF mainly uses scrap as the material. In Philippines, since there is no process reducing iron ore as an integrated steel mills, energy intensity per ton of crude steel is lower. The production cost is generally low although it is greatly dominated by the scrap price. The EAF cannot remove impurities such as Cu, Cr, and Ni from the scrap, so it is not suitable for production of high-purity quality steel. However, the EAF contributes to improvement of iron and steel products recycle rate and the product cost is low. Therefore, its share will be expanded. The EAF and heating furnace are picked up and explained as characterized equipment in factories with EAF.

Figure II-7-1 shows the flow of material and product in a factory with EAF.

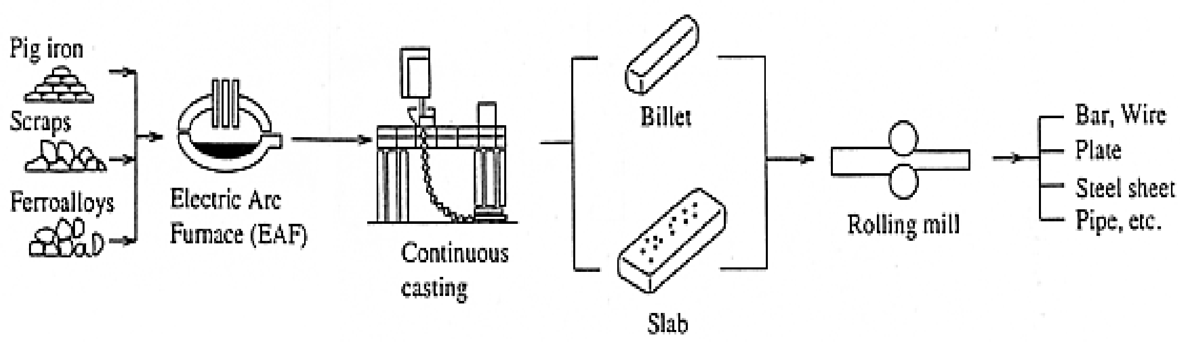


Figure II-7-1 Process Flow of Material and Product in a Factory with EAF

(1) EAF

1) Iron and steel making processes with EAF

   In iron and steel making processes, after scrap is heated, melted, and reduced (degassing, etc. are performed on the secondary refining equipment, if necessary), molten metal is fed to the continuous casting equipment (CC) and steel blocks, such as billets and slabs are produced.

   The energy consumption in the iron and steel processes occupy approximately 75% of the total energy used in the overall factory. In these iron and steel making processes, energy used by the EAF is the largest and occupies the most part of energy used.

   In the EAF, scrap is heated and melted by the arc heat generated between the scrap and electrode and the electrical resistance heat generated in the scrap. The main energy source is normally the 3-phase AC electricity.

Figure II-7-2 shows the flow chart of the EAF processes and energy conservation measures.

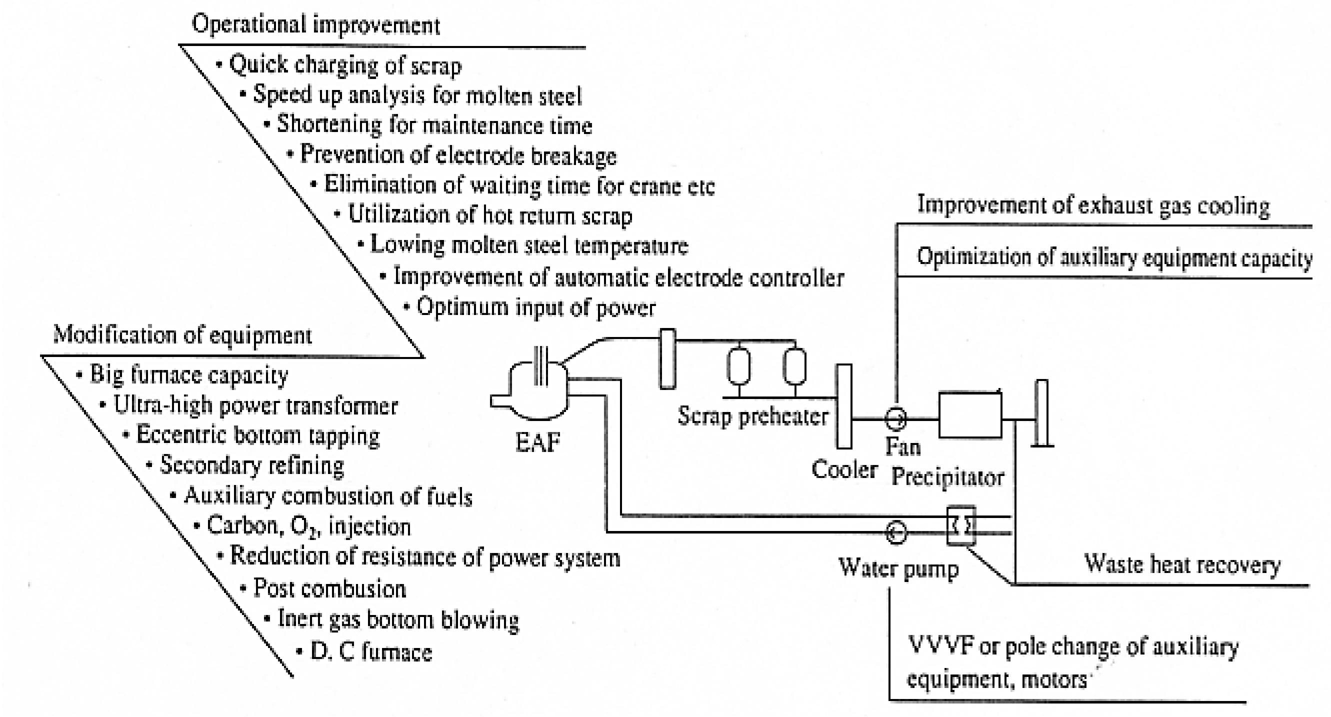


Figure II-7-2 Flow Chart of EAF Processes and Energy Conservation Measures

2) Energy conservation through operation and equipment improvement

In iron and steel making processes, improvement of the continuous casting rate and improvement of EAF's productivity through injection of supplementary fuels such as heavy oil and carbon and oxygen injection greatly contributed to the remarkable energy conservation performance. The EAF has auxiliary equipment such as the dust collector and cooling water pump, for which energy conservation is the technology common to other equipment and therefore description is omitted. Therefore, energy consumption improvement for the EAF itself is mainly described. The EAF consumes a large volume of electricity. If it is assumed that the fuel is converted into electricity in the factory at the net heat efficiency of 35.1%, electricity of 1 kWh is considered to be equivalent to 10,258 kJ (2,450 kcal). To reduce the cost of manufacturing molten steel with the EAF, measures for reducing electric power consumption described below are taken. If the effect is evaluated with 1 kWh=10,258 kJ (2,450 kcal), it can be seen that cost reduction can be impacted by energy conservation measures.

Normally, the EAF suffers stationary losses such as heat losses by cooling water and heat losses due to emission from the furnace body. If energy loaded into the EAF is increased and the tap-to-tap time can be shortened, that is, the loaded energy volume is increased and productivity (tapping volume per unit time) can be increased, the rate of the stationary losses reduces and energy consumption can be reduced. Therefore, productivity improvement is a powerful means for energy conservation of the EAF. Table II-7-1 shows the heat balance (example) of the EAF. For theoretical analysis of the energy balance of the EAF, 1 kWh ≠ 860 kcal = 3,600 kJ is used.

Table II-7-1 Heat Balance of EAF

Mcal/t tapping

Heat input			Heat output		
	10^3 kcal/t	%		10^3 kcal/t	%
Heat by electric power	302	50.2	Sensible heat of molten steel	342	56.8
Combustion heat (Fuel)	41	6.8	Sensible heat of slag	52	8.6
Oxidation heat of electrode	20	3.3	Heat loss by exhaust gas	71	11.8
Oxidation heat of charged raw materials	197	32.7	Heat loss by cooling water	62	10.3
			Heat loss of transformer and secondary conductor	22	3.7
Heat of slag formation	12	2.0			
Heat recovered by preheater	15	2.5			
Others	15	2.5	Others	53	8.8
Heat input total	602	100	Heat output total	602	100

Heat input			Heat output		
	10^3 kcal/t	%		10^3 kcal/t	%
Heat by electric power	373	59.1	Sensible heat of molten steel	340	53.9
Combustion heat (Fuel)	25	4.0	Sensible heat of slag	47	7.4
Oxidation heat of electrode	26	4.1	Heat loss by exhaust gas	111	17.6
Oxidation heat of charged raw materials	192	30.4	Heat loss by cooling water	30	4.8
			Heat loss of transformer and secondary conductor	28	4.4
Heat of slag formation	11	1.8			
Heat recovered by preheater	–				
Others	4	0.6	Others	75	11.9
Heat input total	631	100	Heat output total	631	100

The following measures are taken to improve the productivity of the EAF:

- Increase of the transformer capacity
- Reduction of electric power consumption through utilization of the scrap heating/melting burner, oxygen injection, powder injection, and scrap preheating
- Shortening of the power off time
- Improvement of heat efficiency
- Introduction of the secondary refining equipment

Below are the descriptions for each measure.

a. Increase of the transformer capacity

In recent years, the transformer capacity of the EAF has increased; RP (Regular Power) → HP (High Power) → UHP (Ultra High Power). Table II-7-2 shows the relationship between the furnace capacity and transformer capacity.

Four technologies; ① Improvement of the UHP electrode manufacturing technology, ② Improvement of heat resistance through improvement of the furnace wall/ceiling water cooling technology and refractory technology, ③ Improvement of the operation technology such as slag foaming technology, and ④ Arc stabilization at the initial stage of melting by residual molten metal operation, contributed to making the transformer larger and allowing to load high power.

b. Reduction of electric power consumption

① Scrap heating/melting burner

By providing a scrap heating/melting burner, using kerosene, heavy oil, natural gas, etc., and supplying the required volume of oxygen at the same time, scrap heating and melting are promoted. Normally, the burner is provided toward the cold spot.

Figure II-7-3 shows the effect of reduction of electric power consumption by the heavy oil burner and Figure II-7-4 shows an example of providing the scrap heating/melting burner. The effect of the scrap heating/melting burner is 5 to 9 kWh/L-oil.

Table II-7-2 Relationship Between the EAF Capacity and Transformer Capacity

Nominal capacity of furnace	Outside diameter of furnace core	Metal bath depth	Diameter of electrode	Capacity of transformaer [MV·A]			Secondary voltage (RP furnace)
[10^3 kg]	[m]	[mm]	[mm]	RP	HP	UHP	[V]
2	2.178	300	175	1.5	–	–	180/80
5	2.743	400	200 - 250	3	5	–	200/100
10	3.353	400	300 - 350	5	7.5	–	220/100
20	3.962	450	350 - 400	7.5	12	15	240/100
30	4.572	650	400 - 450	12	18	22	270/120
50	5.182	750	450 - 500	18	25	30	330/130
60	5.486	850	500	20	27	35	400/130
70	5.791	850	500	22	30	40	400/130
80	6.096	900	500	25	35	45	430/140
100	6.400	950	500 - 550	27	40	50	460/160
120	6.706	1,000	550 - 600	30	45	60	500/200
150	7.010	1,000	600	30	50	70	500/200
170	7.315	1,050	600	35	60	80	500/200
200	7.620	1,100	600	40	70	100	560/200
400	9.754	1,200	700	–	–	150	

Notes: RP: regular power, HP: high power, UHP: ultra-high power
Source: Cast Product Handbook, 4th Edition, edited by Japan Cast Product Association

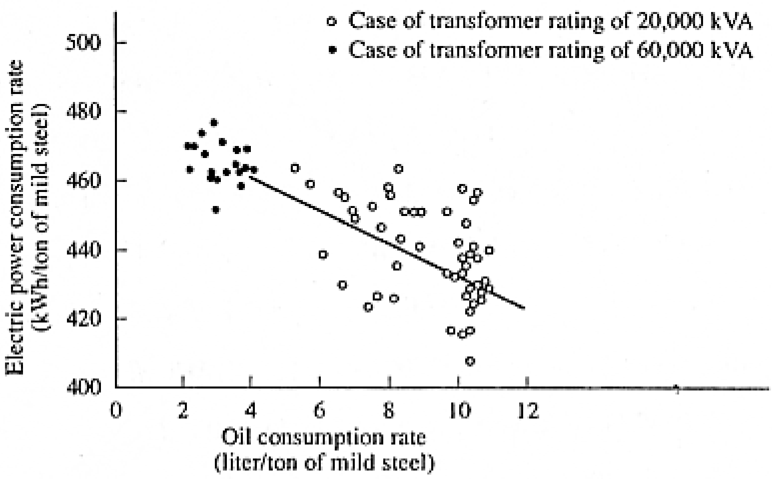


Figure II-7-3 Effect of Heavy Oil Burner on Reduction of Electric Power Consumption

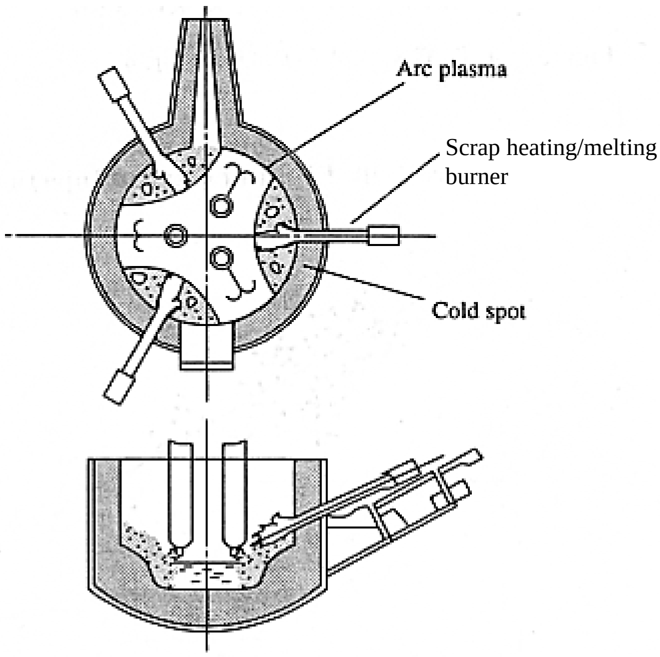


Figure II-7-4 Example of Providing the Scrap Heating/Melting Burner

② Oxygen injection operation

The oxygen injection operation directly blows oxygen to the scrap or molten steel, promotes scrap cutting and Fe oxidization, and improves the heating and melting speeds. In contrast to these effects, the yield of tapping becomes low. To solve this drawback, carbon injection was developed. Presently, electric power consumption is reduced by effectively combining ① Scrap heating/melting burner, ② Oxygen injection, and ③ Carbon injection together. Electricity of 5.5 kWh per 1 m^3_N/t of oxygen is reduced. For 20 m^3_N/t or above, this effect for the reduction of electric power consumption is halved. If oxygen is further increased, the losses by metal oxidization increase as an adverse effect.

Figure II-7-5 shows the effect of oxygen injection.

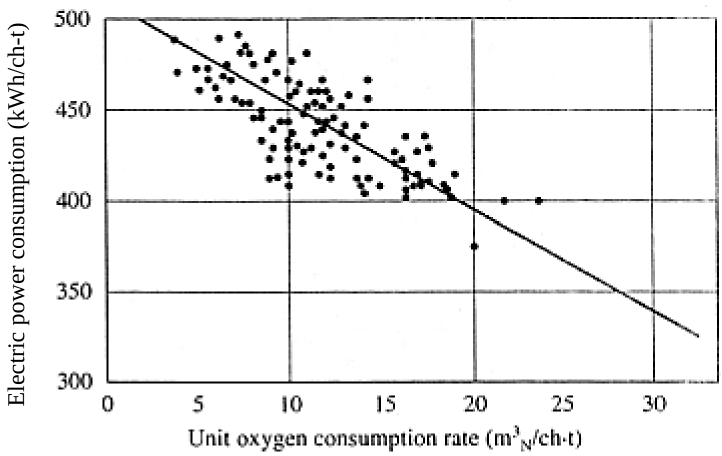


Figure II-7-5　Effect of Oxygen Injection

③ Injection of carbon and aluminum ash

If oxygen and coke powder is injected into the furnace concurrently with scrap melting by electricity, oxidization heat of Fe and C promotes scrap melting. The CO gas generated by reaction between FeO and C in the slag causes the slag foaming phenomenon after melt-down, the arc is sub-merged in slag, then the heat radiation from arc is prevented to transmit to the furnace wall, therefore the electricity loading efficiency is improved.

This sub-merged arc allowed the operation with a higher power factor and loading of higher power. As a result, improvement of power consumption, life elongation of furnace wall, and improvement of the tapping yield were achieved.

Recently, aluminum ash is used as part of combustion supporting materials. Aluminum ash contains 30 to 40% metal aluminum. With the oxidization reaction heat of the aluminum ash, power consumption can be reduced and this reduction effect is 4 to 6 kWh/kg/alum. Further, addition of aluminum ash prevents abrupt reaction between C in steel and oxygen and prevents boiling.

④ Scrap preheating

For scrap preheating, the exhaust gas sensible heat as the main heat loss source of the EAF is used to preheat scrap. Traditionally, the charging buckets containing scrap were put into preheating baths located in the exhaust gas line for drying and preheating. From the standpoint of efficiency and shortening of the processing time, scrap is directly charge in the exhaust gas line on the EAF or two EAFs are used alternately at present. (See (3).) Figure II-7-6 shows the schematic diagram of scrap preheating.

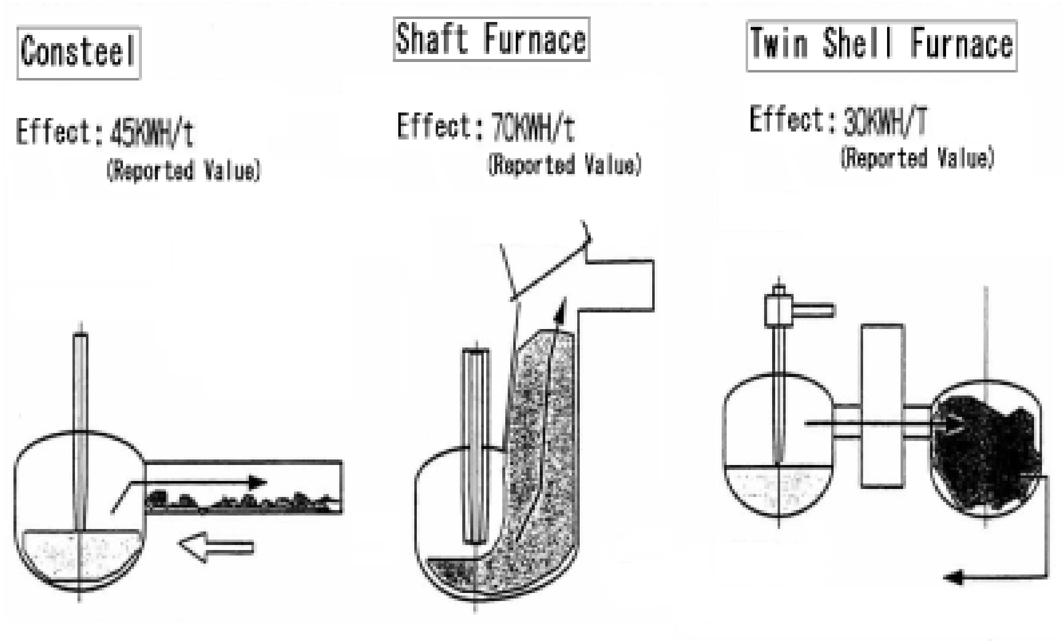


Figure II-7-6 Schematic Diagram of Scrap Preheating

Table II-7-3 summarizes an example of reduction for electric power consumption.

Table II-7-3 Example of reduction for electric power consumption

Oxygen	0 to 20 m^3_N/t	5.5 kWh/m^3_N
	> 20 m^3_N/t	2.7 kWh/m^3_N
Oil	0 to 5L/t	9.0 kWh/L
Natural Gas		8.5 kWh/m^3_N
Coke		3.0～8.3 kWh/kg
Aluminum dross		5.0 kWh/kg-Aluminum
Scrap pre-heater		20 to 40 kWh/t

c. Shortening of power off time

To shorten the tap-to-tap time, the measure of shortening the power off time described below should be implemented concurrently. Figure II-7-7 shows an example of survey on the tap-to-tap time and power off time.

① Shortening of the scrap charging time by speedup of the movement of furnace cover up/down and swing, and electrode up/down

② Shortening of the electrode connection time

③ Improvement of the furnace’s heat resistance by water-cooling of furnace walls and shortening of the furnace repair period

④ Shortening of the tapping time through adoption of the EBT (eccentric bottom tapping) furnace and by the system of receiving molten steel with a ladle car

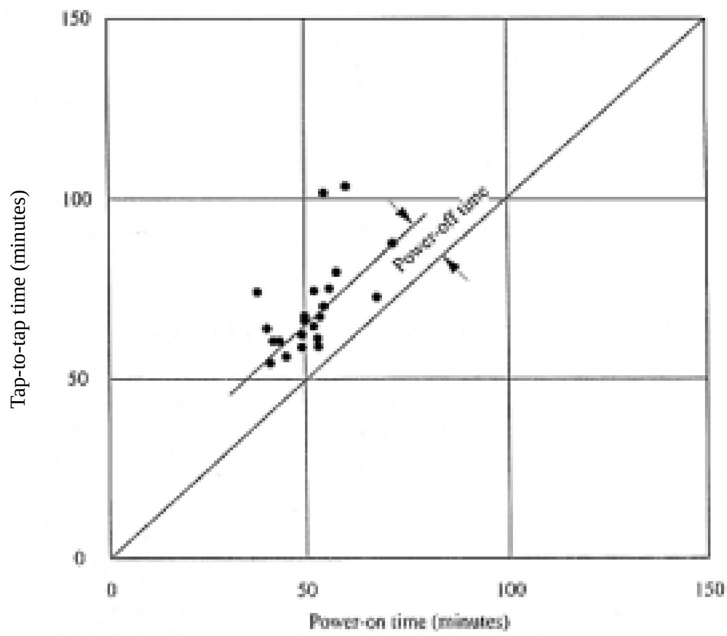


Figure II-7-7 Relationship Between the EAF's Tap-to-tap Time and Power off Time

d. Improvement of heat efficiency

Adoption of the EBT furnace, computer control of power-on time, slag foaming technology, bottom blast of gas, and secondary combustion in furnace will contribute to improvement of heat efficiency. It is said that heat efficiency of the DC EAF increases by stirring of molten steel by DC arc and electromagnetic force (electric power consumption is lower than that of the AC EAF).

e. Introduction of the secondary refining equipment

By adding equipment such as LF (ladle furnace) that refines in the ladle, the hit rate of the temperature and constituents to the targeted values is improved. Additionally, the CC operation is stabilized and quality of steel billets and blooms is improved.

Particularly, by separating the EAF functions from the functions of refining with the ladle, the temperature of tapping from the EAF can be lowered, the tap-to-tap time can be shortened, and the sequencial CC (continuous casting) number can be increased. Note, however, using LF for the steel type that does not require LF causes demerits.

f. Lowering the tapping temperature and reduction of the number of EAFs in service

If speedup of downstream processes (mainly CC) is attempted and the furnace and ladle are made larger, heat radiation from the ladle and molten steel in the ladle relatively reduces. Since the tapping temperature corresponding to this radiation heat value can be lowered, electric power consumption of the EAF can be reduced. If the tapping temperature is lowered by 10ºC, electric power consumption reduces by 3 kWh/t.

It is said that, if the time from completion of tapping from the EAF to completion of CC can be shortened from 150 minutes to 100 minutes, electric power consumption reduces by 50 kWh/t. Thus, CC speedup is effective for increase of productivity and reduction of electric power consumption.

If an EAF in service can be reduced while the production volume is maintained, a significant volume of energy conservation can be achieved and therefore a large economic effect can be expected. Therefore, if plural EAFs are provided, reduction of the number of furnaces in service should always be kept in mind. To reduce the number of furnaces in service, the necessary tap-to-tap time for the furnace in service should be obtained and various improvements should be implemented to achieve the tap-to-tap time. Reduction of the number of furnaces in service can result in large cost reduction (energy reduction), so it is often implemented as a means of energy conservation.

g. Computer control of power-on time (optimization of loaded electricity volume)

Since voltage/current automatic control is effective for cost reduction such as improvement of electrode’s electric power consumption as well as energy conservation, computer control is adopted for most furnaces.

h. Reduction of heat losses by cooling water

Heat losses by cooling water are 10% plus of the heat input to the EAF. Reduction of these losses is a major issue of energy conservation for EAFs.

Water-cooling of the furnace body greatly contributes to making the furnace larger and adoption of UHP and it is useful for energy conservation of the EAF in spite of heat losses by water-cooling. However, there are cases in which the water-cooled area is increased too much and heat losses increase, electric power consumption increases, and the tap-to-tap time cannot be shortened. Review of the water-cooled area will be one of the issues for energy conservation.

i. Relationship between the tap-to-tap time and electric power consumption

Table II-7-4 shows the relationship between the EAF's tap-to-tap time and electric power consumption.

Table II-7-4 Relationship Between Tap-to-Tap Time and Electric Power Consumption

Tap-to-tap time	Electric power consumption
180 minutes	550 to 600 kWh/t
120 minutes	480 to 520 kWh/t
90 minutes	430 to 470 kWh/t
70 minutes	380 to 420 kWh/t
60 minutes	360 to 400 kWh/t

3) Exhaust heat recovery and equipment modernization

a. Improved EAF

There are factories that have installed two EAFs installed as the twin shell furnace, each of which alternately has the function of the heating/melting furnace or scrap-preheating furnace, or have installed the shaft furnace that continuously heats scrap. These factories have started operation with the full volume of preheated scrap and then heated/melted with several new proposed processes in this paper aiming at reduction of electric power consumption by 20%. Although the result is not announced, EAFs at 250 kWh/t or below will appear soon.

b. Exhaust heat recovery

Heat recovery from the EAF's cooling water and exhaust gas is possible. However, in Japan, there is no implementation example in terms of the use of hot water as a result of exhaust heat recovery and the recovery cost.

(2) Heating furnace for rolling

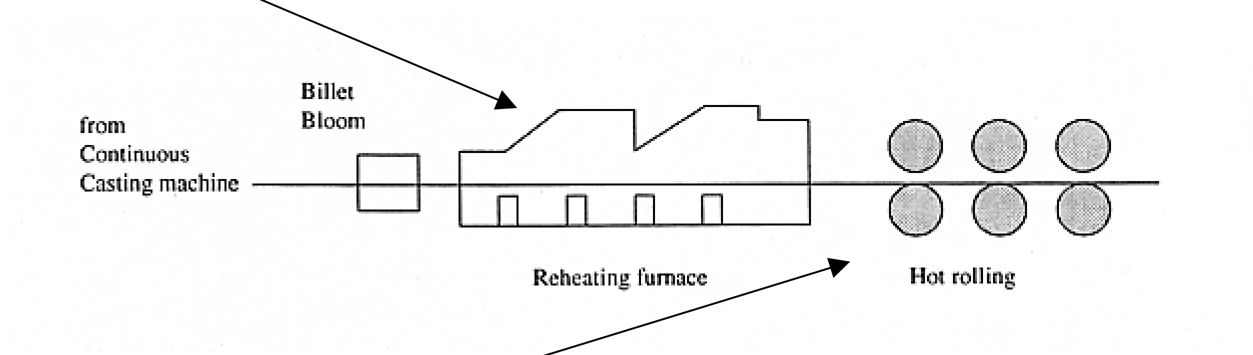
1) Rolling process

The rolling mill processes heats steel blocks (billets, blooms, slabs) to the specified temperature in the heating furnace, rolls them with the rolling mill and finishes to the desired shape and size.

Normally, most products finished by rolling mill in the factory with EAF are hot rolling products such as shapes and sections, bar and wires, etc.

Figure II-7-8 shows the flow chart of the primary rolling process and energy conservation measures.

- Improvement of air/fuel ratio
- Improvement of recupirator heat recovery
- Extraction of billet at a lower temperature
- Improvement of heat pattern
- Hot charge rolling/Hot direct rolling
- Improvement of heat loss, cooling water loss
- Improvement of heat transfer
- Improvement of production plan
- Optimization of combustion air fan capacity



- Improvement of yield
- Optimization of auxiliary equipment,
- Capacity (cooling water pump,
- Mill motor fan, etc)
- Increase of productivity
- Prevention of idling

Figure II-7-8 Flow of Hot Rolling Process and Energy Conservation Measures

Energy conservation measures for the heating furnace that consumed the most part of energy in the hot rolling processes are described below.

2) Energy conservation through operation and equipment improvement

For energy used in the hot rolling process, the fuel is 60% and the rest electricity and steam. Remarkable energy conservation performance has been shown as reduction of fuel consumption for the heating furnace. Before the oil crisis, fuel consumption of many heating furnaces exceeded 450 Mcal/t but furnaces at 200 Mcal/t or below have appeared recently.
Table II-7-5 shows an example of a heating furnace's heat balance.

Table II-7-5 Example of a Heating Furnace's Heat Balance

Charged slab temperature : cold Example 1
Charged billet temperature: hot Example 2

(Example 1)

Heat Input	Mcal/t	(%)	Heat Output	Mcal/t	(%)
Combustion heat of fuel	318.7	(97.6)	Heat content of extracted slab	194.8	(59.7)
Sensible heat of fuel	0	(0)	Sensible heat of scale	2.1	(0.6)
Heat content of charged slab	0	(0)	Sensible heat of exhaust gas	33.3	(10.2)
Scale formation heat	8.0	(2.4)	Heat of cooling water	43.8	(13.4)
			Heat loss	52.7	(16.1)
Heat recovered by recuperator	(62.7)	((19.2))	Heat recovered by recuperator	(62.7)	((19.2))
Total	326.7	100	Total	326.7	100

Overall heat efficiency = {194.8/(318.7 + 8.0)} × 100 = 59.6 %

(Example 2)

Heat Input	Mcal/t	(%)	Heat Output	Mcal/t	(%)
Combustion heat of fuel	168.8	(65.6)	Heat content of extracted billet	174.9	(67.9)
Sensible heat of fuel	0.3	(0.1)	Sensible heat of scale	3.1	(1.2)
Heat content of charged billet	73.9	(28.7)	Sensible heat of exhaust gas	30.7	(11.9)
Scale formation heat	13.2	(5.1)	Heat of cooling water	41.9	(16.3)
Sensible heat of atomizer	1.3	(0.5)	Heat loss	6.9	(2.7)
Heat recovered by recuperator	(16.7)	((6.5))	Heat recovered by recuperator	(16.7)	((6.5))
Total	326.7	100	Total	257.5	100

Overall heat efficiency = {174.9/(168.8 + 0.3 + 73.9 + 13.2 + 1.3)} × 100 = 67.9 %

Heating furnaces are categorized into the batch type and continuous type. The batch type mainly reheats special-shape material, however the continuous type is the main stream for mass production. As continuous heating furnaces, there are the pusher type, walking beam type, and walking hearth type. Since the construction cost of the pusher type is low, it is adopted for small furnaces at 150 t/h or below. For large furnaces, the walking beam type is used. The walking hearth type is used for heating or heat treatment of special materials such as steel rods.

As the causes for reduction of the furnace's heat efficiency, there are heat losses due to consumption for heat keeping or heat increasing based on external factors such as material waiting and rolling mill troubles as well as heat losses such as exhaust gas heat losses that occur in the normal furnace

operation. Care must be taken to keep the temperature constant and to rise temperature because an unexpected large volume of heat value is required. Additionally, effects of the rolling speed (heating furnace's load rate) to heat losses cannot be ignored.
Energy conservation measures are described below.

a. Improvement of combustion air ratio

The combustion air ratio should be maintained adequately and the in-furnace pressure controller should be adjusted to reduce the volume of air entering in from the outside. Figure II-7-9 shows the relationship between the air ratio and fuel consumption. For example, if the air ratio is reduced from 1.5 to 1.2 at an exhaust gas temperature of 500°C, the fuel can be reduced by 9%.

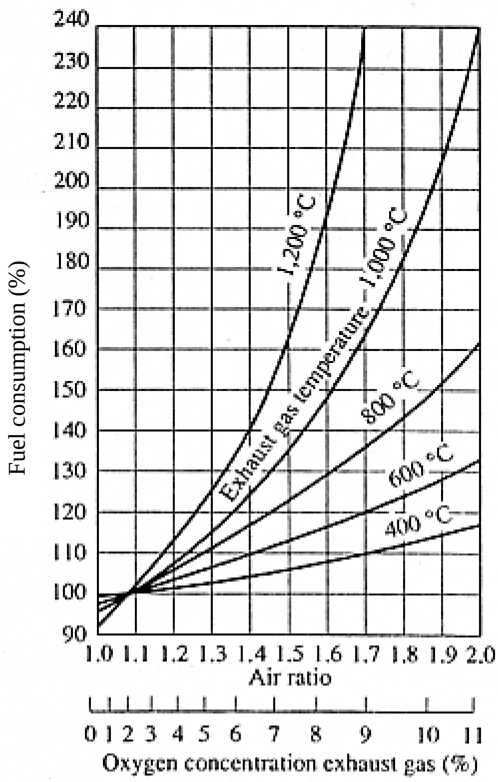


Figure II-7-9 Relationship Between Air Ratio and Fuel Consumption

b. Enhancement of exhaust heat recovery

If the heat transmission surface of the air pre-heater (recuperator) becomes dirty, its performance is extremely degraded and fuel consumption increases. Therefore, simple heat balance calculation should be performed on a regular basis to maintain the heat transfer efficiency at the initial stage of installation.

If the performance is not restored, the air pre-heater should be repaired, reinforced, or replaced depending on the cause.

c. Low temperature extraction

If steel blocks are extracted from the heating furnace at a lower temperature, fuel consumption decreases but electric power consumption increases. Therefore, these effects should be fully analyzed for extraction at the optimum temperature in order to achieve energy conservation. In this case, attention should be paid to the skid mark. If extraction at a low temperature is possible, reduction of fuel consumption by 3 to 5 Mcal/t can be expected by lowering the extraction temperature of 10°C.

d. Improvement of hot charging rate

The designed fuel consumption of the heating furnace that heats cold steel blocks only is approximately 300 Mcal/t to 400 Mcal/t. On the other hand, in factories with EAF producing deformed reinforcing bar, there are many heating furnaces for rolling at a fuel consumption of 200 Mcal/t or below. The reason is that high-temperature steel blocks produced in the continuous casting equipment are charged into the heating furnace for rolling (hot charge rolling=HCR) or rolled by the rolling machine (hot direct rolling=HDR).

To implement hot charging, it is of course desirable that the CC is close to the heating furnace. However, there is a difference between the CC's capacity and the rolling mill capacity, 100% hot charging is difficult. Therefore, a heat insulation box is normally provided to temporarily store the high-temperature continuously cast billets as a buffer function. The heat-keeping box is made of steel plates with lining of heat insulation material and has a removable cover for loading/unloading the billets.

Energy conservation by hot charging is approximately 20 Mcal/t per 100°C of charging temperature.

e. Prevention of heat losses due to radiation and heat transmission

For furnaces recently installed, the walls are covered with ceramic fiber of a low specific heat. The heat insulation effect is excellent and the accumulated heat volume is small. Thus, heat losses from furnaces walls are improved.

Even though furnace walls of an existing furnace are made of bricks, both heat radiation volume and accumulated heat volume can be reduced by approximately 30 to 40% by lining a 50 mm thick ceramic fiber on the inner walls of the furnace.

f. Prevention of heat losses from the opening

If an opening is provided, heat in the furnace goes out of the furnace as the radiation heat. Further, leakage of combustion gas results in heat losses. Therefore, the opening should be minimized.

g. Prevention of heat losses from cooling water

For continuous heating furnaces, the cooling heat loss from the water-cooling skid pipe occupied 10 to 15% of fuel consumption. To reduce the cooling heat loss, the double heat insulation method for the skid was developed. This method can be adopted for the existing furnaces as well as newly installed furnaces and heat losses are down by half.

Figure II-7-10 shows an improvement example.

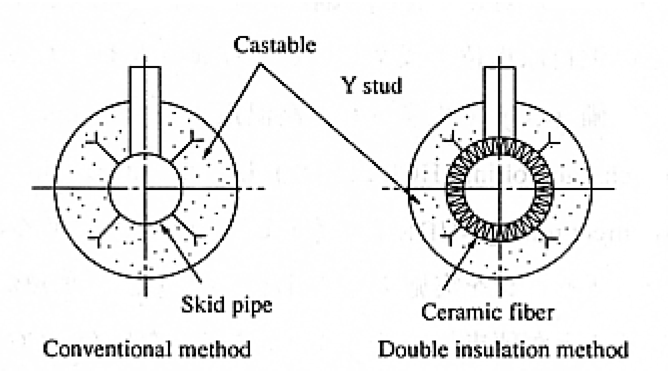


Figure II-7-10 Double Heat Insulation for Water-Cooling Skid Pipe

h. Improvement of the heat transmission efficiency in the furnace

Steel blocks in the furnace are mainly (approximately 95% or more) heated by heat radiation of combustion gas (gas radiation of CO_2 and H_2O and solid radiation of high-temperature fine carbon particles contained in the flame). Therefore, the "optical thickness of gas" should be sufficiently large and the furnace volume is required to meet the specified capacity.

Whether the required furnace volume is reserved should be studied, and if it is insufficient, elaborations such as changing the furnace shape by providing a partition wall for promotion of heat transmission in the furnace are necessary. Additionally, the high-temperature gas flows on the upper part of furnace only, the gas temperature on the lower part may be low, and the radiation heat transmission volume may be small. Therefore, measures to improve uniformity of the in-furnace temperature in the vertical direction should be studied.

i. Prevention of heat losses due to external factors

If the air-fuel ratio of the heating furnace is adequately controlled and continuous operation is possible at a heating speed (t/h) within the specified range, fuel consumption can be maintained in a very good level.

However, in the actual operation, operation may have to be performed at a higher or lower heating speed or heat may have to be kept for many hours because of the relationship with the preceding and following processes. As a result, the annual average fuel consumption may be extremely poor.

If such a condition occurs, actions for removing the cause are required and the production schedule itself may have to be changed or improved.

For example, improvement should be made so that the furnace can be operated in a scheduled manner, by adjusting the production speed with the preceding and following processes and taking actions against troubles in the preceding and following processes. Additionally, criteria for keeping the temperature constant and rising temperature of the furnace should be specified for control.

Then, the heat value is improved very much. If there are multiple rolling lines (and therefore multiple lines of heating furnaces) to produce various products, the production capacity of the continuous casting equipment often does not match the production capacity of the rolling lines. Some rolling lines may have to be shut down frequently. If such a condition constantly occurs and cannot be solved by adjustment of the production schedule and operation procedure, measures such as reduction of heat radiation losses and heat accumulation losses by means of replacing the heat insulation material of the heating furnace with ceramic fiber are indispensable.

3) Energy conservation through exhaust gas heat recovery

a. Heat regenerative type burner

If the air pre-heater is old and should be replaced, installation of the regenerative burner should be studied.

b. Regenerative burner system

By repeating combustion and heat recovery alternately at an interval of tens of seconds with a “pair” of burners A and B containing the heat accumulating unit, a temperature efficiency of at least 85% (preheated air temperature higher than 1,000°C) can be obtained. The reason is that burner B is an exhaust port when burner A is performing combustion and heat is exchanged between exhaust gas of burner A and the heat accumulation unit of burner B. On the other hand, on burner A that is performing combustion, heat is exchanged between the heat accumulation unit and combustion air and high-temperature air is supplied to burner A.

This system uses alumina refractory for the heat exchanging element unit and the high-temperature parts are the burner and heat exchanging element unit only. Since the exhaust gas line and air tube line are at a low temperature, the system is compact. Also, the heat recovery/combustion changeover valve is provided on the low-temperature side, so wear is small as a feature and fuel can be saved by 30 to 50%. Additionally, despite that the preheated air temperature is high, NOX is 150 ppm or below as an excellent feature.

Figure II-7-11 shows the regenerative burner system and Figure II-7-12 shows the preheated air temperature rise effect.

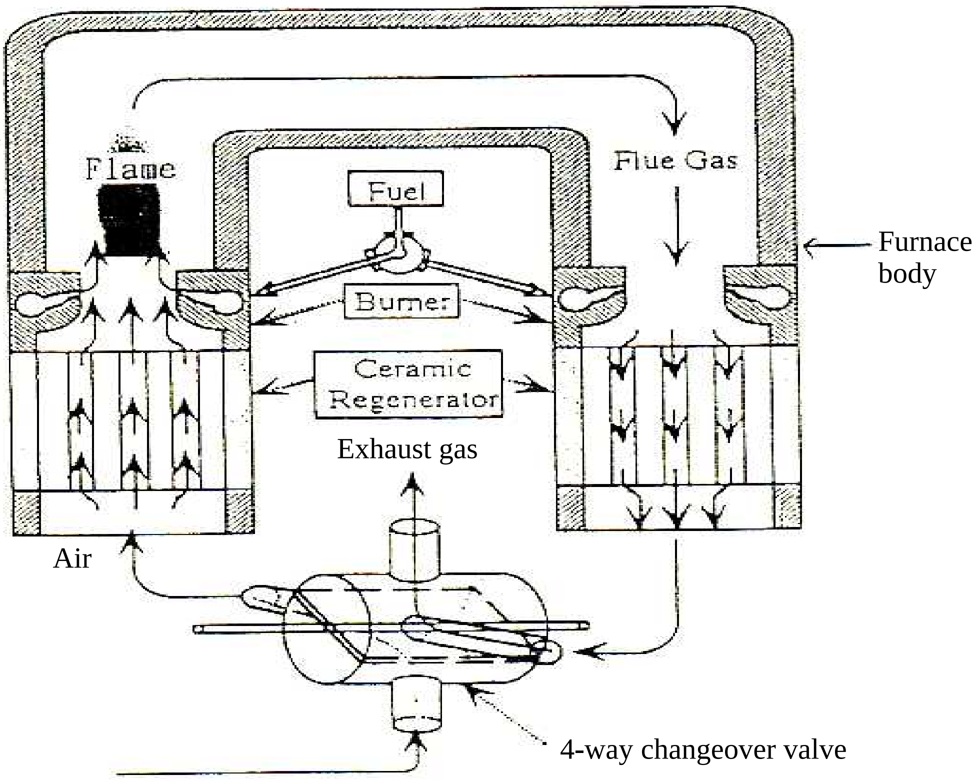


Figure II-7-11 Regenerative Burner System

c. Sensible heat recovery from skid cooling water

If a heating furnace exhaust gas boiler is installed, heat recovery is possible for preheating the supplied water.

d. Furnace exhaust gas boiler

Installation should be studied by considering reduction of the exhaust gas volume as a result of fuel consumption reduction through hot charging.

If the regenerative burner is installed, the exhaust gas temperature is 200 to 300°C. The merit of installing the exhaust heat boiler reduces and the investment effect decreases.

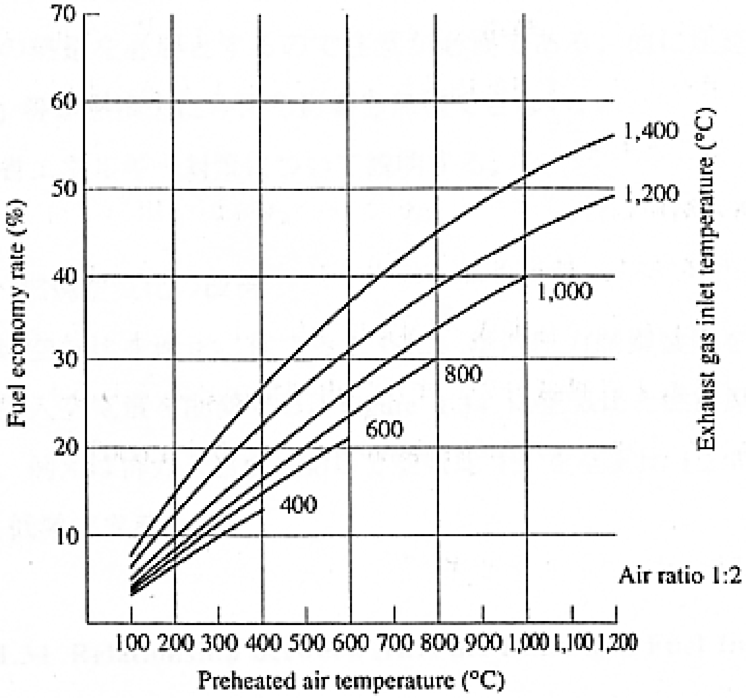


Figure II-7-12 Preheated Air Temperature Rise Effect

4) Yield improvement and trouble reduction

Yield improvement results in energy conservation at the rolling processes and the upstream processes. It is important to improve the yield by reducing scale losses, crop losses, and mis-roll. If a trouble occurs in the rolling line, fuel consumption of the furnace becomes low, the mis-roll rate increases, and the yield is worsened. Therefore, it is important to reduce equipment troubles. Trouble reduction is directly linked to energy conservation.

7.2 Grasping the Actual Status of Energy Consumption

First, we should recognize what process in manufacturing processes uses utilities such as electricity, water, steam, compressed air and how they should be grasped.

(1) Data collection in advance

Data should be collected in advance and input in Factory Energy Use Status Table prepared by each factory (i.e. input the production volume and used quantities of electricity, fuel, steam, water, and compressed air).

(2) Prepare a graph showing the energy consumption

For example, a graph showing the electricity volume used in the factory should be prepared as shown in Figure II-7-13.

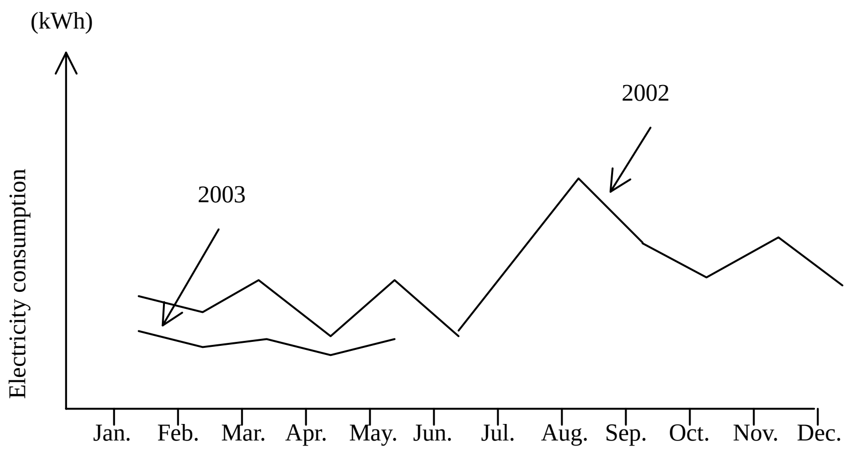


Figure II-7-13 Electricity Volume Used in the Factory (Example)

(3) Prepare a graph showing the production volume and energy intensity in the factory.

For example, a graph showing the production volume and electricity consumption should be prepared as shown in Figure II-7-14.

(4) Enhancement of energy management

Measuring instrument should be installed for respective utilities so that periodic measurement, data collection, and management of the energy volume used in the factory will be possible.

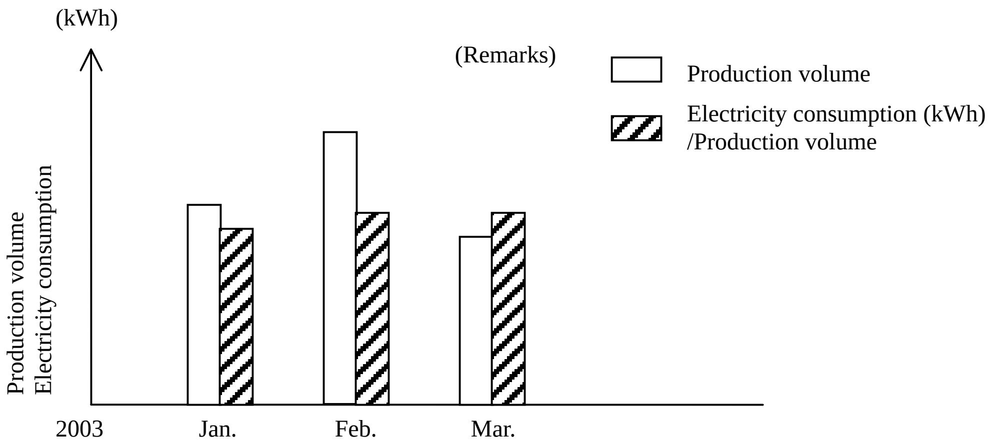


Figure II-7-14　Production Volume by Electricity Consumption (Example)

7.3 Extraction of Problems by Energy Conservation Check List

When graphs of the energy consumption data collected, production volume, and energy consumption and intensity are available, check should be made according to the check list given below to extract problems in energy conservation.

1) Electricity management
   a. How to determine the contracted electricity and the system of the electricity charge should be understood.
   b. The contracted electricity and maximum demand electricity as well as the power consumption used should be reduced.
   c. Isn't electricity loss found in comparison of monthly data with those of previous year in checking the graph showing the electric power consumption?
   d. Is electric power consumption being improved?

2) Energy conservation check points for major equipment
   a. Electricity receiving/transforming equipment
      - Isn't there any transformer that can be shut down in the nighttime or on holidays?
      - Is the power factor improved?

   b. Air compressor
      - Isn't there leakage from piping?
      - What about ventilation? Isn't the air compressor intake temperature high?
      - Isn't it possible to drop the delivery pressure of the air compressor?

- What is the air compressor’s capacity adjusting system?
- Is the air compressor shut down when it is not used?
- What is the operation to be performed against variation of the used volume?
- Has introduction of controlling the number of air compressors in service been studied?

c. Blower and pump
   - Are they shut down when they are not necessary?
   - Doesn’t the flow rate or pressure have a too large margin?
   - Is the flow rate adjusted, and by what?
   - Was changing the number of revolutions or impeller cutting studied?

d. Lighting
   - Is lighting turned off when or where it is not required?
   - Is daylight used and is lighting turned off?
   - Is illumination adequate and is it measured?
   - Was adoption of high-efficiency lighting apparatuses studied?

e. Air-conditioning equipment
   - Can’t the heat load generated from components and outer air load be reduced?
   - Can’t heat insulation for the building and daylight shielding be improved?
   - Is the set value for room temperature adequate?
   - Can’t the air conditioner running time be reduced?
   - Isn’t air conditioning run in unnecessary spaces?
   - Is the filter cleaned periodically?
   - Upon renewal, new installation, or expansion, was adoption of the ice heat storage system studied?

7.4 Energy Conservation Approaches

After problems are extracted according to the Energy Conservation Check List, approaches for solving the problems are required.

The following are the energy conservation approaches for problem solution.

Energy conservation should be studied according to these approaches. The result of studying energy conservation should be forwarded to implement the energy conservation actions based on the economical evaluation with use of the energy conservation effects and equipment investment.

Examples of approaches:

Approach 1: Reduction of Maximum Electric Power with a Demand Controller

Approach 2: Power Factor Improvement Method

Approach 3: Energy Conservation Technique for Air Compressors

Approach 4: Energy Conservation and Cost Reduction through Control of the Number of Air Compressors in Service

Approach 5: Control of the Number of Revolutions for Blowers and Pumps

Approach 6: Application of High-efficiency Lighting Apparatus

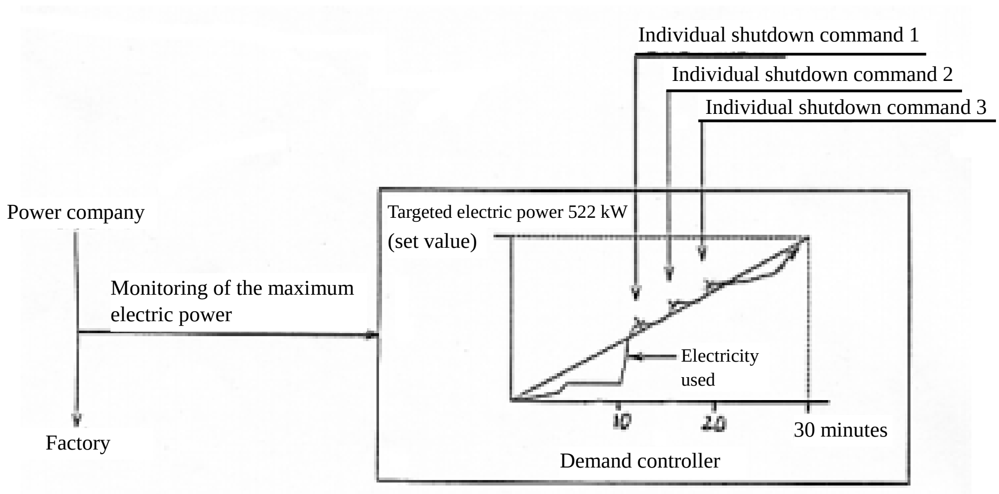
Approach 1: Reduction of Maximum Electric Power with a Demand Controller

1. Operation of Demand Controller

The demand contract is a contract system based on the maximum electric power. Consumption once a large value occurs, this value is the contracted electric power for coming one year. Reduction of the contracted electric power from 612 kW to 522 kW by suppressing the maximum electric power is described below.

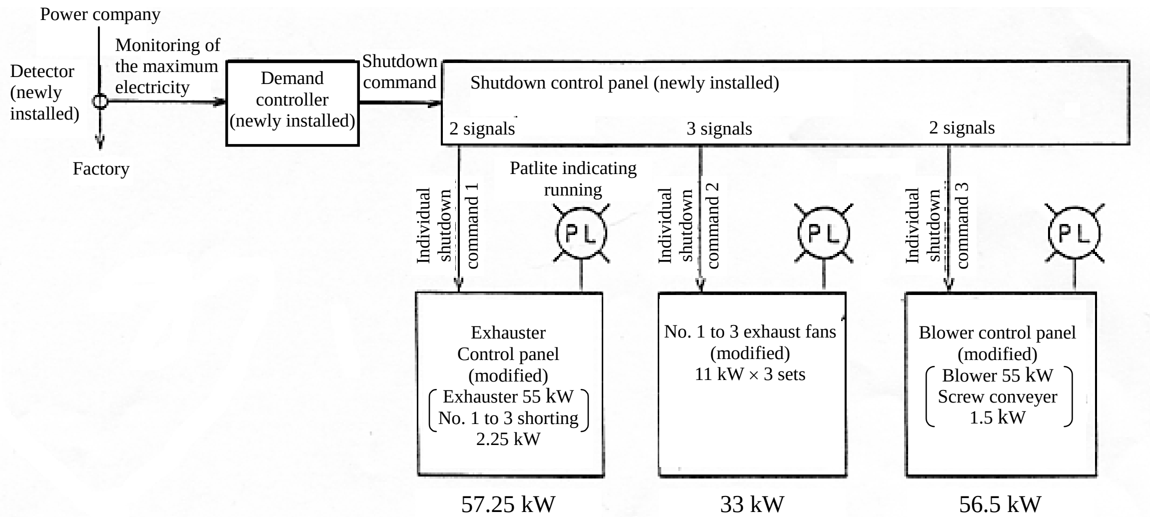
If it is estimated that the actual electric power consumption is likely to exceed the targeted electric power of 522 kW, individual shutdown commands 1 to 3 are sequentially issued to shut down the equipment not critical in the factory and suppress the value below the targeted electric power.

After 30 minutes, the stopped equipment started up automatically (sequentially by timers) to achieve demand control and operation in unmanned and automatic mode.



2. Schematic Diagram of Demand Controller

The factory receives electricity from the power company. This system monitors the maximum electric power at the electricity receiving point as shown below and shuts down the non-important equipment in the factory with the shutdown signals from the load shutdown control panel to suppress the peak electric power. By suppressing the maximum electric power (peak), the contracted electricity can be maintained low and a significant amount of electricity charge can be reduced.



3. Investment Performance by the Demand Controller

If it is assumed that the present contracted electric power of 612 kW is suppressed to 522 kW by execution individual shutdown commands 1 and 2 in the table below, the amount of introduction merit is 1.45 million yen annually.

Since a peak may occur any time in the present status (non-monitoring state), it is recommended to introduce the demand controller.

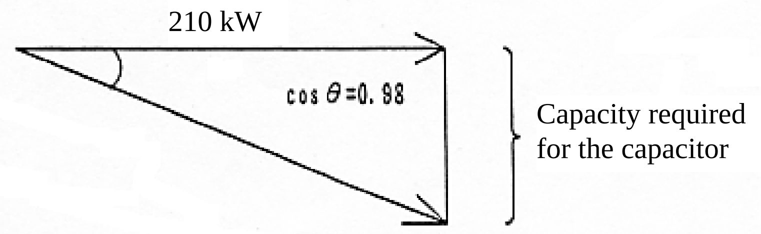
Once the demand controller is introduced, the maximum electricity can be easily managed and therefore it is easy to implement energy conservation measures.

	Equipment to be shut down	Saved electricity	Investment effect/year	Total investment effect
Individual shutdown command 1	Exhauster	57.25 kW	57.25 kW × 1575 yen/kW × 0.85 × 12 = 919,721 yen	919,721 yen
Individual shutdown command 2	Exhaust fan	33 kW	33 kW × 1575 yen/kW × 0.85 × 12 = 530,145 yen	1,449,866 yen
Individual shutdown command 3	Blower	56.5 kW	56.5 kW × 1575 yen/kW × 0.85 × 12 = 907,762 yen	2,357,538 yen

If up to individual shutdown command 3 is implemented, the effect is approximately 2.3 million yen annually.

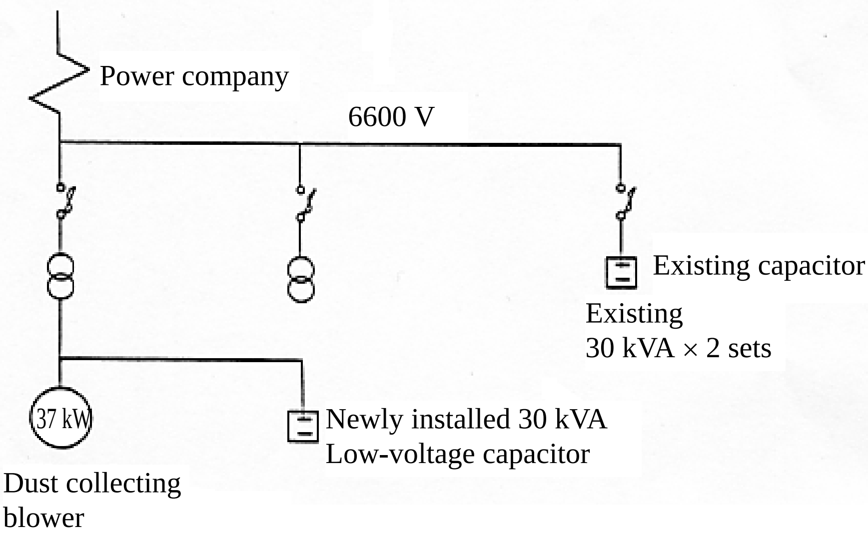
Approach 2: Power Factor Improvement Method

1. If the present maximum electricity is 210 kW and the power factor is 98%, the capacity required for the capacitor for improvement to a power factor of 100% is as follows:

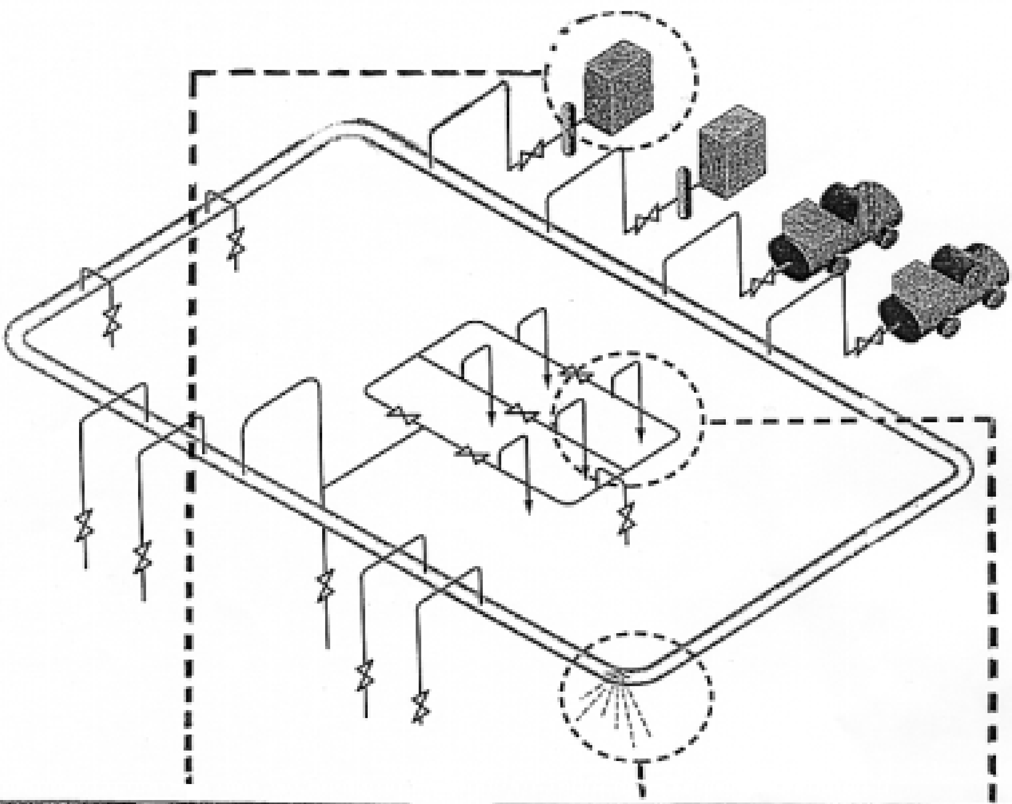


Capacity required for the capacitor $=210\times\tan\theta=210\times0.2\approx 42KVA$

2. Installation of the power factor improving capacitor



Approach 3: Energy Conservation Technique for Air Compressors



(1) Renewal to a new machine (high-efficiency air compressor)

<Expected effect> Energy conservation of 7 to 15% (per air compressor)

(2) Adoption of the system controlling the number of air compressors in service

<Expected effect> Realization of the minimum necessary air compressors in service

(3) Improvement of installation (intake) condition

- Lowering the intake air temperature
- Reduction of the intake resistance

<Expected effect> Realization of operation with optimum energy conservation

Improvement measures	a. Review of the intake port and exhaust port b. Optimization of the ventilation fan capacity

(4) Reduction of the delivered air pressure and use-end pressure

<Expected effect> If a delivery gauge pressure of 0.69 MPa (7 kgf/cm^2) is dropped to 0.59 MPa (6 kgf/cm^2), energy conservation is approximately 9%.

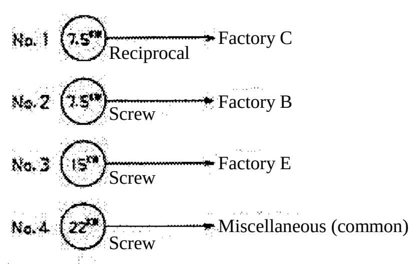
Measures for reduction of pressure losses	a. Periodic maintenance of auxiliary equipment (filters, etc.) b. Loop piping and review of pipe diameter

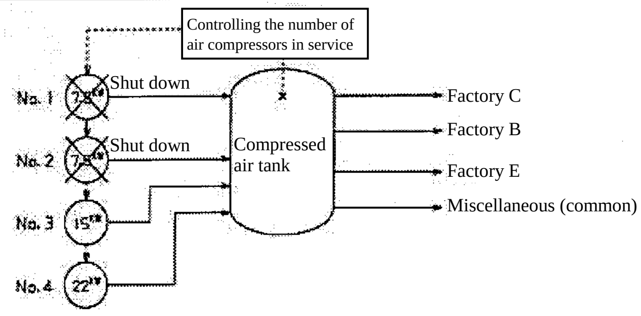
(5) Repair of air leak from piping

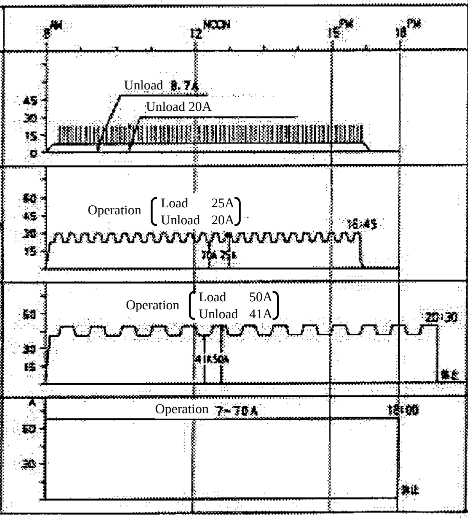
<Expected effect> If 10 positions of 1 mm dia. hole are repaired, energy conservation corresponds to a 5.5 kW air compressor.

Approach 4: Energy Conservation and Cost Reduction through Control of the Number of Air Compressors in Service

Individual supply system (before improvement)	Number of air compressors in service control system

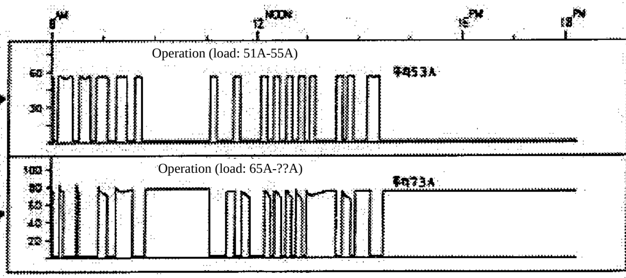






No.	Application / Air Compressor capacity	Load/unload operation prerequisite operation		Electricity consumption per day	
1	Factory C only 7.5kW× m³/min Reciprocal type	Load operation	Time 0.5	kW/day 3.35	→ Shut down
		Unload	8.25	24	
			1.0×0.5/3.75 =0.06	27.35 kW/day	
2	Factory B only 7.5kW×1.0m³/min Screw type	Load operation	4.05	kW/day 34	→ Shut down
		Unload	4.7	31.5	
			1.0×4.05/8.75 =0.46	65.5 kW/day	
3	Factory E only 15kW×2.4m³/min Screw type	Load operation	10.6	kW/day 177.6	→
		Unload	1.9	26.1	
			2.4×10.6/12.5 =2.04	203.7 kW/day	
4	Miscellaneous 22kW×3.7m³/min Screw type			221.5 kW/day	→

Total 526.05 kWh/day
Annual electricity volume (265 days) 139,403 kWh
Electricity charge (@18 yen/kWh) 2,509,254 yen



Time of load operation and shutdown		Electricity consumption per day
Load operation	Time 1.87	33.2 kW/day
Shutdown	8.13	
Load operation	Time 7.4	181.04 kW/day
Shutdown	2.6	

Total 214.24 kWh/day
Annual electricity volume (265 days) 56,774 kWh
Electricity charge (@18 yen/kWh) 1,021,932 yen

Cost reduction effect
1,467,300 yen/y

Approach 5: Control of the Number of Revolutions for Blowers and Pumps

If the intake air flow rate is Q m^3/min, the pressure is H mmAq, and the efficiency is η, the required electricity P kW for the blower is:

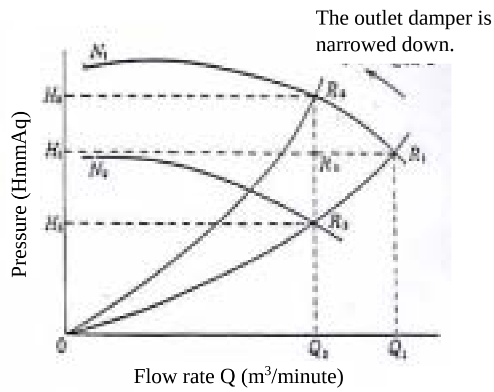
$P = QH/6120\eta$.

If the number of revolutions is N^{rpm} and the constant is k, the relationship between the number of revolutions and power is as follows:

$Q = k_1N$, $H = k_2N^2$

$P = k_3N^3$

In the figure at right, if the outlet damper is narrowed down to reduce the air flow rate of the blower that is running at the number of revolutions N_1 and air flow rate Q_1 to Q_2, the resistance curve of piping changes from OR_1 to OR_2, power changes from rectangle $OH_1R_1Q_1$ to $OH_2R_2Q_2$. Power does not decrease very much when the air flow rate is reduced by narrowing down the damper.

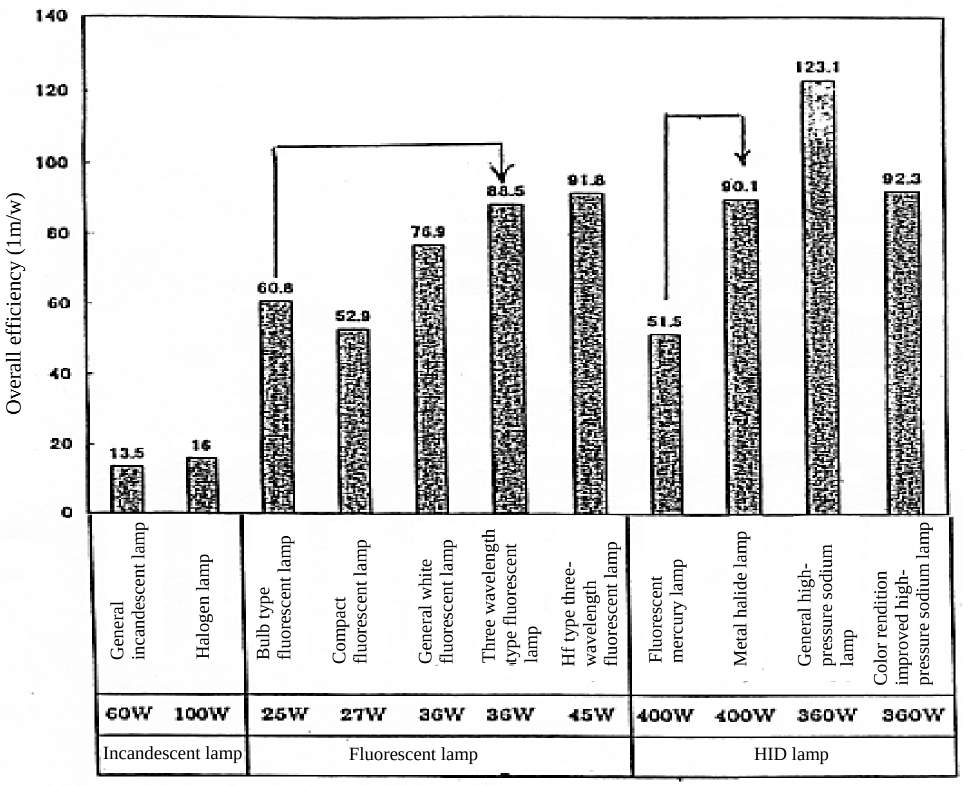


In contrast, N_1 is reduced to N_2 by controlling the number of revolutions, power reduces from the area of rectangle $OH_1R_1Q_1$ to the area of $OH_3R_2Q_2$.

As you see, controlling the number of revolutions is more advantageous that controlling the outlet damper in energy conservation.

Generally, an inverter unit (VVVF) is adopted for controlling the number of revolutions.

Approach 6: Application of High-efficiency Lighting Apparatuses



	Type of light source	Lamp Power [W]	Input Power [W]	Total luminous flux (1) [lm]	Overall efficiency (2) [lm/W]	Color temperature [K]	Average color rendering index [Ra]	Rated life [h]
Incandescent lamp	Incandescent lamp							
	General lighting	60	60	810	13.5	2850	100	1000
	Ball bulb	57	57	705	12.4	2850	100	2000
	Crypton lamp	60	60	840	14.0	2850	100	2000
	Halogen lamp							
	Single-ended mold	100	100	1600	16.0	2900	100	1500
	With infrared radiation reflex film	85	85	1680	19.8	2900	100	2000
	Small type (low-voltage type)	50	50	1000	20.0	3000	100	2000
	Double ended mold	500	500	10500	21.0	3000	100	2000
Fluorescent lamp	Bulb type fluorescent lamp							
	Electronic lighting – bulb color	25	25	1520	60.8	2800	84	6000
	Electronic lighting – daylight white color	25	25	1460	58.4	5000	88	6000
	4-tube type – daylight white color	23	23	1550	67.4	5000	84	8000
	General fluorescent lamp							
	White	40	43	3000	69.8	4200	61	12000
	Same as above (power saving type)	36	39	3000	76.9	4200	61	12000
	Three-wavelength type – daylight white color	40	43	3450	80.2	5000	88	12000
	Same as above (power saving type)	36	39	3450	88.5	5000	88	12000
	High-frequency Hf) type							
	32W lighting – daylight white color	32	35	3200	91.4	5000	88	12000
	45W lighting – daylight white color	45	49	4500	91.8	5000	88	12000
	Compact type							
	27W type – daylight white color	27	34	1800	52.9	5000	88	7500
	36W type – daylight white color	36	40	2900	72.5	5000	88	9000
HID lamp	Fluorescent mercury lamp	400	427	22000	51.5	3900	40	12000
	Metal halide lamp	400	444	40000	90.1	3800	70	9000
	Same as above (double ended mold)	250	263	20000	76.0	4300	85	6000
	High-pressure sodium lamp	360	386	47500	123.1	2050	25	12000
	Same as above (improved rendering type)	360	390	36000	92.3	2100	60	12000

List of Attachments

Philippines

The Philippines is important to world energy markets because it is a growing consumer of energy, particularly electric power, and a major potential market for foreign energy firms. It also may become a major producer of natural gas.

BACKGROUND

The new millennium has brought about important changes to the island nation of the Philippines. With the installation of former Vice-President Gloria Macapagal-Arroyo on January 20, 2001, the Philippines has undertaken an economic transformation, deregulating its energy sector and offering new incentives for foreign investment. President Macapagal-Arroyo, a trained economist, came into power when former President Joseph Estrada was forced from office. Under Macapagal-Arroyo, key economic indicators, including GDP growth rate, foreign investment, and inflation have trended favorably. But while a certain degree of success has been achieved, the country's fiscal deficit, declining currency, and regional inequality are still problematic. A major natural gas discovery in the Malampaya field, officially inaugurated in October of 2001, coupled with increasing military support from the United States could prove to have a significant impact on the country's future.

ECONOMY

Real Gross Domestic Product (GDP) grew by 4.6 % and Gross National Product (GNP) by 5.2% in 2002. This increase exceeded both Philippine and international expectations. Much of the country's renewed economic vibrancy results from improved agricultural yields with a positive growth of 3.5%, as well as from an increase in domestic consumption brought about by curbed inflation. Growing confidence in the Macapagal-Arroyo administration, as well as the excitement surrounding the sizable Malampaya natural gas field also have had a positive effect. Foreign investment shot up 171%, to $3.4 billion in 2001, as investors gained confidence in Manila's political climate as well as a newly deregulated and privatized energy sector.

In services, benefits of deregulation in the telecommunication sector grew robustly by 8.9%. Trade continues to benefit from strong consumer demand, as giant local retailers opened up new malls in regions outside Metro Manila.

With the economy on healthy footing in 2002, it was forecasted that a sustained GDP growth would be 4.2 – 5.2 percent and GNP by 4.5 – 5.4 percent. Agriculture is expected to pace 3 – 4% in 2003 as the government continues to implement El Nino mitigating measures and other productivity-enhancing measures like distribution of high yielding seeds.

In industry, policies that will boost mining, housing and Small to Medium Enterprises (SME's) will support industrial growth in 2003 by 3.4 – 4.4%. Tariff rates for capital goods and other inputs not locally produced have been reduced to one percent in December 2002; this should provide buffer to manufacturing sector as they cope with expected oil price increases.

Services is expected growing 5.2 – 6.3%, led by telecommunication, trade and private services. Policies to liberalize air transportation, and measures to boost housing should further keep services healthy. In banking and finance, the implementation of the Special Purpose Vehicle Act will pave the way for greater financial activity in 2003 and over the medium term. Continued macroeconomic stability, especially those relating to fiscal policy, will be important to sustaining economic growth.

ENERGY

The Philippines' energy sector is relatively dynamic. Major reforms are underway, as are projects to electrify isolated villages, to reduce the Philippines' dependence on imported oil, and to change the relative composition of fuel consumption. The Philippine Energy Plan (PEP) for the period 2003-2012 complements and reinforces the macroeconomic goals of the arroyo administration to promote balanced economic growth, poverty alleviation and a market based energy industry. With this macroeconomic goals as basis, Department of energy sets down the goals for the energy sector which is as follows: 1) Stable and secure energy supply 2) Wider access to energy supply 3) Fair and reasonable energy prices 4) Clean and efficient energy fuels and infrastructures 5) Enhanced consumer welfare and protection 6) Technology transfer and manpower development 7) Job creation from energy activities

OIL

The Philippines began 2001 producing an average of only 1,000 barrels per day (bbl/d) of oil. Production jumped to 20,000 bbl/d by October, and reached 22,000 bbl/d by year's end. This dramatic increase was due primarily to the discovery of new deep-sea oil deposits beneath the natural gas-bearing structures in the Malampaya field. But while new hydrocarbon discoveries will significantly reduce the Philippines' oil import bill, the country is still a highly dependent net oil importer. The Philippines consumed 356,000 bbl/d on average in 2001 and produced 8,460 bbl/d, resulting in net oil imports of 347,540 bbl/d.

This dependence on imported oil makes the Philippine economy vulnerable to sudden spikes in world oil prices. For example, the Philippine oil import bill increased over 70% during the first eight months of 2000. The Philippine Institute of Petroleum estimates that local oil companies lost between 3.5-4.0 billion pesos in 2000 due to their inability to adjust petroleum prices to fully reflect the increased cost of imported oil and foreign exchange depreciation. Oil consumption is expected to increase by 5.9% annually over the next several years as economic growth increases demand in most sectors. Oil demand for power generation, however, is expected to decline by over 50% by 2011, as the government retires aging oil-fired electric power plants and switches to natural gas and alternative power sources.

Despite small proven oil reserves, the Philippines had enjoyed a recent wave of optimism amongst domestic and foreign drillers. In October of 2001, exploration underneath the Malampaya gas field revealed an estimated 85 million barrels of oil condensate. Shell Philippines Exploration (SPEX) has committed $4.5 billion to the combined oil/natural gas project, and anticipates potential crude oil production of 35,000-50,000 bbl/d by 2003. In addition, six new offshore explorations have commenced in the Malampaya basin, led by Nido Petroleum, Philippines National Oil Company Exploration Corp., Trans-Asia Oil, Unocal Corp., and Philodril. Also, Trans-Asia has conducted exploratory drilling at the San Isidro well in the East Visayan Basin. This area may contain as much as 60 million barrels of oil according to some estimates. The Philippine government estimates reserves of up to 246 million barrels in northwestern Palawan, and 37.4 million barrels in the Minduro-Cuyo basin. The Philippines National Oil Company also expects to begin drilling in Lagao, Lambayong province in July of 2002, seeking an estimated 561 million barrels of oil.

Refining & Downstream
The Philippines' downstream oil industry is dominated by three companies: Petron, Pilipinas Shell (Royal Dutch/Shell's Philippine subsidiary), and Caltex (Philippines). Petron is the Philippines' largest oil refining and marketing company. The company was a wholly owned subsidiary of the state-owned Philippine National Oil Company (PNOC) until 1994. Currently, the Philippine government and Saudi Aramco each own 40% of the company, with the remaining 20% held by portfolio and institutional investors, making it the only publicly listed firm amongst the three oil majors. Petron's Limay, Bataan refinery has a crude processing capacity of 180,000 bbl/d. Petron's market share at the start of 2002 was 38.3%, a 3.4% gain over 2001. Caltex (Philippines), a subsidiary of Caltex, the Texaco-Chevron joint venture based in Singapore, operates a 86,500-bbl/d refinery, two terminals, and more than 1,000 gasoline stations throughout the Philippines. Its market share is 23.8%, a 2.2% gain over 2001. Pilipinas Shell has a 153,000-bbl/d refinery, one of the largest foreign investments in the Philippines, and operates some 1,000 Shell gas stations. Shell's market share is 38%, a 4.7% gain over 2001. Overall, Philippine refineries run at around 80% of capacity, and there is not a great deal of demand for new refinery construction.
Oil market deregulation, beginning in 1998, continues to have a significant effect on the industry. Since deregulation started, 62 new firms, including TotalfinaElf, Flying V, SeaOil (Philippines), Eastern Petroleum, Trans-Asia Energy and Unioil Petroleum Philippines Inc., have invested $13 billion and built approximately 312 new retail stations. By the end of 2000, the new players had amassed 10.4% of the local oil market. These new entrants have organized the "New Players Petroleum Association of the Philippines" (NPPAP), and have been credited with putting significant downward pressure on retail fuel prices in the country. Currently, the Philippines enjoys the lowest fuel prices of any non oil-exporting Asian country. However, price swings associated with deregulation and higher world oil prices have angered many impoverished Filipinos. Despite public calls for explicit price controls, the government has remained committed to deregulation . In December 1999, the Supreme Court upheld the constitutionality of the country's deregulation program. The NPPAP has shown some opposition to the program, claiming its provisions are insufficient as new players have not been able to capture at least 30% of the market.

Major downstream developments on the horizon include a $600 million naptha cracker plant to be built by the Philippine National Oil Company in conjunction with Brunei's Mashor Group and Malaysia's Petron. The plant, which most likely will be supplied with natural gas from the Indonesian Dongi field, would enable the Philippines to become an independent producer of advanced petrochemical products and plastics. The government has also called for a new LNG receiving terminal to be built in Bataan to receive imported natural gas.

In January 2000, the Philippines' Department of Energy announced plans to accelerate the phase out of leaded gasoline. Leaded gasoline is banned already in Manila.

NATURAL GAS

The Philippines has 3.693 trillion cubic feet (Tcf) of proven natural gas reserves, but no significant production at the present. While in the past the gas sector has not been developed extensively, the government has made expanding gas use a priority, particularly for electric power generation, in an effort to cut oil import expenses. The government expects total domestic natural gas production to increase annually by 146.4 billion cubic feet (Bcf) to reach 1.5 Tcf by 2011.

The impetus for the dramatic change in the country's natural gas sector is the Malampaya offshore field. Malampaya is the largest natural gas development project in Philippine history, and one of the largest-ever foreign investments in the country. Shell Philippines Exploration (SPEX, operator, with a 45% stake), Texaco (45%), and the PNOC (10%) have come together to form the Malampaya Deepwater Gas-to-Power Project. The Malampaya field is located in the South China Sea, off the northern island of Palawan, and contains an estimated 2.6 Tcf of natural gas. A 312-mile (504-kilometer) pipeline links the field to three power plants in Batangas. The pipeline is among the longest deep-water pipelines in the world, with half of its length more than 600 feet deep. With completion of the sub-sea pipeline and conversion of the first of three power stations, (San Rita, operated by British Gas and Philippines 1st Gas Corp.), the Malampaya project was officially inaugurated on October 16, 2001. Gas from Malampaya eventually will fire three power plants with a combined 2,700-megawatt (MW) capacity for the next twenty years and will displace 26 million barrels of fuel oil, according to the government. The BG/Philippines 1st Gas Corp. partnership has announced that it expects to have a second station, the San Lorenzo facility, converted for natural gas use by 2003. The government has publicly considered selling a 10% share in the Malampaya project to the public; however no date has yet been set for the IPO.

An $80 million joint venture between PNOC, RoyalDutchShell and Brunei's Mashor Group, to expand the pipeline from Batangas to Metro Manila is being planned. This pipeline would supply gas to additional power plants as well as the industrial and commercial sectors. PNOC has also commenced plans with Malaysian Petronas to build a 620-mile (1000-kilometer) line between the two countries, completing one of the five components in the developing ASEAN power grid.
A number of foreign and domestic firms also are looking at onshore and offshore exploration projects in the Philippines. A consortium of five companies (PNOC as operator holding 78.75%, and four Australian companies) is exploring natural gas fields on and around Fuga Island under Geophysical Survey and Exploration Contract 84. This area has been estimated to contain up to 5 Tcf of natural gas, but this is still unconfirmed. The Fuga 1 exploration well was plugged and abandoned in June 2000 after producing no hydrocarbons. This area, to the north of Luzon, is still being considered, however, for a pipeline to Taiwan if a large enough gas find comes into production. Also, exploration is soon to begin in Southern Cebu by two undisclosed American firms, as well as in the Sultan Kodurat province by undisclosed European and Middle Eastern firms. Three natural gas fields were closed down in 2001. Fields in the Tukankuden and the Cotabato Basin were shut down due to the proximity of rebel soldiers, while another field in

Victoria, Tarlac, was closed because the gas discovered was too saturated with water for commercial production.

The Philippine government is developing a policy framework for the emerging gas industry that foresees the government's role as that of facilitator while attempting to ensure competition. Domestic development is to be encouraged, but competition from imported gas also is to be allowed. Gas supply to wholesale markets will have market-set prices, while prices for captive markets and small consumers will be regulated.

COAL

Development of new natural gas projects in the Philippines has come largely at the expense of the country's struggling coal industry**.** Despite producing 1.49 million short tons in 2000, PNOC announced that it plans to close its national coal subsidiary. The government also announced that many of the country's coal-fed power plants are being considered for conversion to natural gas, including the 600-MW Calaca plant south of Manila. Napocor, the National Power Company, has followed suit, ordering its coal-fired plants to operate at diminished capacity in order to allow more capacity for natural gas-fired plants. The country has decided to restructure the use of its 366 million short tons of estimated coal reserves, which is mostly low-rank lignite, for processing in smaller "clean coal" plants, for eventual end-use as household fuel, and briqueting. In the Department of Energy's 2002-2009 energy plan, three new smaller-scale plants are planned, including a $62 million 50-MW power plant in Isabela, which should be completed by 2005.

The Philippines consumed 9.5 million short tons of coal in 2000, eight million short tons of which were imported. Indonesia and China are major exporters of coal to the Philippines, and both have been in negotiations with Manila about increasing their quotas. There has been very little new exploration for coal in the Philippines since a methane explosion in 1997 killed many workers and caused public hostility to the industry. New plants have faced increasing opposition from both agricultural and church groups.

World Trade Organization (WTO) regulations require that the Philippines lift import restrictions on coal. Since the 1970s, when the National Coal Authority was created, Philippine coal importers have been required to obtain a government certificate of compliance before importing coal, allowing the authorities to force importers to buy domestic coal each time they purchased coal from abroad. President Macapagal Arroyo has committed to honoring the international coal supply contracts approved by the previous government.

ELECTRICITY

Energy production in the Philippines is concentrated in the electricity sector. Geothermal power accounts for the country's largest share of indigenous energy production, followed by hydropower, coal, oil and gas. The Philippine government has made shifting from reliance on imported oil a major goal, and is pushing the current boom in natural gas-fired electricity development.

The most significant event in the Philippine energy industry in recent years has been the Power Industry Reform Act of 2001. After 7 years of congressional debate and court cases, the Act came into force on June 26, 2001. The act has three main objectives: 1) to develop indigenous resources; 2) to cut the high cost of power in the Philippines; and 3) to encourage foreign investment. Passage of the Act sets into motion the deregulation of the power industry and the breakup and eventual privatization of state-owned enterprises. Actual sale of state assets and implementation of the program is not likely to take place until late 2002 or 2003.

The legislation requires the state-owned utility National Power Corporation (Napocor) to break-up its vertically integrated assets into smaller sub-sectors such as generation, transmission, distribution and supply in order to prepare for eventual privatization. The result will be a system in which privatized generators would sell directly to private distribution companies. Working with consultants from Hunton and Williams, Napocor has designated two new subsidiary companies designed solely for eventual privatization. These two firms, Transco and Psalmcorp, will entail the state's high voltage transmission lines and infrastructure, and power plants, respectively. The government also will sell off its share of Meralco, a smaller company that serves Manila and the immediate surrounding area by buying power from various Independent Power Producers (IPPs).

Napocor will need to transfer its existing power purchase obligations to private distributors, and also to renegotiate high-priced contracts. The cost savings lie in the fact that private distributors will likely be unwilling to enter into agreements that are above market rates. There are other financial incentives for the government as well. Napocor's huge debt and $9 billion in power purchase agreements are unsustainable, and the government must already contribute $300 million per year to keep Napocor afloat. Finally, the government needs more foreign investment in the sector as demand is projected to outpace supply by around 2005 at current rates of investment.

In order to make the sale of Napocor more attractive to investors, the government has absorbed a significant amount of Napocor's $6.7 billion debt. In addition, the $9 billion in power purchase agreements with IPPs also will be sold off. The transmission system will be transferred to an independent company, Transco, which is scheduled for privatization by mid-2002. Privatization of Transco, however, is contingent upon congressional approval for the rules governing a new wholesale spot market as well as a reduced transmission tariff, or "wheeling charge". According to deregulation laws, no one potential buyer will be allowed to own more than 30% of the Philippines' generating assets.

Electricity demand in the Philippines is expected to grow by around 9% per year through 2009, necessitating as much as 10,000 megawatts (MW) of new installed electric capacity. Current contracts will provide about half of that amount, with the remainder expected to be filled once the market deregulates. Medium-term increases in power demand are to be satisfied largely by the three gas-fired plants (Ilijan, Santa Rita, and Sucat) that will be linked to the Malampaya gas field, plus the coal-fired 470-MW Quezon Power Project that was inaugurated in June 2000. The Korea Electric Power Corporation (KEPCO) plans to complete the 1,200-MW Ilijan plant in 2002. KEPCO will run the plant under a build-operate-transfer scheme for 20 years, after which ownership will revert to Napocor. Minority stakeholders in the plant are Southern Energy of the

United States (20%) plus Mitsubishi (21%) and Kyushu Power (8%) of Japan. First Gas Power completed its 1,020-MW plant at Santa Rita in August 2000, with the plant running on condensate until gas becomes available. First Gas Power's subsidiary FGP Corporation is building a 500-MW power plant nearby the First Gas facility in Santa Rita, in Sucat. Operators are expected to begin by 2006.

Other power facilities planned, under construction, or recently completed include four small hydroelectric plants with a total capacity of 650 MW in the Mindanao region and three small diesel-fired plants in Oriental Mindoro operated by Southern Energy. The CE Casecnan Water and Energy Company (a subsidiary of California Energy International) is constructing a multipurpose irrigation and 150-MW hydroelectric facility in Luzon.

Southern Energy is the Philippines' largest IPP, operating five power plants in the country. Southern's new coal-fired Sual plant began commercial operation in late 1999. The 1,218-MW plant is located about 130 miles north of Manila, and reportedly is the nation's largest and lowest-cost electricity producer. Napocor is the sole purchaser of Sual electricity.

Several power-generating facilities also are under extensive rehabilitation. The 100-MW Binga hydroelectric plant in Itogon, Benguet has been under renovation since 1993 following damage from a 1990 earthquake. Due to political factors, this renovation has so far been unsuccessful, with the dam in worse shape now than in 1993. A larger project is the $470 million contract with Argentine firm IMPSA (*Industrias Metalurgicas Pescarmona Sociedad Anonima*) to rehabilitate and operate the 750-MW Caliray-Botocan-Kalayaan (CBK) power complex in Laguna, south of Manila. The CBK complex is the grid regulator in Luzon, and as such is able to transmit power to other plants on the grid in the event of breakdowns. IMPSA, in conjunction with new partner Edison Mission Energy of the United State, was able to get a performance undertaking guarantee despite Napocor's and some government officials' objections, facilitating long-delayed financing of the project.

In March 2000, Texas-based El Paso Energy International and Hawaiian Electric Industries formed a 50-50 joint venture to own and operate five power plants now owned by East Asia Power Resources Corporation, a public Philippine company. The total generation capacity of the venture's holdings will be 390 MW. The oil-fired plants are located in Manila and Cebu.

Volatility in electric power prices has angered many Filipinos, who blame the Power Industry Reform Act of 2001. The Act calls for an Energy Regulatory Board, which reviews and approves applications by the National Power Corporation for price increases. Controversy over pricing still exists, however, as the Association of Philippine Electric Cooperatives demonstrated in May of 2001 with an organized blackout to protest a 30 centavo rate increase instigated by Napocor.

The Philippines, due to its geography, has problems linking all of its islands together into one grid and ensuring availability of electric power to the remaining 9,708 villages without electricity. The government has set a target date of 2004 for electrification of all these villages through the 14-billion peso "O-Ilaw" program, and also is taking steps to link together the country's three major power grids (Luzon, Visayas, and Mindanao). As of March, 2002, the government claims the project is 85.6% complete. Where it is not economical to link small islands' grids into the national grid, separate local systems are being established around small generating plants.

Renewables

The Philippines is the world's second largest producer of geothermal power, with an available capacity of 1,931 MW, according to the Philippine government. The government would like to bring on another 990 MW, bringing capacity to 2,921MW, and exceeding the U.S. capacity of 2,775 MW. Geothermal power currently makes up around 16% of the Philippines' installed generation capacity, most of which has been developed by the PNOC - Energy Development Corporation (PNOC-EDC). Privatization of PNOC-EDC is expected in the near future, with several firms already expressing interest. PNOC-EDC bought Napocor's geothermal assets in March 2001. Kyushu Electric company is in a joint venture with PNOC-EDC to develop a 40-MW geothermal plant in Sorsogon, Albay province, and Marubeni of Japan has expressed its intent to build the 100-MW Cabalian geothermal plant in Leyte. California Energy's Philippine unit is working with PNOC to develop three new geothermal power plants in Leyte, producing a total of 540-MW of electricity. Plans are underway to develop nine new facilities in Luzon, ranging from 20 MW to120 MW that will eventually bring a total of 440 MW of geothermal energy to the grid. By 2004, the new 40-MW Mambucal and 40-MW Rangas power stations in Dauan, Negros Oriental are expected to come online.

Besides geothermal, the Philippines also is exploring the use of other renewables for electricity generation, particularly in the country's unelectrified villages. In December 2000, WorldWater Corp. signed an agreement with Cebu Electric Cooperative to provide 1,200 homes with solar electrification. In March 2001, the Philippine and Spanish governments, in conjunction with BP, agreed to a $48 million contract to bring solar power to 150 villages. BP and the government of Australia also have partnered with the Philippines to supply solar power to rural villages, bringing 1,145 solar-powered systems to 52 new municipalities. New solar-powered facilities were also inaugurated for villages on Samal Island on December 7, 2001.

The Philippines appears to have a strong potential for wind farming. The United States Department of Energy wind mapping survey estimates that wind resources in the Philippines have a power generation potential of as much as 70,000 MW, seven times the country's current power demand. Garrad Hassan Ltd. of the United Kingdom has expressed interest in a $220 million wind power pilot project. Another wind power project is the 40-MW, PNOC-EDC Northern Luzon project in Ilocos Norte, scheduled to begin operations in 2002. PNOC and the Japan Bank of International Cooperation also plan to build a $64.7 million, 40-MW wind farm in Burgos. The Burgos facility will be the country's first commercial wind farm, and may possibly be connected by a spur line to the Luzon Island power grid. This project is the first in a series of three to add 120 MW of wind power to the NAPCOR grid. A biomass waste-to-energy plant is planned for Negros Occidental that would use 450 tons of municipal waste and bagasse per hour.

Nuclear

In March 2000, the government announced that it would build a 600-MW nuclear power plant similar to the Bataan plant by 2020. However, the Bataan plant was declared inoperable due to its location on an earthquake fault, and the government continues to pay $250,000 per day to service the debt on the inoperable plant. The Triga Research Reactor, which dates from 1963, is to be replaced with a new 20-MW research reactor. However, though as it may say, energy from Nuclear sources is very unpopular proposition among Filipinos.

The Energy Conservation Technology Realized in Japanese Steel Industry

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The Energy Conservation Technology Realized in Japanese Steel Industry

February, 2003

The Energy Conservation Center, Japan
〔ECCJ〕

ECCJ

1

Main Activities of ECCJ

Industry

① Energy conservation audits services for factories
② Education & training on energy conservation
③ State examination for energy managers (assigned by the Gov.)
④ Technological development
⑤ Disseminating (conference for successful cases of E-C activities, excellent energy conserving equipment, etc.)
⑥ ISO14001 seminar for environmental inspectors

Residential & Commercial

① Energy conservation audits services for buildings
② Ranking catalogue for energy efficient appliances
③ Promotion of Energy labeling system
④ International energy star program implementation
⑤ Smart driving for energy conservation – Stop idling –
⑥ Energy conservation "navi"
⑦ Establishment of "energy conservation republic"
⑧ ESCO research and development

Overall

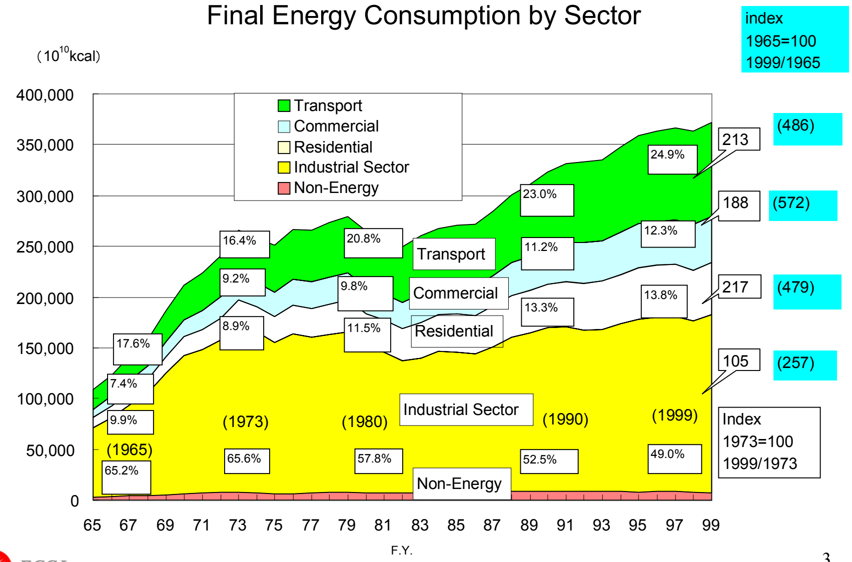
① Energy conservation campaign & exhibition (ENEX)
② Commendation (grand energy conservation prize)
③ Information & data base
④ Publicity and publishing
⑤ Consulting service through e-mail
⑥ International cooperation

ECCJ

2

1. Trends of Energy Consumption

Final Energy Consumption by Sector



ECCJ

3

Why did the manufacturing industry of Japan succeed in the energy conservation after the Oil Crisis?

- Cost reduction (enforcement of international competitiveness) and self-help efforts by companies
- Regulation measures by Government（Energy Conservation Law）
- Support and subsidy system by Government（finance, tax, subsidiary aid）

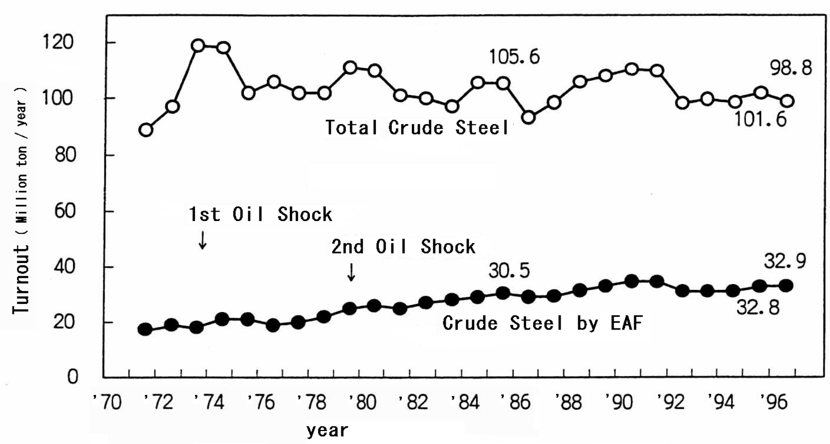
Mutual effect, synergy

Japan became the first class in energy conservation technology by the rapid progress of energy conservation.

ECCJ

4

Trend of Crude Steel Production of EAF in Japan



ECCJ

5

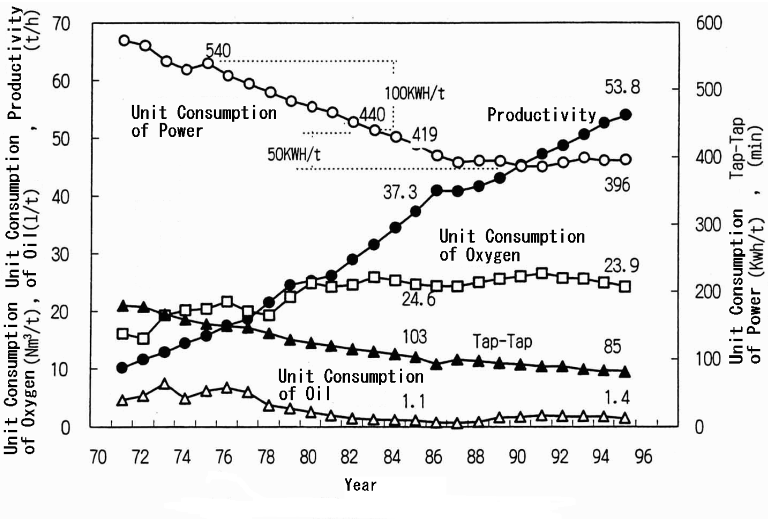
Activity Incentives for Energy Conservation

1. **Cost-down of Energy, Fuel and Electricity**
2. **Improvement in Productivity and Rationalization in Production System**
3. **Fulfillment of Company's Social Responsibility, Load Reduction to Global Environment**

ECCJ

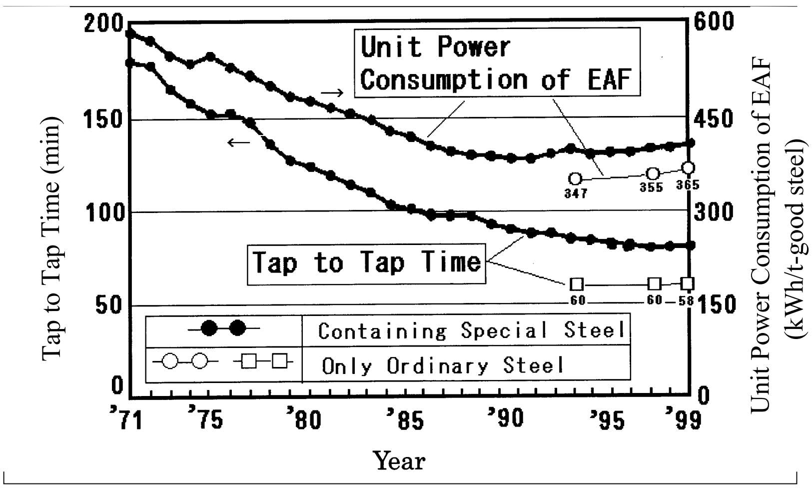
6

Trend of EAF Operation Data in Japan



ECCJ

Example of Trend in Operation Indexes of EAF



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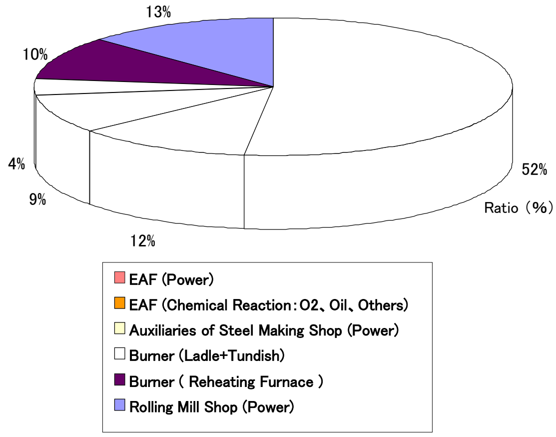
Example of the Energy Items in Japan's Mini Mill

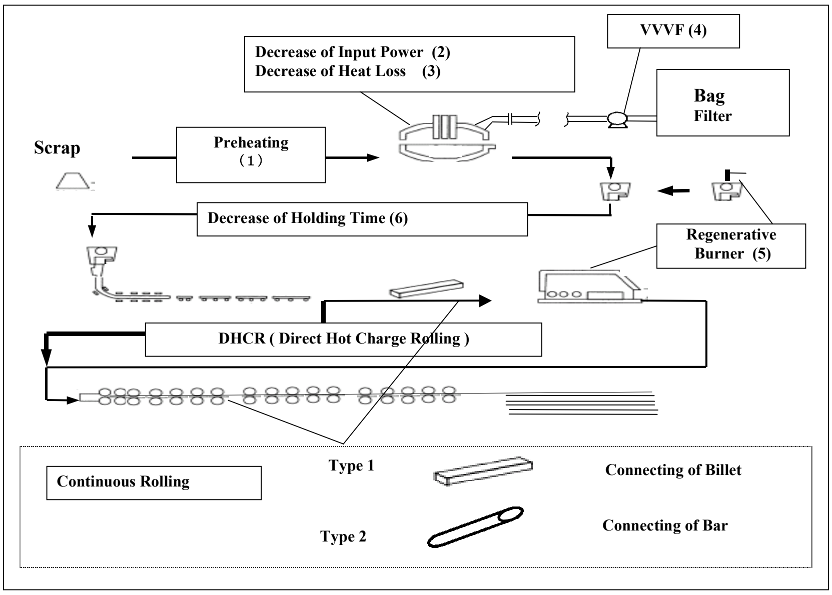
(Products: Steel Bars for Concrete Reinforcement)



ECCJ

9

Several Energy Saving Technology in Material Flow Chart



Energy Conservation for EAF-Mini Mill Factory

1) Energy conservation in EAF shop

1-1) EAF

a) Increasing of input energy

- Enrichment of O_2

According to above countermeasure

- ***Increasing of Oil (Burner), Carbon, Low cost alloys (Al ash, Bundle made from Can, etc)***

ECCJ

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b) Increasing of efficiency in input energy

- Power

Common (DC, AC) :

- **VVVF** ***control of electrode lifting***
- ***Foaming slag control in refining stage, etc***

AC : Al-arm, Reactor (in case of enough capacity of power station and high voltage operation), etc

- Other

Post combustion (Shaft furnace), Supersonic lance, etc

ECCJ

12

c) Decreasing of output energy

- *Increasing of heat size*
- *Decreasing of Tap to Tap time and waiting time of the time after tapping (from tapping to the start of ladle teeming)*
- *Decreasing of heat loss by slag*
  - *Hot recycle of slag, Control of scrap's dust, etc*
- *Scrap preheating*

  Shaft furnace with decreasing technology of dioxin
- *Others*

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1-2) Others

- *Decreasing of power saving in auxiliaries*
  - *VVVF control in the motor of dust collector, etc*

2) Energy conservation in Ladle and CC

- *Regenerative burner of ladle*
- *Matching of the productivity between EAF and CC*

3) Energy conservation in Rolling Mill

- *Regenerative burner of reheatig furnace*
- *DHCR (Direct Hot Charge Rolling), etc*
- *Matching of the productivity between CC and Mill*

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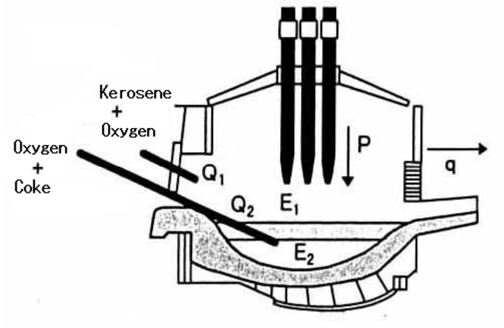
Conceptual Drawing of Heat Balance at EAF



P= Input power
(Thermal efficiency η)

q= Thermal loss per hour

Q= Kerosene heating value Q_1
+ Oxidization heating value Q_2

E_1= Sensible heat of slag

E_2= Sensible heat of molten steel

T = Time (Melting and Heatig)

$$(P\eta - q)T + Q = E_1 + E_2$$

$$T = \{(E_1 + E_2) - Q\}/(P\eta - q)$$

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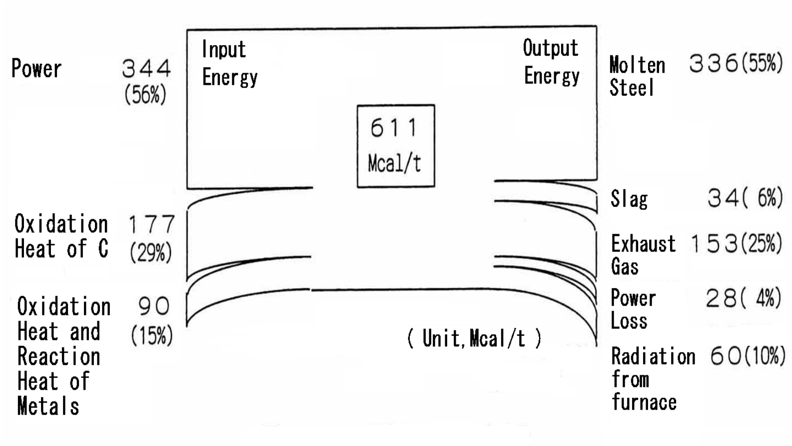
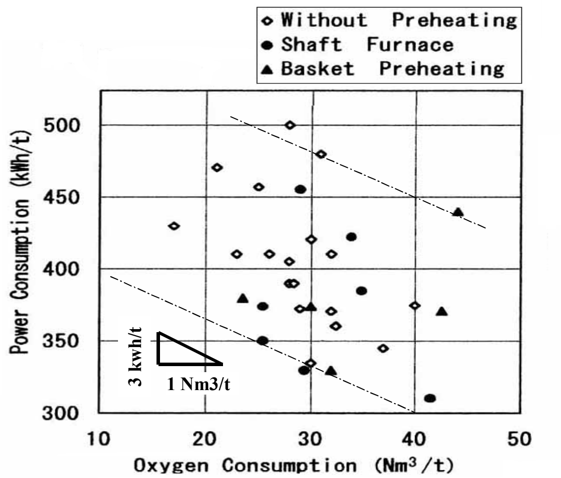
Example of Heat Balance in EAF



ECCJ 16

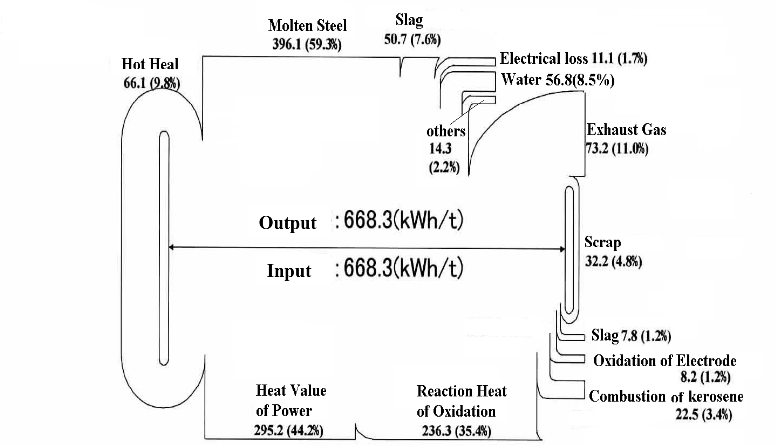
Influence of Oxygen and Reheat on Power Consumption



ECCJ

17

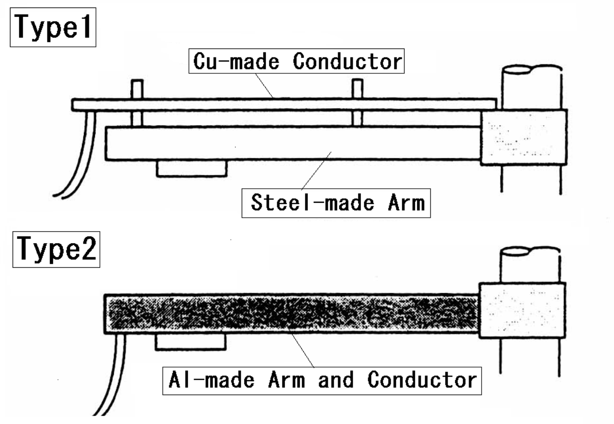
Example of Heat Balance in EAF (With Al ash)



ECCJ

18

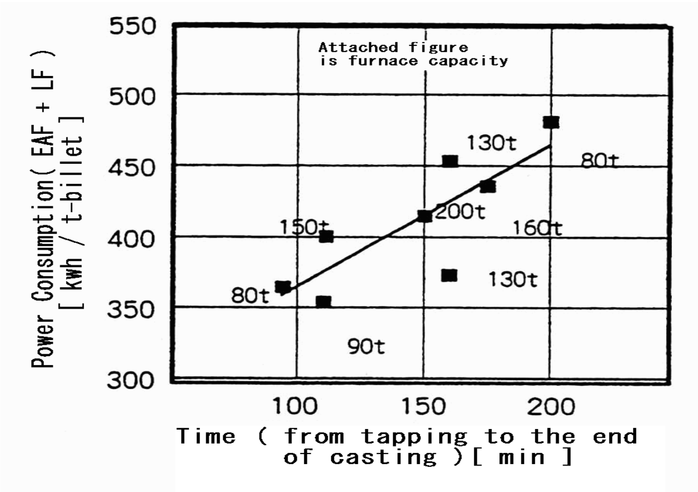
Secondary Conductive Arm



Effect （Type2 - Type1 ）= 5～10 kwh/t-billet

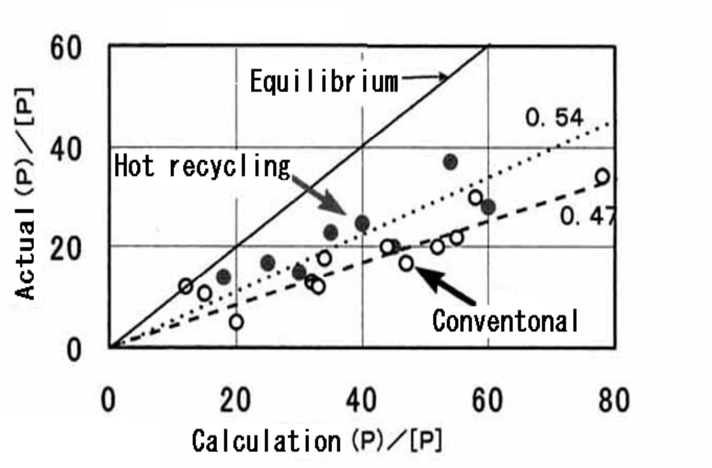
ECCJ 19

Relationship between Power Consumption and the Time from Tapping to the End of Casting



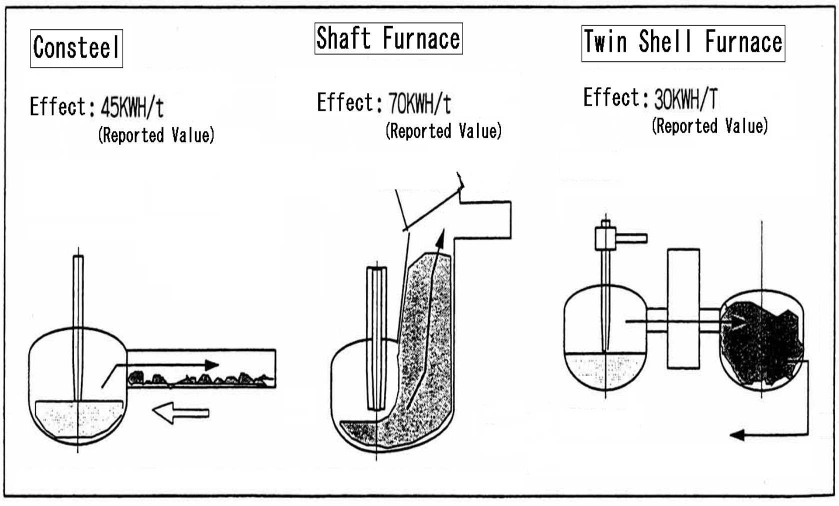
ECCJ 20

Hot Recycling of EAF Slag
(Less slag-off after tapping)



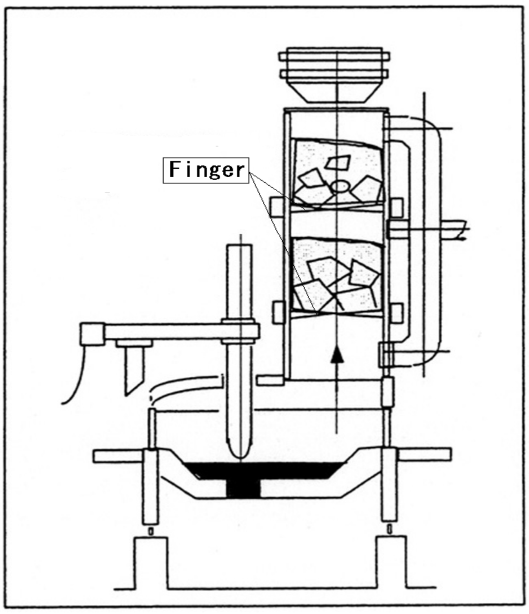
ECCJ 21

Several Type in Recent Scrap Preheating



ECCJ 22

Shaft Furnace A (2 Finger Type)



ECCJ

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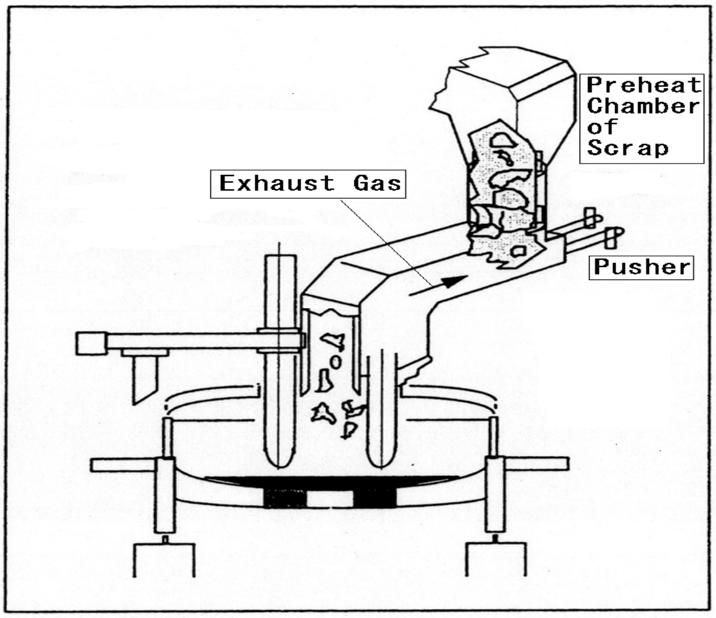
Shaft Furnace B



ECCJ

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Effect of VVVF

	Without VVVF	With VVVF
Blower Motor of Direct Dust Collector (970KW)	970*0.85*MIN/60 =960KWH/CH (1CH:70 MIN)	970*0.85*{1*11/60+0.85^3*10/60+0.75^3*49/60} =520 KWH/CH
Power Consumption	960/80 =12 KWH/t	520/80 =6.5 KWH/t
Difference	5.5KWH/t	

ECCJ

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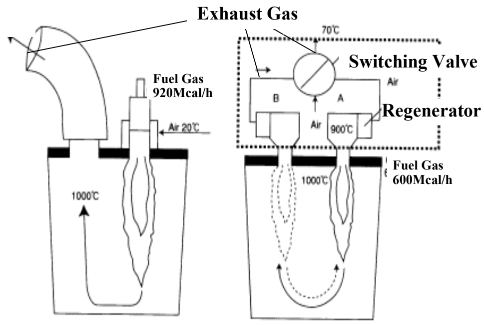
Regenerative Burner of Ladle



Conventional **Regenerative Burner**

Effect

Reduction Ratio of Fuel

= -51%

[Condition]

- **Ladle Capacity ; 100 t**
- **Heating Time ; 10 hour**

ECCJ

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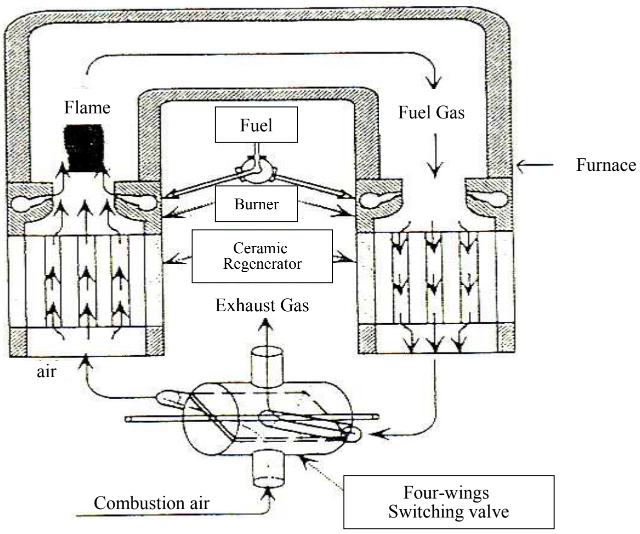
Concept Drawing of Regenerative Burner



ECCJ

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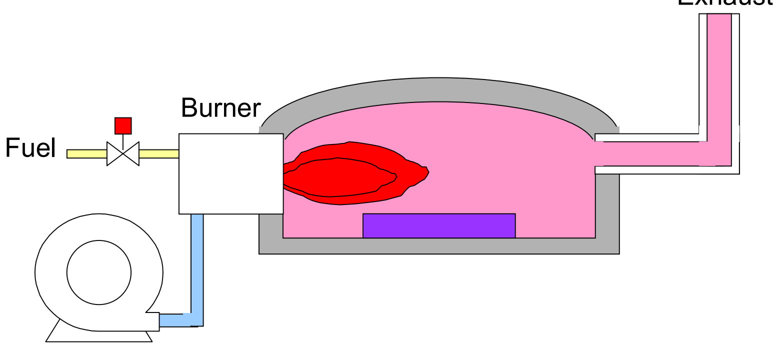
Regular Industrial Furnace

When waste heat recovery is not implemented, the exhaust temperature is almost equal to furnace heating temperature



ECCJ

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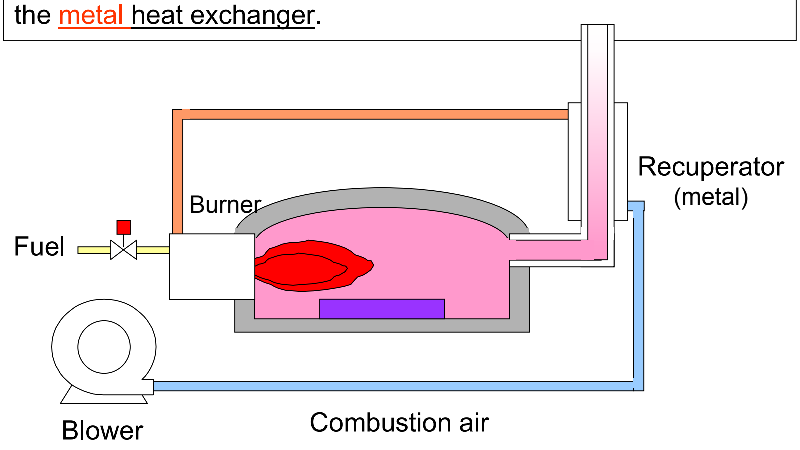
High-performance Industrial Furnace (1)

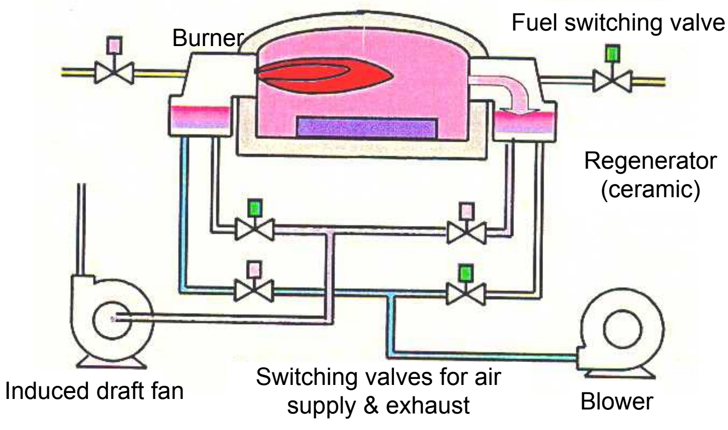
Typical energy conservation is to preheat the combustion air with the metal heat exchanger.



ECCJ 29

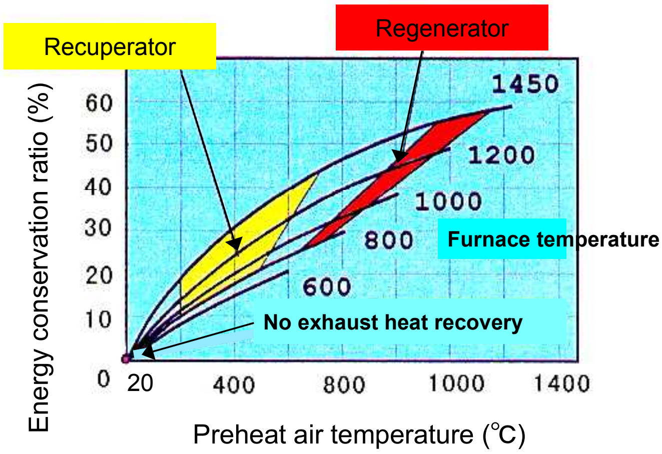
High-performance Industrial Furnace (2)

Locate a pair of burners with a built-in ceramic storage heat exchanger.
Combust and exhaust in turn, implement high temperature preheat (heat recovery) of combustion air.



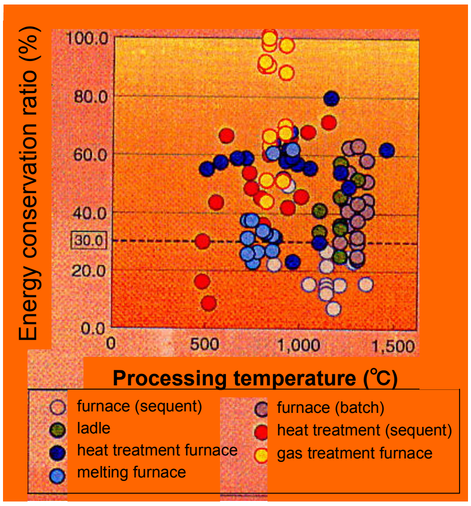
ECCJ 30

High-performance Industrial Furnace & Regular Industrial Furnace



ECCJ

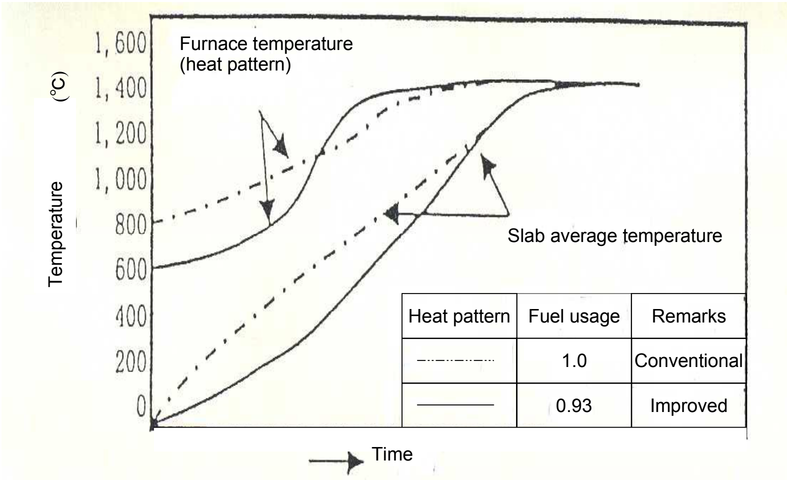
Demonstration of energy conservation effect by High-performance Industrial Furnace



"Field test program of introduction of high performance industrial furnace" (1998-2000)

ECCJ

Effect of Heat Pattern Change in Furnace



Heat pattern	Fuel usage	Remarks
—··—··—··—	1.0	Conventional
————	0.93	Improved

ECCJ

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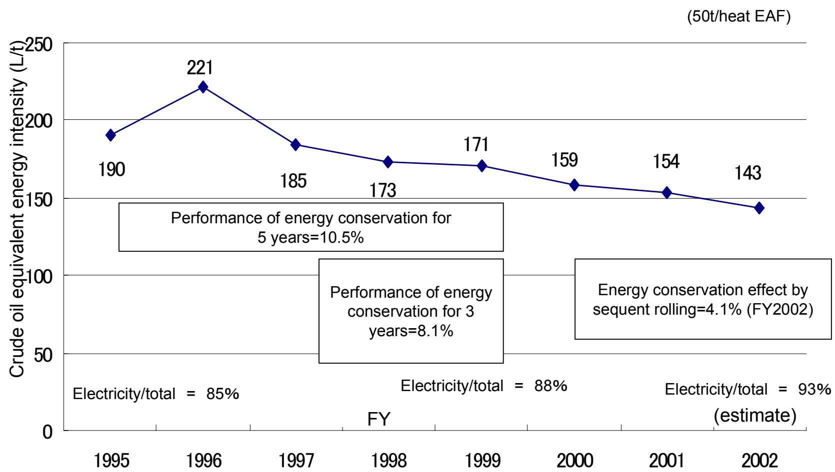
Transition of Total Energy Intensity (crude oil equivalent)



ECCJ

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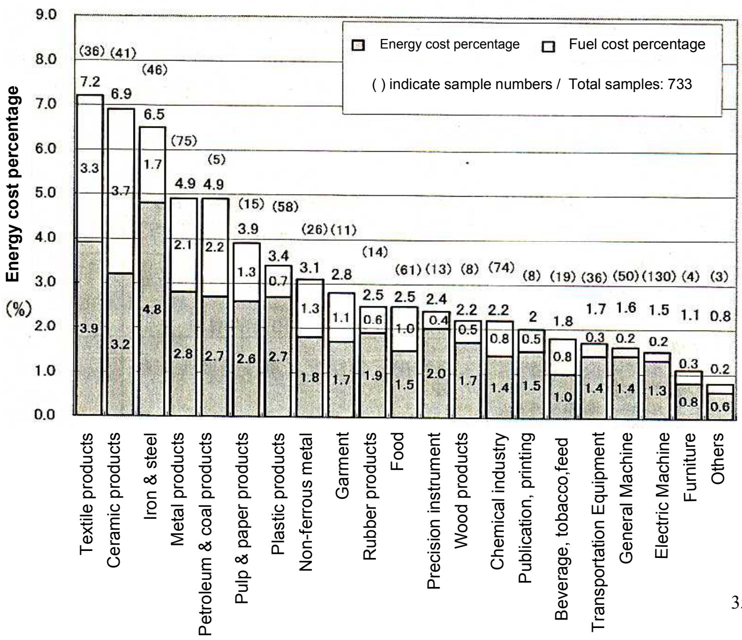
Energy Cost Ratio in Small & Medium Industries (Japan)



ECCJ

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More Information

- You can find information regarding ECCJ's activities as well as trends of energy efficiency and conservation in Japan through accessing ECCJ's Internet Home Page:
- URL: http://www.eccj.or.jp/index_e.html

ECCJ

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[A] Information Required for ASEAN Industry Audit (EAF Steel Industry)

[I] Necessary information （Answers to Questionnaire） before audit execution

(We want following information by November 29, 2002)

1. Company general information for factory energy consumption
2. Production of Major Products
3. Utility consumption data
   3-A Steel-making process (Daily, Monthly and Annual)
   3-B Rolling process (Daily, Monthly and Annual)
4. Electric power receiving
5. Boiler
6. Major energy consuming facilities

[II] Necessary information during the audit execution

7. Necessary drawings and documents including energy intensity
8. Energy conservation plan
9. Energy conservation items in the past (including results)
10. Energy conservation items undergoing (including expected results)

11 Problem items if you have.

[III] Item as requirement for steel maker selection

Two factories in the area of Manila, Philippines

[IV] Necessary measuring instruments

Please prepare following measuring instruments for audit execution.

Temperature gauge (Non-touch radiance type)
Luxmeter,
Clamp type Ammeter (0~300A or 500A),
Clamp type Wattmeter
Pressure gauge,
Gas analyzer,
Thermo-camera

[B] Company Information for Factory Energy Conservation / Questionnaire

[EAF Steel Industry]

Company Name	
Replied by	
Division	
Date	

1. General

1	Name of Factory		
2	Address		
3	President		
	Factory Manager		
	Energy Manager		
4	Type of Industry		
5	Capital		
6	Annual Sales Amount		
7	Number of Employees		
8	Number of Engineers		
		Electrical Engineers	
		Mechanical (Heat) Engineers	
9	Organization Chart		
10	Brief Company History		
11	Meteorological		

2. Production of Major Products

No.	Name of Production	Production Capacity	1999			2000			2001			2002		
			Annual Operating Hour	Production Volume (ton)	Sales Amount (ton)	Annual Operating Hour	Production Volume (ton)	Sales Amount (ton)	Annual Operating Hour	Production Volume (ton)	Sales Amount (ton)	Annual Operating Hour	Production Volume (ton)	Sales Amount (ton)
1	Steel-making process													
1)	Steel ingot													
2)	CC billet													
3)	CC Bloom													
4)	CC slab.													
2	Rolling process													
1)	Plate													
2)	Steel bar													
3)	Shape steel													
4)	Sheet													
3	Utility													
1)	Electric power													
2)	Steam													
3)	Oxygen													
4)	Nitrogen													
5)	Compressed air													
6)	Water gas													
7)	Others													

3A-1. Daily Utility Consumption

Steel-making process (Scrap pretreatment, Steel-making, Casting, Material handling and Transportation)

No.	Name of Utility	Month / Date																															Total
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	
1	Electricity (kWh)																																
2	Fuel Oil (kL)																																
3	Diesel Oil (kL)																																
4	Kerosene (kL)																																
5	Gasoline (kL)																																
6	LPG (t)																																
7	Natural Gas (m^3)																																
8	Coal (t)																																
9	Coke (t)																																
10	Oxygen (m^3)																																
11	Nitrogen (m^3)																																
12	Compressed Air (m^3)																																
13	Steam (t)																																
14	River Water (m^3)																																
15	Well Water (m^3)																																
16	City Water (m^3)																																
17																																	
18	Production (t/y)																																
19																																	
20																																	

3A-2 Monthly Utility Consumption

Steel-making process (Scrap pretreatment, Steel-making, Casting, Material handling and Transportation)

No.	Name of Utility	Lower Heat Value	2001												
			January	February	March	April	May	June	July	August	September	October	November	December	Total
1	Electricity (kWh)														
2	Fuel Oil (kL)														
3	Diesel Oil (kL)														
4	Kerosene (kL)														
5	Gasoline (kL)														
6	LPG (t)														
7	Natural Gas (m^3)														
8	Coal (t)														
9	Coke (t)														
10	Oxygen (m^3)														
11	Nitrogen (m^3)														
12	Compressed Air (m^3)														
13	Steam (t)														
14	River Water (m^3)														
15	Well Water (m^3)														
16	City Water (m^3)														
17															
18	Production (t/y)														
19															
20															

3A-3 Annual Utility Consumption

Steel-making process (Scrap pretreatment, Steel-making, Casting, Material handling and Transportation)

No.	Name of Utility	Lower Heat Value	1999			2000			2001			2002		
			Consumption (kWh,kL,t,m^3)	Unit Price (PHP)	Purchase Amount (PHP)	Consumption (kWh,kL,t,m^3)	Unit Price (PHP)	Purchase Amount (PHP)	Consumption (kWh,kL,t,m^3)	Unit Price (PHP)	Purchase Amount (PHP)	Consumption (kWh,kL,t,m^3)	Unit Price (PHP)	Purchase Amount (PHP)
1	Electricity (kWh)													
2	Fuel Oil (kL)													
3	Diesel Oil (kL)													
4	Kerosene (kL)													
5	Gasoline (kL)													
6	LPG (t)													
7	Natural Gas (m^3)													
8	Coal (t)													
9	Coke (t)													
10	Oxygen (m^3)													
11	Nitrogen (m^3)													
12	Compressed Air (m^3)													
13	Steam (t)													
14	River Water (m^3)													
15	Well Water (m^3)													
16	City Water (m^3)													
17														
18														
19														
20														

3B-1. Daily Utility Consumption

Rolling process (Heating Furnace, Rolling, Transportation & Shipping)

No.	Name of Utility	Month / Date																															Total
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	
1	Electricity (kWh)																																
2	Fuel Oil (kL)																																
3	Diesel Oil (kL)																																
4	Kerosene (kL)																																
5	Gasoline (kL)																																
6	LPG (t)																																
7	Natural Gas (m^3)																																
8	Coal (t)																																
9	Coke (t)																																
10	Oxygen (m^3)																																
11	Nitrogen (m^3)																																
12	Compressed Air (m^3)																																
13	Steam (t)																																
14	River Water (m^3)																																
15	Well Water (m^3)																																
16	City Water (m^3)																																
17																																	
18	Production (t/y)																																
19																																	
20																																	

3B-2 Monthly Utility Consumption

Rolling process (Heating Furnace, Rolling, Transportation & Shipping)

No.	Name of Utility	Lower Heat Value	2001												
			January	February	March	April	May	June	July	August	September	October	November	December	Total
1	Electricity (kWh)														
2	Fuel Oil (kL)														
3	Diesel Oil (kL)														
4	Kerosene (kL)														
5	Gasoline (kL)														
6	LPG (t)														
7	Natural Gas (m^3)														
8	Coal (t)														
9	Coke (t)														
10	Oxygen (m^3)														
11	Nitrogen (m^3)														
12	Compressed Air (m^3)														
13	Steam (t)														
14	River Water (m^3)														
15	Well Water (m^3)														
16	City Water (m^3)														
17															
18	Production (t/y)														
19															
20															

3B-3 Annual Utility Consumption

Rolling process (Heating Furnace, Rolling, Transportation & Shipping)

No.	Name of Utility	Lower Heat Value	1999			2000			2001			2002		
			Consumption (kWh,kL,t,m^3)	Unit Price (PHP)	Purchase Amount (PHP)	Consumption (kWh,kL,t,m^3)	Unit Price (PHP)	Purchase Amount (PHP)	Consumption (kWh,kL,t,m^3)	Unit Price (PHP)	Purchase Amount (PHP)	Consumption (kWh,kL,t,m^3)	Unit Price (PHP)	Purchase Amount (PHP)
1	Electricity (kWh)													
2	Fuel Oil (kL)													
3	Diesel Oil (kL)													
4	Kerosene (kL)													
5	Gasoline (kL)													
6	LPG (t)													
7	Natural Gas (m^3)													
8	Coal (t)													
9	Coke (t)													
10	Oxygen (m^3)													
11	Nitrogen (m^3)													
12	Compressed Air (m^3)													
13	Steam (t)													
14	River Water (m^3)													
15	Well Water (m^3)													
16	City Water (m^3)													
17														
18														
19														
20														

4. Electric Power Receiving

No.	Items	Unit	1999	2000	2001	2002	Note
1	Receiving Voltage	kV					
2	Maximum Demand	MW					
3	Annual Electricity Consumption	MWh					
4	Paid Amount of Electricity	PHP					
5	Power Factor						
6	Annual Operating Hour	h/y					
7	Average Electricity	MW					
8	Maximum Electricity	MW					
9	Transformer Capacity per Unit	MVA					
10	Number of Transformers						
11	In-house Generation Capacity	MW					

5. Boiler

No.	Boiler No.	1	2	3	4		
1	Type						
2	Built Year						
3	Nominal Capacity (Steam)						
	Steam Pressure (kg/cm^{2}G)						
	Steam Temperature (℃)						
	Evaporating Volume (t/h)						
4	Nominal Capacity (Electricity)						
	Generated Electricity (kWh)						
	Generated Voltage (kV)						
	Power Factor						
5	Kind of Fuel						
	Fuel Consumption						
6	Operating Period **(Hours/Day)**						
	1999						
	2000						
	2001						
	2002						
7	Operating Period **(Hours/Year)**						
	1999						
	2000						
	2001						
	2002						

6. Major Energy Consuming Facilities

No.	Name of Equipment	Built Year	Kind of Product	Kind of Energy	Nominal Output of Product	Operating Period and Output											
						1999			2000			2001			2002		
						H/Day	D/Y	Output	H/Day	D/Y	Output	H/Day	D/Y	Output	H/Day	D/Y	Output
1	Steel-making process																
1.1	Scrap pretreatment, Handling																
1.2	Electric furnace																
1.3	2nd refining equipment																
	Ladle/Tundish heater																
1.4	Ingot casting																
1.5	Continuous casting																
1.6	De-dusting equipment																
1.7	Others																
2	Rolling process																
2.1	Plate mill																
2.2	Steel bar mill																
2.3	Shape steel mill																
2.4	Cold rolling mill																
2.5	Heating furnace																
2.6	Others																
3	Utility																
3.1	Power generation																
3.2	Steam boiler																
3.3	Oxygen generator																
3.4	Water treatment/supply station																
3.5	Others																
4	Others																
4.1	Transportation/Material handling																

7. Necessary Drawings and Documents

No.	Items
1	Plant Layout
2	Process Flowchart of Major Products
3	Energy Flowchart
4	Electric Skeleton Diagram
5	Structural Drawing of Major Equipment
	Measuring Points and Name of Instruments for Energy Consumption
6	Specification and Structural Drawings of Boiler

7	Energy Intensity : Energy Consumption / Output of Products						
No.	Kind of Product	Kind of Energy	Unit	1999	2000	2001	2002
a	(Example)	Production	t/y	300,000	320,000	320,000	350,000
	Steel bar	Fuel Oil	kL/y	30,000	32,000	31,000	33,000
		Electricity	MWh/y	30,000	32,000	32,000	33,000
b		Production					
c		Production					
d		Production					
e		Production					
f		Production					

8. Energy Conservation Plan

9. Energy Conservation Items in the Past (including results)

10. Energy Conservation Items Undergoing (including expected results)

11. In case you have any problem(s) in your course of promotion of energy conservation, please circle the number(s) of applicable item(s) among the following.

1	Uncertainty of energy prospect
2	Less impact of energy cost to the whole cost of the enterprise
3	The increasing energy cost can be covered by rising the price of products
4	Little possibility of energy shortage
5	Little potential for promoting further energy conservation
6	Shortage of engineers
7	Difficulty in obtaining good energy efficient equipment
8	Unreliable results from energy efficient equipment
9	Uncertainty about return of investment in energy conservation facilities
10	Difficulty in obtaining good information such as successful case of energy saving activities
11	Insufficient system of research and development
12	Shortage of fund for facility improvement and modification
13	Out-of-date facilities
14	Low consciousness of employees
15	Lack of personnel who can educate the employees
16	Shortage of measuring equipment
17	No time to analyze energy consumption rate
18	Shortage of information on government's measures
19	Shortage of government's subsidiary measures
20	Others (Please add comments)

Philippines

The Philippines is important to world energy markets because it is a growing consumer of energy, particularly electric power, and a major potential market for foreign energy firms. It also may become a major producer of natural gas.

BACKGROUND

The new millennium has brought about important changes to the island nation of the Philippines. With the installation of former Vice-President Gloria Macapagal-Arroyo on January 20, 2001, the Philippines has undertaken an economic transformation, deregulating its energy sector and offering new incentives for foreign investment. President Macapagal-Arroyo, a trained economist, came into power when former President Joseph Estrada was forced from office. Under Macapagal-Arroyo, key economic indicators, including GDP growth rate, foreign investment, and inflation have trended favorably. But while a certain degree of success has been achieved, the country’s fiscal deficit, declining currency, and regional inequality are still problematic. A major natural gas discovery in the Malampaya field, officially inaugurated in October of 2001, coupled with increasing military support from the United States could prove to have a significant impact on the country's future.

ECONOMY

Real Gross Domestic Product (GDP) grew by 4.6 % and Gross National Product (GNP) by 5.2% in 2002. This increase exceeded both Philippine and international expectations. Much of the country's renewed economic vibrancy results from improved agricultural yields with a positive growth of 3.5%, as well as from an increase in domestic consumption brought about by curbed inflation. Growing confidence in the Macapagal-Arroyo administration, as well as the excitement surrounding the sizable Malampaya natural gas field also have had a positive effect. Foreign investment shot up 171%, to $3.4 billion in 2001, as investors gained confidence in Manila's political climate as well as a newly deregulated and privatized energy sector.

In services, benefits of deregulation in the telecommunication sector grew robustly by 8.9%. Trade continues to benefit from strong consumer demand, as giant local retailers opened up new malls in regions outside Metro Manila.

With the economy on healthy footing in 2002, it was forecasted that a sustained GDP growth would be 4.2 – 5.2 percent and GNP by 4.5 – 5.4 percent. Agriculture is expected to pace 3 – 4% in 2003 as the government continues to implement El Nino mitigating measures and other productivity-enhancing measures like distribution of high yielding seeds.

In industry, policies that will boost mining, housing and Small to Medium Enterprises (SME’s) will support industrial growth in 2003 by 3.4 – 4.4%. Tariff rates for capital goods and other inputs not locally produced have been reduced to one percent in December 2002; this should provide buffer to manufacturing sector as they cope with expected oil price increases.

Services is expected growing 5.2 – 6.3%, led by telecommunication, trade and private services. Policies to liberalize air transportation, and measures to boost housing should further keep services healthy. In banking and finance, the implementation of the Special Purpose Vehicle Act will pave the way for greater financial activity in 2003 and over the medium term. Continued macroeconomic stability, especially those relating to fiscal policy, will be important to sustaining economic growth.

ENERGY

The Philippines' energy sector is relatively dynamic. Major reforms are underway, as are projects to electrify isolated villages, to reduce the Philippines' dependence on imported oil, and to change the relative composition of fuel consumption. The Philippine Energy Plan (PEP) for the period 2003-2012 complements and reinforces the macroeconomic goals of the arroyo administration to promote balanced economic growth, poverty alleviation and a market based energy industry. With this macroeconomic goals as basis, Department of energy sets down the goals for the energy sector which is as follows: 1) Stable and secure energy supply 2) Wider access to energy supply 3) Fair and reasonable energy prices 4) Clean and efficient energy fuels and infrastructures 5) Enhanced consumer welfare and protection 6) Technology transfer and manpower development 7) Job creation from energy activities

OIL

The Philippines began 2001 producing an average of only 1,000 barrels per day (bbl/d) of oil. Production jumped to 20,000 bbl/d by October, and reached 22,000 bbl/d by year's end. This dramatic increase was due primarily to the discovery of new deep-sea oil deposits beneath the natural gas-bearing structures in the Malampaya field. But while new hydrocarbon discoveries will significantly reduce the Philippines' oil import bill, the country is still a highly dependent net oil importer. The Philippines consumed 356,000 bbl/d on average in 2001 and produced 8,460 bbl/d, resulting in net oil imports of 347,540 bbl/d.

This dependence on imported oil makes the Philippine economy vulnerable to sudden spikes in world oil prices. For example, the Philippine oil import bill increased over 70% during the first eight months of 2000. The Philippine Institute of Petroleum estimates that local oil companies lost between 3.5-4.0 billion pesos in 2000 due to their inability to adjust petroleum prices to fully reflect the increased cost of imported oil and foreign exchange depreciation. Oil consumption is expected to increase by 5.9% annually over the next several years as economic growth increases demand in most sectors. Oil demand for power generation, however, is expected to decline by over 50% by 2011, as the government retires aging oil-fired electric power plants and switches to natural gas and alternative power sources.

Despite small proven oil reserves, the Philippines had enjoyed a recent wave of optimism amongst domestic and foreign drillers. In October of 2001, exploration underneath the Malampaya gas field revealed an estimated 85 million barrels of oil condensate. Shell Philippines Exploration (SPEX) has committed $4.5 billion to the combined oil/natural gas project, and anticipates potential crude oil production of 35,000-50,000 bbl/d by 2003. In addition, six new offshore explorations have commenced in the Malampaya basin, led by Nido Petroleum, Philippines National Oil Company Exploration Corp., Trans-Asia Oil, Unocal Corp., and Philodril. Also, Trans-Asia has conducted exploratory drilling at the San Isidro well in the East Visayan Basin. This area may contain as much as 60 million barrels of oil according to some estimates. The Philippine government estimates reserves of up to 246 million barrels in northwestern Palawan, and 37.4 million barrels in the Minduro-Cuyo basin. The Philippines National Oil Company also expects to begin drilling in Lagao, Lambayong province in July of 2002, seeking an estimated 561 million barrels of oil.

Refining & Downstream

The Philippines' downstream oil industry is dominated by three companies: Petron, Pilipinas Shell (Royal Dutch/Shell's Philippine subsidiary), and Caltex (Philippines). Petron is the Philippines' largest oil refining and marketing company. The company was a wholly owned subsidiary of the state-owned Philippine National Oil Company (PNOC) until 1994. Currently, the Philippine government and Saudi Aramco each own 40% of the company, with the remaining 20% held by portfolio and institutional investors, making it the only publicly listed firm amongst the three oil majors. Petron's Limay, Bataan refinery has a crude processing capacity of 180,000 bbl/d. Petron's market share at the start of 2002 was 38.3%, a 3.4% gain over 2001. Caltex (Philippines), a subsidiary of Caltex, the Texaco-Chevron joint venture based in Singapore, operates a 86,500-bbl/d refinery, two terminals, and more than 1,000 gasoline stations throughout the Philippines. Its market share is 23.8%, a 2.2% gain over 2001. Pilipinas Shell has a 153,000-bbl/d refinery, one of the largest foreign investments in the Philippines, and operates some 1,000 Shell gas stations. Shell's market share is 38%, a 4.7% gain over 2001. Overall, Philippine refineries run at around 80% of capacity, and there is not a great deal of demand for new refinery construction.

Oil market deregulation, beginning in 1998, continues to have a significant effect on the industry. Since deregulation started, 62 new firms, including TotalfinaElf, Flying V, SeaOil (Philippines), Eastern Petroleum, Trans-Asia Energy and Unioil Petroleum Philippines Inc., have invested $13 billion and built approximately 312 new retail stations. By the end of 2000, the new players had amassed 10.4% of the local oil market. These new entrants have organized the "New Players Petroleum Association of the Philippines" (NPPAP), and have been credited with putting significant downward pressure on retail fuel prices in the country. Currently, the Philippines enjoys the lowest fuel prices of any non oil-exporting Asian country. However, price swings associated with deregulation and higher world oil prices have angered many impoverished Filipinos. Despite public calls for explicit price controls, the government has remained committed to deregulation . In December 1999, the Supreme Court upheld the constitutionality of the country's deregulation program. The NPPAP has shown some opposition to the program, claiming its provisions are insufficient as new players have not been able to capture at least 30% of the market.

Major downstream developments on the horizon include a $600 million naptha cracker plant to be built by the Philippine National Oil Company in conjunction with Brunei's Mashor Group and Malaysia's Petron. The plant, which most likely will be supplied with natural gas from the Indonesian Dongi field, would enable the Philippines to become an independent producer of advanced petrochemical products and plastics. The government has also called for a new LNG receiving terminal to be built in Bataan to receive imported natural gas.

In January 2000, the Philippines' Department of Energy announced plans to accelerate the phase out of leaded gasoline. Leaded gasoline is banned already in Manila.

NATURAL GAS

The Philippines has 3.693 trillion cubic feet (Tcf) of proven natural gas reserves, but no significant production at the present. While in the past the gas sector has not been developed extensively, the government has made expanding gas use a priority, particularly for electric power generation, in an effort to cut oil import expenses. The government expects total domestic natural gas production to increase annually by 146.4 billion cubic feet (Bcf) to reach 1.5 Tcf by 2011.

The impetus for the dramatic change in the country's natural gas sector is the Malampaya offshore field. Malampaya is the largest natural gas development project in Philippine history, and one of the largest-ever foreign investments in the country. Shell Philippines Exploration (SPEX, operator, with a 45% stake), Texaco (45%), and the PNOC (10%) have come together to form the Malampaya Deepwater Gas-to-Power Project. The Malampaya field is located in the South China Sea, off the northern island of Palawan, and contains an estimated 2.6 Tcf of natural gas. A 312-mile (504-kilometer) pipeline links the field to three power plants in Batangas. The pipeline is among the longest deep-water pipelines in the world, with half of its length more than 600 feet deep. With completion of the sub-sea pipeline and conversion of the first of three power stations, (San Rita, operated by British Gas and Philippines 1st Gas Corp.), the Malampaya project was officially inaugurated on October 16, 2001. Gas from Malampaya eventually will fire three power plants with a combined 2,700-megawatt (MW) capacity for the next twenty years and will displace 26 million barrels of fuel oil, according to the government. The BG/Philippines 1st Gas Corp. partnership has announced that it expects to have a second station, the San Lorenzo facility, converted for natural gas use by 2003. The government has publicly considered selling a 10% share in the Malampaya project to the public; however no date has yet been set for the IPO.

An $80 million joint venture between PNOC, RoyalDutchShell and Brunei's Mashor Group, to expand the pipeline from Batangas to Metro Manila is being planned. This pipeline would supply gas to additional power plants as well as the industrial and commercial sectors. PNOC has also commenced plans with Malaysian Petronas to build a 620-mile (1000-kilometer) line between the two countries, completing one of the five components in the developing ASEAN power grid.
A number of foreign and domestic firms also are looking at onshore and offshore exploration projects in the Philippines. A consortium of five companies (PNOC as operator holding 78.75%, and four Australian companies) is exploring natural gas fields on and around Fuga Island under Geophysical Survey and Exploration Contract 84. This area has been estimated to contain up to 5 Tcf of natural gas, but this is still unconfirmed. The Fuga 1 exploration well was plugged and abandoned in June 2000 after producing no hydrocarbons. This area, to the north of Luzon, is still being considered, however, for a pipeline to Taiwan if a large enough gas find comes into production. Also, exploration is soon to begin in Southern Cebu by two undisclosed American firms, as well as in the Sultan Kodurat province by undisclosed European and Middle Eastern firms. Three natural gas fields were closed down in 2001. Fields in the Tukankuden and the Cotabato Basin were shut down due to the proximity of rebel soldiers, while another field in

Victoria, Tarlac, was closed because the gas discovered was too saturated with water for commercial production.

The Philippine government is developing a policy framework for the emerging gas industry that foresees the government's role as that of facilitator while attempting to ensure competition. Domestic development is to be encouraged, but competition from imported gas also is to be allowed. Gas supply to wholesale markets will have market-set prices, while prices for captive markets and small consumers will be regulated.

COAL

Development of new natural gas projects in the Philippines has come largely at the expense of the country's struggling coal industry**.** Despite producing 1.49 million short tons in 2000, PNOC announced that it plans to close its national coal subsidiary. The government also announced that many of the country's coal-fed power plants are being considered for conversion to natural gas, including the 600-MW Calaca plant south of Manila. Napocor, the National Power Company, has followed suit, ordering its coal-fired plants to operate at diminished capacity in order to allow more capacity for natural gas-fired plants. The country has decided to restructure the use of its 366 million short tons of estimated coal reserves, which is mostly low-rank lignite, for processing in smaller "clean coal" plants, for eventual end-use as household fuel, and briqueting. In the Department of Energy's 2002-2009 energy plan, three new smaller-scale plants are planned, including a $62 million 50-MW power plant in Isabela, which should be completed by 2005.

The Philippines consumed 9.5 million short tons of coal in 2000, eight million short tons of which were imported. Indonesia and China are major exporters of coal to the Philippines, and both have been in negotiations with Manila about increasing their quotas. There has been very little new exploration for coal in the Philippines since a methane explosion in 1997 killed many workers and caused public hostility to the industry. New plants have faced increasing opposition from both agricultural and church groups.

World Trade Organization (WTO) regulations require that the Philippines lift import restrictions on coal. Since the 1970s, when the National Coal Authority was created, Philippine coal importers have been required to obtain a government certificate of compliance before importing coal, allowing the authorities to force importers to buy domestic coal each time they purchased coal from abroad. President Macapagal Arroyo has committed to honoring the international coal supply contracts approved by the previous government.

ELECTRICITY

Energy production in the Philippines is concentrated in the electricity sector. Geothermal power accounts for the country's largest share of indigenous energy production, followed by hydropower, coal, oil and gas. The Philippine government has made shifting from reliance on imported oil a major goal, and is pushing the current boom in natural gas-fired electricity development.

The most significant event in the Philippine energy industry in recent years has been the Power Industry Reform Act of 2001. After 7 years of congressional debate and court cases, the Act came into force on June 26, 2001. The act has three main objectives: 1) to develop indigenous resources; 2) to cut the high cost of power in the Philippines; and 3) to encourage foreign investment. Passage of the Act sets into motion the deregulation of the power industry and the breakup and eventual privatization of state-owned enterprises. Actual sale of state assets and implementation of the program is not likely to take place until late 2002 or 2003.

The legislation requires the state-owned utility National Power Corporation (Napocor) to break-up its vertically integrated assets into smaller sub-sectors such as generation, transmission, distribution and supply in order to prepare for eventual privatization. The result will be a system in which privatized generators would sell directly to private distribution companies. Working with consultants from Hunton and Williams, Napocor has designated two new subsidiary companies designed solely for eventual privatization. These two firms, Transco and Psalmcorp, will entail the state's high voltage transmission lines and infrastructure, and power plants, respectively. The government also will sell off its share of Meralco, a smaller company that serves Manila and the immediate surrounding area by buying power from various Independent Power Producers (IPPs).

Napocor will need to transfer its existing power purchase obligations to private distributors, and also to renegotiate high-priced contracts. The cost savings lie in the fact that private distributors will likely be unwilling to enter into agreements that are above market rates. There are other financial incentives for the government as well. Napocor's huge debt and $9 billion in power purchase agreements are unsustainable, and the government must already contribute $300 million per year to keep Napocor afloat. Finally, the government needs more foreign investment in the sector as demand is projected to outpace supply by around 2005 at current rates of investment.

In order to make the sale of Napocor more attractive to investors, the government has absorbed a significant amount of Napocor's $6.7 billion debt. In addition, the $9 billion in power purchase agreements with IPPs also will be sold off. The transmission system will be transferred to an independent company, Transco, which is scheduled for privatization by mid-2002. Privatization of Transco, however, is contingent upon congressional approval for the rules governing a new wholesale spot market as well as a reduced transmission tariff, or "wheeling charge". According to deregulation laws, no one potential buyer will be allowed to own more than 30% of the Philippines' generating assets.

Electricity demand in the Philippines is expected to grow by around 9% per year through 2009, necessitating as much as 10,000 megawatts (MW) of new installed electric capacity. Current contracts will provide about half of that amount, with the remainder expected to be filled once the market deregulates. Medium-term increases in power demand are to be satisfied largely by the three gas-fired plants (Ilijan, Santa Rita, and Sucat) that will be linked to the Malampaya gas field, plus the coal-fired 470-MW Quezon Power Project that was inaugurated in June 2000. The Korea Electric Power Corporation (KEPCO) plans to complete the 1,200-MW Ilijan plant in 2002. KEPCO will run the plant under a build-operate-transfer scheme for 20 years, after which ownership will revert to Napocor. Minority stakeholders in the plant are Southern Energy of the

United States (20%) plus Mitsubishi (21%) and Kyushu Power (8%) of Japan. First Gas Power completed its 1,020-MW plant at Santa Rita in August 2000, with the plant running on condensate until gas becomes available. First Gas Power's subsidiary FGP Corporation is building a 500-MW power plant nearby the First Gas facility in Santa Rita, in Sucat. Operators are expected to begin by 2006.

Other power facilities planned, under construction, or recently completed include four small hydroelectric plants with a total capacity of 650 MW in the Mindanao region and three small diesel-fired plants in Oriental Mindoro operated by Southern Energy. The CE Casecnan Water and Energy Company (a subsidiary of California Energy International) is constructing a multipurpose irrigation and 150-MW hydroelectric facility in Luzon.

Southern Energy is the Philippines' largest IPP, operating five power plants in the country. Southern's new coal-fired Sual plant began commercial operation in late 1999. The 1,218-MW plant is located about 130 miles north of Manila, and reportedly is the nation's largest and lowest-cost electricity producer. Napocor is the sole purchaser of Sual electricity.

Several power-generating facilities also are under extensive rehabilitation. The 100-MW Binga hydroelectric plant in Itogon, Benguet has been under renovation since 1993 following damage from a 1990 earthquake. Due to political factors, this renovation has so far been unsuccessful, with the dam in worse shape now than in 1993. A larger project is the $470 million contract with Argentine firm IMPSA (*Industrias Metalurgicas Pescarmona Sociedad Anonima*) to rehabilitate and operate the 750-MW Caliray-Botocan-Kalayaan (CBK) power complex in Laguna, south of Manila. The CBK complex is the grid regulator in Luzon, and as such is able to transmit power to other plants on the grid in the event of breakdowns. IMPSA, in conjunction with new partner Edison Mission Energy of the United State, was able to get a performance undertaking guarantee despite Napocor's and some government officials' objections, facilitating long-delayed financing of the project.
In March 2000, Texas-based El Paso Energy International and Hawaiian Electric Industries formed a 50-50 joint venture to own and operate five power plants now owned by East Asia Power Resources Corporation, a public Philippine company. The total generation capacity of the venture's holdings will be 390 MW. The oil-fired plants are located in Manila and Cebu.

Volatility in electric power prices has angered many Filipinos, who blame the Power Industry Reform Act of 2001. The Act calls for an Energy Regulatory Board, which reviews and approves applications by the National Power Corporation for price increases. Controversy over pricing still exists, however, as the Association of Philippine Electric Cooperatives demonstrated in May of 2001 with an organized blackout to protest a 30 centavo rate increase instigated by Napocor.

The Philippines, due to its geography, has problems linking all of its islands together into one grid and ensuring availability of electric power to the remaining 9,708 villages without electricity. The government has set a target date of 2004 for electrification of all these villages through the 14-billion peso "O-Ilaw" program, and also is taking steps to link together the country's three major power grids (Luzon, Visayas, and Mindanao). As of March, 2002, the government claims the project is 85.6% complete. Where it is not economical to link small islands' grids into the national grid, separate local systems are being established around small generating plants.

Renewables

The Philippines is the world's second largest producer of geothermal power, with an available capacity of 1,931 MW, according to the Philippine government. The government would like to bring on another 990 MW, bringing capacity to 2,921MW, and exceeding the U.S. capacity of 2,775 MW. Geothermal power currently makes up around 16% of the Philippines' installed generation capacity, most of which has been developed by the PNOC - Energy Development Corporation (PNOC-EDC). Privatization of PNOC-EDC is expected in the near future, with several firms already expressing interest. PNOC-EDC bought Napocor's geothermal assets in March 2001. Kyushu Electric company is in a joint venture with PNOC-EDC to develop a 40-MW geothermal plant in Sorsogon, Albay province, and Marubeni of Japan has expressed its intent to build the 100-MW Cabalian geothermal plant in Leyte. California Energy's Philippine unit is working with PNOC to develop three new geothermal power plants in Leyte, producing a total of 540-MW of electricity. Plans are underway to develop nine new facilities in Luzon, ranging from 20 MW to120 MW that will eventually bring a total of 440 MW of geothermal energy to the grid. By 2004, the new 40-MW Mambucal and 40-MW Rangas power stations in Dauan, Negros Oriental are expected to come online.

Besides geothermal, the Philippines also is exploring the use of other renewables for electricity generation, particularly in the country's unelectrified villages. In December 2000, WorldWater Corp. signed an agreement with Cebu Electric Cooperative to provide 1,200 homes with solar electrification. In March 2001, the Philippine and Spanish governments, in conjunction with BP, agreed to a $48 million contract to bring solar power to 150 villages. BP and the government of Australia also have partnered with the Philippines to supply solar power to rural villages, bringing 1,145 solar-powered systems to 52 new municipalities. New solar-powered facilities were also inaugurated for villages on Samal Island on December 7, 2001.

The Philippines appears to have a strong potential for wind farming. The United States Department of Energy wind mapping survey estimates that wind resources in the Philippines have a power generation potential of as much as 70,000 MW, seven times the country's current power demand. Garrad Hassan Ltd. of the United Kingdom has expressed interest in a $220 million wind power pilot project. Another wind power project is the 40-MW, PNOC-EDC Northern Luzon project in Ilocos Norte, scheduled to begin operations in 2002. PNOC and the Japan Bank of International Cooperation also plan to build a $64.7 million, 40-MW wind farm in Burgos. The Burgos facility will be the country's first commercial wind farm, and may possibly be connected by a spur line to the Luzon Island power grid. This project is the first in a series of three to add 120 MW of wind power to the NAPCOR grid. A biomass waste-to-energy plant is planned for Negros Occidental that would use 450 tons of municipal waste and bagasse per hour.

Nuclear

In March 2000, the government announced that it would build a 600-MW nuclear power plant similar to the Bataan plant by 2020. However, the Bataan plant was declared inoperable due to its location on an earthquake fault, and the government continues to pay $250,000 per day to service the debt on the inoperable plant. The Triga Research Reactor, which dates from 1963, is to be replaced with a new 20-MW research reactor. However, though as it may say, energy from Nuclear sources is very unpopular proposition among Filipinos.

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