2005 Achievement Report

International Project for Increasing the Efficient Use of Energy
International Project for Improving Infrastructure for the Efficient Use of Energy
(Programs for Promotion of Energy Conservation in Major Industries in ASEAN Countries)

Report on the Results

March, 2006

The Energy Conservation Center, Japan

Preface

Recently, efforts to prevent global warming have been recognized as a challenge to be shared by all humankind, while sustainable development of economy has been sought for. Mankind is facing with the challenge of overcoming the two different conditions entirely conflicting each other.
In order to get over these severe conditions, what are required are technical innovations such as technologies to use energy efficiently with as little burden on the environment as possible and the development of energy having little impact on the environment, etc.
In order to contribute to the balanced development of economy and environment in developing countries, it is necessary to render support that is adoptable and appropriate to the respective countries concerned based on the understanding of the actual condition of their energy use and environmental measures and on the results of in-depth surveys on the progress in development of infrastructure, living habits, etc.

Under these circumstances, we advanced to and worked on a new stage in this project as the second year followed by 2004 that aimed to strengthen the infrastructure for implementing and promoting energy audits and improvement plans, on the strength of the achievements of the energy audits and energy audit skills transfer programs that we implemented in 10 ASEAN counties regarding one selected industry per country during the past 4 years, 2000~2003.
For an effective tool to help achieve such an aim, we carried on to create the Technical Directory and Database/Benchmarks/Guidelines by business category.
In the meanwhile, as the activities to strengthen the infrastructure for the mentioned implementation and promotion, we conducted follow-up surveys on the factories that were subject to energy audit in the past to check the progress in the practice of the recommended improvement plans and also walk through energy audits in other factories to ensure the transfer of energy audit skills. In 2005, the factories that received our follow-up survey and walk through energy audit included that of the garment factories in Cambodia, the steel factories in Philippines, a pulp & paper and a textile factory in Indonesia and a cement and beverage factory in Brunei Darussalam. Furthermore, we held seminar and workshop in each country, inviting people from the government agency or factories of different categories of industries in countries other than the host country to make a report on their successful energy conservation cases so that information could be shared in the ASEAN region and the foundation of promotion activities could be provided. In the seminars and workshops, the concept and development policy regarding the creation of the Technical Directory and particularly database by category of industry were discussed, and a concrete example as a part was shown off.
We believe it is very meaningful that as the result of the activities for the second year in the project, we could achieve the above objectives and create steadily the bases of the promotion of energy conservation in the new stage.
We hope that this project will contribute to energy conservation in the industrial sector and environmental protection in the respective ASEAN countries so that they can eventually achieve environment-friendly and sustainable development in economy and also that this project will serve as a bridge of technical exchange and friendship between Japan and the countries concerned.

March, 2006
The Energy Conservation Center, Japan

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Questionnaires and answers of audited factories
Seminar-Workshop programs and presented materials at 4 countries
Materials for the Summary/Post Workshop

Summary

ASEAN counties are continuing to achieve dramatic economic development and their energy consumption is anticipated to increase rapidly from now on. It will become vital to use energy more efficiently and to give sufficient consideration to prevention of global warming.

This project has entered its 6th year. ASEAN Center for Energy (ACE), our ASEAN counterpart and people concerned of the respective ASEAN countries are engaged in more and more enhanced and substantial energy conservation activities, thereby contributing to gradually spread change in the consciousness of the people in ASEAN countries toward the reduction of energy consumption, particularly with the increases in energy price resulting from the recent soaring crude oil prices and the Kyoto Protocol put into force in the background.

The current year was positioned as the second year of the 2nd stage for making serious efforts to put into practice and disseminate the results we have made to date by combining all the achievements we made in the projects of the phase-1, past 4 years and making further self-supporting efforts. In other words, the 2nd stage aims to establish the infrastructure for implementing and promoting practical improvements centered on improvement plans discussed and proposed in the respective countries in the past, based on the achievements and results of energy audits conducted on factories of 10 different types of businesses in all ASEAN countries over the past 4 years.

Specifically, the following activities were developed in 4 countries; Cambodia (garment industry), Philippines (steel industry), Indonesia (pulp/paper and textile industries) and Brunei Darussalam (cement and food processing industries).

- Follow-up survey on the factories that underwent an energy audit in the past and walk through energy audits on newly chosen factories
  Intended for understanding of the problems lying in carrying out, promoting improvement plans and the development of improvement measures
- Creation of Technical Directory
  Intended to introduce effective technologies usable in garment/steel/pulp & paper/cement industries in ASEAN countries and also successful cases of the utilization of the respective technologies for the purpose of information-sharing and enhancing the possibility of implementation and dissemination of these technologies
- Development of databases/benchmarks/guidelines
  Intended to establish a scheme for setting numerical targets to advance energy conservation activities and providing guide lines to achieve such goals
  As an immediate task, the development of databases in 4 categories of businesses; Garment/steel/pulp & paper/cement, is essential.

In the above mentioned countries, surveys including energy audits and seminars/workshops were conducted. In the survey conducted in each country, guidance was given to the local people concerned on the site again while the progress in their acquisition of energy audit skills

transferred from Japanese specialists in the past was confirmed so that technology transfer could be further ensured. In addition, as it was found in the survey that some factories had not practiced improvements as instructed, factors seemingly constituting impediments to the implementation as well as solutions were discussed, which lead to create the clue for the implementation and progress in the future.
In the seminar/workshop held in each country, in addition to the aforesaid discussions, people from the governments and the factories including those of different categories of industry in other ASEAN countries (including people of the factories undergoing energy audit in the past) were invited to join with the people of the factories of the countries concerned to report on their respective activities and the cases of practicing improvement plans. The seminar and workshop held in each country had a large number of participants each, playing an important role in terms of information sharing and dissemination.
On-site activities of the project of the current year were commenced with Inception Workshop held in late June 2005 (Same as the one for both Building and Energy Management Infrastructure Development Projects).
In the Inception Workshop, for the purpose of smooth launching of the project, the action plan was explained and finalized, and preparations for the activities at site were confirmed among the participants. Following that, surveys and workshops in 4 countries were smoothly completed by December 2005, and topped off by Summary /Post Workshops conducted in late January 2006 (common with Building and Energy Management Infrastructure Development Projects).
In Summary Workshop/Post Workshop where delegates from ASEAN countries (Focal Points) were present, reports on the activities and the results in the 4 countries, including those on the ASEAN Benchmarking activities and the results, were made with the view to knowledge- and information-sharing, and discussions regarding the creation of Technical Directory and the development of database/benchmark/guideline for each country were held. Finally, the policy for action plans for the project next year and in the future was discussed.

Specific details of activities of the major industry project for this year are as follows;

August 22-September 2, 2005 (Trip: August 21-September 3)
On-site activities in Cambodia and Philippines (Primary survey)

1. Follow-up survey on garment factories (Cambodia) and a steel factory (Philippines) surveyed in the past, and a walk through energy audit of a newly selected factories of garment/Cambodia and steel/Philippines
   Surveys on the factories were conducted and reporting of the results and discussions were made in each factory.

2. Seminar-workshop in each country
   40-60 people participated in each country and were engaged in active information exchange through vigorous discussions. The policy for creation of Technical Directory and the action policy regarding the development of database/benchmark/guideline proposed by Japan were

approved in principle from the participants. The seminar- workshop was concluded successfully.

(1) Energy conservation policy and program (each country and Japan)
(2) Report on energy conservation cases by people concerned in major industries in each host country and other ASEAN countries
(3) Discussions on the policy regarding the creation of Technical Directory
(4) Discussions on the action policy regarding the development of database in each host country

December 5-17 2005 (Trip: December 3-19);
On-site activities in Indonesia and Brunei Darussalam (Secondary survey)

1. Follow-up surveys on a pulp/paper factory (Indonesia) and a cement factory (Brunei Darussalam) surveyed in the past and a walk through energy audit of a newly selected factories of textile/Indonesia and food processing/Brunei Darussalam
   Surveys on the factories were conducted and reporting of the results and discussions were made in each factory.

2. Seminar-workshop in each country
   60-100 people participated in each country and were engaged in active information exchange through vigorous discussions. The policy for creation of Technical Directory and the action policy regarding the development of database/benchmark/guideline proposed by Japan were approved in principle from the participants. The seminar- workshop was concluded successfully.
   (1) Energy conservation policy and program (each country and Japan)
   (2) Report on energy conservation cases by people concerned in major industries in each host country and other ASEAN countries
   (3) Discussions on the policy regarding the creation of Technical Directory
   (4) Discussions on the action policy regarding the development of database in each host country

January 26-27, 2006 (Trip: January 25-29)
Summary Workshop /Post Workshop
Participated in “Summary Workshop and Post Workshop on Promotion of Energy Efficiency and Conservation (PROMEEC) (Major Industry, Building and Energy management), SOME-METT Work Program 2005-2006” (Venue: Bandung, Indonesia, same as the one for building and energy management infrastructure development)
Although delegates from Myanmar, Singapore and Vietnam were absent, about 22 people including delegates of ASEAN countries and members of ASEAN Center for Energy (ACE) and Energy Conservation Center, Japan (ECCJ) participated and had comprehensive discussions on the items given below. After reports of local activities at 4 countries by ECCJ and evaluation and future improvement of local activities prepared by 4 countries we visited this time and on

the policy regarding and the progress in the development of Database/Benchmark/Guideline in each country were made, lively and active discussions were held.
Although we confirmed that it remained our future challenge to make more efforts to improve mutual understanding of the specific ways of advancing these practical works, we could earn high evaluations from ASEAN countries on the results of our activities for this year and also gain agreement in principle on the policy for advancing the project in the years to come.

Opening address (Delegates of the countries surveyed and the organizations concerned)
Summary Workshop
Session 1: Major industries

- Activity report of this year/results and evaluations
- Evaluation and future improvement of local activities
- Country initiatives towards the preparation of TD and status / plan of Database preparation
- Status of preparation for TD and Database for major industries in ASEAN
- Policy for approaches to be taken after next year.

Session 2: Buildings
Session 3: Energy management

Post Workshop
Session 1: Summary of discussions held in Summary Workshop for each project
Session 2: Basic implementation plan for years after next

In the current fiscal year, with an aim to support ASEAN countries in the establishment of a firm foundation for developing continuous energy conservation activities, we improved the level of our activities, requesting them to further make self-help efforts. As we could gain cooperation in our activities from all the participating countries, we successfully made significant results. On the other hand, we recognized the necessity to gain further understanding of our improved activities and build a system in each country so that they could fully respond to us. Thus, our future task was clarified. At the same time, we appreciate such identification of our future issue as a step forward in our activities, because it looked emerging when our project made substantial advance and results.

Finally, we hereby would like to thank all those at ACE along with the organizations and companies concerned in each country for their all-out cooperation.

Abbreviation list

EE&C	Energy Efficiency and Conservation
TD	Technical Directory
DB/BM/GL	Database / Benchmark / Guideline
ACE	ASEAN Center for Energy
METI	Ministry of Economy, Trade and Industry
ECCJ	The Energy Conservation Center, Japan
Cambodia	
MIME	Ministry of Industry, Mines and Energy, Cambodia
EE&S Office	Energy Efficiency and Standard Office
EDC	Electricite du Cambodge
DET	Department of Energy Technique
Philippines	
DOE	Department of Energy
DOST	Department of Science and Technology
RE	Renewal Energy
MERALCO	Manila Electric Company (Old Name: Manila Electric Railroad and Light Company)
ECPH	Training course of Energy Conservation for the Philippines held at June, 2005 in Japan
FAS	Factory Automation System
WESM	Wholesale Electricity Spot Market
Indonesia	
MEMR	Ministry of Energy and Mineral Resources
DIP	De-Inking Plant
BIO	Biotechnology
PM	Paper Machine
PLN	Perusahaan Listric Negara PERSERO (Indonesia Electricity Corporation)
KONEBA	PT Konservasi Energi Abadi (Persero)
Brunei Darussalam	
DES	Department of Electrical Services, Prime Minister’s Office
BHC	Butra Heidelberg Cement
Malaysia	
PTM	Pusat Tenaga Malaysia（Malaysia Energy Center）

Ⅰ. Purpose and Background of the Project

This project generally aims to contribute to the promotion of energy conservation and environmental protection in Southeast Asian countries by helping promote energy conservation measures in the major industries in the countries concerned through providing support for activities on the ASEAN with the view to promote and disseminate technologies for the efficient use of energy in the major industrial fields.

This project was set up in 2000 with ASEAN Center for Energy as the core organization, with the aim of reducing ever-increasing energy consumption in the industrial sectors in the ASEAN region. ASEAN call this project PROMEEC (Major Industries). PROMEEC is an abbreviation of “Promotion of Energy Efficiency and Conservation” and a cooperative project with Ministry of Economy, Trade and Industry certified by the conference of ministers of energy-related ministries of 10 ASEAN countries. We are providing support for the promotion of energy conservation in the industrial sectors of ASEAN countries in the aspects of technology and management through the activities of the project.

The project has the following objectives;

1. To deepen and strengthen the cooperative relation between ASEAN countries and Japan in the energy field
2. To promote energy efficiency and energy conservation in the major industries in ASEAN countries.
3. To promote transfer of energy-related technologies of Japan and the introduction of good practice cases of energy conservation.
4. To raise the quality level of ASEAN countries through energy audits and OJT for energy audit
5. To create Database/Benchmark/Guideline for energy audit in ASEAN countries.

The current year is positioned as a second year of the activities to be developed in the second stage, with the understanding that this cooperative project are advanced in the 3 stages based on the discussions held to date with ASEAN countries including ACE. Through the activities we developed in all ASEAN countries by March 2004 in the first stage, we could build a foundation for developing energy conservation activities on an equal footing with ASEAN countries.

1st stage: Transfer of technologies and experiences from Japan to ASEAN countries (Completed in 2003)
2nd stage: Japan-ASEAN joint implementation of improvement plans in each country and promotion in other countries
3rd stage: Promotion of energy conservation with independent efforts by ASEAN countries

Starting in last year, we began to create a basis for advancing implementation and dissemination of energy conservation based on the prepared foundation. In short, our activities are centered at follow-up surveys on the factories that underwent energy audit in the past, the creation of Technical Directory and the development of Database/ Benchmark /Guideline for each category of industry. In the current fiscal year, we developed such activities mentioned above targeting the garment industry in Cambodia, the steel industry in Philippines, the pulp & paper industry in Indonesia and the Cement Industry in Brunei Darussalam.

In the respective countries, we conducted follow-up surveys on the factories that underwent an energy audit in the past to grasp the progress and the issues lying in the implementation of improvement plans and also OJT-based walk through energy audits of newly selected factories jointly with local people involved. In addition, we held seminar- workshop in which we invited instructors from a government agency or factories of several categories of business in the host country and other countries to introduce successful cases of implemented improvement plans and cases of cutting-edge energy conservation technology to further raise the awareness of energy conservation among ASEAN countries. The concept for promoting the creation of Technical Directory and Database/Benchmark/Guideline for the use of each country and practical preparation activities were discussed and the future direction was determined. These activities are intended to serve as the core work for establishing the foundation for promoting energy conservation in the respective countries subject to the survey and to establish networks to promote it to other countries.

In the end, we held Summary Workshop bringing together delegates of the respective countries to share the results and achievements of the activities made in the respective countries and to discuss the basic plan for future activities.

Ⅱ. Cambodia (Garment Industry)

1. Outline of the Activities

The follow-up energy audits of the companies that had performed energy audits in Phase I (Dec. 2002 and Feb. 2003) were conducted, and the Seminar-Workshop was held in Phnom Penh (Cambodia), which involved the results of follow-up energy audits and the presentations on practical examples for energy conservation in various industries.

This time, the energy audits were carried out in two garment factories as a follow-up and newly walk through energy audit in one garment factory.

In the inception workshop held in June 2005, it was agreed that, starting this fiscal year, the MIME should play a leading role in conducting follow-ups and reporting the results. However, the ECCJ eventually had to have an initiative instead. Furthermore, the problems were that, when we visited two garment factories, questionnaires, which had been sent to the MIME via the ACE prior to the visit, had not reached two factories. Therefore, it took long time obtaining and confirmation of the answers.

Here, we describe two garment companies as “Company A” and “Company B” according to demand of these companies.

1.1 Implementation Period

Aug. 22 ~ Aug. 26, 2005

1.2 Site of Implementation

Follow-up energy audit: Garment factories of Company A and M & V International Manufacturing Ltd. (in Phnom Penh)

Walk through energy audit of a new factory: Garment factory, Company B (in Phnom Penh)

Seminar-Workshop: Phnom Penh Hotel (in Phnom Penh)

1.3 Schedule (Material No. D-101E)

Aug. 22 (Mon.): Follow-up energy audit of the garment factory, Company A

Aug. 23 (Tue.): Follow-up energy audit of the garment factory, Company A, and walk through energy audit of a new garment factory, Company B

Aug. 24 (Wed.): Follow-up energy audit of the garment factory, M&V International Manufacturing Ltd.

Aug. 25 (Thu.): Follow-up energy audit of the garment factory, M&V International Manufacturing Ltd.

Aug. 26 (Fri.): Seminar-Workshop

1.4 Relevant Persons

ACE (ASEAN Center for Energy):

Mr. Christopher G. Zamora: Manager

Mr. Ivan Ismed: Project Officer

Cambodia: Ministry of Industry, Mines and Energy (MIME)

Mr. Lieng Vuthy, Deputy Director, Dep't of Energy Technique (DET)

Mr. Heang Bora, Head of Energy Efficiency and Standard (EE&S) Office, DET (Cambodia Focal Point)

Mr. Ly Chamroeun, Vice Chief Officer, EE&S Office

Mr. Nong Chhavyvann, EE&S Office, DET

Mr. Choun Teiea, EE&S Office, DET

Japan: International Engineering Department, ECCJ

Mr. Fumio Ogawa, Technical expert

Mr. Hisashi Amano, Technical expert

Mr. Hideyuki Tanaka, Technical expert

Situation of Cambodia

(1) General circumstances

- Area: 181,000 km^2 (less than half of Japan)
- Population: 13.661 million (2005)
- Religion: Mainly Buddhism
- Government: Constitutional monarchy
- Economy: Key industries: Agriculture, forestry and fisheries (33.4% of GDP) Industries (26.3% of GDP) (Data from the Ministry of Planning, 2002)

  GDP: US$4.5billion (2004)

  GDP per capita: US$330 (2004)

  Currency: Riel, 1US$ = approx. 4,000 riel (as of 2004)

  Trade (2002):

  Export: Garment products, meats, vegetables, natural rubber, and rubber goods to the U.S., Germany, UK, Singapore and Japan. (Exports: US$ 1.74 billion)

  Import: Garment fabrics, machinery, vehicles, fuel from Thailand, Singapore, Hong Kong and China. (Imports: US$ 2.48 billion)

  Energy/GDP: 35kWh/per capita
- General economic conditions: Decrease in foreign investments and proceeds of tourism due to the Asian economic crisis, which slowed the economic growth rate temporarily. After that, the country maintained steady growth rate ranging from over 5.5% to 7% range. The third coalition government, which started in July 2004, has continuously considered economic growth and industrial development to be the most important policy goals. How to invite foreign direct investment may be a key to achieve the target in the future.

(2) Current state of energy in Cambodia

In Cambodia, the hydro power in addition to the renewal energy is available; however all of oil products are imported.

Electrification rate was 17%, electricity expense is US$0.15/kWh, gasoline price was approximate 3,500Riel/L and diesel oil was approximate 2,800Riel/L at the time of follow up energy audit in 2005.

2. Follow-up Survey of the Garment Factory of Company A

2.1 Outline of Garment Factory of Company A

(1) Company profile

Products:	Casual wear（Main product：T-shirts）
Production:	1.17 million dozens (results of 2001), 1.69 million Dozens (the actual results of 2004)
Payroll:	4,393 persons (Nov. 30, 2002), approx. 5,000 (Aug. 2005)
Working shift:	7.5 hours in two-shift system (6:15-14:15 (7.5 hours), 14:15-22:15 (7.5 hours)

(2) Manufacturing process and energy consumption of the garment factory

The following are the previous situation of the factory and the follow-up results:

1) Outline of operation

Company A manufactures casual products, mainly T-shirts, under the management of the headquarters located in Malaysia. This company founded in 1992 and started operation in 1994, exporting all of the sewn products to the U.S, EU and Australia.

Energy sources are electricity and oil products. The company has purchased electricity generated by a diesel electric generator of Independent Power Producer (IPP) installed in its own factory and in 2001 began to purchase electricity from Cambodian government-owned company (EDC) as well. The factory consumes electricity from IPP from 14:15 to 22:15, while it uses electricity from the EDC in another time zone. Such a method has been still adopted at the time of investigation. What were changed are the use of tap water and steam drain for water supply to a boiler, and use of blended oil of “Diesel & heavy fuel oil” instead of only Diesel oil.

Figure Ⅱ-2-1 shows a flow chart of the manufacturing process and utilization of energy in a typical garment factory. Company A has adopted a similar manufacturing process.

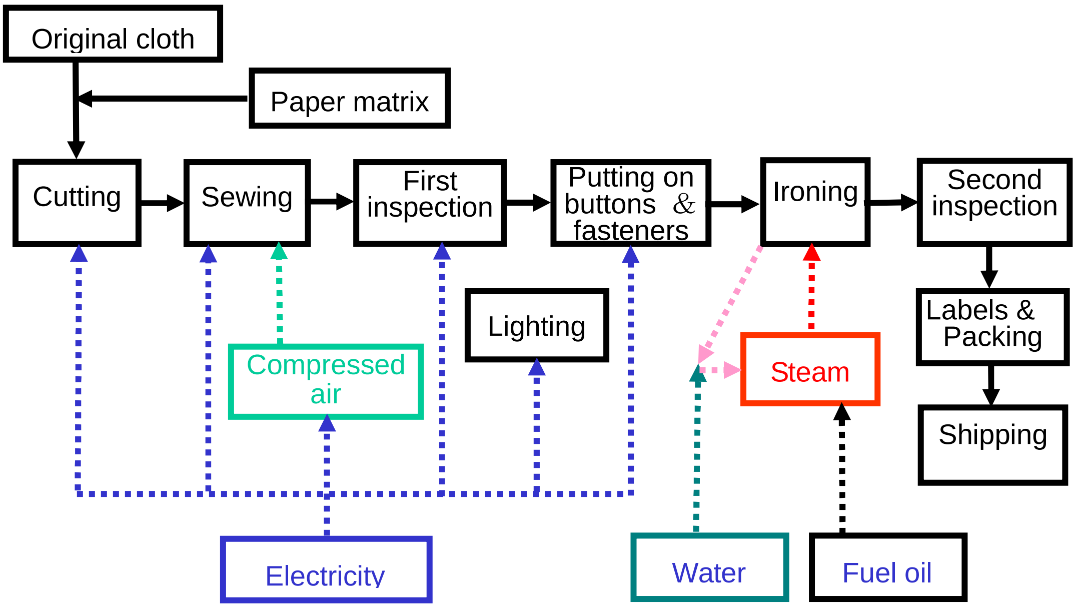


Figure Ⅱ-2-1 Flow chart of the manufacturing process and utilization of energy in a typical garment factory

2) Facilities

Boilers:	No.1 boiler: Once-through boiler	783kg/h
	No.2boiler: Once-through boiler	500kg/h (suspended)
	No.3 boiler: Once-through boiler	300kg/h (suspended)
	No.4 boiler: Once-through boiler	783kg/h (in operation)

Power receiving equipment: 22kV (Transformer: 22kV/400-230V, 1500kVA, one transformer)

Air compressors: No. 1 compressor = 12.95m^3/min×85.9kW, reservoir tank 1m^3
No. 2 and No. 3 compressors were removed.
No.4 compressor (New) = 75kW plus a reservoir tank 0.3m^3

Other facilities: Cutters, sewing machines, steam irons, lighting fixtures, air conditioners, etc.

3) Energy consumption

Table Ⅱ-2-1 shows the production and each type of energy consumption of 2001 and 2004.

Table Ⅱ-2-1 Energy consumption (2001 and 2004)

Items		2001	2004	Improvement (2004/2001)
Production (Dozens/y)	Casual wear	1,170,000	2,110,000×0.8=1,688,000 (By subcontract: 20%)	(1.443)
Energy consumption	Fuel for Boilers (L/y)	Diesel Oil: 198,000	Diesel Oil: 30,000 Fuel Oil: 171,000 (Total = 201,000)	(1.015)
	Electricity (kWh)	IPP: 1,676,000 EDC: 2,170,000 (Total=3,846,000)	IPP: 1,356,000 EDC: 3,549,000 (Total = 4,905,000)	(1.275)
Primary energy unit	Fuel	0.169L/Dozen	0.119L/Dozen	0.704
	Electricity	3.287kWh/Dozen	2.906kWh/Dozen	0.884
Improved skills	Workers No.	4,400	5,000	(1.136)
	Output per person	266 Dozens/person/y	338 Dozens/person/y	1.27
Energy Price	Fuel	Diesel oil US$0.35/L	Diesel oil US$0.60/L	(1.71)
	Electricity	US$0.122/kWh	US$0.15/kWh	(1.23)

2.2 Outline of the Results of Previous Energy Audit on Garment Factory owned by Company A

The items suggested for improvement at the previous audit were as follows:

(1) Utilize recycled drain from ironing process for water supply to boiler or for heating.

The recycled drain from the ironing process had not been effectively utilized, but just disposed. Effective utilization of the drain will contribute to saving about 7 kL/y of fuel oil.

(2) Heat insulation of the bare piping lay between boilers, steam headers and the factory.

Binding a 60m bare 40A pipes with a 30mm thick heat insulator can save about 7.2 kL/y of fuel oil.

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

Of the three air compressors (75kW: 1 unit, 37 kW: 2 units), 75kW type has always been in operation and repeating a cycle of loading and unloading. Therefore, we suggested an introduction of a system to control On/Off operation of multiple air compressors through the use of the pressure of a newly installed reservoir tank. It was estimated to reduce about 113MWh/y.

(4) Energy conservation by relocating lighting fixtures

The cutting and sewing rooms are provided with both ceiling and pendant fluorescent lights. By lowering the position of those pendant lights, the number of fluorescent lights can be reduced. Reduction of about 47MWh per year is possible.

2.3 Follow-up Energy Audit

The energy audit team visited the garment factory for two consecutive days to conduct a follow-up energy audit of the improvement based on the previous guidance, and to examine their new activities.

(1) Date of energy audit:

August 22 (Monday) 2005 at 9:00 a.m. - 16:00 a.m.
23 (Tuesday) 2005 at 9:00 a.m. - 12:00 a.m.

(2) Audit team members:

Cambodia: Department of Energy Technique (DET), MIME
Mr. Lieng Vuthy, Deputy Director (only paid our respects in the morning of Aug. 22)
Mr. Heang Bora, Head of EEE&S Office, DET, MIME
Mr. Ly Chamroeun, Vice Chief Officer, EE&S Office, MIME
Mr. Nong Chhavyvann, EE&S Office, MIME
Mr. Choun Teiea, EE&S Office, MIME

Japan: International Engineering Department, ECCJ
Messrs. Fumio Ogawa, Hisashi Amano and Hideyuki Tanaka, Technical Experts

(3) Attendees from the factory:

Administration Manager (only paid their respects in the morning of Aug. 22)
Account & Payroll Manager, Counterpart for audit team
Maintenance Supervisor

(4) Outline of the follow-up investigation

When the energy audit team visited the factory of Company A, a questionnaire ECCJ had sent to the MIME prior to the visit, had not reached the factory. Although the factory was very cooperative to the investigation, the investigation efficiency was poor because they had no time to prepare their answers to the questionnaire. The team conducted a walk through energy audit of the factory in the morning, Aug. 22, and made question-and-answer in the afternoon about production and energy consumption etc. The team agreed that some data would be received next day because it took time. In the morning of Aug. 23, Audit team visited there again to receive the answers, audited again the checkpoints on job site and measured the temperature and illumination, etc.

Compared with the previous investigation of the factory (December 2002 and February 2003), the production process (receiving textile stuff, cutting, sewing, ironing, packing and shipping) as well as operational methods were basically unchanged, but the production in quantity over 40%, and partial improvements (renewal of air compressors, improved air conditioning system, recycling of steam drain, etc.) have already been made. As a result, primary fuel/electricity units significantly decreased, approximately 30% and 12% down, respectively.

As for recycling of steam drain, they seem to have followed previous suggestion. Following the suggestion about air compressors, they adopted a high-efficiency model. The steam pipes have been partially insulated, but the lighting fixtures have been untouched.

Relevant technical explanations on this matter are shown in an attached document No. D-116 “Follow up of Energy Audit EE&C Activities in Garment Industries, Cambodia”.

In addition, there were not any documents received from Company A.

2.4 Results and Discussion of the Investigation

(1) Production status and energy intensity (Material No. D-103E)

Table Ⅱ-2-1 shows data, while Figure Ⅱ-2-2, Ⅱ-2-3 and Ⅱ-2-4 indicate the comparison between 2001 and 2004. Production greatly increased from three years before, while the consumption of fuels and electricity moderately increased, as a result, the energy intensity was dramatically improved. The Counter part (C/P) of Company A pointed out the following reasons:

- Technical capabilities of employees were so improved that the production efficiency increased, leading to a large growth in production. During the last three years, the production per person increased by 127%.
- Renewal of sewing machines every four to five years contributes to energy conservation and efficient production
- Investment for energy conservation began to have effect as mentioned later.

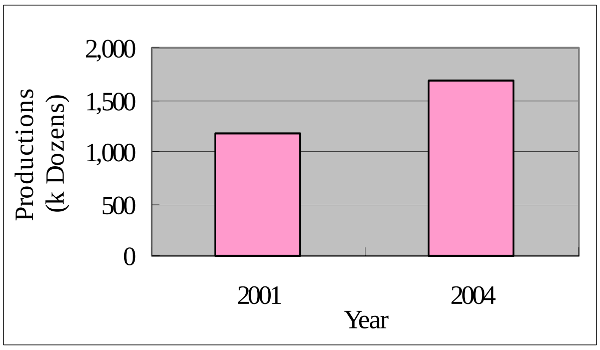
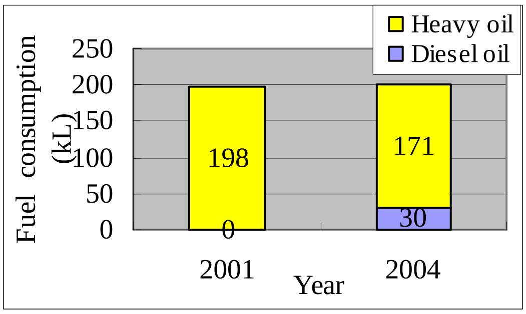


Figure Ⅱ-2-2 Change in production (Comparison between 2001 and 2004)



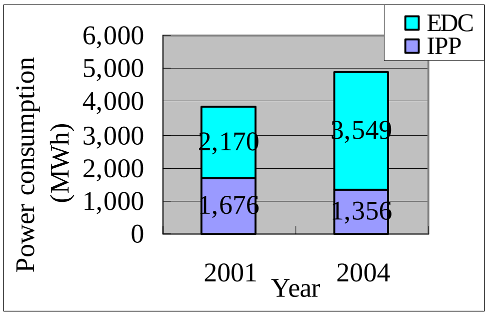


Figure Ⅱ-2-3 Change in fuel consumption and electricity consumption

(Comparison between 2001 and 2004)

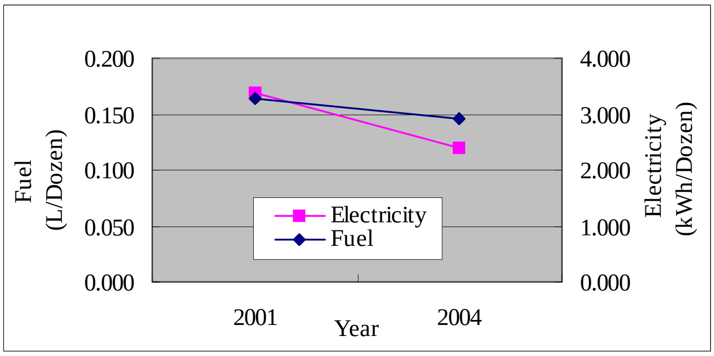


Figure Ⅱ-2-4 Change in primary energy unit (Comparison between 2001 and 2004)

(2) Energy management

C/P of Company A, in charge of accounting, well understood the importance of energy conservation. However, the personnel in the factory as a whole were generally less aware of its importance and did not grasp data sufficiently. On the other hand, production per group was shown on a white board. This suggests that a small group activity appeared to have started.

The energy audit team highly evaluated C/P's understanding of the importance of energy conservation. It is expected him to set up a measurement system and develop persuasive activities based on quantitative data.

The energy audit team obtained the results shown in Table Ⅱ-2-2 through questions and answers as well as on-site investigation to grasp each type of electricity consumption. In the factory, the team checked specifications and the number of equipment, readout electric power and consumption indicated by the electric switchboard, the control panel, etc., and estimated the consumption by taking into account the information obtained from the Q&A sessions. The estimation would be helpful for participants in the MIME and C/P of Company A.

In the future, it is necessary to grasp the kaleidoscopic changes quantitatively. Consequently, the point at issue will become clear, and they must be able to take measures, more easily.

Table Ⅱ-2-2 Electricity consumption by purpose

Equipment		Estimation	Power Consumption	Ratio
1	Sewing Machines	(1440 units)×(0.55kW)×0.5 = 396kW Total No.: 360 pieces×4 factories Operation Ratio = 50%	396kW	49%
2	Lightings	1926 units×0.08W = 154kW Total No.: 321 pieces×6 factories	154kW	19%
3	Air Conditioners	64 pieces×1.5kW = 96kW	96kW	12%
4	Air Compressors	1 piece×75kW = 75kW One operating, one stand-by	75kW	9%
5	Air Cooling System	Fan 40 pieces×0.75kW = 30kW Pump 6 pieces×2.2kW = 13.2kW	43kW	6%
6	Others	40kW (Office, Elevator, Boiler pumps, etc.)	40kW	5%
		Total	804kW	100%

(On the other hand, the total power consumption by readings of meters on panel was 840kW.)

(3) Air compressors

In addition to No.1 compressor (BroomWade, 75kW), Screw Compressor (HISCREW 75, 75kW) manufactured by Hitachi Ltd. was newly purchased and installed about three months ago and both were operated alternatively. The latter reduces required power by varying the number of revolution according to the change in loading. It operated steadily at the outlet pressure of about 0.5MPa at the time of energy audit. No. 1 and No. 2 compressors had been removed. Figure Ⅱ-2-5 shows the present configuration of air compressors.

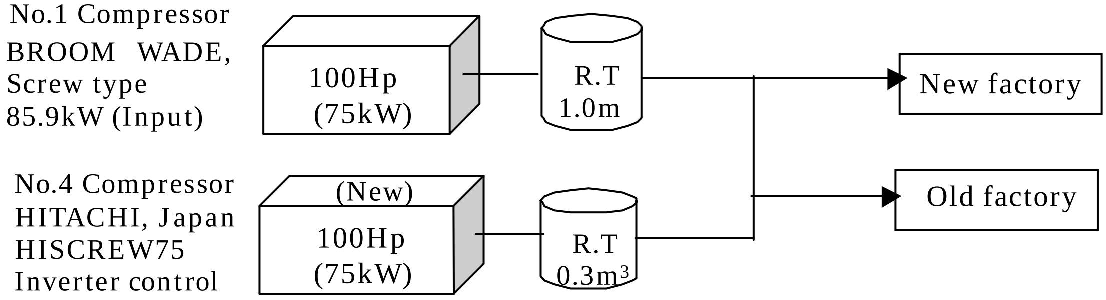


Figure Ⅱ-2-5 Configuration of air compressors

The compressed air was sent to the sewing process (the four sewing sections: each section had about 500 sewing machines, half of which were those which feed thread cut by the compressed air. At the inlet of each sewing machine, there was a regulator controlling the outlet pressure at the setting of about 0.4MPa. Although ECCJ experts had suggested improvements previously, the audit team again placed an emphasis on the following matters:

1) Decreasing the outlet pressure

The pressure of the regulator seemed higher than necessary, so we suggested that they should perform a test to find whether or not decreasing the pressure of the regulator would create a problem. If the regulator pressure is decreased, the outlet pressure of the air compressor can be decreased. This will lead to energy conservation. For example, when the outlet pressure is lowered from 0.5MPa to 0.45MPa, the electricity consumption will be decreased about 6%.

2) Looped piping

If the ends of the branched piping are connected in a loop to decrease the loss of piping pressure, the distribution of the pressure in the factory can be leveled out and piping pressure loss can also been reduced.

3) Prevention of air leakage

Check air leakage and repair a leaking place. The team insisted that it was difficult to decrease the amount of leakage to less than 5%, but possible to decrease it to 5% easily. Decreasing the amount of leakage directly reflects electricity conservation. C/P of Company A said that his superior had instructed him to consider the modification of the piping of the compressor outlets

(4) Lighting fixtures

1) Improvement of the illumination in the workplace

ECCJ suggested that the position of lighting fixtures should be lowered in the workplace at the previous investigation but they have not done it yet this time. Operations using sewing machines belong to detail work, so insufficient illumination negatively affects operation efficiency and reduces yield. The measurement of illumination at a considerably dark place indicates 400Lux, which was a little low from the viewpoint of the Japanese Industrial Standards (JIS). Comparing with the standards, desirable illumination is about 800Lux.

The illumination is inversely proportional to the square of the distance. If the position of pendant lamps is lowered by 500 mm as we suggested, the distance decreases from 1,800 mm to 1,300 mm, and the illumination becomes as follows:

$$(1800/1300)^2 \times 400LX = 1.917 \times 400LX = 767LX$$

This value almost satisfies the abovementioned standard. This should be considered continuously. In contrast, in the rooms where additional fluorescent lights were installed at a lower position, the ceiling lights might be turned out. In addition, we thought it was brighter than necessary near the windows, in the warehouses, and packaging and shipping rooms. However, C/P of Company A explained such high illumination was necessary for CCD-type surveillance TV cameras.

2) Installing refractors

By installing aluminum mirror refractors and specially coated refractors, actual illumination can be improved. Figure Ⅱ-2-6 shows the examples of improved reflectance. In this case, a 1.5-times improved reflectance is obtained. Various types of refractors attached to lighting fixtures are available and some of them are directly attached to fluorescent lamps.

3) Adopting high-efficiency fluorescent lights at the time of replacement

For fluorescent lights, the use of the Hf (high-frequency lighting lamps) enables further energy conservation. Through the use of high-frequency lamps, various illumination adjustment functions can be added.

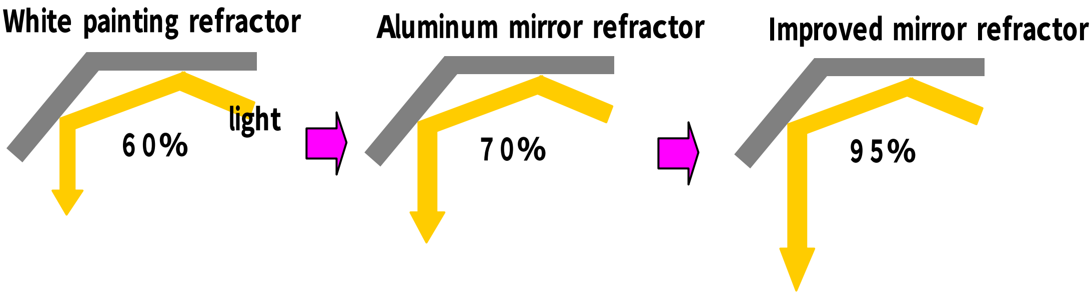


Figure Ⅱ-2-6 Examples of improved reflectance of lighting

4) Maintenance management of lighting fixtures

With the increase in light-up time, the light beam (brightness) decreases. For fluorescent lights, lighting for 5,000 hours decreases the illumination to 86% (80% after the 10,000-hour lighting). Furthermore, soiling causes a decrease in light beam. Light beam is reported to decrease to 85% after one-year lighting under ordinary conditions. Fluorescent lights decreases to 73% (= 0.86×0.85) in brightness after lighting for 5,000 hours in a year. Therefore, you should clean fluorescent lights at least once a year and replace old lights with new ones.

(5) Power of sewing machines

Many of sewing machines were made in Japan, and each consumption power was 550W. C/P of Company A explained that they were replaced every 4 to 5 years and more effective machines are introduced every time.

It was difficult to estimate the distribution as to how many percent of sewing machines operate simultaneously, so we assumed that the distribution rate was 50% based on the above calculation.

(6) Air conditioning facilities

Air conditioners in the shop floor were replaced with new ones adopting a new cold air ventilation system about one and half years ago. The system works as follows: Exhaust fans (40 units, 0.75kW each) are installed on the walls, and heat exchangers incorporating paper corrugated plates (made in the U.S.) are installed on the air inlet side, or opposite side of the wall to drip water from the upper side, so that its evaporation latent heat directly cools the air. The dripped water is recycled through the return pipes and circulated again with water pumps (6 units, 1.65kW each). We thought that this system was economical as a cooling system for a large room, but the working place did not produce comfortable environment when considering the number of the workforce in the room.

On the other hand, there were air conditioners (64 units, 1.5kW each) in each room of the office. We suggested that they should increase the preset temperature (20℃).

(7) Boilers and steam piping

No.4 boiler (1,725 Lb/h), whose installation had been reported in the previous report, was operating.

They are adopting two-boiler system with No.4 and No.1 (manufactured by FULTON). The recycle of drain, which was advised at the previous investigation, was already performed by newly installing a drain tank about one and half a year before. The energy audit team found that steam was rising around the descending drain pipes at the top portion of the tank and, sometimes, water was overflowing and running down on the wall of the tank. On the other hand, the valve for the piping to make up fresh water was manually shut. The temperature on the wall of the tank was 80℃ or more at the top part and 60℃ or more at the lower part. It was confirmed that the difference between these temperatures and the outside-air temperature was big; therefore the device had effect. Under these circumstances, the team advised as follows:

a. Prevent steam leakage by using a steam trap.
b. Automatically control supply of fresh water with level adjustment of the tank.
c. Insulate the whole boiler, the steam header, and the bare part of the piping.
d. Perform combustion control (Especially, the control of air ratio).
e. Consider heat recovery from exhaust gases.

(8) Management of the usage of electricity

The team explained confirmation of the installation of condensers for improving the power factor of electricity and discussed for grasping power consumption.

In the electric distribution system in the garment factory of Company A, Watt-hour Meters are installed in each principal workplace. The team recommended that they grasp the electricity consumption using these meters. At the predetermined times, they get a reading of an integrating wattmeter and calculate the day-to-day difference so that they can grasp the electricity consumption in each department everyday. Based on these data, a load curve (graph) per day is obtainable as shown in Figure Ⅱ-2-7. Referring to Table Ⅱ-2-2 as well, the electricity amount to be reduced can be determined by analyzing the data. Especially, a decrease in nighttime consumption and peak consumption of electricity is cost-effective. Instantaneous power can be found by the rotation speed of the disk in the Watt-hour Meter.

Through these measures, they will know how to challenge other issues for energy conservation.

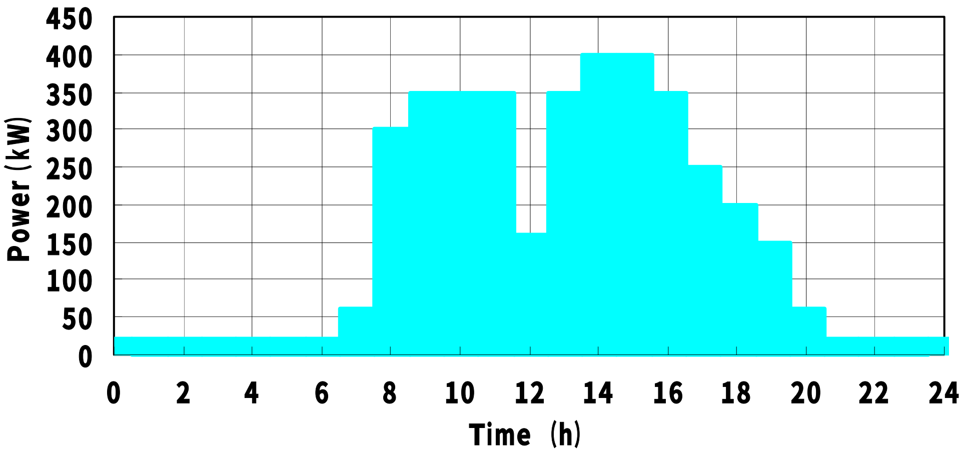


Figure Ⅱ-2-7 Load curve (graph) per day of electricity consumption

(9) Summary of energy conservation activities for the past three years through follow-up investigation

For the four improvements for which ECCJ made suggestions at the previous investigation, mentioned in 2.2, Table Ⅱ-2-3 shows the survey results at this follow-up.

Table Ⅱ-2-3 Results of energy conservation activities performed on the items suggested for improvement at the previous survey

Recommended Technology/Practice	Implementation	Status of Implementation
(1) Drain recovery from the ironing process	Yes	Installing of water tank for drain recovery.
(2) Heat insulation for boilers, steam header and bare piping	No	Re-recommendation
(3) Introduction of control for number of compressors in operation	Yes	Installation of new compressor controlled by inverter.
(4) Improvement in lighting, changing the position of the lighting fixtures	No	- Much investment cost - Recommended to fix reflectors

3. Walk-through Energy Audit of the Garment Factory of Company B

At the meeting in the morning of Aug. 23, the counterpart of Company A made a sudden request, saying “Your advice and recommendations are very helpful. A new factory of another company that belongs to the same group has started operation. So, would you kindly pay a short visit there and tell us any points to be improved?” We discussed it with the MIME and accepted the request.

We stayed the factory for a little more than one hour. First, we toured the factory and then explained the items to be improved for energy conservation.

3.1 Visit of the Garment Factory of Company B

(1) Outline of our visit

Company B is a sister company of Company A.

Location:	Phnom Penh, Cambodia	
Day of visit:	Aug. 23 (Tuesday), 2005, 12:30-13:45	
Visitors：	MIME	Mr. Heang Bora (FP of Cambodia)
	June Textiles	Mr. L.K. Shyan (Accounting & Payroll)
	ECCJ	Messrs. Fumio Ogawa, Hisashi Amano and Hideyuki Tanaka (Technical Experts)

Person in charge in Company B: Factory Manager

(2) Outline of the factory

The new factory of Company B located about a 30 minute drive from the factory of Company A or about 4 km from Phnom Penh airport, is built in a considerably large area of a vast industrial park. The factory built for the first term has already started operation about three months earlier. The factory appeared to be designed aiming at high efficiency and high productivity based on the experiences of Company A. Working environment was far more excellent than in Company A.

As the first term, the factory started operation with half of its capacity. The number of workers is presently 2,000 with two working shifts and will double to 8,000, and will employ 10,000 in total including indirect department and other kinds of staff.

In Cambodia, there is another bigger factory owned by a company in Hong Kong. They said that among a total of 200 garments manufacturing companies, this group is ranked within the nation’s five largest groups.

1) Sewing process

In a huge building (about 50m×70m) with an appearance of the newest factory, it was a grand sight that a large number of female workers were all working with sewing machines.

The ceiling seemed to be about two stories high and for the air cooling system, “the air cooling draft system by dripping water”, the same as that of Company A, was introduced. Transparent vinyl sheets were hanging from the ceiling at intervals of ten meters, so the airflow was limited within some meters above the floor of the working place. We felt the airflow and found that it produced comfortable environment.

2) Ironing process

Like the factory of Company A, two pipes for supplying and returning steam were installed, to which two flexible pipes with small diameter from each ironing machine were connected. We could not find how drain recovery was performed, but the effective use of drain was not conducted at present.

3) Air compressors

Also like the factory of Company A, Screw compressors manufactured by Hitachi Co., Ltd. have been installed. The outlet pressure was set at about 0.67MPa, a little high value.

4) Boilers

Fuel oils were used (there were the tanks marked as Petronas, a petroleum company in Malaysia). The heat insulator was attached only to the bodies of the boilers but heat recovery drain has not been performed. Headers were arranged in the near the boilers, and the drain from the lower part of the boiler was discharged to the nearby street via the steam trap, and a cloud of steam was rising.

3. 2 Advice and Recommendations for EE&C Activities

(1) The working environment was very good because of the high ceiling and the air was flowing etc. We felt that the air-cooling draft system worked well there.

(2) The fluorescent lights installed on the high ceiling of the warehouse were not appropriate in terms of the characteristics of light distribution. We recommend replacement of them with HID type ones.

(3) The air filters for intake of air compressors seemed to be frequently cleaned. We recommend installation of intake duct to intake fresh air. The discharge pressure was a little high.

(4) Concerning boilers and steam piping etc., we made the same explanations as we made for in Company A. Especially, we recommended early improvement in manual supply of water to the tanks and effective use of drain.

4. Follow-up Survey of the Garment Factory of M&V International Manufacturing Ltd.

4.1 Outline of the Garment Factory of M&V International Manufacturing Ltd.

(1) Company profile

Company name: M&V International Manufacturing Ltd. (Headquarters: Macao, China.)

Factory name: M&V International Manufacturing Ltd.

M&V has four factories in Cambodia. This is the third factory (MV3).

Address: No. 1623 Chac Angre Kraum, Phnom Penh, Cambodia

Tel: (855) 23-425 041

Products: Knitwear (sweaters)

Production: 5.1 million (achieved in 2001), 8.3 million (achieved in 2004)

Employees: 3,000 (Nov. 2002), about 3,200 (Aug. 2005)

Working shift: 8 hours in one shift (7:00 - 11:00 and 12:30 - 16:30)

(2) Manufacturing process of the sewing (knitting) factory and energy consumption

The results of this follow-up visit are described compared with those at the previous examination as follows:

1) Outline of operations

The factory (MV3) manufactures only sweaters under the management of the headquarters located in Macao, China. The MV3 did not have detailed data as previous investigation because the headquarters control the organizations for production and the factory only manufactured under the order of the headquarters.

M&V International Manufacturing Ltd. was established in 1994 and the MV3 factory started operation in 1997. The annual production increased from 5.1 million (2001) to 8.3 million (2004). The production is mainly winter clothes, so production decreases in the winter. All of the manufactured products are exported to the U.S.A., EU, etc.

Energy sources are electricity and oil products, and self-generated electricity by a diesel generator is mainly used. Electricity for nighttime lighting etc. is purchased from the EDC (Electricite du Cambodge, a Cambodian government-owned company). For the boilers, river water and heavy oil are used. The above-mentioned state hardly changed compared with that of the previous investigation three years ago.

FigureⅡ-4-1 shows a flow chart of manufacturing process of the sewing (knitting) factory and of energy used.

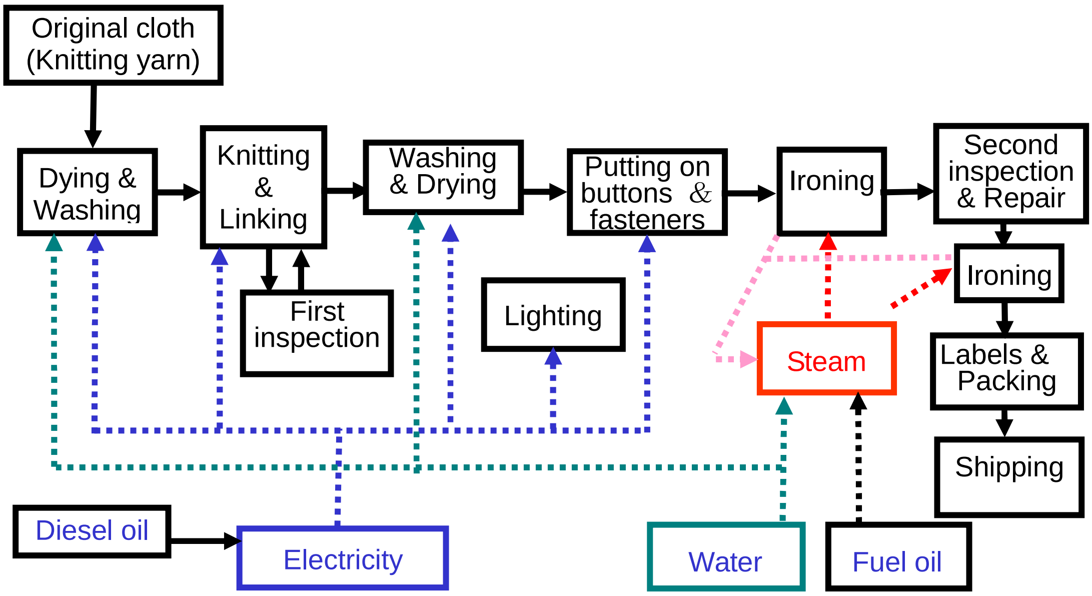


Figure Ⅱ-4-1 Flow chat of manufacturing process of the sewing (knitting) factory and of energy used

2) Facilities

Boilers:	No. 1 boiler	horizontal fire-tube boiler	4,200kg/h
	No. 2 boiler	once-through boiler	1,560kg/h
	No. 3 boiler	once-through boiler	783kg/h
	No. 4 boiler	horizontal fire-tube boiler	6,000kg/h
Generators:	Of three generators, No. 2&3 Diesel generators were operating 720kVA/unit		
Power receiving equipment:		380V (no transmitter)	

The facilities of the sewing (knitting) factory consists of dyeing equipment, washing machines, dryers, sewing machines, knitting machines, irons, lighting fixtures, air conditioners, and water treatment facilities, etc.

3) Energy consumption

Table Ⅱ-4-1 shows each type of energy consumption in 2002.

Table Ⅱ-4-1 Energy consumption (2001- 2004)

Year	2001	2003	2004
Production million pieces/y, and (ratio)	5.10 (100)	6.50 (127)	8.30 (165)
Energy consumption Heavy oil (for boilers) kL/y Light oil (for generation) kL/y Electricity (purchased power) MWh/y	 928 480 214	 1,044 536 unknown	 1,152 592 unknown
Primary energy unit Heavy oil (for boilers) L/piece (ratio) Light oil (for generation) L/piece (ratio)	 0.182 (100) 0.094 (100)	 0.161 (89) 0.082 (87)	 0.139 (76.3) 0.071 (75.8)
Unit price of energy Heavy oil (for boilers) Light oil (for generation) Electricity (purchased power)	 US$0.25/L US$0.35/L US$0.152/kWh		 US$0.60/L

4.2 Outline of the Results of the Previous Energy Audit on M&V3 Garment (Knitting) Factory

The items suggested for improvement at the previous energy audit were as follows:

(1) Heat recovery from exhaust gas of diesel engines

Install heat exchangers in the exhaust gas ducts of No. 2 and 3 diesel engines to generate low-pressure steam (co-generation), which reduces the load on boilers, and fuels. This will save about 28 kL/y of fuel oils.

(2) Enhanced heat insulation of bare parts of the steam piping

Installing a heat insulator to about 60m-long 25A bare pipes will save about 3.1kL/y of fuel oils.

(3) Energy conservation by changing the installed position of lighting fixtures

In the cutting and sewing rooms, both fluorescent ceiling lights and pendant lights were installed. We recommended that the ceiling lights be turned off because the turning off hardly had effect on illumination. It was estimated to bring out a saving of 32MWh/y.

4.3 Follow-up Energy Audit

In order to conduct a follow-up to investigate whether the problems pointed out at the previous audits had been improved or not, and what kind of new activities had been promoted, we visited the sewing (knitting) factory for two days.

We thought the M&W3 factory was not cooperative in the investigation, probably due to busyness. A technical engineer who accompanied us spoke only Chinese, while a person in charge of general affairs translated in English, Khmer and Chinese, but did not know much about technical terms, so the efficiency in communication was bad.

This factory did not receive the questionnaire either that we had sent to the MINE via ACE prior to the investigation, so we could not obtain sufficient data in spite of our request. We were told that only the headquarters in China grasped the statistic data. Consequently, we only confirmed the production and consumption of fuels in 2003 and 2004. Furthermore, we were prohibited from entering more areas than at the previous investigation. We only saw the generators, boilers and passed by the yard for packaging and ironing. We just conducted a simple follow-up audit investigation for a short time.

(1) Date of the energy audit:

Aug. 24 (Wed.), 2005, at 9:15 a.m. - 10:30 a.m.

Aug. 25 (Thu.) 2005, at 9:00 a.m. - 12:00 a.m.

(2) Audit team members:

Cambodia: Department of Energy Technique (DET), MIME

Mr. Lieng Vuthy, Deputy Director

Mr. Heang Bora, Head of Energy Efficiency and Standard (EE&S) Office

Mr. Ly Chamroeun, Vice Chief Officer, EE&S Office

Mr. Nong Chhavyvann, EE&S Office

Mr. Choun TEIEA, EE&S Office

ACE (ASEAN Center for Energy):

Mr. Christopher G. Zamora, Manager

Mr. Ivan Ismed, Project Officer

Japan: International Engineering Department, ECCJ

Messrs. Fumio Ogawa, Hisashi Amano and Hideyuki Tanaka, Technical Experts

(3) Attendees from the factory (M&V3):

Mr. Shu Jin Fa, Maintenance Manager

Ms. Wen Ying Fang, C.O.C

(4) Outline of the follow-up investigation

The main product of the factory is knitwear, mainly sweaters, in which there was no difference both at the previous visits (Dec. 2002 and Feb. 2003) and this visit. At the previous visit, we obtained data of 2001 and, this time, data of 2003 and 2004. These data showed that production steadily increased, which was the main cause of a large decrease in the primary energy unit. They didn't seem to invest exclusively for energy conservation. The number of enrolled employees was 3,000 in 2001 and presently 3,200, which showed no big difference.

4.4 Results and Discussion of the Investigation (Material No. D-104)

(1) Status of production and primary energy unit

Table II-4-1, Figure II-4-2 and II-4-3 show energy consumption of the factory. Fuels (heavy oil) are used for boilers. Electricity consists of self-generated one by diesel generators with light oil (the generation amount is proportional to the consumption of light oil for self-generation) and received electricity (purchased one) from the EDC (Cambodian government-owned company). During daytime, electricity necessary for production is self-generated, and only electricity consumed for the safety purpose during nighttime (9:00 p.m. - 7:00 a.m.) is purchased from the EDC.

The primary energy unit of both fuels and electricity significantly decreased, about 24%, and it is mainly due to drastic growth of production.

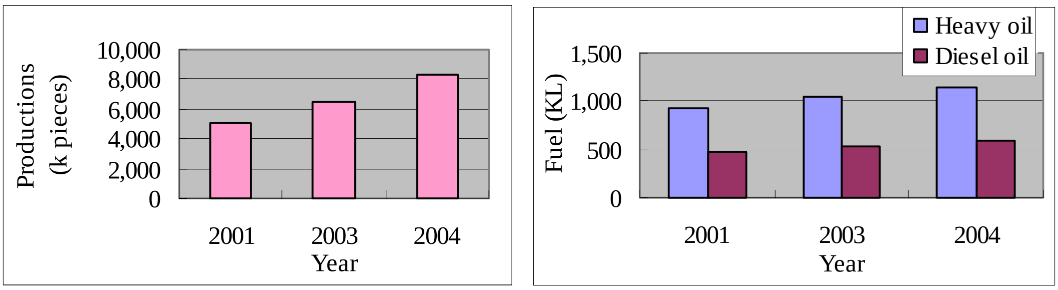


Figure II-4-2 Change in production and consumption of fuels (2001-2004)

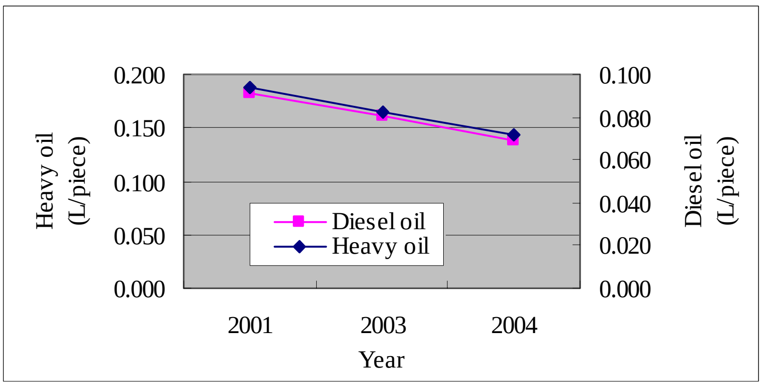


Figure II-4-3 Change in primary energy unit (2001-2004)

(2) Management of energy

Due to an increase in production, the primary energy unit has been greatly improved as mentioned above, but we had no impression that the factory's system of energy management was excellent. However, for electricity consumption, it seemed that the instantaneous value of a control board meter was obtained several times a day as mentioned below, but due to lack of explanation, it was unknown how they analyzed and used the measurements. Relevant items are described below.

1) Seasonal change

The products are exported mainly to the U.S., etc.; accordingly demand varies with seasons. The production changes proportionally. The peak production period is from April through October and other period is off-peak production period. Since there is a big gap between the peak and off-peak periods (the number of employees in clock hours varies with the number of enrolled employees), therefore, it is impossible to grasp the data throughout the year only by obtaining instantaneous values of electricity consumption.

2) Change in electricity consumption during a day

It was in the peak consumption period. For example, the time-series values of electricity measured yesterday (Aug. 24) varied as follows (The production was 30,000pieces.):

07:00 - 11:00	630kW (full operation)	self-generation
11:00 - 12:30	380kW (during lunch time)	ditto
12:30 - 16:30	630kW (full operation)	ditto
16:30 - 21:00	470kW (operation)	ditto
21:00 - 07:00	?	(Electricity consumed for the safety purpose, purchased power)

Figure II-4-4 shows a daily load curve (graph) based on the values read by this wattmeter. This graph will enable to grasp general tendency of electricity consumption.

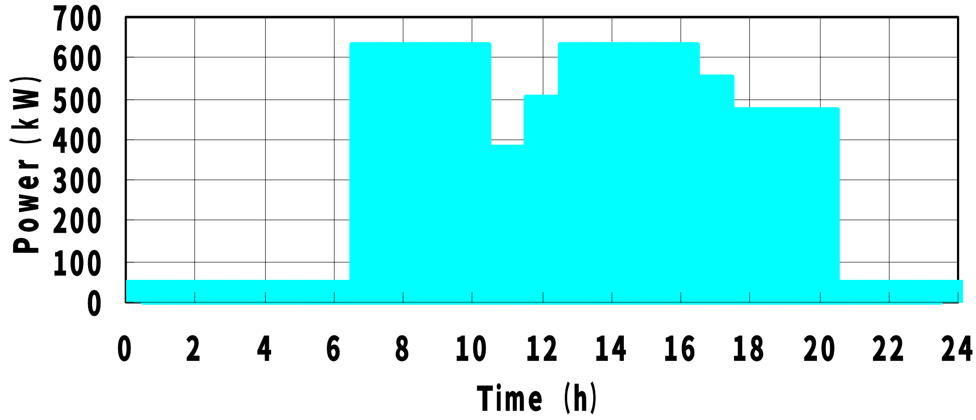


Figure II-4-4 Daily load curve (graph) of electricity consumption

3) Fuel price

Compared with data in 2001, the price of fuels has increased. For the price of electricity, the present price of light oil is US$0.6/L. If 1 liter of light oil could generate 4kWh of electricity, it costs US$0.15 per 1kWh.

(3) Heat recovery from exhaust gases of diesel engines

This heat recovery was not performed in the factory. We talked about the importance of heat recovery to them this time, too, but their understanding was insufficient, so we had no productive discussion. We told them that that was a challenge to be reviewed later.

For diesel engines, heat recovery is possible from exhaust gases as well as engine coolants. The amount of heat recovery is almost equal to that of output. Operation of two generators produces about 600kW of electricity; consequently 600kWh (2,1600MJ) of heat output is obtained. If the efficiency of a boiler is estimated to be 85%, it is equal to conservation of 95L/h (= 218kL/y).

(4) Boilers and steam piping

There were four boilers of A, B, C and D as mentioned in the previous report. The main bodies were insulated. Almost all of the steam headers and pipes were already insulated. Some valves and flanges were bare; therefore perfect insulation is desired.

"Recovery of drain" has been implemented previously, however whether they utilize it or not is unknown.

The outlet pressure of steam was about 0.7MPa, and it may be necessary to determine adequate pressure and temperature for the consumption side. A radiation thermometer read

109℃ on the surface of the external wall of pipes for exhaust gases.

(5) Turning off the ceiling lights (general)

Lights were not turned off in the ironing rooms, etc. On the other hand, the illumination on the desks in the packaging process was 380Lux. It was a little dark but not an extremely low level. We had heard at the previous investigation that they were attempting to turn off lights during an intermission, and unnecessary lights. This time, we investigated only part of the factory during operational hours. Therefore, the actual state in other parts of the factory was unknown.

(6) Summary of the results of the follow-up investigation of energy conservation in the past three years

Table II-4-2 indicates the follow-up investigation results of the three items of 5.2 whose improvement was suggested at the previous audits.

Table II-4-2 Results of energy conservation activities performed in order to resolve the items suggested for improvement at the previous audits

Recommended Technology/Practice	Implementation	Status of Implementation
(1) Heat recovery from exhaust gas of diesel engines	No	Recommended again
(2) Heat insulation for boilers, steam header and bare pipes	Yes	Valves and flanges need to be insulated.
(3) Lighting off the ceiling lights in all shops	(Yes)	Maybe OK

5. Seminar and Workshop

5. 1 Summary

The seminar and workshop was held on Aug. 26 (Friday), 2005.

Dr. Sat Samy, Under Secretary of State of Cambodia delivered an opening address, while Mr. Tun Lean, Director General, General Department of Energy, MIME (Ministry of Industry, Mines and Energy) gave a closing address. Less than 60 serious people took part in the seminar and workshop. The fruitful meeting ended successfully.

(1) Date and Time

Aug. 26 (Friday) 8:30 to 16:50.

(2) Venue

Phnom Penh Hotel, 1F Crystal Ball Room, Phnom Penh, Cambodia

(3) Reports presented on the Seminar and Workshop

A program attached separately shows the content of presentations. The participants of Cambodia reported on the EE&C activities performed by the MINE. The participants from ASEAN countries made four presentations. For questions and answers, in-house translators of the MINE served between English and Khmer. (Material No. D-109)

(4) Participants (List was not circulated)

Cambodia：

Dr. Sat Samy, Under Secretary of State
Mr. Tun Lean, Director General, General Department of Energy, MIME
Mr. Chan Socheat, Director, Department of Energy Technique (DET), MIME
Mr. Lieng Vuthy, Deputy Director, DET, MIME
Mr. Heang Bora, Head of Energy Efficiency and Standard Office, DET, MIME
Ms. Chum Sopha, Head of Research Office, DET, MIME
Mr. Ly Chamroeun, Vice Chief Officer of Energy Efficiency and Standard, DET, MIME
Mr. Nong Chhavyvann, Staff, DET, MIME
Mr. Choun Teiea, Staff, DET, MIME

Rank-and-file 58 participants of Cambodia including ones from the Garment Industry, and teachers and students of colleges (as told by Mr. Vuthy): We asked them to send us a list of participants as an electronic file within one week, but have not received it yet.

ACE (ASEAN Center for Energy):

Mr. Christopher Zamora, Project Manager

Mr. Ivan Ismed, Project Officer

Malaysia:

Mr. Nor Hisham Sabran, Technical Assistant, Energy Industry & Sustainable Development, Division – MIEEP, Pusat Tenaga Malaysia (PTM)

Lao PDR:

Mr. Vanthong Khamloonvylayvong, Deputy Manager of Nam Ngum Hydropower Plant, Electricite du Laos (EDL)

Indonesia:

Mr. Subagyo, Supervisor, Pencana dan Evaluasi Produksi, PT Kertas Leces (Persero)

Vietnam:

Mr. Le Tuan Phong, Official on Energy and Environment, Ministry of Industry, Science and Technology Department

Japan: International Engineering Department, ECCJ

Messrs. Mr. Fumio Ogawa, Mr. Hisashi Amano and Hideyuki Tanaka, Technical Experts

5. 2 Results of the Seminar and Workshop

(1) Opening ceremony (speeches)

1) ACE

Mr. C. Zamora read the address of Dr. Weerawat, Executive Director of the ACE. Dr. Weerawat emphasized that energy conservation was becoming more important in terms of that the price of crude oil recently reached an all-time high. Also, he talked about the activities of the ACE under the PROMEEC project for major industries and building energy control (including public recognition of an excellent case of energy conservation in a building) and told that Cambodia was the first country that worked on energy conservation especially in the major industries in the four countries in this fiscal year.

2) ECCJ

Mr. Tanaka, Technical expert, made a speech on behalf of the METI and ECCJ, Japan. He explained the meaning of this project, outline, resent state and Japan’s cooperation and contribution to ASEAN.

3) MIME

Dr. Sat Samy, Under Secretary of State, gave a speech in Khmer. He emphasized reduction of the rising cost of oil by means of energy conservation to achieve competitiveness, and necessity of further energy conservation and measures against global warming, by gaining and utilizing new knowledge through a seminar. (English version was distributed.)

This ceremony was covered and filmed by the TVK (Cambodian TV) and the Cambodia Daily (an English newspaper). After that, photographs were taken.

(2) The energy conservation plan and report on the activities

1) Overview of EE&C Activities in Cambodia- Mr. Vuthy, MIME (Material No. D-113)

Materials were written in English but explained in Khmer. Barriers pointed out four items including lack of consciousness and unclear policies. We understood economic difficulties in Cambodia concerning power generation using expensive imported oil and urgent necessity of international cooperation.

2) Case Study 1 - Glass Industry, Malaysia - Mr. Nor Sabran (Material No. D-114)

A staff member of the PTM made a presentation instead of a technical engineer of the glass factory. We saw the pride and capabilities of the PTM.

3) Case Study 2 - Hydropower Plant, Lao PDR - Mr. Vanthong (Material No. D-130)

Some new data was added to the content presented last year. We were impressed by that the data since 1972 was shown in a graph in the documents.

4) Case Study 3 - Pulp & Paper Industry, Indonesia - Mr. Subagyo (Material No. D-115)

Audience seemed to be interested in explanation of fuel conversion (from heavy oil to natural gas, and further to coal). However, the price of fuels deeply depends on the government’s policy (subsidies or tax). It is needed to pay attention to differences in situation among countries.

5) Case Study 4 - Porcelain (Ceramics) Industry, Vietnam- Mr. Phong (Material No. D-125)

Updated data presented by the ECCJ last year: It was found that some of the items, which were pointed out or recommended again at the follow-up of last year, have been implemented.

(3) Results of the follow-up audits

1) Follow-up Energy Audit Findings at Garment Factories - Mr. Bora, Mr. Amano (Material No. D-116)

We had previously agreed that the members of the host country would play a leading role in conducting a follow-up and make a presentation at the workshop. However, for Cambodia, it was difficult in terms of the willingness and capabilities of the MINE. Therefore, ECCJ prepared Materials for this theme and asked Mr. Bora of the MIME to make a presentation of the first part (three sheets of slides) (He explained it in Khmer). Mr. Amano made a presentation of the remaining.

For the presentation of the follow-up, Company A asked us “not to reveal the name and details of the company.” So, concerning Company A and M&V, we were forced to make a vague expression, such as “These things generally apply to garment factories in Cambodia.” The audience (including many in the same trade) was greatly interested in this topic and we thought the presentation sufficiently satisfied their interest.

2) Barriers and Measures to implement EE&C - Mr. Ogawa (Material No. D-117)

Using the last year’s documents, he explained the topic, based on garment industries in Cambodia as well as quoting the presentations made by other persons on the day.

(4) Workshop

1) Technical Directory - Mr. Tanaka (Material No. D-118)

He explained the purpose of TD, its preparation and format, etc. and presented examples in order to give better understanding. Mr. Ivan was newly employed, so Mr. Zamora told “ACE will be in charge of this matter from now on.”

2) Database/Benchmark/Guideline for Industry - Mr. Ogawa (Material No. D-119)

He made a brief explanation on this topic because its priority was lower than TD and the garment industry in Cambodia was not well developed yet.

(5) Q&A Session

At the ends of Session 1 and Session 2, a question-and-answer session was held. Many questions were presented actively, but some of them were not appropriate for the workshop. Followings are typical questions and answers:

Q: Which should cover a leading part, provider or user, in responsibility for promoting energy conservation (EC)?

A: Both. In Cambodia, it is practical that the user side of energy makes efforts to reduce the consumption of energy.

Q: What are the criteria when choosing the equipment for EC?

A: The technical directory (TD) will help you choose the equipment in the future, not presently. It is because the TD is based on the users’ experiences, which is different from a manufacturer’s catalogue.

(6) Closing speech

The workshop ended after Mr. Tun Lean, Director General of General Department of Energy, the MIME, delivered a closing speech in English. (The handout was provided to the audience.)

Ⅲ. Philippines (Steel Industry)

1. Outline of the Activities

We have held seminar and workshop that included follow-up energy conservation audit of Company C, with whom we have conducted Phase I (Feb 10-14, 2003), follow-up of Feb 2004 and Feb 2005 JETRO-JEXSA energy audit of Primary Steel Co. and presentation of examples of energy conservation efforts in various industries in the Metro Manila, Philippines.

Actually, we will describe one company name as “Company C” according to the agreement at Phase I.

Department of Energy (DOE) of the Philippine Government was to mandated to take the initiative in conducting follow-up energy audit and assessment reporting at Inception Workshop at Philippines, June 2005, however, ECCJ had to have initiatives instead.

1.1 Implementation Period

Aug 29 - Sep 2, 2005

1.2 Site of IMprementation

Follow-up survey:	Rolling mills of Company C and Primary Steel Corp (Metro Manila area)
Seminar and workshop:	Makati City (Metro Manila)

1.3 Schedule (Material No. D-101E)

Aug. 28 (Mon):	Follow-up energy audit (Company C)
29 (Tue):	Follow-up energy audit (Company C), DOE visitation
30 (Wed):	Follow-up energy audit (Primary Steel Corp)
Sep. 1 (Thu):	Follow-up energy audit (Primary Steel Corp), DOE visitation
2 (Fri):	Seminar and workshop

1.4 Relevant Persons

ACE (ASEAN Center for Energy):

Mr. Christopher G. Zamora: Manager

Mr. Ivan Ismed: Project Officer

Philippine Government:

Department of Energy (DOE)

Mr. Marlon R.U. Domingo, Sr. Science Research Specialist, Energy Efficiency Division

（The Focal Point in the Philippines）

Mr. Michel Estrada, Energy Efficiency Division

Department of Science and Technology (DOST)

Mr. Oscarlito Malvar, Science Research Specialist, Fuels and Energy Division

Ms. Rochell, Fuels and Energy Davison

Japan: International Engineering Department, ECCJ

Mr. Fumio Ogawa, Technical Expert

Mr. Hisashi Amano, Technical Experts

Mr. Hideyuki Tanaka, Technical Expert

Current Situations of Philippines

(1) General

- Area: 299,404km^2 (80% of total area of Japan): Comprised of 7,109 islands
- Population: 81.5 million (2003 World Bank data)
- Religion: Roman Catholics 83%, Other Christian Sects 10%, Islamic 5%
- Constitution; Constitutional Republican Form of Government
- Economy: Major Industries: Agriculture and Fisheries (Approx. 37% of the entire work force)

  GDP per Capita: 1,050 US dollars (2003)

  Economic Growth: 4.5% (2003)

  Currency: Philippine Peso, approx. 2 yen (June 2005)

  Trade (2003):

  Export: Electronic, electric machinery and tools, transportation equipment to US, Japan, and the Netherlands: Export value 35.75 billion US dollars.

  Import: Communications and electric machinery and tools, electronic parts, heavy electric equipment for generation, etc. imported from Japan, US and Korea: Import value 37.45 billion US dollars
- Economic Condition: In gradual recovery since Asian currency crisis. Recorded GDP growth rate of 4.5% in 2003: Government Objective of 4.2 - 5.2% was met. To sustain growth, economic structural reform, elimination of budget deficit, disposal of bad debts, and restoration of civil order are necessary to secure public/international confidence in Philippine economy.

(2) Energy Situations

The self-supplied primary energy in Philippines was 56%, such as the renewable energy (RE), geothermal energy, hydropower and natural gases. Import of oil and gas was 44%. The energy consumption in industry sector was 26.5Mtoe/y, 31% of total (2003).

The electricity price, varying in region, was US$0.12/kWh in Metro Manila in 2005. The prices of gasoline and light oil were US$0.57/L and US$0.52/L each.

2. Follow-up Survey of Rolling Mill Factory of Company C

2.1 Outline of the Rolling Mill Factory of Company C

(1) Company profile

Established in 1966, and the rolling mill began operation with annual steel rod production capability of 30 thousand tons, and later increased production capability to 90 thousand tons in the old plant, M-II. Planning for a new mill on the present site (adjoining to the M-II site) of 360-thousand ton capacity was put in place in 1994 and production operation began in 1996. It is one of major steel bar production companies in Philippines and all of its products are consumed domestically.

Presented below are conditions at the time of the Phase I energy audit including the status at the time of the follow-up visit.

Name of the Company: Company C

Location: North of Metro Manila, about 1 hour by automobile

Products: Does not use electric furnace; only rolling of purchased raw material

Steel bars (Diameter: 10、12、16、20、25、28、32、36、40、50mm)

Employees: 450 (of whom technical personnel 56)

Operations: Three shifts, 8-hours each

(2) Facilities of the rolling mill and energy conservation

1) Operation

Because the mill uses all imported billets (raw material), exposing the production cost to the overseas economic condition, the company is forced to make frequent adjustments in procuring the raw material. At the time of the Phase I energy audit, the mill was in the midst of stop-operation of 1 week and maintenance operation, due to a lack of raw material. At the time of the present visitation (Aug. 2005), operation appeared to be sound, as the company has procured a large supply of Russian billets.

In the Philippines, the layout of rolling mills generally is in so-called cross-country type; however, the layout in this plant is in a simple straight line.

2) Facilities

Billet Yard: Out of door, 2 gantry cranes

Reheating Furnace:

Type: Walking beam, bunker oil burning with recuperator

Capacity: 65t/h max. 12mL billet

Burner: Two-row configuration

Rolling Mill: 18-stand tandem, horizontal/vertical type, linear array

Incidental Equipment: Continuous quenching equipment, cooling bed, and automatic binder, etc.

Power Receiving Equip.: Transformers: 4 units

Air Compressors: 6 units

Cooling water supply and water treatment: 1 unit

Also emergency power source, illumination and air conditioning as devices for rolling mill facilities were equipped.

3) Energy consumption

Relationship between output of the rolling mill and energy consumption is presented in Table Ⅲ-2-1.

Table Ⅲ-2-1 Rolling Mill Output and Energy Consumption

Year	2002	2003	2004
Output t/y (Ratio to year 2002)	173,713 (100)	173,458 (100)	212,103 (122)
Energy Consumption Heavy Oil (for furnace) kL/y Electricity (rolling, etc) MWh/y	 5,412.8 14,613	 5,403.7 17,737	 6,776.0 20,877
Energy Intensity and ratio to year 2002 Heavy Oil (for furnace) L/t Electrical (for mill, etc) kWh/t	 31.16 (100) 84.12 (100)	 31.15 (100) 102.26 (121.6)	 31.95 (102.5) 98.43 (117.0)

In addition, the Mill uses LPG and oxygen (billet cutting) and diesel oil for emergency private electric generator.

2.2 Outline of the Results of the Previous Energy Audit on Company C

Recommendations for improvement in the last energy audit were as follows:

(1) Heat recovery in waste gas from the reheating furnace

For heat recovery in waste gas, a metal heating tube-type recuperator is used; in order to reduce the unit consumption of fuel further, installation of regenerative burners was recommended. Since the regenerator in the regenerative burner system is heated by the exhaust gas of high temperature as opposed to the recuperator uses the furnace exhaust gas, which has lost some heat in the preheating zone and ducts as the source of heat in heat exchange with the combustion air, the former generates preheated air of higher temperature, raising the energy conservation effect by 10 to 20%.

(2) Reduction of basic electric charge due to reduced electrical demand

This system sounds an alarm automatically when the actual maximum power (15-minute demand value) is to be exceeding the target demand value, and restricts load on electrical equipment of lower priority (e.g., air conditioning) in order to regulate the values within the target demand value.

For instance, when power contract of 8,000kW are to be reduced by 500kW, assuming the mean electric cost is around 5.5PHP/kWh, a cost-reduction of approximately US$26,630/y based on the electric charge structure of this area will be feasible. Under this assumption, the investment for system installation is recoverable in approximately 1 year.

(3) Power factor improvement through deployment of MERALCO Receiving Power Factor Enhancement System.

The mean receiving power factor for 2002 was 94.25%. When raised to 100%, about US$22,560/y in power factor discount can be realized. Investment required may be recovered in approximately 4 and half years.

Though demand power reduction or power factor improvement does not directly result in energy conservation in the user’s side, such measures are beneficial for energy conservation of the supplier of the power.

(4) Air compressor number control in operation

Change air compressor operation will be shifted from individually controlled system to quantitatively controlled operation. However, because actual operating condition (on-load/un-load condition) could not be determined, estimation was not effected.

2.3 Follow-up energy audit

Visited the rolling mill factory of the Company C for 2 days of monitoring of implementation of the Phase I recommendations and additional other miscellaneous activities.

Even though the first visiting day happened to be a State holiday and the mill scheduled to be closed, however, the corporate management acceded to DOE request and received the survey team. In spite of the holiday, all of the necessary personnel was present and cordially received the surveyors.

(1) Date of energy audit: Mon, Aug 29, 2005 Company C Plant Visit (follow-up)
Tue Aug 30, 2005 Company C Plant Visit (follow-up)

(2) Audit team members:

Philippines

Department of Energy (DOE)

Mr. Marlon R.U. Domingo, Sr. Science Research Specialist, Energy Efficiency Division（Focal Point of the Philippines）

Mr. Michel Estrada, Energy Efficiency Division

Department of Science and Technology (DOST)

Mr. Oscarlito Malvar, Science Research Specialist, FED

Ms. Rochell, Fuels and Energy Davison （FED)

ACE (ASEAN Center for Energy)

Mr. Christopher Zamora, Project Manager

Mr. Ivan Ismed, Project Officer

Japan: International Engineering Department, ECCJ

Messrs. Fumio Ogawa, Hisashi Amano and Hideyuki Tanaka, Technical Experts,

(3) Attendees from the factory:

Senior Manager, Quality Assurance, Safety and Environment (Leader of Energy Control Team)

Head of Electrical Maintenance and 2 Engineers

Head of Mechanical Maintenance and 2 Engineers

Engineer, Engineering Development

Three Engineers, Production

One Engineer, Energy Team Coordinator (Total 12 participants)

(4) Outline of the follow-up investigation

On the first day of visit on August 29, after confirming the purpose of the present visit and the schedule with the receiving party, we have made rounds of the mill in order to see the present status and to locate potential problems. In addition, we have discussed the questionnaire, which has been mailed prior to the visit (Material No. D-105E). On the second day on August 30, we have made rounds of the mill again and quantitatively monitored electrical equipment. Subsequently, we have summarized our findings and presented them.

Because Energy Management Team was put in place only in May of this year, the results of improvement effort implemented since the last visit have been somewhat ambiguous, but they were good enough to expect future improvements. We believe that achievements such as we noted were due to Senior Manager's visit to Japan as one of members for "FY2005 Trainee Invitational Program under International Energy Use Rationalization Measures for the Philippines (ECPH)" held in June, 2005.

Technical details of the present summary may be found in the attached "Follow-up of Energy Audit EE&C Activities in Steel Industry, Philippines". (Material No. D-126 (1) & (2))

2.4 Results and Discussion of the Investigation

(1) Status of production and energy intensity

Figures III-2-1, III-2-2 and III-2-3 are graphic representation of data in Table III-2-1. The growth of output of 2004 in comparison with that of 2002 was 22%. In terms of energy intensity, the growth was close to none in fuel and electrical consumption increased by 21% (2003) and 17% (2004).

These figures alone are not revealing all the reasons; they are as follows:

a. Energy intensity varies among products (steel bar size) due to difference in conditions of production operation.
   (Based on data on another rolling mill, it is reported that unit consumption of fuel increases by 1.2 to 2.5L/t as the size of the steel bar decreases by one step.)

b. Time lost in changing over the product size is disadvantageous in production of many articles.

In order to make proper assessment of energy intensity, it is necessary to analyze each plant and product on a separate basis. This mill is accumulating the data on energy intensity of each product, but lacked enough data to revise the above-described data.

During the round of August 29, the indicator for fuel unit consumption in the operation room was showing the 27L/t level for continuous rolling operation of same size product (around 20 or 25mm).

During the last visit, the management stated that only the new mill was in operation at the time, however, M-II (no visitation; about 300m away from the new mill) is operating during this visit. The data for both mills are processed in this plant so that figures alone were not useful in the assessment.

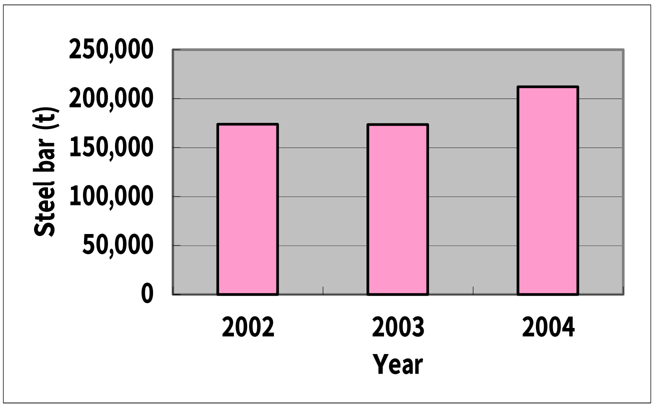


Figure Ⅲ-2-1 Change in Output

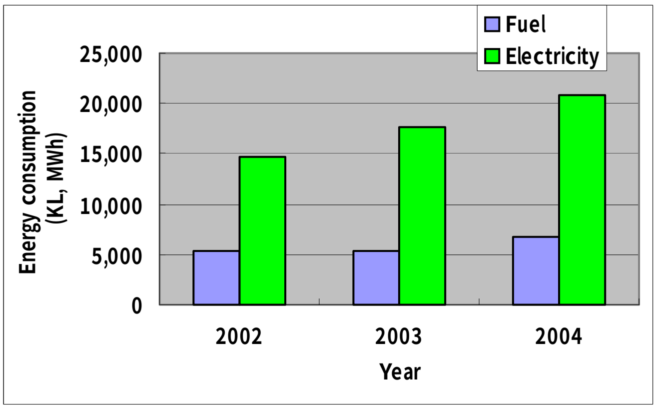


Figure Ⅲ-2-2 Change in Fuel and Power Consumption

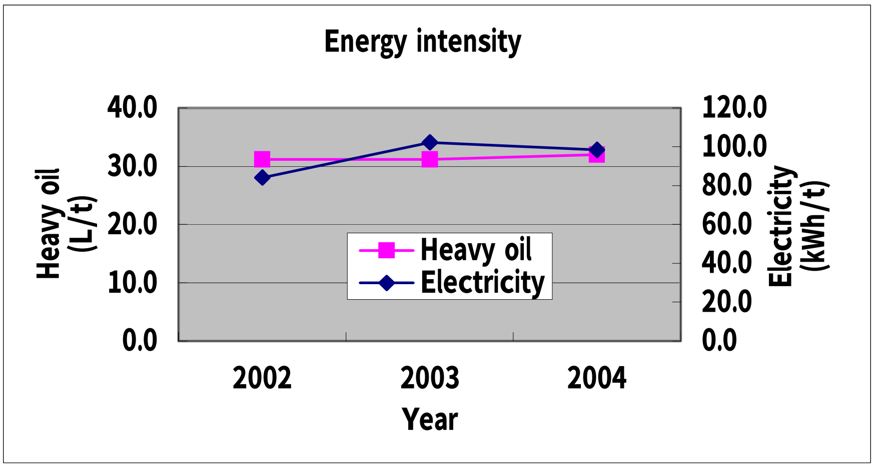


Figure Ⅲ-2-3 Change in Energy Intensity

(2) Energy management activities

The Company has taken a step in May 2005 toward systematic activities in internal energy conservation by organizing the Energy Management Team. The team membership consists of representatives of departments and meets on a weekly basis. The team leader is Senior Manager as mentioned above.

The Company intends to make full use of training Senior Manager received in Japan in June 2005. As a starting point, the Company has decided to focus on "minimization of downtime energy consumption and in 'awareness-raising' of employees in general toward energy conservation.

(3) Furnace air ratio control and heat recovery from exhaust gas

1) Installation of regenerative burner

No action has been taken on this matter. The Company explained that fuel conservation of the existing recuperator is 30% and apparently is satisfied with its performance.

In actuality, the temperature of the exhaust gas at the recuperator intake port is 700℃ and temperature of the furnace air supply is raised from 30℃ to 350℃. Some times it reaches 400℃ (however, under these conditions, fuel saving should be in the 20% level at the maximum).

While regenerative burner is effective, and installation of regenerative burner system by Japanese manufacturers is possible in newly constructed furnace, decision is a difficult one because conversion is costly due to the equipment price and necessity for operational shutdown during the period of conversion.

We do hope that Company C considers it important to keep the project on the agenda for the future.

2) Internal air leak of the recuperator

While the air ratio is maintained at 1.1 in the upstream part of the recuperator, the downstream oxygen level in the throat of the stack "is measured once a week; the oxygen level is 5 - 7%" was the answer. When the intake air-oxygen ratio is 1.1, the oxygen level of the exhaust gas should be approximately 2%. This is a separate issue, however it is quite possible that some air meant for fuel combustion is leaking into the furnace.

We attempted to measure the oxygen content in the exhaust gas but due to a problem with the sampling tube, the attempt was unsuccessful. As an alternative, we used the oxygen content of the exhaust gas at the throat of the stack, the fuel oil component and the combustion air ratio, and then estimated the amount of the air that may be leaking into the furnace. However, since we have not determined the oxygen content at the air intake of the recuperator, we disregarded air leakage at the billet charge and discharge ports, furnace body and ducts. The result of the calculation indicated that, of the preheated air in the recuperator, leakage rate into the exhaust gas was 17% when the oxygen content was 5% at the throat of the stack, 23% when the oxygen content was 6% and 28% when the oxygen content was 7%.

We expect the Energy Management Team to take this matter seriously and inspect the recuperator and repair any deficiencies it might find.

3) Consideration of the necessity of exhaust fan on the stack

We have doubts as to the effectiveness of the existing fan on the stack. Citing examples of fan-less furnaces, we suggested review of the relationship of drafting capability with the height of the stack and controlling of suction force on the exhaust gas by the use of a damper. We pointed out that it might be possible to remove the fan depending on the result.

(4) Demand control (maximal power control) at the power receiving station

Recommendation was not implemented; however, it is true that reactivation of M-II altered the condition and the issue needs to be reconsidered.

The electric power charge is composed of the combination of basic charge and metered charge. The basic charge is imposed on monthly maximum power consumption measured in terms of 15-minute demands. The time period of 15 minutes is too short to render control by means of manned watch. Thus, deployment of automatic measurement system is appropriate and functional integration into the factory automation system (FAS) is recommended.

While it is conceivable to utilize the demand meter system recommended in the 2003 Phase I energy audit, functional integration into the FAS that is a control system for production facilities may be superior, in consideration for future expansion of the control functions.

On the other hand, daily power consumption control is also important. It may be implemented on the basis of various power indications in the power distribution system.

The simpler approach is to read off various cumulative power consumption indications at the same time period on a daily basis, calculate the differences with the readings of the previous day and summarize the results by Department. This method would generate clues for further approaches to energy conservation. Data so obtained could also be used to generate the daily load curve of power consumption.

In order to obtain more detailed equipment data for examining energy conservation, power measurements would be required.

(5) Improvement of power factor

A condenser was already installed directly after installation of the transformer. Therefore, effect generated by the power factor improvement on the loading side is limited to the improvement in ohm-loss in the power distribution line.

The Company indicated that they would take care of larger motors. In this respect, we have made some calculations based on measurements made on August 30.

Transmission loss, W(kW) is approximated by formulas presented below:

W = Voltage drop rate×apparent power = $(\Delta V/V) \times (P/\cos\varphi)$

where,

ΔV = Voltage drop rate, V = line Voltage, P = load power, $\cos\varphi$ = power factor, $P/\cos\varphi$ = apparent power

The results of the estimation are shown in Table Ⅲ-2-3.

Distribution loss due to pumps and compressors is below several percent of the load power. Such values are within the allowable range and installing a condenser on the motor for the purpose of improvement of power factor is not a wise policy.

Table Ⅲ-2-3 Load Measurements of Pumps and Compressors

Item \ Pump & Compressors	For Plant Water Supply (100hp)	For Cooling Water (75hp)	For Quenching Water (200hp)	For Compressors (200hp)
Voltage (V)	453	447	433	437
Electric current (A)	99.7	69.2	183.6	219
Load Power (kW)	68.7	48.3	126.0	142.1
Power Factor cosφ	0.854	0.900	0.909	0.850
Transmitted Voltage V (V)	456	436	448	448
Load Side Voltage (V)	453	447	433	437
Voltage Drop ΔV (V)	3	9	15	11
ΔV/V	0.66%	1.97%	3.25%	2.46%
Load Power / cosφ	80.4	53.7	138.6	167.2
Distribution Loss W (kW)	0.53	1.06	4.64	4.10
Distribution Loss/Load (%)	0.8%	2.2%	3.7%	2.9%

(6) Energy conservation measures for air compressors

1) Reduction of number of air compressors in operation

No air compressor consolidation system was provided.

Company C has appealed that it would like to start working on the compressor issue with minor refitting (changeover of control valves, etc.) for rationalization of piping and work on such matters as revolution frequency in the future.

Company C air compressor configuration includes four 200hp and two 100hp units. Difference in deployment number came about as a result of reactivation of M-II. When M-II was inactive, all air compressors were moved to M-I for concentration.

At this point, we have described an approach to determine the required capability and focal points in controlling the number of units of air compressor in operation in the following manner.

While the air compressor configuration is four 200hp and two 100hp units, however, we assume that actual operating requirement may be met with two 200hp and one 100hp units.

Calculate the actual load rate requirement in routine operation in terms of load time T1 and unload time T2 and apply them in the following formula for estimation:

$$\text{Load ratio} = T1/(T1+T2)$$

$$\text{Compressor discharge rate} = \text{Load ratio} \times \text{rated value}$$

On the basis of the results of above calculations and rated output, assign main units for rated operation and sub-units for load/unload operation. In operation control, customary approach is to use a unit number control panel, but it is possible to accomplish the objective through adjustment of discharge pressure control values of each unit. By narrowing the range of controllable pressure of the sub-units in comparison with the main units, they can serve as load/unload units, respectively.

2) Determination of leakage and control measures

To facilitate this operational mode, it is necessary to locate leaks and repair the exit side of piping system. Company C side has told us that the company has “conducted piping inspection based on the steps planned by the Energy Management Team approximately 2 weeks ago. Some 50 leaks were found”. In that case, it would be possible to lower the pressure on the exit side provided leaks are repaired.

In any compressed air system, invent in a newly installed system, there is generally leakage of 3 to 5%, exceed 10% as a function of aging and even reach 35%. Leaks principally develop in connecting parts of piping (corrosion of the flange, deterioration and development of gaps in the gasket, loosening of bolts, etc.), sealed area of devices (rubber or metal seal on an elastic body), slackening or break of the hose and incomplete closing of the valves.

Quantitative determination of leakage may be accomplished through measurement of loading factor in operation of the compressor system when the mill is not in operation.

3) Placement of compressors

The air pressurized by the compressor is delivered with pressure to the terminal equipment through piping and is subjected to loss of pressure and flow (leaks) under delivery.

Thus, needlessly distant delivery with pressure is not always warranted. That is, it is possible to have an instance in which it is more effective in terms of energy conservation to set up multiple independent compression systems according to the load.

In addition, other miscellaneous measures such as looping of branching pipes, placement of receiver tank in locally heavy loaded area, etc. is possible against loss of pressure. Timely response is desirable.

4) Reduction of discharge pressure

The discharge pressure control of the compressor is set at a rather high level of 100 to 110psi (0.7 – 0.77MPa). Company C side explained that this high level of compression is needed to maintain the terminal equipment pressure in M-II Mill, 300m far from compressor room. A close study may reveal that it would be necessary to reinstall the compressors for M-II in the original location.

In decreasing the discharge pressure of the compressors and determining the optimal values, it would be desirable to first ascertain the pressure requirement of each unit before decreasing the pressure. For instance, discharge pressure reduction from 0.7MPa to 0.6MPa would result in power saving of approximately 8%.

Low-pressure load: Pressure reduction by mean of reducing valve

High-pressure load: Consider pressure increase by means of boosters

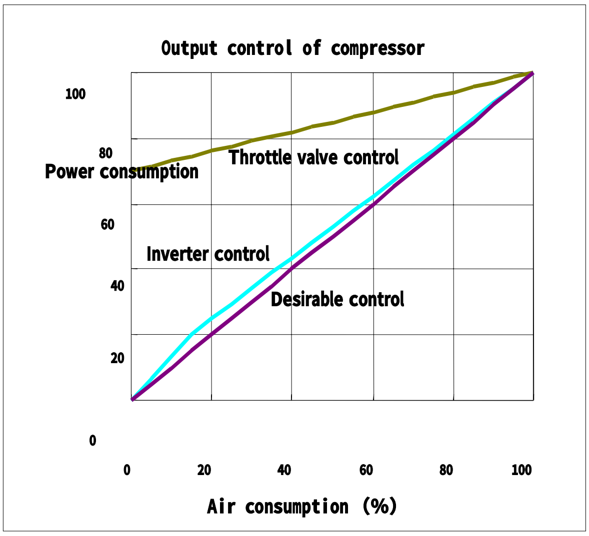
For example, air blow pressure for the cleaner can be low (approximately 0.3MPa), etc.

An abnormally high pressure of 0.85MPa was indicated on one of the receiver tanks. The first step in data management is to conduct comparative examination immediately to do calibration at abnormal meter readings.

5) Selecting the inverter unit (variable load-compatible type)

A throttle valve generally affects capacity control of the screw type compressor and such a compressor consumes approximately 70% of rating under unloaded condition; partial load property of the screw type compressor is not good. For this reason, as a sub-unit requiring volume regulation, an inverter-controllable compressor is favorable. This topic must be on the agenda in time of system renewal.

Figure Ⅲ-2-5 shows compressor characteristics and those under systematized operation.



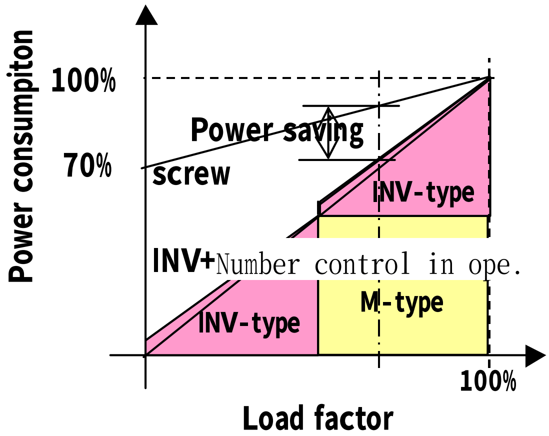


Figure Ⅲ-2-5 Operational Characteristics of Compressors

(7) Miscellaneous energy conservation measures

a. Installation of heat resistant canvas on furnace door

b. Installation of additional wattmeter: Will be installed within this year.

(8) Summary of energy conservation activities of the past 2 years as of the Follow-up visit

Concerning status of the four measures of improvement proposed in the Phase I visit for energy audit and other miscellaneous items described in 2.2, results of the Follow-up visit are presented in Table Ⅲ-2-3.

(9) Energy conservation measures noted at the time of the DOE visit

Energy conservation issues noted at the DOE offices are as follows:

1) English translation of Japan's "5S" was on display on the office wall. It gave us the impression that such Japanese approach/spirit is spreading.

2) Two bulbs of the set of 3 bulbs in the fluorescent light fixture were taken out and a large stainless steel reflector was installed in stead.

Table Ⅲ-2-3 Energy Conservation Activities Concerning Improvement Measures Suggested at the Time of the Phase I Visit for Energy Audit

Recommended Technology	Adjudication	Status of Implementation
(1) Heat recovery from the furnace exhaust gas	Yes	By recuperator, the combustion air is preheated at 350℃, and fuel saving is about 20%. But no studying for regenerative burner system.
(2) Demand control for the electricity receiving/ transforming equipment	No	Under studying the methods
(3) Power factor improvement	Yes	Installed capacitor
(4) Control of the air compressors in service	No	Under studying - Re-arranging of control valves - Use of variable frequency drive
(5) Insulation of heat resistant cloth canvass for discharging and charging door of furnace	(Yes)	Installed in September 2005.
(6) Installation of additional KWH meters	(Yes)	Installed within 2005.

3. Energy Audit of Rolling Mill Factory of the Primary Steel Corporation

Rolling mill of the Primary Steel Corporation is a newcomer as a subject for the energy audit under our PROMEEC Project. Nevertheless, the energy audit visit for energy conservation guidance has been made in February 2004 and February 2005 under the JETRO-JEXSA Project "The FY2004 Support Project for Establishment of National Steel Industry Energy Conservation Audit Program in the Philippines", and as such it was a de facto follow-up visit, and after that, improvement has been made somewhat. We were given the impression that the corporate management is enthusiastic toward taking further action in improvement effort.

Mr. Go, Vice President and Plant Manager, has been a trainee member of the ECPH Program and visited Japan in June 2005. His awareness of the necessity of energy conservation was clear and was very helpful toward the visiting entourage.

3.1 Outline of the Rolling Mill Factory of the Primary Steel Corporation

(1) Outline of the Corporation

Former Dependable Metal Co., through merger in 1998, leased land and facilities from KUMECO (Kudos Metal Co.) and began to manufacture steel rods for concrete reinforcement, rods, square rods and small angle irons.

The plant is one of medium scale in the Philippines and its annual production capacity is 240 thousand tons. The company has shown aggressiveness by adding 3 rolling stands to the rolling facilities in order to increase efficiency in small steel rod rolling capability in 2004 and replaced obsolete furnace heat recuperator.

Corporate Name: Primary Steel Corporation	
Plant Address:	No.3 MGM Industrial Compound, Bagdaguin, Valenzuela City, 1442, Philippines Tel: 63-9-36-97-83 (Located in northwest of Metro Manila, about 1 hour by automobile)
Products:	No electric furnace; rolling mill operation only (OEM rolling only), Steel bars (mainly of 10, 12, and 16mm bars)
Employees:	200 (including 56 technologists)
Operations:	Three 8-hour shifts

(2) The Rolling Mill and Energy Consumption

We described data on energy conservation activities involving information on JEXSA Program of JETRO, in February 2004 and February 2005.

1) Outline of corporate operation

The current products consist of steel rods for concrete reinforcement and steel rods (10、12、16mm in diameter), square rods and small angle irons (20mm maximum), and these products are manufactured on the OEM-basis from other corporations of the steel industry. For this reason, clients deliver the raw materials into the mill and receive the finished products on site. Thus, manufacturing operation of this company is simpler than independent rolling mills to the extent of the lack of row material procurement and product transportation.

In comparison with steel rods of larger size, small rods manufacturing is less efficient in rolling efficiency and as a result higher in energy intensity. This corporation, consequently, is aggressive in cost-reducing efforts such as energy conservation and in its effort to expand its involvement in smaller steel products other mills tend to avoid.

2) Facilities

Billet Pool: Outdoors, 1 unit gantry crane

Rolling Furnace — Pusher type bunker oil burning furnace
Capacity: 40t/h max. 6mL billet heating is possible
Burner configuration: Two-side in heating zone, axial type of burners in the soaking area with exhaust heat recovery recuperator

Rolling Equip. — 15-stand tandem, horizontal/vertical type
Line configuration except first two roughing stages in cross-country configuration
Cooling bed, automatic binding unit and others

Power Receptor — Transformers: 4 units (34.5kV)
Air Compressors: 2 units (180kW)
Cooling water distributor and wastewater processor unit: one complete set
Miscellaneous items in the rolling mill including emergency power source, lighting and air conditioning and others

3) Energy consumption

Relationship between output of the rolling mill and energy consumption is presented in Table Ⅲ-3-1.

Table Ⅲ-3-1 Rolling Mill Output and Energy Consumption

Year	2002	2003	2004	2005 (1-7)
Output t/y (Incr. over previous year)	109,687 (100)	133,981 (122)	120,344 (110)	55,615 (An. equiv. 87)
<u>Energy Consumption</u> Bunker Oil (furnace) kL/y Electrical (rolling, etc) MWh/y	 4,489 11,623.5	 4,889 15,470	 4,026.0 13,975.5	 1,855 6,541.5
<u>Energy Intensity</u> Bunker Oil L/t Electricity kWh/t (Incr. over previous yr)	 40.93 (100) 105.97 (100)	 36.49 (89.2) 115.46 (109)	 33.45 (81.7) 116.13 (109.6)	 33.35 (81.5) 117.62 (111)
<u>Energy Price & Transition</u> Bunker Oil PHP/L Electricity PHP/kWh (Incr. over previous yr)	 8.74 (100) 4.98 (100)	 10.73 (123) 5.56 (112)	 11.89 (136) 5.50 (110)	 13.84 (158) 7.08 (142)

In addition, the Mill uses LPG and oxygen (for billet cutting) and diesel oil for emergency power source equipment.

(1PHP = approximately 2 yen at Aug 2005)

3.2 Suggested Energy Conservation Measures for the Rolling Mill Factory

Recommended improvements up to 2004 comprised of the following items:

(1) Increasing heat-recovery from furnace exhaust gas

For heat recovery of exhaust gas, a recuperator of metal tube for combustible air heating is in use; however, the temperature of pre-heated air remains below 250℃ (max. 297℃). The conceivable cause of inefficiency may be low temperature of exhaust gas at the intake port of the recuperator at 600℃ and that the pre-heated air is leaking inside of the recuperator.

The low temperature of the exhaust gas may be attributed to effective transfer of exhaust heat to the billet within the preheating zone of the furnace, however heat is poring out of the billet charging port of the furnace. Reducing this opening by half would conceivably reduce heavy oil requirement by approximately 170kL/y. In addition, the furnace appears to be taking in air at the billet discharging port; it requires considerable work to keep outside air from entering. The furnace and ducts also require their heat-keeping capability to be raised. The combustible air ratio of less than 1.0 means either the furnace is operating under the assumption of having to compensate for considerable penetration of outside air or malfunction of the indicator.

Recuperator was replaced in July 2004, but penetration of the pre-heated air in the recuperator was detected already in February 2005. Procedure in maintenance appears to require strengthening, now and in future.

(2) Prevention of compressed air leaks

Personnel of the Primary Steel Corporation has tested the air leakage in about half of the compressed air distribution piping and measured 12.1% of leakage loss. It means that the loss is over 20% in the entire piping. For example, if this loss were reduced by 1%, the savings would amount to approximately 80,000 PHP per year. Thus, we have recommended reducing the current compression leak by over half with the objective of lowering to 5%.

(3) Implementation of demand control

The maximum electric power consumption in December 2004 was 4085kW and those of many of the past months approached 4000kW. The mean monthly loading rate is low in the 50% level.

We have therefore proposed that the Corporation install the demand meter. A concerted effort of conservation by setting a maximum monthly level on the basis of monthly production volume would achieve a considerable effect in reduction of the basic monthly power bill.

For example, an achievement of 1,500kW monthly reduction would result in the savings as follows:

$$1,500\text{kW} \times 270.6\text{PHP/kW} \times 12\text{month/y} = 4,870,800\text{PHP/y}$$

3.3 Follow-up energy audit

We have made a 2-day visit of the Rolling Mill of the Corporation for the purpose of follow-up energy audit of the status of implementation of recommendations made in the JEXSA visit and monitoring of other activities.

Mr. Go, Vice President and the Plant Manager, has participated in the METI-ECCJ reception training program (ECPH) of June 2005 as a trainee and was an avid believer in energy conservation efforts. He stated that cost reduction achieved in 2004 exceeded 4 million pesos (PHP, Philippines Peso). Also, he is planning to achieve even greater savings this year. He was very cordial toward us, the visiting investigators.

(1) Date of the energy audit:

August 30, 2005 (Wed) Visitation of the rolling mill of Primary Steel Corp.

September 1 (Thu) Return visit of the rolling mill

(2) Audit team members:

Philippines

Department of Energy (DOE)

Mr. Marlon R.U. Domingo, Sr. Science Research Specialist, Energy Efficiency Division（Focal Point in the Philippines）

Mr. Eric Navarrete, Energy Efficiency Division

Department of Science and Technology (DOST)

Mr. Oscarlito Malvar, Science Research Specialist, Fuels and Energy Division

Ms. Rochell, Fuels and Energy Davison

ACE （ASEAN Center for Energy)

Mr. Ivan Ismed, Project Officer

Japan: International Engineering Department, ECCJ

Messrs., Fumio Ogawa, Hisashi Amano and Hideyuki Tanaka, Technical Experts

(3) Attendees from the factory:

Mr. Henry Go, Vice President – Operations (partially involved)

Mr. Ramon R. Mangibunong, Assistant Plant Manager

Mr. Noel, Electrical Engineer

(4) Summary of the follow-up survey

Initially confirmed the purpose and schedule of the present visit and made the round of the site to grasp the present conditions and possible problems. Subsequently we have discussed the Corporation responses to the items in the questionnaire previously delivered by DOE (Material No. D-106). On the second day, we have conducted electrical measurements of the air compressors and measurements of oxygen content and temperature of the exhaust gas of the furnace. Finally we explained the measurement results, and summarized the energy audit.

The technical discussions concerning this paragraph are shown in the attached document, ”Follow-up of Energy Audit EE&C Activities in Steel Industry, Philippines” (Material No. D-126).

3.4 Survey results

(1) Status of production and energy intensity

Figures III-3-1, III-3-2 and III-3-3 are graphic representation of data in Table III-3-1. The output is variable from 2002 through 2005. This variability reflects the mode corporate operation of production on the basis of consignment.

1) Heavy oil

Furnace fuel is heavy oil (No.6 Fuel Oil or Bunker Oil). Fuel tank of 100kL was used to receive the fuel delivered by tankers. As shown in Table III-3-1, the fuel prices rose by approximately 36% during 2002 through 2004 and approximately 56% in 2005.

Unit consumption of the fuel has been improving each year. This improvement is attributable to objectified management by means of unit consumption values by product; a variety of conservational improvement measures effected as described below.

2) Electrical power

The unit consumption of the electrical power has been on the decline, which, according to corporate explanation, is principally attributable to the increase in the consignment in product of smaller diameter and expansion of operation by additional installation of 3 rolling finishing stands (to total of 15 tandem stands).

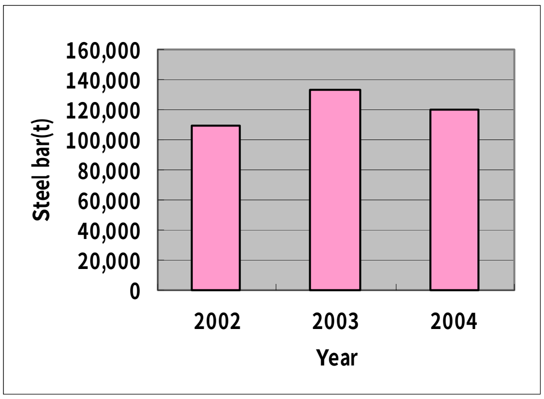


Figure III-3-1 Changes in Production Volume

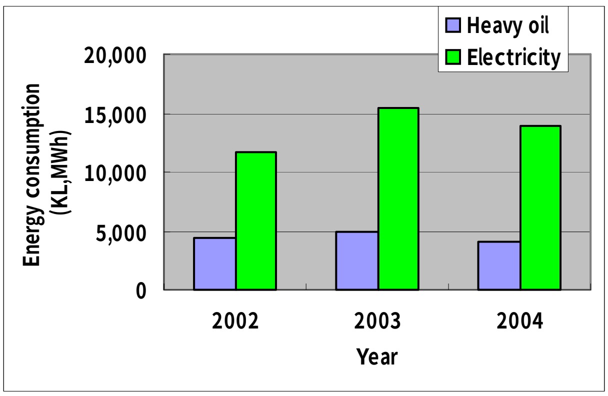


Figure III-3-2 Consumption of Fuel and Electric Power

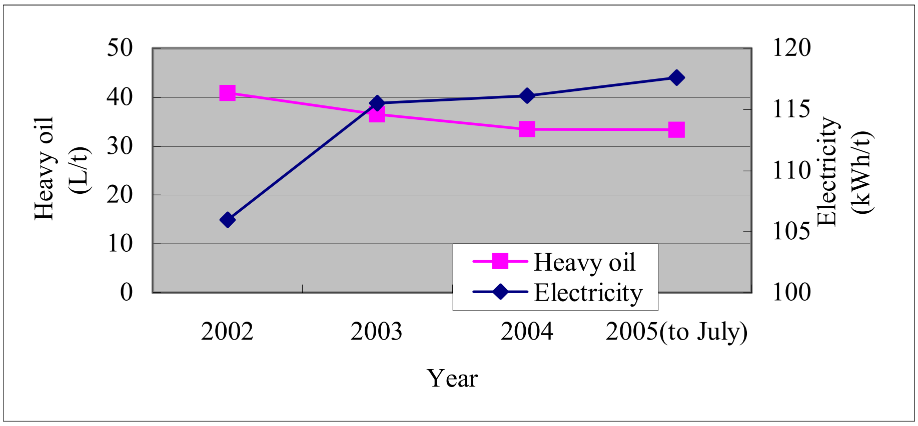


Figure Ⅲ-3-3 Changes in Energy Intensity

(2) Energy control activity

In March 2005, "Energy Conservation Group" was organized in the following Departments.

i) Maintenance

ii) Production

iii) Materials (warehouse, etc.)

iv) Administration

The activities of these Groups are principally awareness rising of energy conservation, turning off lights and air conditioners if not necessary and turning off equipment when the task is completed and other such miscellaneous items.

In addition, the Corporation is planning a program to perform energy-use audit (principally on use of fuels and electric power) on a semiannual basis.

(3) Recovering heat from furnace exhaust gas

The existing recuperator had damaged tubing and other defects and the exit port temperature of air for the fuel at the time of 2003 visit was low at 220°C. The replacement with a recuperator of same capacity in July 2004 raised the exit port air temperature to 245°C (maximum temperature at 297°C). According to Primary Steel, "there is no more leaks after replacement"; nevertheless, we took measurements of the exhaust gas temperature and oxygen content at the intake and exit ports of the recuperator on September 1. The results are shown on Table Ⅲ-3-2.

The combustion air ratio (m) indicator located in the furnace control room was reading 0.92. This value is doubtful; it is displaying either a compensated value to offset the air leaks or the meter is faulty. It is necessary that Primary Steel pursue the matter at a later date.

The exhaust stack was issuing a slightly smoky gas, however the oxygen content of the exhaust gas taken at the intake port of the recuperator (furnace exit port) indicated the level indicative of good combustion condition within the furnace.

Table III-3-2 Exhaust Gas Temperature and Oxygen Content at the Front-end and Rear-end of the Recuperator

Item	Number of Sampling	Intake Port	Exit Port	Difference
Temperature (°C)	First time	606	324	282
	Second time	586	321	265
Oxygen Content (%)	First time	2.3	5.3	+ 3.0
	Second time	2.0	4.4	+2.4
Measurements were taken at the temperature measurement openings at the front-end and rear-end of the recuperator. Since only 1 oxygen meter was available, we measured temperature first followed by oxygen; thus, in all cases, oxygen and temperature were not simultaneous measured.				

Since the oxygen content level of the exhaust gas at the exit port was greater than that of the intake port by 2.4 – 3%, it was conceivable that combustion air was leaking into the exhaust gas inside the recuperator and, as a result, the temperature of the exhaust gas at the exit port was lowered. From the measured oxygen content, the air ratio could be roughly estimated to be resulted by air leak of approximately 17% to flow rate of exhaust gas. This level was sufficient enough to be remedied from the standpoint of energy conservation. We have, accordingly, advised the corporate side “to take advantage of next plant closing to inspect the recuperator for air leaks.” In addition, we have demonstrated a method of calculating the exhaust gas flow rate on the basis of the characteristics of the fuel and to obtain an estimate of leaked air.

(4) Improvement of furnace doors

Improvements of the following items have been completed:

i) Fine adjustment of charging billets by installation of a winch at the billet charging port

ii) Installation of width-adjustable door on the billet discharging port

iii) Improvement of sequencer on the insertion pusher side.

iv) Improvement of sequencer on the billet-discharging door: The door occasionally remained open too despite the improvement. The corporate side explained that the cause was deformation of the billets and it was unavoidable.

(5) Temperature maintenance of the fuel heavy oil

With respect to fuel oil temperature, setting of 90℃ was raised to 110℃. In addition, we strengthened insulation of piping and flexible tubing feeding the burners. With these measures, the corporate staff felt that spraying improved and combustion looked smoother (fuel oil temperature was slightly higher than the temperature set in usual operation).

(6) Demand control of power reception

This item was not implemented. The corporate side admitted that the problem was beyond the level of staff capability in techniques and knowledge, and the cost was prohibitive.

The billing system for the electrical power consumption is composed of the combination of basic and specific duty charges. The basic charge is imposed on monthly maximum power consumption measured in terms of 15-minute demands. The time period of 15 minutes is too short to render control by means of manned watch. Thus, deployment of automatic measurement system is appropriate for monitoring and requires integration into the FAS (Factory Automation System).

Daily power control is also important, however, this function may be implemented on the basis of various power indications in the power distribution system. The simplest approach is to read off various cumulative power consumption indications at the same time period on a daily basis, calculate the differences with the readings of the previous day and summarize the results by Department. This method would generate clues for further approaches to energy conservation. Data so obtained could also be used to generate the daily load curve. In order to obtain more detailed equipment data for energy conservation, power meters would be required.

(7) Energy conservation measures for air compressors

1) Energy conservation measures of priority

- Reduction of leaks.

  Currently, half of the system accounts for 12.1% of compression leaks. For the entire system, the leak may exceed 20%. Thus, inspection and repairs are urgently required. Institution of periodic inspection schedule is also advisable.

- Estimate the pressure requirement of compressed air and adjust the discharge pressure.

Pressure loss reduction in piping can be expected by looping of piping system and eliminating leaks (reduction in flow rate). Installment of boosters where high pressure is required must also be considered. In addition, consider whether there are other measures to facilitate energy conservation.

2) Consideration of air compressor loading rate

There are 2 units of 250hp (186kW) air compressors installed and one of them is always in operation (and the other in standby). Since it is constantly loaded and unloaded repeatedly, it is conceivable that the compressor is a device of overcapacity.

i) Electrical measurements

In an effort to estimate the loading factor of the compressor, loading and unloading time were measured and electrical measurements during periods for loading and unloading were made. Each measurement was carried out twice and the mean values were adopted for calculation. Table Ⅲ-3-3 presents the result of measurements.

The measurements were taken when the compressor No. 2 was in line during the production of 10mm reinforcing bars. Discharge pressure conditions for pressure control were set at Pmax = 0.57MPa and Pmin = 0.54MPa.

Table Ⅲ-3-3 Electrical Measurement Results

Item	Loaded	Unloaded
Time (s)	9.715	5.69
Time Rate (%)	63.1	36.9
Voltage (V)	433.5	421.5
Current (A)	337.5	232
Power (kW)	216.5	149.5
Power Factor (%)	87.2	86.1

ii) Estimation of loading factor

Compressor output

$$P_{out} = 186\text{kW} \times 0.631 = 117.6\text{kW}$$

Compressor input as power consumption

$$P_{in} = 216.5\text{kW} \times 0.631 + 149.5\text{kW} \times 0.369 = 191.8\text{kW}$$

Proportion of power consumption when in full (100%) operation of Pin

$$191.8\text{kW}/216.5\text{kW} = 0.886\ (88.6\%)$$

Proportion of power consumption when in unload of Pin

$$149.5\text{kW}/216.5\text{kW} = 0.691\ (69.1\%)$$

iii) Estimation of optimal rate

Efficiency of the compressor may be expressed as a ratio of its output and input in the following manner:

η = 117.6kW/191.8kW = 0.613 (61.3%)

When the ratio of the nominal output (186kW) and the output of full load (216.5kW) as $\eta 100$, then it is

$\eta 100$= 186kW/216.5kW = 0.859 (85.9%).

If the operational efficiency is 61%, installment of inverter type of air compressor is difficult to establish as economically efficient. Thus, we have made a recommendation to consider leak detection discussed above to determine the measures to prevent diminution of air flow rate and pressure loss at the exit port and to consider installation of the inverter-controlled air compressors at the time of future occasion to replace the air compressors.

(8) Measures the Primary Steel Corporation has implemented

1) Installation of a compressor for use when the mill is shut down

In order to supply required compressed air during the period of mill shut down, the Corporation has acquired a small, 75hp air compressor (previously used unit) so that the larger compressors may be turned off (Aug 2005).

2) Temperature control of air conditioner for offices

Issued a directive to the employees to turn off the air conditioning when not in use (as a matter of fact, we have noted that some of the thermostats have been set low).

(9) Miscellaneous

1) One of inappropriate practices we noted was that defective finished products were stacked at various places on the premises. Such a practice is serious enough to offset all the steady efforts for energy conservation the Corporation has been accumulating over these years. We have thus attempted to convince the corporate staff that the following efforts would be meaningful while improving the product yield significantly contributed toward conservation of energy.

- Reducing down time
- Increasing productivity (reducing losses) - According to Mr. Ramon, the process yield reached 95%, however, observation of the site gave us the impression it was actually less. We feel that raising the product yield even by 1% is needed.

2) 5S of rolling operation electrical control room

When we looked at the electrical control room of the rolling mill, we were surprised by the cleanliness of the room. Its cleanliness made us wonder that this was in a plant and gave the impression that not a spec of dirt could be found in the room. Mr. Go told us that the staff decided that they should have at least one thing that they could be proud of. We expect that this movement would affect other units of the plant, and if it does, implementation of energy conservation would become easier in this mill.

(10) Assessment of corporate energy conservation activities

Implementations of the diagnostic recommendations described in 3.2 as well as improvement efforts conducted by the Corporation are shown in Table Ⅲ-3-4.

Table Ⅲ-3-4 Results of Corporate Energy Conservation Activity

Recommended Technology	Adjudication	Status of Implementation
(1) Heat recovery from the furnace exhaust gas, and reheating furnace issues		
a. To raise the preheating air temperature	Yes	New recuperator was installed in 2004. Air temp. is 245℃ from 220℃.
b. To maintain the recuperator minimizing air leakage	Yes	The worn out tubes end was closed. Recuperator house-keeping is scheduled every month.
c. To solves the furnace door opening issue, and to maintain the efficient combustion	Yes	Lifting type cover was installed at charging door. Discharging door opening time was reduced by 3 seconds. Fuel oil temperature was raised to 110℃ from 90℃ to attain the efficient combustion.
(2) Air compressor: To minimize the air leakage	Yes	Air leakage is continuously monitored by mechanical maintenance.
(3) Demand control of electricity receiving/transformer equipment	No	Under feasibility study

4. Seminar and Workshop

4.1 Summary

The seminar-workshop was held on September 2, 2005.

Mr. Matanog M. Mapandi, Assistant Secretary of DOE made the opening speech. The seminar and workshop attended by 42 participants appeared to be meaningful to attendants and may be considered to be a successful one.

(1) Date and time

September 2 (Friday), 2005 8:30: Start of registration, 17:00: Closed

(2) Venue

Second floor Yakal Room, Dusit Hotel Nikko, Makati City, Philippines

(3) Reports presented on the Seminar and Workshop

The contents discussed in the workshop are shown in the attached program (Material No. D-110). Representatives of the Philippines presented an overview of the DOE's energy conservation efforts and the Wholesale Electricity Spot Market (WESM) as well as 2 industrial-sector reports. ASEAN participants presented 3 reports but those of Indonesia and Vietnam were repeated presentation of those reported in a meeting in Cambodia.

(4) Participants (List was not circulated)

Philippines:

Hon. Matanog M. Mapandi, Assistant Secretary, Department of Energy (DOE)

Mr. Marlon Romulo U. Domingo, Sr. Science Research Specialist, DOE

Mr. Eric Naovarette, Science Research Specialist, DOE

Mr. Oscarlito C. Malvar, Science Research Specialist, Dep't of Science & Technology (DOST)

Ms. Rochelle Retamar, Science Research Specialist, DOST

Approximately 30 participants (number of attendance certificates issued, according to Mr. Domingo) were representing the industrial sectors (including the steel industry) of the Philippines. Presence of consultants was conspicuous among the participants (including ESCO's; some were former DOE staff members).

ASEAN Center for Energy (ACE):

Mr. Ivan Ismed, Assistant Project Coordinator

Malaysia:

Mr. Ghazali Talib, Energy Audit Engineer, Energy Industry & Sustainable Development Division – MIEEIP, Pusat Tenaga Malaysia (PTM)

Indonesia:

Mr. Subagyo, Supervisor, Pencana dan Evaluasi Produksi, PT Kertas Leces (Persero)

Vietnam:

Mr. Van Long, Official on Energy and Environment, Ministry of Industry, Science and Technology Department

Japan: International Engineering Department, ECCJ

Messrs. Fumio Ogawa, Hisashi Amano and Hideyuki Tanaka, Technical Specialists

4.2 Results of the Seminar and Workshop

(1) Opening ceremony (speeches)

1) DOE of the Philippines

Mr. Mapandi, Assistant Secretary of DOE made the welcoming speech. He pointed out that consumers and industries ought to be conscious of energy conservation and that we all required to faster our skills in conservation including technology and structures. He stressed that, to achieve success in energy conservation efforts, cooperation within each of the industries was mandatory and mutual support within ASEAN nations was required. He cited steel, food and chemical industries of the Philippines as examples in which such cooperation was taking roots.

2) ECCJ

Mr. Tanaka, representing the Japan side (METI and ECCJ) discussed the intended objectives of the Project, its development, current status as well as the intentions of the government of Japan concerning cooperation and contribution toward the member nations of ASEAN.

3) Asian Center for Energy

Mr. Ismed read the message from Dr. Weerawat, Executive Director of Asian Center for Energy (ACE). The message stated that, in view of the sky rocketing petroleum prices, energy conservation was increasingly important in the current world. The message specifically touched upon the Program of the Promotion of Energy Efficiency and Conservation (PROMEEC).

(2) Session 1　Activities of EE&C

1) Energy Efficiency and Conservation Promotion Activities in Philippines

- Mr. Domingo (Material No. D-120)

His discussion included objectives, strategies, educational campaigns, energy management advisory services, demand-side management, the "Don Emillio Abello EE Award" and other topics. Especially interesting was the introduction of the new DOE motto, the "EC Way of Life" (the DOE staff was wearing the tee shirts bearing the new motto at the time of site visits).

2) Energy Efficiency and Conservation Activities of Industries in Japan

- Mr. Tanaka (Material No. D-121)

He described structural changes in energy consumption in Japan, historical review of regulatory and administrative changes on energy conservation, efforts of Japan's industries toward energy conservation, Action Plan of Keidanren and many of the ECCJ activities. We believe that these topics were helpful to participants as reference information.

(3) Session 2 Examples of EE&C activities toward the industrial sectors

1) Overview of Wholesale Electricity Spot Market - Mr. Fernandez (Material No. D-122)

He described the development of the Wholesale Electricity Spot Market (WESM) and what it means to the South East Asia and proceeded to state that WESM is becoming the new trend in the Region. The talk we felt was very interesting.

2) Energy Efficiency and Conservation Best Practices in Chemical Industry

- Mr. Veloso (Material No. D-123)

His talk centered on his successful effort to develop a method of producing cold water by applying waste heat. Through his work with the RI Chemical Corporation he was successful in applying Vapor Absorption method to produce cold water.

3) Energy Efficiency and Conservation Best Practices in Food Industry - Mr. Erestain

He spoke on examples of energy conservation through efficient lighting system and motors but he spoke without any presentation materials, rendering understanding of his talk quite difficult.

4) Energy Efficiency and Conservation Best Practices in Iron & Steel, and Food Industry, Malaysia - Mr. Talib (Material No. D-124)

As a part of PTM (Pusat Tenaga Malaysia) activity, the government of Malaysia provides free energy conservation audit. In connection with this service, the author has visited plants of a variety of industries for energy audit and will summarize his experience herein. PTM has acquired a variety of measuring equipment for the purpose of energy audit.

One of the steel industry cases, the Malayawata Corporation has an electric furnace and a rolling mill in its organization and worked on many of the issues of the present workshop such as those involving furnaces, compressed air, electrical power and cooling water, and the case certainly would of interest to the participants of this workshop (many participants belonging to the steel industry). In another example, in manufacturing addible oil (palm oil), the company has shown us excellent results.

5) Energy Efficiency and Conservation Best Practices in Pulp & Paper, Indonesia
   - Mr. Subagyo (Material No. D-115)
   The talk was identical to one presented in Cambodia.
6) Energy Efficiency and Conservation in Ceramic Industry, Vietnam
   - Mr. Long (Material No. D-125)
   The talk was identical to one presented in Cambodia, but a different speaker presented it.

(4) Session 3 Results of the follow-up visits and the workshop

1) Follow-up Energy Audit Findings at Garment Factories
   - Mr. Domingo & Mr. Amano (Material No. D-126)
   Concerning this theme, materials were prepared by ECCJ. Of the materials presented, Mr. Domingo of DOE has taken initiative in the initial portion of the presentation (covering 3 slides) contributing the objectives of the ASEAN PROMEEC and its activities. Mr. Amano presented the remainder. His presentation centered on the technical aspects of electric power and furnaces, which appeared to have amply answered the questions of many of the participants.
2) Barriers and Measures to implement EE&C - Mr. Ogawa (Material No. D-117)
   Using the data of the past year, he has skillfully described the current status while emphasizing on its ramifications on the Philippines and answering many of the questions posed by the workshop participants.
3) Technical Directory (TD) - Mr. Tanaka & Mr. Ismed (Material No. D-118)
   They have explained the purpose, method of compilation, format and other details of technical directory and illustrated their talk with many actual examples. Mr. Ismed presented the exemplary cases.
4) Database/Benchmark/Guideline for Industry - Mr. Ogawa (Material No. D-119)
   Because of shortage of time, a short discussion of this item was presented and summarized.

(5) Q&A Session

Some questions were posed during presentations but this Q&A session was held at the end of the workshop. The participants asked many questions, but perhaps because of presence of some experienced consultants; they gradually turned into criticisms against governments. Most frequent voices pertained to the invalidation of the energy conservation bill submitted by DOE of the Philippines due to the lack of action within the time limit after the legislation of specified duration; they were urging the government (DOE and Department of Science and Technology) of the Philippines requiring more efforts.

Also numerous was the suggestion that the security protection requirements of DB/BM/GL were impracticable and that data collection and analysis themselves (in major industries) were too cumbersome.

(6) Closing speech

Ms. Teresita M. Borra, Director, Energy Utilization Management Bureau, DOE was scheduled to give the closing speech but was unable to attend. Mr. Domingo, in her stead, gave the closing talk.

IV. Indonesia (Paper/Pulp and Textile Industries)

1. Outline of the Activities

This survey includes a follow-up energy audit of PT KERTAS LECES, whose initial Phase 1 energy-conservation audit was carried out from January 22-25, 2001, and a new energy-conservation audit recently carried out on a spinning mill. A workshop was also held in Jakarta, at which case studies of energy-conservation activities in various industries were reported.

1.1 Implementation period

December 5 to December 9, 2005

1.2 Sites of Implementation

Follow-up investigation:	PT KERTAS LECES, Paper Mill (Leces Village, Jawa Timur District, about 120km southeast of Surabaya City)
New energy-conservation audit:	INDUSTRI SANDANG NUSANTARA (UNIT PATAL GRATI) Spinning Factory (Jawa Timur District, about 80km southeast of Surabaya City)
Seminar workshop:	Jakarta City

1.3 Schedule (Material No. D-102E)

December 2005, 5 (Monday):	Follow-up energy audit (PT KERTAS LECES)
6 (Tuesday):	Follow-up energy audit (PT KERTAS LECES)
7 (Wednesday):	Follow-up energy audit (PT KERTAS LECES)
8 (Thursday):	Walk through energy audit (PT Industri Sandang Nusantara, Patal Grati Spinning Mill)
9 (Friday):	Preparation of report; visited PT KERTAS LECES to receive information materials.
12 (Monday):	Seminar workshop at Jakarta

1.4 Relevant Persons

ACE:

Dr. Weerawat Chantanakome, General Director
Mr. Christopher G. Zamora, Project Manager
Mr. Ivan Ismed, Project Officer

Indonesia:

Ms. Meryam Ayuni, Directorate General of Electricity and Energy Utilization, MEMR (Focal Point of Indonesia)
Mr. Parlindungan Marpaung, Inspector of Electricity, MEMR

Japan:

International Engineering Department, ECCJ

Messrs. Fumio Ogawa, Hisashi Amano and Hideyuki Tanaka, Technical Experts

The background situation in Indonesia

(1) General information about Indonesia

- Area: about 1,890,000km^2 (about 5 times that of Japan)
- Population: about 215 million (according to the demographic survey of 2003)
- Religion: Islam 87%, Christianity 10%, Hinduism 2%
- System of government: Republic
- Economy: Major industries: mining industry (petroleum, LNG, aluminum, tin), agriculture (rice, rubber, palm oil), industry (wood products, cement, fertilizer)

  GDP per capita: $954 (2003)

  Economic growth rate: 4.5% (2003)

  Currency:rupiah, ¥1 = about 80RP (rupiah) (as of December 2005)

  Trading (2003):

  Exports: petroleum and gas (25%), transportation equipment and parts (17%), textiles and clothing (12%), etc. are exported to Japan (21%), U.S.A. (13%), Singapore (8%) (according to Indonesian statistics). Total value of exports: $61.058 billion (according to IMF statistics).

  Imports: general machinery and transportation equipment (26%), fuel and lubricants (24%), chemical raw materials and products (16%), etc. are imported from Japan (16%), China (12%), and Singapore (11%) (according to Indonesian statistics). Total value of imports: $32.61 billion (according to IMF statistics)
- Economic situation: After the Asian Currency Crisis of July 1997, the Indonesian government promoted structural economic reforms based on an agreement with the IMF. The economy is now experiencing a recovery, supported by strong private consumption and free from the supervision of the IMF at the end of 2003. However, domestic and foreign investments have not yet recovered to the levels experienced before the currency crisis and, since his election, President Yudhoyono has given the expansion of foreign investment top priority.

(2) Energy situation

Oil prices have risen 10 times in the past five years, and the present gasoline price is US$0.5/L. The cost of electricity is US$0.05/kWh.

2. Follow-up Survey of the Pulp and Paper Mill of PT KERTAS LECES

2.1 Outline of the Pulp and Paper Mill of PT KERTAS LECES

(1) Outline of the company

The company was established in 1938 during the period of Dutch administration. The pulp and paper operation was started on February 22, 1942, with the No. 1 paper machine. The company was originally owned by a Dutch company, nationalized after independence in 1961, and privatized in 1982. It now has five paper machines with a total production capacity of 570t/d. Actual production is between 120 and 140 thousand tons per year.

The first energy-conservation audit (Phase 1) was carried out in January 2001. After this initial investigation, the company vigorously promoted energy-conservation activities and achieved great success, with the results being reported at every PROMEEC Seminar. While the company was very cooperative in the present investigation it was, however, apparent that they were experiencing business problems due to changes in the external economic environment. When we visited, the plant was operating at less than half its capacity and several major facilities were inoperative.

The situation during the first energy audit and the follow-up investigation were as follows:

Company name:	PT Kertas Leces (Persero) Pulp and Paper Mill
Location of the plant:	Jl. Raya Leces, Leces, Probolinggo 67202, Jawa Timur – Indonesia Tel: 632-62-335-680993 Fax.: 632-62-335-680954
Products:	Printing paper, industrial paper, tissue paper, news print paper, bagasse pulp
Production:	120-140 thousand t/y
Number of employees:	About 3,150 (three eight-hour shifts with three groups of workers)

(2) Facilities and energy consumption at the paper mill

1) Outline of the operation

Although the production level was high during the first energy-conservation audit (Phase 1), the present production level is very low due to the slump in sales of the operation's major products such as newsprint (about 40% of total output).

2) Facilities

Boilers for power generation:	90t/h × 4.484MPa × 5 units. Fuel was changed from heavy oil to natural gas in 2003, and economizers have recently been installed.
Recovery boilers:	40t/h × 4.59MPa × 1 unit & 45t/h × 4.48MPa × 1 unit Liquor content = 43%
Steam turbines:	EBPT (back-pressure turbine) × 1 unit, output =19,400kW

CT (condensing turbine) × 1 unit, output =19,400kW
ECT (extraction c. t.) × 1 unit, output = 27,000kW

Paper machines

No. 1 machine: 2,700mm × 125m/min (for cardboard liners: 30t/d)
Steam consumption: 0.6MPa steam × 3.5t/t-paper
Electricity consumption: 876kWh/t-paper

No. 2 machine: 2,700mm × 325m/min (for industrial paper and writing paper: 60t/d)
Steam consumption: 1.25/0.6MPa steam × 3t/t-paper
Electricity consumption: 695kWh/t-paper

No. 3 machine: 6,000mm × 550m/min (for writing paper and printing paper: 175t/d)
Steam consumption: 0.6MPa steam× 3t/t-paper
Electricity consumption: 810kWh/t-paper

No. 4 machine: 2,400mm × 900m/min (for tissue paper: 30t/d)
Steam consumption: 3.3/1.25MPa steam × 3.5t/t-paper
Electricity consumption: 1,528kWh/t-paper

No. 5 machine: 7,000mm × 750m/min (for newsprint paper, writing paper and printing paper: 275t/d)
Steam consumption: 0.6MPa steam × 1.8t/t-paper
Electricity consumption: 684kWh/t-paper

Facilities for bagasse pulp

DIP (De-inking Plant: facility for de-inking)

Wastewater treatment plant

Water supply pump: 11 units

Air compressor: 6 units

3) Amounts of energy consumption and energy costs

The production volume, energy consumption, and energy price are shown in Table IV-2-1 and Table IV-2-2.

Table IV-2-1 Production volume of paper and amounts of energy consumption

Items / Year Production & Used Energy	Unit	2000		2005	
Baggase pulp	t	14,876		823	
De-inked pulp	t	42,865		0	
Paper production	t	135,717		114, 273	
Energy source			toe/y		toe/y
Fuel oil	kL/y	147,832	143,397	5,184	5,028
LPG	kg/y	267,290	297	0	0
Natural Gas	km^3N/y	0	0	951,149	81,464
Electricity	MWh/y	219,628		143,669	

Table IV-2-2 Energy price (US$)

Energy Source	Unit	Price (2000)	Price (2005)
Fuel oil*	L	0.0428	0.3937*
Natural Gas	m^3N	-	0.1228
LPG	kg	0.1479	-
Electricity**	kWh	0.0216	0.0501

* Excl. Transport Cost

** Electricity only, average price, excludes steam cost to plant

*** LPG used at PM (Paper Machine) #3 for Infrared Dryer up to Nov. 2001 and then changed to Natural Gas. Natural Gas was used at PM #3 and at the Power Plant, but since 2003 PM #3 has no longer used Natural Gas.

2.2 Summary of the Results of the Previous Energy Audit of PT KERTAS LECES Pulp and Paper Mill

The following issues were pointed out in the previous energy audit as being in need of improvement. It was noted that the “5 S’s” were not being enforced sufficiently.

(1) Measures for energy conservation in the use of boilers and turbines for power generation

The percentage in-house power generation at LECES Mill in 2000 was about 99%. Since the price of heavy oil was US$43.5 (¥5,000)/kL, which was very inexpensive, the cost of in-house power generation was only $0.0052 (¥0.60)/kWh for extraction power generation and US$0.019 (¥2.17)/kWh for condensing power generation.

The cost of condensing power generation was about half that of purchased power (RP315,840 = ¥4.62/kWh for peak hours and RP263,200 = ¥3.85/kWh for night-time use). Therefore, any further investment in electricity saving was not usually worthwhile. Furthermore, since the condensing power generation had to be increased by about 0.45t/h in order to save 1t/h of steam, although the simply calculated steam cost was about US$3.78 (¥435)/t, the actual effect of any saving was thereby reduced to little more than half this amount: US$2.09 (¥240)/t. This fact indicated that any effective investment in further energy conservation was practically impossible.

1) Currently, large amounts of steam are leaking from steam traps, valves, piping, and heaters all over the plant, and heat insulation and painted surfaces are not adequately maintained.
2) Reduction of wasteful operation of water supply pumps (BFP)

   A total of four pumps (three BFPs for Stage III and a BFP for Stage IV) are currently in operation. Although their design pressure is 6.85MPa (2.9m^3/min), 6.MPa should be adequate. Since the maximum load for pumps is 240m^3/h or less, one or two pumps are sufficient in operation (BFP: Boiler Feed Pump)

   The actual loads on the pumps are 25, 25, 27, and 26 Amperes, respectively; making the total load 889kW while the rated load is 36.5 Amps. If only one pump was operated, then 600kW could be saved, and 390kW could be saved with two-pump operation. The conversion cost is estimated at US$4,350 (¥500,000) for the 30m of 150A piping and two diversion valves required.
3) Excessive blowdown water — installation of drain filters

   While the electrical conductivity of the supply water is only 0.788mS/m, the blowdown water amounts to 15% of the average volume of supply water used for the four evaporators. The heat contained in the superheated blowdown water corresponds to 4.67t/h of steam and all this heat is currently wasted. Since the specified maximum electrical conductivity of circulating water for boilers operating at a pressure of 5.0MPa is 80mS/m, (according to JIS B 8223-1977) the amount of blowdown can be reduced to about 1% (= 2.5t/h) for all four evaporators, even if the electrical conductivity of the supply water is kept at the present value of 0.788mS/m.

   LECES Mill has an excellent water purification system that provides pure water with an electrical conductivity of 0.5mS/m or less. However, the electrical conductivity of the condensate can be up to 0.788mS/m. Installation of drain filters would prevent any resultant damage to the boiler tubes.

   Total cost for the installation of drain filters and changeover of piping: US$261,000 (about ¥30 million).

   Although the average temperature of waste gas can be as high as 214.2℃, waste heat can be recovered down to about 130℃ since the sulfur content of the heavy oil used at LECES Mill is low as 2.5%. However, the price of heavy oil, about ¥5,000/kL, is already so low, as described above, that it is effectively impossible to invest in further energy conservation.

By taking the measures described above, it is expected that the heat efficiency of this boiler plant could be improved up to about 93%.

4) The temperature of the steam generated by the boilers is low.

It can be seen from the daily logs that the steam pressure is kept stable between 4.4 and 4.5MPa, but the two-day average values of steam temperature for No. 1 to No. 4 boilers are 425, 435, 445 and 405℃, respectively, showing fluctuation among the individual boilers. The temperatures of No. 1 boiler and No. 4 boiler are particularly low. By raising the temperatures of No. 1 and No. 4 boilers by 10℃ and 30℃, respectively, the amount of power generated would be increased by 7kW/t and 2kW/t, respectively.

Steam condensate would also decrease by the following amounts:

No. 1 boiler 2kW/t × 54.6t/h/200kW/t = 0.55t/h

No. 4 boiler 7kW/t × 39.5t/h/200kW/t = 1.4t/h

This would result in about 2t/h in total. Therefore, a profit of about US$60,400/y (= 2t/h × 8,000h/y/11.5t/kL × US$43.4 (¥5,000)/kL, or about ¥7 million/y) could be expected.

5) Extraction pressure of the turbines is too high.

In spite of the fact that a steam pressure of 0.25MPa or less is sufficient for the evaporators and all the other facilities, except for PM2 (No. 2 paper machine), the Yankee dryer of PM4, and the digesters for the bagasse pulp, the pressure at the LP steam header is set at 0.5MPa. Since drain attack is not a concern because the extraction steam is sufficiently superheated, the pressure could be decreased to 0.4MPa or less (although it would be necessary to check with the manufacturers as to the blade strength, thrust bearings, etc. first). This would increase the extraction power generation by 10kW/t × 50t/h = 500kW, decreasing the condensation power generation by about 2.5t/h. A profit of US$75,480/y (= 2.5t/h × 8,000h/y/11.5t/kL × US$43.4/kL, or about ¥8.7 million/y) could be expected.

6) The exhaust temperature of the condensing turbines and extraction condensing turbines is too high.

The values of 59-62℃ for the condensing turbines are too high and even those of 39-46℃ for the condensing extraction turbines are relatively high. The water used is cooled in cooling towers but the temperature of the cooling water can still be up to about 33℃ because the average ambient temperature is 30℃ and average ambient humidity can be as high as 65%. As a result, exhaust temperatures can rise to about 42℃. On the other hand, the temperature of the fresh water is about 27℃ throughout the year, which is comparatively low. Since about 700m^3/h of fresh water is used, it would be desirable to heat the fresh water using part of the output from the condenser tubes.

In addition to the increase in power generation, 10% or more can decrease the amount of condensate because the efficiency of dewatering is improved by the rise in temperature of the showering water used for the paper machines.

Since the fresh water has a high level of hardness and contains TDS, particularly SiO_2, stains on the tubes may cause a problem. It is necessary to carry out periodic flushing or to provide automatic cleaning equipment.

(2) Problems and recommendations relating to evaporators and recovery boilers

1) The wastewater from the bagasse pulp contains large amounts of calcium silicate and calcium oxalate derived from the large amounts of calcium silicate in the fresh water and bagasse, and this causes a serious problem with tube staining. Taking this problem into consideration, LECES Mill always alternates the use of No. 1 evaporator and No. 2 evaporator, while the other is being cleaned in a five-vessel quadruple-utility operation. However, it is also necessary to wash the other three evaporators. By raising the design value for the concentration of rich black liquor from 37.8% to 45%, the amount of generated steam per unit of solid content is increased and fuel costs are reduced. In addition, corrosion of the IDF and other parts are reduced due to the decrease in the use of heavy oil with high sulfur (S) content. The profit from this is expected to be US$20,000/y.

2) It is recommended that the supply vessel used be changed from #5 vessel to #4 vessel.
Since the temperature of the dilute black liquor supply can reach 85-90℃, the liquor should be supplied to #4 vessel, whose design vaporization temperature is 70-75℃. This will save energy because the steam vaporized in #4 vessel can then be used as heating steam in #5 vessel. The profit from this is estimated to be US$7,600/y.

3) The CO content can be as high as 5ppm, whereas the remaining O_2 content in the exhaust gas can be as high as 7.0%.
Since the maximum allowable CO concentration in the exhaust gas is 20ppm, this value does not cause an environmental problem. However, it is still important to control the CO content in the recovery boilers. Each recovery boiler has four injection burners for the black liquor, but only three are used at present. Since this causes non-uniform combustion, decreasing the size of each burner should use all four burners. Because a large amount of supplementary heavy oil is used, the remaining O_2 content will then be reduced to 2% or less, resulting in an increase of generated steam by about 3%. The profit from this is estimated to be US$980/y.

4) It seems that considerable amounts of NaO, $NaCO_3$, and $NaSO_4$ are dispersed in the exhaust gas from the cascade evaporators used for the condensation of black liquor (making use of the heat of the exhaust gas from the recovery boiler). The recovery rate of NaOH could be increased from 50% to 90% or more by installing a scrubber to collect NaO + $NaCO_3$ and by using CaO of better quality. The limestone being used at present is a yellow color, indicating that its purity is low.
If 30% of this uncollected 50% NaOH is then successfully recovered (assuming that 80% of the design value is collected), an annual profit of US$613,700(= ¥70million) could be obtained through the increase in NaOH recovery.
Since the cost of steam is low, it is possible to install evaporators for drying the exhaust gas from the scrubber, but it is better to utilize the heat of the exhaust gas from the heavy oil boilers, whose temperature is 200℃ or higher (As described above) for the condensation process, since this would not require the use of any additional energy.
Since the necessary construction cost is estimated at only about $435,000 (¥50million), this renovation should also be made for reasons of environmental pollution control.

(3) Problems and recommendations relating to PM5

1) Promotion of the “7 S’s” (Seiri, Seiton, Seiso, Seiketsu, Shitsuke, Sho-shigen and Sho-enerugi)
   Pulp and scraps of paper are scattered all around the plant. The campaign should start with the first “3 S’s”.
2) Since the surface temperature of the dryer groups is roughly equal and since there is no difference in steam pressure between the dryer groups, the condensed steam draining from the dryers is not always discharged satisfactorily. This results in accumulation of the condensed steam in the dryer cylinders causing an increase in the load on the driving motors. Consequently, only one doctor is used in the dryer and the others have been removed (and even the one remaining doctor does not actually work because it is kept raised).
   The load on the doctors need not be large if they are well maintained. Therefore, all the doctors should be reconditioned and put back into use. If doctors are not used, then perforation and tearing are caused in the calender because paper scraps and powder residues cannot be removed. In addition, adhesive materials attached to the dryer surface cause pinholes in the paper and can adhere to the paper. This may result in the paper tearing. Therefore, all doctors should be reconditioned and restored.
3) In order to implement energy conservation, it is necessary to stop the process in order to inject steam equally to all 20 dryers in the steam drainage system, providing a pressure difference of 0.04MPa or more between the dryer groups. If this is not done, the driving load rises making it impossible to increase the speed. If such an improvement is carried out, the optimum speed could be increased to 750-1000m/min. Speeding-up the process requires an increase in electric power (proportional to the speed raised to the power of about 2/3) and, since the steam consumption rate is also improved, this results in significant energy conservations. Increasing the speed to 1,000m/min could increase the present maximum daily production of 240t/day to 500t/day. This would produce remarkable economic benefits. Speeding-up the process can also be realized by preventing paper break.
4) When paper break occurs, the operation is often restarted without eliminating the causes of paper break. Thus, the average resetting time can be as short as 12.0 min/reset, as shown below, but another paper break may soon occur. On PM5, paper break sometimes occurs 7 to 10 times a day. During the 300 days of operation per year, paper break accounts for 1.3% of the total operating time on PM1, 7.8% on PM3, and 4.0% on PM5. The effect of preventing paper break is significant because the energy-conservation effects are doubled when the large amounts of defective paper wasted before and after the paper break are also taken into account.
   In particular, PM3 is out of operation for more than three weeks (23.4 days) each year. The “zebra patterns” caused by the presence of adhesive materials are often observed on the paper rolls at the 3P outlet of the paper press. Such stains must be cleaned off whenever a paper break occurs. Since the removal of adhesive materials from the DIP is not sufficient, the DIP

pulp must be cleaned thoroughly.

5) The maintenance of dryer hoods is inadequate. All the hoods on the 2FL are open and some of those on the 1FL are also open. This not only wastes energy but also adversely affects the paper drying process. Hoods must be maintained properly and kept closed.

6) Repair costs in 2000 were only US$1.200 million, which corresponds to 1.5% or less of total sales. The standard value for such repair costs in Japan is between 3 and 3.5% of total sales. Since the labor costs for repair work in Indonesia are even less than those in Japan, this value are too low. Judging from the present status of the plant, the decent facilities will deteriorate if spending on maintenance is not increased to about 2.5%. The low operating rates of the paper machines shown in Table III-2-3 reflect inappropriate levels of maintenance. In Japan, the normal operating rate for such machines is about 95%, and some paper machines achieve 98% or more.

Table III-2-3 Operating rates of paper machines at LECES Mill and the number of personnel employed for each paper machine in 2000 (four groups in three shifts)

Paper machine No.	PM1	PM2	PM3	PM4	PM5
Operating rate (%)	89.77	75.19	78.62	84.90	80.09
Number of personnel	70	83	105	79	98

Speeding-up the process, using the measures described above, would increase production by 125t/day × 340 days/y = about 43,000t/y.

(4) Problems and recommendations relating to DIP

1) Actual production capacity is about 200t/day, whereas the design capacity is 250t/day. The major bottleneck is the lack of capacity for rough screening. Changing the shape of the slits in the screen plate could solve this problem.

2) The pulper has surplus capacity and the number of revolutions can be increased by 6%. The capacity of the present facilities would then be increased to about 300t/day. However, the following measures, described in 3) and 4) below, must also be taken in order to achieve this.

3) The amount of froth in the flotator (sponge cake-like aggregates of ink, fillers and pulp attached to bubbles formed by the air injected during the de-inking operation) is abnormally large, resulting in an excessive amount of good-quality pulp spilling out.

The percentage of reject froth that includes a large volume of good-quality fibers can be as high as 5.7%. This must be reduced.

Five flotators are being operated in parallel. However, half will reduce losses if four of them are used as primary flotators and the remaining one is used as a secondary flotator, increasing the pulp yield by 2.9%.

Prices of used paper in Indonesia are high because used paper is currently imported. In particular, ONP (waste newsprint) costs about ¥24/kg, which is about twice that in Japan. As of 2000, 42,865t/y of DIP was produced using 61,151t/y of used paper. If this yield could be improved from 70.1% to 73.0%, the following benefits would result. Considering the fact that the yield of ONP in Japan is 85% or higher, it seems to be possible for this mill to achieve a yield of about 83% because the used paper at this mill is of good quality. This means that an increase of yield by 12% (18% overall) could be achieved.

61,151t/y - 42,865t/y/0.73 = 2,432t/y

2,432t/y × US$205/t = US$498,600/y (= ¥57.3 million/y)

4) Johnson screens are used for the final treatment of rejects and round holes of 5-6φ are used for all screens, except for the tertiary screening.

Since large particles of foreign material are not removed, they circulate until they are crushed and then pass through the secondary screen.

It is strongly recommended that the screen be changed to a slit plate with 0.20-0.25mm² slits.

By raising the yield to 83%, significant profits would result (as described below) because the price of used paper at LECES Mill can be as high as US$205/t.

In 2000, 61,151t of ONP was used to produce 42,865t of DIP. If the yield were raised to 83%, significant benefits would result, as described above. Furthermore, the scale of the sludge incineration facilities required would be reduced.

42,865t/y/0.83 = 51,645t/y

51,645t/y— 61,151t/y = ▲9,506t/y

9,506t/y × US$205/t = US$1,950,000/y = ¥224 million/y

Investment: a rough estimation is $2,000,000 (¥230 million), including the renovation of the incineration furnace.

(5) Yield of bagasse is low.

1) The harvesting season for bagasse is about 6 months, during which it is stored outdoors. LECES Mill says that such bagasse stored outdoors does not deteriorate since hypochlorite solution is used to prevent bio-deterioration. Although HYPO solution is sprayed on to prevent bio-deterioration, mildew is observed growing even on newly brought-in bagasse because the HYPO solution is washed away by frequent rain. Silos should be installed to store the bagasse.

2) The yield of bagasse is only 36.8%, in spite of its high price of US$83 (¥9,545)/BLT. Although the yield of bleached bagasse depends on its place of origin, it is usually 42% or higher. Assuming that the actual production of pulp was 14,258t/y in 2000, the benefits obtained by reducing the deterioration of bagasse in order to increase its yield would be:

35,508t/y - 14,528t/y × 0.9/0.42 = 4,377t/y

4,377t/y × $83 = $363,000/y (= ¥41.8 million/y)

Estimated construction cost of 15,000t of silo capacity: $1,300,000 (= ¥150 million)

(6) Paper machines other than PM5

1) There are 4 single canvases of PM2 at present. It would be better to increase this number to eight. Half without reducing the drying capacity would then decrease the driving load.
2) Both the #1P and #2P presses of PM2 have a small diameter. It would be better to change these to the #3P type that has a larger diameter.
3) The doctor of the dryer for PM3 is not being used. Since this is one of the reasons for paper break, it should be reconditioned and put back into use.
4) PM1 has only primary and secondary cleaners. A tertiary cleaner should be installed, as in the other PMs.
5) Furthermore, it is recommended that a fourth and a fifth cleaners installed or that FRU be installed for PM3 and PM4. This would not be very effective in terms of energy conservations because the energy cost is low, but it would be very effective in terms of resource savings because the costs of used paper and pulp are high. If the amount of raw materials saved by PM3 and PM4 were 3t/day and 5t/day, respectively, and assuming that the average price of pulp was ¥50/kg and ¥30/kg, annual savings in raw materials would be about US$435,000 (= ¥50 million) each, totaling US$870,000 (= ¥100 million) overall.
   Estimated facility costs are US$174,000 (= ¥20 million) and US$261,000 (= ¥30 million), totaling approximately $435,000 (= ¥50 million) overall.

2.3 Follow-up Energy Audit

We visited the PT KERTAS LECES Paper Mill for two and a half days to carry out a follow-up energy audit on the implementation of previous advice given by the ECCJ team in January 2001 and to investigate the other operations of the mill. Although the Indonesian MEMR was supposed to play a key role in the follow-up energy audit, ECCJ actually led the survey.

The purpose of the visit was explained and the schedule was discussed. Since many of the facilities were not operating, No. 3 paper machine was selected as the object of investigation. Since a detailed energy audit had been carried out on the paper-making process in the previous visit, this investigation focused mainly on the utility facilities and the detailed advice was given.

(1) Date of energy audit: December 2005, 5 (Mon.) 16:20 - 17:20
6 (Tue.) 9:00 - 16:00
7 (Wed.) 9:00 - 16:00 and
9 (Fri.) 13:00 – 14:00

(2) Audit team members:

Indonesia

MEMR:

Ms. Maryam Ayuni, Department of Energy Efficiency
(Indonesian coordinator, participated only in parts 5 and 6)
Mr. Parlindungan Marpaung, Inspector, Dept. of Energy Efficiency

PLN:

Ms. Sutji Rahayu, Jakarta Office (participated only in parts 5 and 6)

Japan: International Engineering Department, ECCJ

Messrs. Fumio Ogawa, Hisashi Amano and Hideyuki Tanaka, Technical Experts

(3) Attendees from PT KERTAS LECES

Mr. Ir. Djoko Wiryono, Manager Litbang (Reporter at PROMEEC)
Mr. Ir. M. Nugroho Basuki, Manager Plant 1
Mr. Ir. Tri Prasetyono, Manager Plant 3
Mr. Ir. Didik Mudiarto, SI Plant 1B
Mr. Supriyadi, SI Plant 3B
Mr. Ir. Subagyo, SI PP Produksi (Reporter at PROMEEC)
Mr. Ir. M. Arifin, SI Penelitian
Mr. Gatot Subroto, SV Utilitas
Mr. Ir. Bondan As, SV KSP 3
Mr. Sutarmadji, SV Compressor
Mr. Imam Hadi, Listrik
Mr. Z. Abldin Iw, Konera 4 (Ir. stands for bachelor)

(4) Outline of the follow-up investigation

On December 5 (Mon), the purpose of the visit was explained and the overall schedule was discussed.

On December 6 (Tue), PT KERTAS LECES explained the changes in the external environment and a walk through on-site audit was carried out for the bagasse storage yard, power generators, boilers, No. 3 paper machine, and the wastewater treatment plant. The investigation team toured the plant and made comments. Since many facilities were not in operation, No. 3 paper machine was selected as the object of investigation. Since a detailed energy audit had been carried out on the paper-making process in the previous visit, this investigation focused mainly on the utility facilities and the detailed advice was given. Issues such as the prevention of paper break were also discussed.

On December 7 (Wed), a tour of the plant was undertaken, measurements were carried out on air compressors and pumps (in the water supply room), and the rest of the time was spent writing a report. We visited the mill once again on the afternoon of December 9 (Fri) to collect additional information and materials.

The information and materials we received from PT KERTAS LECES included:

The "Boiler Performance Curve", "Boiler Blowdown Volume", "Specification and operating rate of Air Compressors", "Electrical power chart of paper machines", and "Table of downtime of No. 3 paper machine caused by paper break (2001-2005)".

(5) Results and discussion of the investigation

1) Recent changes in the situation

PT KERTAS has produced significant results by following the detailed advice for improvements given in the previous energy audit in January 2001, and by implementing its own improvements such as fuel conversion from heavy oil to natural gas. The results of these improvements have been reported at every PROMEEC Seminar Workshop making PT KERTAS an "honor student" among the participants in this project. However, our impression was that the external economic environment was worsening, and that the company was fighting not only to save energy but also to keep operating smoothly. When we visited the plant, it was operating at less than half capacity with many major facilities lying idle. Therefore, the original plan to convert from gas fuel to coal was in jeopardy due to financial restrictions.

While production in 2000 was about 135,700 tons, recent production has been reduced to a level of 120,000 tons. Major changes in the operational situation are roughly as shown in the following sections. Measures taken by PT KERTAS are also described. Questions and answers are included in Material No. D-107.

a. Shortage of raw material (bagasse)

When we visited the plant, the depithing and pulpers were lying idle. bagasse is bought in from sugar plants in Java, but shipments of bagasse have now decreased because, due to the recent increase in fuel prices, it is now used as fuel within the sugar plants. The following two measures may be taken to address this problem.

- To ask PTPN (Plantation Enterprises) to increase the supply of bagasse by using coal as a fuel instead. This measure is expected to secure 68,000 tons in 2006.

- To find alternative raw materials, including long fiber wood such as Kalimantan.

b. Sluggish sales of newsprint paper

Sales of newsprint paper are decreasing because newspaper companies increasingly produce newsprint paper by themselves. Although PT KERTAS exports newsprint paper, production is decreasing. The operation of the DIP that treats used paper has therefore been suspended. Consequently, No. 5 paper machine (PM5) has stopped producing newsprint paper and is now producing printing paper instead.

c. Unstable supply of natural gas

PT KERTAS succeeded in reducing costs by converting from heavy oil to natural gas in June 2003. However, the production volume of the natural gas field (owned by a PT Pertamina-related company) is now decreasing and the pressure of the gas source supply is also decreasing. For this reason, a quota system is now used for the natural gas supply, which sometimes reduces daily production to 250-300 tons. To cope with this situation, the amount of in-house power generation that uses natural gas has been reduced and electricity is now purchased instead. They seem to be waiting for the discovery of new gas fields.

d. Price rise of heavy oil

Although the consumption of heavy oil is not as large, the price of natural gas goes up so too does the price of heavy oil. As a result, the cost of fuel, as a proportion of the total production cost, has risen from 17% to 22-23%. This value is comparable to the level before fuel conversion, which was 24%. Possible measures for remedying this are as follows:

- To improve energy efficiency.
- To convert the fuel supply yet again.

It was originally planned to convert from natural gas to coal in 2006, but this cannot now be realized due to the lack of investment funds.

2) Situation at the time of the visit

The operating situation at the time of our visit was as follows, reflecting the changes in environmental conditions mentioned above:

Equipment	(Main product)	(Capacity)	Operating situation/	Reason for suspension
PM 1	Cardboard liner	30t/D	In operation	
PM 2	Printing paper /industrial paper	60t/D	In operation	
PM 3	Printing paper	175t/D	In operation	
PM 4	Tissue	30t/D	Operation suspended	maintenance
PM 5	Newsprint paper, printing paper	275t/D	Operation suspended	production adjustment

Bagasse Pulp Plant, including the Depithing Plant, Vacuum Evaporator, Recovery Boiler, Lime Kiln,

Re-causticizer & Chlor-Alkali Plant, DIP	Operation suspended	production adjustment

Among the other facilities inspected, only three out of five power boilers were operating, and only one out of three turbine generators. The wastewater treatment facilities were operating.

3) Energy prices and activities for reducing costs and consumption

Energy costs are as follows:

Natural gas: US$4.36/MMBtu

Heavy oil: US$9.60/MMBtu

Coal: US$1.90/MMBtu (Base: 22,190kJ/kg, 1Btu = 1.055kJ)

Electricity:

・Reactive Power Charge = 609 × {effective power (kW) - 0.62 × reactive power (kVAr)} RP/kWh

This is the same in Japan as the charge is zero when the power factor is 85%.

・Active Power Charge: normal time = 439RP/kWh

@ Peak Load period (18:00-22:00) = 878RP/kWh

Total power consumption at PT KERTAS Mill is 17,400kW, of which 2,400kW (14%) is purchased from PLN and 15,000kW (86%) is supplied by in-house generation. The proportion of in-house generation was 99% at the time of diagnosis in 2001.

Since PT KERTAS does not have an energy manager, a comprehensive, overall perspective seems to be lacking.

4) Results of the follow-up diagnosis (in comparison with the previous results)

The items advised by Miyabe (technical expert of ECCJ) in the previous energy audit (January, 2001) are described in 2.2. Referring to the activity report on energy conservation submitted by PT KERTAS in the PROMEEC Seminar Workshop, the explanation presented by PT KERTAS and the comments made by the investigation team are listed in Table IV-2-4 (relating only to items that have not been implemented, however). Some items have not been implemented because the level of operation is now much lower due to the environmental changes mentioned above.

Table IV-2-4 Comments on the items which were identified by ECCJ previous audit and have not been implemented

No.		Finding	PT's Comment/Action	Follow-up result
F	Recovery Boiler			
	3	Change the FDF and IDF to the proper size, for both the quantity and the head	Has not been done yet: too expensive	Company policy on the payback period of investment is 3 years or less.
G	Power Boiler			
	2	Should be connected to each pump by a common header so that you can stop the two BFPs and thereby save about 400kW of electricity.	Has not been done yet: the characteristics of the pumps are not the same.	In the past, connecting the pumps was tried and major problems resulted. (The issue may still be worth studying further.)
	3	Change the FDF and IDF to the proper size, for both the quantity and the head.	Has not been done yet: too expensive	Same as F-3 above
	4	Remaining O_2 content is too high (4 to 7%, as measured by our team) and should be reduced to less than 2%.	O_2 monitor has been installed. Excess O_2 in the stack can be adjusted to 2% manually.	PT is now controlling the remaining O_2 content at 2-4%, depending on load levels. (Recommended that O_2 be reduced to 2-3%.)
	5	Exhaust gas temperature is a little high at 170 to 180˚C.	We have tried to add an economizer. The flue gas temperature has been decreased to 160˚C.	There is no space to add a heat exchanger on-site.
H	Turbine and Generator			
	3	Electrical technician has mistakenly made some kind of error with the Power Factor (PF)	Since 2001 we have had to repair the old capacitor and install a new capacitor. The power factor has now increased from 0.71 to 0.74. The budget to install new capacitors is US$100,000.	PF has now reached about 0.95 and should be OK.
	4	If the PF is rose from 70% to over 85%, then the pay back from the Electric Company will cover some of the cost.	New capacitors have been installed in the electrical company (PLN) line since 2001 and no payments have been needed to the Electric Company for reactive power.	Confirmed the situation as described

5) Results and impressions gained from the on-site survey

The impression gained from the on-site survey is that employees are seriously committed to achieving a high level of operation. As described in the previous energy audit report (Phase 1), the original motto of PT KERTAS, namely the "5 R's" (corresponding to the Japanese "5S's" in Bahasa Indonesia), is posted everywhere throughout the plant and offices.

a. Paper machines

As for the paper break problem, we obtained specific data on this problem for No. 3 paper machine. Although the occurrence and amount of resultant downtime fluctuates, the frequency of occurrence is gradually decreasing compared with the data from 2000 (Table IV-2-5). The speed of the paper machine (m/min) has not been changed.

Table IV-2-5 Occurrence of paper break on No. 3 paper machine

Year	Number of paper breaks	Downtime due to paper breaks (min)	Proportion of downtime (% of calendar days)
2000 (Phase 1 data)	2,292	33,691	6.4
2001	2,490	48,510	9.2
2002	2,579	34,310	6.5
2003	1,259	19,240	3.7
2004	2,258	40,245	7.7
2005 (Up to December 5)	1,439	23,843	4.9

We explained our experiences with the paper break problem in Japan (and how the incidence of paper break was reduced by ensuring that the machinery was cleaned properly whenever the operating rate dropped). They commented that they had the same experience and that downtime had been reduced to as little as 4%.

b. Boilers for power generation

Three boilers are operated in order to supply the approximately 150t/h of steam required (50t/h each). We asked why they didn't just operate two boilers at 75t/h each, and they replied that they operated three boilers for safety reasons because the natural gas supply was unstable. It was understood that this was a separate matter from that of energy conservation.

c. Power generators and power receiving installations: only one of three generators is being operated.

d. Air compressor plant

Although the plant is spread over a large area, a central air supply system is employed. The plant has four centrifugal compressors and two screw type compressors, of which two centrifugal compressors (CENTAC: 500hp, KOBELCO: 500hp) were operating. The

KOBELCO model was newly installed after scrapping one of the screw type compressors (commissioning had been carried out two weeks earlier, on November 23). In fact, four compressors (including two screw types) were on standby, showing that the utilized capacity was very low.

All the operating air compressors are of large-scaled type, and use suction vanes for capacity control so that the partial-load vs. power consumption characteristics is poor. Past data on power consumption has been obtained and will be studied (described later).

The control range of the discharge pressure is between 0.65 and 0.7MPa, which is relatively high. This range has probably been set after taking possible pressure drops in the piping into consideration. However, the actual fluctuation in discharge pressure is very small and the pressure is kept at around 0.66MPa. This may be because the compressors are of the centrifugal type.

Compressed air is supplied through a receiver tank and dryer (adsorption type).

e. Water supply pumps

We investigated water supply pumps that were representative of the utility facilities, overall.

The eleven water supply pumps have a large capacity of 200kW, and water is supplied to each plant from three sites located outside the mill (two sites in Ronggojalu and one site in Sumber Kramat). However, when we visited, the facilities at only one site were in use because some plants were out of operation. On the day we visited, water was being supplied from a water reservoir in Ronggojalu, about 1km from the mill, using only two out of the five pumps installed on the line. This is another example of low capacity utilization.

The power factor has been improved to 95% by installing phase advance capacitors on the pump motors. Since a capacitor is installed on each pump, there is no adverse leading power factor effect. The electricity is supplied at a high voltage (6kV), which is transformed to a low voltage (400V), using a transformer of 1,000kVA installed at the pump site, before the current reaches the motors.

This case is a typical example of the measures employed to reduce distribution loss. The installation of phase advance capacitors was reported in the PROMEEC workshop held last year.

The preceding energy audit report described how the water is taken from wells. However, the actual feed water is taken from water reservoirs, and PT KERTAS has an obligation to the government to supply a certain amount of treated wastewater for agricultural use in the neighboring region.

2.4 Technical Discussion and Recommendations

(1) Measures for partial-load operation

It is impossible to always keep the plant operating at its full capacity and the plant is often forced to operate with a partial load. Figure IV-2-1 shows the relationship between production volume and operating conditions schematically.

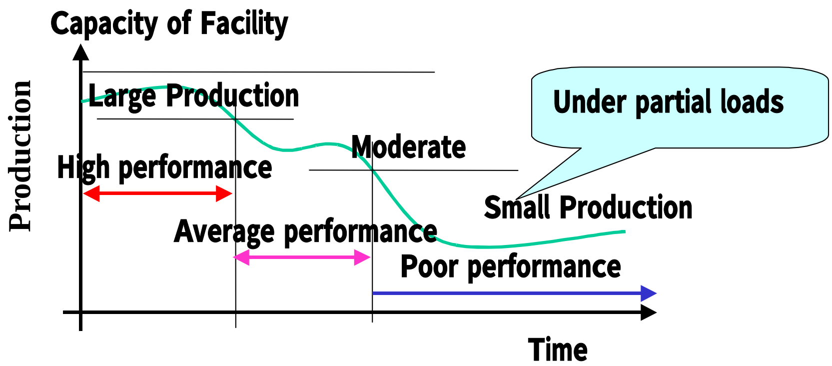


Figure IV-2-1 Decrease in production volume and partial-load operation

When production corresponds to the capacity of the plant, the equipment efficiency is high and the energy intensity is also kept at a low level. However, when production decreases, waste and low efficiency in every facility cause to raise the energy intensity. In such a case, the size of the production facilities is usually adjusted to the actual production volume, but it is often difficult to adjust utility facilities in this manner.
The following are countermeasures for partial operation taking PT KERTAS' utility facilities as an example.

1) Partial-load operation of the boiler system

a. Boiler systems and the present operating situation

Three steam turbine systems are installed in the mill but only one of them is now in operation. Figure IV-2-2 shows the layout of the operating system.

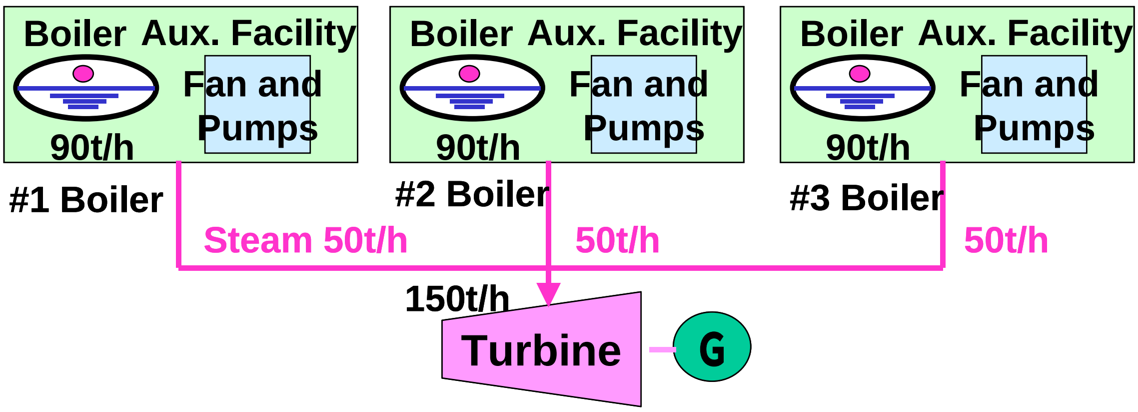


Figure IV-2-2 Boiler system of PT KERTAS

Three steam boilers, capacity 90t/h per each, supply steam to a steam turbine with a rating of 150t/h. The load factor of the boilers is 56% (= 50t/h/90t/h).
Since the specified capacity is 90t/h, two boilers could supply the amount of steam required.

If one boiler was shut down, the following benefits could be expected:

- Improvement in efficiency due to the increase in the load factor of the boiler.
- Energy conservation coming from the shutdown of auxiliary equipment.

b. Improving the boiler efficiency

By reducing the number of operating boilers to two, the load factor rises to 83% (= 75t/h/90t/h).

Figure IV-2-3 shows the partial-load characteristics of the boiler (based on data received from PT KERTAS)

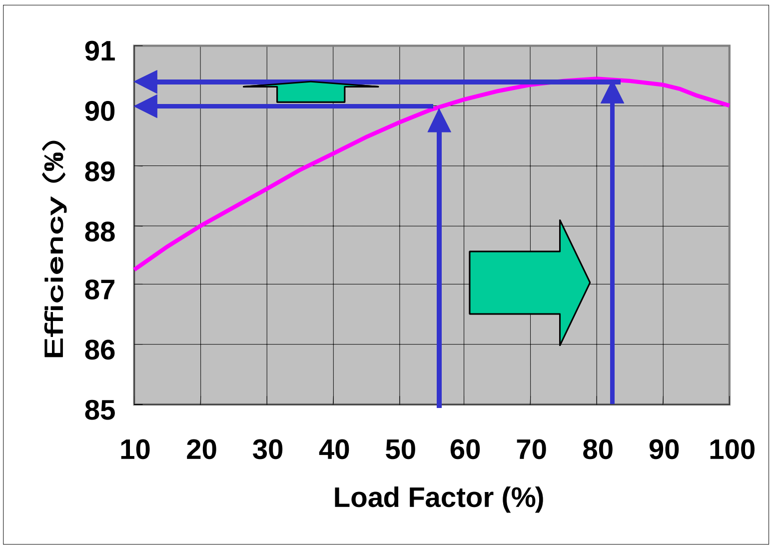


Figure IV-2-3 Partial-load characteristics of the boiler
(Based on data received from PT KERTAS)

The partial-load characteristics are excellent. This is probably because all necessary measures for lower level combustion have already been taken and any further significant saving of fuel cannot be expected. The graph shows that the expected improvement is only 0.4% (= 90.4% - 90.0%).

c. Effects of the shutdown of auxiliary equipment

The amount of auxiliary equipment operated can be reduced from three units to two units.

Table IV-2-6 shows the auxiliary equipment and its rated power consumption. Excluding FOP (which currently uses a gas-fired boiler), the total power consumption of the auxiliary equipment is 705kW. Taking the increase in load factors of fans and pumps into consideration, it is assumed that the power consumption could be increased from 65% to 90% of the rated value. The values of estimated power consumption are shown in Table IV-2-7.

Table IV-2-6 Auxiliary equipment for the boilers

Fan/Pump	(kW)
FOP	11
BFP	315
DEP	75
FDF	315

Table IV-2-7 Energy consumption of the auxiliary equipment

Items	Present	Improved
Number of Units in Operation	3	2
Load Factor of the Boiler (%)	56	83
Pumps and Fan Power Consumption Rate (%)	65*	90*
Power Consumption per Unit (kW)	458.3	634.5
Total power Consumption (kW)	1,375	1,269

(*: Estimated value)

From Table IV-2-7, the energy conservation is calculated as follows:

1,375kW - 1,269kW = 106kW, 106kW/1,375kW= 0.077 (= 7.7%)

2) Controlling the capacity of the air compressor

Four centrifugal (turbo type) compressors, one with a 500hp electric motor and two screw type compressors, are installed and two or three turbo type compressors are in operation.

a. Air compressors (turbo type)

Generally, dynamic compressors such as the turbo type are used as large-capacity compressors in situations where the screw and reciprocating types cannot be used. However, capacity control is difficult due to surging and the stonewall phenomenon (as shown in Figure IV-2-4).

The turbo type is suitable for constant-power operation and is an effective way to construct a system that addresses the fluctuation of the load by combining with positive displacement pumps such as the screw type and reciprocating type. That is, a screw type or reciprocating type pump is combined with a turbo type pump to offset the shortage of air so that the load of the turbo type is used for the base load as much as possible. The screw type and reciprocating positive displacement types allow for load/unload control, and the shaft power is significantly reduced under unload conditions.

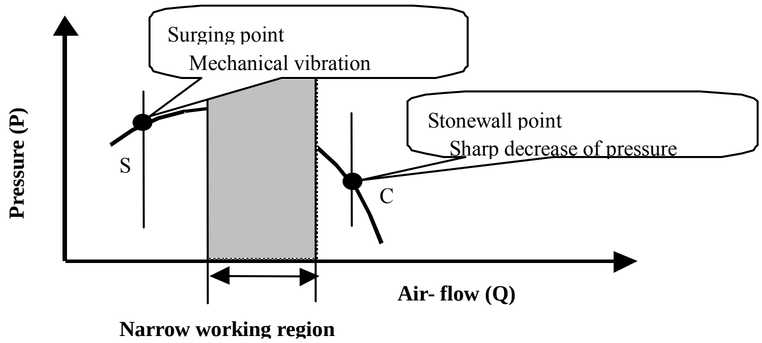


Figure IV-2-4 Stone-wall point and surging of a turbo type compressor

Figure IV-2-5 shows operation patterns when a turbo type compressor is combined with a screw type compressor.

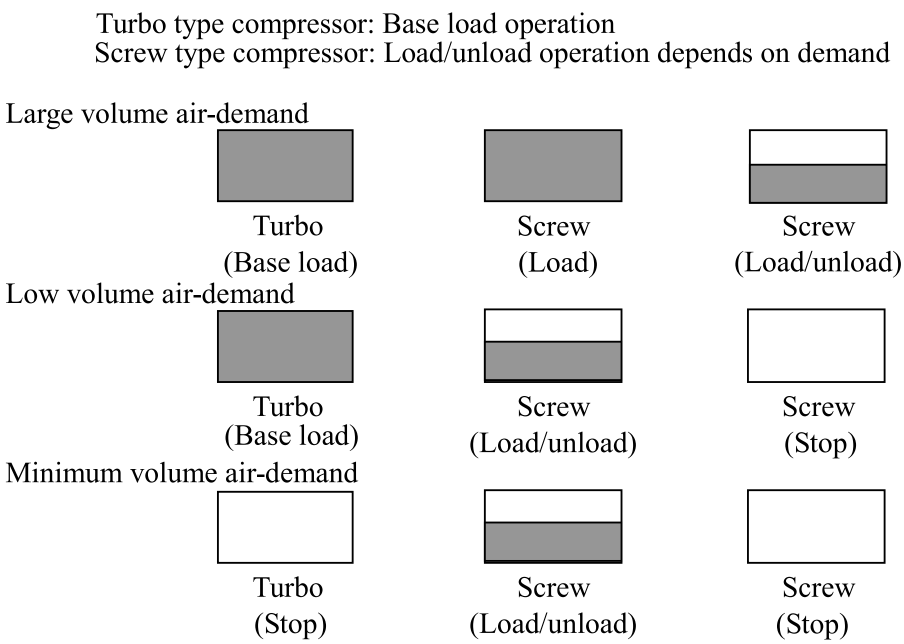
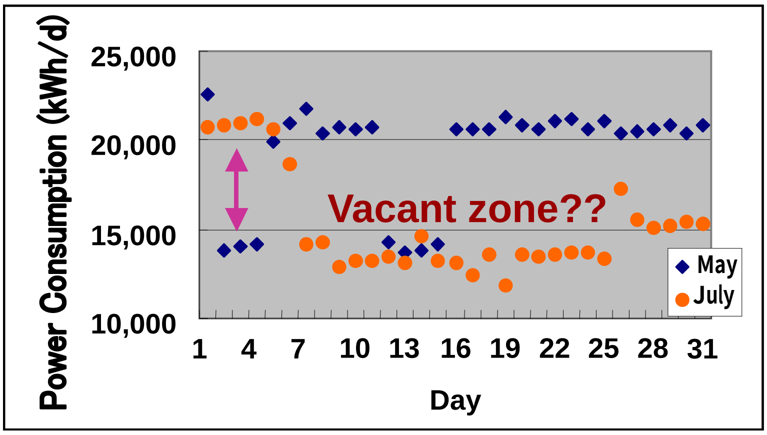


Figure IV-2-5 Operation of a turbo type compressor combined with a screw type compressor

b. Operating system

The number of turbo type compressors being operated is controlled either manually or automatically. Two compressors are operated continuously at the base load and one compressor is operated intermittently according to the required load. Figure IV-2-6 shows the changes in power consumption over two specific months when three compressors were operated at the base load and two compressors were operated intermittently. A peculiar characteristic of this graph is that very few data points are found in the zone between 15,000kWh/d and 20,000kWh/d. Since the load of an air compressor is normally continuously distributed, the distribution shown in Figure IV-2-6 is abnormal. It seems that this phenomenon derives from the partial-load characteristics of this turbo type compressor. Figure IV-2-7 shows partial-load characteristics of compressors that use various types of capacity control methods.



Power Consumption in May and July on 2005

Figure IV-2-6 Power consumption of air compressor systems

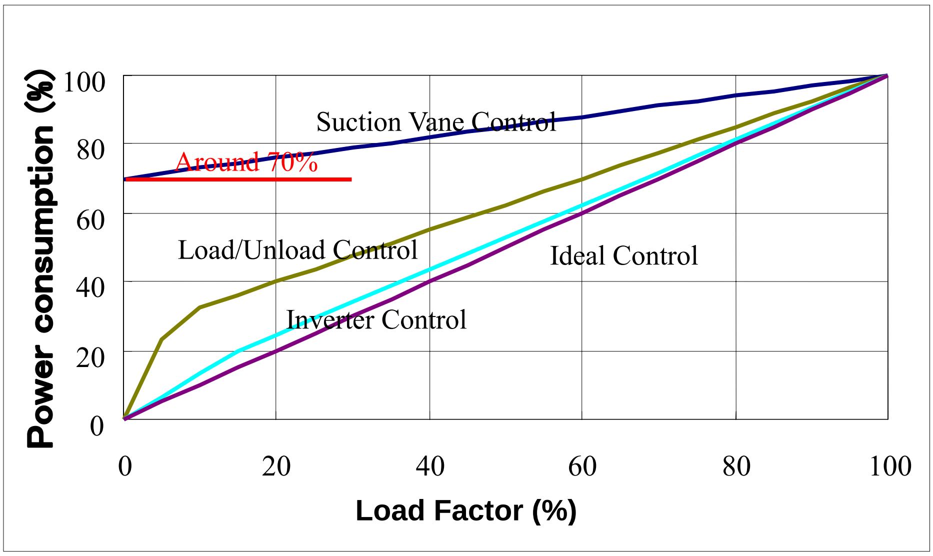


Figure IV-2-7 Characteristics of air compressors using various types of capacity control method

Suction vane control is used for the capacity control of turbo type air compressors. When suction vane control is used, as shown in the figure, power consumption is about 70% of the full load, even if the load is zero. On the other hand, air compressors with inverter control (screw type) that have been put on the market recently have almost ideal control characteristics, while those with load/unload control fall in the intermediate range. Figure IV-2-8 shows the relationship between power consumption and capacity control in the operation of two compressors with suction vane control when the number of operating unit is controlled.

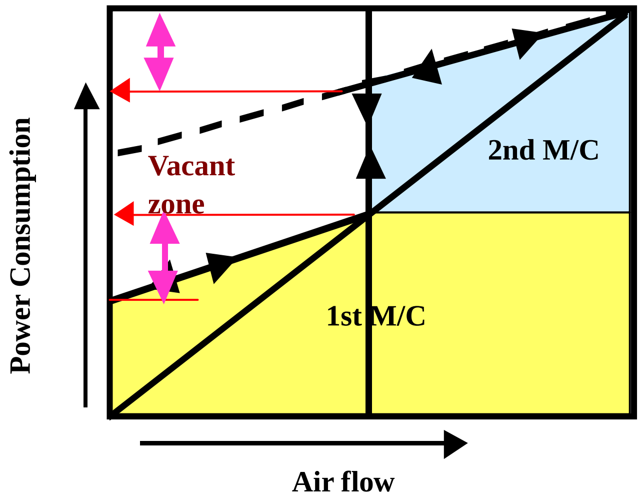


Figure IV-2-8 Operating unit control by air compressors with suction vane control

At maximum load, two air compressors are used to supply the compressed air. As the load decreases, the first M/C is run at its maximum load and the second M/C is partially run according to the required load. When the load decreases to about 50%, the second M/C is brought to a halt, and only the first M/C is kept running. The y-axis in the figure above shows the power consumption in the operation.

As the load decreases, power consumption decreases in accordance with the partial-load characteristic curve of the second M/C. Since the partial-load performance characteristics are inferior to those at full load, the decrease in power consumption is slow and as much as 85% of the power consumption at the maximum load is still required even when the load decreases to almost 85% (= 50% + 1/2 × 70%). When the load drops below 50%, the second M/C stops so that only the first M/C continues to operate. In this case, as shown on the graph, the power consumption then follows the characteristics curve of the first M/C.

In these circumstances, power consumption then drops abruptly in the neighborhood of 50% from 85% down to about 50%. This explains why the “vacant” region is found in the above graph.

c. Countermeasures

Although the use of an inverter controller with superior partial-load characteristics is desirable, in practice this is impossible because the maximum capacity of the existing equipment (75kW) does not meet the required capacity of 500hp. However, using the screw type compressor for load/unload control of the capacity control can reasonably solve the problem.

FigureIV-2-9 shows control conditions after the partial load and characteristics are improved.

A turbo type compressor can be used for constant load operation in conjunction with a screw type compressor whose capacity is controlled by the load and unload control. When the load is heavy, two compressors are operated. As the total load decreases, the output of the screw type compressor decreases and power consumption also decreases in accordance with the decrease in output. When the load reaches 50% or less, the compressor of the constant load air compressor is brought to a halt and only the air compressor whose capacity is controlled is operated. With this arrangement, the large “gap” in power consumption, as shown in Figure IV-2-6, does not occur.

The improvement achieved depends on the distribution of the load factor. Here, 50% is taken as the center of the distribution, and a normal distribution with 2σ ranging from 0 to 50% and 50 to 100% is assumed.
While the use of suction vane control increases power consumption by 38% relative to the ideal control state, the calculation shows that the increase is 14% in the load/unload control, which represents an energy conservation of about 25%. It is therefore recommended that the control of existing screw compressors be investigated and the operating unit control panel be used for capacity control.

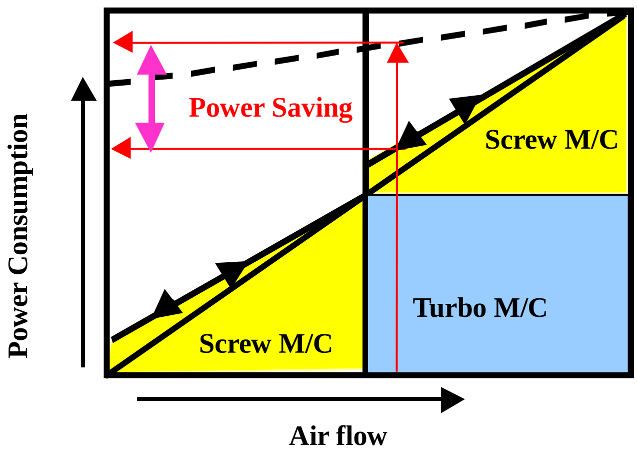


Figure IV-2-9 Operating unit control of screw type and turbo type compressors

3) Partial-load characteristics of motors and fans

a. Motors

Measuring the power consumption and comparing it with the rated value obtain the load factor of an induction motor. This measurement is not always easy because both the voltage and the current must be measured simultaneously. However, it is not difficult to judge whether the motor is oversized or not by just measuring the current. Figure IV-2-10 shows the characteristic curves for efficiency, power factor, and current (as a percentage of the rated value) against the load factor of a squirrel-cage induction motor (400V).

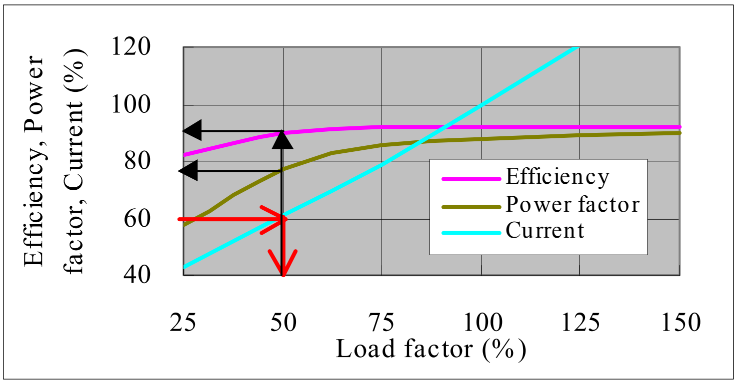


Figure IV-2-10 Characteristics of a squirrel-cage induction motor (400V)

It can be seen from the diagram showing the relationship between the current and the load factor (above) that the load factor is 50% when the current is 60% of the rating. The power factor decreases from 88% to 77%, and the efficiency decreases from 92% to 90%. In a motor operated at a higher voltage as well, the load factor is about 50% when the current is 60%.

Although the decrease in efficiency observed is several percent, at most, in a motor driven at a high voltage its operation must be improved because the load factor of 50% corresponds to about twice the actual demand.

That is, the criterion for judging whether the motor used is oversized or not is 60% of the rated current.

b. Pumps and fans

Compared with motors, the efficiency of pumps and fans depends more on the load factor (Figure IV-2-11).

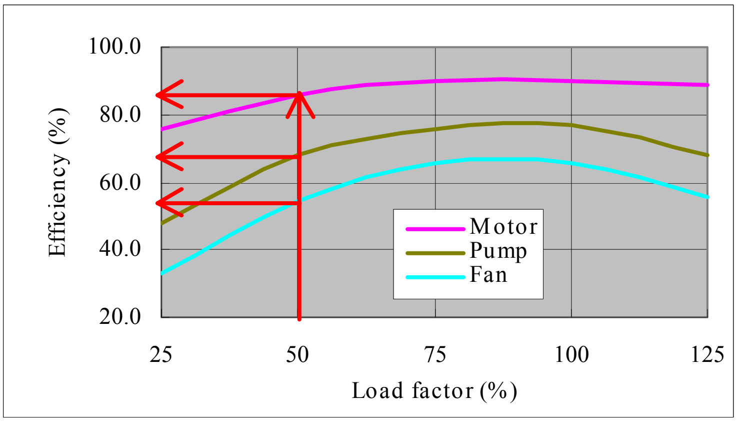


Figure IV-2-11 Relationship between the load factor and the efficiency of pumps and fans

At a load factor of 50%, efficiency decreases by about 10% in both pumps and fans. In addition, the rate of efficiency decreases drastically below 50%.

Table IV-2-8 shows the measured values of the current of #701B supplementary equipment in the previous energy audit (January 2001).

Table IV-2-8 Measured current of the fans and pumps of #701B

Fan/Pump	Capacity kW	Design Volt.	Design Amp.	Actual Amp.	Actual/ Design
1. FOP	11	380	22.5	14.5	0.64
2. BFP	315	6,000	36.5	29.5	0.81
3. DFP	75	380	131	67.4	0.51
4. FDF	315	6,000	36.6	17.5	0.48

The measured values of current for DFP and FDF are less than 60% of the rated design values. This indicates that the load factor is less than 50%. For example, the damper of the FDF can be narrowed down to about 50%. In such a case, it is possible to make significant savings in energy by adjusting the number of revolutions by changing either the pulley ratio or the gear ratio.

(2) Operation of the air compressor system

1) Flow control and air leakage control

The air compressor room is located at the center of the mill and, from there, compressed air is delivered to each plant. While such an integrated system has an advantage in that the facilities are utilized efficiently and the operation is centrally controlled, long pipelines are required and, as a result, air leakage, pressure loss, and imbalance between the supply and the demand are apt to occur. Therefore, meticulous control is required.

Is it sure that little amount of air is used while the mill is closed. Flow control and periodic air leakage checks should therefore be implemented.

Even in newly installed pipelines, air leakage of 3-5% usually occurs. As time passes, the leakage may exceed 10% and sometimes reaches 35%. Air leakage mainly takes place at piping junctions and around equipment seals.

Operating the compressor when the plant is out of operation, using the method shown in Figure IV-2-12, can check the amount of leakage.

To check the air leakage, close all the ends of the piping completely and start the operation of the air compressor. When the pressure has reached a specified value, stop the compressor. The changes in discharge pressure occurring after the start and finish of compressor operation are shown in Figure IV-2-12. In the figure, P1 is the pressure used, which is usually set to around P1-P2 = 0.05 - 0.1MPa.

Approximate air leak rate, L, is calculated by the following equation: $L = t1/(t1 + t2) \times 100[\%]$

Estimation of the Air leakage
L: Air leakage (%)

$$L = \frac{t1}{t1+t2} \times 100\ (\%)$$

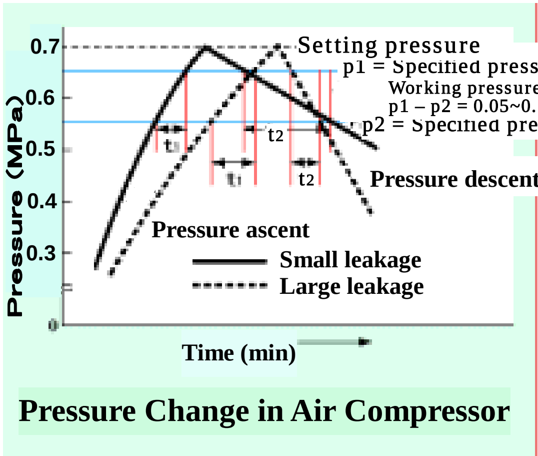


Figure IV-2-12 Check for air leakage

2) Dryer

Adsorption type dryers are installed. The adsorption type dryer can, by purging adjust, be used for electronics production plants and suchlike where a very low dew point is required. In such a dryer, valuable compressed air may be uselessly released by purging if the dew point is set excessively low. It is recommended that the dew point control be reviewed, following these steps:

- Confirmation of the required dew point.
- Adjustment of the purging volume (purging time)
- Investigation of the possibility of using a heating type (or refrigeration type) dryer (either in a changeover or in parallel use).

(3) Examples of successful energy conservation in the distribution system (energy conservation in the pump station and improvement of the power factor)

1) Reduction of distribution loss

Key points are as follows:

Distribution loss, W [W], is expressed by the following equation:

$$W = I^2 \times r$$

Where, I: current [A], and r: resistance of the distribution line [Ω].

To reduce the distribution loss, it is necessary to reduce the current (I) and the resistance of the distribution line (r) in the above equation.

a. To reduce the current:

- Supply electricity with a high voltage to the center of the load, and
- Raise the power factor.

b. To reduce the resistance of the distribution line:

- Make the length of the low voltage distribution line as short as possible.

PT KERTAS has constructed an ideal system for the water feed pump station, which satisfies all these conditions. Actual measures taken are as follows:

2) Pump station

The water feed station is located at the water reservoir about 1km from the mill, and five pumps are installed.

Figure IV-2-13 shows the equipment connections involved by means of a one-line diagram.

The following are measures taken to ensure the reduction of distribution loss:

a. Long distance feed with a high voltage (6kV)

For a certain amount of the electrical power supply, increasing the voltage, resulting in a reduction in distribution loss, can decrease the current.

b. Installation of transformers as close as possible to the load

By transmitting power with a high voltage as close as possible to the load, it is possible to shorten the length of low voltage distribution line requiring a large current so that the loss in the low voltage distribution line is reduced.

c. Installation of phase-advance capacitors

Phase-advance capacitors improve the power factors of motors so that the current that flows through the distribution line is reduced. The installation of phase-advance capacitors has reduced the current from 320A to 280A, resulting in a decrease in the loss caused by the distribution line to 77% (= $(280/320)^2$)).

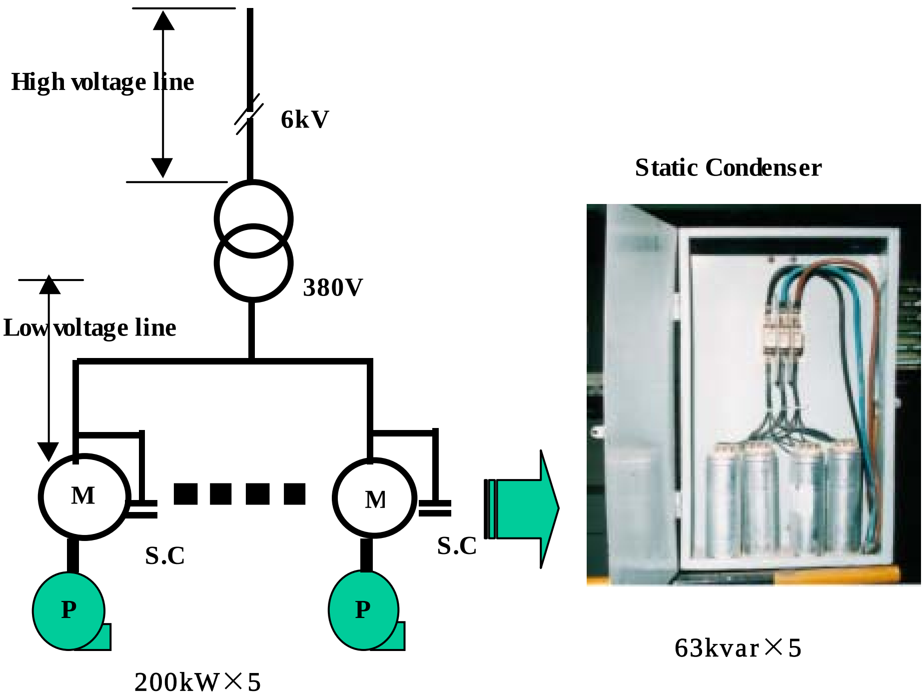


Figure IV-2-13 Connection diagram for the pump station

3. Walk-through Energy Audit at the Patal Grati Spinning Mill of Industri Sandang Nusantara

We visited a second new plant in the neighborhood, Unit Patal Grati Textile (Spinning) Mill, to make a walk through energy audit.
Since the visit to the PT KERTAS Paper Mill was scheduled early in our trip, we asked MOE to arrange another visit to a new plant in the neighborhood. However, it was only three days before the departure of the investigation team that the visit to the mill was confirmed. Although the visit was arranged at short notice, the mill staff accepted the visit by the investigation team in a friendly and cooperative manner.
Patal Grati Spinning Mill is very eager to save energy, having organized the EC Committee in 1996. After hearing a description of their activities, we made a tour of the plant and then gave our comments. This mill is a spinning mill mainly used for polyester yarn manufacture. Cotton and rayon yarn manufacture is carried out in other factories belonging to the same company.

3.1 Visit to the Patal Grati Spinning Mill

(1) Outline of the visit

Name of the company: PT Industri Sandang Nusantara
Name of the mill: Unit Patal Grati
Time and date of visit: December 8 (Thu) 9:00-16:00
Location: Jl. Raya Grati KM.14 Grati, Pasuruan 67184, Jawa Timur, Indonesia
(About 80km southeast of Surabaya)
Company staff: Mr. Naulila, General Manager
Mr. Ir. Mulyono, Manager Teknik
Six staff members of EC Committee (Team Konservasi Energi)*
*Although called a “Committee”, it is actually a department in the company organization.
Investigation team members:
Indonesia, MEMR:
Mr. Parlindungan Marpaung, Inspector, Dept. of Energy Efficiency
Japan, International Engineering Department, ECCJ
Messrs. Fumio Ogawa, Hisashi Amano, and Hideyuki Tanaka, Technical Experts

(2) Outline of the mill

Raw material: polyester yarn. (Although they have other factories that handle rayon and cotton raw materials, the investigation team only surveyed the polyester mill.)

Product:	Polyester thread
Production capacity:	400t/month (medium size for an Indonesian spinning mill)
Actual production:	Production has increased to about 360t/month, which is about 90% of total capacity.
Number of employees:	536 (including operators working three shifts in four groups)

Area of the mill: 26ha

Type of operation: Continuous operation, including nights, holidays and weekends.

Periodic maintenance and repair are carried out sequentially by suspending operations once every three months, for four hours each time.

Energy used: Electricity only (purchased from PLN)

(3) Production process

The production process consists of the following eight steps:

a. Blowing: Raw material (yarn) is aspirated by air blowers and then transported through a duct before being compacted on a roller-beater.

b. Carding: Filaments with a diameter of about 2 cm are formed (then stored in a drum type vessel).

c. Drawing: After carding, eight strands of filament are simultaneously on one side of the machine, which are intertwined to form threads.

d. Speed: The threads are further drawn and wound on longitudinal bobbins.

e. Ring Spinning: Finished textile threads are formed in this step, using several hundred bobbins connected to a single machine.

f. Cone Winding: The final twist is given to the threads and the threads are wound around cone type bobbins.

g. Packing (not investigated.)

h. Storage (not investigated.)

(4) Energy being consumed and energy-conservation activities

As described above, energy-conservation activities started in 1996 and successful results have been achieved. However, power costs still account for 47% of the total production costs.

Installed Capacity of power receiving system: 2,770kVA

Diesel Generator Capacity: 1,250kW×2units, 300kW×1unit

Mr. Mulyono (Technical Manager) is the energy manager (director of the EC Committee). Although some managers and staff members from other departments are included as members, the committee mainly consists of about 40 dedicated personnel with knowledge of technology and electricity and who have been recruited from within the mill and trained especially for their role on the committee. The committee members are divided in half into the following two groups:

G1: In charge of process matters: patrolling the plant periodically to check processing equipment and to promote efficiency.

G2: In charge of utility matters: In addition to the same responsibilities relating to utility equipment, maintenance is within the scope of job.

The following improvements in unit cost have been achieved as a result:

1996: 950kWh/Bale-Product (1 Bale = 181kg)

2002: 850kWh/Bale

2005: 750kWh/Bale (Peak Load: 650kWh/Bale)

(5) On-site survey and impressions

First, the flow of the process from raw materials to products was surveyed, and then the utility facilities (air conditioning, chillers, air compressors, power receiving system, generators, etc.) were checked.

It was explained that the members of the EC Committee patrol every hour to check the temperature and humidity and correct the environment if it is outside the specified range. However, it was hot and humid when we visited.

General "housekeeping" of the plant seemed to be insufficient, and the Japanese "5 S's" is needed to implement more thoroughly.

1) Illumination

Attempts to save energy could be seen, such as the diligent reduction in the number of or extinction of fluorescent ceiling lamps in use. Some of the regular bulbs are also being replaced with fluorescent lamps.

2) Air conditioning

The control targets for temperature and humidity are from 30˚C to 33˚C and 65% respectively, and wet and dry bulb thermometers are provided to monitor the workplace environment. However, there are no actual facilities to control the humidity.

Since the workplace environment for spinning and winding must be carefully controlled, cold water is provided by chillers, and two large-scale AHU units are installed.

Since it was the rainy season, the temperature was not too high and the two water-cooled turbo chillers (800RT) were not operating. They are operated during the dry season. Using the AHU, cold water for showering is prepared by exchanging heat with the cold water of the chiller, and the cold water is then used to directly exchange heat with the air to provide cool air for the building.

Although the system is basically a circulating system, it is possible to take in outdoor air or exhaust indoor air according to the enthalpy relative to outdoor air. The temperature of the incoming air on the day of our visit was 29.3˚C.

3) Air compressor

The main compressors used are four screw type compressors driven by 30kW motors. Three compressors were running on the day of the visit and the discharge pressure was 0.72MPa at the receiver tank. There was very little pressure fluctuation between the screw type compressors.

Although the person in charge explained that the compressors were controlled by load-unload control within the range of 0.65 to 0.8MPa, no load-unload action was observed while we were on the site (about 20 minutes). The air is supplied to the load equipment through a dryer.

Hot air is directly released into the environment and the condition of the indoor atmosphere was fairly good when we visited. There is both a compressor line and a blower line, and it seems that the discharge pressure of the compressors can be reduced.

4) Power receiving system and the emergency generator

The electricity is received at 20kV and the system consists of two lines: one line that reduces the voltage to 3.3kV using two main transformers (1,600kVA) and another line that directly reduces the voltage to the low voltage used in the plant using a one-stage transformer.

Seven low-voltage transformers decrease the 3.3kV to 380V. This two-stage step down appears to be redundant and may be a historical result. The main transformers are of an old oil-immersion type equipped with a conservator and should be replaced shortly. It is also necessary to reconsider the distribution system when doing this.

However, since the output voltage of the emergency generator is 3.3kV, some consideration must be given to the type of linkage used.

Although all the feeders are equipped with ammeters, watt-hour meters are only provided for the three systems used for receiving power. Energy meters are installed in all the workshops. Mr. Mulyono explained that measurements were being made, but no measuring system was seen for any of the utilities, including the power receiving system.

Patal Grati Mill submitted the following materials:

"Power Single-Line Diagram", "Plant Layout" and "Specifications for major facilities"

3.2 Advice and Recommendations for EE&C Activities

At the end of the meeting, the investigation team gave the following advice and comments:

(1) Measures suggested (in order of priority) based on the analysis of the power consumption data.

Although it is appreciated that the members of the EC Committee are dedicated to the patrolling and collection of data on equipment use, how the data are analyzed is also important. For example, the data may be classified according to the processes and areas concerned, but they should be further classified according to use (such as illumination, air conditioning, compressed air, and pumps). The data should then be analyzed in order to set priorities based on their importance and effectiveness for energy conservation.

(2) Key points for selecting appropriate operating conditions and facility capacities

In the on-site survey, it was found that some facilities are oversized for the capacity actually required. It is necessary to adjust their size according to actual operating conditions. It is also necessary to maintain high efficiency in accordance with the fluctuating load. One example of an inappropriate specification is the air compressor outlet pressure of 0.8MPa. This value is too high.

Mr. Mulyo said that 0.8MPa was required to prevent thread breakage in cone winding, but the pressure gauges for compressor operation and the receiver tank actually indicated 0.7MPa.

(3) Keeping efficiency high by carrying out regular maintenance

Maintenance plays an important role in keeping EC efficiency high. For example, periodically checking the leakage of compressed air pipelines and repairing when necessary is an effective means of ensuring efficiency. Grati Plant explained that they check for leakages once a week.

(4) Investment in energy conservation is necessary in the future

It seems that Grati Mill has either not invested in energy conservation at all or has carried out only a small investment in energy conservation which has now finished. Further investment is required to promote EC in the future.

(5) Advice and comments from Mr. Parlin (MOE) are as follows:

1) Openings on the vacuum suction part of the roller-beater used in the blowing process should be closed.
2) Suction air for the ventilation fan in the air compressor room should be taken directly from outdoors (where the temperature is lower than that of indoor air).
3) Ventilation in the main transformer room should be improved in order to lower the ambient temperature.

3.3 Recommendations for Improvements and Expected Effects

The following are recommendations for improvements proposed by ECCJ (in addition to the advice and recommendations described above).

(1) Controlling the cold water temperature of the turbo chiller

Two 800RT turbo chillers are installed. Although detailed operating conditions are not known, the general principles of energy conservation using cold water and cooling water are as follows:
The following conditions are required to increase the COP of refrigerator operation:

- Load factor (= capacity ratio) should be higher.
- Cooling water temperature should be lower.
- Cold water temperature should be as high as possible.

Power consumption is expressed by "total power = power of cooling water pump + power of cooling tower + power of refrigerator". All these components must be considered comprehensively.

Generally speaking, in any turbo refrigerator controlled by speed, the total power consumption drops when the cooling tower is not controlled. However, it is said that when controlled only by the suction vane, the total power consumption still drops even when the cooling tower is controlled. Optimum operation patterns therefore need to be set, in relation to the season, and both alternatives compared.

1) Energy conservation by raising the temperature of the cold water

Figure IV-3-1 shows the relationship between the cooling water temperature, cold water temperature, and power required for the motor (corresponding to power consumption).

The graph shows the required motor power when the cold water temperature and cooling water temperature are changed (taking the base cold water temperature as 32℃ and base cooling water temperature as 5°C). When the outlet temperature of the chiller is raised from 5°C to 7°C and then to 9°C, the power consumption (motor power) decreases to 96% and then to 92% if the cooling water temperature is maintained at 32°C.

This means that raising the cooling water temperature when the load is light can reduce the power consumption.

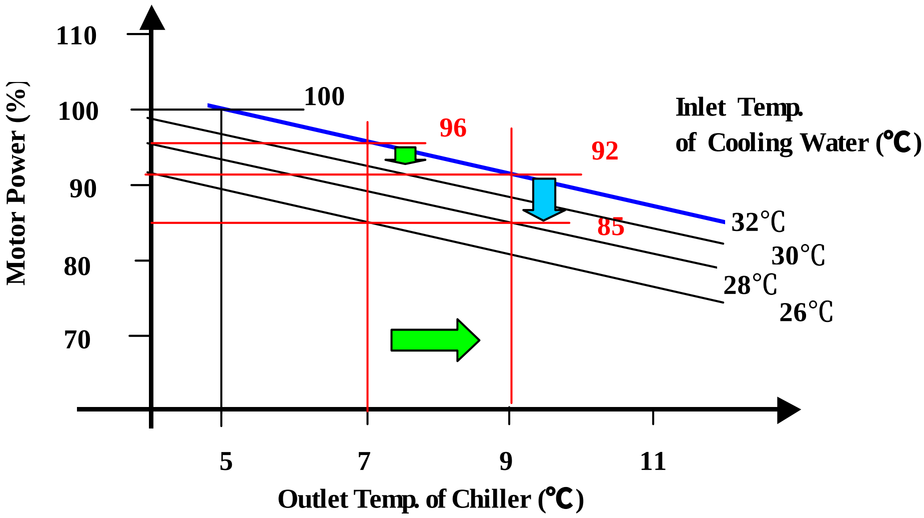


Figure IV-3-1 Relationship between cold water temperature cooling water temperature, and motor power (turbo refrigerator)

2) Energy conservation by changing the cooling water temperature

The performance of a cooling tower depends on the wet bulb temperature. Table IV-3-1 shows meteorological data from the Surabaya region.

Table IV-3-1 Temperature and humidity in the Surabaya region

Items	Max.	Min.	Ave.
Ambient Temperature (ºC)	32	29	30
Relative Humidity (%)	80	55	65
Wet Bulb Temperature (ºC)	29	21	25

The wet bulb temperature was calculated from ambient temperature and relative humidity. The wet bulb temperature varies between 21ºC and 29ºC. Figure IV-3-2 shows the relationship between the wet bulb temperature and cooling water temperature at the outlet. Since the cooling tower is usually operated with Δt = 5ºC, the minimum temperature of the cooling water is 28ºC and the maximum temperature is 33ºC.

By lowering the cooling water temperature from 32ºC to 28ºC while the cold-water temperature is kept at 9ºC, the refrigerating capacity increases by about 8% (= 1-85%/92 = 0.08) so that the motor power required decreases.

It depends on the method used to control the capacity of the refrigerator whether it is better to save the energy of the cooling tower by fixing the cooling water temperature at 32ºC or to save the energy of the refrigerator by lowering the cooling water temperature according to the decrease in the wet bulb temperature. The cooling tower and refrigerator should both be taken into consideration when choosing the optimum operation pattern to use in order to save power.

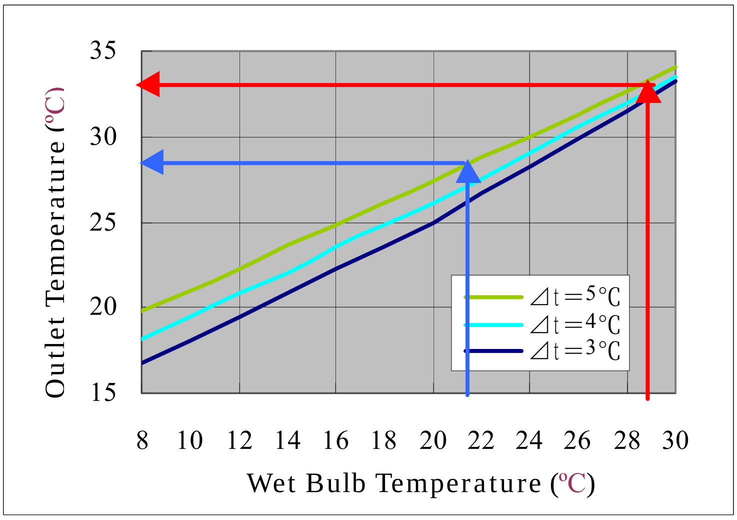


Figure IV-3-2 Relationship between the wet bulb temperature and cooling water temperature of the cooling tower

(2) Air compressor

Four screw type compressors with 30kW motor each are operated with the control of the number in operation. Although there are some problems in the treatment of waste heat, no significant problems have been identified in the arrangement of the facilities and the installation environment. The following items should, however, be taken into consideration in order to promote energy conservation:

1) Discharge pressure and power consumption

The control range of 0.65 – 0.8MPa for the discharge pressure is relatively high.

A decrease in the discharge pressure would be desirable, based on the required pressures for equipment loading.

Possible measures are:

Low-pressure load:	Reduction of pressure using a pressure reducing valve.
High-pressure load:	Investigation of the possibility of increasing the pressure using booster.

Air pressure for the cleaner can be reduced to about 0.3MPa.

2) Air pressure and air leakage

Compressed air from the compressors is supplied to all equipment through pipelines, resulting in pressure loss caused by friction in the pipelines and flow loss due to leakage. The pressure loss is adjusted considering the piping costs and the flow loss can be controlled, aiming at zero leakage. Please refer to Item 2 for details of the leakage measurements and countermeasures.

(3) Automation of collection and control of data

Let us now discuss energy conservation in the production line. Energy consumed can be divided into effective energy that is utilized for the production process, and ineffective energy that is wasted. Ineffective energy derives from defective products, waiting time loss, loss caused by machine faults, and material loss. Figure IV-3-3 shows effective energy and energy loss in the production line.

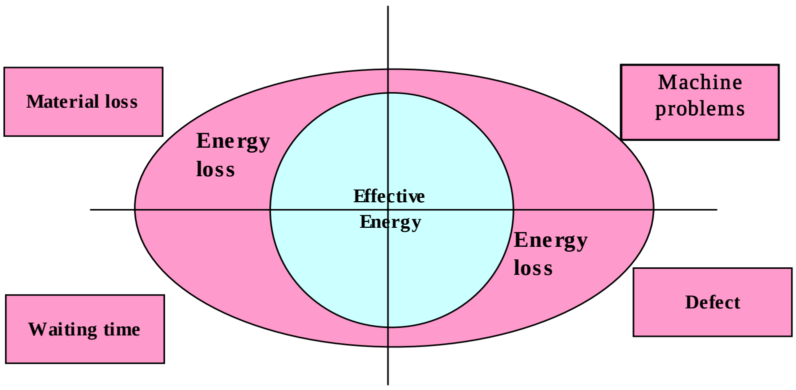


Figure IV-3-3 Effective energy and energy loss

Since there is little material loss in Patal Grati Mill because materials are not processed there, other losses are discussed below.

1) Loss due to defective products

The energy that has been used to produce defective products represents the ineffective consumption of energy. Consequently, activities for improving yield are also energy-conservation activities. Among the factors that affect yield and quality, the following are those related to environmental control of the workplace.

In Patal Grati Mill, the temperature and humidity in the plant are periodically checked and controlled. However, there are concerns about the control system used and the speed of response because the number of sampling points is limited and the data is collected manually. Since temperature and humidity are important factors that affect quality and yield, a system is required that can constantly monitor and maintain the environment. Particularly in workplaces where products are produced on a continuous basis, it is necessary to assess the situation and take immediate measures in an emergency. With this in mind, the next step that Patal Grati Plant should take is to automate the data collection and control procedures.

Temperature and humidity sensors are easily obtained and there is plenty of watt-hour meters available equipped with a data transmission function. It is recommended that a system be constructed utilizing such functions.

2) Loss due to machine breakdowns and waiting time

The energy lost due to machine breakdowns and waiting time is ineffective energy that does not contribute to production. Waiting time is a matter of production scheduling and the occurrence of machine breakdowns is a matter of maintenance.

Patal Grati explained its system of preventive maintenance in which maintenance is implemented periodically so that breakdowns are avoided. This system is recognized as being very effective. It is suggested that this maintenance system could be improved further by adding an automated system for the trend control of deterioration and abrasion of equipment.

4. Seminar and Workshop

4.1 Summary

A seminar Workshop was held on December 12, 2005 (Mon).

At the Seminar Workshop, the Honorable Mr. Soekanar of the Ministry of Energy and Mineral Resources made the opening speech and Dr. Weerawat, Director General of the ASEAN Center for Energy (ACE) gave the closing speech. There were about 60 active participants and the Workshop was very successful and productive.

(1) Date and time

December 12, 2005 (Mon) 8:30: registration 17:30: closed

(2) Venue

Gran Mahakam Hotel, 2F (Ball Room), Jakarta, Indonesia

(3) Reports presented on the Seminar and Workshop

The program of the Seminar Workshop is described in Material No. D-111.

ACE reported on the EE&C activities of ASEAN, and ECCJ explained the guidance on energy conservation matters in the industry. It seemed that private participants were disappointed that the Indonesian government did not report anything at the seminar.

The Indonesian pulp and paper mill for which we made the follow-up energy audit submitted a report and other ASEAN countries such as Lao PDR, Malaysia, Philippine and Thailand also made presentations.

(4) Participants

Major participants were as follows:

Indonesia:

Mr. Soekanar, Secretary for Director General, MEMR, Directorate General of Electricity and Energy Utilization (DJLPE or DGEEU)

Ms. Maryam Ayuni, DJLPE, MEMR

Mr. Ir. Parlindungan Marpaung, Inspektur Ketenagallistrikan, DJLPE, MEMR

Ms. Sutji Rahayu, Tariff Expert, Marketing Division, PNL

Mr. Djoko, Manager of R & D, PT Kertas Leces (Persero)

About 60 Indonesian delegates from government offices and various industries attended the seminar. Although we asked to see the list of participants later, in an electronic form, we have not received it yet.

ACE:

Dr. Weerawat Chantanakome, Director General

Mr. Christopher Zamora, Project Manager

Mr. Ivan Ismed, Project Officer

Mr. Junipard

Ms. Maureen

Ms. Tewi

Laos:

Mr. Vanthong Khamloonvylayvong, Deputy Manager of Nam Ngum Hydropower Plant, Electricite du Laos (EDL)

Malaysia:

Mr. Pubalan, Energy Auditor, PTM

Philippines:

Mr. Marlon Domingo, DOE

Thailand:

Mr. Arthit Vechakij, Managing Director, Excellent Energy International Co., Ltd.

Japan: International Engineering Department, ECCJ

Messrs. Fumio Ogawa, Hisashi Amano and Hideyuki Tanaka, Technical experts

4.2 Results of the Seminar and Workshop

(1) Opening ceremony (congratulatory address and opening speech)

1) Speech by ACE

Dr. Weerawat, Executive Director of ACE, stated in his speech that, in recognition of the recent high price of crude oil, energy conservation was now more important than ever. He also explained that the basic plan for the period from 2004 to 2009 was decided at the ASEAN Ministers Meeting held in Manila last July and he then introduced the activities of PROMEEC and the outline of the program for the day.

2) ECCJ

Mr. Tanaka, representing Japan (METI and ECCJ), made a speech. He explained the significance, history and recent developments of this project, and described Japan's cooperation with and contribution to ASEAN.

3) DJLPE

The Honorable Mr. Soekanar made a speech explaining the energy-conservation policies of the Indonesian government and announced the opening of the meeting.

(2) Session 1: Policies and initiatives on EE&C

1) Overview of ASEAN Plans and Programs on EE&C (Dr. Weerawat, ACE) (Material No. D-127)

The establishment of ASEAN in 1967 and its subsequent development was explained from the viewpoint of geopolitics, and the history and the present role of ACE were outlined. Mention was also made of "ASEAN+3" that had been held in Kuala Lumpur just before the seminar. He then introduced the outlook for primary energy every 5 years until 2010, in ASEAN region and predicted that the consumption of oil would decrease and that of natural gas would increase. Furthermore, he remarked that the estimated amount of investment necessary for the development of energy resources in each ASEAN countries adding that the amount of

Indonesia is enormously large. He also reported that basic principles are being negotiated with the EU on the Energy Charter Secretariat. Six basic strategies for Multinational Cooperation in the period between 2004 and 2009 were also explained.

2) Initiatives and Programs of ECCJ on EE&C in Industry in Japan (Mr. Tanaka, ECCJ) (Material No. D-128)

Mr. Tanaka outlined the status of energy consumption in Japan, the history of energy conservation, methods of energy conservation, designated factories, qualified persons for energy management, ECCJ activities such as energy audit, education and training courses, and presented successful cases of energy conservation and the award system.

(3) Session 2: Presentation of successful cases of EE&C in industry

1) Paper and pulp industry, Indonesia – Mr. Djoko

The attendees seemed to be interested in the explanation given about the conversion from heavy oil to natural gas and then to coal. Fuel prices largely depend on governmental policies (such as subsidies and taxes) so it is necessary to note the difference between countries. The report was made based on Material No. D-115 together with Material No. D-129 "Recent difficult situations", as explained when the investigation team visited the mill.

2) Hydroelectric power generation, Laos – Mr. Vanthong (Material No. D-130)

This report was the same as that presented at the Cambodian PROMEEC Seminar Workshop. Neatly arranged data since 1972 were reported in a series of graphs.

3) Glass and textile industries, Malaysia – Mr. Phubalan (Material No. D-131)

This report was about the glass industry (JG Containers) and the textile industry (AMDB). What impressed us was that PTM is functioning as an Energy Auditor and that high quality portable measuring instruments are being used.

4) Steel industry/cement industry, Philippines – Mr. Domingo (Material No. D-132)

The present situation of the Philippine steel industry and the activities of two companies (a rolling mill company and a steel sheet coating company) who received Don Emilio Abello EE Awards in 2005 were reported. This Award honors distinguished companies involved in EE activities in the Philippine industry. In addition, some comments were made on the cement industry, based on information Mr. Domingo had received from one of his friends.

5) Biomass, biomass cogeneration, and ESCO, Thailand – Mr. Arthit (Material No. D-133)

Mr. Arthit, the president of ESCO, talked about cogeneration, which is his favorite subject, and about ESCO (rather than the scheduled topic concerning a caustic soda plant). He was asked to fill in for Mr. Prasert (FP of Thailand) just before the Seminar. Although his presentation was not related to successful cases, his story was highly instructive, including 10 KFS (Key Factors for Success). The attendees showed much interest and there were many questions.

(4) Session 3: The Way Forward

1) Barriers and Measures for the implementation of EE&C – Mr. Ogawa (Material No. D-117)

This presentation was based on past data, with the Indonesian paper industry in mind and referring to the reports submitted earlier that day.

2) Technical Directory – Mr. Amano and Mr. Ivan, ACE (Material No. D-138)

The purpose, method of preparation and format of TD were explained, and examples were presented to help develop a better understanding. Mr. Ivan presented several actual examples of TD sheets.

3) Database/Benchmark/Guidelines for Industry – Mr. Ogawa (Material No. D-119)

A plan to construct an ASEAN database by linking the databases of participating countries was outlined.

(5) Q&A Session

Questions and answers were exchanged at the end of each session. There were as many as 20 brisk questions in total. The following are some of those questions and answers:

Q: How can Indonesian private companies ask ECCJ for an energy audit? (There were several similar questions.)

A: ECCJ acts within the framework agreed upon between governments. For general issues, it is recommended that you consult the government of your own country or ACE.

Q: Who funds the "Low Interest Loan" which is one of the incentives for EC in Thailand?

A: A gasoline tax of 0.04 baht/L is collected and this is used as an energy-conservation fund. The government lends the money to private banks with interest set at 0.5%. The banks then loan this money to those who implement EC, with interest set at 4%.

Many other questions, in addition to those described above, were also asked relating to bio-diesel, risk management of ESCO, time of completion of TD, etc.

(6) Closing speech

After the comments made by the three VIPs (including Ms. Maryam, speaking on behalf of Mr. Soekanar of Indonesia), Dr. Weerawat closed the meeting with a final speech.

V. Brunei (Cement Industry and Food Processing Industry)

1. Outline of the Activities

This survey includes a follow-up energy audit of a cement company whose initial (Phase 1) energy conservation audit was carried out in February 2001, and a new walk through energy audit implemented for energy conservation at a beverage factory. A seminar workshop was also held in Bandar Seri Begawan (BSB), Brunei, at which case study of energy conservation activities in various industries were reported.

The follow-up energy audit and survey of the cement factory was only a walk through energy audit and no measurements were carried out using instruments. Many people participated in the diagnosis including FP representatives from the government. ECCJ played a key role in the energy audit and the company presented the results of its energy conservation activities over the past five years. There were many participants in the energy audit of the beverage factory as well and several people, including the factory manager, also participated in the seminar workshop.

1.1 Implementation Period

14 to 17 December 2005

1.2 Sites of implementation

Follow-up investigation:	Cement factory: Butra Heidelberg Cement SDN BHD
New walk through energy audit:	Beverage factory: Kingston Beverage & Creamery Sdn. Bhd
Seminar workshop:	Center Point Hotel, 6F (Purple Jade Room), BSB, Brunei Darussalam

1.3 Schedule (Material No. D-102)

December 14 (Wed): Follow-up energy audit of the cement factory of Butra Heidelberg
15 (Thu): walk through energy audit of Kingston Beverage & Creamery
16 (Fri): Observation tour of oil fields in Seria (Western Brunei). (Observed the oil fields from the car)
17 (Sat): Seminar workshop

1.4 Relevant Persons

ACE:

Dr. Weerawat Chantanakome, Executive Director

Mr. Ivan Ismed: Project Officer

Brunei: Prime Minister's Office, DES

Mr. Hj Umar bin Hj Mohd Tahir, Head of Energy Policy & Planning

Mr. Haji Abd Shawal bin Yaman, Energy Division

Mr. Pg. Zamra (Pg. stands for Royal Family.)

Mr. Ismail bin Hj. Mohd. Daud, Head of Safety and Enforcement Unit

Japan: International Engineering Department, ECCJ

Messrs. Fumio Ogawa, Hisashi Amano and Hideyuki Tanaka, Technical Experts

General situation in Brunei Darussalam

(1) General information on Brunei

- Area: 5,765km^2
- Population: 350,000 (2003) (including foreign residents)
- Religion: Islam (national religion), Christianity, Buddhism, Taoism, etc.
- System of government: limited monarchy
- Economy: Major industry: petroleum and natural gas

  Nominal GDP per capita: US$13,418 (provisional for 2003)

  Currency: Brunei dollar (equal to the Singapore dollar, 1 Brunei dollar is about ¥65, as of January 2005)

  Trading (2003):

  Exports: Petroleum and natural gas (about 90% of total exports) are exported to Japan (41%), Korea (11%), and Thailand (9%). Total export value is US$4.4 billion.

  Imports: Machinery, transportation, industrial products, and foodstuffs are imported from Singapore (20%), Malaysia (20%), U.S.A. (12%), and Japan (10%).
  Total value of imports is US$1.3 billion.
- Economic situation: Abundant petroleum and natural gas resources maintain a stable economy and a high income level. However, Brunei aims to diversify its economy by developing downstream industries related to petroleum and to reduce its excessive dependency on energy resources.

  In the past, Japan provided ODA mainly in the form of technical development, but this assistance was terminated in January 1998 after Brunei became an ODA graduate country in January 1996.

(2) Energy situation

Brunei is a producer of petroleum and natural gas, exporting significant amounts to Japan, Korea and other countries. There is a monument in the oilfields of Western Brunei that commemorates the production of one billion barrels of petroleum in 2000. The price of gasoline at December 2005, was B$0.5/L (= US$0.32/L) and electricity price was B$0.07/kWh (= US$0.045/kWh).

2. Follow-up Survey of the Cement Factory of Butra Heidelberg Cement (BHC)

2.1 Outline of the Cement Factory of Butra Heidelberg Cement (BHC)

(1) Outline of the company

Name of the company:	Butra Heidelberg Cement SDN BHD (a 50-50 joint venture with a German cement company)
Name of factory:	Butra Heidelberg Cement (BHC) Factory
Location:	Lot 3, Serasa Industrial Area, Muara BT1728
Product:	Ordinary Portland cement (shipped by tank trucks and packed in paper bags)
Amount of production:	220,000-250,000 t/y
Number of employees:	110 (February 2001)
Working system:	Three shifts, eight-hours per shift

(2) The cement production process and energy consumption

The following is a summary of what we learned from our two visits:

1) Outline of the operation

Butra Heidelberg Cement Factory (BHC) was established in 1993. It is about a 30-minute drive from Bandar Seri Begawan, the capital of Brunei, and is the only cement factory in Brunei that specializes in crushing cement. The company is a joint venture with a German company and was originally called Butra Heidelberger Zement before it changed its name.

The production capacity is 500,000 tons per year but the present annual production is only 250,000 tons due to the stagnant economy. All the raw materials, cement clinker and gypsum, are imported from East Asian countries such as Japan and Taiwan. The harbor has a water depth of 9 meters and permits the berthing of 25,000-ton vessels. While two vessels usually enter the harbor monthly, only about one vessel enters each month at present due to the low level of production. The factory has a production line with a closed-circuit tube mill whose capacity is 72 tons per hour and a high performance O-SEPA (Onoda type) separator. Storage facilities include a clinker silo, storage of gypsum, and two cement silos, and shipping facilities include packers and tanks for loading the materials onto trucks.

The factory has obtained ISO9002 certification in 1997, which proves its high level of quality. Measures are taken for dust prevention, and dust collectors (of the 1-bag filter/hopper type), dust prevention nets, and water sprinklers are provided.

2) Facilities

Clinker storage silo: 50,000t × 1unit

Gypsum storage: 6,000t × 1unit

Finishing mill:

Type of finishing mill: Closed-circuit type tube mill × 1unit

Crushing capacity: 72t/h
Mill size: 4,200mm diameter × 10,500mm length
Mill motor capacity: 2,800kW
Separator: O-SEPA・N-1500 type × 3,000mm diameter
Mill bag filter: Dust collecting capacity 10,000m^3/h × 1unit
Mill bag filter fan: 110,000m^3/h × 700mmAq × 355kW × 1unit

Cement transport equipment: FK screw pump 80t/h × 55kW × 2units
Cement storage silo: Capacity 7,000t × 2units
Power receiving facility: Receiving voltage: 11kV, transformer: 7,500kVA

3) Amount of energy consumption

Electricity is the only energy source. Table V-2-1 summarizes the production, power consumption, and unit consumption of electricity from 2000 to November 2005, based on the data provided by BHC.

Table V-2-1 Energy consumption (2000 to 2005)

Items		2000	2002	2004	2005 (1~11)	Improvement (2004/2000) [2005/2000]
Production	Cement (t/y)	232,174	231,697	247,733	213,240	(1.07) [1.0]
Energy consumption (Entire Plant)	Electricity (MWh/y)	14,723.4	14,296.4	16,674.64	14,150.8	(1.13) [1.05]
Energy Intensity	Electricity (kWh/t)	63.42	61.70	67.31	66.36	(1.06) [1.05]
Energy Price	Electricity (US$/kWh)	0.045	0.045	0.045	0.045	(1.0) [1.0]

2.2 Outline of the Results of the Previous Energy Audit of BHC Cement Factory

The aim of the previous energy audit was to survey the cement crushing line. The results of temperature and pressure measurements were close to specified values, which suggested fairly good operating conditions. We recommended implementing the following items to further improve energy efficiency under these operating conditions.

(1) Upgrading and maintenance of sensors and meters (for pressure, temperature, and electric power)

The piping of pressure gauges had been left in a clogged condition, electrical meters were not working, and all the sensors and meters were uncontrolled. Since it is very important that meters and sensors function correctly and without error in order to ensure the normal and efficient operation of facilities, as well as to prevent accidents, daily checks of measured values and periodic calibration of all instruments are required.

(2) Utilization of the exhaust from the dust collector as secondary air for the O-SEPA

Although ambient air is used as secondary air for the O-SEPA, the specification of the O-SEPA permits the use of air containing dust. Dedicated dust collector (bag filter) is installed in front of the mill to collect dust from the clinker hopper and the gypsum hopper. Since this dust collector is located close to the O-SEPA, connecting the dust collector and the secondary air duct of the O-SEPA with pipelines can use the exhaust from the dust collector. This reduces the operation of the dust collector and saves power. Furthermore, maintenance of the dust collector is no longer needed so that maintenance costs are also reduced. The annual saving in power consumption (43.8MWh/y) and maintenance costs could total US$5,300.

(3) Changing the method of cement transport

A screw pump, which is a type of pneumatic conveying system, is used for the transport of cement to the storage silo. Generally speaking, pneumatic conveying systems (such as airlifts and screw pumps) consume about three times more energy to transport the same amount of cement than mechanical conveying systems (such as a combination of air slides and bucket elevators). Therefore, changing the screw pump to a mechanical conveying system should be considered. Savings in power consumption (188MWh/y) would reduce the power cost by US$8,600/y.

(4) Preparation of manuals and check sheets for periodic maintenance

To prevent the malfunction of facilities, periodic maintenance should be carried out. To do this, manuals and check sheets that stipulate standards for the repair and replacement of facilities must be prepared in order to facilitate preventive maintenance.

(5) Measures for preventing any recurrence of breakage in the clinker shoot and gas duct

The amount of wear on the gas ducts and clinker shoot is remarkable. Even though this damage is repaired immediately, the repair work is always done in the same way so that the cycle of wear-damage-repair is simply repeated. The actual causes of the damage should be identified in order to prevent any recurrence of the problem.

(6) Dividing the air layer of the air slide

Since the long air layer of the air slide is not divided, any breakage of the canvas (even at a single point) causes clogging of the raw material all over the air layer so that the operation is stopped. Furthermore, once such an accident has occurred, considerable labor and time are required to restore operations. The air layers should be divided so that any damage is limited, thereby enabling the operation to continue.

2.3 Follow-up Energy Audit

We visited BHC Cement Factory to carry out a follow-up energy audit on the progress made in addressing the issues raised in the previous visit and to review new activities.

(1) Date of Energy Audit: December 14 (Wed), 2005, 9:00 – 16:30

(2) Audit team members:

Brunei: Prime Minister's Office, Department of Electrical Services (DES)

Mr. Hj. Abd Shawal bin Yaman, Energy Division (Focal Point)
Mr. Ismail Bin Hj. Mohd Daud, Head of Unit, Safety and Environment
Mr. Junidi bin Hj. Jafar
Mr. Hj. Nor Amin bin Mohd Yassin
Mr. Hj. Shamshul Zamicse bin Hj. Sabtu
Mr. Ahmad bin Hj. Mohammad
Mr. Mohad. Tazim bin Akub
Mr. Hj. Aziz bin Hj. Ali
Ms. Dyg. Noor Dina Zhrina binti Hj. Yahya

Brunei: Professors of University of Brunei Darussalam (UBD)

Dr. A. Q. Malik (from Pakistan, specialist in materials)
Dr. M. Blundell (from Britain, specialist in electrical engineering)

Japan: International Engineering Department, ECCJ

Messrs. Hideyuki Tanaka, Fumio Ogawa and Hisashi Amano, Technical Experts

(3) Attendees from BHC:

Mr. Ardi Widjaja, General Manager
Mr. Achmad Hidayat, Maintenance Manager (attended the previous audit)
Several other people

(4) Outline of the follow-up investigation

The ECCJ team carried out an energy audit at this factory in February 2001, and the present visit was for a follow-up energy audit. This was their second experience of energy audit for BHC since the start of operations.

As shown in the list of participants, above, many people from DES participated in the investigation, including a lady from Perth who was studying "renewable energy" in Australia, and two professors from foreign countries who had been teaching at the University of Brunei Darussalam for a long time. According to Mr. Yaman of Brunei FP, the reason for the high level of DES participation was to train staff members of DES by OJT in the energy audit.

The investigation included BHC's explanation of activities relating to energy conservation over the past five years, confirmation of questions from BHC, walk through audit, and the explanation and discussion of further improvements. When we visited the factory, operation was under a halt due to a failure at the mill and only the shipping facilities were operating.

Since we received the written replies to the questions that had been submitted to DES through ACE (included in Material No. D-108) on the way to visit BHC, the investigation proceeded smoothly. However, the report on Phase 1 had not been sent to BHC so it was necessary to explain some of it to them.

We found that their business prospects were worsening because of low-cost cement imported from China since July 2005. As a result, the company is facing a serious crisis with a low operating ratio of only about 50%, making it difficult to invest in energy conservation.

The president of the German stock-holding company only visits the factory once every three months, for several days at a time, and no technical assistance is provided. The factory manager, Mr. Wdjaja, has had experience working at the Indonesian Cement Company, located about 30km south of Jakarta. He was doing his best to cope with the low operating ratio.

The government of Brunei announced that December marked the start of an energy conservation campaign and the activities of PROMEEC appeared in newspapers in both English and the Bruneian language.

We obtained the following materials from BHC:

"Brochure about BHC", "Power consumption in 2005", "Table showing the operating ratio of the mill" and "Material for presentation at the seminar"

2.4 Results and Discussion of the Investigation

(1) Recent changes in the situation and operating conditions of the facilities

As described in Material No. D-135, demand from the Brunei domestic market recorded a maximum value of about 770,000 tons in 1996 and has decreased since then due to the economic stagnation in the region. Demand over the past five years has varied from 230,000 to 250,000t/y, which corresponds to about 50% of the maximum production capacity of 500,000t/y.

The quality of the cement produced by BHC is a little higher than that of regular cement due to the higher content of clinker, but BHC is not competitive because their factory is not an integrated operation provided with its own kiln, and neighboring countries charge import duties of about 5%. Therefore, it is difficult for them to export their products. In addition, inexpensive Chinese products (of uncertain quality), which are imported tax-free into Brunei, began to invade their market in July 2005. About 20,000 tons of cement has been imported from China.

(2) Status of production and unit consumption of energy

Electricity is the only energy source used, and this is purchased from the government (DES). The unit consumption of electricity in the mill is 50-56kWh/t-product. In 2005, the electricity consumption was 55.4kWh/t in January and 57.9kWh/t in November, which was a little higher than usual. These values are about 84% (on average) of the unit consumption of electrical power for the whole factory. It was explained that consumption would only be 45kWh/t if the plant had been operating at 100% of production capacity and that the inferior power consumption was due to the higher quality of the products produced and the increased loss caused by the starting and stopping brought about by the low operating ratio.

(3) Walk through energy audit of the cement factory

During the plant tour, we inspected the mill and the drive unit in the crushing plant, the raw material feeders for clinker and gypsum, the dust collectors, electric room, cement transport devices, receiving equipment for clinker and gypsum, and the storage silo, cement silo, air compressors and cement-bagging devices. The facilities were almost the same as those described in the previous report. The finishing mill, which is a major user of electricity, was not operating due to a problem that had occurred two days before. In the previous report, it was pointed out that the mill motor (made in China) could not achieve the rated crushing capacity due to the restriction placed on its use by the bearing overheating. The motor had therefore been replaced with one made in the U.S.A. Although the new motor has only the same capacity of 2,800kW, it can be used without problems because of its higher design temperature.

The only facilities operating at the time of the investigation were the cement-bagging machine and the loading machine for tank trucks. Products were being shipped in bulk using tank trucks and packed in bags. These are 50kg bags made of paper and printed with a mark indicating that the product conforms to BS certification. The overall impression gained was that the workplaces were disorganized.

The factory had received ISO9001 and ISO14001 certification since the previous energy audit. The following comments are based on those issues discussed during and after the walk through energy audit.

(4) Power receiving and distribution system.

Electricity is received at 11kV and reduced to a high voltage of 6.6kV by a 7,500kVA transformer. Motors (2,800kW) for the mill and fans (355kW) for conveyors are operated with this voltage. A phase advance capacitor of 1,200kvar is provided for the high voltage line. However, since costs are not charged to the power factor in this country, the only advantage gained is loss reduction at the main transformer.

It seems to be insecure that only one receiving transformer is installed. Since the factory only operates at 50% of full capacity, and from the viewpoint of energy conservation, it would be better to use two transformers of about 3,000kVA each.

Electricity at a low voltage of 380V is obtained from the 6.6kV supply using a 1000kVA transformer. A phase advance capacitor is also provided for the low voltage line to reduce the loss in the distribution system.

We commented on these matters as follows:

1) Problems relating to the present power receiving and distributing system

The data for 2005 show that 84% (= 11,956MWh/14,151MWh) of the total power consumption is high voltage power for the mill. The operating ratio of the mill is only about 50% (47% by calculation) due to the reduced production level. Figure V-2-1 shows a schematic diagram of the existing power receiving and distribution system.

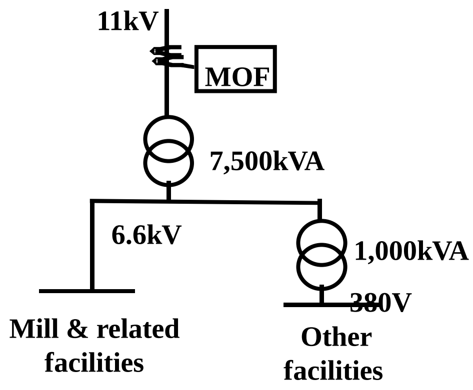


Figure V-2-1 General connection diagram for the power receiving and distributing system

The demand factor (= maximum power demand/facility capacity) of the receiving transformer is 47% (= 3,500kVA/7,500kVA) when the mill is operating but only 4% (= 300kVA/7,500kVA) when the mill is idle. Therefore, the amount of electric power required for the mill is assumed to be 3,200kW, and the amount of power and the power factor of the other facilities are assumed to be 300kW and 100%, respectively.

2) Remedial plan

The following procedure is recommended to reduce the loss from the 7,500kVA transformer in the low-demand period.

Use the 7,500kVA transformer only for the mill and parallel off when it is not operated. This eliminates the loss from the 7,500kVA transformer during the low-demand period. Install a 750kVA transformer for the other facilities. The transformer can be connected to the 11kV power source separately. Figure V-2-2 shows the connection diagram for the remedial plan.

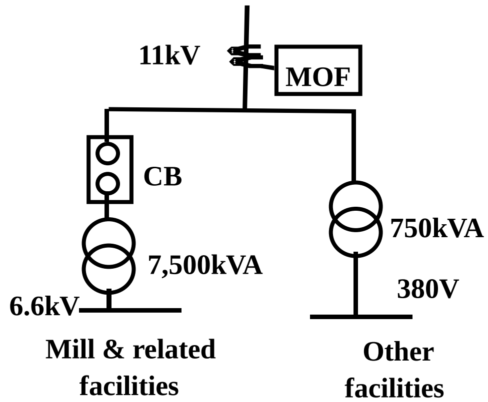


Figure V-2-2 Power receiving and distributing connection diagram for the remedial plan

3) Estimation of benefits

Assuming that the demand for mill-related power is 3,200kW, and it is operating 50% of the time, while the other facilities use 300kW constantly throughout the day with a power factor of 100%, then the benefits can be estimated as shown below. (The values shown in Table

V-2-2 are used for the no-load loss and load loss of the transformers).

Table V-2-2 Loss characteristics of transformers used for receiving and transforming power

Transformer Capacity	No-load Loss (kW)	Load Loss (kW)
7,500kVA	14.5	60.6
1,000kVA	1.88	11.89
750kVA	1.44	9.52

The transformer loss per day is found by calculating the load loss and no-load loss, as follows:

- Transformer loss in the present arrangement

7,500kVA transformer: 14.5kW × 24h/d + 60.6 kW × $(3,500/7,500)^2$ × 12h/d + 60.6 kW × $(300/7,500)^2$ × 12h/d = 507.5kWh/d

1,000kVA transformer: 1.88kW × 24h/d + 11.89kW × $(300/1,000)^2$ × 24h/d = 70.7kWh/d

- Transformer loss in the improved arrangement

7,500kVA transformer: 14.5kW × 12h/d + 60.6 kW × $(3,200/7,500)^2$ × 12h/d = 306.4kWh/d

750kVA transformer: 1.44kW × 24h/d + 9.52kW × $(300/750)^2$ × 24h = 71.1kWh/d

Thus, the following energy conservation benefits are obtained:

(507.5+70.7)kWh/d - (306.4+71.1)kWh/d = 200.8kWh/d (= 73MWh/y).

Assuming that the power consumption in 2005 is 15,437MWh (=14,151MWh × 12/11), then the improvement ratio is:

73MWh/15,437MWh = 0.0047 (= 0.47%).

In this plan, while the 7,500kVA transformer requires only a change of connection, the 750kVA transformer must be newly installed. Since the improvement ratio is not very high, this plan should be implemented in the future on a suitable occasion unless low voltage power receiving is possible.

(5) Air compressors

Two screw type compressors of 200hp (= 149kW) are currently installed. When we visited the factory, one of them was still operating even though the factory was almost at a halt. It was explained that discharge pressure was controlled between 105 and 90psi by capacity control and that the pressure was about 103psi. Load/unload action was not observed. However, the pressure was reduced to about 90psi when the regenerative cooler was operated in the regenerative mode. (Note: 100psi = 0.689MPa)

A receiver tank is provided for each air compressor, next to the cooler, from which the air is supplied throughout the plant. Although a pressure gauge was provided at each receiver tank, it was hard to read the gauge because cement powder covered the surface of the gauge. One of the facilities making use of the air was the packing equipment, and the pressure for this equipment was kept stable at 0.6MPa. However, it seemed that pressure control was insufficient because a rubber tube of about 10mm diameter, probably used for cleaning, was attached directly to the piping system.

We asked whether the regenerative cooler was really necessary for the cement factory. Their reply was that it was necessary because problems had resulted when they had carried out experiments at high dew points. They also said that the pressure could not be reduced. There must be problems involving the capacity of the air compressors.

1) Discharge pressure and power consumption of the compressors

Compressed air supplied to the plant is dried first in adsorbent type dryers. On the day we visited, one dryer was operating and another was on standby. The discharge pressure of 0.7MPa seems to be too high.

Table V-2-3 shows the effect on energy conservation resulting from a reduction in discharge pressure from the present 0.7MPa standard.

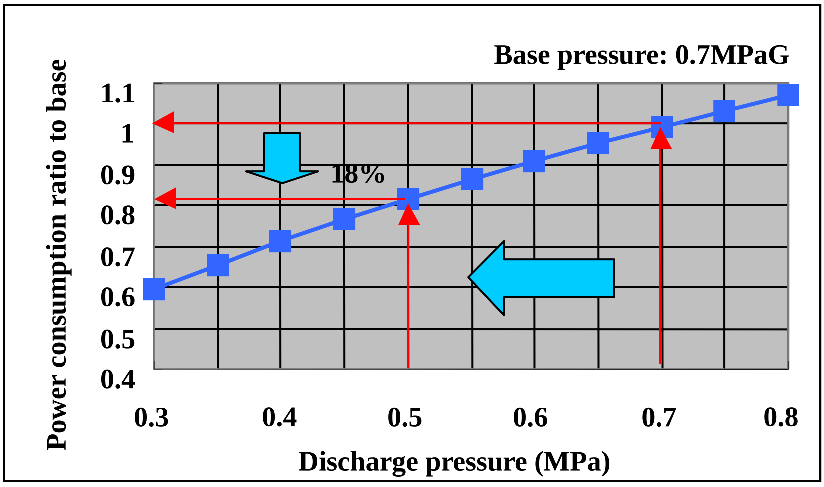


Figure V-2-3 Relationship between discharge pressure and power consumption

Reducing the discharge pressure from 0.7MPa to 0.6MPa saves about 10% of power and about 18% by reducing it to 0.5MPa. After studying the pressure needed for each load facility, it is therefore recommended that the discharge pressure be reduced.

Possible measures for reducing the pressure are:

Low-pressure load: Reducing the pressure using pressure-reducing valves

High-pressure load: Increasing the pressure using a booster

The air blow pressure for cleaning can be reduced to about 0.3MPa.

2) Pressure and air leakage

The compressed air generated by the air compressors is supplied to all facilities through pipelines, during which some pressure and flow volume are lost, as shown in Figure V-2-4.

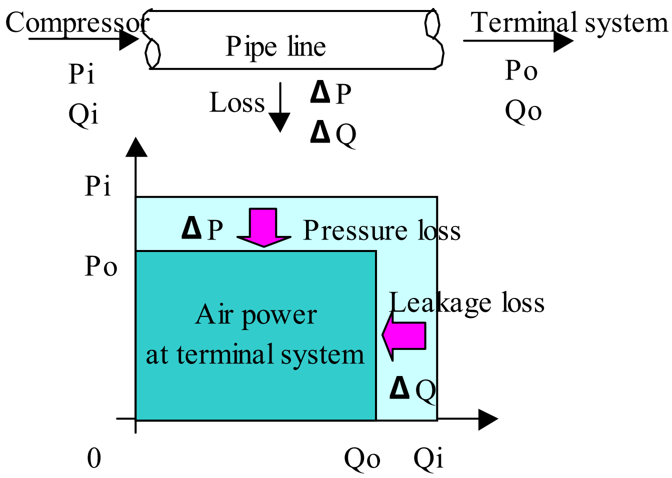


Figure V-2-4 Pressure loss and air leakage

In the figure, ΔP is the loss generated by friction, the curvature of the pipe, and expansion and reduction of the pipe, while ΔQ is the leakage from the pipeline. The former problem is set based on the balance with the piping cost and the latter can be controlled, aiming at zero leakage.

3) Flow control and air leakage control

The factory air compressor system is centralized. While such a system has advantages in ensuring the effective utilization of facilities and centralized control, air leakage and pressure loss due to the long pipelines and an imbalance between supply and demand are apt to occur. Therefore, careful control is required for effective operation.

Since little air is consumed when the plant is not in operation, this is an opportunity to install flow meters to control the airflow and implement periodic air leakage checks.

Generally speaking, leakage of 3 to 5% occurs even in newly installed pipelines and increases over time, up to 10% or even 35%. Air leakage occurs mainly at the following points:

- Piping joints: due to the corrosion of flanges, creation of gaps between flanges, and the loosening of bolts,
- Seals: elastic seals (rubber), and metal seals.

The amount of leakage can be checked by operating the compressors when the plant is not in operation, as shown in Figure V-2-5.

After completely closing the ends of all pipelines, operate the compressor until the pressure reaches the specified value. Then stop the compressor. The discharge pressure will change as shown in Figure V-2-5, where P1 is the working pressure. Usually, P1-P2 is set at 0.05 to 0.1MPa.

Estimation of the Air leakage
L: Air leakage (%)

$$L = \frac{t1}{t1+t2} \times 100\ (\%)$$

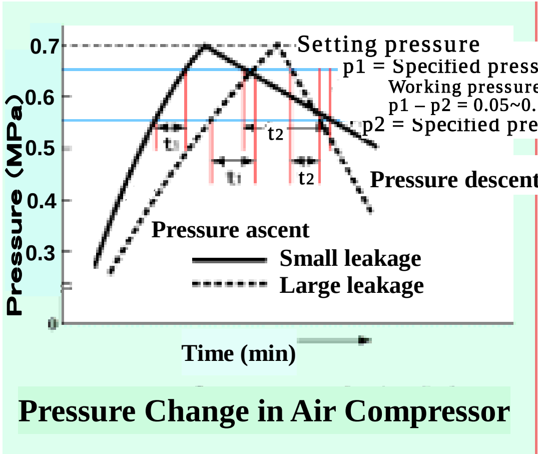


Figure Ⅴ-2-5 Air leakage check

4) Dryer

Adsorbent type dryers (heatless dryers) have been installed. Adsorbent type dryers can, by adjusting the amount of purge, be used in electronics plants producing electronic parts and the like, where very low dew points are required.

Table V-2-3 shows the relationship between purge and dew point. A dew point of -19ºC can be obtained with 15% purge.

Table V-2-3 Purge ratio and dew point in heatless dryers

Dryer	Purge Ratio (%)	ADP (ºC)	PDP (ºC)	Usage
Chiller Type	0%	-17	10	
Heatless Type	15%	-40	-19	Measuring & Control
	25%	-70	-55	Electronic parts

ADP: Atmospheric Dew Point, PDP: Pressure Dew Point

The dew point of the BHC factory is -8ºC, with saturated water content of 2.531g/m3.

Figure V-2-6 shows the relationship between dew point and saturated water content.

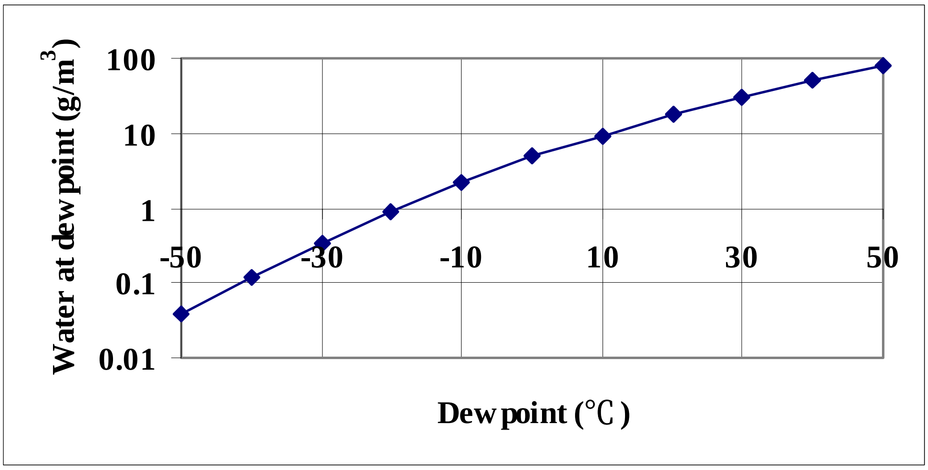


Figure V-2-6 Saturated water content and dew point

In this cement factory, there is no process in which the temperature of the compressed air pipelines drops below 0ºC. Excessive dew point setting results in the wasteful release of precious compressed air by purging. Therefore, it is recommended that a review of dew point control be undertaken, comprising the following steps:

① Confirmation of required dew points,

② Adjustment of purging volume (purging time)

③ Studying the possibility of using heat type dryers (chiller type), (either in changeover or in parallel use)

5) Reduction of purging volume

Figure V-2-7 is a schematic diagram showing a drying system in which the dew point is reduced using a chiller type dryer for the first stage, followed by an adsorbent type dryer.

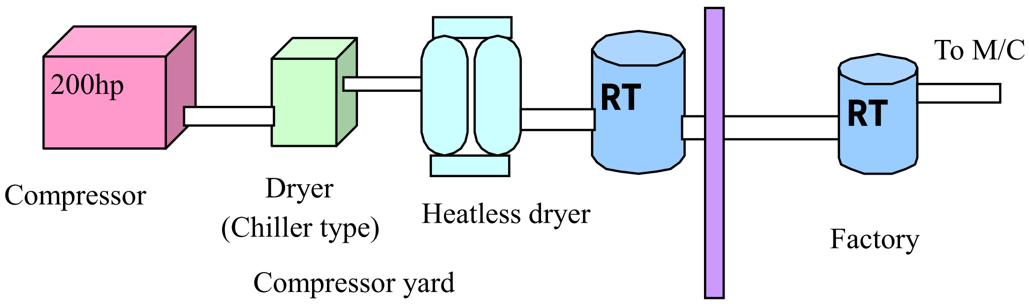


Figure V-2-7 System in which a chiller type dryer is used in the first stage

In this system, since regeneration is carried out using dry compressed air, less time is required and the purging volume of the absorber is reduced. Assuming that the present purge is 15%, the reduction in purge volume is estimated as follows.

According to the manufacturer’s catalog, the discharge volume of an air compressor of

200hp (= 149kW) is 28.5m^3/min. Thus, the amount of air used for purging is:

$28.5m^3/min \times 60min/h \times 0.15 = 256.5m^3/h$

Converting to electricity, this value corresponds to 15% of the supplied power. Assuming that the motor efficiency is 90%, the following value is obtained:

$149kW/0.9 \times 0.15 = 24.8kW$

Assuming that the temperature of the output air from the compressor is 42℃ and the air is 100% saturated with water, the amount of water contained in it is 56.5g/m^3. When the dew point of the outlet air (PDP) of the chiller type dryer is 10℃, the amount of water contained in it is 9.39g/m^3.

Since the water content of the purging air has dropped from 56.5g/m^3 to 9.39g/m^3, the efficiency of purging has been improved. The amount of reduction in the purging of the adsorbent dryer due to the installation of a preliminary dryer is proportional to the water content at the inlet. Therefore, the ratio of the reduction in purging volume is:

$1 - 9.39g/m^3/56.5g/m^3 = 0.83.$

Thus, the amount of reduction in power saving is:

$24.84kW \times 0.834 = 20.7kW.$

Subtracting the power consumption of the preliminary dryer (about 6.5kW) from 20.7kW results in energy saving of 14.2kW. The ratio of this amount to the total power consumption is 14.2kW/(149kW/0.9) = 0.0858.

This indicates that the total efficiency is improved by adding a preliminary dryer to the adsorbent type dryer.

(6) Central control room and data control

The FAS data control system has been installed, which monitors all major data collected in the factory using two CRTs. This system is made in China. Although many data printouts are produced, the data do not seem to be utilized systematically.

The data are manually recorded on daily log sheets on an hour-to-hour basis instead of being automatically recorded directly from the CRT display. These data are then manually entered into a computer in order to prepare charts for analysis. Since there are 10 personnel in the utility section for maintenance, etc., there seems to be enough labor to carry out all this manually. They therefore have no plan to computerize the data collection/calculation process.

Some old-fashioned operating systems are incompatible with other versions and this system may be one of them, making it difficult to add a data logging function. Since data collection is the basis of energy conservation activities, however, it is recommended that a computerized central data monitoring system be introduced as soon as possible.

(7) Partial load characteristics of motors and fans

1) Motors

While the load factor of an induction motor can be obtained by measuring its power consumption and comparing this with the rated value, the measurement of electric power is not always easy because the voltage and current must both be measured simultaneously. However, it can be easily judged whether the motor is oversized or not just by measuring the current. Figure V-2-8 shows the performance characteristics of a squirrel-cage induction motor (driven at 400V). These characteristics include the efficiency, power factor, and current (as a percentage of the rated value) plotted against the load factor.

The relationship between the current and the load factor indicates that the load factor is 50% when the current is 60% of the rated value. It can also be seen that the power factor decreases from 88% to 77% and that efficiency decreases from 92% to 90%. In motors that are driven at a high voltage, the load factor also decreases to about 50% when the current is 60%.

Although the decrease in efficiency is only several percent at most, even in high voltage motors, the load factor of 50% means that each motor has double the capacity needed and so the overall system is in need of improvement.

Therefore, a rough guide to judge whether the motor is oversized or not can be obtained from 60% of the rated value.

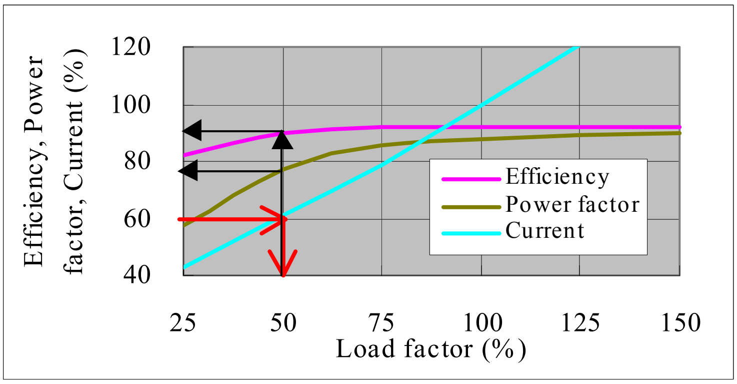


Figure V-2-8 Characteristics of squirrel-cage induction motor (driven at 400V)

2) Pumps and fans

Figure V-2-9 shows the relationship between the load factor and the efficiency of a pump and a fan. It can be seen from the figure that the efficiencies of pumps and fans are both more dependent on load factor than those of motors.

Efficiencies decrease by 10% at a load factor of 50% in both pumps and fans. The efficiency then decreases drastically at even lower load factors.

Table V-2-3 uses the current of a motor measured in the Phase 1 energy audit (February 2001) as an example. The current ratio of the separator is extremely low. Although it is necessary to confirm these measurements, if these values are correct then the capacities of the motors and fans in use need to be checked.

The use of bag filter fans must also be reviewed. When the opening of the damper is narrowed to 65%, air flow is reduced. Energy conservation may be implemented by adjusting the number of revolutions by changing the pulley ratio.

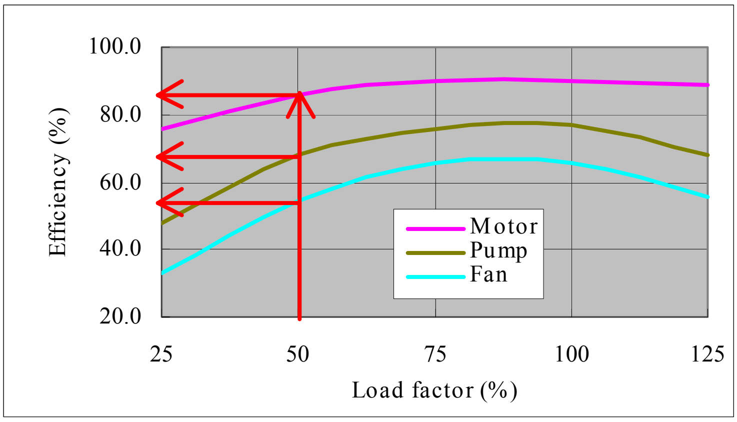


Figure V-2-9 Relationship between load factor and efficiency of a pump and a fan

Table V-2-3 Current measurements of motors

Motor	Capacity kW	Design Volt	Design Amp	Actual Amp	Actual/ Design
Mill motor	2800	6,000	300	263	0.88
Separator	90	380	152	35	0.23
Bag filter fan	400	6,000	43	29	0.68

Figure V-2-10 shows the ratio of shaft power of the motor for the damper control and rotational speed control.

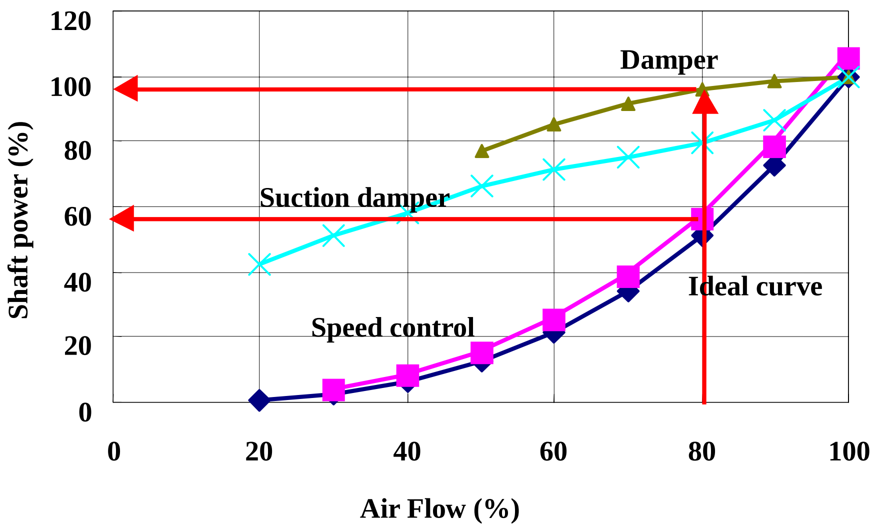


Figure V-2-10 Damper control and rotational speed control

When the airflow is reduced to 80%, energy conservation of 40% is realized by adjusting the rotational speed. Since the amount of energy conservation is approximately in proportion to the capacity of the motor, the energy conservation is 400kW × 0.40 = 160kW. Assuming the operating ratio is 50%, annual savings will be:

$$160kW \times 24h/d \times 365d/year \times 0.5 = 700{,}800kWh/y.$$

This value corresponds to 4.5% of the estimated total power consumption of 15,437MWh/y of the factory.

2.5 Status of Implementation by BHC

(1) Status of Implementation of previous advice

As described in the attached written reply to the questions submitted, there are many items that have not yet been implemented. This is probably because the factory is too busy with day-to-day activities to address the other critical conditions affecting the company, as described earlier, and because the EC investments cannot be easily recouped at the present low operating ratio.

1) Updating, maintenance and control of sensors and meters・・・implemented.
The company has obtained BS, ISO9001, and ISO14001 certification, and it was explained that these items have been implemented as a matter of course.

2) Utilization of the dust collecting gas as secondary air for O-SEPA・・・not yet implemented.
This item has not been implemented in case this results in deterioration in product quality.

3) Changing the method of cement transport・・・not yet implemented.
The company agrees with the basic idea, but the investment cannot be recouped at the present low operating ratio.

4) Preparation of manuals and check sheets for periodic maintenance・・・implemented.
The SOP (Standard Operating Procedures), mentioned below, includes all the items relating to factory operations, including the preparation of manuals and check sheets.

5) Prevention of any further breakage of the clinker shoot and gas duct・・・not implemented.
BHC did not understand the previous advice given on this topic (the previous report written in English had not been delivered to BHC) so ECCJ explained it again. Mr. Widjaja replied positively saying, “The idea is interesting, but there are some other possible methods such as changing the materials used to castable refractory or stainless steel, so further studies will be carried out first”.

6) Division of the air layer of the air slide・・・not yet implemented.
The situation here was as described above for the preceding item, and ECCJ explained the process again.
The basic idea here is to continue the operation for the time being, even if about 50% of the canvas is broken, and not stop the operation for repairs under the present low operating ratio of only about 50%.

(2) BHC's original improvements

As described in the explanatory material (attached PPT Material) and the written reply to the questions, the following items have either been implemented or planned:

1) Improvement of the power factor by introducing a Reactivated Capacitor Bank・・・ implemented.

2) Use of a Grinding Aid (an aqueous solution of chemicals that functions as an antiadhesive agent. This solution prevents the pulverized powder from adhering to the milling balls) ・・・ at the planning stage.

3) Introduction and establishment of SOP・・・implemented.

4) Reducing the clinker receiving time from 7 days to 4 days・・・implemented.

This contributes not only to a reduction in the power consumption of the receiving operation but also to the prevention of demurrage payments.

5) Timers added to the lighting equipment to save the outdoor illumination during daytime・・・ implemented.

6) Since two of the three pier hoppers were not provided with bag filters, these were added to both hoppers.・・・implemented.

(This item is not for energy conservation but for environmental improvement.)

In addition, changing the present mill to a more energy-efficient type is under consideration. However, profitability is doubtful under the present operating conditions.

3. Walk-through Energy Audit of the Beverage Factory of Kingston Beverage & Creamery Sdn. Bhd.

DES selected a factory that produces beverages and ice cream, owned by Kingston Beverage & Creamery Sdn. Bhd., as the second factory for energy audit. This factory is located in an industrial complex close to the center of the capital. This was the first experience by the factory of an energy audit and the management responded in a very friendly and cooperative manner.
In Brunei, there are not many factories that consume large amounts of energy, and more energy is consumed by other facilities such as night golf courses owned by hotels and resort facilities.

3.1 Outline of the Beverage Factory of Kingston Beverage & Creamery Sdn. Bhd.

(1) Outline of the visit

Company name: Kingston Beverage & Creamery Sdn. Bhd.
Time and date of visit: December 15, 2005, (Thu) 10:20 - 17:00
Location: Plot 73 & Lot 3,4,5 & 6, Beribi Industrial Complex, Jalan Gadong, Gadong BE1118
Participants from the company: Mr. Valentine Hon, general Manager
Mr. Albert K. G. Lim, Plant Manager

Surveyors:

Brunei: DES

Mr. Hj. Abd Shawal bin Yaman, Energy Division (Focal Point)
Mr. Ismail Bin Hj. Mohd Daud, Head of Unit, Safety and Environment
Mr. Hj. Shamshul Zamicse bin Hj. Sabtu
Mr. Mohad. Tazim bin Akub
Mr. Hj. Aziz bin Hj. Ali

Japan: International Engineering Department, ECCJ

Messrs. Fumio Ogawa, Hisashi Amano and Hideyuki Tanaka, Technical Experts

(2) Outline of the factory

The company was established in 1976, and the factory we visited was built in the industrial complex in 1994. Beverages (mainly “Pepsi Cola”) and ice-cream are produced by 150 employees.
Beverages are canned or bottled, and 1,000 cartons of each are produced and delivered monthly. In the busy season, after the month of Ramadan, the factory is operated 24 hours a day with a three-shift system, but for the rest of the year the factory is only operated for half a day. (A carton contains 50 to 60 cans of about 250cc or 12 plastic bottles of 1.5L.)

(3) Production process and facilities

There are four production lines. Two lines are for blending and bottling “Pepsi Cola”, one line is for ice-cream production, and one line is for molding plastic bottles. Most parts of these lines are automated by electrically operated devices. Part of the cartoning operation is the only process carried out manually.

Energy consuming facilities (except in the beverage bottling process) are as follows:

Boiler:	Diesel oil-fired smoke tube boiler: 150PSI (= 1.05MPa) × 5t/h × 1unit
Air compressors:	- General purpose centrifugal compressors: 22hp × 4units - Reciprocating type compressors for ice-cream production 1.3MPa: 20hp× 1unit and 30hp× 1unit
Ammonium compressors:	100hp × 1unit
Refrigerators:	5hp and 7.5hp, one each
Water supply pumps	Many pumps
Emergency diesel generator:	380kVA × 1 (Just enough capacity for the operation of the ice-cream process when there is a power outage. It is kept outdoors on a wheeled rack.)
Power receiving facilities:	The receiving voltage of 11kVA is transformed to 400V by a 1,000kVA transformer. A watt-hour meter (owned by the government) is provided.

(4) Consumption

Electricity and diesel oil are used as energy sources. Diesel oil is used for the boilers and transport equipment such as trucks and forklifts. A receiver tank of 40 to 50m3 is installed in the factory.

3.2 On-site Walk-through Energy Audit

(1) After listening to the outline of the factory, we surveyed the production lines for beverages and ice-cream, related utility facilities, and the plastic bottle molding machines.

As might be expected of a food manufacturer, special care is taken for hygiene in the production lines, and quality inspection is carried out frequently. Facilities related to utilities are separated in a different building from those used for food, and include city water receiving and storage facilities, boilers, diesel fuel receiving and storage facilities, refrigerator compressors, and air compressors.

Among the machines present, the 100hp ammonium compressor for the ice-cream production process uses the most energy, followed by the plastic bottle molding machine, consisting of a 50hp motor and a 2-stage molding machine. Since the voltage drop caused by reactive power was our main concern, we asked about the phase advance capacitor. However, they replied that they did not have a phase advance capacitor. They are not interested in reactive power because they don’t have a rate system for reactive power.

There seems to be a considerable amount of reactive current loss, including the outdoor electricity distribution lines. Since capacitors are relatively inexpensive, it may be an effective strategy for the government to promote improvement of the power factor at a national level. Among the various power loads, compressors are the most numerous, comprising a wide range of types and discharge pressures. Since all the compressors are of a reciprocating type, partial loads do not cause a serious problem, but energy conservation may be possible by reducing the discharge pressure.

(2) Energy conservation activities

After the plant tour, several energy conservation issues were discussed at a meeting in the conference room. During the course of the discussion, it was found that the factory did not possess fundamental data on energy consumption. The amounts and costs of electrical power are known only from the monthly bills sent by DES. In the same way, the amounts of diesel oil received are managed as a lump sum, but it is not known how much is used for boilers and transportation equipment. This shows that energy conservation activities are not really performed at all. One reason for this may be that energy costs are low in Brunei. However, we urged them to start energy conservation immediately, and explained how to promote energy conservation activities.

The first step in saving energy is to collect data on energy consumption. Since the main energy source is electricity, we explained how to collect data on electricity consumption using a watt-hour meter, which can be carried out rather easily. We also explained how to collect approximate data on power consumption in production lines and utilities using the clamp-type ammeters that they already possess. Furthermore, we explained the concept of unit consumption of energy and advised them to calculate the energy consumption per sales volume for the time being, if it is difficult to collect data on the energy consumption per production volume, and to then look at the trends.

Materials we obtained from Kingston include: “Brochure about Kingston”, “Flow Chart for the Beverage Production Process”, “Flow Chart for Ice-Cream Processing”, and “List of Participants in the Seminar Workshop (hard copy)”.

3.3 Advice and Recommendations for EE&C Activities

(1) Understanding the energy consumption status

The first step in any energy conservation activities is to understand the status of energy consumption.

Data on the amounts of electrical power, fuel, and water resources used must be made available on a daily and monthly basis. The types of data required depend on the purpose of the energy conservation activities. They may include detailed measurements collected using instruments or specific data on individual facilities.

1) Ascertaining data on electric power consumption

a. Monthly use

Monthly use can be determined from the electrical bills, but this involves a time delay. Daily consumption data are required in order to assess day-to-day activities. Daily consumption is easily measured using a watt-hour meter, but it is also possible to calculate the power consumption by reading the supply meter of the electric power company if a dedicated watt-hour meter is not available.

A simple method is to read the watt-hour meter at a specific time every day then compare this with the values obtained on previous days. Table V-3-1 shows an example of a record-keeping form.

Table V-3-1 Daily report for receiving power

Receiving power daily report Apr. 2005

day	Transformer #1					Transformer #2				
	Voltage V	Current A	P. Factor %	Acc. power kWh	Power kWh	Voltage V	Current A	P. Factor %	Acc. power kWh	Power kWh
1(Fri)				①	=②−①				①	=②−①
2(Sat)				②	=③−②				②	=③−②
3(Sun)				③	=④−③				③	=④−③
4(Mon)				④	=⑤−④				④	=⑤−④

b. Daily load chart

A daily load chart is prepared to help determine hourly electric power consumption on a daily basis.

This chart can be obtained using the same principle described above. Read the watt-hour meter every hour, calculate the difference from the previous hour, and then draw a daily load chart by plotting the differences. When the receiving board is provided with a voltmeter, ammeter, and power-factor meter, electrical power can be calculated using the measurements from these instruments.

The following method is another way to determine electrical power consumption based on the rotational speed of the circular plate in the watt-hour meter. This method does not require any other measuring instruments. Figure V-3-1 shows a photograph of a supply meter and a drawing of the rotating circular plate.

① Obtaining the value of Wh/r

The circular, rotating plate with a black mark is actually a dial plate that indicates integral power consumption, and the specifications of the meter are displayed nearby. The specification “21.6Wh/r” shown (surrounded with a red circle in the above photograph), means that 21.6Wh of electricity are required for one rotation of the circular plate.

The supply meter at Kingston reads “1.5r/kWh”. In this case, use the inverse of this value (i.e. 1/1.5r/kWh = 667Wh/r).

② Measuring the rotational speed of the circular plate

To measure the rotational speed of the circular plate, utilize the black mark on the edge of the plate. The speed can be measured in many ways, but one simple method is to measure the time required for 10 rotations.

The rotational speed of the circular plate thus obtained is then designated as S [revolutions/min].

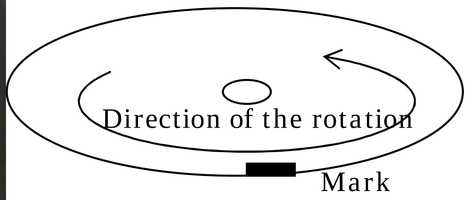


Figure V-3-1 Supply meter and circular plate

③ Calculation of the electric power

Rotational speed [revolutions/min] is then converted into revolutions per hour by 60 × S [revolutions/h]. The electric power is obtained by multiplying this value by the Wh/r value using the following equation:

60 × S [revolution/h] × electric power for a revolution (Wh/r value)

④ An example of measurement

In the case of the Kingston site, the value of Wh/r is known to be 667Wh/r (calculated from the reading displayed of "1.5r/kWh").

When the rotational speed is S = 20 [revolutions/min], the electric power P is obtained as follows:

P = 60 × 20 [revolutions/min] × 667Wh/r = 800kW

The purpose of the above explanation is to introduce a method for measuring the power used when other instruments are not available. The use of a watt-hour meter provided with a recording function enables an even more complete daily load chart to be compiled.

By drawing a graph noting the power consumption every hour, a daily load chart can be obtained, as shown in Figure V-3-2.

c. Electric power consumption by use

To get a better understanding of detailed power consumption by classifying the loads, it is convenient to divide the received power by the number of trunk lines at the electricity receiving board. Measure the current of each trunk line using a clamp ammeter and assume that the power factor is about 0.8. Then divide up the total received power in proportion to the calculated currents. This calculation includes some error due to the estimation of the power factor, but this will only deviate by 10% at most, which does not matter for the purpose of this calculation.

However, this measurement gives only those values for a given moment in time, and a watt-hour meter must be used to compare the proportion of power consumption used over periods of days or months. It is therefore recommended that a watt-hour meter be installed to implement comprehensive electric power control.

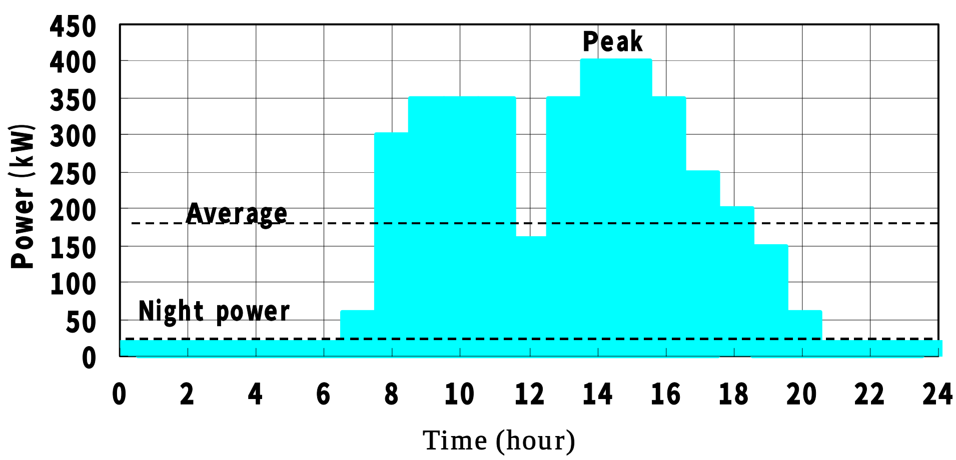


Figure V-3-2 Daily load chart

2) Getting a better understanding of fuel consumption

It is recommended that a flow meter be installed in the fuel pipeline for boiler fuel. Since the diesel fuel for the boilers is transported through a pipeline, a flow meter should be installed in this pipeline. It is also necessary to install a flow meter to monitor the steam supply.

(2) Analysis of data and exploitation of themes for energy conservation

Try to comprehend the pattern of energy consumption by analyzing the fluctuations in use and the correlations between the data, in order to identify both potential problems and countermeasures.

1) Analysis of the daily load chart

The daily load chart is analyzed in order to decide how best to reduce power consumption. Reducing power consumption during the night and reducing peak power can be especially effective.

Compare the chart with the operation pattern of the factory to check whether there is waste power consumption during recess time or at night, when factory operations halt. Since power consumption during the night and on holidays is fixed, any reduction in power consumption is very effective because the loss is constantly integrated over time.

Changing the operation schedule can sometimes disperse peak power. Peak power is directly related to the electricity tariff. The same measures described for reducing power consumption during off-peak operation should be taken when the electricity rate is high.

2) Unit consumption

Unit consumption is defined as the index expressed "by dividing the energy used for production by the production volume". Unit consumption can therefore be calculated as follows:

Unit consumption = amount of energy used/production volume

Unit consumption is a useful index for evaluating the achievements of energy conservation activities, and can be used for many different purposes such as comparison with other companies and setting targets for energy conservation (for example, a 1% REDUCTION IN UNIT CONSUMPTION).

Since the unit consumption expresses the degree of energy conservation on a macroscopic level, the ratio of energy consumption to the production volume for each process can also be used to assess the degree of energy conservation at each stage of the process.

3) Converting fixed energy to variable energy

By plotting energy consumption against production volume on a graph, as shown in Figure V-3-3, energy consumption can be divided into fixed elements and variable elements.

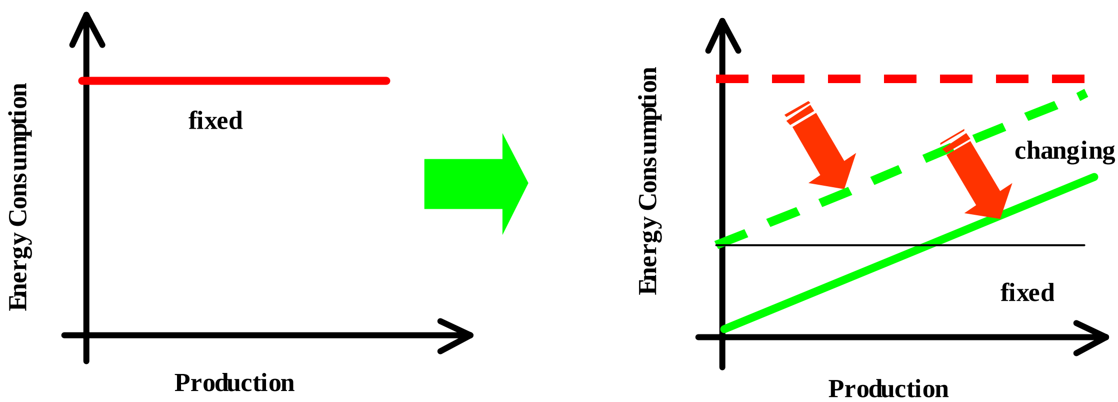


Figure V-3-3 Fixed elements and variable elements of energy consumption

In a production system where the fixed elements dominate, unit consumption drastically increases as the production decreases. One of the targets of energy conservation is therefore to convert fixed elements into variable elements. Facilities that operate regardless of production must be converted so that they operate in conjunction with production. Generally speaking, facilities for utilities are apt to contribute more to fixed elements.

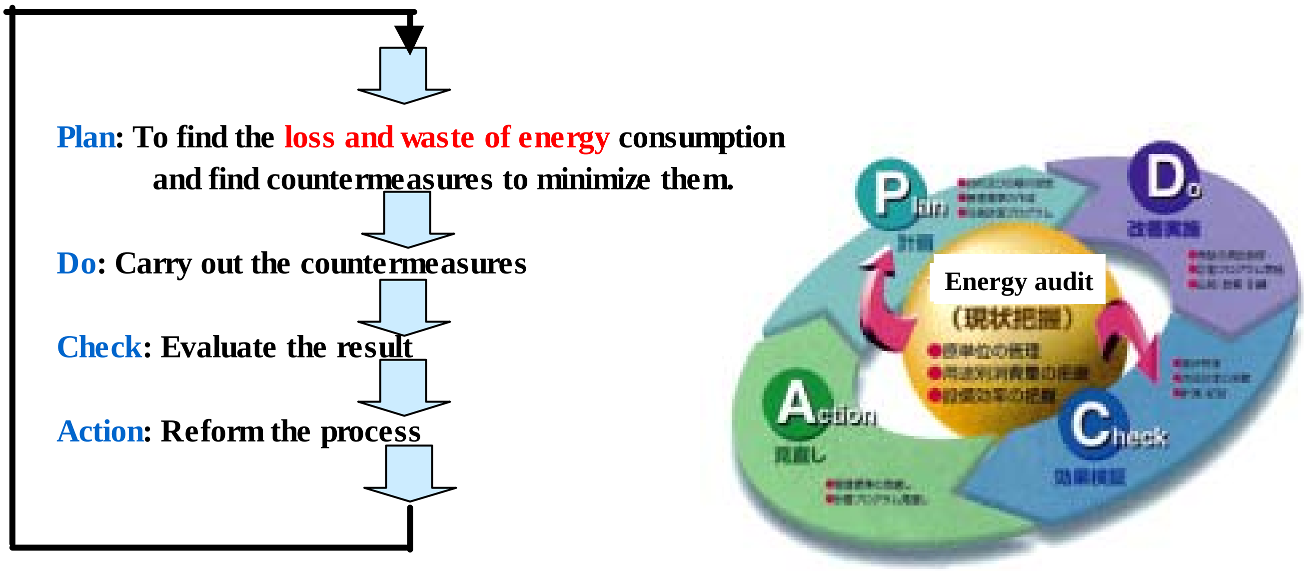
(3) Implementation of improvements

Once targets for energy conservation are set, specific measures to achieve these targets can be implemented.

The procedure for this should follow the PDCA (Plan-Do-Check-Action) cycle, as illustrated in Figure V-3-4.

What is important here is to numerically assess each achievement in the “Check” stage. Numerical expression enables the sharing of the achievements resulting in vitalization of the activities. This is the reason why numerical measurements are important in all energy conservation activities.

When the set target is achieved, the results are standardized as a work standard to ensure further improvement.



Making improvements using the PDCA cycle

Figure V-3-4 The PDCA cycle

(4) Major object facilities

1) Motors, fans, and pumps

The capacities of fans and pumps are apt to be in excess of what is actually required. In the case of a pump, for example, various allowances can be made, such as 10% for the deviation from actual conditions, 50% for leakage in the pipeline, and 10 – 15% for pump capacity. After adding up all these allowances, the load factor in the actual operation may only be 70% or thereabouts, in many cases.

Figure V-3-5 shows the relationship between the load factor and efficiency for a motor, fan, and pump.

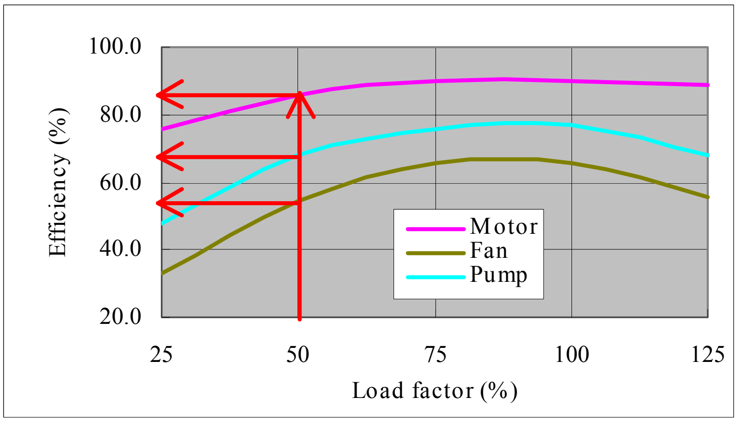


Figure V-3-5 Relationship between load factor and efficiency for a motor, fan, and pump

When the load factor is only 50%, efficiency decreases by 10% both in the pump and the fan. When the load factor decreases even further, efficiency decreases drastically. Since a load factor, 50% means that a motor capacity is more than twice as necessary used. This situation must be improved.

The easiest way to identify a facility with excessive capacity is to measure the current of the driving motor. If the current is less than 60% of the rated value, it is possible that the load factor of the pump or fan is 50% or less.

A simple method to improve the load factor is to adjust the capacity by reducing the rotational speed by changing either the pulley ratio or the gear ratio.

2) Air compressors

a. Reduction of discharge pressure

Since the number of operating compressors is controlled using a main compressor and an auxiliary, reciprocating compressor, partial load must be dealt with appropriately. To confirm this, it is recommended that the current be measured both when loaded and unloaded to check whether the capacity is adjusted properly. The control is appropriate if the current decreases to about 30% when unloaded.

In displacement compressors such as a reciprocating or screw type, decreasing the discharge pressure can reduce the shaft output of the motor.

Figure V-3-6 shows the energy conservation effect when the discharge pressure is reduced, taking the reference pressure as 0.7MPa. (Same Figure V-2-3)

When the discharge pressure is reduced from 0.7MPa to 0.6MPa, the results in power saving is 10% and about 18% when the pressure is reduced to 0.5MPa. Therefore, reducing the discharge pressure to the value actually required by the load facility should save the energy.

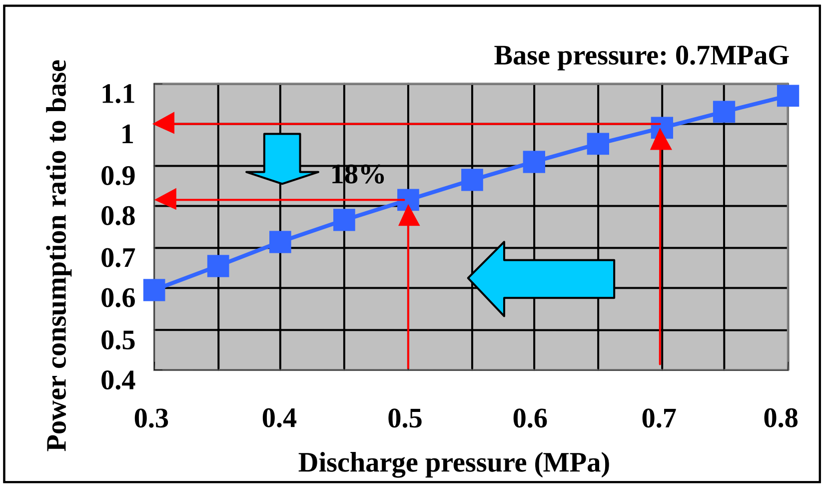


Figure V-3-6 Relationship between discharge pressure and power consumption

b. Dew point control and leakage control

Since there are many low-temperature workshops in the Kingston factory, compressed air must be dried properly before use. Water condenses at temperatures lower than the dew point, causing the lowering of partial pressure of the compressed air and leakages due to the corrosion of the pipelines.

It is said that even in newly installed pipelines 3 to 5% of the air leaks out, and that leaks will exceed 10% with age, eventually reaching 35% or more. Major sites of leakage are:

・Joints of piping: corrosion of flanges, creation of gaps between flanges, loosening of bolts,

・Seals: elastic seals (rubber), and metal seals.

In the case of reciprocating compressors, since the pressure is not constant, air leakage must be checked by operating the compressors when the operations of the factory have been suspended. Air leakage is expressed by the load/unload ratio (Figure V-3-7).

Air leakage is estimated as follows:

L = t1/(t1+t2) × 100[%].

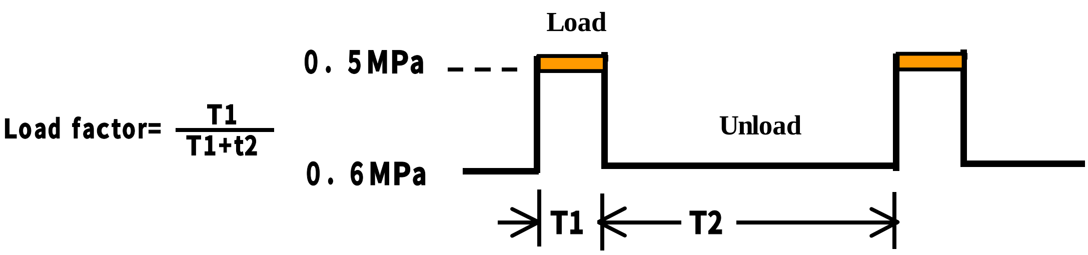


Figure V-3-7 Air leakage check

c. Boiler and steam system

For liquid fuels, the air ratio m (= amount of combustion air/amount of theoretical combustion air) should be controlled at about 1.2.

To effectively utilize the heat contained in exhaust gas, the combustion air should be preheated by the exhaust gas. The supply pressure of the steam should also be reduced in accordance with the pressure actually required.

High-temperature boiler drums, pipelines and valves should be insulated; steam leakage from the pipelines should be prevented; and the drain should be recovered for recycling and heat exchange.

In tropical regions, insulation is apt to be neglected because the ambient temperature is high, but it should be noted that even a high ambient temperature is still more than 100℃ lower than that of the steam.

(4) Installation of a watt-hour meter provided with a recording function

Although Kingston has a clam-type ammeter, to implement energy conservation on specific items of equipment, a better measuring instrument is required as a tool for the energy manager. For this reason, it is recommended that watt-hour meters provided with a recording function should be installed.

Watt-hour meters are available that enable data analysis by inputting data directly to a personal computer. These instruments are provided with various functions such as harmonic measurement and distortion factor measurement. For example, the watt-hour meter shown in Figure V-3-8 is available in Japan at a price of about ¥400,000.

Figure V-3-8 Watt-hour meter provided with a recording function

4. Seminar and Workshop

4.1 Summary

A seminar workshop was held on December 17 (Sat), 2005.

The seminar workshop started with the opening address of Mr. Pg. Zamra (DES) of Brunei who took the chair. The seminar was well attended with more than 100 people, including participants from Brunei DES and three presenters from ASEAN countries. There were many relevant questions and answers and the seminar workshop was very successful.

(1) Time and date

December 17 (Sat), 2005, 8:30: Start of registration, 17:30: Closed

(2) Venue

The Centrepoint Hotel, 6F (Purple Jade Room), BSB, Brunei Darussalam

(3) Reports presented on the Seminar and Workshop

The program of the presentation is shown in Material No. D-112.

In Session 1, a general overview of energy in ASEAN, an energy overview in Brunei, and an overview of EE&C activities in Japanese industry were presented. In Session 2, successful cases of energy conservation activities in ASEAN countries — Brunei, Indonesia, Vietnam, and Malaysia — were reported. ECCJ presented reports on behalf of the Philippines and Laos, whose representatives could not attend the seminar due to the inconvenient schedule. In Session 3, TD and DB/BM/GL were discussed.

Since Mr. Christopher Zamora of ACE was absent from the seminar, Mr. Pg. Zamra of DES took the chair. In the 5-minute question and answer session held after each presentation, the participants asked many relevant questions and productive discussions took place. Media representatives were also present at the seminar, including Media Permata (the local paper) and Borneo Bulletin (an English paper). The seminar proceedings were also televised in the evening.

(4) Participants

Brunei: DES

Mr. Hj Umar bin Hj Mohd Tahir, Head of Energy Policy & Planning

Mr. Haji Abd Shawal bin Yaman, Energy Division

Mr. Pg. Zamra (Pg. stands for Royal Family)

Mr. Ismail bin Hj. Mohd. Daud, Head of Unit, safety and Enforcement

Many other people

ACE:

Dr. Weerawat Chantanakome, Executive Director

Mr. Ivan Ismed, Project Officer

Indonesia:

Mr. Subagyo, PT Kertas Leces

Vietnam:

Mr. Tran Minh Khoa, Institute of Technology

Malaysia:

Mr. Ibrahim Hishamdin, Pusat Tenega Malaysia (PTM)

Japan: International Engineering Department, ECCJ

Messrs. Fumio Ogawa, Hisashi Amano and Hideyuki Tanaka, Technical Experts

More than 100 participants from Brunei attended the seminar, including DES members. Many of them represented governmental organizations, but people from the state-controlled petroleum company, Brunei Shell, and the two factories we visited were also among the attendees. We asked to see an electronic file listing the participants, but we have not received this yet.

4.2 Results of the Seminar and Workshop

(1) Opening ceremony

1) ACE

The speech given by Dr. Weerawat, Executive Director of ACE, was almost the same as that delivered in Indonesia. However, he added that he was impressed by the lush beauty of Brunei, which he was now visiting for the first time, and that energy was one of the most important topics of the recent East Asian summit meeting held in Kuala Lumpur. He further stated that his successor in ACE would be selected from Vietnam and that it would be Brunei's turn to fill the position if Vietnam was to decline.

2) ECCJ

Mr. Tanaka represented Japan (METI and ECCJ). He stated the significance, history, and recent background of this project and outlined the Japanese cooperation and contribution to ASEAN.

3) DES

The Honorable Hj. Umar bin Hj. Mohd Tahir greeted all those present. He outlined the energy conservation policies of the government of Brunei, introduced recent activities such as the PROMEEC (industry) audit, and then declared the seminar open. He attended the workshop for the whole day, listening carefully to the discussions and, at the end of the seminar, handed a diploma to the participants and shook their hands. He also participated in the question and answer session.

(2) Session 1: Policies and initiatives on EE&C

1) Overview of ASEAN Plans and Programs on EE&C (Dr. Weerawat, ACE)

The same material used in Indonesia was presented again, although emphasis was placed on the portion most relevant to Brunei. (Material No. D-127, the same as that used in Indonesia).

2) Energy Overview in Brunei Darussalam (Mr. Yaman, DES) (Material No. D-134)

Production of petroleum and natural gas, power generation facilities, the use of energy by industry, changes in the demand and supply of energy in the past, policies on energy use (petroleum and electric power), and policies on energy conservation in Brunei were all explained.

3) Initiatives and Programs of ECCJ on EE&C in Industry in Japan (Mr. Tanaka, ECCJ) (Material No. D-128)

Immediately before the presentation, the chairman, Mr. Zamra, stated that although he had understood the significance and aims of energy conservation, how should energy conservation actually be implemented? Technical Expert Tanaka replied that it would be helpful to refer to Japanese cases, and he then started his presentation. As a result, the attendees listened to Mr. Tanaka's explanation very carefully. He described such topics as harmonization of the "3 E's", methods of energy conservation, designated factories, qualified energy managers, and the national convention of energy conservation.

(3) Session 2: Reports on successful cases of EE&C in industry

1) Cement industry, Brunei – Mr. Widjaja (Material No. D-135)

The factory manager, Mr. Widjaja of Butra Heidelberg Cement (which the energy conservation follow-up investigation team had visited), reported on energy conservation activities. He explained key points clearly. Taking the opportunity, he also requested that the government restrict the import of cement for the time being.

2) Pulp and paper industry, Indonesia – Mr. Subagyo (Material No. D-129)

PT Kertas Leces (which the investigation team visited in Indonesia) presented the same report made in Indonesia.

3) Ceramics and chinaware industry, Vietnam - Mr. Khoa (Material No. D-136)

Mr. Khoa acted as a last-minute replacement for Mr. Phon. His report was on the energy conservation activities of HAPOCO, which the investigation team visited in 2004, and another company (Mailam Ceramic).

4) Glass industry and textile industry, Malaysia – Mr. Hishamdin (Material No. D-131)

PTM presented the same report made in Indonesia.

5) Steel industry (Philippines) and hydroelectric power generation (Laos) (part of Material No. D-130 and No. D-137)

Mr. Tanaka and Mr. Ogawa of ECCJ reported in place of the scheduled presenter. Because the presenter from the Philippines could not attend due to a flight cancellation, two Technical Experts from ECCJ reported in place of the scheduled presenter. Since neither of these industries actually exists in Brunei, only the general principles were reported, and Tanaka gave a lecture relating to methods for promoting energy conservation in general.

(4) Session 3: The Way Forward

1) Barriers and Measures to implement EE&C –Mr. Ogawa

He used Material No. D-117 and referred to the presentations from Session 2.

2) Technical Directory – Mr. Amano (Material No. D-138)

As in the Workshop held in Indonesia, Amano explained the purpose of TD sheets, how to prepare them, and the format to be used, showing actual examples. In addition, Mr. Ivan explained actual examples of TD sheet use. Furthermore, Dr. Weerawat urged people from Brunei to prepare TD sheets for themselves.

3) Database/Benchmark/Guideline for Industry - Mr. Ogawa

He based his presentation on Material No. D-119, as used in Indonesia.

In the middle of the presentation, an engineer from Brunei Shell asked many questions. "What is the advantage of developing this database? Are there any political motives? Isn't it better to collect data on the whole energy chain from the start of supply through to final consumption? Isn't it difficult to compare different countries because subsidy conditions are different?" While Ogawa was replying, Mr. Yaman said, "As I recall, an APEC database is being developed separately, and it is difficult to coordinate different countries with different conditions. For example, it is sometimes difficult even to standardize the energy units being used". These, and other such matters, were then discussed.

There was also a supplemental question concerning the development of the database being undertaken and the agreement among the governments of ASEAN countries. Eventually time ran out, however, and Mr. Weerawat wound up the discussion with the comment, "This matter cannot be brought forward if even a single country is against it. We must have exhaustive discussions to gain a consensus among all members."

(5) Questions and answers

As described above, a Q&A session was held and there were many relevant questions. The following are some examples:

Q: Is there any incentive for a factory to have an energy audit carried out?

A: You pay less energy bills. That's it. (Mr. Yaman)

Q: What are the penalties for violation of the energy conservation laws in Japan?

A: Fines are charged. However, Japanese companies abide by the laws because they value their reputation.

(6) Closing address

The seminar was closed by the closing address of Dr. Weerawat and Mr. Tanaka.

VI. Activities and Efforts as ASEAN

1. Outline of Summary Workshop and Post-Workshop Discussions

Summary workshop and post-workshop discussions on three project areas shared by all participating ASEAN countries -- promotion of energy conservation in major industries and buildings, and the development of a common basis for energy management -- were held in Bandung, Indonesia. These workshops were attended by the representatives of the seven ASEAN countries and the representatives of the ASEAN Center for Energy (ACE) and the Energy Conservation Center, Japan (ECCJ), in order to assess the results and achievements of each project carried out this year and to confirm the activities to be carried out in coming years. In the summary workshop, the year's activities for each of the three project areas -- promotion of energy conservation in major industries and buildings, and the development of a common basis for energy management -- were reported by Japanese representatives. All participants then discussed the assessment of the achievements and problems to be resolved.

1.1 Period of Summary Workshop and Post-Workshop Discussions

26 (Thu) – 27 (Fri.) January 2006

1.2 Location of Summary Workshop and Post-Workshop Discussions

Grand Preanger Hotel (Bandung), JL Asia Africa 81 P.O. Box 1220, Bandung, West Java, Indonesia

1.3 Participants in the Summary Workshop and Post-Workshop Discussions

Focal Points (FPs) from 10 ASEAN countries were supposed to attend the seminar. However, thirteen people from seven ASEAN countries, five from ACE, and four from ECCJ, totaling 22 people, actually attended. The names of the participants are listed below. Delegates from Myanmar, Singapore, and Vietnam were absent because the holidays of the Lunar New Year had already started.

Indonesia (7 persons)

Ms. Maryam Ayuni:	Head of Energy Conservation Div., MEMR
Ms. Endang Lestali:	Coordinator, Energy Conservation and Environmental Research Program, Center for R & D on Energy and Electricity Technology, MEMR
Ms. Devi Laksmi:	Staff of Energy Conservation Div., MEMR
Dr. Nugroho Sulami:	Department of Engineering Physics, Institute Technology Bandung
Ms. Sutji Rahayu:	Tariff Expert, Marketing Div., Indonesia Electricity Corporation (PT PLN (Persero)), Observer
Dr. Ir. Widodo W. Purwanto:	Head of Clean Energy & Products Research Group, Universitas Indonesia, as an observer

Mr. Pramdi B. Pradja PT KONEBA, Observer

Brunei Darussalam (1 person)

Mr. Haji Abd Shawal bin Yaman: Head of Energy Div., DES

Cambodia (1 person)

Mr. Lieng Vuthy: Deputy Director, Dept. of Energy Technique, MIME

Lao PDR (1 person)

Mr. Khamso Kouphskham: Deputy Chief of EMD, Ministry of Industry and Handcrafts, Dept. of Electricity, Elect. Manage. Div. (EMD)

Malaysia (1 person)

Mr. Ahmad Zairin Ismail: Deputy Director, Energy Industry & Sustainable Development Div., PTM

Philippines (1 person)

Mr. Marlon R. Domingo: Senior Science Research Specialist, Energy Efficiency Div., Energy Utilization Management Bureau, DOE

Thailand (1 person)

Dr. Prasert Sinsukprasart: Department of Alternative Energy Development and Efficiency (DEDE)

ACE (5 persons)

Dr. Weerawat Chantanakome: Executive Director

Mr. Christopher Zamora: Administration and Finance Manger

Ms. Maureen C. Balamiento: Database and IT Specialist

Mr. Ivan Ismed: Project Officer

Mr. Junianto M.: IT Staff

ECCJ (4 persons)

Mr. Tsuzuru Nuibe: Senior General Manager

Mr. Kazuhiko Yoshida: General Manager

Mr. Yoshitaka Ushio: General Manager

Mr. Hideyuki Tanaka: Technical Expert

2. Summary Workshop related Major Industries

For the outline of the achievements of the project, related to major industries, Dr. Prasert took the chair of the meeting, which proceeded according to the workshop agenda (Material No. D-201).

2.1 Activities for Major Industries in Four Countries in FY2005.

In the Phase 1 activities, energy conservation audit were carried out for 10 ASEAN countries by ACE-ECCJ. In the second year (Phase 2) activities, follow-up energy conservation audit were carried out on major industries in the four countries described below. Furthermore, in the course of Phase 2 activities, some factories were newly surveyed in order to check on the dissemination of the energy audit and guidance provided in Phase 1. In addition, a seminar workshop was held in each country. In the summary workshop, an outline of the activities in all these four countries was presented. (Material No. D-202E)

Countries visited in the second year (Phase 2) activities and periods of activities.

Cambodia	22 to 26 August, 2005
Philippines	29 August to 2 September 2005
Indonesia	5 to 12 December, 2005
Brunei Darussalam	14 to 17 December, 2005

Table VI-2-1 shows an overview of the activities in each country.

Table VI-2-1 Overview of Phase 2 Activities in 2005

Items / Country / Time		Brunei Dec. 13〜17	Cambodia Aug. 22〜26	Indonesia DEC. 5〜12	Philippines Aug. 29〜Sep.2
1. Follow-up / Energy Audit		Cement & Food Processing Factories	3 Garment Factories	Pulp/Paper and Textile Factories	2 Rolling Mill Factories
2. Seminar-Workshop	1) EE&C Policy	Brunei - MOE ACE / ECCJ	Cambodia-MIME	ACE ECCJ	Philippines - DOE ECCJ
2) EE&C Activities	Cement (Brunei)	Brunei - BHC			
	Ceramics (Vietnam)	Vietnam - MOI	Vietnam - MOI		Vietnam - MOI
	Chemical (Caustic Soda) (Thailand)				Philippines - R.I. Chemicals Co.
	Garment (Cambodia)		F-up: MIME/ECCJ		
	Food (Singapore)				Malaysia - PTM Philippines- URC
	Iron/Steel (Philippines)	(ECCJ)		Philippines - DOE	F-up: DOE/ECCJ Malaysia - PTM
	Oil Refinery (Myanmar)				
	Power (Lao PDR)	(ECCJ)	Lao PDR-MIH	Lao PDR-MIH	Power - DOE
	Pulp/Paper (Indonesia)	Indonesia - PT Kertas Leces	Indonesia - PT Kertas Leces	Indonesia - PT Kertas Leces	Indonesia - PT Kertas Leces
	Textile (Malaysia)	Malaysia -PTM		Malaysia -PTM	
	Other Industries	Glass-Malaysia	Glass-Malaysia	Glass - Malaysia Co-Gene & ESCO - Thailand	
3) Way Forward		1) What are the Barriers & Measures for the Implementation of EE & C [ECCJ] 2) Development of Technical Directory, DB/BM/GL for Industry [ECCJ & ACE]			

In the seminar workshop, the host country reported policies on energy conservation and the energy conservation activities carried out by the industry. Presenters from three or four ASEAN countries, listed above, attended the meeting in order to report on the status of activities for energy conservation in the major industries of their own country. When the presenters from other countries/industries could not attend the seminar in person, ECCJ representatives took their place.

There were many reports presented by various countries other than the host country, describing ceramics in Vietnam; hydroelectric power generation in Laos; the pulp and paper industry in Indonesia; glass, textiles, food, iron and steel in Malaysia; iron and steel in the Philippines; and cogeneration and ESCO in Thailand.

The following overview concerns the activities carried out in these four countries. (Refer to items II to IV for details of the activities of each country.)

(1) Activities in Brunei

During the four days of activities, a follow-up energy audit of a cement factory and a walk through energy audit of a food-processing factory were conducted. On the last day, a seminar workshop was held. More than 100 people participated in the seminar workshop, which was a proof of the profound interest in energy conservation in Brunei. Among the ASEAN countries present, Vietnam reported on activities in the ceramics industry, Indonesia reported on those in the pulp and paper industry, and Malaysia reported on those in the glass and textile industries. The question and answer session held after each report was very lively. The cement factory prepared a written reply to the questionnaire submitted by ECCJ and presented an activity report on energy conservation, demonstrating a high level of factory management. The factory manager attended the seminar workshop and reported on all these activities.

(2) Activities in Cambodia

During a weeklong visit, follow-up energy audits were carried out on two garment factories. In addition, a sister company of one of these factories, which had just started operation, also requested a walk through energy audit and Cambodian FP and ECCJ personnel visited this factory. A seminar workshop was held on the last day.

The two factories for which follow-up energy audit were carried out were very serious about the promotion of energy conservation. ECCJ had to report the results of each follow-up energy audit, and it seemed that these energy audits were well received by the industry staff.

Among the ASEAN countries participating, successful cases of energy conservation presented included the ceramics industry in Vietnam, hydroelectric power generation in Laos, the pulp and paper industry in Indonesia, and the glass industry in Malaysia. The selection of these industries was made by the Cambodian MIME, which provided suitable information for the preparation of the reports.

(3) Activities in Indonesia

A follow-up energy audit was carried out on a pulp and paper factory located in East Java. Taking travel to and from Jakarta into consideration, a six-day visit was scheduled. Another walk through energy audit was also carried out in the same region and a seminar workshop was held on the sixth day.

The staffs of the pulp and paper factory were very serious about energy conservation, and all the items for improvement recommended in Phase 1 had been implemented, wherever possible. They have reported on energy conservation activities at every PROMEEC seminar workshop, having a significant influence on the industrial world of the ASEAN countries.

Among the ASEAN countries, successful cases of energy conservation were reported by Laos, regarding hydroelectric power generation; by Malaysia, regarding the glass and textile industries; by the Philippines, regarding the iron and steel industry; and by Thailand, regarding cogeneration and the ESCO industry.

(4) Activities in the Philippines

In the Philippines, a follow-up energy audit was carried out on a steel rolling mill and a walk through energy audit was carried out on another rolling mill. A seminar workshop was held on the fifth day.

The rolling mill for the follow-up energy audit was very serious about energy conservation and keeping costs down and had organized an energy conservation team. Such activities began rather recently after one of their managers participated in a training seminar on energy conservation in Japan. ECCJ had to report the results of the follow-up energy audit.

Successful cases of energy conservation activities in ASEAN countries were reported by Malaysia on the food and steel industries; by Vietnam on the ceramics industry; and by Indonesia on the pulp and paper industry.

2.2 Status of Energy Conservation Activities in ASEAN Countries

(1) Follow-up energy audit of factories

Table VI-2-2 shows a summary of the results of activities at the factories for which an energy conservation audit was carried out in Phase 1. The results are for the factories and major industries in each of the four countries we visited this time and those we carried out follow-up energy audits on in 2004. (Additional information obtained afterwards is included in the latter). The results achieved (relating to the recommendations and advice given) are classified as either “finished,” “under study,” or “not implemented”.

With regard to the follow-up energy audits of 2005, the sum of “finished” and “studied”, (which means that at least some measures have been taken) is about 90% of the total. The remaining 10% is “under study” or “not implemented” and it is expected that some kind of measures will be taken in the near future.

Combining the results for 2004, it can be seen that 83.3% of all activities have been implemented, which surpasses the 64.5% figure for 2004. This indicates that all activities are being energetically carried out. This table also shows that energy conservation activities are especially common in the Indonesian pulp and paper factory studied. The results at the Vietnamese ceramics factory were achieved after the follow-up energy audit in 2004, which shows that the achievements there are due to the concerted efforts of the whole factory.

Table VI-2-2 Summary of EE&C Activities (Follow-up Energy Audit)

	Country	Company Name (Industry)	Item Numbers and Ratio (%)			
			Recommended by ECCJ	Finished or Studied	Under Study	Not Imp-lmented
2005	Brunei	Butra Heidelberg Cement (Cement Industry)	6	5 83%	0 0%	1 17%
	Cambodia	M&V International Mfg (Garment Industry)	3	2 67%	0 0%	1 33%
		Company A (Garment Industry)	3	2 67%	0 0%	1 33%
	Indonesia	PT KERTAS LECES (Pulp/Paper Industry)	34	28 ⇨ 34 100%	0 0%	6 ⇨ 0 0%
	Philippines	Company C (Iron/Steel Industry)	4	2 50%	1 25%	1 25%
2004 + Presentation	Vietnam	Hai Duong Porcelain Co. (Ceramics Industry)	11	2 ⇨ 10 91%	0 0%	9 ⇨ 1 9%
	Lao PDR	Num Ngum Hydropower Plant (Power Industry)	4	4 100%	0 0%	0 0%
	Malaysia	Arab-Malaysia D. B. (Textile Industry)	9	4 44%	5 56%	0 0%
	Myanmar	Mann Thanbayakan (Oil Refinery)	4	2 50%	2 50%	0 0%
		Total 2004 only	78 62	65 (83.3%) 40 (64.5%)	8 (10.3%) 7 (11.3%)	5 (6.4%) 15 (24.2%)

(2) Energy conservation activities at the newly visited factories

Four new factories were visited in 2005, one in each of the four countries. Details are as described above in the introductory paragraph supplied for each country. Three of the four factories had just started energy management. The other factory had previous experience of energy audit and the factory manager had taken a training course on energy management in Japan. Therefore, the level of energy conservation activities at this factory was comparable to that of the factories that had participated in Phase 1 of the PROMEEC program.

Due to the recent steep rise in energy prices, all the factories were eager to take some measures for energy conservation, and this probably contributed to the welcome extended to the investigation team. It is hoped that the information obtained from the on-site energy audit and guidance will be utilized for the promotion of further energy conservation.

(3) Participants in the energy audit of factories and the seminar workshop

In the PROMEEC activities of 2005, government officials from member countries and managers and engineers of private companies were supposed to play a proactive role in the follow-up investigation and energy audit of new factories, with the assistance of ECCJ experts, on an OJT basis. As a matter of fact, nothing happened unless ECCJ experts took the initiative themselves. OJT training had the intended result of increasing the number of participants in the energy audit of factories in 2005 from an average of 1.6 to an average of 4.2, as shown in Table VI-2-3.

On the other hand, the number of attendees at the seminar workshop decreased from 71.5 to 56.5, which may have been caused by budget restrictions.

Table VI-2-3 Number of participants in the diagnoses and seminars in various countries

Item		Year	
		2004	2005
Energy audit	Number of factories	7	9
	Total number of participants	11	38
	Average number of participants/factory	1.6	4.2
Seminar workshop	Number of seminars	4	4
	Total number of participants	286	226
	Average number of participants/seminar	71.5	56.5

(4) Outline of successful cases of energy conservation reported in the seminars

Representatives from six countries reported on 14 successful cases of energy conservation. Some examples are shown in Table VI-2-4. Activities in hydroelectric power generation reported by Laos and those in the glass industry and textile industry reported by Malaysia are omitted here because they are not significantly different from those reported last year. Indonesia reported on energy conservation activities in the pulp and paper industry, but these are also omitted because they appear elsewhere in the description of activities in Indonesia.

(5) Summary of energy conservation activities in ASEAN countries in 2005

The activities carried out in 2005 gave a strong impression that energy conservation is being actively promoted in ASEAN countries. In particular, it seems that the recent steep rise in energy prices has caused energy-poor countries to increase their efforts to promote energy conservation in order to keep costs down.

To promote energy conservation activities, recognition of their importance and clear leadership by top management is required to trigger activity in each individual factory. Once it is understood that energy conservation leads to profits for the company and that it will eventually benefit the society as a whole, energy conservation activities will be stimulated even more. It cannot be denied that barriers exist to the promotion of energy conservation in ASEAN countries, but we believe that such barriers will be overcome through the PROMEEC programs and through various kinds of training seminars for further energy conservation.

Table VI-2-4 Successful cases of energy conservation reported by ASEAN countries

Country	Industry	EE&C Activities
Malaysia	Food Industry (Edible Oil Refinery)	1. Installation of economizers on LP boilers 2. Waste heat recovery from hot water boilers 3. Process oil cooling by cold feed water 4. Condensate collection system Total fuel saving = 116,703GJ/y (=Approx. 2,920kL/y)
	Iron/Steel Industry Capacity: EAF: 700kt/y, Mill: 550kt/y	1. 2-stage recuperator (Recovery of flue gas temp.) 2. Air compressor change, from piston type to screw type: Power saving = 45% 3. VSD for rolling mill cooling water pump process Power saving = 25% compared to throttle valve Power saving = 1.7%, Fuel saving = 13.7% Total cost reduction = 3%
Philippines	Chemical Industry RI Chemical Corp.	Change the 200RT refrigeration system from a vapor compression type to a vapor absorption type, wherever there is waste heat and a need for chilled water. Effect on productivity: +3.6%
	Iron/Steel Industry (By DOE)	Introduction of outline of Philippines' steel industry and "2005 Don Emilio Abello EE Awards" [Rolling Mill Co. saved 580kL/y of fuel oil by heat recovery from the furnace, etc. and Steel sheet coating Co. saved 107kL/y of oil]
Vietnam	Porcelain Industry (By MOI)	Significant percentage improvement after 2004 follow up Similar presentation at last Summary-Workshop
	Brick Industry (By MOI)	Energy audit at brick factory: Fuel saving = 3%. Power saving = 13% by insulation strengthening, etc.
	Energy Audits at 12 industrial factories (By Institute of Energy)	Main measures identified by audit: VSD, boiler improvements, condensate collection system, maintenance method, compressed air systems, etc. Saving: Fuel = 0~38%. Power = 5~40%

(6) Barriers to Energy Conservation in Industry and Possible Countermeasures

We felt that this year's on-site survey highlighted the same barriers that existed last year. For example, lack of policies, shortage of personnel resources, low technical levels, a shortage of finance, and a lack of information were frequent topics of discussion. The attitude of top management is yet another barrier to the promotion of energy conservation. It may be true that companies with favorable business prospects make profits without promoting energy conservation, but the situation will change as energy prices continue to rise.

2.3 Outline of the Reports Presented by the Four Host Countries at Summary Post Workshop

This year's four host countries submitted reports on EE&C activities.

(1) Report of Brunei (Material No. D-203)

Since Brunei is a producer of petroleum and natural gas, energy prices are low in this country, whereas facilities for energy conservation are costly. Therefore, people are not always interested in energy conservation and it is difficult to promote energy conservation without reasonable incentives. It is therefore necessary to promote EE&C education of the general public, to prepare policies and action plans, and to discuss how best to implement them.

(2) Report of Cambodia (Material No. D-204)

To overcome the low electricity diffusion rate of 17% and high electricity prices, it is planned to triple the power supply over the next decade. The report presented was mainly concerned with PROMEEC activities in the garment industry. Further dissemination of energy conservation in this country still seems to be necessary.

Activities planned in the future are: cooperation with Thailand regarding renewable energy and energy conservation; participation in further PROMEEC activities; and the promotion of CEEP (Cambodian Energy Efficiency Project) as a local initiative.

(3) Report of Indonesia (Material No. D-205)

It was reported that six walk through energy audits and 15 detailed energy audits had been carried out for more than six types of industry. (This number includes the energy audits carried out in the present PROMEEC program.)

It was also reported that MEMR was developing an energy conservation database (DB) and an energy efficiency model (EEM), whose menu includes company profiles, facilities and power consumption, fuel consumption, energy consuming facilities, and energy conservation activities.

(4) Report of the Philippines (Material No. D-206)

The energy conservation audit for the iron and steel industry carried out as part of PROMEEC and the results of the seminar held in the Philippines were presented. The PROMEEC activities are helpful for establishing information networks among private companies, and TD and DB are useful for the EE&C of private companies. However, there are many barriers still to be overcome.

The Philippines has an award system for the Industry and Building sector and, in the Industry category, 23 companies received these awards in 2004 and 15 companies received awards in 2005.

Although energy conservation has not yet been legislated, the relevant regulations and rules were explained.

2.4 PROMEEC Activity Plan for FY2006 (Material No. D-207)

METI-ASEAN PROMEEC will be continued in 2006 with the ACE, ECCJ and FPs (Focal Points) of each country carrying out the same key roles as they did in 2005. As shown in Figure VI-2-1, on-site surveys in 2006 are scheduled for August and November, visiting two countries each month. This will include Singapore and Thailand, two countries that have not yet been involved in any energy audit. Two more countries that are actively promoting energy conservation activities and can host the survey are invited to apply. The selection will be decided at the inception workshop in 2006.

When implementing the on-site survey, those ASEAN countries involved in energy audits are obliged to select the factories to be audited, establish an energy audit team consisting of five or more members sharing the necessary roles, implement preliminary education, and prepare a written reply to the questionnaire. A week's visit is scheduled for each country and a maximum of two factories are selected for the follow-up energy audit and new energy audit. A seminar workshop is then held where the energy audit team presents the results. Also at the seminar, the host country reports on its energy conservation activities and member countries designated by the host country report on their activities. In the workshop, the preparation of Technical Directories (TD), and the formulation and status of Databases (DB), Benchmarks (BM), and Guidelines (GL) are also discussed.

A final workshop is then held after summarizing all activities carried out in 2006.

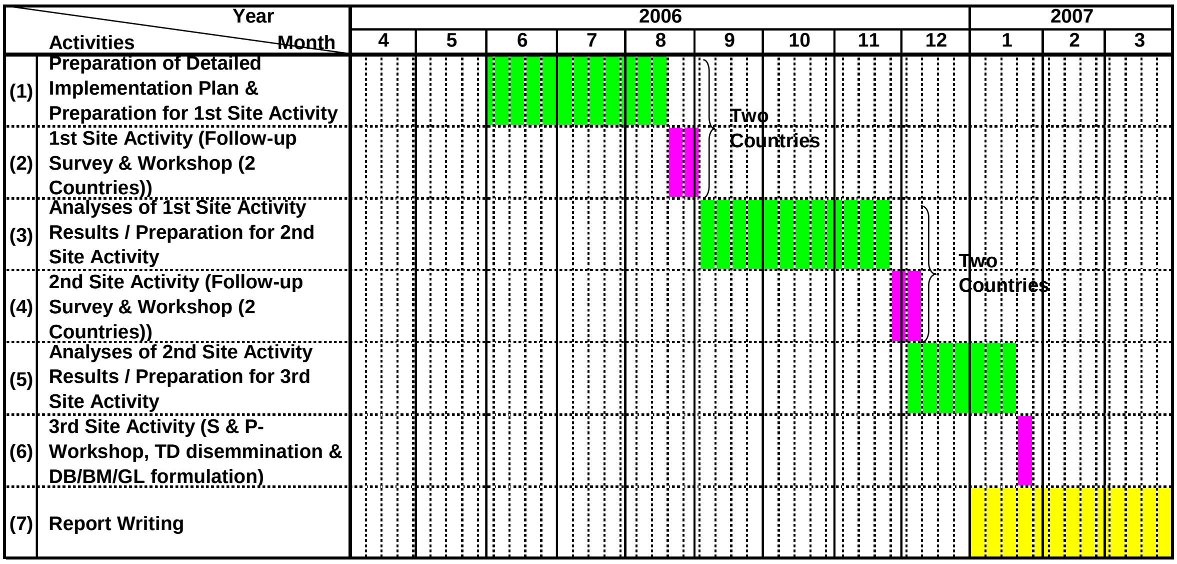


Figure VI-2-1 Implementation Schedule, PROMEEC (Industry) for 2006 - 2007

2.5 Discussion

(1) Energy conservation energy audit, aiming at OJT

1) There were no objections to the request from ECCJ that an energy audit team consisting of about five members should be established and that sufficient preparation must be undertaken. There was an opinion expressed that the required capabilities of the members must be clearly defined. It is doubtful whether competent personnel can always be found.

   Several ASEAN countries, including Brunei, Cambodia, Indonesia, Laos, and the Philippines requested that the ECCJ expert team give a detailed lecture for about several hours on the methods and techniques used by the energy audit team. It was pointed out that independent energy audit is possible for some industries but not always possible for others. ECCJ and ACE commented that those countries that are conducting an independent energy audit can make use of the energy audit team. The request for a field exercise to be held for all team members prior to any actual energy audit will be considered as required.

2) There was also recognition (from Thailand and Indonesia) that the ECCJ experts are expected

to give supervision and guidance in energy audit to local engineers.

ECCJ and ACE concluded that energy audit is a key component of energy conservation and that actual experience is important in developing energy audit techniques; that it is important to continue the energy audit activities, aiming at OJT, and differences in the level of training must be taken into consideration; and that ECCJ staff should propose the methods to be used.

(2) Importance of successful cases of energy conservation

1) It is important to highlight successful cases of energy conservation in the seminar in order to help motivate the participants. This is also an effective way to promote energy conservation and to introduce the follow-up activities planned for those factories where energy audit has already been conducted. Key points and methods of energy conservation are instrumental in bringing about improvements for all the industry. (Malaysia, Laos and Brunei)

2) Successful cases serve as useful reference points for others. Governments should therefore assist in the preparation of reports so that more cases are collected. They are also helpful for legislation. (Indonesia)

In Indonesia, it is a requirement that a report be submitted within six months of the energy audit, and some successful cases have been reported. However, it is often very difficult to have the business world understand the meaning and objectives of the energy audit and so the number of successful examples reported is still very small. From this year on, the Indonesian government will attempt to have the business world understand the objectives of the reporting process by communicating the intentions of the government through the association. At present, pilot factories have been designated in four to six industrial fields in East Java to promote energy conservation projects.

3) Problems related to the location of the factory to be diagnosed (Laos)

One energy audit was carried out in a town that took one whole day just to get to. An effective audit can be conducted even in a far away location. It depends on the situation (ACE, ECCJ).

3. Post-Workshop Discussions

3.1 TD (Technical Directory)

ACE introduced a technical directory (for the Industry and Building sector) which has been compiled from data provided by Japan but and does not include successful cases, along with a database (for the Building sector). Although the system is being formed, the contents must be enriched from now through the cooperation with the personnel of ACE.

3.2 DB/BM/GL (Databases/Benchmarks/Guidelines)

(1) Clarification of the objectives and scope of the project

A common recognition is that there is a difficult problem about establishing Databases/Benchmarks/Guidelines due to the problem of confidentiality. The purpose of this project is to systematically construct an “In-house Database/Benchmark/Guideline System” utilizing the results from the energy audit activities so that energy management can be smoothly implemented by each factory and building. Therefore, it must be emphasized that the objective is to design a standard database that can be used by all factories and buildings, and not to construct a statistical system merely as a tool for formulating policies (such as the ASEAN labeling of buildings). ACE added that although it takes time to establish, they expect to complete a system (including the industrial sector) to be completed next year, and that they will then discuss the matter further.

(2) Discussion on the establishment of a Database/Benchmark/Guideline system

1) It is important to recognize what databases (such as energy consumption, process, or facility) are to be constructed and what their objectives are. The data currently available on the internet are often meaningless. Detailed data are required. (Thailand)

2) Feasible in-house Data Management and in-house Benchmarking systems are important.
An in-house database is a collection of all the data required on site. Such databases are actually used to implement energy conservation (ECCJ). Statistical databases are quite different.
An in-house database is also a useful tool for policy making if it is used as a kind of model. (Brunei)

3) A Malaysian glass factory has succeeded in energy conservation by setting a benchmark at the request of the government. Energy conservation cannot be promoted based only on in-house data. It is important to obtain information on successful external cases. (ECCJ)

4) There are in-house benchmarking and external benchmarking systems, but it is inevitable that private companies will refuse to provide some information in order to maintain confidentiality. Therefore, it is recommended that each industrial association arrange some kind of agreed system among its member companies by which information can be exchanged. Malaysia has adopted such systems in four different industrial sectors. It is also possible to use the results of the energy conservation audit as the database. Information from three to four factories would

be adequate. (Malaysia)

5) Data from the energy audit are not sufficient to establish an entire database. It is impossible to establish a system that can be used at the factory level for all industrial sectors. Even the amount of data provided by 20 or so companies is insufficient. (Thailand)

It is definitely better to have more data but, as shown in Japan, even a small amount data can be effective. (ECCJ)

6) The discussion has been very instructive for ACE, and ACE will make use of it in their future work. ACE intends to collect further information with the cooperation of the CCI (Chamber of Commerce & Industry) of member countries. (ACE)

ASEAN countries agreed to accept the proposal of ACE.

Indonesia will cooperate in establishing databases in three industrial sectors.

The compilation of the database is certainly an important activity but it will be difficult to decide who can access it. The problem of confidentiality arises if the database is made open to the public. (Laos)

It is difficult to construct a common system for all the ASEAN members. It must be constructed on a country-by-country basis. (Thailand)

In conclusion, it was agreed that the objective of the basic policy should be to utilize the results since 2000 for the establishment of specific databases so that all members can use the data. It was also decided that the original approach we have adopted, to date, should be maintained in the future.

The year’s achievements and the results presented in the above discussions were much appreciated by all who participated. In the post-workshop session, the philosophy, basic approach and plans for the next year were unanimously agreed upon, and the basic plan proposed by Japan was adopted unanimously with the consent of all the Focal Point representatives from the member countries and ACE.

Ⅶ. Reference Material

The materials used at site activities in 4 countries and summary & post workshop regarding to the major industries are listed here.

These materials are as follows;

- Site activity schedules
- Answers to questionnaires at energy audit
- Seminar/Workshop programs
- Presentation materials at site visits from ASEAN countries, ACE and Japan
- Presentation materials at S-P workshop from ASEAN countries and Japan

The Participant Lists are omitted because ECCJ could receive this from only one country. The material numbers are shown as “Document No. D-100”, etc.

1. Materials for the energy audits and Seminar-Workshop in each country

1.1 Activity Schedules of ECCJ Technical Experts

D-101E Schedule of 1st Site Activity
D-102E Schedule of 2nd Site Activity

1.2 Answers to questionnaires at follow up and walk through energy audit

D-103E Answers from Company A, Cambodia
D-104 Answers from M&V International Manufacturing Ltd., Cambodia
D-105E Answers from Company C, Philippines
D-106 Answers from Primary Steel Corporation, Philippines
D-107 Answers from PT. Kertas Leces (Persero), Indonesia
D-108 Answers from Butra Heidelberg Cement BDN BHD, Brunei Darussalam

1.3 Seminar-Workshop Programs in 4 countries

D-109 Seminar-Workshop Program in Cambodia
D-110 Seminar-Workshop Program in Philippines
D-111 Seminar-Workshop Program in Indonesia
D-112 Seminar-Workshop Program in Brunei Darussalam

1.4 Presentation materials at Cambodia

D-113 Overview of EE&C Activities in Cambodia
D-114 Case Study, Glass Industry in Malaysia
D-115 Case Study, Pulp and Paper Industry in Indonesia
D-116 Follow Up of Energy Audit Findings at Garment Factories, Cambodia

D-117 What are the Barriers and Measures on the Implementation in Industry?
D-118 The Development of Technical Directory (1) and Sample (2)
D-119 The Development of Database/Benchmark/Guideline for Industry

1.5 Presentation materials at Philippines

D-120 EE&C Promotion Activities in the Philippines
D-121 EE&C Activities in Industries in Japan
D-122 Overview of Wholesale Electricity Spot Market, Philippines
D-123 EE&C Best Practices in Chemical Industry, Philippines
D-124 EE&C Best Practices in Iron & Steel, and Food Industry, Malaysia
D-125 EE&C Best Practices in Ceramic Industry, Vietnam
D-126 Findings of Follow Up Energy Audit at Iron and Steel Industry in the Philippines, Introduction (1) and Follow Up (2)

1.6 Presentation materials at Indonesia

D-127 Overview of EE&C Programs of ASEAN, ACE
D-128 Initiatives and Programs of ECCJ on EE&C in Industry in Japan
D-129 Case Study of Pulp and Paper, Indonesia
D-130 Case Study of Hydropower, Lao PDR
D-131 Case Study of Glass/Textile Industry, Malaysia
D-132 Case Study of Steel and Cement, Philippines
D-133 Case Study of Co-generation and ESCO, Thailand

1.7 Presentation materials at Brunei Darussalam

D-134 Energy Overview in Brunei Darussalam
D-135 Case Study of Cement Industry, Brunei Darussalam
D-136 Case Study of Ceramics/Porcelain and Brick Industry, Vietnam
D-137 Case Study of Steel and Energy Audit, ECCJ for Philippines
D-138 The Development of Technical Directory, ECCJ

2. Materials for the Summary/Post Workshop (Major Industries)

D-201 Summary Workshop Agenda (Industry Only)
D-202E Summary of Local Activities, ECCJ
D-203 Evaluation and Future Improvement of Local Activities, Brunei Darussalam
D-204 Evaluation and Future Improvement of Local Activities, Cambodia
D-205 Evaluation and Future Improvement of Local Activities, Indonesia
D-206 Evaluation and Future Improvement of Local Activities, Philippines
D-207 Proposed Plan for 2006-2007, ECCJ

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