4-6-2 Plan for Extension of Promotion of Energy Efficiency

The outline of plan for extension of the promotion of energy efficiency carried out by private entities with governmental measures is summarized.

(1) Purpose

This plan shows the improvement of mode entities on a plan - do - see cycle to achieve better use of energy along with the measures MECM, JBE&G, PTM and concerned government organizations can take at the right time.

(2) Outline of Plan

The outline of plan for nationwide energy efficiency promotion is illustrated in Figure 4-3.

(3) Schedule

Start: Year of 2000

1) First Step (2000)
   1. Identification and Selection of Model Entities
   2. Implementation of Audit
   3. Formulation of Plan based on Recommendation from Audit Results
2) Second Sep (2001-2002)
   1. Execution of the Plan at Model Entities
   2. Assessment of Results
   3. Recognition of Entities
3) Third Step (2003 and the year after)
   Nationwide Execution

(4) Important Measures for Execution of Plan

Problems and measures are listed in the column of figure. Among them, the followings are identified with the important measures for the execution of the plan.

(a) Enactment of Law and Regulation

(b) Preparation of Standards and Guidelines

(c) Preparation and Legalization of Incentives

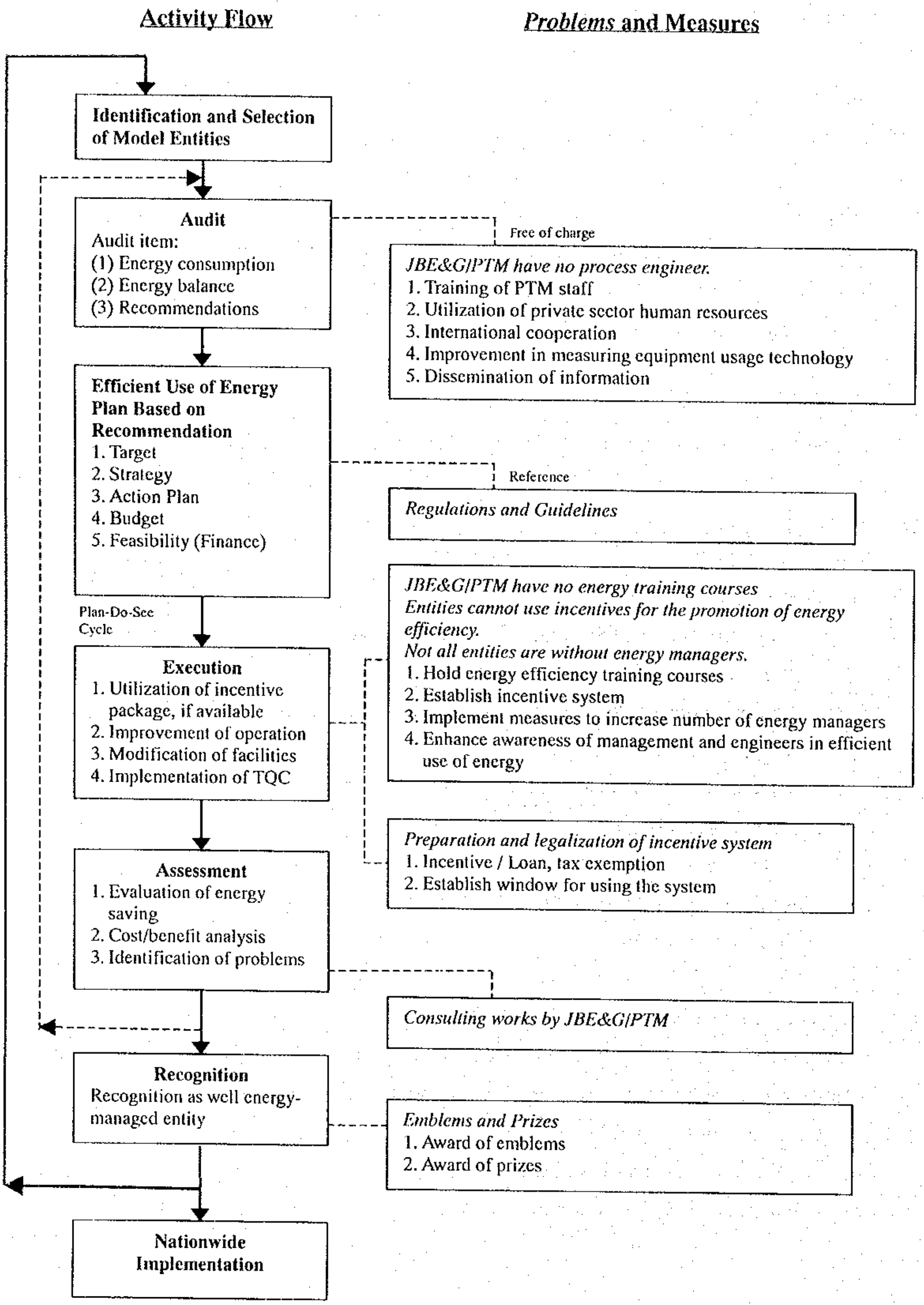


Figure 4-3 Plan for Extension of Promotion of Energy Efficiency

Chapter 5 Standards and Guidelines for Promotion of Energy Efficiency

This chapter describes standards and guidelines for the promotion of energy efficiency. The standards and guidelines of energy efficiency studied are described in Chapter 7 of the main report.

5-1 International Comparison of Energy Efficiency Standards

For proper establishment of Malaysian energy efficiency standards, the study team surveyed the situation of two developing countries, Thailand and Turkey, for reference. Table 7-1 shows the simplified result of comparison. In this table, currently proposed Malaysian Standards are also described. Japanese standards, which form the basis of this study report, and cover almost all aspects of energy efficiency in industrial and commercial sectors, are not described here.

Turkey has no energy efficiency standards for the time being. However, they are trying to establish them in near future. On the other hand, Thailand passed a law including energy efficiency standards in 1992. Compared to the proposed standards of Malaysia, Thai's standards specify the efficiency of electrical equipment. The New Building Code of Thailand also specifies only the energy efficiency of electrical equipment installed in the buildings.

The study team appreciates such trends as establishing the standards of electrical equipment as the initial step of energy efficiency promotion activities. And this could be easy to control by asking electrical equipment manufacturers, users and traders to obey the regulations. In addition, manufacture of electrical equipment is a major industrial area in Malaysia, so energy efficiency promotion of electrical equipment could render considerable impact on other industrial and commercial areas.

However, as a study in Malaysia focusing on overall energy efficiency of the commercial and industrial sectors, the energy efficiency of electrical equipment plays a rather small part of total consumption. Therefore, the present standards of Thailand, proposed standards of Malaysia and situation of Turkey could not be adopted as a model of Malaysian standards.

The capacity of Malaysia to tackle higher standards of energy efficiency is easier than these two countries, because of rapid economic growth and industrial maturity. For these reasons, it is recommended that the target of energy efficiency in Malaysia be Japan.

Table 5-1 International Comparison of Energy Standards

Categories	Items	Malaysia (Planned)	Thailand	Turkey
Commercial Sector	Air-Conditioner Lighting System Building Code		water-cooled Air Conditioner Air-cooled Air Conditioner Package Unit Window/Split Type Fluorescent Tube New Commercial Building Code Air-conditioned Efficiency Lighting Efficiency	Standards are not included in the regulations for the rational use of energy. The Turkish government, with the collaboration of the Energy Conservation Coordination Board, is planning to prepare guidelines for the rational use of energy in the following fields. 1. Improvement of fuel combustion 2. Improvement of heating, cooling, heat transfer, etc. 3. Prevention of heat loss 4. Recovery and utilization of waste heat 5. Improved conversion from heat to power 6. Prevention of electricity loss 7. Improved conversion from electricity to power
Industrial Sector	Motor System		Variable Speed System High Efficiency Motor Single-and Three-Phase Induction Motor	
Electrical Appliance	Energy-Consuming Items	Freezers Clothes Washers Lamps Transformer Thermal Storage Water Heater Television Video Monitors Vacuum Cleaners		
	Scheduled Products	Ballasts for Fluorescent Lamps Fans(Box/Ceiling/Sand/Table/Wall) Refrigerators Room Air Conditioners		

5-2 Energy Efficiency Standards

After conducting energy audits in the commercial and industrial sectors of Malaysia, it is evident that the application of current Japanese standards to the commercial sector would be rather difficult compared to the industrial sector.

The reasons for this are as follows:

(1) In the context of Japanese standards, a more in-depth investigation of the construction standards of existing buildings is necessary, since they include revision concerning heat loss, etc; (2) old buildings have old facilities of low energy efficiency, but it is rather difficult to replace such facilities with modern ones under present economic conditions; and (3) the energy price difference between Malaysia and Japan makes energy investment in Malaysia less feasible.

Though Japanese standards were established on the basis of technical and economic appropriateness and are supported by every commercial sub-sector in Japan, they could be applied as a basis for setting long-term standards for Malaysia, by making adjustments for climate and other environmental differences.

Accordingly, it seems realistic to apply Japanese standards and guidelines to Malaysia in a step-by-step manner.

The following is an outline of the plan.

(1) Target : To attain the current level of energy efficiency in Japan within ten years

(2) Periods and duration : Preceding term of 4 years and latter term of 6 years

(3) Preceding four years: Soft approach (Management, operation and maintenance)

(4) Latter six years:

- Application of current Japanese standards to new facilities
- Application of energy efficiency standards to existing facilities requiring relatively small investment
- In the case of equipment renovation, standards equivalent to those for new equipment could be applied.

On the other hand, the necessity and technological level of energy efficiency in the industrial sector seems more advanced compared to the commercial sector. And the promotion of energy efficiency in soft aspects such as management, operation and maintenance is an important management target. However, there are still old types of energy-consuming facilities whose energy efficiency is markedly different from new ones.

In terms of also strengthening the international competitiveness of Malaysian products, the application of Japanese standards and guidelines are considered to be highly significant.

In the case of the industrial sector, it is recommended that the standards portion of Japanese criteria be adopted in the preceding four years and the targeted portion in the latter six years.

	Category	Preceding 4 years	Latter 6 years
Commercial sector	New	Soft aspects (management, operation and maintenance)	Current Japanese standards
	Existing		Minimizing investment
	Renovation		Current Japanese standards
Industrial sector		Standards portion of Japanese criteria	Targeted portion of Japanese criteria

5-2-1 Commercial Sector (Preceding 4 Years)

The following three categories of standards could be easily adopted in Malaysia, because these focus on soft aspects and require nil or minimal investment. Therefore it is possible to apply them as standards of the preceding four years.

(1) Lighting intensity
(2) Room environment
(3) Electricity standards

5-2-2 Commercial Sector (Latter 6 Years)

In this section, energy efficiency criteria are specified for heat loss through walls and windows of buildings, air-conditioning systems, ventilation systems, lighting systems and hot water systems. A detailed calculation of energy efficiency and a comparison between standards and calculated values are required. And if energy efficiency is lower than the standards, it will be necessary to adopt appropriate measures according to the guidelines described in the next section.

(1) Prevention of Heat Loss through External Walls, Windows and Others
(2) Effective Utilization of Energy in Relation to Air-conditioning Equipment
(3) Effective Utilization of Energy in Relation to Lighting Apparatus
(4) Effective Utilization of Energy in Relation to Hot Water Supply Systems

(5) Effective Utilization of Energy in Relation to Elevators

5-2-3 Industrial Sector (Preceding 4 Years)

Malaysia, one of the most industrialized countries in Asia, seems somewhat behind in the promotion of energy efficiency. However, judging from the steady achievements of industrialization and the national character, it would not be so difficult for Malaysian industries to absorb the methods of energy efficiency promotion that advanced countries, in the area of energy-efficiency promotion, have cultivated by long-term research and development works. For that purpose, energy consciousness at management level is the most important factor. Consequently, it seems possible for the standards portion of Japanese criteria to be adopted in the preceding four years and the targeted portion in the latter six years.

Energy Efficiency Standards concerning the following items are stipulated.

1. Rationalization of fuel combustion system
2. Rationalization of heating, cooling and heat transfer system
3. Prevention of heat loss due to radiation and transmission
4. Recovery and utilization of waste heat
5. Rationalization of systems to convert heat into motive power
6. Prevention of electric power loss due to resistance and other factors
7. Rationalization of systems to convert electricity into motive power, heat, etc.

5-2-4 Industrial Sector (Latter 6 Years)

After realization of the promotion plan of the preceding four years, Malaysia would establish the energy-consciousness, sufficient human resources and technical capability in industrial management to challenge more severe standards of energy efficiency. The following are current targeted standards of Japan and could be realized using the guidelines described in the next section.

5-3 Guidelines for Promotion of Energy Efficiency

To achieve the standards mentioned in previous section, it is effective to apply guidelines developed by advanced countries in the area of energy efficiency. The guidelines specified below could be adapted not only to the three industrial and three commercial sectors, but also other sectors. And the guidelines could serve as a basic technological structure of the Malaysian Energy Center.

5-3-1 Commercial Sector

General guidelines on formulation of measures for energy efficiency in existing buildings are classified into the following major categories:

Short range target (Proceeding 4 years):

1. Operation & maintenance management, life-style and others

long range target (Latter 6 years):

1. Architectural structure of buildings
2. Renovation and expansion of facilities (long range target)

5-3-2 Industrial Sector

General checkpoints on formulation of measures for energy efficiency in the industrial sector are classified into the following major categories:

1. Improvement of fuel combustion in combustion equipment
2. Improvement of heating, cooling, heat transfer, etc., in heat-consuming equipment
3. Prevention of heat loss due to radiation, conduction, etc., from heat-consuming equipment
4. Recovery and utilization of waste heat
5. Improvement of conversion from heat to power in combined heat and power generation equipment
6. Prevention of electricity loss due to resistance, etc., in electrical equipment
7. Improved conversion from electricity to power, heat, etc., in electrical equipment

Short range target (Proceeding 4 years):

Measures for improvement of operations and maintenance, and renovations with small investment.

Long range target (Latter 6 years):

Measures for improvements, renovations and modification, or installation.

Chapter 6 Outline of Energy Audit

This chapter described selection of model factories and Institutions and general procedure of energy audit.

6-1 Selection of Model Factories and Institutions

The Study Team and JBE&G jointly selected one factory or institution for an energy audit in each of six sub-sectors. Fourteen entities belonging to the commercial or industrial sector were selected as candidates for energy audit by JBE&G. Preliminary energy audits for the selection were carried out jointly by the study team and JBE&G, and three model entities in the commercial sector and three factories in the industrial sector were selected based on the mutual understanding between the study team and JBE&G, as shown in Table 6-1.

Table 6-1 Entities to be Audited

Commercial Sector	
Hotel:	MingCourt Vista Hotel
Shopping Complex:	Bandar Utama City Corporation Sdn. Bhd.
Hospital:	Hospital Seremban
Industrial Sector	
Cement:	Associated Pan Malaysia Cement Sdn. Bhd.
Food Processing:	Central Sugars Refinery Sdn. Bhd.
Steel:	Amsteel Mills Sdn. Bhd.

6-2 General Procedure of Energy Audit

The general procedure and the energy audit items in the commercial and industrial sectors are shown in Figure 6-1 and Figure 6-2. An outline of the procedure and schedule is as follows.

(1) Recognize Current Condition

The following items were investigated in steps, during the first field survey (February and March, 1998).

1. Outline of the institution, factories and facilities
2. Operating and managing conditions
3. Total and unit consumption of energy
4. Energy management and monitoring
5. Flow sheet for major products
6. Thermal insulation of buildings
7. Experiences and plan for energy efficiency promotion
8. Energy price of fuel, electricity and others
9. Major energy-consuming facilities
10. Electric power receiving
11. Others

(2) Identify Current Problems

The following items were reviewed and scrutinized during the first field survey, the first homework in Japan and the second field survey (February, 1998-July, 1998).

1. Problems with major energy-consuming facilities and building structures
2. Already recognized problems in energy consumption
3. Items requested for energy audit
4. Major items and points of energy audit
5. Others

(3) Formulate and Prepare Energy Audit Plan

The following items were reviewed and formulated during the first homework in Japan (March and April, 1998).

1. Review and analysis of premises for energy audit
2. Formulation of detailed plan for energy audit (measurement, field investigation, deployment of measuring equipment and others)
3. Planning of personnel allocation and schedule for audit
4. Necessary preparatory work and modifications of equipment for energy audit
5. Others

(4) Conduct Energy Audit

This step was conducted in cooperation with members of JBE&G, and each entity in the second and third field survey (June-July and September-October, 1998). The major items are as follows.

1. Explanation and discussion of detailed energy audit plan with the entity
2. Confirmation of preparations (points of modification, and measurement)
3. Deployment of measuring equipment
4. Installation and calibration of measuring equipment
5. Monitoring of operating and surrounding conditions of facilities
6. Measurement and collection of records of measurements and operation
7. Confirming detailed data and specifications of target facilities
8. Identifying problems by observing operating conditions
9. Collecting relevant data, information and records
10. Others

(5) Identify Problems Requiring Measures

As a result of the actual energy audit, the following items were reviewed and analyzed during the second and the third field survey, and the second and the third homework in Japan (June-November, 1998).

1. Review and analysis of measurement results
2. Review and analysis of relevant data and information
3. Identifying problems and determining the necessity for improvement
4. Scrutiny and formulation of items for improvement
5. Others

(6) Assess and Recommend Measures

As the final step of the overall energy audit, the following items were assessed and formulated during the second and the third homework in Japan (July-August and October-November, 1998).

1. Calculation and analysis of the effect of energy saving
2. Examination and selection of proper measures
3. Estimation and prediction of measures' effectiveness
4. Overall evaluation of energy efficiency improvement measures

6-3 Major Items of Each Energy Audit

There are various kinds of entities, representing each commercial and industrial sub-sector. There are also various types of energy consumption, such as thermal and electrical energy. Though detailed procedures and results of each energy audit are presented in Chapters 7 through 12, major items of each energy audit are summarized here.

(1) Commercial Sector

1) MingCourt Vista Hotel

1. Electrical power receiving and distribution
2. Air-conditioning system
3. Lighting system
4. Heat-consuming facilities
5. General energy consumption

2) Bandar Utama Shopping Complex

1. Electrical power receiving and distribution
2. Air-conditioning system
3. Lighting system
4. General energy consumption

3) Hospital

1. Electrical power receiving and distribution
2. Air-conditioning system
3. Lighting system
4. Heat consuming facilities
5. General energy consumption

(2) Industrial Sector

1) Associated Pan Malaysia Cement

1. Raw material grinding department (Electricity consumption)
2. Coal drying & grinding department (Electricity & heat consumption)
3. Cement grinding department (Electricity consumption)
4. Burning department (Electricity & heat consumption)
5. General energy consumption

2) Central Sugars Refinery

1. Boiler & steam turbine generator
2. Heat-consuming facilities
3. Steam trap system
4. Thermal insulation system
5. Air compressing system
6. Hot water cooling tower

7. Electrical power generation & distribution
8. General energy consumption

3) Amsteel Mills
   1. Shredding (Material & energy balance)
   2. EAF & LF (Material & energy balance)
   3. CCM (Energy balance)
   4. Reheating furnace (Material & energy balance)
   5. Bar mill & wire rod mill (Material & energy balance)
   6. Electricity receiving, distribution and consumption

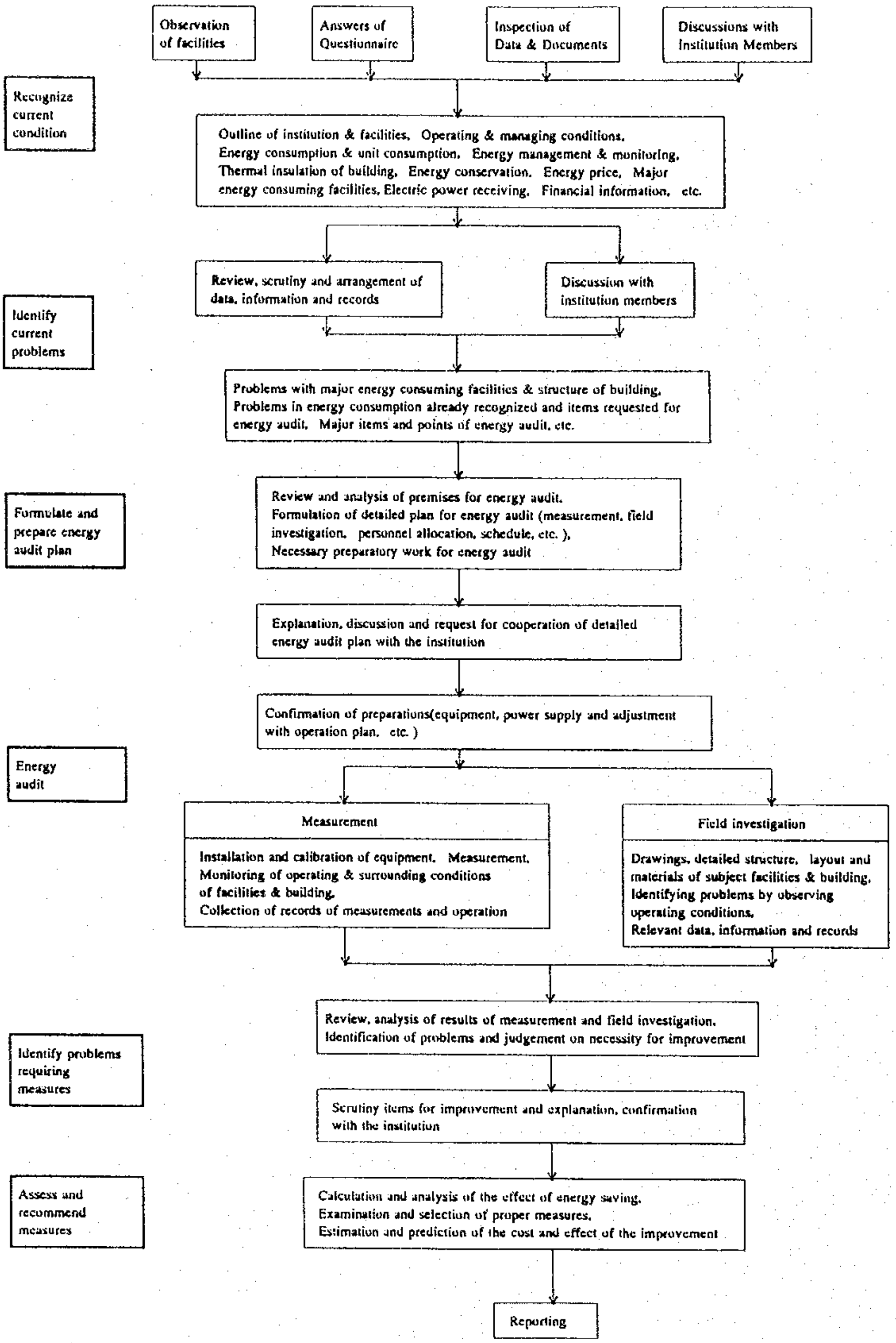


Figure 6-1 General Energy Audit Procedure (Commercial Sector)

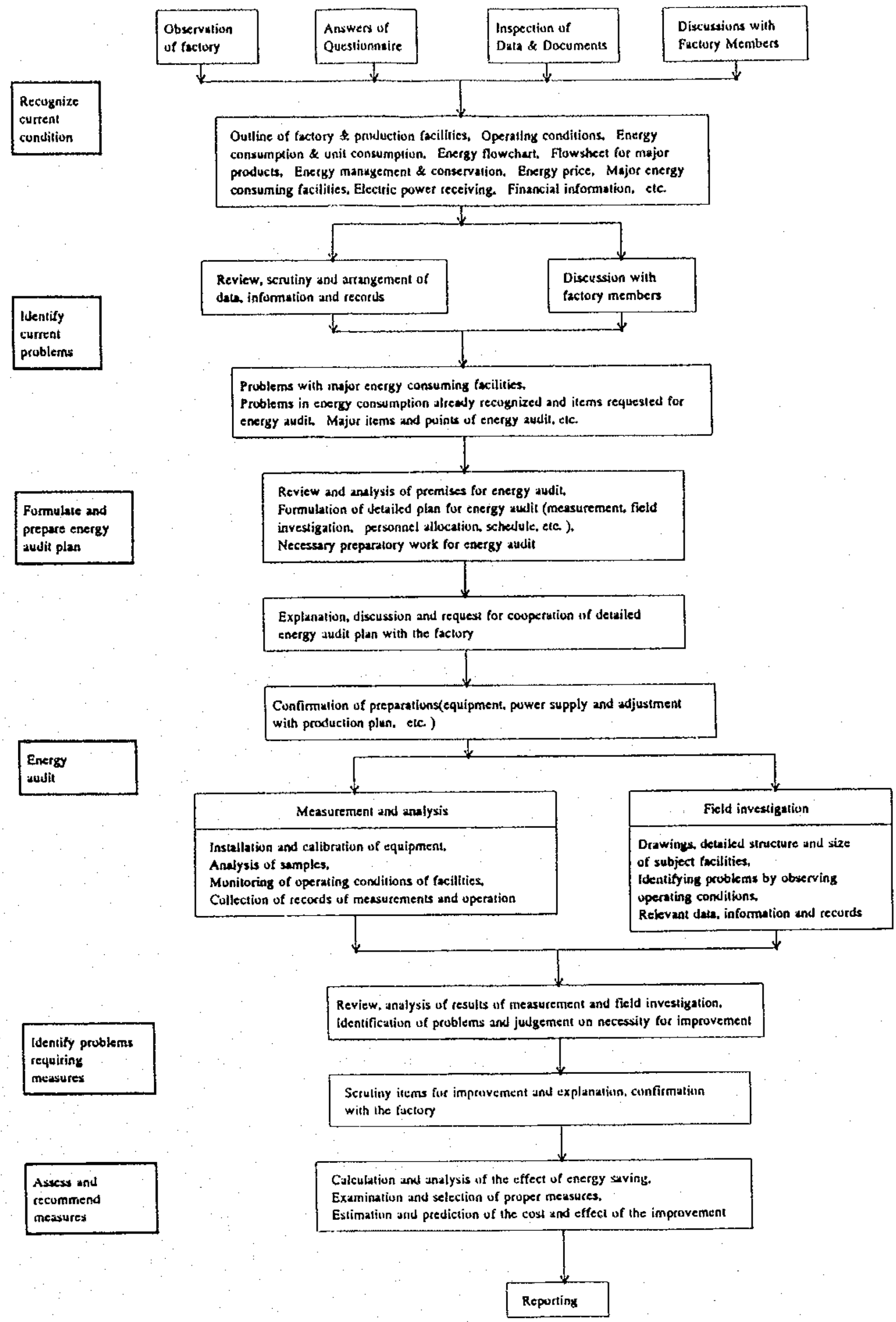


Figure 6-2 General Energy Audit Procedure (Industrial Sector)

Chapter 7 Hotel (Mingcourt Vista Hotel)

Mingcourt Vista Hotel, a typical Kuala Lumpur hotel founded in 1984, is a 14 storey building with 447 rooms. The hotel has various kinds of energy-consuming equipment that are being utilized in the commercial sector, such as facilities using electricity, fuel oil, chilled water, hot water and steam. Accordingly, the study team has conducted an energy audit concerning the various types of energy consumption.

7-1 Outline of the Hotel

7-1-1 Major Characteristics of the Hotel

(1) Operation Mode of the Hotel

1) Days of operation per annum

The hotel operates 365 days per year. Thus it is open throughout the year.

2) Operation Mode of Facilities

There are three types of operation modes depending on the facilities: batch, semi-batch and continuous, corresponding to the characteristics of each facility.

3) Maintenance Mode of Facilities

Routine maintenance work is carried out. A spare unit is installed in the main facility. Maintenance of special facilities such as the lifts, chillers, boilers, kitchen equipment and the fire prevention system is performed by the manufacturers or approved maintenance companies.

(2) General Characteristics of Energy Consumption

1) Forms of Energy

1. Electricity: All electricity for normal use is being received from an external electric company. It accounts for about 84 % of the total energy cost.
2. Diesel Oil: Fuel for steam boilers, hot water boilers and emergency power generators
3. LPG: Fuel for cooking

2) Utilization of Electricity, Steam, Chilled Water and Hot Water

1. Electricity: All the power in the air-conditioning system, lifts, refrigerators, water supply system, etc., as well as lighting fixtures, depend on electricity.
2. Steam: Heating in the hotel landry
3. Chilled Water: AHU (air-handling unit for air-conditioning)
4. Hot Water: Use in cookery, sanitary facilities, baths, the pool and so on

3) Electric Power

1. Charging Systems: There are two prices, corresponding to peak load (daytime 8:00-22:00), and off peak load (midnight 22:00-8:00).
2. Specifications: Voltage is 11 kV. Transformer capacity is 1.5 MVA for each of the 2 units, which are in continuous operation.

(3) Services

Main services of the hotel are as follows.

1) Accommodation: 447 rooms, including 30 suite rooms
2) Multipurpose facilities: Ballroom for banquets, cocktail parties, theatrical performances and meeting rooms
3) Dining facilities: Restaurants, coffee house, bars and lounges
4) Business Center: Secretarial, courier, fax, photocopying, and personal computer services
5) Recreational facilities: Swimming pool, tennis court, sauna, gymnasium
6) Other services: Laundry, limousine service, car parking, beauty & hair salon, others

(4) Features of the Hotel

The hotel is qualified as four-star. The hotel has been in operation for fourteen years. The structures of the building and main facilities were constructed in 1984 and have not yet been remodeled. They are a little old from the standpoint of energy efficiency compared with modernized hotels and buildings.

7-1-2 Outline of the Hotel

Outline of the hotel is as follows.

(1) Number of employees: 297

(2) Number of managing staff: 12

(3) Number of energy-related engineers: 20

(4) Total area of the hotel estate (m^2): 7,800

(5) Building area (m^2) : Total area of 14 floors 35,100

(6) Trends in number of clients: As a guideline, room occupancy percentage is from 46 to 83.

(7) Operation and management of the hotel

1) Operation and maintenance personnel is shown in Table 7-1.

Table 7-1 Staff for Operation and Maintenance

	Permanent staff	Consignor	Night duty
Management of facilities	20	Some for boiler, kitchen, lift, chiller management	2
Security management	7		3
Cleaning	50		4

2) Management of facilities:

1. A ledger is used for operation management.
2. Items for management include observation of operating conditions for main facilities and recording of status, etc.
3. Level of management is determined by a daily inspection system.
4. Judgement for maintenance is based on the inspection of facilities by the makers.

(8) Hotel operation costs

Energy costs, and repair and maintenance costs of the hotel in 1997 were 2,333 kRM and 848 kRM, respectively.

7-2 Outline of Facilities and Energy-Consuming Equipment

As outline of the main energy-consuming and relating facilities in the hotel is as follows.

(1) Air-conditioning system

1) The air-conditioning system is a centralized system.

2) Capacity:

Chiller: 350 USRT – 3 unit

AHU: 3 HP – 7 unit, 5HP – 19 unit, 7.5 HP – 6 unit, 10 HP – 3 unit,
15 HP – 5 unit, 20 HP – 1 unit, 25 HP – 1 unit
Total capacity is 311 HP. This number includes 15 HP for the stand-by unit.

3) Thermal insulation measures of the building

The building uses no specific thermal insulation.
Neither solar shading nor airtight sashes and doors are installed.

4) Ventilation

a) Regulation values in respect to indoor environmental conditions are N.A.
b) The method of ventilation is a centralized system. There are an induced air blower, an exhaust air blower and fans in each AHU.
c) There is an inlet / outlet heat exchanger.

5) Operating conditions

a) Operation mode is continuous and operating hours are 24 per day.
b) There is no control system for the main blowers. For other fans, operation is regulated by on/off.

6) Per-zone air adjustment system

An air adjustment system is employed according to certain types of zones.

7) Energy transfer system (air, water, chilled water)

a) Thermal insulation is used only for chilled water, hot water and steam pipeline.
b) Inverters and other energy-conserving facilities are not employed.

(2) Lighting equipment

1) Illumination criteria are not available.

2) Fluorescent lighting stabilizers are of magnetic type.

(3) Sanitation, water supply and drainage.

1) Water supply conditions

a) Recycling of used water and rainwater is not carried out.
b) Water quality used of city water is not available.
c) Laws and regulations for water supply and drainage facilities are not available.

d) The method of water supply is a receiving tank and head tank supply system.

e) Drainage is not recycled in the hotel.

2) Sanitary facilities

a) Water conservation systems and equipment are yet fully utilized.

b) An inverter based control system has not yet been introduced.

c) Power-saving motors are not used.

3) Hot water supply facilities

a) Hot water is produced in hot water boilers by burning diesel gas oil.

b) Hot water is supplied for rooms, kitchens, the pool, etc. Its temperature is from 65 ℃ to 90 ℃.

4) Recovery of hot water waste heat is carried out.

(4) Boiler system

1) The steam boiler and hot water boiler type is an internal fired horizontal smoke boiler.

2) Main specifications of the steam boiler are 10 kg/cm^2 of operating pressure and 0.9 t/h of steam flow capacity. There are the two units for each steam boiler and each hot water boiler system, respectively, and one for each is a stand-by unit.

3) The control system is on / off operation based on the outlet temperature of hot water and outlet pressure of steam.

(5) Lift

1) There are four passenger lifts and three service lifts.

2) Operating conditions are speed: 105 m/min, capacity: 17-20 persons and 13-14 stops.

3) Loading weights for guest use and service use are 2,550 lb. and 3,000 lb., respectively.

4) Energy consumption is not measured.

(6) Electrical power receiving and distributing facilities

1) The electrical power receiving system is a single line system.

2) Receiving voltage is 11 kV.

3) There are two transformers with capacity of 1.5MVA. Primary and secondary voltage are 11 kV and 415 V, respectively.

4) Transformer type is an oil-immersed transformer.

5) At the 415 V line, there are two normal banks and one emergency bank.

6) A condenser is installed in the low voltage side distribution line to improve the power factor.

7) There are regulations for fluctuation of supply voltage, and the range of fluctuation is + 5% to - 5 %.

8) Three emergency electric generators are installed, each with a capacity of 400 kW.

7-3 Energy Audit and Results

7-3-1 Major Items of Energy Audit and Results

Major items of energy audit for this hotel were as follows:

1. Electrical power receiving and distribution
2. Air-conditioning system
   (1) Mechanical performance
   (2) Environmental conditions
   (3) Electricity consumption
3. Lighting system
4. Heat-consuming facilities
5. General energy consumption

Measurements results are as follows.

(1) Electricity

1) Electricity Power Receiving Point

1. The total electricity consumption on 7 June was 21,451 kWh/d. The electricity consumption during the peak period based on the TNB tariff system was 14,280 kWh/d and the off peak period consumption was 7,171 kWh/d. The portion of off-peak consumption was 33.4 percent.
2. The maximum and minimum demand were 1,087 kW and 662 kW, respectively, and the average was 894 kW.
3. The load factor was 82.2 percent. The load factor in 1997, calculated by energy consumption, was 86.3 percent. Both values are almost the same.
4. There is a large difference in electricity demand between the off-peak period and peak of about 400kW.
5. The voltage and frequency are relatively stable.
6. Trend data for effective, reactive and apparent power show a large difference of electric power between the peak and off-peak periods.
7. Power factor ranged from 0.86 to 0.92. During the peak period, electricity demand was high, however the power factor was low. On the other hand, high power factor and low electricity demand were observed during the off-peak period.

2) 1.5MVA Transformer

1. The electricity of No.1 transformer was stable.
2. The electricity of No.2 transformer and power factor differed largely between peak and off-peak periods. During peak period, electricity demand was high, however the power factor was low. On the other hand, a high power factor but low electricity demand were observed during off-peak period.

3) Feeder

There are three Normal Risers (N1, N2, N3) in the feeder system. There is a large difference in the electricity of the Normal Riser N3 during peak and off-peak periods.

(2) Illumination Intensity and Environmental Conditions

1) Illumination Intensity

The measured values of illumination intensity on the ground floor, 1st floor, 2nd floor and 3rd-12th floors in the hotel are within a reasonable level.

2) Room Temperature

Guest room, corridor, public space, chiller room, electric room, kitchen, steam boiler room, hot water boiler room and elevator operation room temperatures were measured. The temperatures mesured at the above locations were a little low, ranging from 22℃ to 26℃. The temperatures in the laundry and steam boiler rooms were too high.

3) Air Velocity in the Hotel

Air velocity in public space, corridors, lounges and the hotel kitchen was measured. These data were below 0.5 m/s, within a reasonable range except for the air velocity in the kitchen.

4) Humidity and CO_2 Content in the Hotel

Relative humidity, dry bulb temperature and wet bulb temperature were measured. The relative humidity was in the range from 74 percent to 83 percent, which was rather high. CO_2 content in the lobby was 50-120 ppm, which was rather low, but that in the atmosphere was 210 ppm which was considered too high. The value for the atmosphere might be inaccurate because its measuring point was located near the car park.

5) Air Heat Exchanger

Temperature and velocity of used air around the total heat exchanger were 27.1℃ and 2.8 m/s, respectively. Atmospheric temperature was 32℃. Temperature of fresh air at the total heat exchanger outlet was 29-30℃. Fouling was observed on the surface plate in the heat exchanger. Fouling as severe as that in the heat exchanger was observed in the Air Handling Unit (AHU).

(3) Chilled Water System

1) Chiller

Inlet and outlet temperatures of chilled water for No.2 chiller and No.3 chiller are shown in Figure 7-1. Flow rate could not be measured because there was neither a permanent flow meter in the unit nor any possibility of installing the meter recently prepared by JICA. One chiller unit was running for 24 hours and another unit was running from around 10am to 10pm.

2) Cooling Tower

Inlet and outlet temperatures of cooling water of the No.2 chiller and No.3 chiller are also shown in Figure 7-1, together with their flow rates.

(4) Hot Water System

1) Hot Water Boiler

Figure 7-2 shows inlet/outlet temperatures and flow rate of primary water to the hot water boiler, as well as flue gas composition and temperature. Oxygen content in flue gas was from 0.6 to 0.8 vol. %. This shows that the excess air ratio of the boiler is about 1.03, which is too low. Flue gas temperature was from 284℃ to 308℃. The temperature was relatively high compared to the standard value of 250℃. Trend data of flow rate and trend data for cut-in/cut-off time of boiler burning operation, and comments on boiler operation, are shown in Figure 7-3.

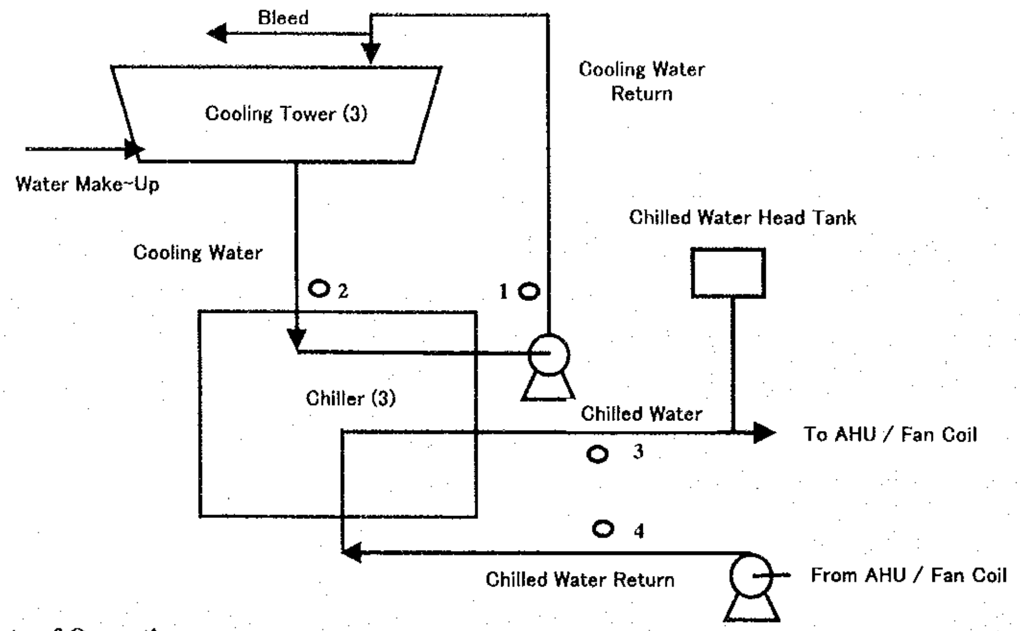
2) Calorifier

There are four calorifier units. Inlet and outlet temperatures of secondary water in each unit of the calorifier are shown in Figure 7-2. Some units were on stand-by.

(5) Steam Boiler System

The surface temperature of the boiler, the condensate tanks and the pipe line in the boiler system; the temperature and pressure of steam; and the fuel oil consumption rate were measured. Electrical conductivity of the boiler feed water was at the normal level.

Chilled Water System



Data of Operation

	Date	4 / 6 / 98							

Chiller No.2

Time		9:45	10:15	11:15	12:00	12:45	14:15	15:30	16:40
Temperature	℃								
1 Cooling	Bar	32.0			32.0	32.0	32.0	31.0	32.0
Water	Instrument	33.2	34.0	33.0	33.0	32.0	33.0	34.0	33.0
Return	Surface T	32.0			32.0	32.0	32.0	32.0	32.0
2 Cooling	Bar	29.7			29.0	30.0	30.0	28.0	29.0
Water	Instrument	29.0	32.0	31.0	31.0	31.0	31.0	32.0	31.0
	Surface T	31.5			30.0	30.0	30.0	30.0	30.0
3 Chilled	Bar	-	-	-	-	-	-	-	-
Water	Instrument	5.0	6.0	5.0	5.0	5.0	5.0	5.0	5.0
	Surface T	-	-	-	-	-	-	-	-
4 Chilled	Bar	-	-	-	-	-	-	-	-
Water	Instrument	8.0	10.0	8.0	8.0	8.0	8.5	8.0	8.0
Return	Surface T	-	-	-	-	-	-	-	-

Chiller No.3

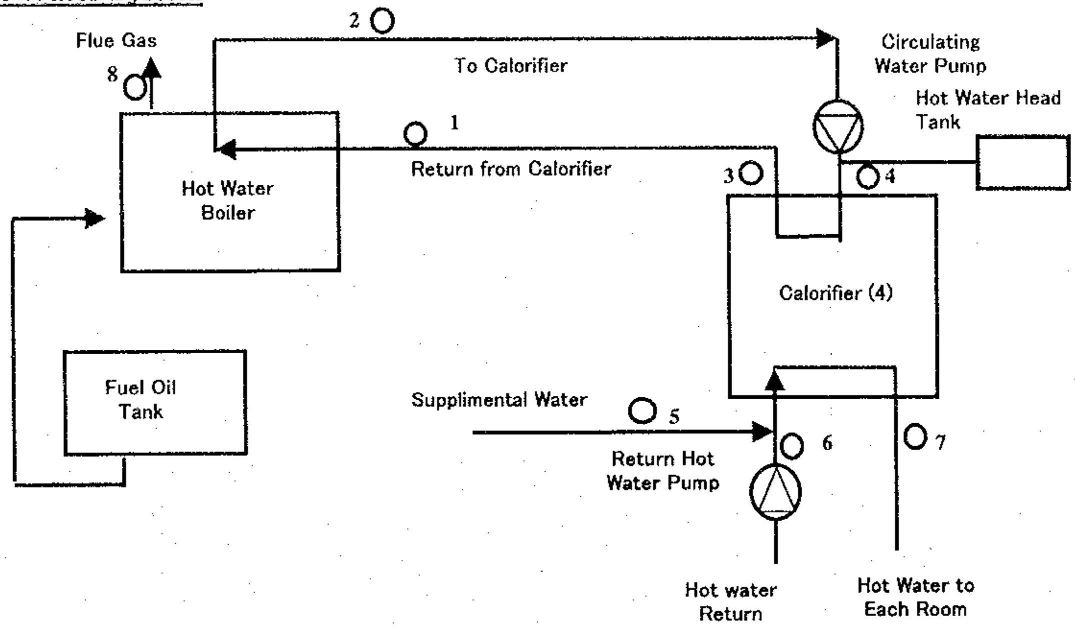
Time		10:45	11:15	12:00	12:45	14:15	15:30	16:40
Temperature	℃							
1 Cooling	Bar	31.0		31.0	32.0	32.0	31.0	31.0
Water	Instrument	34.0	34.0	33.0	33.0	34.0	34.0	33.0
Return	Surface T	31.0		32.0	32.0	33.0	33.5	32.5
2 Cooling	Bar	29.0		29.0	29.0	29.0	28.0	30.0
Water	Instrument	32.0	31.0	31.0	31.0	32.0	32.0	31.0
	Surface T	29.0		29.0	29.0	30.0	30.0	30.0
3 Chilled	Bar	-	-	-	-	-	-	-
Water	Instrument	6.0	6.0	6.0	6.0	6.0	6.5	6.0
	Surface T	-	-	-	-	-	-	-
4 Chilled	Bar	-	-	-	-	-	-	-
Water	Instrument	9.0	9.0	9.0	9.0	9.0	9.5	9.0
Return	Surface T	-	-	-	-	-	-	-

Cooling Tower

Time		10:00	11:00	12:00	12:45	14:15	15:25	16:30
Flow Rate								
2 Cooling Water Return	m^3/h	230	572	563	555	542	543	560

Figure 7-1 Chilled Water System

Hot Water System



Data of Operation

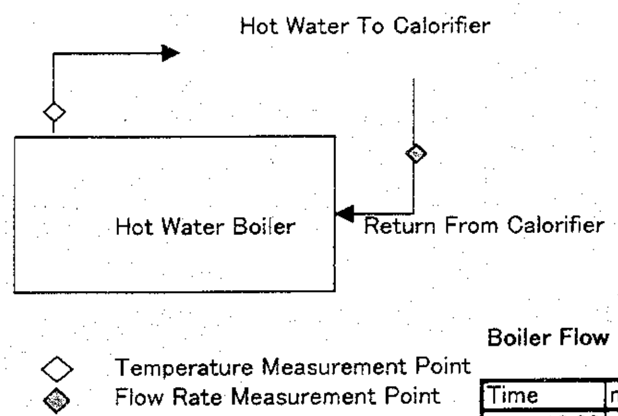
		Unit				
	Date		10/6/98	10/6/98	10/6/98	10/6/98
	Time		10.00	12.00	14.00	0:00
Temperature	Calorifier No					
1 Return from Calorifier		℃	69	69	68	64
2 Hot Water to Calorifier		℃	78	77	78	76
3 Outlet of Calorifier	1	℃	56	65	63	64
	2	℃	63	59	60	63
	3	℃	66	64	60	65
	4	℃	61	61	66	64
4 Inlet of Calorifier	1	℃	56	54	51	53
	2	℃	54	59	53	56
	3	℃	56	56	63	57
	4	℃	68	66	70	69
5 Supplementary Water (1)		℃	31	32	32	32
6 Hot Water Return from Each Rooms	1	℃	56	56	55	54
	2	℃	55	54	57	58
	3	℃	52	55	53	60
	4	℃	56	56	56	55
7 Hot Water to Each Rooms	1	℃	56	55	53	54
	2	℃	55	58	54	56
	3	℃	61	57	58	58
	4	℃	67	66	65	66

Flow Rate						
	Time		12:00	12:27	14:30	15:08
1 Return from Calorifier		m3/h	38.8	1.6	17.8	18.2

Flue Gas Analysis	(Date: 9/6/1998)		Low	High
8 Contents	O2	Vol %	0.6	0.8
	CO2	Vol %	14.0	15.0
	CO	ppm	192	357
	NO	ppm	58	62
8 Temperature		℃	284	308

Figure 7-2 Hot Water System

Hot Water Boiler Operation



Flow Rate
Date: 5th June 1998
Boiler 2 in Operation

Cut IN	Cut Out	Duration
12:15	12:18	0.03
12:23	12:27	0.03
12:32	12:38	0.06
14:10	14:15	0.05
14:32	14:43	0.11
15:03	15:08	0.05

Date 11th June 1998

Cut IN	Cut Out	Duration
9:40	9:44	0:04
9:47	9:51	0:04
9:57	10:00	0:03
10:05	10:14	0:09
10:17	10:21	0:04

Boiler Flow Rate

Time	m3/h
12:00	38.79
12:27	18.60
14:20	17.26
14:30	17.75
14:33	37.78
14:36	37.50
14:38	38.07
14:43	18.18
15:08	18.18
15:05	38.00
15:09	17.61

Hot Water Boiler Operation Comments

a) 24-Hr operation
b) For Rooms and Washing
c) Temp. Set Points : Low 76 C High 87/90 C
d) High burning when load is high
e) Load is highest in morning 7.00 am to 10.00 am and in evening.

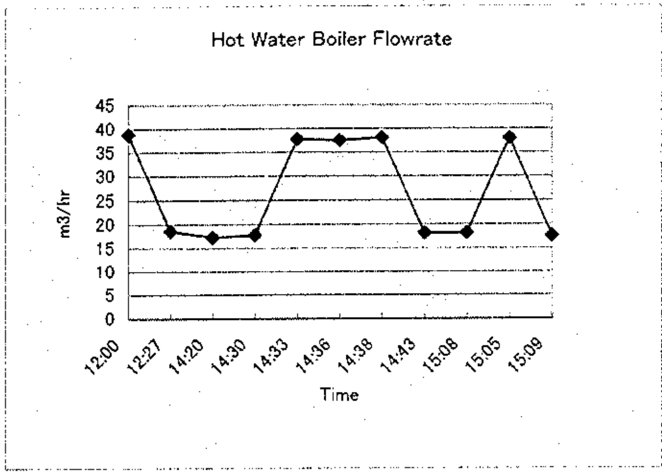


Figure 7-3 Hot Water Boiler Operation

7-3-2 Energy Flowchart

(1) Trends in Annual Energy Consumption by Energy Form

Consumption rates of electricity, diesel oil, LPG and water, and costs from 1995 to 1997 are shown in Table 7-2.

Table 7-2 Trends in Annual Energy Consumption and Costs

Name of utilities	Unit	1995		1996		1997	
		Consumption	Costs kRM	Consumption	Costs kRM	Consumption	Costs kRM
Diesel oil	k l	319.8	208	380.4	247	354.7	231
LPG	Ton	110.9	133	95.5	115	122.7	147
Electricity	mWh	7,302	1,675	8,937	1,963	9,568	2,074
(Peak)	mWh	4,381		5,362		5,741	
(Off peak)	mWh	2,921		3,575		3,827	
(Demand)	kW	1,265		1,265		1,265	
City water	kTon	198	237	190	228	163	196

(2) Energy Flow in Hotel

Various types of energy including electricity, diesel oil and LPG were used in the major facilities of the hotel in 1997, as shown in Table 7-3. The percentages show the ratio of energy flow in the hotel. The percentage breakdowns in electricity and fuel consumption are based on the measured primary energy consumption calculated by the actual data. Main energy consumers in the hotel were air-conditioning, lighting, lifts, sanitary facilities, cooking and the hotel laundry. The main energy source was electrical power, which accounted for about 83 percent of the total energy on a primary energy basis. All energy consumption is converted into kcal on a primary energy basis. Primary energy flow in the hotel is shown in Figure 7-4.

(Unit: 10^6 kcal/y)

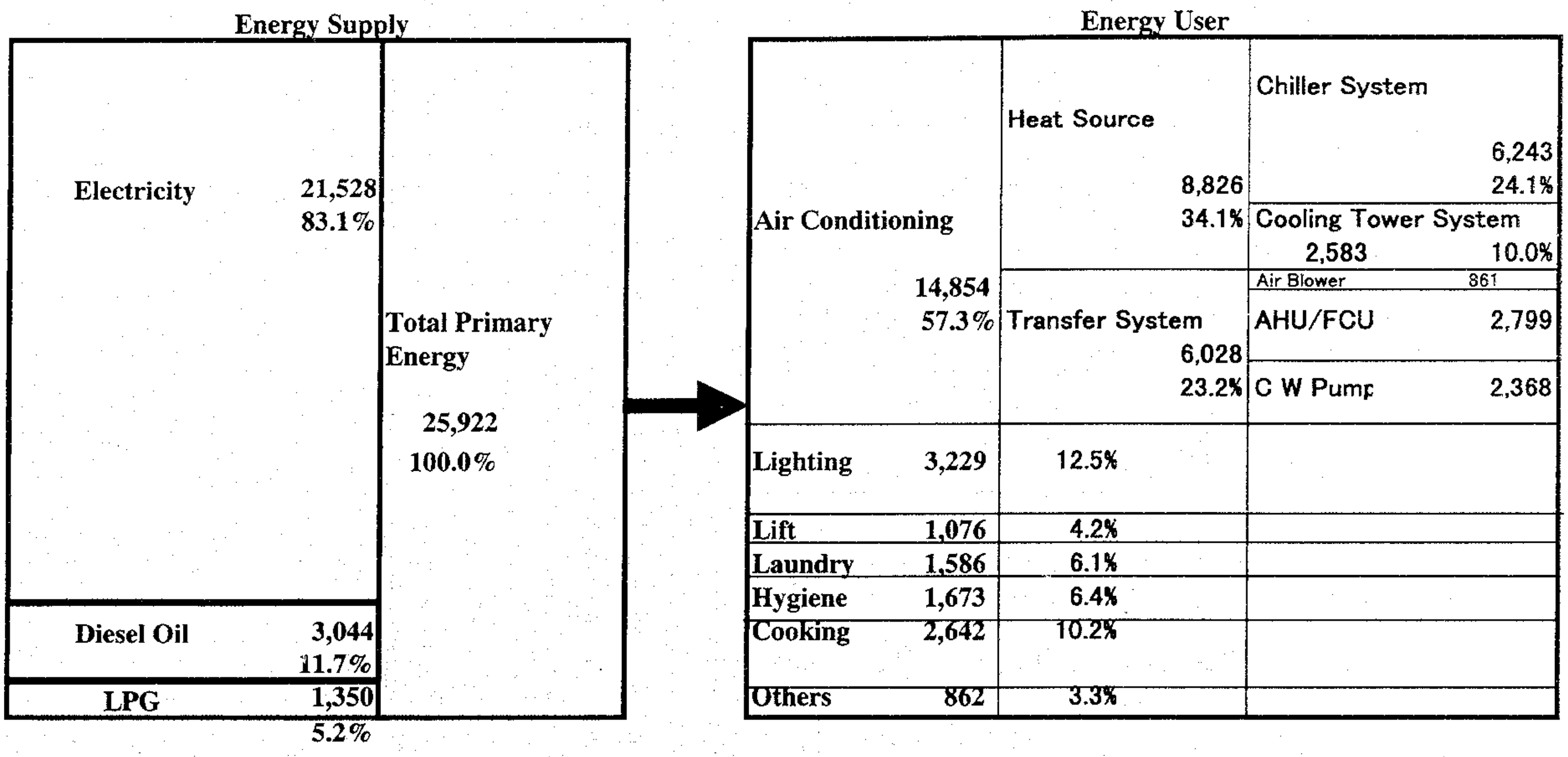


Figure 7-4 Primary Energy Flow in the Hotel

Table 7-3 Energy Flowchart of the Hotel

(1997)

Item	Electricity	Diesel oil	LPG	Total
The amount of consumption	(kWh) 9,568,000	354.7 (kl) 295.5 (ton)	(Ton) 122.7	
Primary energy 10^6 kcal	21,528 (83.1 %)	3,044 (11.7 %)	1,350 (5.2 %)	
Primary energy total	10^6 kcal			25,922 (100%)
Energy consuming facility				
Air-conditioning	14,854			14,854 (57.3%)
(1) Chiller system	6,243			6,243 (24.1%)
(2) Cooling Tower Sys.	2,583			2,583 (10.0%)
(2) Air Blower	861			861 (3.3%)
(3) AHU / Fan Coil U	2,799			2,799 (10.8%)
(4) Chilled Water Pump	2,368			2,368 (9.1%)
Lighting	3,229			3,229 (12.5%)
Lift	1,076			1,076 (4.2 %)
Steam boiler (Laundry)	-	1,586		1,586 (6.1%)
Hot water boiler/Calorifier (Hot water supply)	215	1,458		1,673 (6.4%)
Cooking / Restaurant	1,292		1,350	2,642 (10.2%)
Others	862			862 (3.3%)

Assumption:

1. Conversion factor of electricity to primary energy: 2,250 kcal/kWh
2. Low heating value of LPG: 11,000 kcal/kg
3. Low heating value and specific gravity of diesel oil: 10,300 kcal/kg and 0.8332
4. Percentage of diesel oil consumption: steam boiler 52.1%, hot water boiler 47.9 %

7-3-3 Unit Consumption of Energy in the Hotel

Unit consumption of energy in the hotel is shown in Figure 7-5. Unit consumption is calculated based on the area of extended floor space in the hotel, 35,100 m^2.

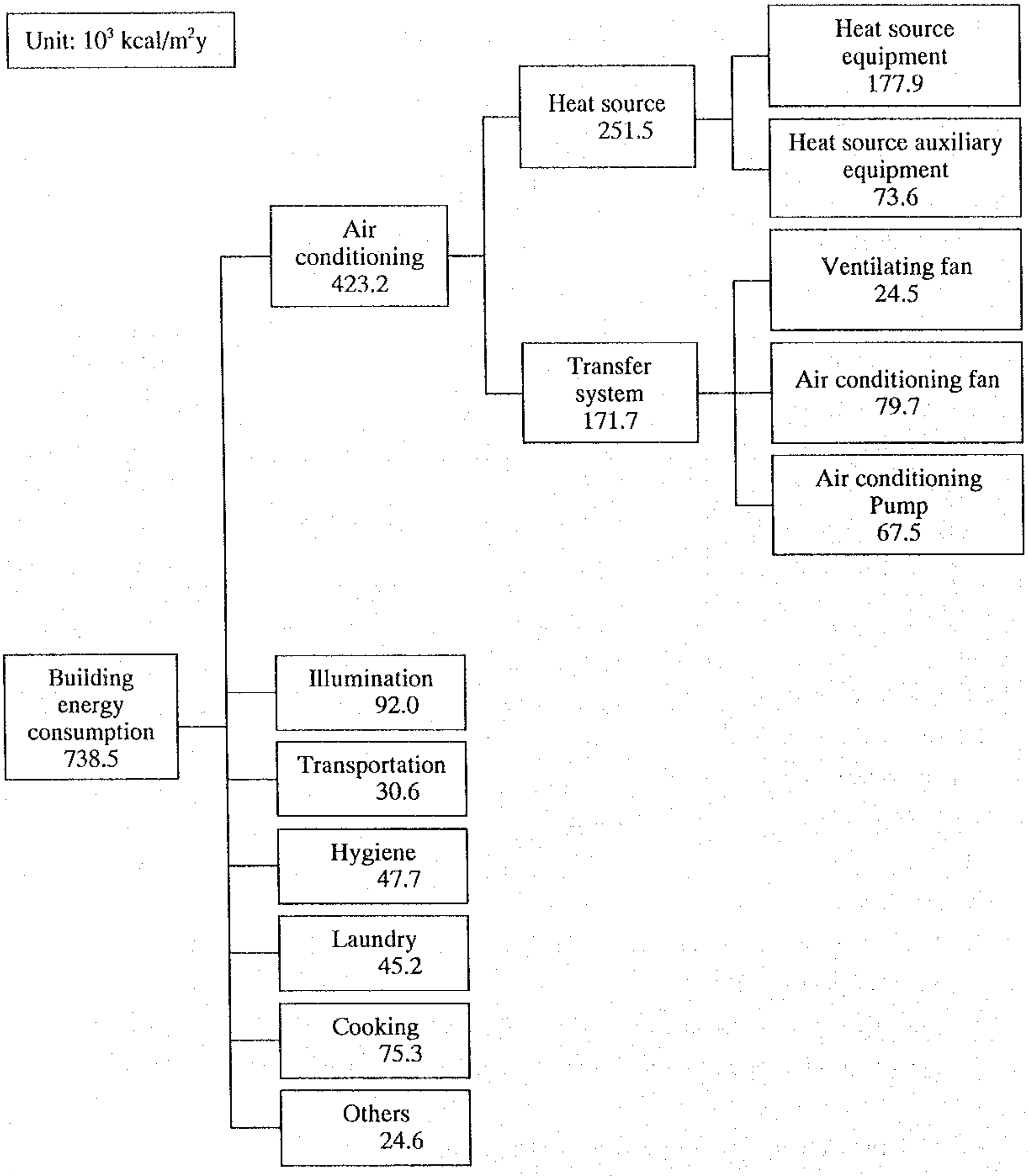


Figure 7-5 Unit Consumption of Energy in the Hotel

7-3-4 Present Situation of Energy Management and Energy Efficiency Promotion

(1) Establishment of Energy Efficiency Targets

Energy efficiency targets are not yet established, but energy costs are projected for each month. Quantitative control of energy is not conducted with a strict standard.

(2) Systematic Activities for Energy Management in the Organization

Under the advice of the manager, basic measures for energy efficiency promotion are being implemented. For example, lighting is switched on and off conscientiously.

(3) Energy Management Utilizing Data and Records

This type of management is not sufficiently implemented.

(4) Education and Training of Employees for Energy Management

The hotel has no experience in conducting such training and education.

(5) Maintenance Management of Building and Facilities

1) Dates for inspection and maintenance of equipment, facilities and buildings are not specifically determined.
2) Maintenance conditions. In terms of maintenance methods, there are two cases: one is routine work maintenance performed by permanent staff, and the other is the maintenance of specified facilities performed by consignor.
3) Periodic and long term maintenance plans are not drawn up.

(6) Measures Carried out for Energy Efficiency Promotion and Their Effects

There are no measures carried out for energy efficiency promotion in the hotel.
The hotel is studying plans for electricity saving prepared by a consulting company in Malaysia, but investigations are in the preliminary stage.

(7) Business Condition of the Hotel

The hotel faces the intense competition of the hotel industry. It plans to reduce energy costs and decrease their percentage of the total cost; this applies particularly to electrical power charges.

(8) Problems in Promoting Energy Efficiency

1) Shortage of engineers
2) Insufficient data and lack of knowledge about energy efficiency promotion
3) Shortage of measuring equipment and operation data in the facilities.

7-4 Measures for Energy Efficiency Promotion

In accordance with the energy audit results, measures to improve energy efficiency are described and discussed in this section. The major points are as follows.

1. Introduction of a heat storage tank for the chiller system
2. Improvement of power factor
3. Introduction of an inverter control system for the lift power supply
4. Improvement of air-conditioning system
5. Improvement of hot water system
6. Improvement of the steam boiler system

7-4-1 Introduction of Heat Storage Tank for Chiller System

(1) Current problems

As mentioned before, the difference between the electricity demand during the peak period and the off-peak period is large (approx. 400kW). The main cause for the difference is chiller No.3. The electricity of No.2 Transformer that supplies electricity to chiller No.3 fluctuates greatly. The difference between the peak and off-peak electricity of chiller No.3 is 230 kW.

At present, only the chilled water pump runs during the off-peak period and all equipment runs during the peak period.

(2) Measures

To address the difference in electricity consumption in Chiller No.3, a heat storage tank is recommended for its electricity cost-saving.

The chiller unit will run during the off-peak period (22:00 to 8:00) to make ice in the storage tank and to supply cooled air during the peak period (8:00 to 22:00). As a result, only the chilled water pump will be operated without chiller operation during the peak period.

(3) Effect

The operation of Chiller No.3 will be based on the following scheme:

Table 7-4 New operational Scheme of Chiller No. 3

Equipment	At Peak	At Off-Peak
Chiller No.3 (181 kW)	× } Supplied by heat storage tank	○
Condenser water pumps (50 kW)	× } Supplied by heat storage tank	○
Chiller water pumps (47 kW)	○	○

Note: kW ... Motor Capacity, ○ : operated, ×: not operated

The modeled current and new operational patterns are shown in Figure 7-6.

As a result, electricity cost savings can be estimated as described in section 7-5.

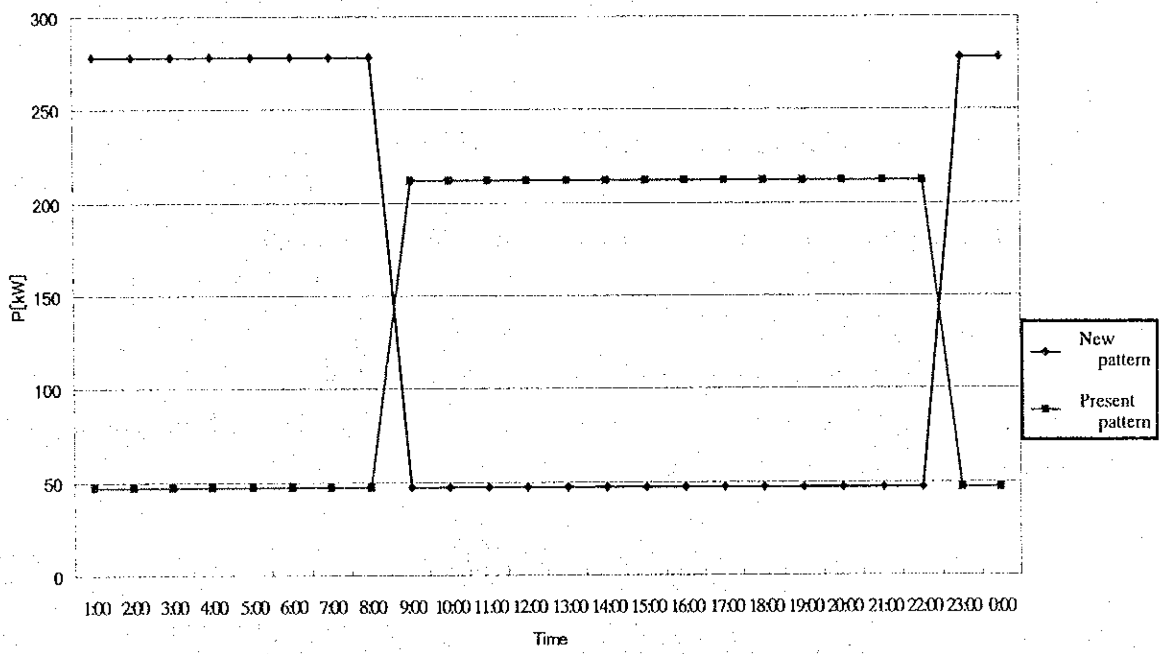


Figure 7-6 Chiller No.3 (Electricity)

7-4-2 Improvement of Power Factor

(1) Current problems

The power factor at the power receiving point dropped as electricity demand increased during the peak period. The drop in power factor was caused by the insufficient capacity of the condenser.

The power factor at Transformer No.2 fell during the peak period as well, though it did not at 1.5MVA Transformer No.1.

(2) Measures

Based on the above situation, the condenser capacity at the Secondary Bus Bar of the 1.5MVA Transformer No.2 needs to be increased.

In order to improve the power factor up to 100 percent, it is necessary to install a condenser of 300 kVA, in accordance with the following formula;

$$
\begin{aligned}
\text{Condenser Capacity} &= P\,\text{kW} \times \left(\sqrt{(1-\cos^2\theta 1)/\cos^2\theta 1} - \sqrt{(1-\cos^2\theta 2)/\cos^2\theta 2}\right) \\
&= 575\,\text{kW} \times \left(\sqrt{(1-0.882^2)/0.882^2} - \sqrt{(1-1^2)/1^2}\right) \\
&= 575 \times 0.5343 = 307 \\
&\fallingdotseq 300\ \text{kVA}
\end{aligned}
$$

(3) Effect

The above measure will reduce the electricity transfer loss in the cable.

7-4-3 Introduction of Inverter Control System for Lift Power Supply

(1) Current problems

This hotel has seven lifts units with the specifications shown in Table 7-5.

Although all 7 lifts are old and the control system is based on relays, all lifts are in good working order and have been well maintained.

Table 7--5 Lift Specification

Control System	ACEE1-D	
Capacity	Lift No.1,2,3,4,6,7 :	17 persons
	Lift No.5:	20 persons
Stops	Lift No.1,5,6,7:	14 stops
	Lift No.2,3,4 :	13 stops
Speed	105 m/min.	
Operation	Lift No.1,2,3,4:	4C-OS75E
	Lift No.5,6,7:	3C-OS75E

(2) Measures

To achieve further energy-efficiency of the lift power supply, it is recommended that the Variable Voltage Variable Frequency (VVVF) power supply system be introduced in the event of future lift renovation.

Instead of the current relay control system, the following control devices will be considered.

Table 7-6 shows the comparison of performance between the installed Ward-Leonard System (VVGD), VVVF and the AC feedback control system (ACEE).

(3) Effect

As Table 7-6 describes, VVVF is superior to other control systems in terms of power consumption, ease of maintenance and reliability, etc.

Table 7-6 Performance Comparison of Power Supply Control System

	VVGD (Ward-Leonard system)	VVVF (variable voltage variable frequency)	ACEE (AC feedback control system)
Riding Comfort	Good Simple feedback control without tachometer	Excellent Perfect continuous torque control and complete feedback control with pulse generator	Very Good Complete feedback control with tachometer. But, discontinuous torque control between motoring and braking
Landing Accuracy	Excellent	Excellent	Excellent
Noise	Large Starting noise of M-G set	Quiet Sine wave current controlled by PWM (Pulse Width Modulation)	Small Motor noise caused by thyristor controlled current
Power Consumption	Large Large consumption caused by M-G set	Very small, about half of ACEE Voltage and frequency control for induction motor at high efficiency	Small Static voltage control, but fixed frequency
Space for Machine Room	Large Large DC motor and M-G set	Very small Small sized single-winding AC motor and control panel	Small Small sized reconnect AC motor
Weight of Machine Room Apparatus	Large	Very small	Small
Reliability	Good Wear and tear of brushes and commutator of DC motor and M-G set	Excellent, superior to ACEE Solid state digital control by micro processor	Very Good Solid state control by analog devices
Response	Poor Time lag to start due to starting time of M-G set	Excellent No time lag to start	Excellent No time lag to start
Maintenability	Poor Required complex "compound adjustment"	Excellent No special adjustment	Very Good No complex adjustment

7-4-4 Improvement of Air-Conditioning System

(1) Present problems

1) AHU and total heat-exchanger

The heat exchange surface in the AHU and the entire exchanger are dirty.

2) Cooling towers

There is severe fouling in the cooling towers.

3) Air intake of the air-conditioning system

Fresh air intake is excessive in the hotel and significantly increases the power consumption of blowers and fans.

4) Room temperature setting

The temperatures of office rooms, corridors, restaurants and others are all 20-23℃.

In particular, temperatures in the machine room, electric switch room and the lift motor rooms are too low, even though the operators do not remain there continuously.

5) Door system

A large volume of outside air is coming into the hotel through the front door and the rear door on the ground floor.

(2) Measures

1) AHU and total heat-exchanger

The heat exchange surface in the AHU and the total exchanger must be cleaned periodically.

2) Cooling towers

Removal of algae from the packing in the cooling towers and the use of an adequate chemical agent such as an inhibitor are recommended.

3) Air intake of the air-conditioning system

It is recommended that a Variable Air Volume (VAV) systems be installed for the hotel's air-conditioning. Various systems are used as control systems of intake air, such as damper control, vane control and various rotating speed controls, as shown in Table 7-7.

Power consumption for each system is also shown in this table.

Table 7-7 Method of Variable Type Air Flow Control

Method	Sub-classification	Power Consumption
Damper Control	Discharge	Rank 1 (Largest)
	Intake	2
Vane Control	Intake	3
Control of Induction Motor Rotating Speed	Change of Number of Poles	4
	Control of Slip (Secondary Resistance Control System)	5
	Primary Frequency Control (VVVF)	6 (Smallest)

As rotating speed control by VVVF (Inverter control system) is easily available for existing motor facilities with considerable efficacy, it should be studied first among other possibilities for the motor of the fresh air intake blower in the total exchanger room for fresh air control.

4) Room temperature setting

The setting of room temperature should be raised by 2 - 3℃ for energy efficiency promotion. It is recommended that a temperature control system be installed, such as fans with an on/off switch.

5) Door system

It is recommended that some air-tight entrance system be installed, i.e., rotary double door system for the front entrance and automatic shut-off door for the back entrance.

7-4-5 Improvement of Hot Water System

(1) Current problems

On/off of firing operation in the boiler was too frequent and the duration of operation was short. This means that the boiler operation is not stable and the efficiency is low because incomplete combustion may be taking place. Not all four calorifiers were operated.

(2) Measures & Effects

It is recommended that the set temperature and both the low and high temperature set points of the primary water at the boiler outlet be checked, and that all the four calorifiers be operated as well. Furthermore, it is recommended that another new calorifier be installed to expand the capacity of the hot water system. The hot water boiler is not being operated efficiently on an on/off switching basis, and the operation is frequently producing start-up and shut-down losses. This operation should be made consistent, extending the capacity of the calorifiers, whose functions also include heat storage. Peak-shifting of electricity consumption will be possible after the installation of another calorifier.

7-4-6 Improvement of Steam Boiler System

(1) Current problems

There was some exhaust steam from the relief valve due to leakage from the valve sheet and from the condensate tank due to vaporization of recovered condensate.

(2) Measures & Effects

It is recommended that adequate maintenance be carried out on the safety valve.
A heat-recovery system for steam vaporized from the condensate tank is also recommended for energy saving.
By sub-contracting laundry work in the hotel to an outside company, the hotel may be able to discontinue use of the steam boiler system, which will enable energy efficiency promotion and cost reduction.

7-4-7 Cost of Measures for Energy Efficiency Promotion

Budget-type costs as of November 1998 were estimated for three recommended modification works. The total costs estimated are as follows. The exchange rates used for estimation are 3.8 RM/US$, 118 Yen/US$, the rates prevailing in November, 1998.

	Recommended Modification Work	Yen	RM
1.	Ice storage system	92,900	2,991,000
2.	VVVF system in the lifts	64,500,000	2,076,000
3.	VAV system in space conditioning	4,132,000	133,000

Remark The cost difference of lift renewal based on the existing specification and the VVVF power supply system is 10 percent of the renewal cost, 208,000 RM.

7-5 Benefit of Measures for Energy Efficiency Promotion

7-5-1 Current Price of Energy in Malaysia

Electric power could be saved by all the recommended measures for improved energy efficiency. The current price of electric power conforms to category C2 of TENAGA NASIONAL's tariff, effective from 1 May, 1997, in the case of Mingcourt Vista Hotel. The following rates are applied, according to this category of tariff.

- Peak load rate (between 800 and 2200 hours): 0.208 RM/kWh
- Off-peak load rate (between 2200 and 800 hours): 0.128 RM/ kWh
- Maximum demand charge: 25.7RM/kW/month

7-5-2 Benefits of Measures

The benefits of the measures are estimated and the results are summarized in Table 7-8.

Table 7-8 Estimation of Benefit from Measures

Measures	Benefit, RM/year
Ice storage system	118,338
VVVF system in the lifts	42,706
VAV system in the air-conditioning	47,582
Increase in room temperature	135,608

7-6 Financial Evaluation of Measures

In this section, financial evaluations are made for the following measures based on investment in order to ascertain the financial feasibility of the measures.

- Ice storage system
- VVVF system in the lifts
- VAV system in the air-conditioning

The financial evaluations for the first and second measures are made under the assumption that the measures would be taken at a time when overage equipment was to be replaced by new equipment. Under such conditions, only the amount of money that would be used for energy-saving equipment is considered as fixed investment, in order to obtain the energy-saving benefit. The remaining invested money is regarded as the replacement cost that is necessary, regardless of energy-saving.

In fact, the cost of a new chiller is excluded from the fixed investment for the purpose of the financial evaluation, assuming an ice storage system is introduced at the time of chiller replacement. As for the second measure, only the cost related to inverters is counted as the fixed investment for the purpose of the financial evaluation, assuming VVVF system lifts with inverters are introduced at the time of lift replacement.

7-6-1 Premises for Financial Evaluation

Financial evaluation were made on the following premises.

1) Exchange rate: US$ 1 = RM 3.8 ; US$ 1 = JY 118
2) Project life: 15 years from the start of operation
3) Corporate tax rate: 35 %
4) Depreciation: The straight-line method is applied. The depreciation rate is 7.5% per annum for the plant and machinery.
5) Fixed investment: Fixed investment cost, shown in Table 7-9 in Malaysian Dollars, converted from the Japanese Yen value in the previous section, is used for the financial evaluation. As previously mentioned, for the first measure, the cost of a new chiller is not counted in the fixed investment of the measure, assuming an ice storage system is installed at the time of chiller replacement. As for the second measure, only the cost related to inverters is counted in the fixed investment of the measure, assuming inverters are installed at the time of lift replacement.

Table 7-9 Fixed Investment for Measures

Measures	Fixed Investment, RM
Ice storage system	1,887,000
VVVF system in the lifts	208,000
VAV system in the air-conditioning	133,000

7-6-2 Results of Financial Evaluation

Table 7-10 shows FIRROI before tax, FIRROI after tax and the payback period for the three measures.

Table 7-10 Results of Financial Evaluation

Measures	FIRROI before tax	FIRROI after tax	Payback Period
Ice storage system	- 0.8%	- 0.5%	15.9 years
VVVF system in the lifts	19.0%	13.5%	6.3 years
VAV system in the air-conditioning	35.4%	24.9%	3.9 years

In addition to the above, three kinds of indicators are calculated for the first and second measures above on the assumption that electricity tariff rises to the rate shown in Table 7-11, which is considered to be the current level in Japan. This calculation is made in order to find out the effect of electricity tariff on the financial feasibility of those measures.

Table 7-11 Assumed Rise in Electricity Rate for Study

	Assumed Electricity Rate for Study		Reference (C2 tariff)
Peak Load Rate	0.483 RM/kWh	(15 JY/kWh)	0.208 RM/kWh
Off-peak Load Rate	0.113 RM/kWh	(3.5 JY/kWh)	0.128 RM/kWh
Max. Demand Charge	49.9 RM/kW/month	(1,550 JY/kWh/month)	25.7 RM/kW/month

Table 7-12 shows the result of the evaluation at the electricity rate assumed in Table 7-11. FIRROI before tax and after tax increased by about 21% and 15%, respectively, for both measures. The payback periods were shortened by 11.3 years for an ice storage system and by 2.8 years for a VVVF system in lifts.

Table 7-12 Results of Financial Evaluation at Assumed Increased Electricity Rate

Measures	FIRROI before tax	FIRROI after tax	Payback Period
Ice storage system	20.4%	14.5%	4.6 years
(Difference from the base)	(+21.2%)	(+15.0%)	(-11.3 years)
VVVF system in the lifts	40.8%	28.6%	3.4 years
(Difference from the base)	(+21.8%)	(+15.1%)	(-2.8 years)

7-6-3 Conclusion of Financial Evaluation

According to the information obtained during the field survey, the lending rate in Malaysia has ranged from 12 to 14% per annum recently. This rate could be regarded as an indication of the opportunity cost of capital in Malaysia.

The ice storage system measure is evaluated under the assumption that it is installed at the time of chiller replacement, as mentioned before. It is concluded that the measure is not financially feasible under the conditions of the study, as its FIRROIs are negative values and its payback period is longer than 15 years. However, it is said that the measure will become financially feasible if electricity tariff increases to the current Japanese level, judging from the indicators shown in Table 7-12.

The VVVF system measure is at a marginal level of financial feasibility, assuming an inverter system is installed at the time of lift replacement. It is recommended that further investigation be made as to whether inverters should be installed or not, when lift replacement is planned. If the electricity tariff increases to the current Japanese level, its financial feasibility will be improve to the satisfactory levels shown in Table 7-12.

As for the third measure, a VAV system in the air-conditioning, FIRROIs before and after tax are 35.4% and 24.9%, respectively, which are well above the opportunity cost of capital in Malaysia, and the payback period is 3.9 years. Because of these favorable indicators, this measure can be regarded as financially feasible.

7-7 Recommendations for Energy Efficiency Promotion

Based on the energy audit and subsequent study for Mingcourt Vista Hotel, the following measures are recommended for improving its energy efficiency.

(1) Measures Requiring Investment

(a) It is recommended that a Variable Air Volume (VAV) system be installed in the hotel's air-conditioning. It can be said that this measure is financial feasible from the results of the financial evaluation.

(b) Investigation is recommended for the installation of an inverter control system in the lifts at the time of lift replacement. According to the financial evaluation, this measure is at a marginal level of financial feasibility.

(c) Although installation of an ice storage system in the hotel's chiller system is not financially feasible under the current electricity tariff of TNB, it has the potential for financial feasibility, provided that the price of electricity increases to the current level in Japan. It is recommended that this measure be investigated in the event that electricity tariff increases in future.

(2) Measures Not Requiring Investment

(a) It is recommended that the hotel investigate increasing the temperature of its building area. The expected benefit from increasing the temperature by 2℃ is an RM 140 thousand annual saving in the electricity bill, which is the largest benefit among the recommended measures.

(3) Other Recommendations

Other recommendations are listed in Table 7-13.

Table 7-13 Other Recommendations

Category		Recommendations
Operation Management	(a)	To reduce suction air volume during air-conditioning
	(b)	To adjust suction air volume to control carbon dioxide content
	(c)	To install automatic control for air-conditioning
	(d)	To optimize setting temperature of water and air supply
	(e)	To optimize setting temperature and humidity in air-conditioned rooms
	(f)	To introduce local air-conditioning for areas where intensive air-conditioning is required
	(g)	To adjust the setting temperature and pressure of the heat source for air-conditioning
	(h)	To adjust the number of operating heat sources for air-conditioning
	(i)	To control and adjust the number of operating fans and pumps in the air-conditioning system
Maintenance Management	(a)	To inspect and repair air-leakage from the ducts
	(b)	To clean the coils and filters of air-conditioners
	(c)	To clean the condensers and evaporators of chillers
	(d)	To inspect and repair automatic control instruments
	(e)	To reinforce the monitoring system by increasing the number of measuring equipment pieces
	(f)	To clean lighting appliances and exchange old lamps
	(g)	To increase lighting efficiency by cleaning the inner surfaces of rooms
	(h)	To extinguish lights around windows
	(i)	To regularly open/close blinds
	(j)	To regularly close front & stairwell doors
	(k)	To frequently open/close windows
	(l)	To disseminate information on energy efficiency promotion and to request guests to follow it.

Chapter 8 Shopping Complex

This shopping complex was founded in 1995, and consists of a 5 storey building with a total floor area of 191,752m^2, making it one of the largest and most modern shopping complexes in Malaysia. Energy consumption is mostly concentrated on electricity, and the study team conducted an intensive audit on electricity consumption.

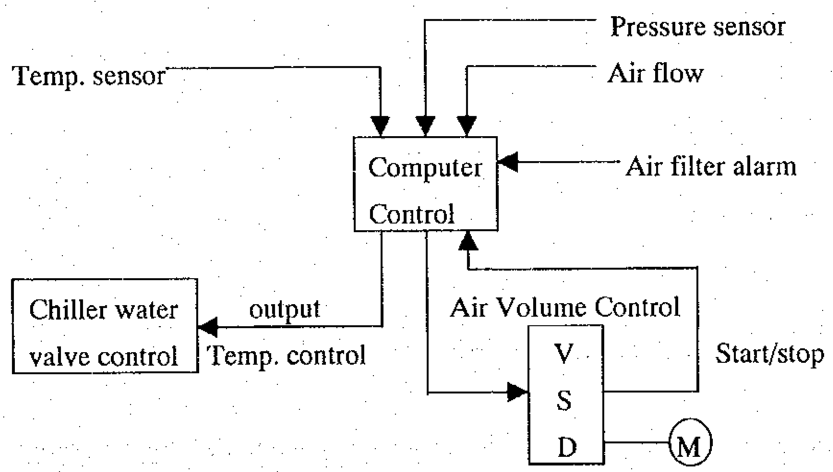
8-1 Outline of Shopping Complex

(1) Name of the Shopping Complex: Bandra Utama Shopping Center
(2) Number of employees (management staff of facilities): 110
(3) Total floor area of the shopping complex : 191,751.53sqm
(4) Year of establishment: August 15, 1995
(5) Service activities: (Daily service hour) From 10:00 to 22:00

8-2 Major Energy-Consuming Facilities

(1) Space conditioning system: Central air conditioning system with two cooling air supply ducts.
VAV (valuable air volume) by computer control is adopted for air conditioning.

Computer control system of chiller:



(2) Ventilation: The car park and toilets have individual ventilation systems.
For basement ventilation, one air control unit is operated under regular conditions and two units are operated under emergency conditions.

(3) Chiller control system: A two-zone system is applied for the suitable zoning of air conditioning.

(4) Energy conveying system: Air ducts are covered with 2-inch thick glass fiber.
2-inch thick polyurethane with a steel cover is applied for insulation of chilled water pipes.

(5) Lighting system: Fluorescent lights and metal halide lamps are in use.

(6) Water condition: City water is exclusively utilized for facilities.

(7) Specification of elevators and escalators:
Carrying capacity: 1,600 kg, 24 persons; Speed: 60 m/min

(8) Electrical power receiving facilities: Receiving type is double- line. Receiving voltage is 33kV.

8-3 Method of Energy Audit and Result

In order to conduct an energy audit of this shopping complex, taking measurements was the first essential step and developing an energy balance the second. The result of the energy audit, including evaluation, analysis and recommendations for improved energy efficiency, are described below.

Major energy audit items for the shopping complex were as follows:

1. Electrical power receiving and distribution
2. Air-conditioning system
   (a) Mechanical performance
   (b) Air conditions
   (c) Electricity consumption
3. Lighting system

8-3-1 Outline of Measuring Items, Points and Measuring Equipment

To calculate and evaluate the current condition of energy consumption and to develop an energy balance, measurements described below for the main energy audit items were conducted according to the schedule.

(1) Electrical Power Receiving and Distribution

1) HV receivers: Trend data of voltage, current, kW and power factor
2) HV distributors: Trend data of voltage, current, kW and power factor
3) LV distributors: voltage and current

(2) Air-conditioning System

1) Chillers and ice storage system: Inlet/outlet water temperature, water flow rate (primary and secondary), voltage, current, kW and power factor
2) Cooling towers: Inlet/outlet water temperature, water flow rate
3) Air Handling Units (AHUs): voltage and current, flow rate and temperature of air, inlet/outlet temperature of chilled water
4) Air-conditioned area: temperature, humidity and CO_2 content
5) Air-conditioned rooms: temperature , humidity and CO_2 content
6) Outdoor conditions: temperature, humidity and CO_2 content

(3) Lighting System

1) Common space: Illumination intensity

(4) General Energy Consumption

1) Electricity consumption
2) Chilled water consumption

(5) Field Investigation

1) Review of equipment list
2) Investigation of drawings
3) Observation of operating conditions of equipment and facilities

8-3-2 Measurement Results

The typical measurement results are as follows.

(1) Electricity

Single Line Diagram

There are two incoming lines from TNB. The measuring points are shown by the number (①

to ⑨) in Figure 8-1.

(2) Electricity Consumption (Figure 8-2)

This figure shows a substantial difference in electricity consumption between day and night.

(3) Operation of Chiller and Pumps (Figure 8-3 and Figure 8-4)

The chiller system is so complicated and advanced that the operating pattern changes quite drastically. These figures show a simplified pattern change. The dark colored equipment in Figure 8-3 and Figure 8-4 are the items in operation.

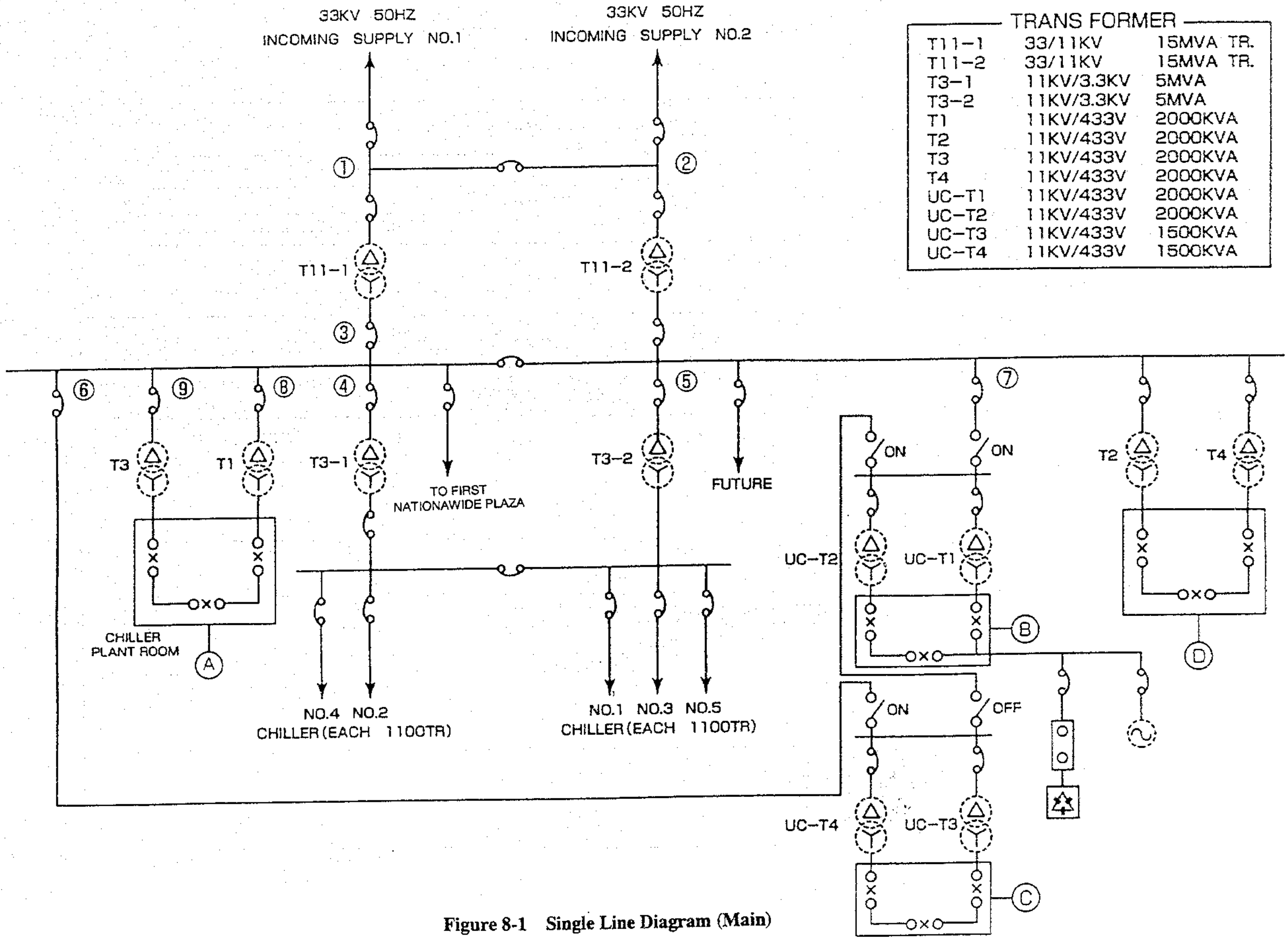
(4) Air Condition in Shopping Building

1) Energy Loss from Building Entrance (Table 8-1 and Figure 8-5)

A large amount of heat was found to be escaping from the front and back entrances.

2) Temperature and Lighting Intensity (Figure 8-6 and Figure 8-7)

These figures show the differences in values.

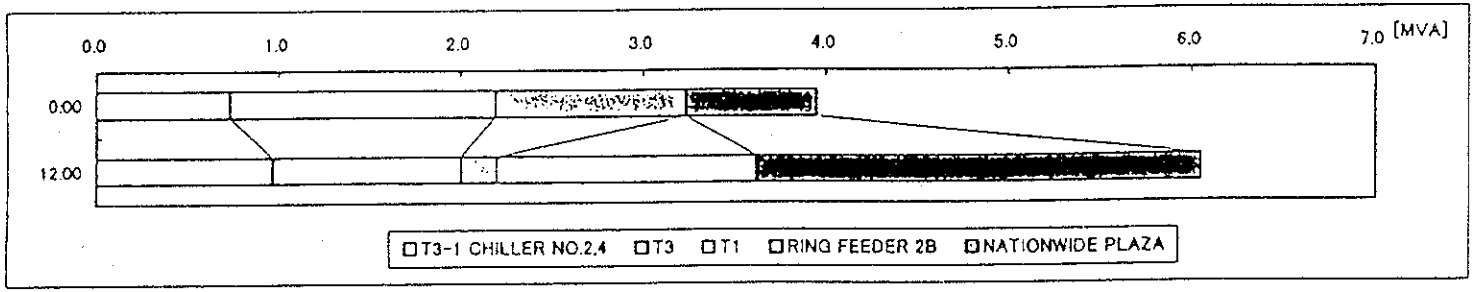


TRANS FORMER		
T11-1	33/11KV	15MVA TR.
T11-2	33/11KV	15MVA TR.
T3-1	11KV/3.3KV	5MVA
T3-2	11KV/3.3KV	5MVA
T1	11KV/433V	2000KVA
T2	11KV/433V	2000KVA
T3	11KV/433V	2000KVA
T4	11KV/433V	2000KVA
UC-T1	11KV/433V	2000KVA
UC-T2	11KV/433V	2000KVA
UC-T3	11KV/433V	1500KVA
UC-T4	11KV/433V	1500KVA

Figure 8-1 Single Line Diagram (Main)

Electric Consumption Balance No.1 [MVA]

	T3-1 CHILLER NO.2,4	T3	T1	RING FEEDER 2B	NATIONWIDE PLAZA	Incoming Supply No.1
0:00	0.73	1.46	1.04	0.00	0.72	3.95
12:00	0.97	1.04	0.20	1.42	2.43	6.05



Electric Consumption Balance No.2 [MVA]

	T3-2 CHILLER NO.1,3,5	RING FEEDER 1A	T2,T4	Incoming Supply No.2
0:00	0.61	0.92	0.75	2.28
12:00	0.00	3.05	1.27	4.32

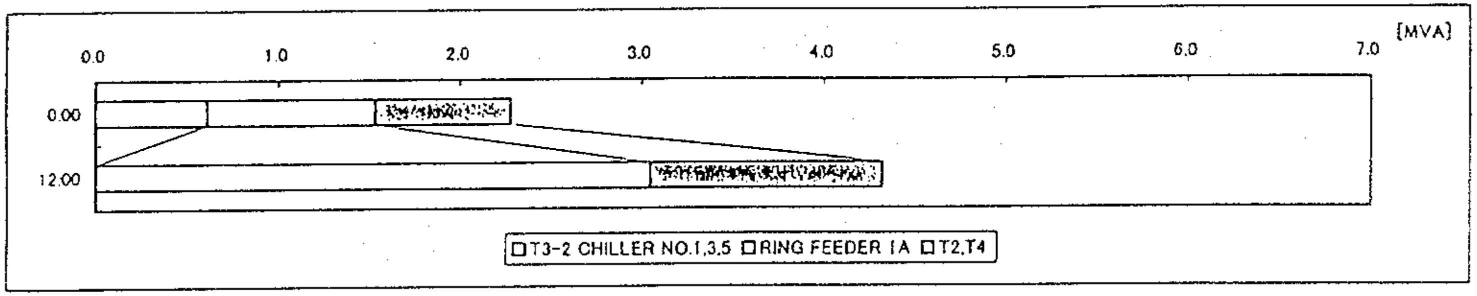


Figure 8-2 Electricity Consumption Pattern

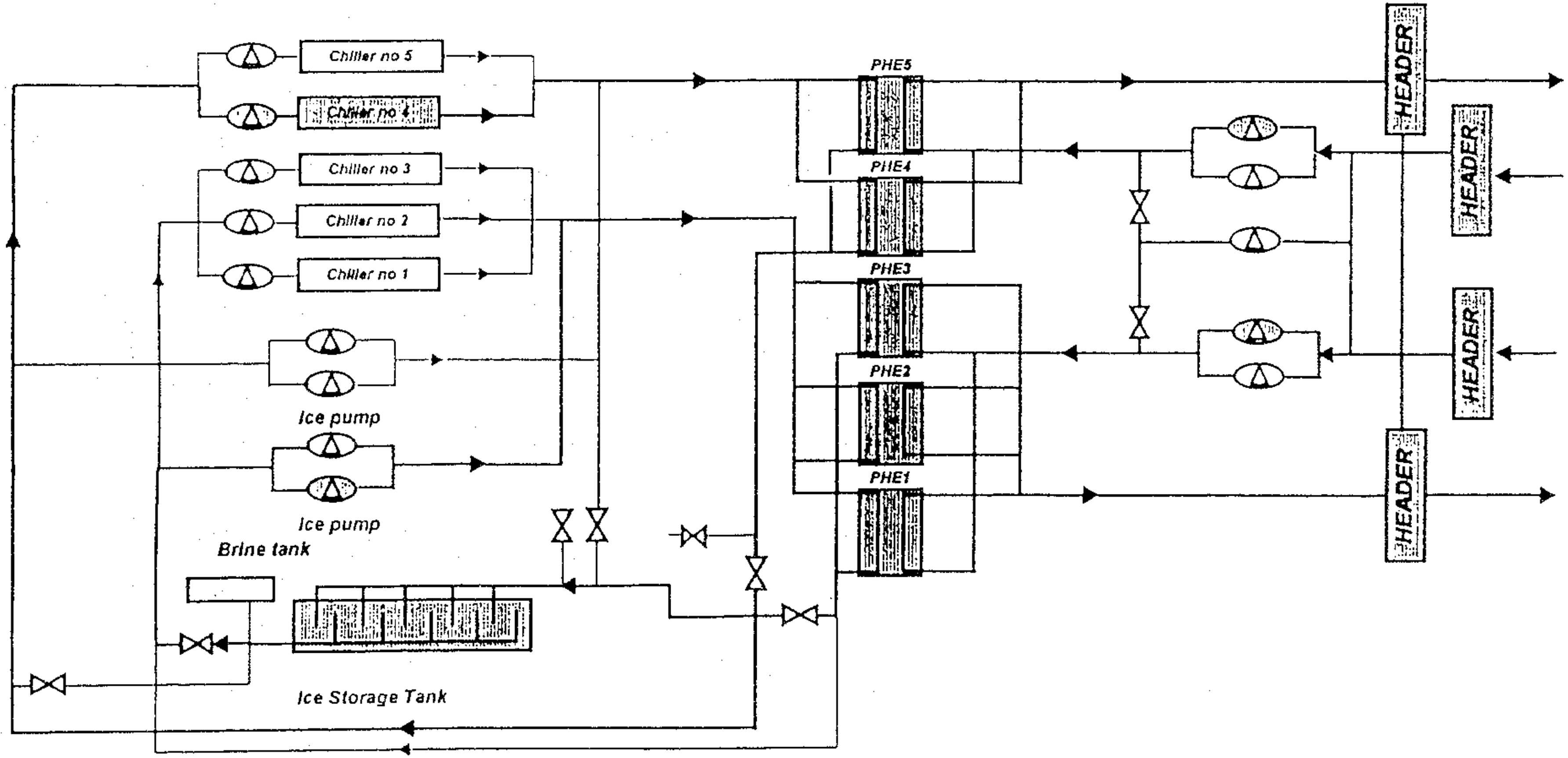


Figure 8-3 Brine / Chilled Water Loop (Daytime Operation)

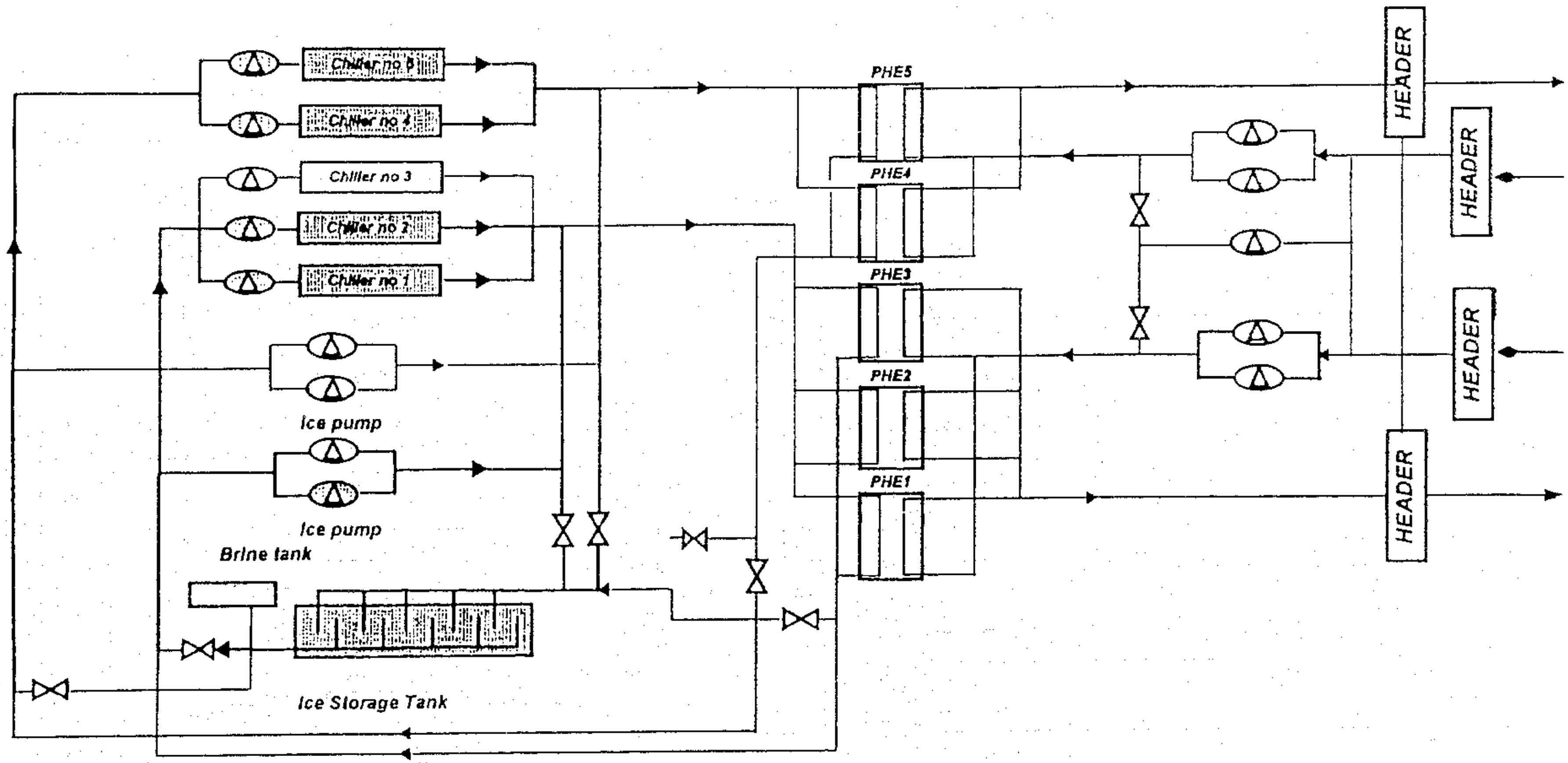


Figure 8-4 Brine / Chilled Water Loop (Nighttime Operation)

Table 8-1 (Air Condition) Heat Loss from Entrance

No	Average Velocity * m/s	Temp Inside °C	Temp Outside °C	Width m	Height m	Area m^2	Comments	Heat Release Rate (kcal/hr)
1	1.086	21	30	1.7	2.05	3.485		38053
2	1.024	24	28	2	1.71	3.42		15649
3	-0.9	25	31	2.37	2.1	4.977	Auto Door 6 Sec	30024
4	-0.86	26	30	2.37	1.76	4.1712		16030
5	1.7	22	25	2.37	1.76	4.1712	Auto Door /Broken	23765
6	1.57	22	27	2.37	1.76	4.1712	Auto	36580
7	1.6	20	30	2.33	1.76	4.1008		73299
8	-0.84	20	30	2.34	1.73	4.0482	Auto/Broken	37989
9	1.8	22	28	1.8	2.1	3.78		45607
10	2	23	30	1.77	2.1	3.717		58134
11	1.46	23	30	0.86	2.1	1.806		20620
12	1.53	24	31	1.77	2.1	3.717		44473
20	1.35	24	28	0.9	2.34	2.106		12705
Total								452.928

* Note: Negative value of average velocity means out-going air flow.

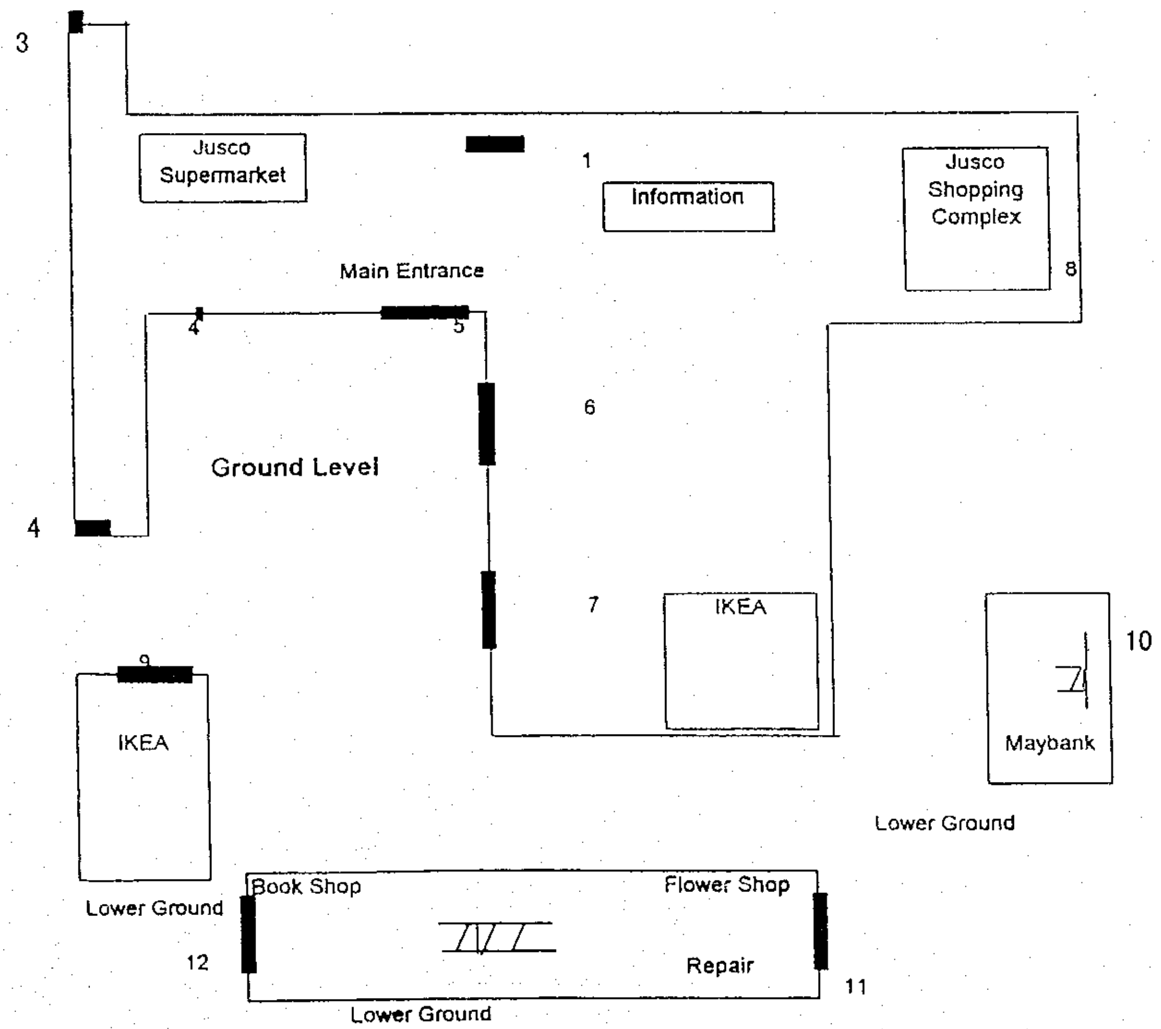


Figure 8-5 Measuring Points of Heat Loss

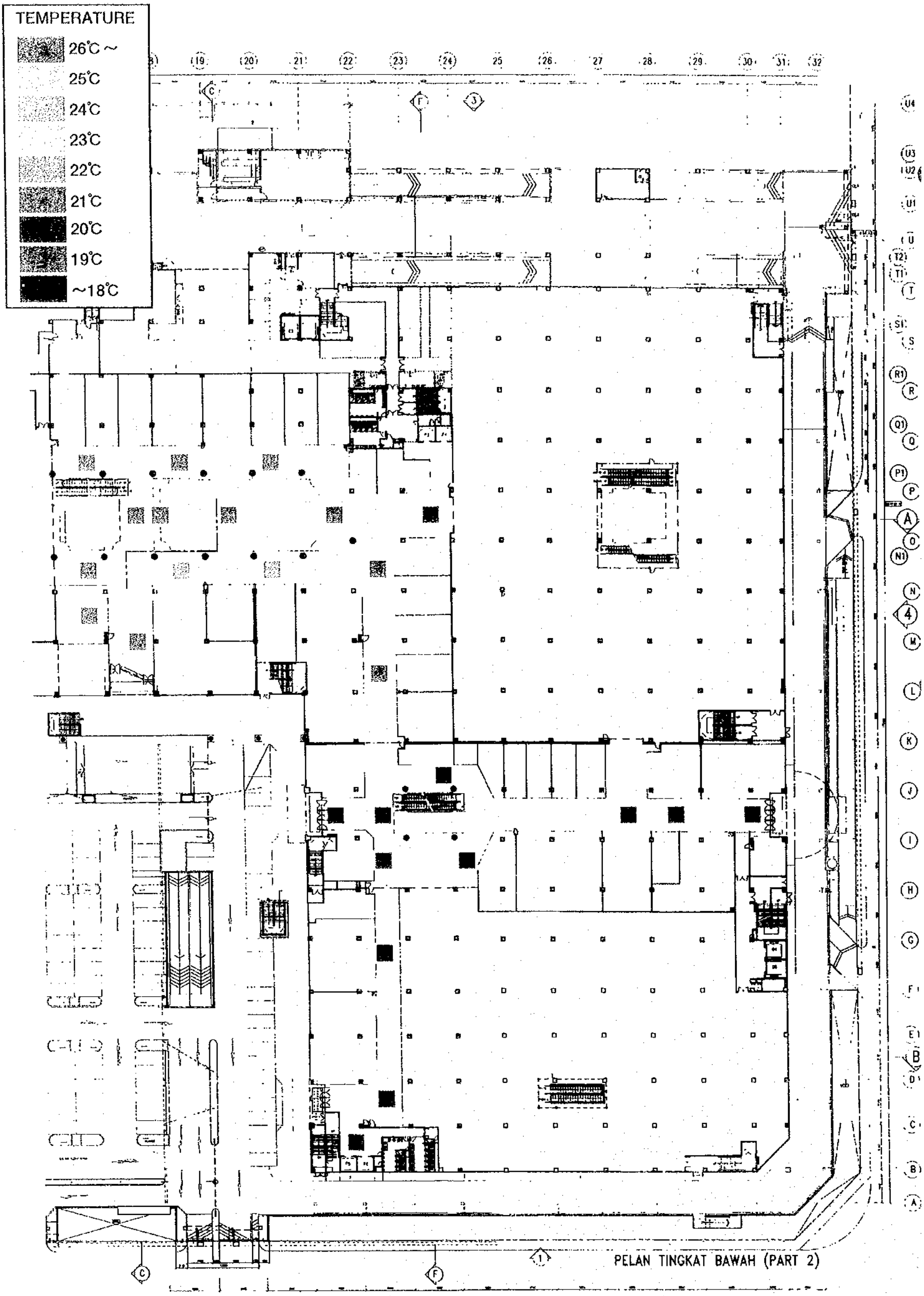


Figure 8-6 Temperature Pattern

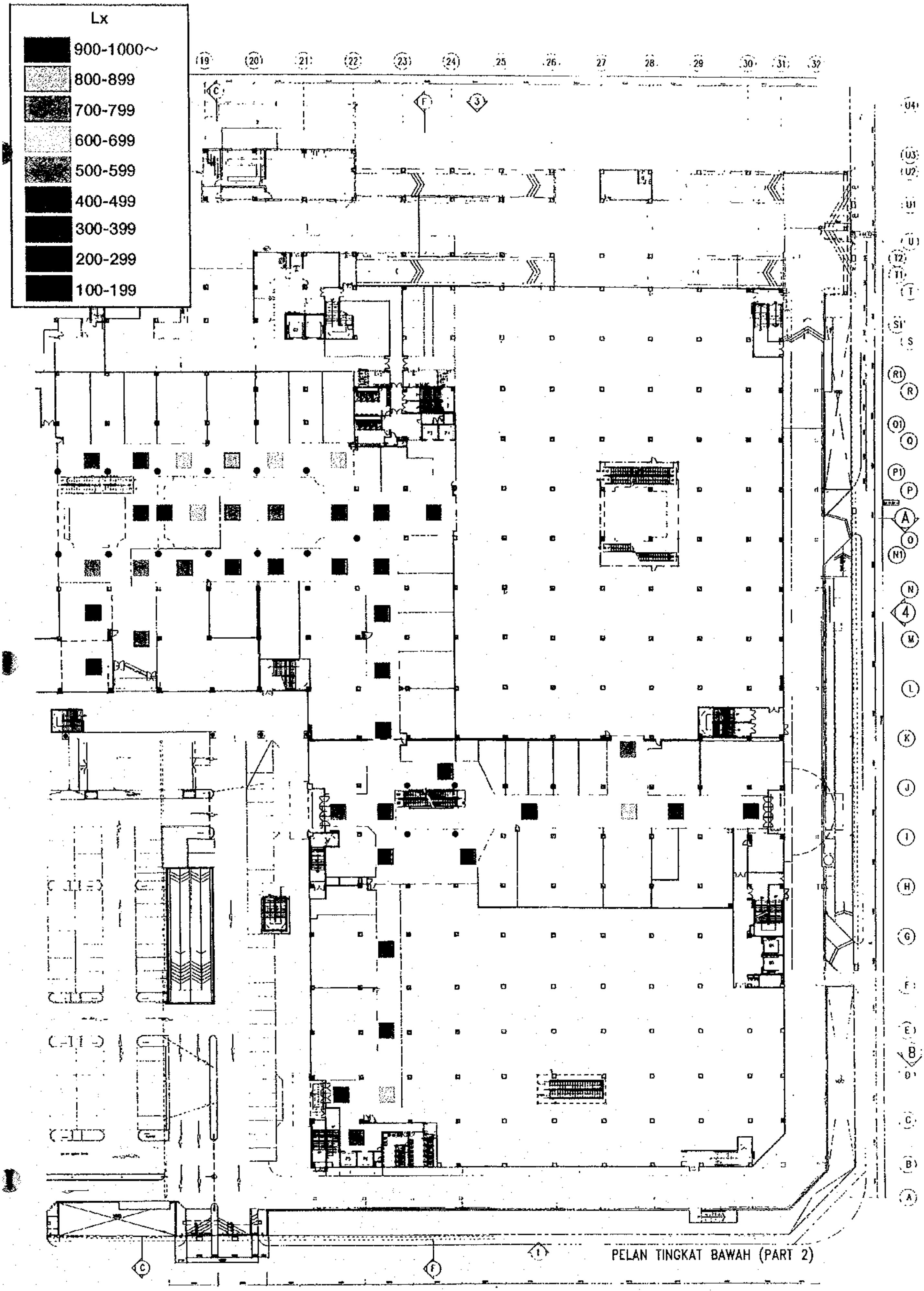


Figure 8-7 Illumination Intensity Pattern

8-3-3 Total Energy Balance of the Shopping Complex and Energy Balance

Table 8-2 Total Energy Balance of the Shopping Complex

Energy Type	Utilization	Energy Consumption		Lake Side Building	
		Basic Unit	Kcal / h*10^3	Basic Unit	Kcal / h*10^3
Electricity	Chiller	4700 kwh/h	10575	490 kwh/h	1100
	Lighting	1870 kwh/h	4207	520 kwh/h	1170
	Lifts	300 kwh/h	675		
	Others	200 kwh/h	450		
LPG	Cooking	2.86 m^3/h	68	3.01 m^3/h	71
City Water	Kitchens / Toilets	12.23 m^3/h	-	6.84 m^3/h	-
Total			15907		

Energy Calculation Rate : (EL) 2250 kcal / kwh, (LPG) 23,640 kcal / Nm^3

Energy Consumption Pattern and Maximum Demand :

Peak Consumption : 70%

Off-Peak Consumption : 30%

Maximum Demand : 9380 kw

a) Heat released from Cooling Tower

Total Condensate : 24,700 Ton/Day

Temperature Difference: 3.78℃

Heat Transferred: 93,300 $\times 10^3$ kcal/Day

b) Total area of the shopping complex: 191,751 m^2

c) Energy consumption per area: 1,990 kcal / m^2/Day

717 $\times 10^3$ kcal / m^2/Year

Compared to Japanese energy consumption levels, this shopping complex shows rather high values because of the ice-storage system. (1996 Data of Japanese Department Stores and Supermarkets: 345 $\times 10^3$ kcal / m^2/Year)

Figure 8-8 illustrates energy flow of the shopping complex.

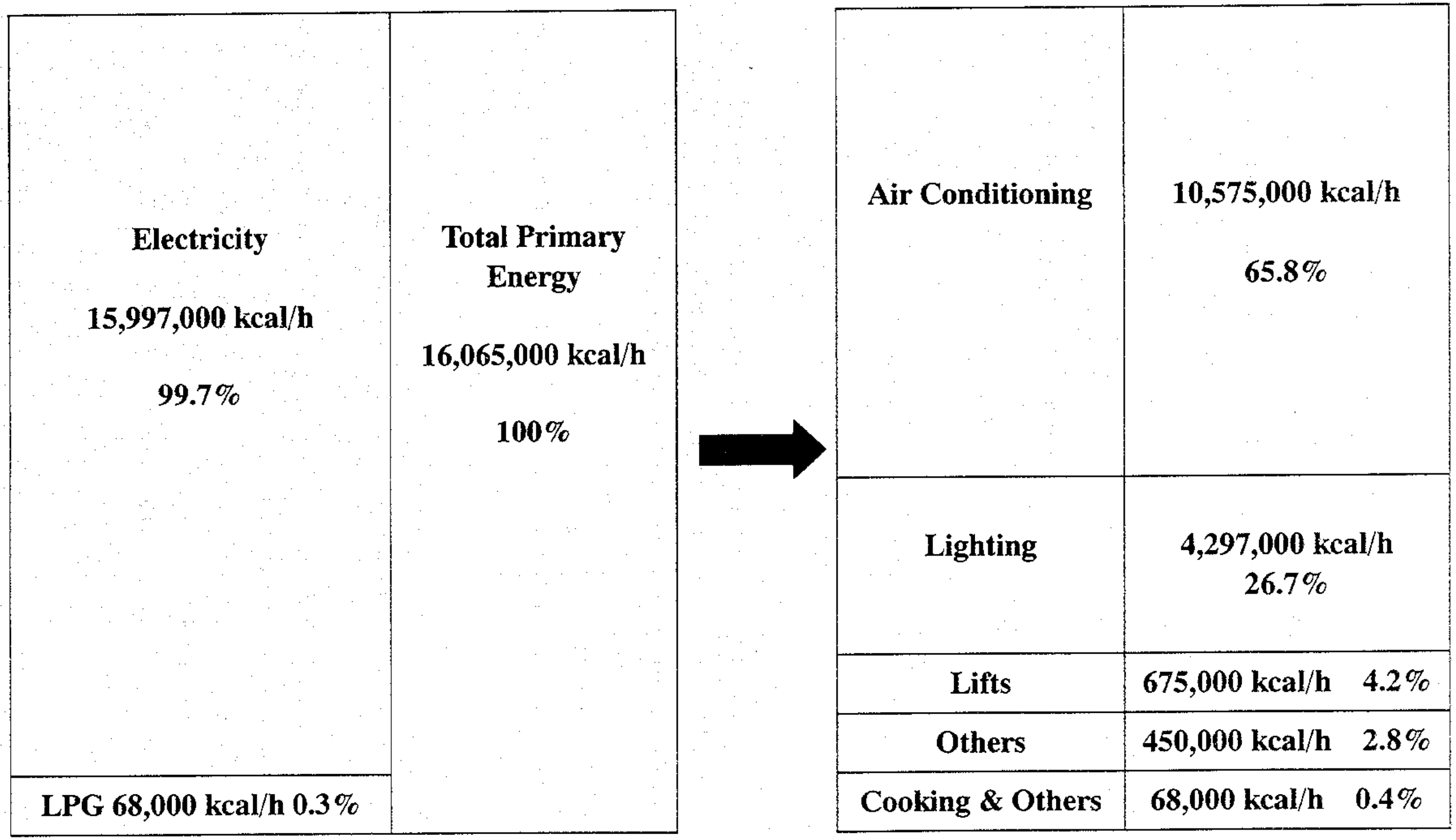


Figure 8-8 Energy Flow of Shopping Complex

8-4 Measures for Energy Efficiency Promotion

8-4-1 Improvement of Electric Power Receiving and Distribution

(1) Demand Ratio of Transformers

It is recommended that in order to adjust the allocation of electricity load to each transformer, the maximum demand ratio should be kept under eighty percent (80%).

(2) Electric Power Balance

As the transformers are operating below capacity, load imbalance poses no serious problem for the time being. However, further increase in load requires a study of the electric power balance together with the efficiency of transformers in future.

(3) Incoming Voltage

Tap adjustment of the transformer or adoption of an automatic voltage controller is recommended.

(4) Frequency

There is no regulation regarding acceptable frequency deviation in Japan. But a Japanese power supplier would keep between 49.8 and 50.2 Hz in the case of a 50 Hz region for example. It is recommended that the operating conditions be observed constantly as a measure.

(5) Electricity Consumption Trend

It is preferable to keep the value at around seventy percent (70%) by improving the ice storage system for example.

(6) Power Factor

The following measures should be taken to improve the low power factor up to 0.5 to 0.6.

1) Improve the operating method (including ice storage system), as the operating load is low judging from the power factor of 0.5 in the Chiller TX-1 circuit.
2) Most circuits except Ring Feeder No.1A show below 0.6. It is recommended that the uneven current of each phase be studied and the connection load adjusted.
3) In order to improve the power factor, it is necessary to review the condenser capacity and the automatic circuit of power factor adjustment.

8-4-2 Improvement of Air-conditioning System

(1) Chillers

Further energy savings could be attained by changing the current operating method to an improved one.

Present: one unit / daytime, four units / nighttime

Improved mode: zero unit / daytime, five units / nighttime

(No chiller operation during daytime)

This change could contribute to a reduction in the maximum demand and take advantage of the difference in electricity prices between night and day to the maximum extent. However, ice-making by the five chillers during nighttime will not be able to supply enough heat to the system, and additional ice-storage tanks will be required.

Unit operation for ice making:

$$700 \times 5\text{units} \times 10\text{ Hours} = 35{,}000$$

A capacity increase of the chillers or an energy saving of 3,000 RT is required.

10,000 RT ice storage tanks are necessary.

From the above calculations, it is strongly recommended that new ice-storage tanks be installed by utilizing the existing spare tanks to the maximum. It is also recommended that a study be conducted on ice-storage expansion method tanks, since new effective energy-saving technology (energy regenerative system) is quite commonly used in Japan, such as plastic ice balls (latent heat storage).

To reduce the electricity consumption of pump motors, a variable water volume system (VWV) would be effective.

In Malaysia, the utilization of natural gas has become quite common and cost-effective. In the event of future expansion of this shopping complex, utilization of natural gas should be studied together with co-generation systems, absorption type chillers and so on.

The brine of this chiller system is ethylene glycols in water. And the concentration of ethylene glycols is 28% (35% is maximum concentration). Increasing the concentration of ethylene glycols would lower the melting point and make the temperature difference greater. Consequently the chiller capacity could be increased.

(2) Air Handling Units

Maintenance of AHU is strongly recommended, especially for the leakage of ducts, cleaning of filters and removal of blocking materials. By careful maintenance of these, pressure drops through the system would decrease and electricity consumption could be saved together with air-quantity control. Installation of a heat exchanger for intake-air and recycling-air (overall type or partial exchangers) is recommended. Co-operation and collaboration between Bandar Utama City Corporation and JUSCO is essential to achieve effective energy use.

(3) Other Facilities

The building itself is quite new and built airtight. However, the following would further improve energy saving.

- Install blinds and curtains (especially management area)
- Renovate glass windows by adopting thermic ray absorption-adjusting film
- Repair of slits and weather strips on the walls.

8-4-3 Improvement of Lighting System and Air Condition

(1) As the lighting intensity of each shop is rather high, decreasing the lighting intensity of common areas would highlight the interior of the shops better.

(2) To normalize the lighting intensity, the following measures should be studied.

- Reduction of number of lights one switch covers
- Utilization of outside light (sun shine)
- Adoption of automatic on-off switch
- Control system for lighting intensity

(3) Decreasing the air volume of the AHU could increase the average temperature, leading to energy efficiency. In addition, the adoption of an inverter control for the AHU fan, which depends on heat requirements, would also contribute to further energy efficiency. The variable air volume (VAV) system should be studied for controlling air volume.

(4) The installation of temperature censors at critical locations provides an effective energy saving method. And the cost of censors is quite cheap.

(5) Front and back entrances are always open, which results in a large heat loss.

8-5 Potential of Energy Efficiency Promotion

The Following are the potentials of energy efficiency promotion.

(1) Stoppage of incoming transformer: 20kW

(2) Decreasing illumination intensity: 24kW

(3) Increasing temperature of building area by 2℃: 940kW
20% reduction in electric energy for chiller

(4) Prevention of heat loss from entrances: 75kW
80% reduction in entrance loss (452,000 kcal/h)

(5) Utilization of off-peak electricity: 940kW-100kW
Decreased electricity: 20+24+940+75-100= 959kW (23,000kW/D)
Converted electricity from daytime to night: 940kW (22,560kW/D)
Current Daily Consumption: 7,070kW (169,700 kW/D)
Rate of Decrease: 13.5%
Convert Ratio: 13.3%

8-6 Cost of Measures for Energy Efficiency Promotion

The following is a summery of the cost of energy efficiency improvements.

(1) Stoppage of Incoming Transformer:
The transformer (T-11-1) could be stopped, since the transformer's total load is rather small.
Consequently, only the transformer (T-11-2) would operate.
Manual cut-off operation could be conducted. Cost : Zero

(2) Decreasing Illumination Intensity :
1) Extinguishing unneccesary lights : 100W*100 (10kW) Cost : Zero

2) Replacing incandescent bulbs (100W) with fluorescent lighting (60W) : 40W*100 (4kW).
Cost : Zero

3) Automatic on-off system activated by lighting intensity : 100W*100 (10kW)

Cost : ¥266,000

(3) Increasing the Temperature of Building Area by 2℃:

Cost : Zero

(4) Prevention of Heat Loss from Entrances:

80% reduction in entrance loss (452,000 kcal/h)

1) Air Curtain	Cost :	¥126,000
2) Rotating Door	Cost :	¥8,000,000

(5) Utilization of Off-peak Electricity:

1) Ice Strorage:		¥68,000,000
2) Brine and chilled water exchanger / Brine tank / Pumps:		¥10,000,000
3) Instrument:		¥8,000,000
4) Piping:		¥21,200,000
	Cost :	¥107,200,000

8-7 Benefit of Measures for Energy Efficiency Promotion

8-7-1 Current Price of Energy in Malaysia

Electric power could be saved by all the recommended measures for improved energy efficiency. The current price of electric power conforms to category C2 of TENAGA NASIONAL's tariff, effective from 1 May, 1997, in the case of Bandar Utama Shopping Center. The following rates are applied, according to this category of tariff.

- -Peak load rate (between 800 and 2200 hours): 0.208 RM/kWh
- -Off-peak load rate (between 2200 and 800 hours): 0.128 RM/ kWh
- -Maximum demand charge: 25.7RM/kW/month

8-7-2 Benefits of Measures

The benefit of measures are estimated and the results are summarized in Table 8-3.

Table 8-3 Estimation of Benefit from Measures

Measures	Benefit, RM/year
Stoppage of Incoming Transformer	36,770
Decreasing the illumination intensity	58,533
Increasing the temperature of building area by 2℃	2,209,720
Prevention of heat loss from entrances	182,916
Utilization of off-peak electricity	836,520

8-8 Financial Evaluation of Measures

In this section, financial evaluations are made of the following measures involving investment in order to find out the financial feasibility of the measures.

- Decreasing the illumination intensity
- Prevention of heat loss from entrances
- Utilization of off-peak electricity

8-8-1 Premises for Financial Evaluation

Financial evaluations are made on the following premises.

(1) Exchange rate: US$ 1 = RM 3.8 ; US$ 1 = JY 118

(2) Project life: 15 years from the start of operation

(3) Corporate tax rate: 35 percent

(4) Depreciation: The straight-line method is applied. Depreciation rate is 7.5% per annum for the plant and machinery.

(5) Fixed investment: The fixed investment cost shown in Table 8-4 in Malaysian Dollars, converted from Japanese Yen value in the previous section is used for the financial evaluation.

Table 8-4 Fixed Investment for Measures

Measures	Fixed Investment, RM
Decreasing the illumination intensity	8,566
Prevention of heat loss from entrances	261,685
Utilization of off-peak electricity	3,452,203

8-8-2 Results of Financial Evaluation

Table 8-5 shows FIRROI before tax, FIRROI after tax and payback period for the three measures.

Table 8-5 Results of Financial Evaluation

Measures	FIRROI before tax	FIRROI after tax	Payback Period
Decreasing the illumination intensity	683.3%	446.8%	0.2 years
Prevention of heat loss from entrances	69.9%	47.9%	2.1 years
Utilization of off-peak electricity	23.2%	16.4%	5.4 years

8-8-3 Conclusion of Financial Evaluation

According to the information obtained during the field survey, the lending rate in Malaysia has been ranging from 12 to 14% per annum recently. This rate could be regarded as an indication of the opportunity cost of capital in Malaysia.

For all three measures, FIRROIs calculated exceed this rate. In addition, the first two measures, "Decreasing the illumination intensity" and "Prevention of heat loss from entrances", have good payback periods, and the last measure "Utilization of off-peak electricity" has a reasonable payback period duration. It is concluded that all three measures can be regarded as financially feasible under the conditions of this study.

8-9 Recommendations for Energy Efficiency Promotion

Based on the energy audit and subsequent study for Bandar Utama Shopping Center, the following measures are recommended for improving its energy efficiency.

(1) Measures Requiring Investment

1) The following are recommended: decrease the illumination intensity by installing an automatic on-off system activated by lighting intensity; replace incandescent bulbs with fluorescent lights; and extinguish unnecessary lights. This investment measure can be regarded as financially feasible based on the financial evaluation.

2) It is recommended that heat loss from entrances be prevented by installation of rotating doors and air curtains. The investment for this measure appears financially feasible.

3) It is recommend that off-peak electricity be utilized by expanding the ice storage system. The investment can be said to be financially feasible as well.

(2) Measures Not Requiring Investment

1) Stoppage of the incoming transformer, T-11-1, is recommended. This measure will enable an RM37,000 annual saving in the electricity bill without any investment.

2) It is recommend that the temperature of building areas be increased by 2℃. By this measure, an RM 2.2 million annual saving in the electricity bill is expected. This is the largest benefit among the recommended measures.

(3) Other Recommendations

Other recommendations are listed in Table 8-6.

Table 8-6 Other Recommendations

Category		Recommendations
Architectural Structure	(a)	To install blinds and curtains on windows to shelter rooms from sunshine
	(b)	To renovate glass windows by adopting thermic ray absorption film
	(c)	To repair slits and replace weather strips on the walls
Renovation and Expansion of Air-conditioning	(a)	To install an overall air heat exchanger in future when the number of customers increases
	(b)	To make a study on the co-generation system if LPG becomes available as a heat source in future
	(c)	To install an additional Variable Air Volume (VAV) system
	(d)	To adjust the room pressure to prevent excess draft
Operation, Maintenance, Management, Living Style and Others	(a)	To reduce suction air volume from entrances
	(b)	To adjust suction air volume by installation of carbon dioxide detectors
	(c)	To establish rules of air-conditioning system operation between Bandar Utama City Corporation and JUSCO before introducing an automatic control system for the air-conditioning system
	(d)	To inspect and repair air leakage from the ducts
	(e)	To clean coils and filters of air-conditioners
	(f)	To clean condensers and evaporators of chillers
	(g)	To reinforce the monitoring system by increasing the number of measuring equipment pieces
	(h)	To clean lighting appliances and exchange aged lamps
	(i)	To increase lighting efficiency by cleaning the inner surfaces of rooms
	(j)	To extinguish lights around windows
	(k)	To regularly open/close blinds
	(l)	To regularly close front & stairwell doors
	(m)	To frequently open/close windows

Chapter 9 Hospital (Hospital Seremban)

9-1 Outline of Hospital

Hospital Seremban was founded in 1969, and has a T-shaped 9-storey tower block accommodating inpatients (800 beds); a single-storey podium housing outpatients; and a Treatment and Diagnostic area. The hospital is owned by the Federal Government as a representative and general hospital in the State (Negeri Sembilan). It has various kinds of energy-consuming facilities found in the commercial sector, such as the facilities using electricity, fuel oil, chilled water, hot water and steam. Therefore, the study team conducted an audit of the various types of energy consumption.

The results of the hospital energy audit, including evaluation, analysis and recommendations for improvements of energy efficiency, are described in this chapter.

9-1-1 Outline of Hospital

(1) Name of Hospital:	Hospital Seremban
(2) Address:	Jalan Dr. Muthu, off Jalan Rasah, 70300 Seremban,Nageri Sembilan Telephone: 06-723333, Facsimile: 06-7625771
(3) Director:	Dr. T. Mahadevan
Hospital administrator:	Dr. K. Gunapusanam (Deputy Director)
Energy manager :	Tongkah Medivest Sdn. Bhd. Service Center, Hospital Seremban (privatized company)
(4) Type of the hospital:	Public (federal government-owned)
(5) Annual expenditure:	RM 60 Million/year
(6) Organization chart:	Shown in the Figure 9-1
(7) Number of employees:	1,700 (permanent staff including clinical, non-clinical and supporting services) Doctors: 172, Nurses: 597
(8) Number of energy-related managing staff:	Maintenance engineers: 4, Maintenance workers: 88
(9) Year of establishment:	1969 (new hospital)

9-2 Outline of Facilities and Energy-Consuming Equipment and Facilities

(1) Total area of hospital, ha: 85 (new hospital: 26, old hospital: 59)

(2) Total floor area, ha: 4 (new hospital: T-shaped 9-storey tower block accomodating inpatients with a single-story podium housing outpatients and a Treatment and Diagnostic area)

(3) Number of beds: 800

(4) Major services: Clinical: 14 disciplines; medical & clinical training: 12 courses; supporting services: 11 items

1) Service Mode for Outpatients

Service days for outpatients in a week are 6 (six) and service hours are as follows:

Monday - Friday:	8:00 AM - 4:15 PM
Saturday:	8:00 AM - 12:45 PM
Sunday:	Holiday

2) Service Mode for Accident and Emergency

Service mode for accident and emergency is as follows:

Service days in a year, days: 365, Service hours in a day, hours: 24

(5) Kinds of fuels:

Light Fuel Oil: Fuel for the horizontal & smoke tube-type boilers (3 units)

Diesel Oil: Fuel for the emergency power generators (2 units) and incinerator

(6) Monthly energy consumption in 1997:

L.F.O, kl/month, RM/month:	85.7,	30,000
Electricity, MWh/month, RM/month:	571.4,	120,000

(7) Outlines of major energy-consuming facilities: Shown in Table 9-1

1) Boilers

2) Chillers

(8) Electric power receiving:

1) Receiving Voltage, kV: 11

2) Current demand, kW: 1,000

3) Current Power Factor, %: 85

4) Capacity of power generator for emergency, kVA: 750 & 819 (50% of normal demand)

(9) Utilization of Steam and Electricity:

1) Steam: Kitchen & laundry, hot water storage calorifiers, domestic hot water calorifiers, bed-pan washer's washing machines, sterilizers, humidifiers and reheating coils of the air-handling units
2) Electricity: All the power for air-conditioning, lighting and others is received from TNB through a sub-station

(10) Energy Management

A privatized supporting service company, named Tongkah Medivest Sdn. Bhd., is in charge of energy and maintenance management in this hospital.

The main hospital complex was built in 1969 and some energy-consuming facilities have been modified since then, for example the chillers.

9-3 Energy Audit and Result

The energy audit for the hospital was conducted from 29 June to 9 July, 1998. It included preparation for measurements and preliminary discussion of measurement results.

9-3-1 Major Items of Energy Audit

To calculate and evaluate the current condition of energy consumption and to develop an energy balance, the measurements described below for the main energy audit items were carried out according to the schedule.

(1) Electrical Power Receiving and Distribution

1) HV receivers: Trend data of voltage, current, kW and power factor
2) HV distributors: Trend data of voltage, current , kW and power factor
3) LV distributor: voltage and current

(2) Air-Conditioning System

1) Chillers: Inlet/outlet water temperature, flow rate of chilled water, voltage, current, kW and power factor
2) Cooling towers: Inlet/outlet water temperature, water flow rate
3) Air Handling Units(AHUs): voltage and current, flow rate & temperature of air
4) Blowers & fans: air flow rate, voltage, current
5) Air-conditioned area: temperature, humidity and CO_2 content

6) Air-conditioned rooms: temperature and humidity

7) Outdoor condition: temperature, humidity and CO_2 content

(3) Lighting System

1) Common space: Illumination intensity

2) Rooms: Illumination intensity

(4) Heat-Consuming Facilities

1) Steam boilers: Flow rate & properties of fuel oil; flow rate, temperature, electric conductivity and pH of BFW; temperature and pressure of generated steam; temperature, O_2, CO and CO_2 content of flue gas

2) Calorifiers: Temperature of hot water

3) Thermal insulation: Surface temperature of the boilers

(5) General Energy Consumption

1) Electricity consumption

2) Fuel oil consumption

(6) Field Investigation

1) Review of equipment list

2) Investigation of drawings

3) Observation of operating conditions, equipment and facilities

Table 9-1 Outline of Major Energy-Consuming Facilities

Name	Type	Number	Manufacturer	Start-up	Rated Capacity	Remarks
Boilers						
Boiler - 1	Horizontal Smoke Tube	1	Multipac	1968	9 bar, 2950 kg/hour	in operation
Boiler - 2	ditto	1	ditto	ditto	ditto	malfunctional
Boiler - 3	ditto	1	ditto	ditto	ditto	in operation
Air Conditioning System						
Chiller - 2	Centrifugal	1	Trane Hermetic	1969	185 tons	uneconomical
Chiller - 1	Vertical Rotary Screw	1	Dunham Bush	1988	250 tons	in operation
Chiller - 3	ditto	1	ditto	ditto	ditto	in operation
Cooling Tower	Louver with 2 Fans	1	Marley		1969	750 Tons
manual control						
Chilled Water Pumps		3				
Cooling Water Pumps		3				
Air-Handling Units		53			290 tons in total	40% of buildings area

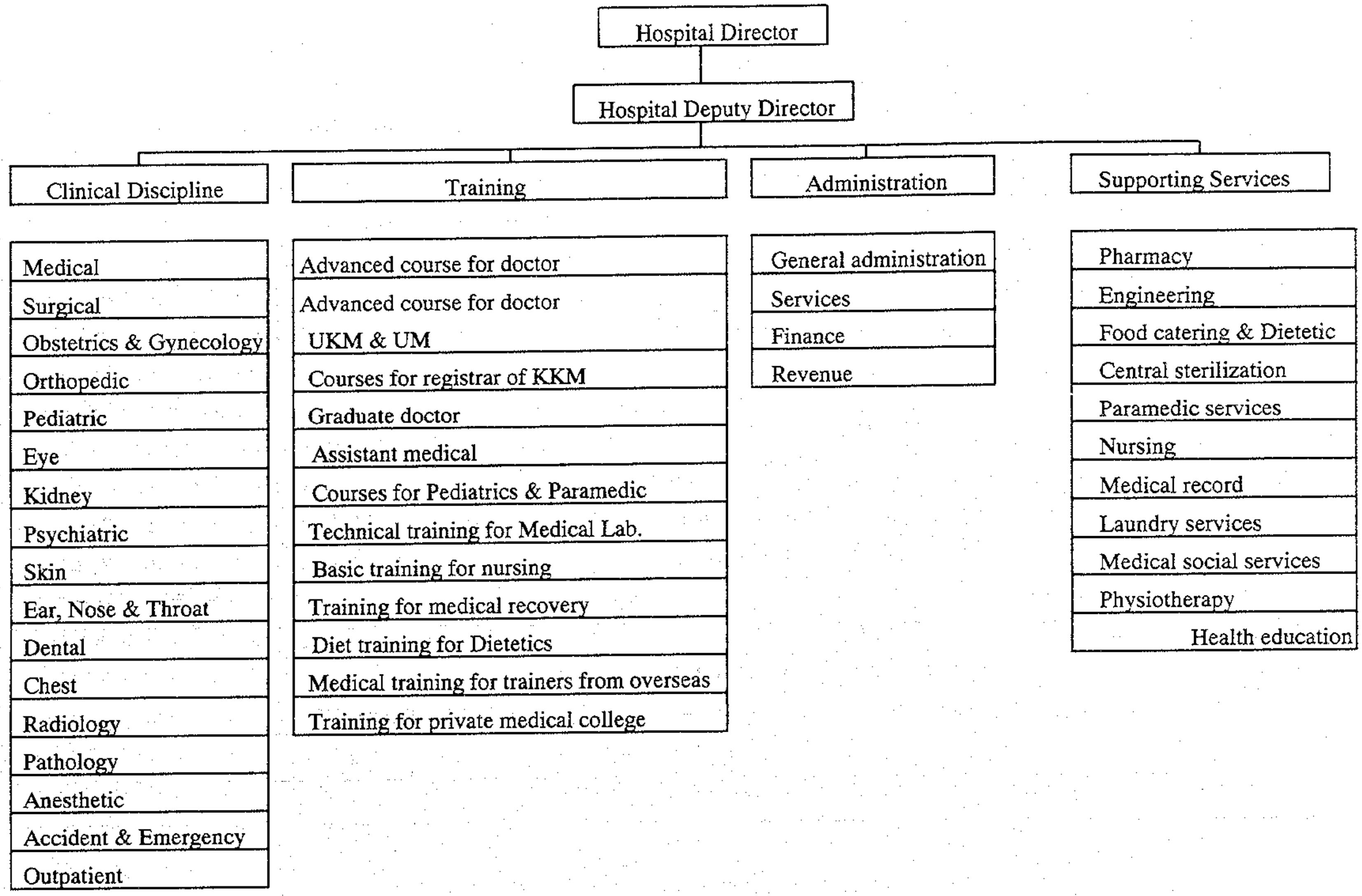


Figure 9-1 Hospital Organization Chart

9-3-2 Results of Energy Audit

(1) Electrical Power Received from TNB

The hospital obtains its electrical supply from TNB using incoming line No.1 or No.2. Electrical power demand per hour varies considerably on weekdays, showing high demand in the day time and low demand at night, while it varies little on Sunday, as Figure 9-2 shows for weekdays.

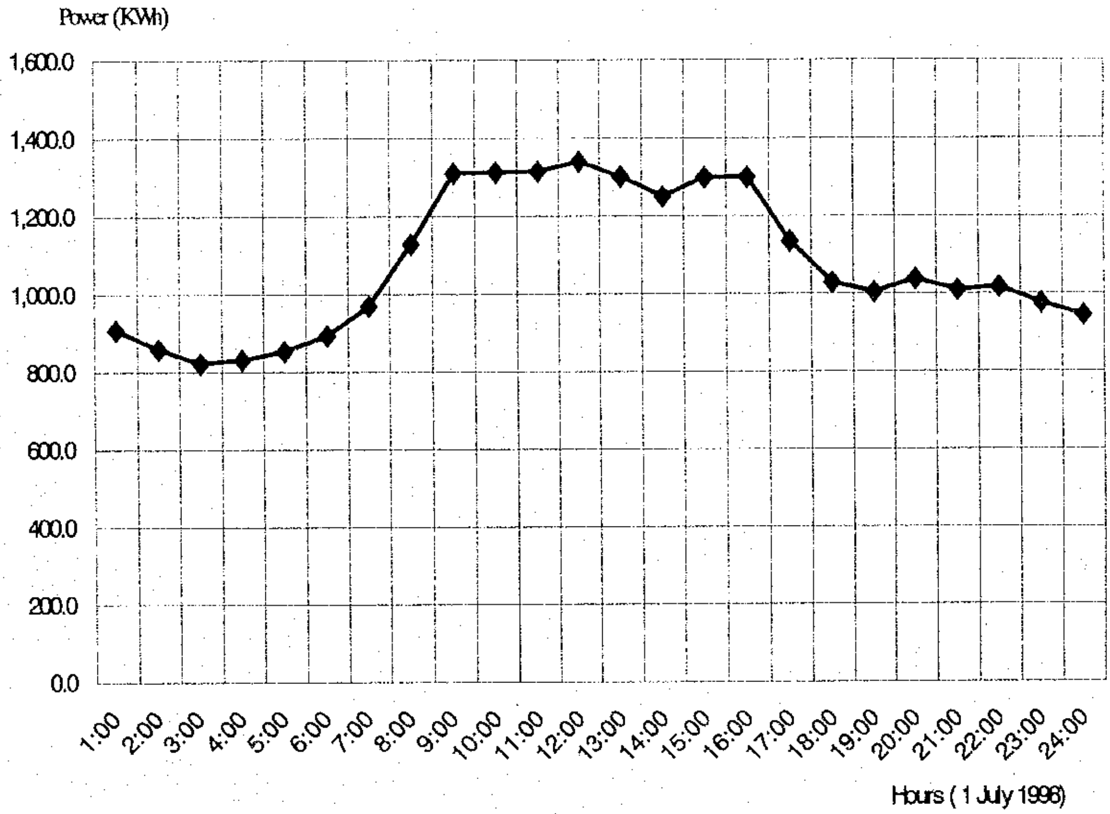


Figure 9-2 Power Receiving TNB

(2) Power Distribution at Incoming Transformer

There are two transformers that supply low voltage power. Transformer No.1 is connected to the non-essential line, while No.2 is connected to the essential line equipped with emergency generators.

- Power Factor: No.1 = 0.733 – 0.679 No.2 = 0.807 – 0.752
- Load: No.1 = 30 – 49 percent No.2 = 26 – 44 percent

The load figures for both No.1 and No.2 transformers are very low and it might be necessary to take some measures to compensate for the fixed power loss of the transformer.

(3) Air-conditioning System

With reference to electricity consumption data for Chiller No.1 and No.3, the power factor is too low and the chiller system has a frequent over-current trip problem.

- Chiller No.1 : Power Consumption, kWh 63.8 – 119.3
  Power Factor 0.30 – 0.49
- Chiller No.2 :Power Consumption, kWh 82.0 – 105.3
  Power Factor 0.37 – 0.48

(4) Boiler System

Table 9-2 shows boiler flue gas content measured on July 8.

Table 9-2 Boiler Flue Gas Content and Intake Air Condition

Instrument:		HODAKA HT-2000	
Parameter (Fuel Type):		"Diesel Oil"	"Heavy oil (C)"
Time:		10:45	14:30
Flue Gas Content			
Oxygen (%)		7.3 - 7.6	7.2
Carbon dioxide (%)		9.9	10.5
Carbon monoxide (%)		7	8
Nitrogen oxide (ppm)		98 - 102	111
TG (degree Celcius)		165.0 - 186.1	195.3
TA (degree Celcius)		33.7 - 33.9	34.9
hPa		-0.97 to -1.12	-1.24
Intake air	0.4497 (Nm^3/s)		
Velocity;	9.04 (m/s)		
Temperature;		30.1 degree Celcius	
Suction Area;		0.0552 (m^2)	

(5) Environmental Conditions within Hospital Building

A natural ventilation system is utilized in most parts of the hospital. An air-conditioning system should be studied for future application.

Illumination intensity varies considerably according to the measuring location, and ranges from 9 to 1,324 lux, and these figures conform to the Japanese lighting standard applied for corridors and stairs of office buildings.

CO_2 content is also within the range of management standards of air conditions regulated by the Building Management Law.

9-3-3 Energy Flowchart

Overall energy flow in the hospital is shown in Figure 9-3.

Various types of energy consisting of electrical power, light fuel oil and diesel oil used in the major facilities in the hospital are shown in Figure 9-4. Their percentages show the features of energy flow in the hospital. The main energy source was electrical power, which accounted for about 56 percent of the total primary energy.

9-3-4 Unit Energy Consumption

454,600 kcal/m²/yr

(Note-1) Energy Consumption Amount

Energy	Consumption	Unit Calorific Value	Energy Consumption Amount
Light Fuel Oil	786,240 kl/yr	9,900 kcal/l	7,783.8 x 10^6 kcal/yr
Diesel Oil	13.63 kl/yr	9,000 kcal/l	122.7 x 10^6 kcal/yr
Electric Power	4,501,099 kWh/yr	2,250 kcal/kWh	10,127.5 x 10^6 kcal/yr
TOTAL			18,034.0 x 10^6 kcal/yr

(Note-2) Total Floor Area

Floor	1	2	3	4	5	6	8	TOTAL
Area, m²	1,920	270	3,750	14,300	2,600	14,200	2,630	39,670

Table 9-3 suggests that major differences exist in the low figures of unit energy consumption for Hospital Seremban. Hospital Seremban is more energy-efficient thanks to:

(1) Applying a more natural ventilation system for air-conditioning and dedicating it to cooling (no heating function needed) for air-conditioning

(2) Introduction of energy-saving management such as careful control of lighting and rational operation of lifts

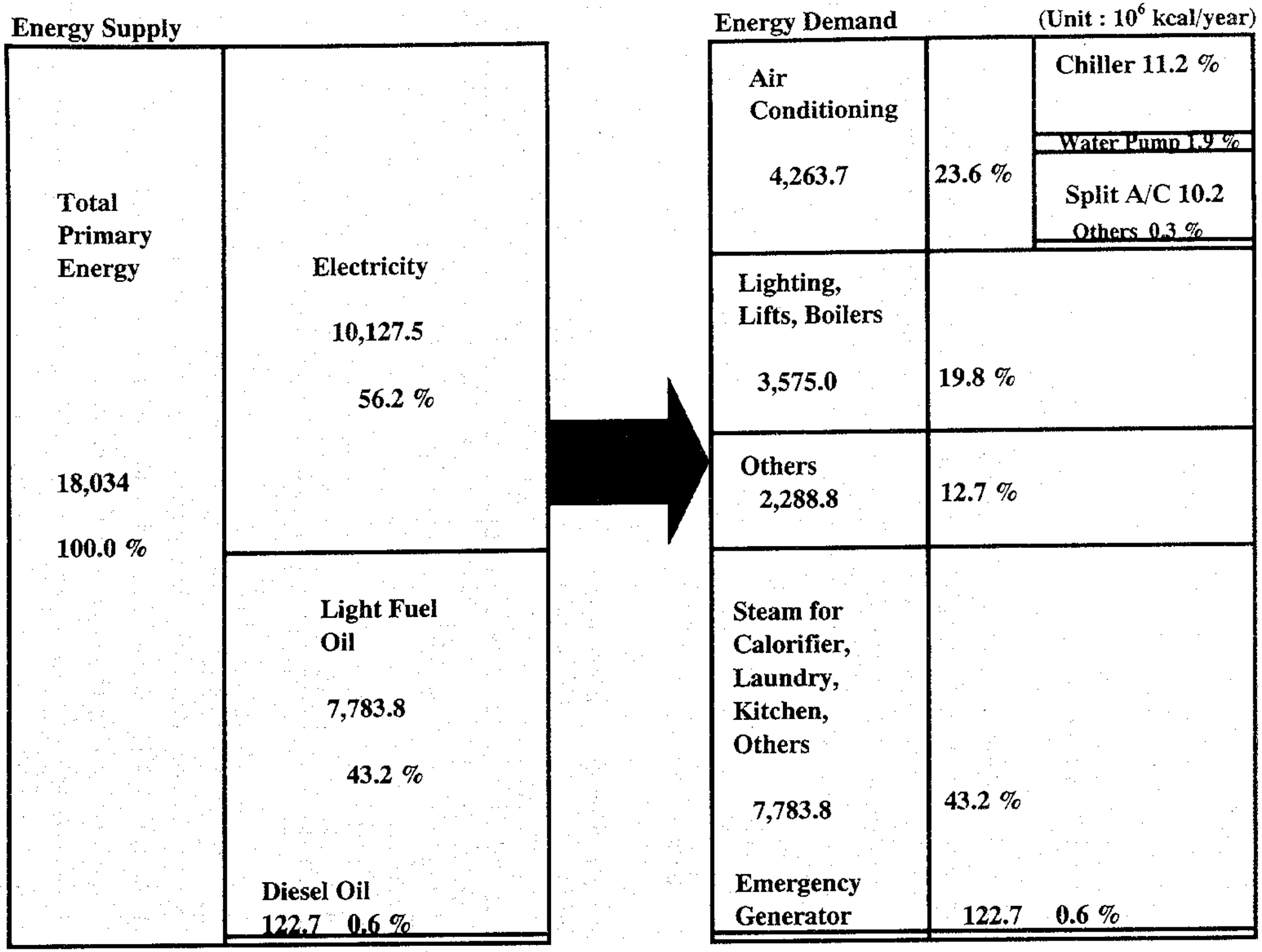


Figure 9-3 Overall Energy Flow in the Hospital

Table 9-3 Hospital Energy Management Comparison

Item	Malaysia National Hospital SEREMBAN	A Tokyo Metropolitan Hospital
1. Establishment	1969(year)	1974(year)
2. Floors	9 (building A) 9 (building B)	14 (building A) 14 (building B)
3. Total floor area	40,000(m^2)	65,238(m^2)
4. Beds	800	801
5. Electricity Consumption Power Receiving Voltage	4,501(MW/year) 11 kV	13,995(MW/year) 22 kV
6. Fuel Consumption (1) Fuel Oil (2) City Gas (3) Others	 786 kl/yr – 14 kl/yr (emergency use)	 2 kl/yr (emergency use) 2,182,027 Nm^3/yr -
7. Boiler (1) Capacity x Unit (2) Steam Pressure	 3 (t/h) x 3 9 (kg/cm^2)	 8.4 (t/h) x 3 7 (kg/cm^2)
8. Chiller (1) Capacity x Unit (2) Type (3) Space Conditioning Unit	 250 RT x 3 Turbo x 3 AHU x 53 Window x 120 Package x 10	 1,000 USRT x 1 350 USRT x 4 Turbo x 4 Absorption x 1 FCU x 461 (Main building) x 126 (Annex building) Package x 31
9. Water Consumption	Not available	273,133 m^3/yr
Unit Energy Consumption (National average)	**454,600 kcal/m^2/yr** ---	**810,700 kcal/m^2/yr** (586,100 kcal/m^2/yr)

9-3-5 Present Situation of Energy Management and Energy Efficiency Promotion

The main hospital complex was built in 1969 and some of the facilities have become out-dated . Features of the hospital energy efficiency problem are as follows.

(1) **Open-type building**

- Utilizing natural ventilation system to maximum extent
- Model facility of old type energy-efficient building
- Coexistence of open and closed zones

(2) **High energy-saving awareness**

- Controlling illumination density at minimum level
- Lift operation control system
- Separation of air-conditioning zones for localized cooling
- Power factor management

(3) **Electricity management**

- Old type of lift power control system
- Frequent over-current trip in chiller system

(4) **Heat management**

- Boiler on/off operation control
- Future expansion of air-conditioning system

9-3-6 Problems with Facilities

In accordance with the hospital energy audit results, problems and recommended measures for energy efficiency improvements were discussed as follows:

(1) Introduction of an inverter control system for the lift power supply
(2) Improvement of boiler exhaust gas oxygen content and temperature
(3) Solution to the frequent over-current trip problem and low power factor operation in the chiller system
(4) Improvement of TNB power receiving system
(5) Improvement of air-conditioning system and introduction of energy storage system for the future

9-4 Measures for Energy Efficiency Promotion

(1) Introduction of Inverter Control System for Lift Power Supply

This hospital has eight lift units whose specifications are shown in Table 9-4.

Table 9-4 Lift Specification at Hospital Seremban

Control System	VVGD-CL	Working status Lift #1 : operating for goods Lift #2,3: stand by Lift #4,5: operating for general usage Lift #6 : operating for patients Lift #7,8: operating for bed/ passengers
Capacity	23 persons	
Stops	9 stops	
Speed	Lift #1,6,7,8 : 90 m/min. Lift #2,3,4,5 :105 m/min.	
Operation	Lift #1,6,7,8 : 1C-2BC Lift #2,3,4,5 : 2C-2BC	

Although the main lift bank of 6 lifts is old and the control system is based on relays, all lifts are in good working order and have been well maintained. The introduction of the Variable Voltage Variable Frequency (VVVF) power supply system in the event of future lift renovation is recommended, in order to achieve both improved energy efficiency and transportation amenability. The power saved is estimated to be approximately 30-40 percent of the total consumption; that is 51-68 kWh per day for No.4 plus No.5 lift.

(2) Improvement of Boiler Exhaust Gas Oxygen Content and Temperature

The study team tried to estimate the actual air ratio figure of the boiler based on the measurement data. The O_2 and CO_2 content in the boiler flue gas are around 7.2 and 10.5 percent, respectively. High oxygen content means excess air in the boiler chamber and low carbon dioxide indicates imperfect combustion. Referring to the general technical chart of flue gas content vs. air ratio, the air ratio could easily be read as 1.45-1.5.

The specific air volume, A, introduced to the boiler was 9.82 Nm^3/kg (intake air volume is 1,620 Nm^3/hr, fuel oil flow rate is 165 kg/hr). Theoretical air volume necessary to burn 1 kg of fuel oil, A_0, can be calculated as 6.54 Nm^3/kg, by consulting the fuel oil chemical elementary analysis data. Then the air ratio is calculated to be 1.5 ($= A/A_0$).

The automatic on/off operation of the boiler may be the reason for the rather high air ratio. Firing on-off in the boiler is rather frequent and operation time is short. This means that it is difficult for the boiler operation to maintain a steady state of operation for long periods, and boiler efficiency may not be always high enough because of imperfect combustion.

The Japanese judgement criteria are published to promote appropriate and rational use of energy at factories. For reference purposes, some of the criteria for small sized boilers are extracted below in Table 9-5.

Table 9-5 Japanese Guidelines for Boiler Operation Conditions (Reference)

Equipment	Air Ratio		Exhaust Gas Temperature	
	(Standard Value)	(Desired Value)	(Standard Value)	(Desired Value)
Steam Boiler Size: less than 5 ton/hr Fuel: Liquid Fuel Load:50-100 %	1.3	1.2-1.3	250 degrees centigrade	220 degrees centigrade

Few measuring instruments are installed around the boilers. Exhaust gas sampling will be necessary in order to improve the air ratio by controlling the Forced Draft Fan (FDF) damper or RPM of the fan motor. Care should be taken to avoid air pollution caused by the lack of air or imperfect combustion, and to improve energy efficiency through combustion control.
Exhaust gas temperature fluctuated from 165 to 195.3 degrees centigrade, and this figure is below the desired Japanese guideline value.

(3) Solution to Frequent Over-Current Trip Problem and Low Power Factor Operation in Chiller System

Chiller No.1 and No.3 are being operated 24 hours continuously at approximately full capacity to supply chilled water to about 40 percent of the main building's areas. This system often stops because of the over-current trip problem.
This system has two problems: extraordinarily low PF (power factor) and high current quite close to the trip set value of 300 amperes. These problems are also found in chiller No.3 system.
The following measures should be investigated.

1) Clarifying the cause of low PF
2) Increasing the fuse from 300 A to 350 A
3) Installation of capacitor
4) Replacing distribution line cable with larger size

(4) Improvement of TNB Power Receiving System

Since renewing the capacitor (or power factor reformer), the hospital has been obtaining the

highest power factor possible from TNB. No supplementary charges have been added since then to the bill. A detailed observation of power receiving data shows that the reactive power is negative and the power factor is approximately -0.96 (leading).
Some adjustment of the automatic control system of the capacitor bank is needed.

(5) Improvement of Air Conditioning System and Introduction of Energy Storage System for Future

Japanese hospitals mainly use a centralized air heating and cooling system equipped with both turbo and absorption-type chillers and supplementary local package-type air conditioners. Hospital Seremban uses a combination of natural ventilation, mechanical ventilation and a centralized and local air cooling system, and approximately 40 percent of the main building's areas are cooled by the centralized system.
In the near future, the demand for air cooling, instead of natural or mechanical ventilation, will become inevitable. In this regard, the following should be studied.

1) Reform the chiller system and select an economical mechanical model.
2) Introduce a latent heat storage facility attached to the centralized chiller system
   Advantages:
   - Effective peak load saving, shifting peak time demand to off-peak period
   - Reduction of demand electricity ammount
   - Investment cost saving by reducing the chiller design capacity

A schematic flow diagram for a future chiller system with a latent heat storage facility is shown in Figure 9-4.

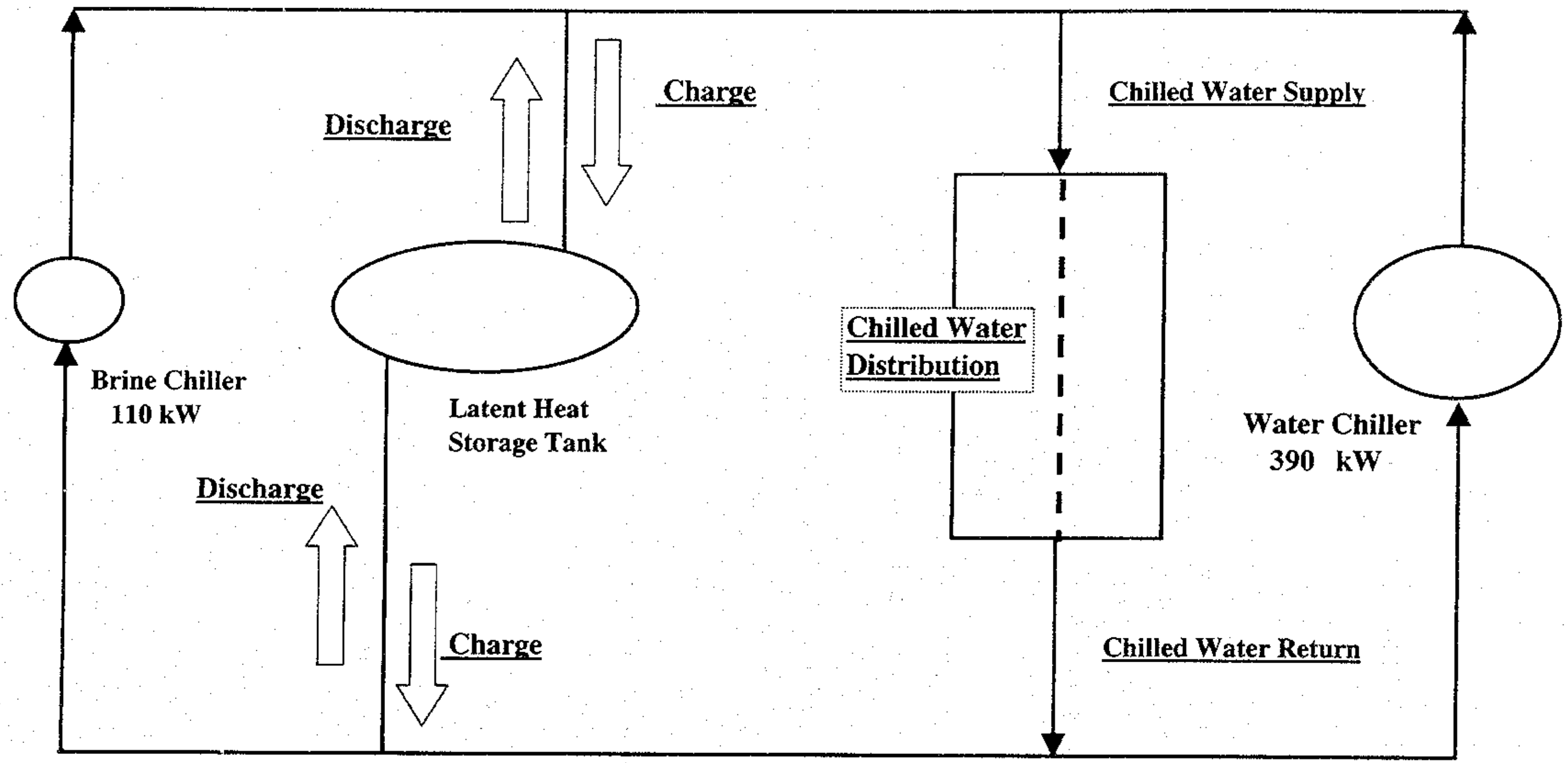


Figure 9-4 Schematic Flow for Latent Heat Storage System