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Kingdom of Saudi Arabia

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The Master Plan Study for Energy Conservation in the Power Sector in the Kingdom of Saudi Arabia

Final Report

February 2009

JAPAN INTERNATIONAL COOPERATION AGENCY

Tokyo Electric Power Company, Inc. (TEPCO)
The Institute of Energy Economics, Japan (IEEJ)

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PREFACE

In response to a request from Government of the Kingdom of Saudi Arabia, the Government of Japan decided to conduct a study on The Master Plan Study for Energy Conservation in the Power Sector in the Kingdom of Saudi Arabia and entrusted to the study to the Japan International Cooperation Agency (JICA).

JICA selected and dispatched a study team headed by Mr.Hitoshi Koyabu of Tokyo Electric Power Company, Inc. (TEPCO) and consisted of TEPCO and The Institute of Energy Economics, Japan between February 2007 and February 2009.

The team held discussions with the officials concerned of the Government of the Kingdom of Saudi Arabia and conducted field surveys at the study area. Upon returning to Japan, the team conducted further studies and prepared this final report.

I hope that this report will contribute to the promotion of this project and to the enhancement of friendly relationship between our two countries.

Finally, I wish to express my sincere appreciation to the officials concerned of the Government of the Kingdom of Saudi Arabia for their close cooperation extended to the study.

February 2009

Seiichi NAGATSUKA
Vice President
Japan International Cooperation Agency

February 2009

Mr. Seiichi NAGATSUKA

Vice President

Japan International Cooperation Agency

Tokyo, Japan

Letter of Transmittal

We are pleased to submit to you the report of the Master Plan Study for Energy Conservation in the Power Sector in the Kingdom of Saudi Arabia (KSA). The report reflects the comments made by not only the Ministry of Water and Electricity, Saudi Electricity Company and Saudi Aramco but also related organizations and institutions in KSA, as well as the advice of related institutions of the Government of Japan.

This report presents appropriate energy conservation targets on 2030 and proposes policies and measurements including high priority projects in order to achieve the targets in KSA. It is indispensable for energy conservation that not only the energy and industrial sector make sincere efforts, but also individual people practice sustainable action everyday. Therefore we collect data and opinions widely from not only the industrial sector, but also related governmental organizations and main universities, so-called collaborative relationship among industry, government and academia, and propose thirteen (13) sustainable energy conservation projects such as energy conservation education for elementary schools and energy conservation museum including establishment and operation of Saudi Energy Efficiency Center to set the entire nation's activities solidly in place. We firmly believe that it will help increase awareness about energy conservation for the whole nation and achieve the energy conservation goal for Saudi Arabia.

We wish to take this opportunity to express our sincere appreciation to the officials concerned of JICA, Ministry of Foreign Affairs and Ministry of Economy, Trade and Industry. We would also like to express our gratitude to the officials concerned of the Government of Saudi Arabia, Ministry of water and Electricity and also to related organizations, JICA Saudi Arabia Office and Embassy of Japan in the Kingdom of Saudi Arabia for their cooperation and assistance throughout our field survey.

Very truly yours,

Hitoshi KOYABU

Team Leader

The Master Plan Study for Energy Conservation in the Power Sector in the Kingdom of Saudi Arabia

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【 Abbreviation 】

AC	Air Conditioner
ADB	Asian Development Bank
AHU	Air Handling Unit
APEC	Asia Pacific Economic Cooperation
ARAMCO	Saudi Arabian Oil Company
BAU	Business As Usual
BEMS	Building Energy Management System
BOO	Built-Operate-Own
CC	Combined Cycle
CDM	Clean Development Mechanism
CFL	Compact Florescent Lamp
CHP	Combined Heat and Power Generation
COA	Central Operating Area
COC	Chamber of Commerce
COP	Coefficiency of Performance
COP13	Conference of Parties No.13
D/D	Detailed Design
DSM	Demand Side Management
DT	Direct Teaching
EC	Energy Conservation
ECCJ	Energy Conservation Center, Japan
ECRA	Electricity and Cogeneration Regulatory Authority
EDP	Eight Development Plan
EEC	Energy Efficeincy Case
EELS	Energy Efficiency Labels and Standards
EER	Energy Efficiency Ratio
EIRR	Economic Internal Rate of Return
EMS	Energy Audit and Management System
EOA	Eastern Operating Area
ESCO	Energy Service Company
EU	Europe Union
F/S	Feasibility Study
GCC	Gulf Cooperation Council
GDE	Gross Domestic Expenditure
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GT	Gas Turbine
HQ	Headquarters

IEA	International Energy Agency
IEEJ	Institute of Energy Economics, Japan
IPCC	Intergovernmental Panel on Climate Changes
IPP	Independent Power Producer
IWPP	Independent Water and Power Producer
JICA	Japan International Cooperation Agency
JIS	Japan Industrial Standards
KACST	King Abdulaziz City for Science and Technology
KSA	Kingdom of Saudi Arabia
LPG	Liquefied Petroleum Gas
LTS	Long-Term Strategy
MEPA	Metrological Environmental Protection Administration
MEPS	Minimum Energy Performance Standard
METI	Ministry of Economy, Trade and Industry (Japan)
M&Is	Manufacturers and Importers
MOCI	Ministry of Commerce and Industry
MOE	Ministry of Education
MOEP	Ministry of Economy and Planning
MOF	Ministry of Finance
MOIA	Ministry of Islamic Affairs
MOMRA	Ministry of Municipalities and Rural Affairs
MOPMR	Ministry of Petroleum and Mineral Resources
MOT	Ministry of Transportation
MOWE	Ministry of Water and Electricity
NEEP	National Energy Efficiency Program
NGO	Non Governmental Organization
NPD	National Project Director
O&M	Operation and Maintenance
OPEC	Organization of the Petroleum Exporting Countries
PME	Presidency of Meteorology and Environment
R&D	Research and Development
RPS	Renewable Portfolio Standard
RT	US Refrgirating Ton
SABIC	Saudi Arabian Basic Industries Corporation
SASO	Saudi Arabian Standards Organization
SBC	Saudi Building Code
SCE	Saudi Council of Engineers
SEC	Saudi Electricity Company
SEEC	Saudi Energy Efficeincy Center
SME	Small and Medium Enterprises
SOA	Southern Operating Area

SR	Saudi Riyal
ST	Steam Turbine
SWCC	Saline Water Conversion Corporation
TEPCO	Tokyo Electric Power Company
TOR	Terms of Reference
TOT	Training of Trainer
TOU	Time of Use
TPES	Total Primary Energy Supply
TQM	Total Quality Management
UK	United Kingdom
UNDP	United Nations Development Program
UNFCCC	United Nations Framework Convention on Climate Change
USA	United States of America
WACC	Weighted Average Capital Cost
WB	World Bank
WOA	Western Operating Area

Part 1 Introduction

Chapter 1 Introduction

1.1 Background

The Kingdom of Saudi Arabia (KSA) has one power utility covering all areas in the country. The power utility, Saudi Electricity Company (SEC), was established to manage generation, transmission, and distribution in April 2000, merging the national power utilities located in each area. The Ministry of Water and Electricity (MOWE) implements power sector administration and promotes energy conservation activities, power development, R&D, and information and data standardization.

Recently, since the population and economy has increased rapidly, power consumption has increased at a rate of 7 %. The current power capacity meets the demand. However, assuming that power demand will increase at the same rate in the future, a power crisis may occur due to the imbalance of capacity and demand. MOWE is now making efforts for privatization of the power supply, international connection, and supply-side management. Further demand-side management, such as penetration of energy conservation awareness and technical and political measures are also required. Against this background, KSA requested that Japan to assist in the formation of a national master plan for energy conservation, that is “The Master Plan Study for Energy Conservation in the Power Sector in the Kingdom of Saudi Arabia” (hereinafter the Study).

1.2 Objective

The objective of the Study is to make a master plan for comprehensive energy conservation reflecting the demand forecast, including the industrial, commercial, and residential sectors by 2030, and to propose practical energy conservation measures based on energy consumption patterns in Saudi Arabia. Through the Study, a technology transfer will also be carried out.

1.3 Study Area and Scope

The study area encompasses all of KSA. The Study is implemented based on the scope of work signed by MOWE and the Japan International Cooperation Agency (JICA) study preparation team in August 2006. The Study period is from February 2007 to November 2008 (22 months).

The Terms of Reference (TOR) entrusted by JICA are shown below.

1) Preparatory Survey for the Master Plan

a) Socioeconomic survey

b) Survey on the climate, weather, and natural conditions, etc.

c) Survey of energy conservation activity plans and projects

d) Survey of laws/regulations regarding energy conservation promotion

e) Survey of the power development plan, energy conservation strategy, policy, and institutions regarding energy conservation

f) Survey of the overview of the National Energy Efficiency Program (NEEP) and the results

2) Preparation of the Master Plan (Establishment of an Energy Conservation Target and Scenario by 2030)

a) Review of the existing plan (power development plan, energy conservation plan, etc.)

b) Establish of preconditions for the forecast scenario

c) Conduct basic surveys for setting energy conservation targets (energy data survey, survey energy conservation awareness, energy conservation activities, and energy audits in the industrial, commercial, and residential sectors)

d) Preparation of the energy conservation scenario based on the results above

3) Propose Energy Conservation Measures for formulation of the Energy Conservation Scenario

a) Demand-Side Management (DSM) in the power sector

b) Dissemination measures

c) Strengthen energy conservation technology R&D

d) Labeling for energy conservation products

e) Development of an Energy Standard, such as a Management Guideline for Factories and Buildings

f) Strengthen energy auditing skills and promotion of ESCO projects

g) Propose establishment of a Saudi Energy Efficiency Center (SEEC)

4) Propose an Action Plan and Framework to Realize Energy Conservation Measures

a) Suggest laws, regulations guidelines, technical standards, etc to promote energy conservation measures

b) Suggest economic incentives, such as a subsidy, tax incentive, low interest rate loan, etc.

c) Suggest an institutional framework for establishment and management of the SEEC

d) Prepare a road map for accomplishing master plan targets

e) Develop human resources for energy conservation

5) Analysis and Evaluation of the Study

a) Analysis and evaluation of the impact of energy conservation on society and the economy

b) Analysis of cost effectiveness

c) Evaluation of impact on global warming measures

6) Implementation of Workshop and Seminar

Figure 1-1 TOR of the Study

1.4 Counterpart

The counterpart in the Study in Saudi Arabia is MOWE. Steering committee and technical committee are also organized for this study.

1.5 Study Team Structure

The structure of the Study is shown below. Basically, the JICA Study Team is separated into 3 small teams, namely the “Energy Strategy Team”, “Energy Management Team” and “Energy Audit Team”. However, when the content of the study covers a wide scope, the teams are rearranged to match the purpose of the survey. For the ease of team rearrangement, the leader and coordinator support communication and arrangement of the teams.

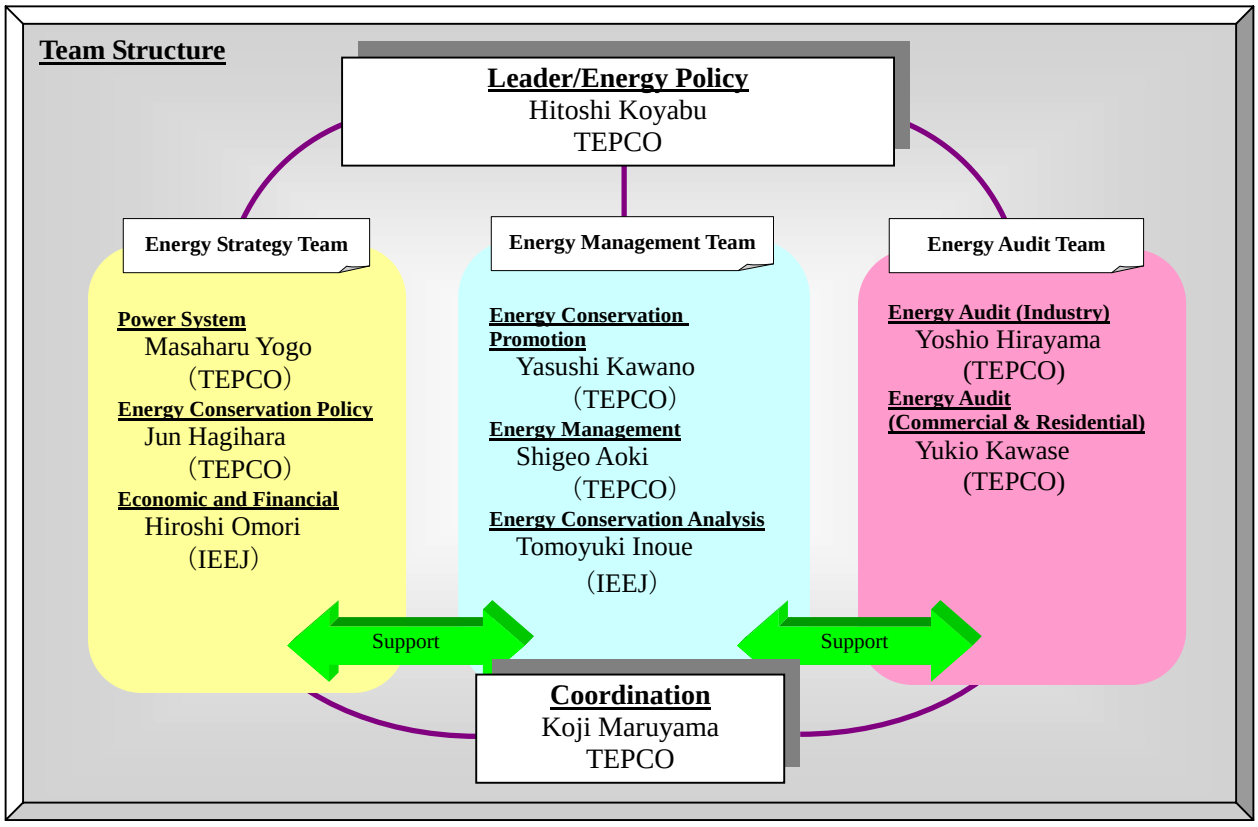


Figure 1-2 Structure of the JICA Study Team

1.6 Local Consultant

To grasp activities and technical potential for energy conservation in the commercial and residential sector, a local consultant conducted a questionnaire survey. The survey started from June 2007 and ended at December 2007.

1.7 Overall Schedule

The overall schedule of the Study is as follows.

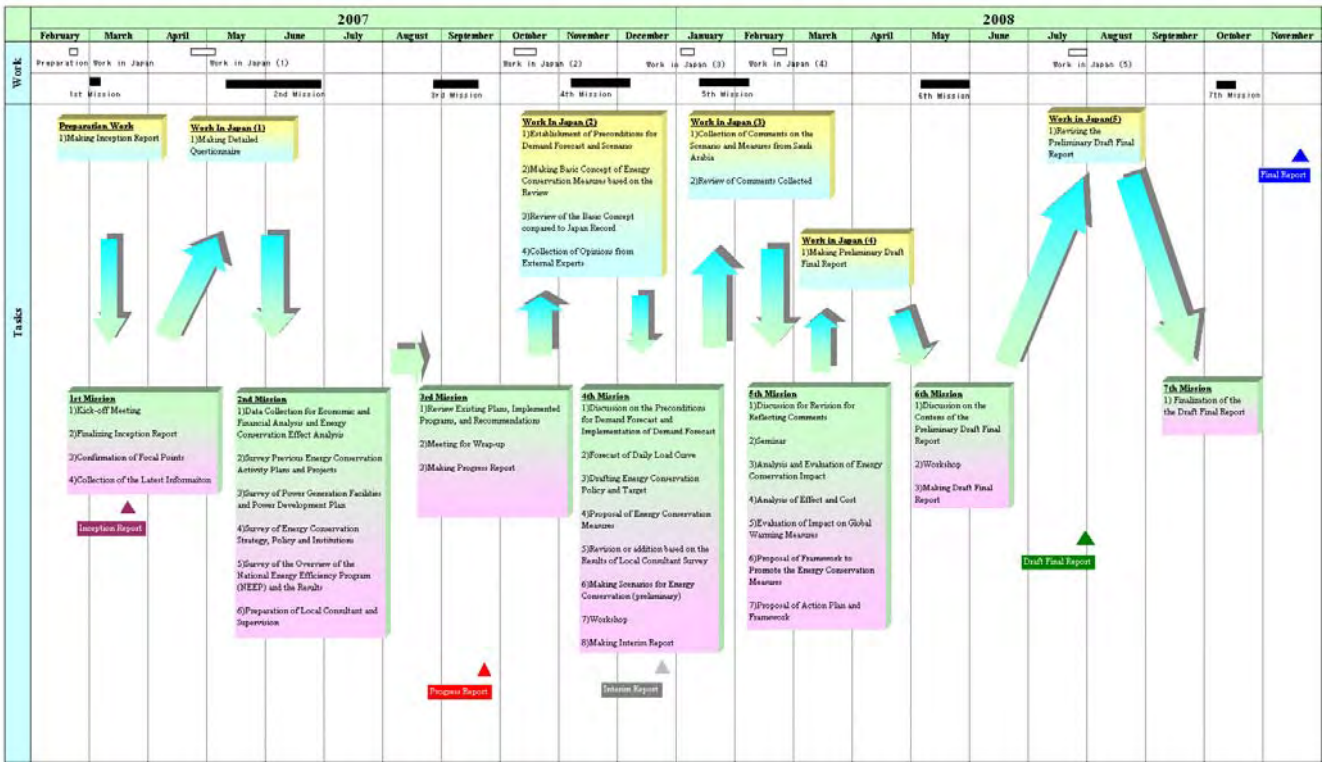


Figure 1-3 Overall Schedule

1.8 Overall Workflow

The overall workflow of the Study is as follows.

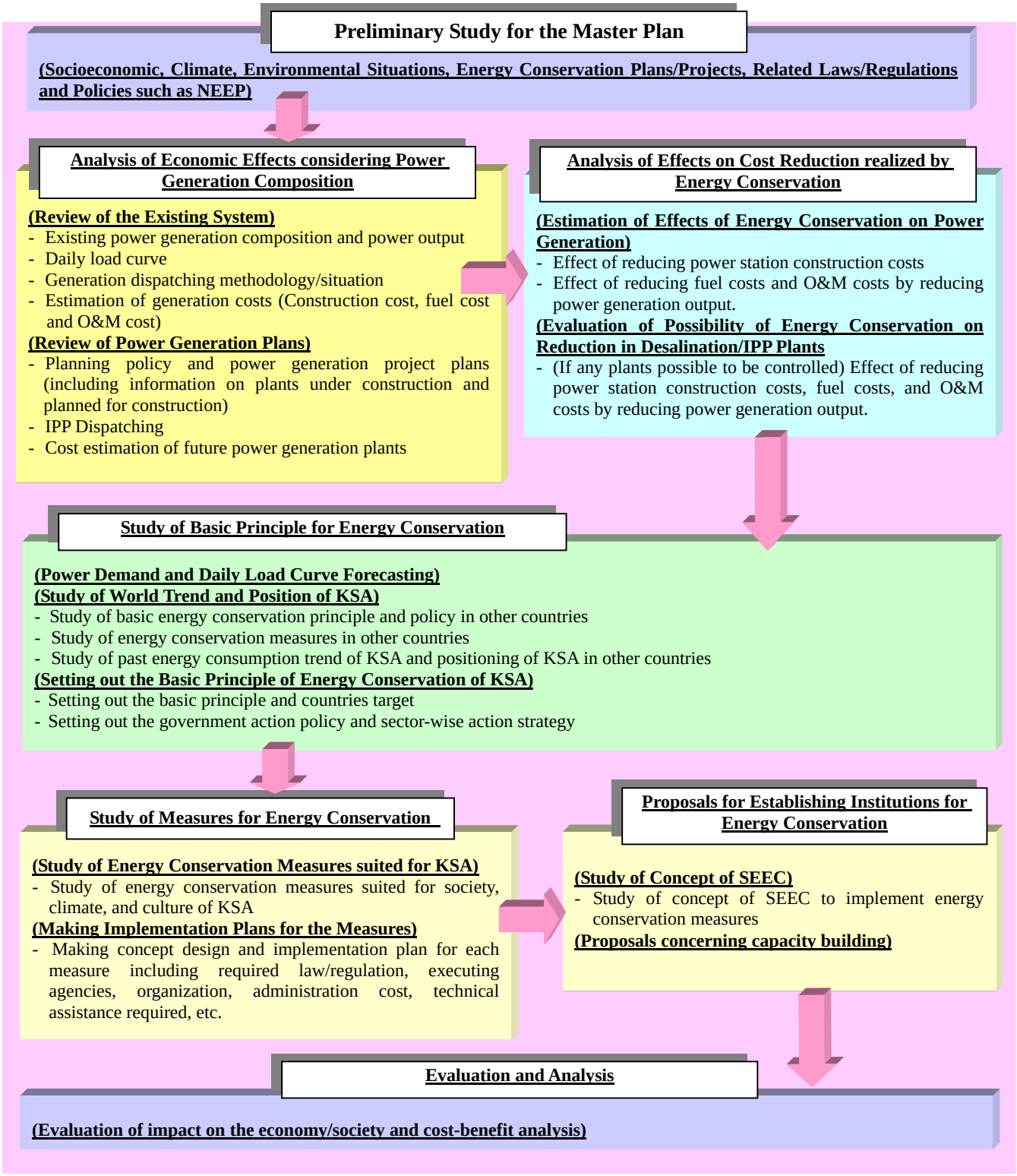


Figure 1-4 Overall Workflow

Part 2 Worldwide Energy Conservation Situation

Chapter 2 Energy Conservation Policy and Measures in Other Countries

2.1 Japan

2.1.1 Energy Policy

(1) Structure of the Energy Principle

In Japan, energy conservation is one of the components regarding energy issues. Therefore, energy conservation policy and strategy are described in an energy act and an energy strategy paper.

The structure of the Japanese energy principle is as follows. Fundamental policy is stipulated in the Basic Act on Energy Policy, a law established in 2004. This law is the basis for energy policy. Actually, this act only describes comprehensive matters. This Basic act stipulates that the Ministry of Economy, Trade and Industry (METI) shall prepare a medium-term Basic Energy Plan for the next 10 years. This Basic Energy Plan describes a more practical and concrete policy and strategy.

METI has established a long-term strategy through 2030 as well.

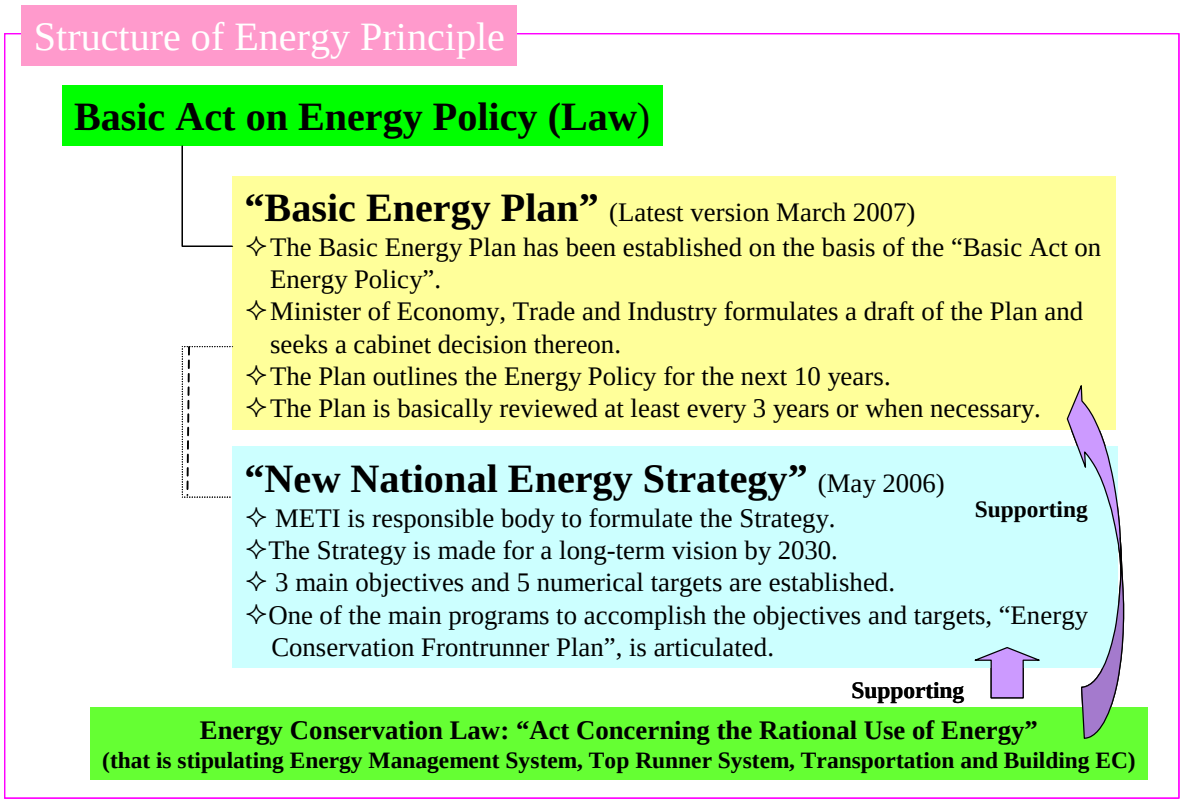


Figure 2-1 Structure of Energy Principle in Japan

In addition, to supporting concrete actions to be carried out in accordance with such policy and strategy, another law, the "Act Concerning the Rational Use of Energy" known as the Energy Conservation Law, has been established.

(2) Basic Act on Energy Policy

The 3 basic objectives of the Act are identified as follows:

- Securing stable supply

- Environmental suitability

- Utilization of market mechanisms

In addition, the basic act describes the responsibility of each player, such as the central government, local government, private sector, and citizenry. The act also stipulates that the State Government shall formulate a basic plan on energy supply and demand (the "Basic Energy Plan") in order to promote measures on energy supply and demand for the middle-term, on a comprehensive and systematic basis.

(3) Basic Energy Plan 2007 (Middle Term Plan)

The Agency for Natural Resources and Energy reported the Basic Energy Plan to the Diet in March 2007. This plan defines the next 10-year direction of measures on the demand and supply based on the basic objectives of the said Basic Act. In this Plan, the details of the 3 principles described in the Basic Act are outlined as follows:

- Securing a stable energy supply
  The following measures should be promoted: (i) Energy conservation, (ii) Diversification of imported energy resources and strengthening the relationship with major oil exporting nations. (iii) Diversification of energy resources, such as developing domestically produced fuels, and (iv) Securing oil and LP gas reserves.
- Environmental sustainability
  The following measures will be promoted to combat global warming: (i) Energy conservation, (ii) Use of non-fossil energy and switch to gas energy and (iii) Development and introduction of clean fossil fuel systems and energy efficiency technology.
- Utilizing the market mechanism
  Promote institutional reforms and design plans to utilize market principles in the framework.

To fulfill the 3 principles outlined above, 4 main policies are articulated as follows:

- ✓ Improving energy efficiency on the demand side and supply side.
- ✓ Comprehensive strengthening of resource diplomacy, and energy and environment cooperation
- ✓ Enhancement of emergency response measures
- ✓ Institutional reform of the power and gas sector

To comply with the policy above, “Improving energy efficiency in demand side”, the following strategies, comprising energy conservation and load leveling, are established

1. Strategy of Energy Conservation
(1) Formulation of Energy Conservation Technology Strategy
Establishment of energy conservation technology strategy that is a roadmap of energy conservation technology development, linking various business fields and combining various technologies
(2) Introduction of Benchmark Approach by Sector and Active Creation of Initial Demand
Introduction of a sector-wise benchmark approach so that consumers can improve efficiency by referring the benchmark as a standard level. In addition, initial demand is promoted by proper assistance measures.
(For the Residential and Commercial Sector)
- Further development of a Top-runner with a labeling system.
- Further development of an energy management system using IT
- Further development of ESCO
- Further improvement of house and building energy conservation performance

(For the Transportation Sector)
- Proper implementation of the Energy Conservation Law targeting the transportation business or owner of goods
- Improvement of energy efficiency for cars
- Improvement of the traffic system

(For the Industrial Sector)
- Introduction of benchmark approach
- Further development of ESCO
- Support voluntary actions of the Japan Economy Association (Keidanren)
- Proper implementation of the “Energy Management System”

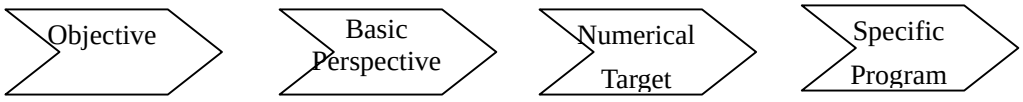
(3) Promotion of Cross Sector Measures
- Further improvement of people’s awareness
- Energy utilization among some owners (factories, buildings and houses) by inter-connection
- Establishment of circumstances through which the market evaluates energy conservation investment
- Formulation of total energy conservation city or province

2. Strategy of Load Leveling
(1) Wide use of high efficiency heat pump and thermal storage
(2) Wide use of battery and high efficiency gas air conditioner
(3) Education regarding the necessity of load leveling

(4) New National Energy Strategy (Long-term Plan)

(a) Structure of the Strategy

In May 2006, the Japanese government released a New National Energy Strategy that extends to 2030. The structure of the Strategy is illustrated as follows.



(b) Objective

The Strategy is comprised of the following 3 objectives. Those objectives cover issues affecting the entire energy sector.

- Establishment of energy security measures that people can trust and rely on.
- Establishment of the fundamentals for sustainable development through a comprehensive approach for energy issues and environmental issues.
- Commitment to assist Asian nations and the world in addressing energy problems.

(c) Basic Perspective

The fundamental viewpoints for attaining those objectives are described in the second layer as follows:

- Establishing a state-of-the-art energy supply-demand structure
- Comprehensive strengthening of resource diplomacy and, energy and environment cooperation
- Enhancement of emergency response measures

(d) Numerical Target

5 numerical targets have been established according to the previously outlined objectives and perspectives as follows. The target for energy conservation is set up at least 30 % improvement in final energy consumption per GDP by 2030.

- Target of energy conservation (Final Energy Consumption/GDP)
  At least another 30 % improvement of efficiency will be attained by 2030 (compared to 2003).
- Target of reducing oil dependence
  The ratio will be reduced to be lower than 40 % by 2030.
- Target of reducing oil dependence in the transport sector
  The percentage will be reduced to around 80 % by 2030.
- Target on nuclear power generation
  The ratio of nuclear power to all power production will be maintained or increased at the level of 30 to 40 % or more up to 2030 or later.
- Target of overseas natural resources development
  Oil volume ratio on ratio will be increased to around 40 % by 2030.

(e) Specific Program

In order to accomplish the target of 30 % efficiency improvement, a concrete plan has been established. The plan is called the “Energy Conservation Frontrunner Plan” and consists of 4 strategies as follows.

Strategy 1: Formulation of Energy Conservation Technology Strategy

Formulate an energy conservation technology strategy that clearly indicates the technical sectors in which a cross-sectoral and mid-long term breakthrough is required, and present the first edition of the strategy in 2006. Subsequently, carry out regular progress evaluation and revision.

Strategy 2: Introduction of a Benchmark Approach by Sector and Active Creation of Initial Demand

Prepare top-runner type standards for various sectors, and selectively reinforce support for those who meet the standards.

(For the Industrial Sector)

- Prepare top-runner standard (benchmark) by factory type
- Assist improvement activities through subsidy/tax incentive

- Support ESCO business for the acceleration of energy conservation

(For the House and Building Sector)

- Develop a method for comprehensive energy conservation assessment of house and appliances
- Accelerate the dissemination of high-performance housing and facilities, by improving the policy framework for information provision and financial support.

(For the Transportation Sector)

- Proper implementation of the Energy Conservation Law targeting the transportation business or owner of goods
- Improve the energy efficiency of cars
- Promote Eco-Drive using IT

(For the Cross Sector)

- Enhance the top-runner system for appliances and cars
- Encourage retail shops, companies, the government, educational organizations, and private persons through a commendation system

Strategy 3: Establishment of circumstances through which the market evaluates energy conservation investment

By 2008, develop a business value assessment method with which companies engaged in energy conservation investment are evaluated by the market (investors), and try to disseminate and establish that method. In order to expand such efforts internationally, aim for the global preparation of the energy conservation standards and an assessment system by sector, and aim for a full-scale international dialogue by 2008 when the G8 summit is to be held in Japan.

Strategy 4: Formulation of total energy conservation city or province

Carry out medium and long-term examination of the challenges faced by the social system or urban structure that require change, such as the improvement of the road networks that contribute to the smooth flow of traffic, the development and dissemination of a system that utilizes IT, promote the use of public transportation in cities, and the effective use of hot exhaust heat in cities and provinces.

(5) Act concerning the Rational Use of Energy (Energy Conservation Law)

This law aims to contribute to the sound development of the national economy through implementing necessary measures for the rational use of energy in factories, buildings, and machinery and equipment, and other necessary measures to comprehensively promote the rational use of energy, while it seeks to ensure the effective utilization of fuel resources that would meet the economic and social environment of energy at home and abroad.

The latest revision was made in 2005. This Energy Conservation Law stipulates energy conservation measures such as an energy management system for large consumer s and the top-runner system, including a labeling system, transportation energy conservation, and architectural energy conservation.

2.1.2 Main Measures for Energy Conservation

(1) Regulations

(a) Efficiency Standards for Buildings

Japanese building codes do not specify energy efficiency, however several guidelines for commercial buildings and residential housing based on the Energy Conservation Law are formulated as follows:

(i) Prevention of heat loss through outer walls, windows, etc. of the buildings

(ii) Efficient use of energy regarding

- Air conditioning equipment
- Mechanical ventilation equipment (other than air conditioning equipment)
- Lighting equipment
- Hot water supply system
- Lifting equipment

(b) Labeling and Target Efficiency Standards (Top Runner Program)

The Japanese government launched the Top Runner Program in 1999, under which the standards are set based on the efficiency level of the most efficient product commercially available in a given category. For each manufacturer and importer, the weighted average efficiency of all units shipped within the same category must meet the standards for that category by the target year decided for each category. The current target product and expected energy conservation are shown in the table.

Table 2-1 Designated Product and Expected Energy Conservation by the Target Fiscal Year

	Equipment	Target Fiscal Year	Expected energy conservation effects as of the previous fiscal year of the target
1	Gasoline passenger vehicles	FY2010	Approx. 23% compared to FY1995
	Diesel passenger vehicles	FY2005	Approx. 15% compared to FY1995
	LPG passenger vehicles	FY2010	Approx. 11.4% compared to FY2001
2	Air conditioners	Frozen at FY2007 Frozen at FY2004: Frozen at FY2004 for blower/wall type items for cooling/heating under 4kW	Approx. 63% compared to FY1997 for coolers/heaters; approx. 14% for dedicated cooler
3	Fluorescent lights	FY2005	Approx. 16.6% compared to FY1997
4	TV sets	FY2003	Approx. 16.4% compared to FY1997
5	Video cassette recorders	FY2003	Approx. 58.7% compared to FY1997
6	Copying machines	FY2006	Approx. 30% compared to FY1997
7	Computers	FY2005	Approx. 83% compared to FY1997
8	Magnetic disk units	FY2005	Approx. 78% compared to FY1997
9	Diesel freight vehicles	FY2005	Approx. 7% compared to FY1995
	Gasoline freight vehicles	FY2010	Approx. 13% compared to FY1995
10	Electric refrigerators and freezers	FY2004	Approx. 30% compared to FY1998
11		FY2004	
12	Space heaters	FY2006	Approx. 1.4% compared to FY2000 for gas space heaters; approx 3.8% for oil space heaters
13	Gas cooking appliances	FY2006	Approx. 13.9% compared to FY2000
14	Gas water heaters	FY2006	Approx. 4.1% compared to FY2000
15	Oil water heaters	FY2006	Approx. 3.5% compared to FY2000
16	Electric toilet seats	FY2006	Approx. 10% compared to FY2000
17	Vending machines	FY2005	Approx. 33.9% compared to FY2000
18	Transformers	FY2006: oil-filled transformers FY2007: mold transformers	Approx. 30.3% compared to FY1999
19	Microwave oven	FY2008	Approx. 8.5% compared to FY2004
20	Electric rice cooker	FY2008	Approx. 11.1% compared to FY2003
21	DVD Recorder	FY2008	Approx. 22.4% compared to FY2004

(Source: ECCJ Website)

As for the designated products, manufacturers and importers etc are obliged to meet the target standard values concerning “energy consumption efficiency” of those products. Standard target values are set based on the value of the most energy efficient products in that market.

Target fiscal years by which the target standard value must be achieved are set up through taking future technological development forecasts, the development period of products, and so on, into consideration, usually in the range of 4 to 8 years from the base fiscal year.

In the target fiscal year, achievement of the target is judged based on energy conservation figures as a weighted average of shipment by product for each product category per manufacturer and importer etc. Top Runner Standards are different from the concept of Minimum Energy Performance Standard (MEPS).

If the results appear to be remarkably low, the government offers recommendations to the manufacturer in question as required. Further, if this advice is not followed, the recommendations are made public and the manufacturer may be ordered to follow the recommendations. The measurement method primarily uses JIS (Japan Industrial Standards).

(c) Energy Management / Audits / Consumption Reporting

(i) Systematic Energy Management

Based on the Energy Conservation Law, systematic energy management is demanded for the factories and buildings, which consume a certain volume of energy, by obliging them to appoint energy managers and formulate and submit periodical reports of energy use and medium to long-term plans for achieving goals as shown below.

- **Type 1 Designated energy management factory**: Consume a large amount of energy (Annual energy consumption is 3,000 kL or more in crude oil equivalent.)
  - ✧ Factories
    - Appointment of a certified energy manager
    - Formulation and submission of periodical reports
    - Formulation and submission of a medium to long-term plan
  - ✧ Buildings
    - Appointment of an energy management officer (who is required to take a seminar for qualified persons regarding energy management of type 2 designated factories)
    - Formulation and submission of periodical reports
    - Formulation and submission of a medium to long-term plan (the appointed energy manager should participate in formulation of the plan)
- **Type 2 Designated energy management factory:** Consume a medium amount of energy (Annual energy consumption is 1,500 kL or more in crude oil equivalent.)
  - ✧ Factories and Buildings
    - Appointment of an energy management officer for a type 2 designated management factory
    - Formulation and submission of periodical reports

(ii) Factory Inspection

A field investigation targeting Type 1 designated energy management factories (overall factory check) has been conducted since FY 2001 guided by government. In the investigation, the observance situation of the criterion part of the judgment standards is evaluated. Assessment results based on the objective standards determine whether any directions should be given.

When the achievement in rational use of energy is extremely insufficient, the factory/building is given instruction to formulate and submit a rationalization plan and to implement it after the on-the-spot inspection.

(iii) Certified Energy Managers

A license for energy management is awarded to any person that passes the energy management examination, or who has been authorized by the Minister for Economy, Trade and Industry (METI) upon completing a qualification course for energy management.

(2) Government Support and Voluntary Program

(a) Voluntary Technical Action Plan by Nippon Keidanren (Japan Business Federation)

Despite regulation, Keidanren is implementing the “Environmental Voluntary Action Plan“, aiming to promote the efficient use of energy on a voluntary basis. Involved industrial organizations are electricity, steel, chemical, petroleum, paper, electronics and electricity, cement, automobile, auto parts, mining, airlines, real estate, department store, chain store, refrigerated warehouse, telecommunication, bank, insurance, franchise and broadcasting corporation.

(b) International ENERGY STAR Program

The international Energy Star program is a voluntary energy-efficiency labeling program designed to promote energy-efficient products. Product categories are Personal computers, monitors, printers, fax machines, copying machines, scanners and multifunction devices.

(c) Energy Audit Program (Free of Charge)

An energy audit of small and midsize factories took place in 1955 and approximately 5,600 energy audits have since been conducted in the factories around Japan.

(3) Economic Incentives and Fiscal Measures

The financial supporting measures are provided to accelerate the introduction of energy efficient technologies and equipment in the industrial and commercial sectors as follows.

Table 2-2 Financial Incentives for Large-size Enterprise

Target Projects	Agency	Interest Rate	%
1. General Energy Conservation Projects The following are considered as general energy conservation projects	DBJ ODFC	Preferential rate I	50%
2. Energy-saving Promotion Projects for the Industrial Sector	DBJ ODFC		
3. Energy-saving Promotion Projects for Buildings	DBJ ODFC	Preferential rate II	40%
4. Projects for acquisition of machinery and equipment that meet specific requirements for energy performance standards			
5. Electric Power Load Leveling Projects	DBJ		

Note : DBJ Development Bank of Japan
ODFC The Okinawa Development Finance Corporation

Table 2-3 Financial Incentives for Small and Medium-size Enterprises (SME)

Target Projects	Agency	Interest Rate
(Promoting the efficient use of energy) Projects for acquisition of energy conservation facilities	JASME NFLC ODFC	Special interest rate
(Promoting the introduction of specific high energy performance equipment) Projects for replacement of obsolete industrial furnaces and/or boilers etc.,		

Note : JASME Japan Finance Corporation for Small and Medium Enterprise
NFLC National Life Finance Corporation

When business operators purchase equipment which contributes to efficient energy use and utilize it for their business activities within a year, they can choose either one of the following options:

- ✓ Tax exemption equivalent to 7 % of the equipment acquisition cost (which should not be more than 20 % of the income tax or corporate tax payable.
- ✓ Special depreciation of 30 % of the equipment acquisition cost in the year of acquisition, in addition to ordinary depreciation.

(4) Support to R&D

To technologically ensure the practice of energy conservation in the future, the R&D of technologies concerned with energy conservation has been promoted in cooperation with industries, the government, and academia.

The New Energy and Industrial Technology Development Organization (NEDO) is responsible for developing energy use rationalization technologies as well as providing support for introducing energy use rationalization technologies, etc.

2.1.3 Energy Conservation Center of Japan

(1) Outline

Under the policy and support of the Japanese Government, Energy Conservation Center, Japan (ECCJ) has been conducting various energy conservation programs for Japan and developing countries. Its profile is shown below:

- Legal status: An incorporated foundation under the supervision of Ministry of Economy, Trade and Industry (METI)
- Establishment: 1978 (when the 2nd oil crisis hit Japan)
- Mission: Core organization responsible for promotion of energy conservation
- Office location: Head office & 8 branches in Japan
- Supporting member: 2,833 members (as of July 2006)
- Number of employees: 122 persons (as of July 2006)
- Budget: 4,527 million yen in FY2005 (39 million US$: @116¥/US$)
- Fields of activity: Industrial, Residential / Commercial and Transportation
- Major activities:

Industry Sector

1) Energy conservation audits services for factories
2) Education & training on energy conservation
3) State examination for energy managers (assigned by the government)
4) Good Practice Dissemination (conference for successful cases of energy conservation activities, excellent energy conserving equipment, etc.)
5) Technological development and spillover

Residential, Commercial & Transportation Sector

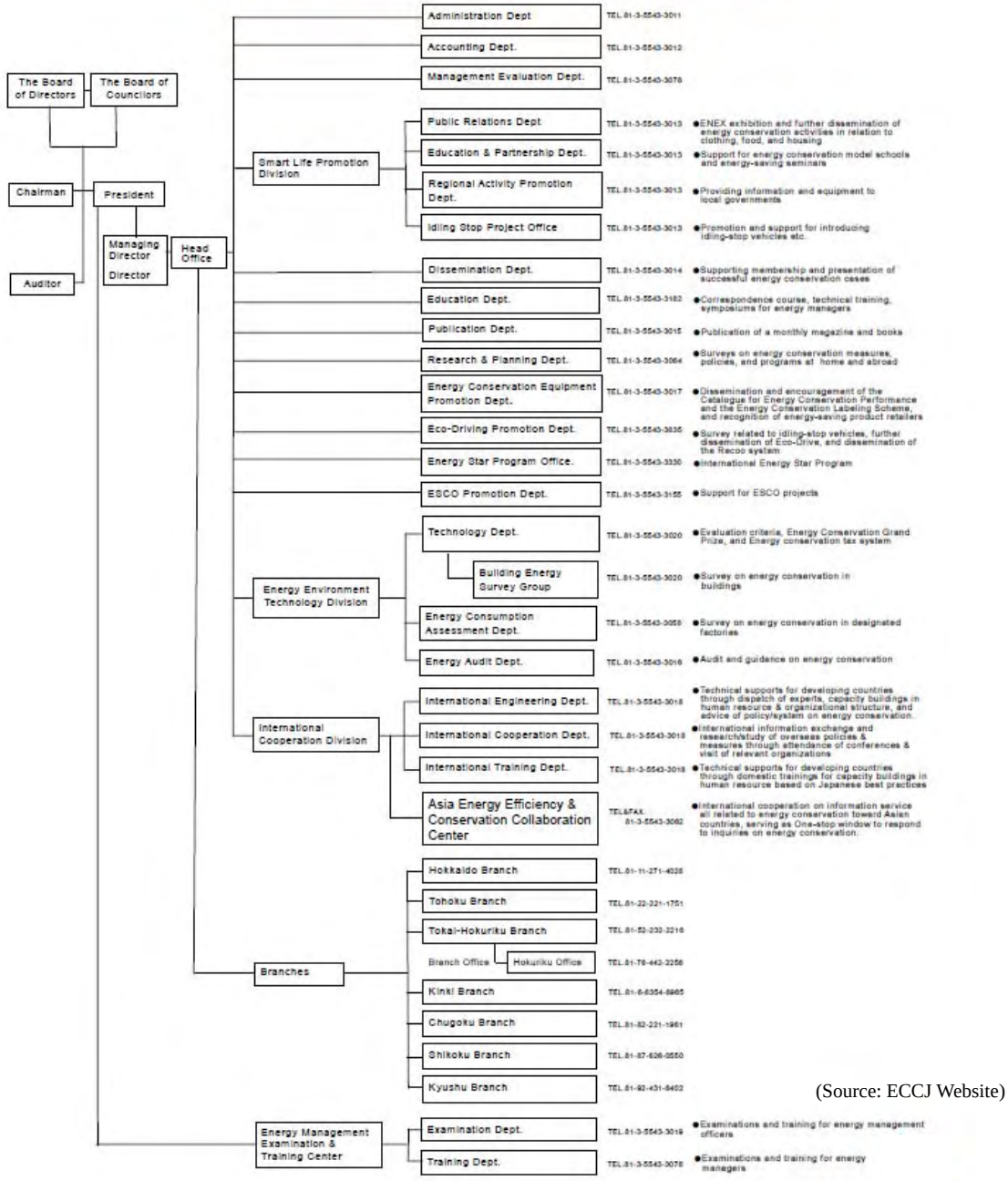
1) Energy conservation audits services for buildings
2) Ranking catalogue for energy efficient appliances (dissemination of Top Runner Program)
3) Promotion of energy labeling system
4) International Energy Star program implementation
5) Energy efficiency product retailer assessment system
6) Dissemination of energy conservation indicator "E-Co Navigator"
7) Energy education at primary and middle schools
8) ESCO research and development

Cross Sector

1) Energy conservation campaign & exhibition (ENEX)
2) Commendation (grand energy conservation prize)
3) Information & data base, publicity and publishing
4) Survey and monitoring
5) International cooperation & communications

(2) Organization

There are one head office and 8 branch offices in Japan. Under the head office, there are 22 departments including project center as shown below. The board meetings are held in twice annually. The members of the board consist of 1 chairman, 1 president, 3 managing directors, 25 directors, 2 auditors. In addition, 30 counsilors are also assigned. Those members are categorized into 2 types, namely part time members who are large energy consuming companies such as power utilities, gas utilities, manufactures and representatives of academy, association, etc., and full time members who are belonging to ECCJ.



(Source: ECCJ Website)

Figure 2-2 Organization Chart of ECCJ (as of April 2007)

(3) Membership

ECCJ is supported by 2,833 members as shown below.

Table 2-4 Membership of ECCJ (as of July 2006)

Metal ore mining	7	Electric machinery	250	Construction materials, ores, metal materials wholesale	1
General construction	31	Information, communication machinery	9	Machine appliances wholesale	4
Equipment construction	61	Electronic parts, device manufacturing	43	Goods retailing	1
Food manufacturing	193	Transport machinery	183	Real estate	8
Drink, tobacco, feed manufacturing	63	Precision machinery	31	Real estate leasing	1
Textile (excludes apparel & clothes)	74	Other manufacturing	57	Hotel	7
Wood & wooden products (excludes furniture)	13	Electricity	229	Medical care, health and welfare	8
Pulp, paper & paper products	115	Gas	58	Education	14
Publishing, printing & their correlatives	13	Heat supply	37	Cooperative association	1
Chemicals & chemical products	373	Waterworks	1	Scientific institute and laboratories	11
Petroleum & coal products	54	Communications	5	Entertainment	3
Plastics products	69	Broadcasting	1	Waste disposal	2
Rubber products	62	Information service	1	Advertising	5
Ceramic, stone & clay products	182	Image, audio, written information	4	Other business services	10
Iron & steel basic industries	120	Railways	3	Politics, economics, cultural associations	32
Non-ferrous products	105	Road freight transport	2	Local contractors	8
Metal products	77	Warehousing	6	Others	57
General machinery	120	Goods wholesale	8	Grand total	2,833

(Source: ECCJ Website)

The members annually pay member fee ranging from 100,000 Yen to 40,000 Yen according to types of member class. For such members, ECCJ provides the following services.

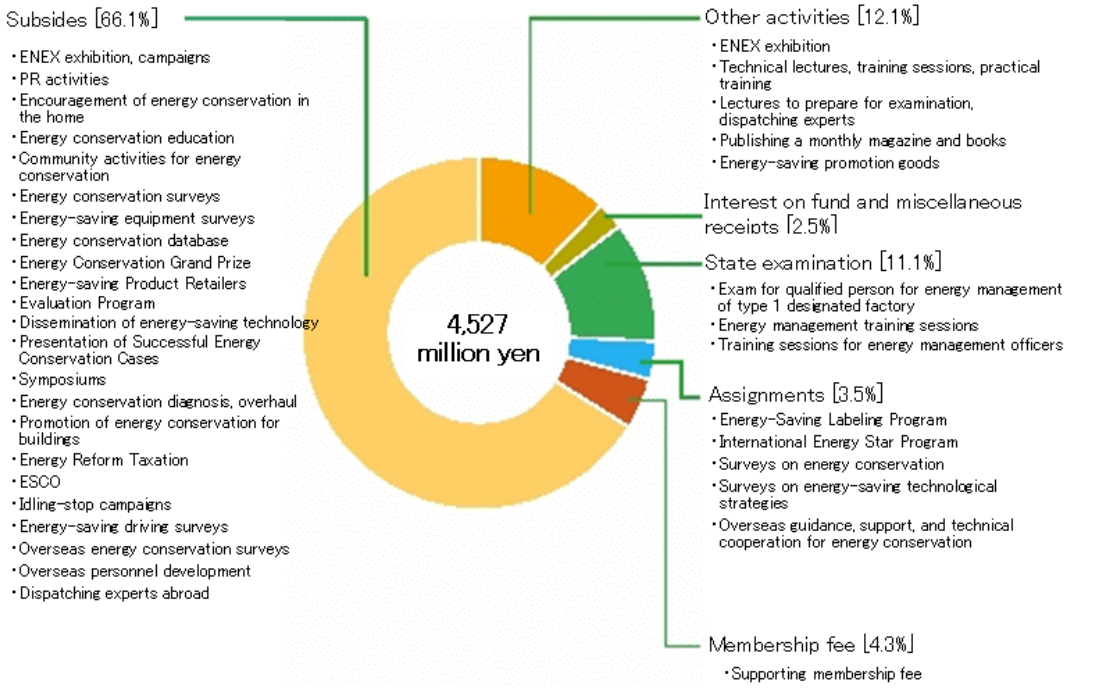
- Distribution of a magazine “Monthly Energy Conservation”
- Utilization for consultation regarding legal matter, technology, etc.
- Discount of seminars, traning programs, publication, etc.
- Other energy related information

Also non member companies, retail shops as well as general people can utilize various information and data by accessing to ECCJ.

(4) Budget

Actual budget of FY 2005 is shwon below. 4,527 million Yen came from subsidies (66 %), state examination implementation including training program (11%), member fee (4.1 %), assignments (3.5%) and so on.

Assistance activities for mandatory program are covered by subsiies. On the other hand, assitance activities for volunary programs are coverd by all budget categories.



(Source: ECCJ Website)

Figure 2-3 Budget Breakdown of ECCJ

2.2 United States of America

2.2.1 Energy Policy

(1) The National Energy Policy 2001

America makes public announcement of its national energy policy once every several years. The National Energy Policy (NEP) of May 2001 is the latest report and outlines the plan for rational use of energy aimed at future supply capacity and environmental protection for the general public, businesses, and the local and federal government.

The National Energy Policy shows three basic principles:

- ✓ The Policy is a long-term, comprehensive strategy. The US energy crisis has been years in the making and will take years to resolve.
- ✓ The Policy will advance new, environmentally friendly technologies to increase energy supplies and encourage cleaner, more efficient energy use.
- ✓ The Policy seeks to raise the living standards of the American people, recognizing that to do

so America must fully integrate its energy, environmental, and economic policies.

Applying these principles, the government urges action to meet five specific national goals. America must 1) modernize energy conservation, 2) modernize US energy infrastructure, 3) increase energy supplies, 4) accelerate the protection and improvement of the environment, and 5) increase US energy security.

NEP includes 105 policy recommendations on management of energy supply/sustainability, energy efficiency and energy infrastructure, and measures to strengthen international cooperation with foreign countries.

(2) The Energy Policy Act of 2005

In August 2005, the Energy Policy Act of 2005 (EPACT) was revised and provisions for enhancement of energy supply capability, such as improving domestic energy availability (oil, natural gas, nuclear power, electricity and etc.) and strengthening relationships with energy resource supply countries.

Now America's key goals are set as follows:

- ✓ Diversify America's energy supply by
  - Promoting alternative and renewable sources of energy
  - Encouraging the expansion of nuclear energy in a safe and secure manner
  - Increasing domestic production of conventional fuels, and
  - Investing in science and technology
- ✓ Increase energy efficiency and conservation in homes and businesses
- ✓ Improve the energy efficiency of cars and trucks
- ✓ Modernize electric power infrastructure
- ✓ Expand the Strategic Petroleum Reserve

Furthermore, in the state of the Union address in January 2006, "The Advanced Energy Initiative" was presented, and a measure for diversification of energy sources and vehicle driving sources was hammered out. Then, in January 2007, President Bush presented "Twenty In Ten: Strengthening America's Energy Security". America has shown its numerical goal which is "Reducing U.S. gasoline usage by 20 percent in the next ten years"

The US Department of Energy is the central and important figure in term of American energy policy. The Office of Energy Efficiency and Renewable Energy within the DOE is responsible for energy conservation. As for the labeling system, with the DOE's cooperation, the Federal Trade Commission (FTC) is in charge of the mandatory system, and the Environmental Protection Agency (EPA) has jurisdiction over the ENERGY STAR program.

2.2.2 Main Measures for Energy Conservation

(1) Regulations

(a) Efficiency Standards for Buildings

The 1992 Energy Policy Act makes it mandatory for states to certify that their energy codes have been updated to meet or exceed minimum levels of efficiency. Online compliance tools can be used to demonstrate energy code compliance.

(i) Federal Building Codes - Residential

The new rule requires that new Federal residential low-rise (3 stories or less above grade) buildings achieve an energy consumption level of at least 70% below those set by the 2004 International Energy Conservation Code (IECC), if cost effective.

(ii) Federal Building Codes - Commercial

This code was issued on January 1, 2002, and is based on ASHRAE/IES Standard 90.1-1989, and all addenda. It became effective on October 8, 2001.

(b) Labeling and Minimum Efficiency Standards

The Energy Guide Label gives two important pieces of information, which can be used to compare different brands and models when shopping for a new appliance. This label is mandatory for the following home appliances.

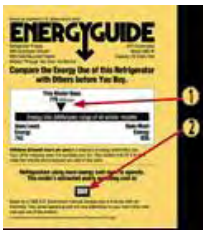


Figure 2-4 Energy Guide Label

Table 2-5 Energy Guide Appliances

No.	Product	No.	Product
1	Central AC (Split type)	10	Heat Pumps (Group-Source)
2	RACs (Window)	11	Fluorescent Lamps
3	RACs (Split)	12	Ballasts (Electronic)
4	Water Heaters (Gas)	13	Refrigerator
5	Water Heaters (Electric)	14	Refrigerator-freezers
6	Boilers	15	Freezers
7	Furnaces	16	Clothes Washers
8	Heaters (Pool)	17	Dishwashers
9	Heat Pumps (Water-loop)		

(Source: Center for Law and Social Policy)

(c) Energy Management / Audits / Consumption Reporting

In the U.S., energy management/audit/report is not obligatory by regulation, except for federal facilities and buildings. Basically, it is executed on a market basis for cost reduction in factories by utilizing ESCO.

EPACT contains many energy efficiency provisions for the federal sector. It sets goals for agencies to reduce building energy use (gross square foot) by 2 % per year from 2006 through 2015. In this act, energy management, including reporting, is mandatory for federal buildings.

(2) Government Support and Voluntary Program

The US federal government is implementing a number of voluntary programs in the residential/commercial buildings sector to accelerate the adoption of highly-efficient building products, appliances, and systems that can significantly reduce energy use and GHG emissions.

(a) Rebuild America

States and community partnerships to promote cost-effective energy efficiency investments in public housing, commercial buildings, and multifamily residences.

(b) Energy Star for Residential Markets

Energy Star for the Residential Market program provides guidance for homeowners on designing efficient kitchens, additions, and whole-home improvement projects and works with major retailers and other organizations to help educate the public.

(c) Energy Star for the Commercial Market

The Energy Star for the Commercial Market leads building owners through a comprehensive, five-stage strategy to capitalize on building system interactions so as to maximize energy savings from a given amount of investment in efficiency.

(d) Energy Star Labeled Products

The Energy Star® label is being used by EPA and DOE to promote products and services that save energy and money and help the environment. Examples of the products covered include appliances, heating and cooling equipment, consumer electronics, home office equipment, windows, lighting, water coolers, dehumidifiers, ventilation fans, ceiling fans, business office equipment, roof products, etc.

Figure 2-5 Energy Star Label

(e) Energy Star for the Industry

Energy Star for the Industry is an EPA voluntary partnership program that enables industrial companies to evaluate and cost-effectively reduce their energy use. It helps establish energy performance benchmarks, strategies for improving energy performance, and provides technical assistance and recognition for companies that reduce energy use. Energy Star for the Industry is a new initiative that integrates and builds upon the former Climate Wise Program and offers a more comprehensive partnership for industrial companies.

2.2.3 Energy Conservation Center

In EPACT 2005, the framework of the “Advance Energy Technology Transfer Center” is shown. This establishes grants to nonprofit institutions, state, and local governments, or universities, to

establish a geographically dispersed network of “Advance Energy Technology Transfer Centers”. Each center shall operate a program to encourage demonstration and commercial application of advanced energy methods and technologies through education and outreach to building and industrial professionals, and to other individuals and organizations with an interest in efficient energy use. However, this plan is still under discussion.

The Industrial Assessment Centers (IACs), sponsored by Industrial Technologies Program (Office of Energy Efficiency and Renewable Energy of DOE), provides eligible small- and medium-sized manufacturers with no-cost energy assessments. Additionally, the IACs serve as a training ground for the next-generation of energy conservation engineers.

There are currently 26 schools across the country participating in the IAC Program.

2.3 United Kingdom

2.3.1 Energy Policy

(1) Climate Change Program

The aim of the program is not only to cut all greenhouse gas emissions by the agreed 12.5% from 1990 levels in the period from 2008 to 2012 (the Kyoto Protocol commitment), but to go beyond this by cutting carbon dioxide emissions by 20 % from 1990 levels by 2010.

The following are among the actions taken to implement the strategy:

- ✓ Climate Change Bill

  In March, 2007, a draft Climate Change Bill was published following cross-party pressure over several years, led by environmental groups. The Bill aims to put in place a framework to achieve a mandatory 60 % cut in the UK's carbon emissions by 2050 (compared to 1990 levels), with an intermediate target of between 26 % and 32 % by 2020.
- ✓ Climate Change Levy
- ✓ Renewable obligation
- ✓ Housing and community grants
- ✓ Carbon reduction commitment

(2) Meeting the Energy Challenge - “A White Paper on Energy, 2007”

(a) General

To deliver energy security and accelerate the transition to a low carbon economy, UK requires the following three urgent and ambitious actions at home and abroad.

- ✓ Save energy;
- ✓ Develop cleaner energy supplies; and
- ✓ Secure reliable energy supplies at prices set in competitive markets.

In this White Paper, it is shown that the draft Climate Change Bill creates a new legal framework for the UK achieving, through domestic and international action, at least a 60% reduction in carbon dioxide emissions by 2050, and a 26-32% reduction by 2020, against a 1990 baseline. It declares the starting point for the UK's energy policy is to save energy, and says that it is often the cheapest way of reducing carbon emissions, certainly in the short-term and it can also contribute to security of supply, for example by reducing the need for energy imports, and reducing fuel poverty through lower bills. The UK declares it will support the European Commission's proposals to save 20% of the EU's energy consumption through improved energy efficiency by 2020.

(b) Strategy for Business

(i) Carbon Reduction Commitment

Large non-energy intensive public and private sector organizations in UK, such as hotel chains, supermarkets, banks, the Central Government and large Local Authorities account for around 10 % of the UK's emissions. Emissions trading could deliver significant energy savings in this sector. The Government has therefore decided to introduce a mandatory cap and trade scheme.

(ii) Energy Performance Certificate

It shall be required for all business premises to have an Energy Performance Certificate, when they are built, sold, or rented out. These certificates describe a building's energy rating and set out what steps can be taken to improve their performance, save energy, and reduce energy bills.

(iii) Advanced and Smart Metering Services

The Government shall also hold consultations on a requirement for energy suppliers to extend to advanced and smart metering services to all business users in Great Britain within the next 5 years.

(c) Strategy for Households

(i) Carbon Emission Reduction Target (CERT)

The program proposes that energy suppliers double their current effort. In the long term, from 2012, the UK wants to develop this scheme to support a transformation in the way suppliers view their relationship with the end consumer, helping their customers save energy, by shifting their focus to the provision of energy services, rather than simply selling units of energy.

(ii) On-line CO2 calculator and Smart meters

The UK will launch an on-line CO2 calculator which will enable households to know how their everyday activities contribute to emissions. The UK is also undertaking trials of smart meters and real time displays which enable people to track their energy use conveniently in their homes.

(iii) Energy Performance Certificates

The Government will also introduce Energy Performance Certificates for new and existing homes. Anyone selling, leasing or renting their property will need to provide a Certificate setting

out the energy performance of the building.

(d) Strategy for Public Sector

By 2012, the Government plans to make all governmental offices carbon neutral. The UK will forward plans for funding of new, energy efficient social housing and public sector buildings, and energy efficient procurement of new public sector cars and energy-using products:

- ✓ Participation in the Carbon Reduction Commitment scheme;
- ✓ UK is making it a condition of Government funding that all new social housing built by registered social landlords and other developers and all new homes developed by English Partnerships comply with level 3 of the Code for Sustainable Homes;
- ✓ Requirement to display a Certificate showing the energy rating of the building; and
- ✓ From 2008, UK will set challenging energy efficiency standards for all new products and services that the Government procures.

2.3.2 Main Measures for Energy Conservation

(1) Regulations

(a) Efficiency Standards for Buildings

Minimum legal requirements for the energy performance of new buildings have been in force since 1965, with the standards tightened regularly every few years.

(i) Standard Assessment Procedure (SAP)

The Standard Assessment Procedure (SAP), introduced in July 1995, is the government standard for home energy rating. Under the Building Regulations, new dwellings and conversions in England and Wales have since 1995 been required to have a SAP Energy Rating.

(ii) Home Energy Conservation Act (HECA)

The Home Energy Conservation Act (HECA) 1995 requires all local UK authorities with housing responsibilities to prepare, publish, and submit an energy conservation report identifying energy conservation measures which they consider practicable, cost-effective, and likely to result in significant improvement in the energy efficiency of all residential accommodation in its area

(b) Labeling and Minimum Efficiency Standards

By law, the European Community Energy Label must be displayed on all new household products of the following types displayed for sale, hire, or hire-purchase:

- ✓ Refrigerators, freezers and fridge-freezer combinations
- ✓ Washing machines
- ✓ Electric tumble dryers
- ✓ Combined washer-dryers
- ✓ Dishwashers
- ✓ Lamps
- ✓ Electric ovens
- ✓ Air conditioners

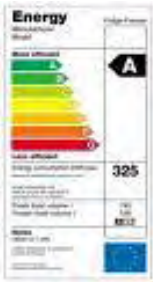


Figure 2-6 Label Sheet

The new Climate Change Program plans the development of energy labels, standards and other product-related measures designed to deliver "market transformation" in the energy efficiency of lighting, appliances, and other key traded goods.

(c) Energy Management / Audits / Consumption Reporting

By Energy Efficiency Commitment (EEC), both gas and electricity suppliers have a statutory responsibility to provide energy advice to consumers. According to this program, gas and electricity suppliers are required to encourage or assist domestic customers to take up energy efficiency measures. The Energy Efficiency Commitment should provide a challenge to energy suppliers while stimulating, in a sustainable way, the development of the energy efficiency industry. EEC will be renewed as Carbon Emission Reduction Target (CERT).

(d) Climate Change Levy

The Climate Change Levy (CCL), effective from April 1, 2001, applies to energy use in the non-domestic sector (industry, commerce, agriculture, and the public sector). Its aim is to encourage energy efficiency and help meet the United Kingdom's targets to reduce GHG emissions. It applies to gas, electricity, Liquefied Petroleum Gas (LPG), and coal. Levy rates are based on the energy content of the different energy products. They are equivalent to 0.43 p/kWh for electricity, 0.15 p/kWh for gas, 1.17 p/kilogram for coal, and 0.96 p/kilogram for LPG. Fuel oils do not attract the levy as they are already subject to hydrocarbon oil duty. The levy is added to energy bills before VAT is applied.

Residential energy users, charities, and very small businesses (using domestic amounts of energy) are exempt from paying the levy. There are also further exemptions for transport, for the production of taxable commodities and hydrocarbon oils, use in “good quality” combined heat and power plants, and in non-fuel uses. Energy-intensive businesses can reduce their levy payments by participating in voluntary Climate Change Agreements. Companies can obtain an 80 % discount if they enter into Climate Change Agreements that extend for a period of 12 years. There is a separate 50 % discount

for a period of up to five years for horticultural producers. The levy package, including the Climate Change Agreements, is expected to save at least 5 million tons of carbon per year by 2010.

(2) Government Support and Voluntary Program

(a) Climate Change Agreements

The Climate Change Agreements between energy-intensive sectors of industry and the Secretary of State are a recent policy mechanism to achieve environmental objectives. In return for agreeing and meeting stringent targets to reduce energy consumption or emissions, these sectors are entitled to an 80% reduction in the Climate Change Levy. Around 5,500 “underlying agreements” have been concluded with participating companies. The agreements cover around 13,000 individual facilities, and more sites are joining.

(b) Making a Corporate Commitment Campaign (MACC)

“Making a Corporate Commitment Campaign (MACC)”, a voluntary commitment, was launched in 1991 with the aim of getting top management to commit to responsible energy management.

Organizations that commit to MACC pledge to Publicly declare their commitment to achieve specific improvement targets as follows:

- ✓ Register their commitment.
- ✓ Agree to make their commitment and targets public.
- ✓ Agree to report annually on their progress towards meeting their targets.

(c) Market Transformation Program

The Market Transformation Program is a policy research, development and support program funded by Defra to improve the availability, adoption and use of domestic appliances and traded goods in the commercial sector that use less energy and do less harm to the environment.

2.3.3 Energy Conservation Center

The Energy Saving Trust (EST), which is an independent non-profit-making organization established in 1992 by the UK government, works to promote, through partnership, the sustainable and efficient use of energy, spreading the message of energy efficiency through advertising programs, advice centers and the endorsement of energy efficient products.

The Trust, on behalf of the government, manages the network of 52 local Energy Efficiency Advice Centers (EEACs).

2.4 German

2.4.1 Energy Policy

Germany is a federal country comprised of 16 Länder (federal states). Responsibility for most energy policy issues (e.g. energy legislation) is at the federal level. At the federal level, the main responsibility for energy policy lies with the Federal Ministry of Economics and Technology. This ministry is also in charge of setting energy efficiency policy and support to renewables.

The Länder governments are responsible for the implementation of federal law. They are in charge of granting licenses in their jurisdiction. Beyond those matters that are under federal jurisdiction (e.g. energy regulation), a Länder, can develop its own measures in the field of energy policy.

“National Climate Protection Program 2005”, is a program to make sure that Germany will be able to comply with the German commitments within the EU burden sharing to reduce its greenhouse gas emission in the period 2008 - 2012 by 21 % as against 1990 levels and thus provide a basis for further ambitious environmental policies after 2012. This program and the 2007 Allocation Act set a limit on carbon emissions of 120 million tons of CO2 annually for the period 2008 to 2012.

On the other hand, “Development in 2020”, namely a doubling in energy productivity until 2020 compared to the reference year 1990, has been confirmed as a target of energy policy. This means that energy efficiency plays an important role for the government. The German Government also intends to give high priority to energy efficiency during the German EU Presidency in the first half of 2007.

To implement the measures contained in the Climate Protection Programme, the Federal Minister of Economics and Technology established the German Energy Agency (Deutsche Energie Agentur : Dena) in September 2000. Dena is not a subordinate agency of a ministry, but was established as a Gesellschaft mit Beschrankter Haftung (GmbH), a private company. Dena is a company that networks various players within the energy sector and was established to implement energy efficiency policy and promote renewable energy sources, climate protection, and sustainable development.

2.4.2 Energy Conservation Law

(1) EnEG (Energieeinsparungsgesetz: Energy Conservation Law)

This is the legal basis for energy conservation regulation can still be amended or created, which is necessary for complete conversion of the European guideline over the total energy efficiency of buildings.

The law authorizes the government:

- ✓ to demand certain standards referring to heat insulation in future buildings yet to be constructed,
- ✓ to demand certain standards referring to installations of heating engineering, ventilation, and air-conditioning technology, as well as water service installations,
- ✓ to demand certain standards referring to the operation of these installations,
- ✓ to demand the distribution of operating costs of collaboratively used installations of heating engineering, ventilation, and air-conditioning technology, as well as water service installations
- ✓ and to regulate inspection and monitoring of firing installations

(2) EnEV (Energieeinsparverordnung: Energy Conservation Ordinance)

This is not only valid for residential buildings, but also for buildings in the industrial and tertiary sector. The target of the Ordinance was to reduce the energy requirements of new buildings by an average of 25 to 30 % compared with the former standard.

According to this ‘holistic approach’ as applied in the EnEV, the primary energy demand of a building is used as a measure. And certain minimum requirements for constructional heating insulation are set in order to ensure a minimum standard in this field. For existing houses, retrofitting regulations are set that are required to be fulfilled under certain circumstances and in a certain period of time. They refer to the following components:

- ✓ Especially old boilers,
    - Non-insulated tubes for heating and warm water in cold rooms
    - Non-insulated highest floor ceilings to attic floors, if these are accessible and not able to be walked on

The execution of EnEV lies within the responsibility of the Bundesländer. They regulate:

- ✓ Responsibilities for exceptions and exemptions
- ✓ Dispatching of verifications and energy passes
- ✓ Monitoring of re-fitting regulations
- ✓ Monitoring of implementation
- ✓ Regulatory offences
- ✓ Utilization of building products and installations

2.4.3 Main Measures for Energy Conservation

(1) Regulations

(a) Efficiency Standards for Buildings

EnEV 2004 requires the following:

- ✓ Energy certificates mandatory for new / substantially refurbished buildings
  Requirements are defined for:
  - a maximum primary energy demand,
  - a maximum average u-value
  - maximal U-values of each element of the building's surface area
  - several requirements on quality of boilers, controls and pipe insulation building air-tightness and
  - avoiding of thermal bridges.
- ✓ Minimum requirements for new / substantially refurbished buildings
- ✓ Holistic calculation method
- ✓ Inspection of boilers

The EnEV also encourages energy efficiency improvements in existing buildings. The Ordinance requires that all boilers installed before October 1978 must be replaced. The ordinance sets stricter energy requirements when modernization or retrofitting measures are undertaken than did the 1995 Thermal Insulation Ordinance.

(b) Labeling and Minimum Energy Efficiency

Since 1 January 1998, energy consumption labeling has been mandatory in Germany. EU Directives have thus been transposed into national law (Energy Consumption Labeling Ordinance). Cooling and freezing equipment, washing machines, dryers, combined washers/dryers, dishwashers and household lamps have to be provided with uniform labels showing information on energy consumption and other product characteristics before they get into the shops. Another Ordinance (Ordinance on Maximum Energy Consumption) to transpose the EU Directive on maximum values of energy consumption by cooling and freezing equipment came into effect on 13 June 1998.

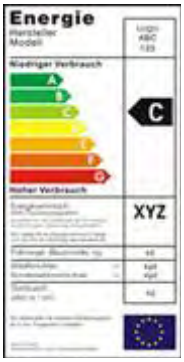


Figure 2-7 Label Sheet

(c) Energy Management / Audits / Consumption Reporting

A mandatory energy management system does not exist in Germany. However there are special regulations for boiler and heat metering as follows.

- ✓ Inspections of Boilers
  - Small and Medium Combustion Plant Ordinance– last amendment 1997

- Exclusively conducted by the district master chimney sweeper

✓ Air Conditioners

- Functional inspection of air conditioner equipment is included in the maintenance schedule

✓ Heat metering

Since January 1996, rooms in occupied buildings in the new Länder have to be equipped with heat consumption metering instruments as in the old Länder where this measure has been in force since 1981.

(d) Eco Tax

One general measure to improve energy efficiency in Germany is the Ecological Tax Reform, i.e. the introduction of a so-called Eco Tax on oil, gas and electricity. The tax was introduced in two stages: a first tax increase from 1 April 1999 and a further four step increase in taxation from 2000 to 2003. There are tax reductions for some consumers, esp. manufacturing industry and agriculture and railways. The revenue from this tax is used for a reduction of the non-wage labor costs and the promotion of renewable energies.

(2) Government Support and Voluntary Program

The federal government relies more on market based measures, such as voluntary agreements, in industry than on regulatory interventions. It does not consider additional regulations necessary because industries implement the most cost-effective measures related to energy savings in order to be competitive. The voluntary agreements signed by industry are aimed at CO2 emissions and improvement of energy efficiency.

The voluntary agreements include evaluation and monitoring by a research institution. The results of the voluntary commitments are continuously analyzed and evaluated by the independent economic institute RWI at the request of the federal government and the private sector.

(a) Demand Side Management (DSM)

Public utilities in Germany are deeply involved in least-cost planning and demand-side management (DSM). German utilities lead the development of load management, and DSM activities are an integral part of business policies. DSM projects consist of advising consumers on energy savings.

(b) Combined Heat and Power Generation (CHP)

The government decided to include into the new Climate Protection Program the new voluntary agreements with the industry and the introduction of a new CHP law, which would again support co-generation by attractive feed-in tariffs.

(c) Advisory Service

On 1 July 1998, a support program to provide advice on energy conservation in residential

buildings was reintroduced; it had ceased at the end of 1997 for financial reasons. This program involves “on-site advice” in residential buildings for which permission to build was given before 1984 (1989 in eastern Germany).

2.4.4 Energy Conservation Center

The German federal government does not have any energy conservation center. However some Länders has one. Typical one is The Energy Agency North Rhine-Westphalia that is an independent and noncommercial contact for any queries concerning efficient and economic use of energy and the application of renewable energy sources.

2.5 Australia

2.5.1 Energy Policy

(1) Report of Securing Australia’s Energy Future 2004

This report estimates that about 40 % of greenhouse abatement from the Australian energy sector expected by 2010 is from energy efficiency measures. The major aspects of this document included:

- ✓ a complete overhaul of the fuel excise system to remove AU$ 1.5 billion in excise liability from businesses and households in the period to 2012-13,
- ✓ the establishment of a AU$ 500 million fund to leverage more than AU$ 1 billion in private investment to develop and demonstrate low-emission technologies,
- ✓ a strong emphasis on the urgency and importance of continued energy market reform,
- ✓ the provision of AU$ 75 million for Solar Cities trials in urban areas to demonstrate a new energy scenario, bringing together the benefits of solar energy, energy efficiency and vibrant energy markets,
- ✓ the provision of AU$ 134 million to remove impediments to the commercial development of renewable technologies,
- ✓ incentives for petroleum exploration in frontier offshore areas as announced in the 2004-05 budget,
- ✓ new requirements for business to manage their emissions wisely,
- ✓ a requirement that larger energy users undertake and report publicly on, regular assessments to identify energy efficiency opportunities.

(2) National Framework for Energy Efficiency (NFEE)

The Ministerial Council on Energy (MCE), which comprises energy ministers from all Australian States and Territories and the Commonwealth, was formed in June 2001. MCE’s objectives are:

- ✓ To provide national oversight and co-ordination of policy development to address the opportunities and challenges facing Australia's energy sector into the future.

- ✓ To provide national leadership so that consideration of broader convergence issues and environmental impacts are effectively integrated into energy sector decision-making.

As a further commitment to progressing energy efficiency, MCE established the Energy Efficiency and Greenhouse Working Group, which consists of all Australian jurisdictions. The group's charter is to provide strategic advice on policy direction and program delivery to significantly enhance energy end-use efficiency. A key task for the group is the development of a comprehensive National Framework for Energy Efficiency. Ministers have now agreed on the implementation plans for NFEE measures for the period 2005-07, which have the potential to save around 50 PJ of energy a year by 2015.

NFEE Stage One includes 'foundation' measures to establish the building blocks of NFEE. It consists of nine integrated and inter-linked policy packages which extend, or further develop, a range of cost effective energy efficiency measures that are currently being implemented at a national or jurisdictional level. Stage One builds on the existing capacity and capabilities developed by jurisdictions with an increased focus on national coordination.

The energy efficiency policy packages included in NFEE Stage One cover:

- ✓ Residential buildings
- ✓ Commercial buildings
- ✓ Commercial/industrial energy efficiency
- ✓ Government energy efficiency
- ✓ Appliance & equipment energy efficiency
- ✓ Trade and professional training & accreditation
- ✓ Commercial/industrial sector capacity building
- ✓ General consumer awareness
- ✓ Finance sector awareness

A number of programs administered through the Commonwealth's Australian Greenhouse Office, within the Department of the Environment and Water Resources, aimed at improving energy efficiency, are managed through local governments.

2.5.2 Main Measures for Energy Conservation

(1) Regulations

(a) Efficiency Standards for Buildings

In 1999, work began on developments to define an acceptable minimum level of energy efficiency for new buildings throughout Australia to consider the delayed case within the industry energy conservation. In 2006, energy efficiency performance requirements for all new building in Australia were included in the Building Code of Australia.

(b) Labeling and Minimum Energy Efficiency

It is said that Australia is the first nation to effectively rebase its labeling scheme. MEPS is adopted for the following items.

- ✓ Refrigerators and freezers
- ✓ Pressure electric storage water heaters for mains
- ✓ Pressure electric storage water heaters for small mains (<80 L) and low pressure and heat exchanger types
- ✓ Three-phase electric motors (0.73 kW to <185k W)
- ✓ Single-phase air conditioners
- ✓ Three-phase air conditioners up to 65 kW cooling capacity
- ✓ Ballasts for linear fluorescent lamps
- ✓ Linear fluorescent lamps - from 550 mm to 1500 mm inclusive with a nominal lamp power >16 W
- ✓ Distribution transformers – 11 kV and 22 kV with a rating from 10 kA to 2.5 MVA
- ✓ Commercial refrigeration (self contained and remote systems)

(c) Energy Management / Audits / Consumption Reporting

(i) Energy Efficiency Opportunities Assessment

Participation in Energy Efficiency Opportunities is mandatory for the estimated 250 corporations that use more than 0.5 PJ of energy per year.

Participants in the program are required to assess their energy use and report publicly on the results of the assessment and the business response.

(ii) Energy Efficiency in Government Operations Policy

Under the jurisdiction of policy for improving energy efficiency in government operations introduced in 1997, budget dependent agencies are required to submit energy consumption data annually to the Department of Industry, Tourism and Resources (ITR).

(2) Government Support and Voluntary Program

(a) Voluntary Labeling Program

This encourages market transformation by promoting highly efficient equipment or by identifying selected energy efficient products through appliance labeling.

(i) Energy Allstars

This makes it easy by listing for buyers the 15-25 % most energy efficient products by category.

(ii) Energy Star

This is an international standard for energy efficient office equipment including computers, printers and photocopiers, and home electronics such as TVs, audio products, and DVD players.

(b) Greenhouse Challenge Plus

This program builds on the success of the Greenhouse Challenge (established in 1995), integrating the Generator Efficiency Standards and the Greenhouse Friendly™ initiative into a single industry program. Greenhouse Challenge Plus is designed to reduce greenhouse gas emissions, accelerate the uptake of energy efficiency, integrate greenhouse issues into business decision-making, and provide more consistent reporting on greenhouse gas emissions levels. Over 700 businesses and industry bodies have already joined in this program.

(c) Energy Efficiency Best Practice (EEBP)

EEBP's major focus is on innovation and training, applying strategies that have the potential to identify efficiency improvements of up to 50 % in key energy-using processes.

2.6 Thailand

2.6.1 Energy Policy

(1) Energy Policy and Development Plan 2006

The Energy Policy and Development Plan delivered to the National Legislative Assembly under the Administration of Prime Minister General Surayud Chulanont on November 3, 2006, presented the following policies;

[SHORT TERM: Immediate implementation]

- Restructure and improve Energy Industry Management, so as to optimize the efficiency of the national energy management
- Procure energy so as to ensure sufficiency and security of energy supply
- Promote energy conservation and energy efficiency
  - Set the energy conservation targets
  - Establish the National Demand Side Management Office
  - Establishment of energy efficiency standards of energy-intensive appliances
  - Support the purchase of power from cogeneration system
- Promote alternative energy suitable for Thailand in order to diversify fuel types and reduce dependency on energy import
- Establish the Energy Price Structure so that energy pricing will be transparent, fair, and reflect actual costs
- Establish measures pertaining to clean energy to reduce the environmental impact resulting from various forms of energy industry operation
- Promote the private sector and general public participation in policy-making to create understanding and cooperation in energy development of the country

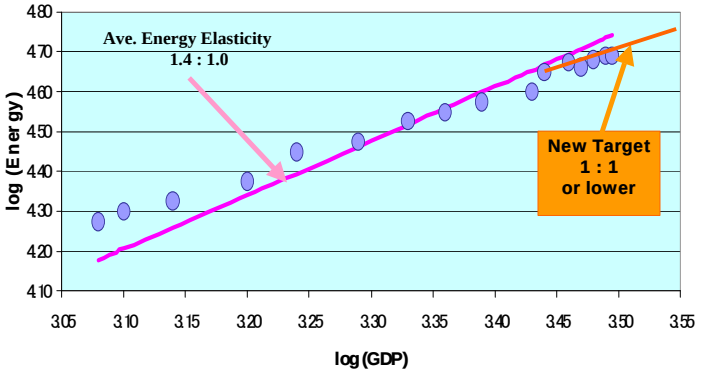
[LONG TERM: Study and research for formulation of energy management]

- Energy Supply
- Sustainable Energy Development

- Energy Efficiency
  - Support other agencies in the development of projects that will help reduce energy consumption, particularly oil, such as the improvement of mass transit and logistics systems, and the development of energy-saving vehicles
- Promotion of Competition in the Energy Business

(2) Target Value

Energy Planning and Policy Office (EPPO) of the Ministry of Energy (MOEN) has presented national energy strategy from 2005 to 2011. Its target is to reduce the GDP elasticity of energy to 1.00 by 2011 (1.40 in average of 1985-2001). In order to achieve the target, two major sectors, namely the transportation and industrial sectors that account for more than 70 % of energy demand shall be focused on for improving energy efficiency.



(Source: MOEN Website)

Figure 2-8 Historical Energy Elasticity of Thailand

2.6.2 Energy Conservation Law

(1) Energy Conservation and Promotion Act E.E 2535

The “Energy Conservation and Promotion Act E.E 2535” was established in 1992. Under this law, the following are regulated.

Table 2-6 Overview of the Energy Conservation Law in Thailand

Chapter	Title	Feature
1	Energy Management System for Designated Factory and Assignment of Energy Manager	- Designation of factories by criteria (Power Contract: 1,000 kW, Transformer: 1,175 kVA or Energy Consumption: 20 million MJ/year) - Assignment of Energy Manager - Submission of periodical report and middle-term plan document - Qualification of Energy Manager (Upper class job course graduation and 3 years experience, or Bachelor Degree of Engineering or Science, Trainee of Specific Training Course)
2	Energy Management System for Designated Building and Assignment of Energy Manager	Same as the above
3	Promotion of Energy Saving Machine and Equipment	- Designation of energy conserving machines and equipment that should receive support
4	Energy Conservation Fund (ENCON Fund)	- Establishment of a fund to support and subsidize energy conservation

(Source: JETRO Bangkok Website)

(2) ENCON Fund

Based on the Chapter 4 of the Energy Conservation Law, the "Energy Conservation Fund (ENCON Fund)" started from 1995 (First phase: 1995-1999, Second phase, 2000-2004). The second phase of the ENCON fund program was subdivided into three categories, namely: the compulsory program, the voluntary program, and the complementary program as follows.

Table 2-7 Overview of the ENCON Fund

Program	Contents
Compulsory Program	The program targets large scale factories, facilities, and buildings, complying with energy efficiency and conservation measures stipulated in the Act. ・Implementation of an energy audit, submission of an energy conservation plan, and appointment of qualified persons for energy management for designated factories and buildings. ・Establishment of building energy use standards.
Voluntary Program	The program targets supporting government agencies, academies, and NGOs for implementing development of renewable energy and research and development (R&D).
Complementary Program	The program supports organizations that wish to utilize the ENCON Fund in the future.

(Source: MOEN Website)

2.6.3 Main Measures for Energy Conservation

(1) Regulations

(a) Efficiency Standards for New Buildings

Based on The Energy Conservation Promotion Act, B.E. 2535 and The Royal Decree on Designated Building, B.E. 2538, a set of Ministerial Regulations are formulated in 1995 (B.E. 2538). Requirements for building and systems are defined by American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) and Singapore Energy Code as models. The followings are regulated.

- Overall Thermal Transfer Value (OTTV) of the building envelope <45 W/m2, for new buildings
- Efficient Electric Lighting < 16 W/m office
- Efficient chillers and compressors (not the system)

(b) Labeling and Minimum Energy Efficiency

(i) Equipment/Appliances Labeling: Mandatory

The Electricity Generating Authority of Thailand (EGAT) initiated the refrigerator labeling program in September 1994 and refrigerators have been labeled since February 1995 with a focus on residential refrigerators. In 1998, labels were made mandatory for single-door, refrigerators and refrigerators-freezers (140-170 L), manual-defrost models and expanded to include two-door and larger sizes models for voluntary labeling.

(ii) Minimum Efficiency Performance Standards

The Energy Planning and Policy Office (EPPO) and Thai Industrial Standards Institute set a long-term efficiency target level for the following appliances:

- Room Air Conditioners (Window)
- Room Air Conditioners (Split)
- Fluorescent Lamps
- Magnetic Ballasts For Fluorescent Lamps
- Electronic Ballasts For Fluorescent Lamps
- Compact Fluorescent Lamps
- Motors (3-phase Induction)
- Refrigerators
- Refrigerators-Freezers

(iii) Energy Management System

The system has been adopted since 1992 in the Energy Conservation Law. Under this law, at least 1 qualified energy manager shall be assigned to a designated factory or building which has a power contract of more than 1,000 kW, a total transformer capacity of more than 1,175 kVA or total annual energy consumption of more than 20 million MJ/year.

The designated factories or buildings have to submit a periodic report, which includes energy consumption data, to a governmental agency every 6 months, a list of energy consuming machines, and a mid-term plan which includes a target to be accomplished and an implementation plan every 3 years.

In 2001, the situation of the designated factories and buildings and the designated energy manager is shown below.

Table 2-8 Situation of Thai Designated Factories and Buildings in 2001

	No. of Factories and Buildings	No. of Assigned Energy Managers	Assignment Rate
Designated Factory	2,375	887	37%
Designated Building	1,504	1,154	77%

(Source: MOEN)

(2) Government Support and Voluntary Program

(a) Electricity Generating Authority of Thailand (EGAT)

EGAT, a generation and transmission utility covering all of Thailand, has implemented 4 pilot projects regarding energy conservation as follows.

Table 2-9 Overview of EGAT's Project

Project	Overview
Energy Label No.5 Products 	The EGAT Labeling is voluntary and EGAT support for Labeling cost and Testing cost. Test result is authorized by Electrical and Electronics Institute (EEI). High efficiency products are certificated as "Label 5". Refrigerators, air-conditioning systems, lamps, ballasts, fans, rice cookers and brown rice are targeted. Minimum standard is specified to the following two appliances: 1. A/C : EER=9.6 2. Ref : 1 door <100L : EC ≤ 0.8 AV + 300 ≥100L : EC ≤ 0.46 AV + 171 Ref : 2 door < 450L : EC ≤ 0.46 AV + 457 ≥ 450L : EC ≤ 0.8 AV + 457 Remark : EC = Energy Consumption (Wh/year), AV=Adjust Volume (m3)
Peak Cut Project	The project assists with the introduction of diesel generators (stand-by) for peak cut in the private sector. The following assistance is provided. - 700,000 Baht Capital Subsidy - 66.45Baht/kW/month for maintenance cost - One third of the fuel cost By 2006, a capacity of 500MW is expected.
Energy Conservation Consultant Program	Energy audits for buildings and factories were conducted. A total of 333 customers were served from 1998 to 2004.
ESCO Pilot Project	4 pilot projects for energy service companies and industries have been conducted.

(Source: DSM Thailand, EGAT)

(b) Distribution Utilities

In 2000, the Time of Use (TOU) option aimed at DSM was introduced. Thailand's electricity tariff is regulated and the retail prices of the distribution utilities (Metropolitan Electricity Authority (MEA) and Provincial Electricity Authority (PEA)) are unified under the regulations. Eight categories exist as follows: Residential, Small General Service, Medium General Service, Large General Service, Specific Business Service, Government Institutions and Non-Profit Organization, Agricultural Pumping Service, and Temporary Service. A TOU option is provided to all the categories, excluding Temporary Service. To take a single example, the table below shows the tariff system for Medium General Service.

Table 2-10 Table Tariff System (Medium General Service)

MEDIUM GENERAL SERVICE 30～999kV:Less than 250,000kWh in three month average			Demand Charge (Baht/kW)	Energy Charge (Baht/kWh)	Service Charge (Baht/month)
Normal	At Voltage of 69 kV and above		-	175.70	1.6660
	At Voltage of 22-33 kV.		-	196.26	1.7034
	At Voltage of less than 22 kV.		-	221.50	1.7314
TOU	At Voltage of 69 kV and above	Peak Monday – Friday 09.00– 22.00	74.14	2.6136	228.17
		Off Peak Monday – Friday 22.00- 9.00 Saturday – Sunday/Holiday (all day)	-	1.1726	
	At Voltage of 22-33 kV.	Peak Monday – Friday 09.00– 22.00	132.93	2.6950	228.17
		Off Peak Monday – Friday 22.00- 9.00. Saturday – Sunday/Holiday (all day)	-	1.1914	-
	At Voltage of less than 22 kV.	Peak Monday – Friday 09.00– 22.00	210.00	2.8408	228.17
		Off Peak Monday – Friday 22.00- 09.00 Saturday – Sunday/Holiday (all day)	-	1.2246	

(Source: MEA Website)

2.6.4 Energy Conservation Center

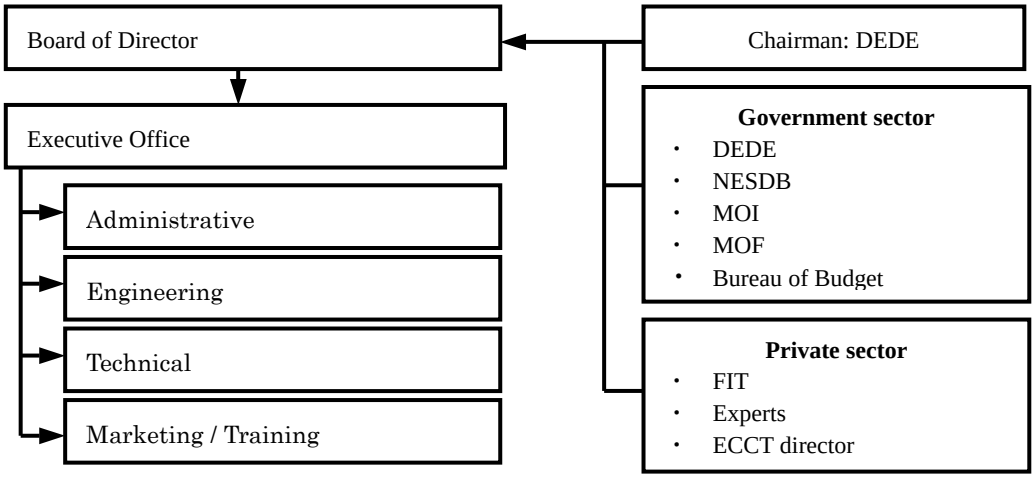
The Energy Conservation Center of Thailand (ECCT) was established as an implementation agency in 1985 through approval by the cabinet and is operated under the joint supervision of the Department of Energy Development and Promotion (DEDP) and the Federation of Thai Industries (FIT).

ECCT received 40 million Baht from the government to cover the cost for five years of operation starting from 1987. By 1992, ECCT provided energy engineering consultancy services to both industrial and commercial sectors with some technical support from various national and international development agencies.

ECCT has four divisions for the purpose of implementation, namely Engineering, Technical, Marketing, and Administrative divisions. The board members consist of a chairman from the Department of Alternative Energy Development and Efficiency (DEDE: former DEDP), other governmental agencies (National Economic and Social Development Board (NESDB), Ministry of

Industry (MOI), Ministry of Finance (MOF), and Bureau of Budget), and private sectors (FIT, Experts, and ECCT director).

Main activities of the ECCT are energy consulting, energy auditing, technical assistance, training, and publication. Organization of the ECCT is shown in the next figure.



(Source: ECCT Website)

Figure 2-9 ECCT Organization

2.7 Indonesia

2.7.1 Energy Policy

(1) National Energy Policy 2003-2020 (KEN)

Indonesia's energy policy was formulated in the National Energy Policy 2003-2020 (KEN) in March 2004. It defined "Secure the energy supply satisfying national benefits" as the Indonesian vision and its major policies are: (i) Improve energy supply capability, (ii) Optimize energy production, and (iii) Energy conservation.

(2) Policy on Renewable Energy Development and Energy Conservation (Green Energy)

Regarding energy conservation, before KEN was established, the Ministry of Energy and Mineral Resources. (MEMR) formulated the "Policy on Renewable Energy Development and Energy Conservation (Green Energy)" in December 2003. Green Energy says it is possible to achieve a 30 % energy saving by both the supply and demand side approach. In addition, it covers short (5 years) and long (by 2020) term programs for energy conservation as follows.

Table 2-11 Programs for Energy Conservation

Program		Major Contents
Short term program (5 years)	Investment	• Promotional activity of financial and investment instituions • Cooperation with overseas investment instituions
	Incentive	• Tax deduction • Free loan for technical sector implementing energy conservation
	Energy price	• Reduction of governmental subsidy
	Standardization	• Promotion of standardization • Application of standards and activity for implementation
	Capacity development	• By seminar and/or training
	Information	• Establishment of center for technological development and management • Establishment of information center and information release • Seminars
	R&D	• Securing revenue • Establishment of partnership between research institution and industrial sector
	Legislation	• Draft of government ordinance for incentives • Draft of energy act • Draft of energy conservation standard
Long term program (2020)	• Regulation on energy conservation (mandatory) • Efficient technology with environmental consciouness • Establishment of fund for energy conservation	

(Source: IEEJ Report, 2006)

(3) Presidential Instruction No 10 of 2005

To enforce the implementation of energy conservation policy, the Government of Indonesia is also enacted Presidential Instruction No 10 of 2005 which defines the means and institutional set-up, identifying the responsibilities of state bodies and their coordination with users and other organizations. This is the first Presidential Instruction specialized only for energy conservation and its contents are shown below.

- Implement energy conservation measures at governmental agencies, state-owned companies and/or public enterprises owned by local government according to its power and authority
  - ✓ Lighting and air-conditioning systems in office buildings and facilities
  - ✓ Energy consuming equipment, fixtures, and instruments in office buildings and facilities
  - ✓ Official vehicle
- Dissemination and awareness on implementation of energy conservation to private companies and citizens by the local governor and mayor
- Report progress on energy conservation every 6 months to the President via the Energy and Mineral Resources Minister by monitoring implementation of energy conservation activities
- The Energy and Mineral Resources Minister shall
  - ✓ Determine the procedure about implementing measures
  - ✓ Provide training and technical assistance to promote energy conservation

2.7.2 Energy Conservation Law

(1) The Energy and Mineral Resources Minister Decree No 31 of 2005

The Government, through the Energy and Mineral Resources Minister Decree No 31 of 2005, also provides a guideline for achieving the energy saving potential. In addition, the Government established the National Blueprint on Energy Conservation to outline the national energy conservation measures and the subsequent programs as well as activities.

MEMR clarifies the basic principle of energy conservation as "Energy conservation is efficient and rational use of energy without decreasing necessary energy use". Energy efficiency activities include campaigns, training, education, demand-side management, partnership program-long term agreement, and energy efficiency standard and labeling. The major topics are shown below:

- ✓ Regulation on temperature setting (25 degree) at governmental office and commercial building
- ✓ Operation restriction of air-conditioning systems and escalators (cease operation one hour before the office closes)
- ✓ Restrict operation of elevator (stop every other floor)
- ✓ Use of CFL and usage restriction of air-conditioners (temperature setting) and cut the load to the residential sector during peak time by a minimum of 50 %
- ✓ Utilization of compressed natural gas base for public transportation,
- ✓ Use Pertamax fuel (higher than normal petrol) for vehicles with over 2000 cc,
- ✓ Utilization of energy saving equipment and/or technology
- ✓ Save energy on street lighting and advertisement
- ✓ Mandatory energy audit for large energy consumers in the industrial sector

According to a paper of MEMR, energy conservation potential is estimated as follows;

Table 2-12 Energy Conservation Potential 2003

Sectors	Total Energy Consumption (Million of BOE)	Energy Conservation Potential	
		(Million of BOE)	Percentage (%)
Industry	188.2	28.23 – 56.46	15 - 30
Transportation	115.0	28.75	25
Household & Commercial	185.9	18.59 – 55.77	10 - 30

2.7.3 Main Measures for Energy Conservation

(1) Regulations

(a) Efficiency Standards for New Buildings

A building code was established in 1996, but industry compliance is voluntary. There is no special requirement regarding energy use for commercial buildings

(b) Labeling and Minimum Energy Efficiency

At this moment mandatory labeling and minimum energy efficiency does not exist in Indonesia. MEPS for the following appliances are under consideration.

- Refrigerators
- Irons (Electric)
- Televisions
- Refrigerator-freezers
- Fluorescent lamps
- Room air conditioner (Split type)
- Room air conditioner (Window type)
- Water heaters (Electric)
- Commercial refrigerate cabinets
- Clothes washers

(2) Government Support and Voluntary Program

(a) Energy Conservation Guideline

Based on the Presidential Instruction No 10 of 2005, MEMR published a Guideline on Energy Conservation. The guideline is outlined as follows:

✓ Governmental offices and commercial buildings
- Regulation of temperature setting (25 degree)
- Maximum room lighting intensity of 15 W/m2
- Restricted operation of the air-conditioning system and escalator (start operation of the escalator when the building opens and stop operation one hour before the building closes)

✓ Residential sector
- Use of CFL
- Regulation on temperature setting (25 degree)
- Minimum 50 W load cut in peak time (17:00 – 22:00)

✓ Industrial sector
- Conduct energy audits for large energy consumers

(b) Labeling

Voluntary energy labeling is adopted for the following equipment.

- Refrigerators
- CFLs
- Refrigerator-freezers
- Room air conditioner (Split type)
- Room air conditioner (Window type)

(c) DSM Activities

The following activities are mainly promoted by a state own power utility (Perusahaan Listrik Negara: PLN).

- ✓ Terang Program: Aimed at reducing electricity consumption by installing Compact Fluorescent Lamps (CFL) in households (450 VA)
- ✓ Public Street Lighting Program: Aimed at reducing electricity consumption by installing the efficient lamps on public streets
- ✓ Peduli Program: Focused on clipping the peak load via a special rebate program on CFL price to households (<900 VA)

(d) Partnership Program

The partnership program is a governmental policy on energy conservation focusing on the improvement of energy efficiency for energy intensive industries and buildings. The purpose of the program is to improve energy efficiency by an average of 20 % in companies interested in joining the program. Government support includes training, free energy audits, technical assistance, and a Seminar/Workshop. Companies commit to conducting energy audits on energy equipment and processes at factories, agree to implement energy saving measures and support the activity of the energy conservation forum.

(e) ESCO

In Indonesia, ESCO has not been developed yet. However, KONEBA, which is a state-owned company specialized for energy efficiency and conservation, is recognized as one of ESCOs. Its main tasks are listed below:

- ✓ Design of energy conservation systems
- ✓ Construction and project management
- ✓ Consulting on energy issues (energy audit, management and technical assistance)
- ✓ Development of energy management plan
- ✓ Test of equipment, inspection, and maintenance

2.8 Comparison of Target and Measures

In this section, to grasp world trend for target and measures regarding energy conservation, comparison tables are described as follows.

2.8.1 Comparison of Target

Target of energy conservation is shown in the following table. Developed countries tend to adopt total volume limitation in consumption or emission, but developing countries tend to adopt energy intensity such as final energy consumption per GDP.

Japan has established a target of final energy consumption per GDP. In addition, CO2 emission reduction has been also committed.

Table 2-13 World Trend in Target

	Japan	**US**	**UK**		**Germany**
Index	Final Energy Consumption per GDP	Gasoline usage	Co_2 emissions		Co_2 emissions
Target	-30%	-20%	-60%	-20%	-21%
Base Year	2003	2007	1990	1990	1990
Achievement Year	2030	2017	2050	2020	2012
Source	New National Energy Strategy 2006	The state of the Union address, Jan. 2007	The Climate Change Program, 2006		National Climate Protection Program 2005
	Australia	**Thailand**	**Indonesia**		**Saudi Arabia**
Index	Co_2 emissions	GDP elasticity	Energy Conservation Potential		-
Target	-40% in energy sector	-28% (1.4 -->1.0)	15 – 30%		-
Base Year	2004	Average in 1985-2001	---		-
Achievement Year	2010	2011	-		-
Source	Securing Australia's Energy Future, 2004	National Energy Strategy, 2005 - 2011	MEMR Paper		CTI Industry Joint Seminar 2005

The index of energy intensity allows energy increase with GDP increase. In other word, if GDP increases more rapidly than energy consumption, the index will be decrease (more efficiency). Actually it seems to be a reason why developing countries tend to adopt this target. On the other hand, for developed countries which have already been slow economy increase, the index of energy intensity seems to be stricter than developing countries.

2.8.2 Comparison of Measures

(1) Industrial and Commercial Sector

The main measures for industrial and commercial sector are summarizes as follows.

Table 2-14 Main Measures in Industrial and Commercial Sector

Japan	US	UK	Germany
1. Designated energy management 2. Energy manager 3.Action plan by Nippon Keidanren [20] 4. Free of charge energy audit 5. Tax incentive 6. Soft loan	1. ENERGY STAR for industry	1.Energy Efficiency Commitment 2. Climate Change Levy 3. Climate Change Agreements 4. Making a Corporate Commitment Campaign (MACC) 5.The Carbon Trust	1. Inspections of boilers and air conditioner 2. Heat metering 3. Eco-Tax 4. Feed-in-tariffs for CHP 5. Agreement with government
Australia	**Thailand**	**Indonesia**	**Saudi Arabia**
1.Energy Efficiency Opportunities Assessment 2.Greenhouse Challenge Plus (Over 700 companies)	1.Energy management • >1,000 KW or • >1,175 KVA 2.Audit program	1. Guideline on energy conservation	Mandatory Voluntary Others

(2) Government Sector

The main measures for government sector are summarized as follows.

Table 2-15 Main Measures in Government Sector

Japan	US	UK	Germany
1. Law on Promoting Green Purchasing 2. Lead by Example 3. Same as "Measures: Building" "Measures: Industry"	1.Federal energy management program (FEMP) • Reduce 2%/year • Mandatory energy management at federal building.	1. Local government energy efficiency activity 2. Home Energy Conservation Act (HECA)	1. Same as "Measures: Building" "Measures: Industry"
Australia	**Thailand**	**Indonesia**	**Saudi Arabia**
1.Energy Efficiency in Government Operations (EEGO) Policy	1. Same as "Measures: Building" "Measures: Industry"	1.Report energy conservation activity in every 6 months	Mandatory Voluntary

(3) Cross Sector

Regarding cross sector which covers more than 2 sectors, labeling and energy efficiency standards, building energy conservation standards and energy conservation center are summarized as follows.

Table 2-16 Labeling and Energy Efficiency Standard

Japan	US	UK	Germany
1. Top runner program [21] 2. Labeling [16] 3. ENERGY STAR	1. Energy Guide [17] 2. MEPS [20] 3. ENERGY STAR [25] for • Residential market • Commercial market • Labeled products 4. MEPS [2]	1. MEPS [4] 2. Labeling [10] 3. Labeling [23] 4. Market Transformation Program	1. Labeling [12] 2. Maximum energy consumption [2] 3. Labeling of the Group of Energy Efficient Appliances (GEEA) 4. ENERGY STAR
Australia	**Thailand**	**Indonesia**	**Saudi Arabia**
1. Labeling [10] 2. MEPS [15] 3. Labeling [29] 4. MEPS [2]	1. Energy Label No.5 Products (EGAT) [2] 2. Energy Label No.5 Products (EGAT) [5]	1. Labeling [5]	1. Under Drafting

Mandatory
Voluntary
Others

Note: [ ] is number of products

Table 2-17 Building Energy Conservation Standards

Japan	US	UK	Germany
1.Energy Conservation Law and associated guidelines • Insulation, AC, Lift • Ventilation, Lighting • Hot water supply	1.Building Code • Residential< -30% of 2004 IECC • Commercial = ASHRAE/IES std 90.1	1. Standard Assessment Procedure (SAP) 2. Warm Front (England only)	1. Energy certificates 2. Minimum requirement for new building
Australia	**Thailand**	**Indonesia**	**Saudi Arabia**
1. BC 2006 includes energy efficiency performance requirements first 2. Energy efficiency campaign “Your Home”	1. Efficiency standards for new buildings (now under revision)	1.Building Code 2.Industry compliance is voluntary	1. Draft of energy conservation chapter of the building code

Mandatory
Voluntary
Others

Table 2-18 Energy Conservation Center

Japan	US	UK	Germany
1. Energy efficiency center, Japan (ECCJ)	1. 26 Industrial Assessment Centers (IACs)	1. 52 local Energy Efficiency Advice Centers (EEACs)	1. No governmental center 2. Energy Agency North Rhine-Westphalia (NRW)
Australia	**Thailand**	**Indonesia**	**Saudi Arabia**
1. No governmental center	1. Energy Conservation Center of Thailand (ECCT)	1. No governmental center (under investigation) 2. Education and Training Center on Energy and Electricity	1. Under investigation

Nations
Local
Others

Chapter 3 Energy Data in Various Countries and KSA

3.1 Macro Data

3.1.1 Past Trend in KSA

(1) GDP and Total Primary Energy Supply (TPES)

The following table summarizes GDP at 2000 prices, Total Primary Energy Supply (TPES), population as well as their relating parameters form 1971 until 2004 in the Kingdom of Saudi Arabia (KSA). As a typical oil-dependent economy, the KSA's GDP directly reflects crude oil prices.

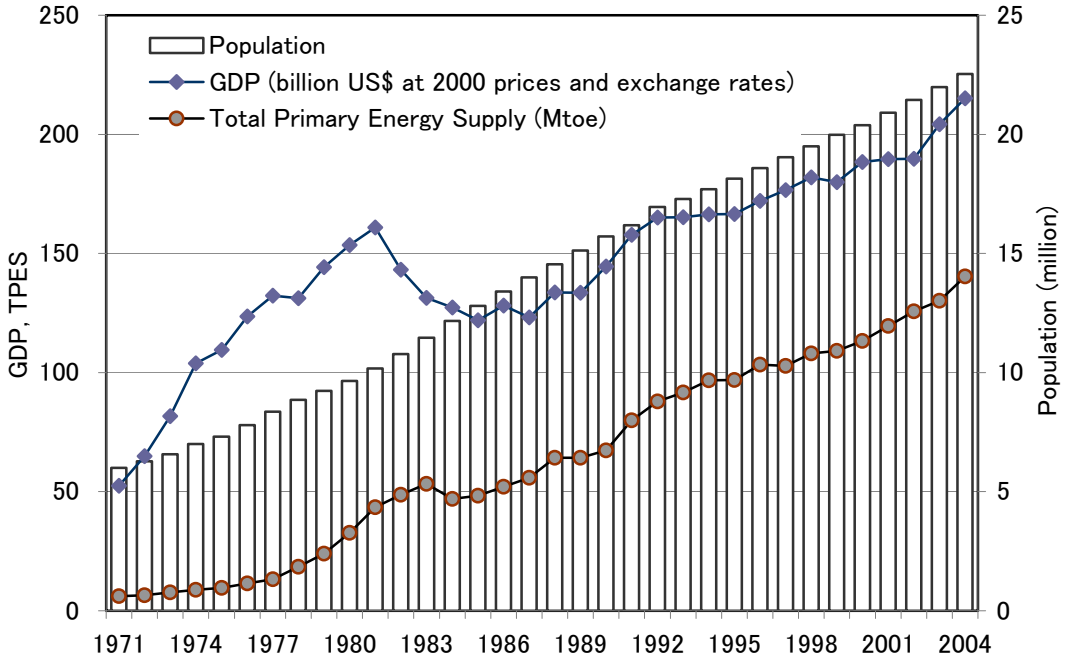
Table 3-1 Transition of GDP and Total Primary Energy Supply (TPES) in KSA

Year	GDP (billion US$ at 2000 prices)	Population (Thousand)	TPES (ktoe)	GDP/capita (US$/person)	TPES per GDP (toe per thousand US$)	TPES per capita (toe per person)
1971	52	6,000	6,136	8,745	0.117	1.023
1972	65	6,280	6,637	10,334	0.102	1.057
1973	82	6,580	7,758	12,411	0.095	1.179
1974	104	7,000	8,801	14,847	0.085	1.257
1975	109	7,310	9,673	14,972	0.088	1.323
1976	124	7,790	11,560	15,869	0.094	1.484
1977	132	8,360	13,329	15,819	0.101	1.594
1978	131	8,860	18,464	14,811	0.141	2.084
1979	144	9,230	24,004	15,625	0.166	2.601
1980	154	9,650	32,748	15,910	0.213	3.394
1981	161	10,170	43,516	15,816	0.271	4.279
1982	143	10,780	48,727	13,277	0.340	4.520
1983	131	11,460	53,297	11,468	0.406	4.651
1984	127	12,170	46,963	10,468	0.369	3.859
1985	122	12,800	48,279	9,528	0.396	3.772
1986	128	13,410	52,043	9,552	0.406	3.881
1987	123	14,000	55,860	8,802	0.453	3.990
1988	134	14,550	64,296	9,190	0.481	4.419
1989	134	15,120	64,295	8,831	0.482	4.252
1990	145	15,710	67,380	9,200	0.466	4.289
1991	158	16,180	79,915	9,755	0.506	4.939
1992	165	16,950	87,902	9,736	0.533	5.186
1993	165	17,280	91,715	9,562	0.555	5.308
1994	166	17,700	96,796	9,397	0.582	5.469
1995	167	18,140	96,941	9,183	0.582	5.344
1996	172	18,580	103,327	9,262	0.600	5.561
1997	177	19,040	102,840	9,272	0.583	5.401
1998	182	19,500	107,994	9,332	0.593	5.538
1999	180	19,980	109,162	9,010	0.606	5.464
2000	186	20,380	113,265	9,127	0.609	5.558
2001	188	20,910	119,611	8,981	0.637	5.720
2002	188	21,440	125,744	8,768	0.669	5.865
2003	202	21,980	130,209	9,209	0.643	5.924
2004	213	22,530	140,413	9,434	0.661	6.232

(Source: IEA Energy Statistics 2006; Achievement of the Development Plans, Facts and Figures 1970-2006)

As shown in the next figure, GDP of KSA presented several rapid upward courses, especially during the two oil crises. In some cases, the GDP was even subject to fluctuations year by year due to the change in oil prices. On the other hand, the population of KSA monotonously increased

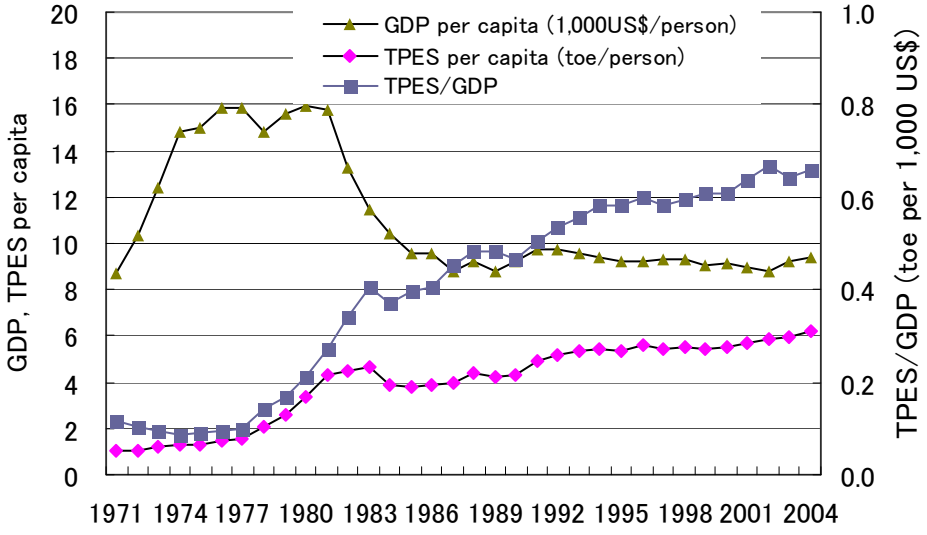
during that period, although the annual growth rate showed a slowdown to 2.6 % after 1990, down from 5.0 % in the 1980s. On the whole, the TPES indicated a smooth increase despite a considerable decrease in 1984 and a slow increase in the late 1980s due to reduced oil production.



(Source: IEA Energy Statistics 2006; Achievement of the Development Plans, Facts and Figures 1970-2006)

Figure 3-1 Transition of GDP, Total Primary Energy Supply and Population in the KSA

As a consequence of the trends mentioned above, GDP productivity in the KSA has followed a unique path as shown in the following figure.



(Source: IEA Energy Statistics 2006; Achievement of the Development Plans, Facts and Figures 1970-2006)

Figure 3-2 Transition of Energy Intensity, GDP per Capita and TPES per Capita in the KSA

After the GDP reached a high of US$ 15,000 per capita during the oil crises in the late 1970s and early 1980s, it dropped rapidly until the mid 1980s. Although GDP started increasing again in the late 1980s, GDP per capita has remained at a relatively low level, approximately US$ 9,000 per capita, due to a rapid increase in the population. The increasing rate of TPES per capita decreased as well for the same reason.

(2) Electric Power Consumption and Intensity per Capita and GDP

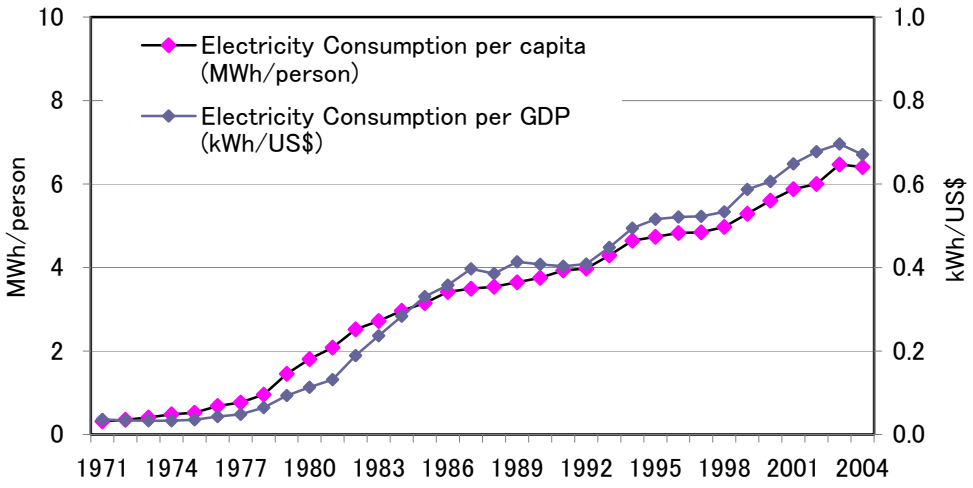
The following table summarizes electricity consumption, intensity, growth rate, and GDP elasticity in KSA. Different from TPES, electricity consumption showed a monotonous increase independent of GDP during that period. For the next 14 years after 1990, where GDP recovered from the sharp drop after the oil crises, the average annual incremental rise in electricity consumption was 6.7 %, while GDP and the population increased by 3.3 and 2.7 % per year respectively; thus the GDP electricity elasticity was 2.0 for the said period.

Table 3-2 Transition of Electricity Consumption and Growth Rate in the KSA

Year	Electricity Consumption			Growth Rate		GDP Electricity Elasticity
	(GWh)	per GDP (kWh per US$ in 2000)	per Capita (kWh per person)	GDP	Electricity Consumption	
1971	1,902	0.036	317			
1972	2,202	0.034	351	23.70%	15.77%	0.67
1973	2,678	0.033	407	25.83%	21.62%	0.84
1974	3,400	0.033	486	27.27%	26.96%	0.99
1975	3,826	0.035	523	5.31%	12.53%	2.36
1976	5,323	0.043	683	12.95%	39.13%	3.02
1977	6,385	0.048	764	6.98%	19.95%	2.86
1978	8,466	0.065	956	-0.77%	32.59%	-42.27
1979	13,456	0.093	1,458	9.90%	58.94%	5.95
1980	17,452	0.114	1,808	6.46%	29.70%	4.60
1981	21,173	0.132	2,082	4.77%	21.32%	4.47
1982	27,144	0.190	2,518	-11.02%	28.20%	-2.56
1983	31,152	0.237	2,718	-8.17%	14.77%	-1.81
1984	36,111	0.283	2,967	-3.07%	15.92%	-5.19
1985	40,319	0.331	3,150	-4.26%	11.65%	-2.73
1986	45,796	0.358	3,415	5.03%	13.58%	2.70
1987	48,908	0.397	3,493	-3.79%	6.80%	-1.79
1988	51,531	0.385	3,542	8.51%	5.36%	0.63
1989	55,201	0.413	3,651	-0.15%	7.12%	-47.69
1990	58,972	0.408	3,754	8.25%	6.83%	0.83
1991	63,632	0.403	3,933	9.21%	7.90%	0.86
1992	67,437	0.409	3,979	4.55%	5.98%	1.31
1993	74,113	0.449	4,289	0.13%	9.90%	75.98
1994	82,198	0.494	4,644	0.67%	10.91%	16.40
1995	85,902	0.516	4,736	0.15%	4.51%	30.34
1996	89,641	0.521	4,825	3.30%	4.35%	1.32
1997	92,228	0.522	4,844	2.59%	2.89%	1.12
1998	97,050	0.533	4,977	3.08%	5.23%	1.70
1999	105,612	0.587	5,286	-1.07%	8.82%	-8.23
2000	114,164	0.606	5,602	4.68%	8.10%	1.73
2001	122,945	0.648	5,880	0.64%	7.69%	12.07
2002	128,640	0.678	6,000	0.09%	4.63%	53.30
2003	142,191	0.696	6,469	7.64%	10.53%	1.38
2004	144,251	0.671	6,403	5.28%	1.45%	0.27

(Source: Achievement of the Development Plans, Facts and Figures 1970-2006)

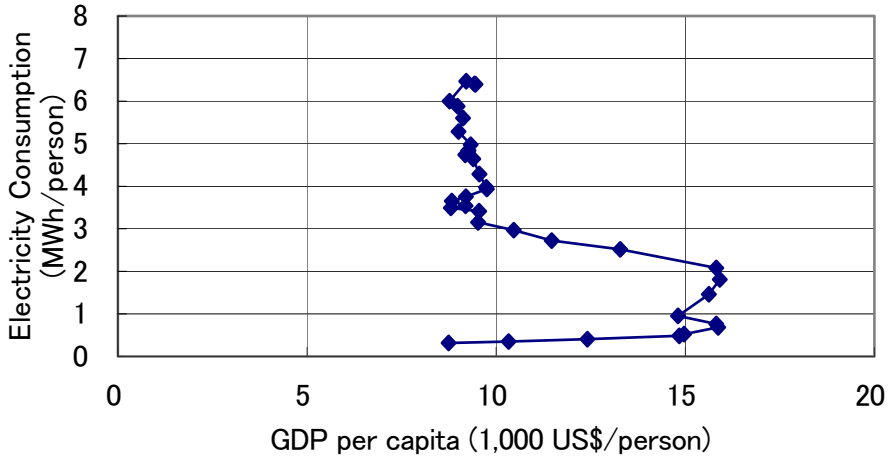
Electricity consumption per capita followed a mostly continued upward course, while that of per GDP decreased for several years as shown below.



(Source: Achievement of the Development Plans, Facts and Figures 1970-2006)

Figure 3-3 Transition of Electric Power Intensity in the KSA

As shown in the following figure, it can be seen that that electricity consumption per capita increased almost independently of GDP per capita, which was largely influenced by the price and production of crude oil.



(Source: Achievement of the Development Plans, Facts and Figures 1970-2006)

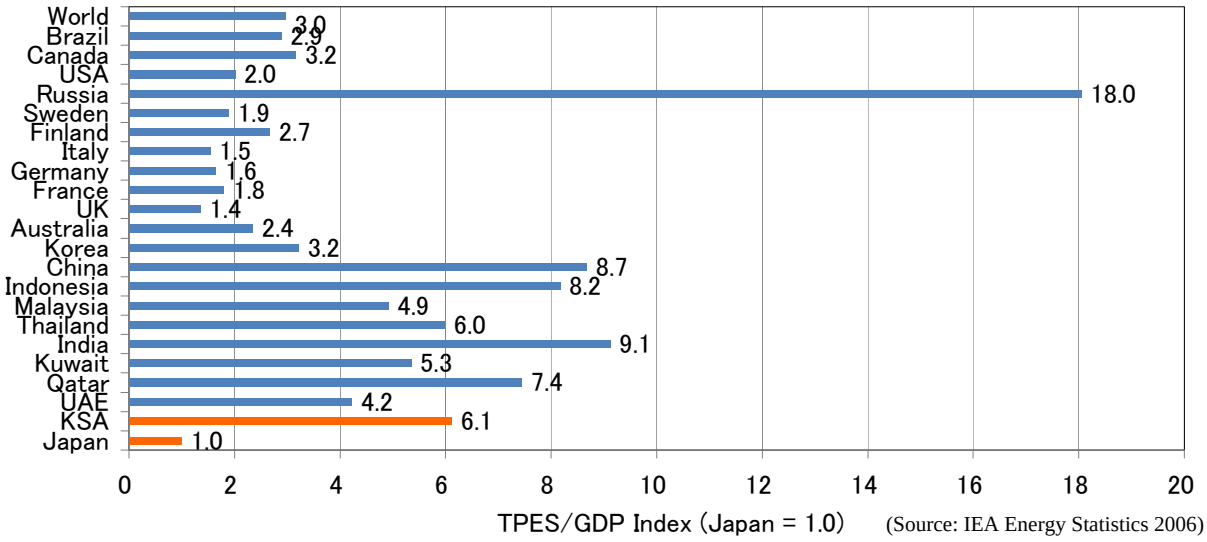
Figure 3-4 Electric Power Intensity and GDP Productivity in the KSA

3.1.2 Macro Data for Various Countries and KSA's Position

(1) TPES per Capita and per GDP in Various Countries in 2004

TPES per capita in various countries for 2004 are plotted in the following figure. The horizontal axis represents an index obtained by dividing TPES per GDP at 2000 prices by that of Japan's, which is ranked highest in terms of energy efficiency.

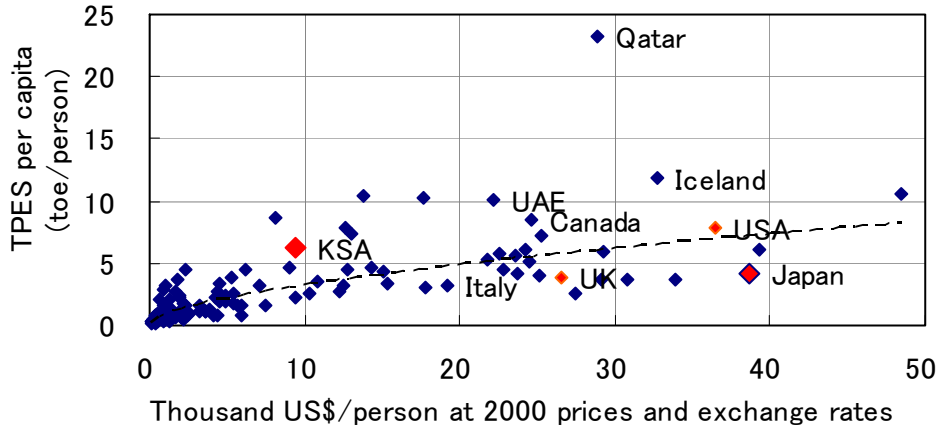
North American and European countries, except Russia, present relatively low figures compared with Asian countries. The figure of KSA doubles the world average and is ranked mid-level among Asian countries.



(Source: IEA Energy Statistics 2006)

Figure 3-5 TPES per GDP at 2000 Prices

The following figure compares TPES per capita with GDP per capita in 2004 for all the countries listed in IEA Energy Statistics for 2006. The line indicates a regression curve that represents the average level.



(Source: IEA Energy Statistics 2006, Achievement of the Development Plans, Facts & Figures)

Figure 3-6 TPES per Capita vs. GDP per Capita in 2004

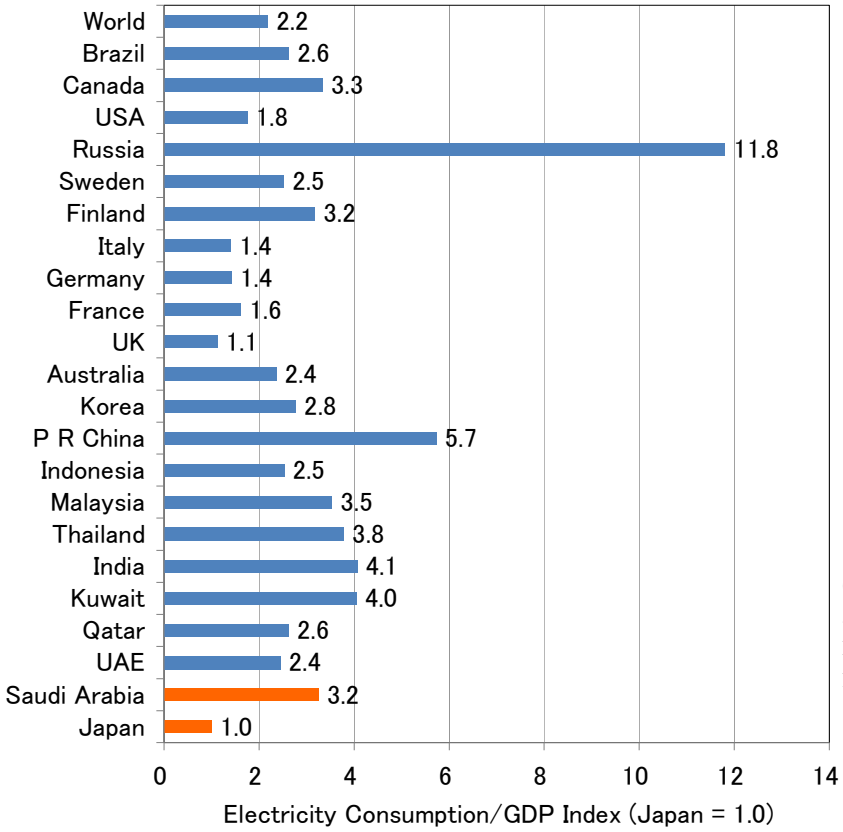
Energy efficiencies compared with economic standards are higher than average in countries such as Japan, UK, France, Germany, and Italy, and so on, which are located below the regression line. Efficiency in the KSA located on the opposite side, along with the USA, Canada, Australia, Korea, Russia, or China, is lower than the average.

The average level of TPES per capita at the same economic level as KSA is approximated at 3 toe/person. The level of KSA's TPES per capita, 6.2 toe/person, is the equivalent of the economic standard of approximately US$ 30,000/person, which is more than threefold the actual figure.

(2) Electric Power Consumption per Capita and per GDP in Various Countries in 2004

Electricity consumption per capita in various countries in 2004 is compared in the following figure in the same manner as TPES. The horizontal axis represents an index obtained by dividing electricity consumption per GDP at 2000 prices by that of Japan's.

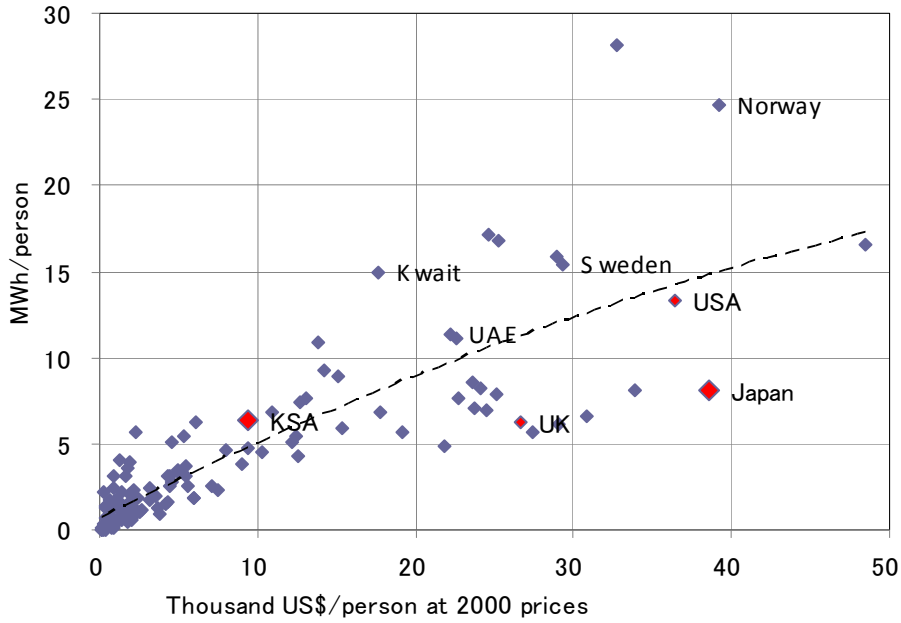
This indicates a similar pattern of TPES, although figures for most countries tend to be lower.



(Source: IEA Energy Statistics 2006, Achievement of the Development Plans Facts and Figures 1970-2006)

Figure 3-7 Electricity Consumption per GDP at 2000 Prices

Electricity consumption per capita is compared with GDP per capita in 2004 for all the countries as shown below.



(Source: IEA Energy Statistics 2006, Achievement of the Development Plans Facts and Figures 1970-2006)

Figure 3-8 Electricity Consumption/Capita vs. GDP/Capita in Various Countries in 2004

Electric energy efficiencies compared with economic standards are higher than average in countries such as Japan, UK, France, Germany, Italy, USA and so on, which are located below the dotted line. The KSA is located on the opposite side, along with Canada, Australia, Korea, Russia, and the UAE.

The annual electricity consumption per capita at the same economic level as KSA is approximated at 4.5 MWh/person. The level of KSA's electricity consumption per capita, 6.4 MWh/person, is comparable to the economic standard of approximately US$ 13,000/person. In order to bring electricity consumption per capita in KSA to the average level, while doubling GDP per capita as stated in the Long-Term Strategy 2025 (LTS 2025), electricity consumption must be limited to 8.3 MWh/person at a GDP of US$ 19,000 /person.

3.2 Energy Consumption Data by Sector

3.2.1 Sector-wise Energy Data in KSA

(1) Gross Final Energy Consumption by Sector in KSA

During 15 years following 1990, final energy consumption increased by 72 % overall. The industrial sector consumed approximately 55 % of the final energy in KSA. The transportation sector accounted for more than 32%, but has gradually lowered. The portion consumed by the commercial, governmental, and agricultural sectors, which consume only electricity, was less than 4 %. It is noted that the share consumed by the residential sector has increased.

As for energy carriers, fossil fuel accounted for more than 85 %. It is significant, however, that the share of electricity has continuously increased. The following table summarizes the final energy consumption by sector in the KSA.

Table 3-3 Transition of Final Energy Consumption by Sector in KSA (Unit: ktoe)

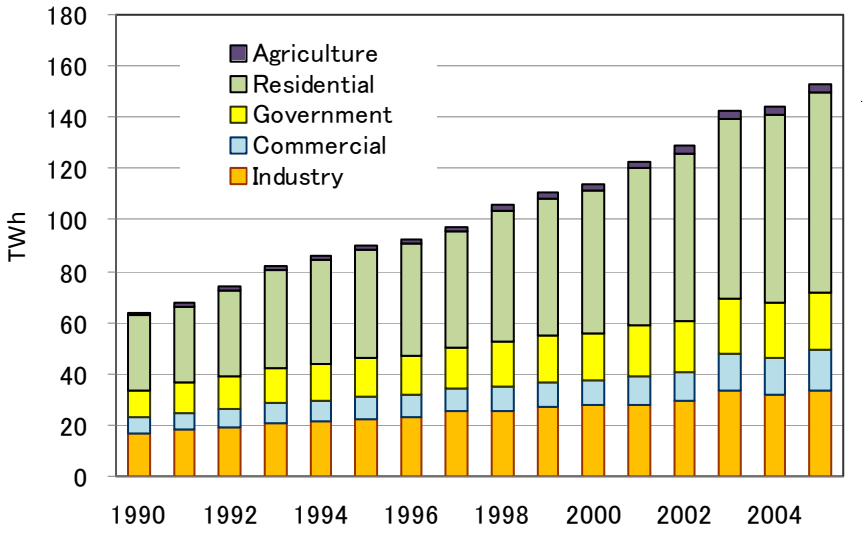
Sector	Energy Carrier	1990	1995	2000	2005
Industrial Sector	Electricity	1,461	1,936	2,379	2,907
	Fossil Fuel	25,430	31,546	36,193	43,510
	Total	26,891 (54.3%)	33,482 (56.1%)	38,572 (56.1%)	46,417 (54.4%)
Commercial & Services Sector	Electricity	509 (1.0%)	711 (1.2%)	857 (1.2%)	1,340 (1.6%)
Governmental Sector	Electricity	931 (1.9%)	1,299 (2.2%)	1,566 (2.3%)	1,829 (2.1%)
Transportation	Fossil Fuel	17,685 (35.7%)	19,383 (32.4%)	21,599 (31.4%)	27,200 (31.9%)
Residential Sector	Electricity	2,490	3,625	4,821	6,734
	Fossil Fuel	921	1,084	1,205	1,420
	Total	3,411 (6.9%)	4,709 (7.9%)	6,026 (8.8%)	8,154 (9.6%)
Agriculture, Forestry.& Fishery	Electricity	81 (0.2%)	138 (0.2%)	195 (0.3%)	272 (0.3%)
Total	Electricity	5,472 (11.1%)	7,709 (12.9%)	9,818 (14.3%)	13,082 (15.4%)
	Fossil Fuel	44,036 (88.9%)	52,013 (87.1%)	58,997 (85.7%)	72,130 (84.6%)
	Total	49,508 (100%)	59,722 (100%)	68,815 (100%)	85,212 (100%)

(Source: Achievement of the Development Plans Facts and Figures 1970-2006, MOEP)

(2) Trend of Electric Power Consumption by Sector in KSA

With regard to electricity consumption, it is remarkable that the portion of electricity consumed by the residential sector has continuously increased and exceeded 50 % after 2000. Both the industrial and governmental sectors gradually reduced their share of electricity consumption to 22% and 14 % in 2005 respectively. Consumption by the governmental and commercial sectors accounted for approximately 25 % during the period.

Electric power consumption and distribution by sector in KSA are shown in the following figure and table respectively.



(Source: Achievement of the Development Plans, Facts and Figures 1970-2006)

Figure 3-9 Transition of Electric Power Consumption by Sector in KSA

Table 3-4 Distribution of Electric Power Consumption by Sector (Unit: %)

	1990	1995	2000	2005
Residential Sector	45.5	47.0	49.1	51.5
Government	17.0	16.9	16.0	14.0
Commercial Sector	9.4	9.2	8.7	10.2
Industrial Sector	26.7	25.1	24.2	22.2
Agricultural Sector	1.5	1.8	2.0	2.1

(Source: Achievement of the Development Plans, Facts and Figures 1970-2006)

(3) Electric Power Consumption and Intensity in the Industrial Sector

Electric power consumption in the industrial sector by year is summarized as follows.

Table 3-5 Electric Power Consumption and Intensity in the Industrial Sector in KSA

		1990	2001	2002	2003	2004	2005
Consumption (GWh)	Refinery/Petrochemical (%)	8,698 (51)	14,663 (52)	14,477 (49)	15,942 (48)	15,465 (49)	15,698 (46)
	Manufacturing (%)	8,291 (49)	13,570 (48)	14,849 (51)	17,442 (52)	16,395 (51)	18,103 (54)
	Total	16,988	28,233	29,326	33,384	31,860	33,801
Growth Rate (%)			66.0	3.9	13.8	-4.6	6.1
Number of Customers		NA	5,753	6,180	5,943	6,791	6,154
Intensity (MWh/customer/year)		-	4,908	4,745	5,617	4,692	5,493

(Source: Achievement of the Development Plans, Facts and Figures 1970-2006, MOWE & SEC Reports)

Both the refinery/petrochemical industries and manufacturing industries consumed electric power in the neighborhood of 50 % of the industrial sector; however, the latter portion has increased year by year.

Calculation of electric power intensity in the sector was conducted by dividing consumption by

the number of customers, which are obtained from Ministry of Water and Electricity (MOWE) and Saudi Electricity Company (SEC) reports. No clear trends were calculated in such intensity.

(4) Electric Power Consumption and Intensity in the Commercial Sector

Electric power consumption in the commercial sector by year is summarized in the following table. Although there appeared fluctuation in annual increasing rates, electricity consumption in the sector has been increasing as a whole. Electricity intensity calculation was also conducted in the same manner as the industrial sector. It seems that electricity intensity per customer increased after 2003.

Table 3-6 Electric Power Consumption and Intensity in the Commercial Sector in KSA

	1990	2001	2002	2003	2004	2005
Consumption (GWh)	5,924	11,147	11,112	14,315	14,301	15,580
Growth Rate (%)	88.0	-0.3	29	-0.1	8.9	
Number of Customers	NA	489,761	497,271	534,274	577,797	609,423
Intensity (MWh/customer/year)	-	22.8	22.3	26.8	24.8	25.6

(Source: Achievement of the Development Plans, Facts and Figures 1970-2006; Electricity 2005 MOWE)

(5) Electric Power Consumption and Intensity in the Residential Sector

Electric power consumption in the residential sector by year is summarized in the following table. Different from the other sectors, the residential sector showed constant increase in electricity consumption. Its electricity intensity is calculated at approximately 20 MWh per customer per year by the same way mentioned above.

Table 3-7 Electric Power Consumption and Intensity in the Residential Sector in KSA

	1990	2001	2002	2003	2004	2005
Consumption (GWh)	28,953	61,337	65,465	70,372	73,360	78,304
Growth Rate (%)	112	6.7	7.5	4.2	6.7	
Number of Customers	NA	3,122,282	3,340,417	3,511,431	3,700,161	3,897,916
(MWh/customer/year)	-	19.6	19.6	20.0	19.8	20.0

(Source: Achievement of the Development Plans, Facts and Figures 1970-2006, MOWE & SEC Reports)

3.2.2 Sector-wise Energy Data in Japan

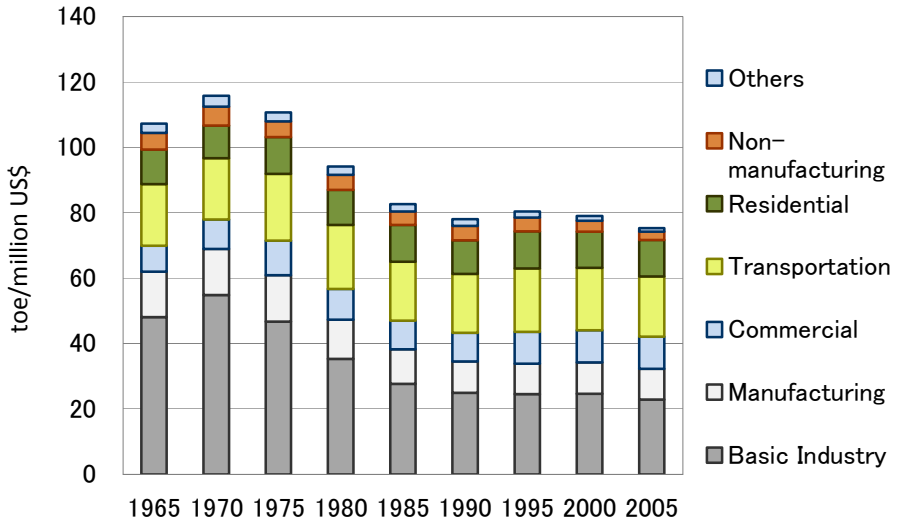
(1) Energy Intensity by Sector in Japan

Final energy intensity per GDP in Japan is shown in the following figure, where each sub-sector is comprised of individual industries as follows:

Basic industry: Iron & Steel, Chemical industry, Ceramic, Stone & Clay, and Pulp & Paper;

Manufacturing industry: Food & Tobacco, Textile, Non-ferrous metals, Metal machinery, and others; and

Non-manufacturing industry: Agriculture, Forestry & Fishery, Construction industry, and Mining.



(Source: 2007 EDMC Handbook of Energy & Economic Statistics in Japan, IEEJ)

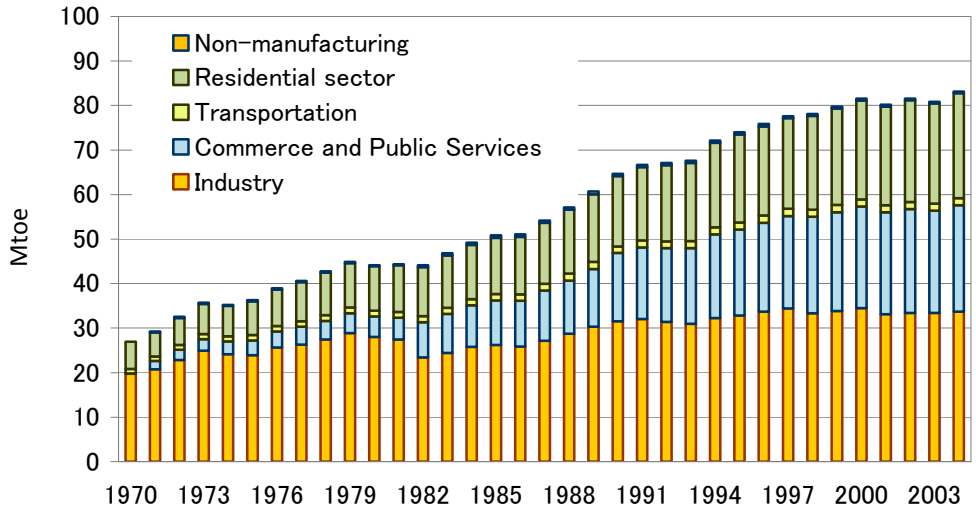
Figure 3-10 Transition of Final Energy Intensity per GDP by Sector in Japan

Energy conservation in Japan was achieved mainly by the industrial sector during the period of the oil crises to cope with a steep rise in oil prices. In the industrial sector, contribution of basic industry to energy conservation was larger than other sub-sectors.

The industrial sector still consumes around 43 % of the total after 1990s. The transportation sector has been second with 24% followed by the residential with 14 %. Roughly speaking, energy consumption shares of the industry, commercial, and residential sectors, and the transportation sector changed from 4:1:1 in 1970s to 2:1:1 in 2000s.

(2) Electric Power Consumption by Sector in Japan

The following figure shows the historical power consumption by sector in Japan.



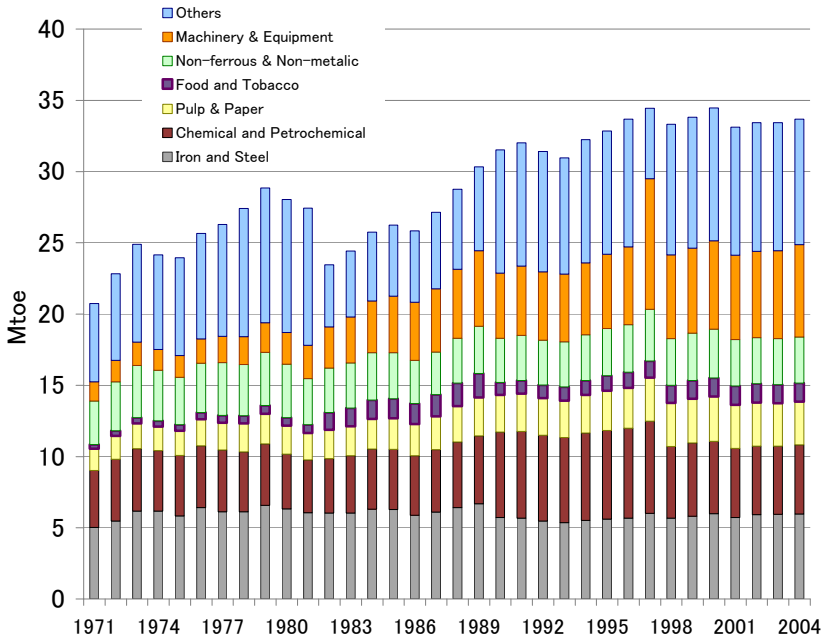
(Source: 2007 EDMC Handbook of Energy & Economic Statistics in Japan, IEEJ)

Figure 3-11 Transition of Electric Power Consumption by Sector in Japan

Consumption of electricity in Japan increased constantly except during the oil crises and the economical depression after the early 1990s. Both the commercial and residential sectors exhibited remarkable growth, while the industrial sector leveled off after the late 1990s.

(3) Electric Power Consumption by Sub-sector in the Industrial Sector in Japan

The following figure shows the trend of electric power consumption by sub-sector in the industrial sector in Japan.



(Source: 2007 EDMC Handbook of Energy & Economic Statistics in Japan, IEEJ)

Figure 3-12 Transition of Electric Power Consumption in the Industrial Sector in Japan

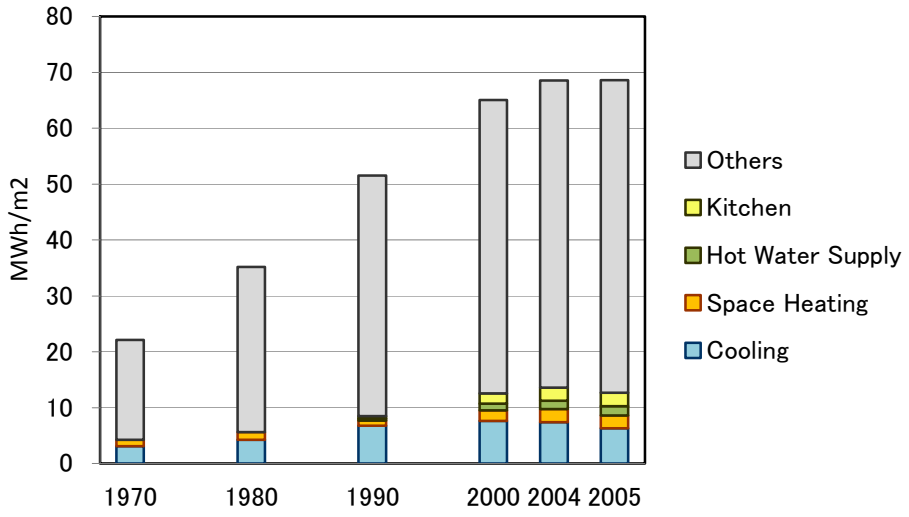
Demands for electric power in basic industries such as iron & steel, the chemical industry, and pulp & paper gradually increased and leveled-off after a drop in 1998 due to an economic depression, which was triggered by the Asian Financial Crisis. The machinery and equipment sub-sector exhibited a rapid increase in electricity consumption, accounting for nearly 20 % in the 2000s, while it was only 6 or 7 % in 1970s. Consequently, the share consumed by basic industries dropped to 41 % from 50 % in 1970s.

(4) Electricity Intensity by End-use in the Commercial Sector in Japan

A constant increase in electric power consumption in the commercial sector is shown in Figure 3-11, caused by the rise in electricity intensity per unit floor area and the increase in total floor area. Total floor area rapidly increased in sub-sectors of office, wholesale, and retail trade, and schools.

Electric power intensity per unit floor area in the sector is shown in the following figure. The increasing rate in intensity had been very high until 2000 and showed a slowdown afterward. The end-use classified as others, which includes lighting, motor power for elevators, escalators, pumps,

IT equipment, and so on, exhibited the largest increase, reflecting the progression of computerization in the sector.



(Source: 2007 EDMC Handbook of Energy & Economic Statistics in Japan, IEEJ)

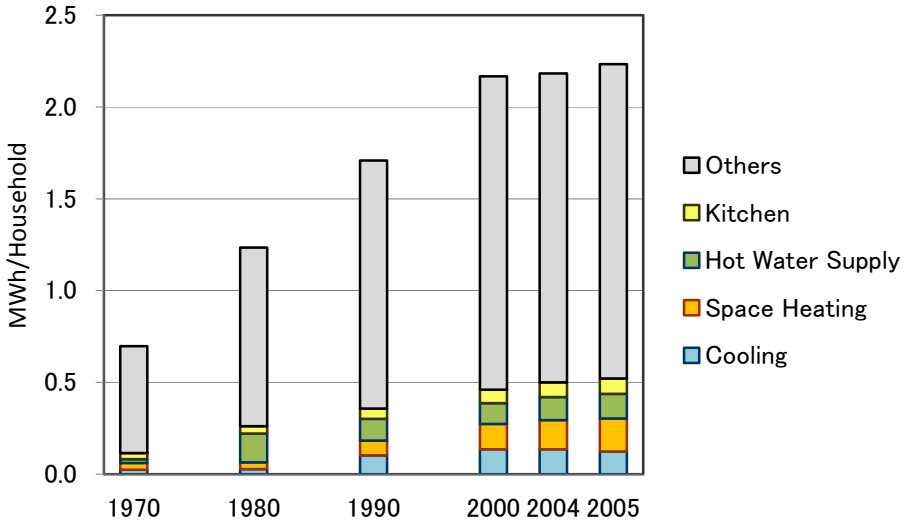
Figure 3-13 Transition of Electric Power Intensity in the Commercial Sector in Japan

(5) Electricity Intensity by End-use in the Residential Sector in Japan

As seen in Figure 3-11, electric power consumption in the residential sector increased constantly. This was brought about by:

- A change in the public lifestyles to pursue convenience and comfort, and
- A change in social structure, such as an increase in the number of households or the increasing percentage of the elderly.

Electric power intensity per household in the sector increased rapidly until 2000 and leveled off afterward, as shown in the following figure.



(Source: 2007 EDMC Handbook of Energy & Economic Statistics in Japan, IEEJ)

Figure 3-14 Transition of Electric Power Intensity in the Residential Sector in Japan

The end-use classified as others includes lighting and use of appliances and made up a significant proportion, although its share was gradually reduced to 76 % in 2005, down from 84 % in 1970. The increase in the intensity per household is believed to have occurred for the following two reasons:

- While energy efficiency of appliances specified in the Energy Conservation Law improved, since the Top Runner program went into effect in 1999, new lifestyles promoted upsizing and increasing the number of units in possession; and
- Hitherto little-used home electric appliances became widely available.

3.2.3 KSA to Japan Comparison

(1) General

The energy consumption distribution by sector in KSA and Japan is summarized in the following table. The classification method of sectors in energy statistics is different and the commercial sector is considered to correspond to the sum of the KSA's commercial sector and a part of the governmental sector.

Table 3-8 Energy Consumption Distribution by Sector in 2005 (Unit: %)

	Total Final Energy		Electric Power	
	KSA	Japan	KSA	Japan
Industrial Sector	54.4	43.4	22.2	41.5
Commercial Sector	1.6	13.3	10.2	28.3
Governmental Sector	2.3		14.0	
Transportation Sector	31.9	24.7		2.1
Residential Sector	9.6	15.0	51.5	27.3
Others	0.3	3.5	2.1	0.8
Total	100.0	100.0	100.0	100.0

With respect to final energy, the sum of the industrial and transportation sectors is assumed to be 85 % and 68 % in the KSA and Japan respectively. The KSA's high figure explains that fossil fuel is utilized in limited sectors as shown in Table 3-3.

As for electric power, distinctive features are seen in industrial and residential sectors. The industrial sector in Japan still keeps the largest share at 42 %, while the figure of 22 % in KSA is less than the sum of commercial and governmental sectors. The residential sector in KSA makes up 52 % of the total and that share is growing, while that in Japan remains at 27 %.

(2) Industrial Sector

Through continuous energy conservation efforts, Japanese industries have reduced unit consumption of energy for production. Energy intensity indices for producing various products are summarized in the next table, where energy efficiency in various countries is shown on a basis of 100 for Japan. It is understood that Japan has achieved the highest level of energy efficiency in the industrial sector in the world.

Table 3-9 Comparison of Energy Intensity in Basic Industries among Various Countries

Unit: Index (Japan=100)

	Iron	Aluminum	Copper	Cement	Caustic Soda	Petrol. Products	Paper	Electric Power
Year	2003			2003	2003	2002	2003	2003
Japan	100	100	100	100	100	100	100	100
Saudi Arabia								
Korea	105			131	100			
China	120			152	104			129
Asia			143			101		
USA	120			177	110	113	144	117
Canada							134	
North America			154					
South America			202	145				
UK								
Germany				110				110
France				120				123
Sweden							123	
EU	110		133					
Eastern Europe					115			
Western Europe					119	102		
Russia	125			178				
World		127						

(Source: METI Website)

Unfortunately, however, there is no data available for KSA. In order to improve productivity, it is necessary for enterprises in the industrial sector to have a grasp of the unit consumption of energy per unit of production based on basic data for energy consumption, which have not been collected and analyzed yet in the KSA. Therefore, it is desired that a relevant organization in KSA launch an initiative to upgrade data acquisition and management in the sector. Under such an initiative, basic data collection, including power monitoring should be assigned top priority.

(3) Commercial Sector

With respect to energy intensity in the commercial sector, no data is available to compare KSA with Japan. In order to create a target figure for energy management in the sector, it is desired that a similar initiative to the industrial sector be launched to collect and analyze basic data, such as electric power consumption, building dimensions, principal activities of the building, end use of energy, and so on.

(4) Residential Sector

It is found that electric power intensity per household in KSA, which is 20 MWh/year in 2005 as shown in Table 3-7, is ten times higher than that in Japan shown in Figure 3-14. It is considered that the difference explains why the air-conditioning loads are much higher in the KSA than Japan due to the following factors:

- Sever climate conditions in KSA; and
- Larger housing units in KSA than in Japan.

Part 3 Current Situation of KSA

Chapter 4 Basic Information of KSA

4.1 Geography and Natural Environment

4.1.1 Geography

The KSA has the area of 2,149,690 km2 and is 5.7 times larger than Japan. Sand and soil deserts or rocky mountains cover 95 % of Saudi Arabia. The long coastal areas along Red Sea are backed by steep mountain ranges. From there, the altitude of land gradually decreases towards Arabian Sea as follows.

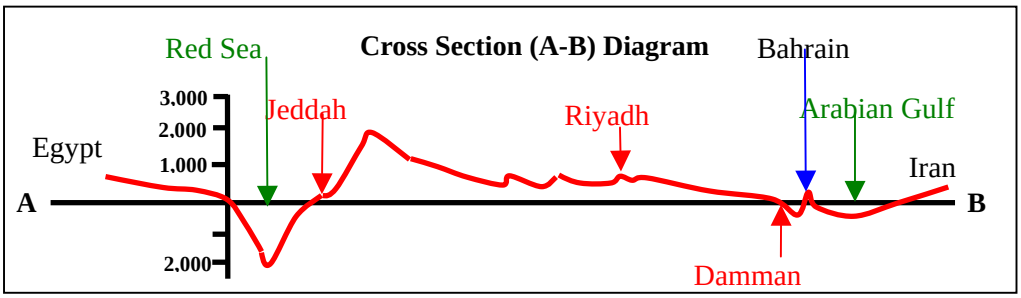


Figure 4-1 Cross Sectional View of Saudi Arabia

The land of the KSA is categorized into 5 regions according to their feature as shown below.

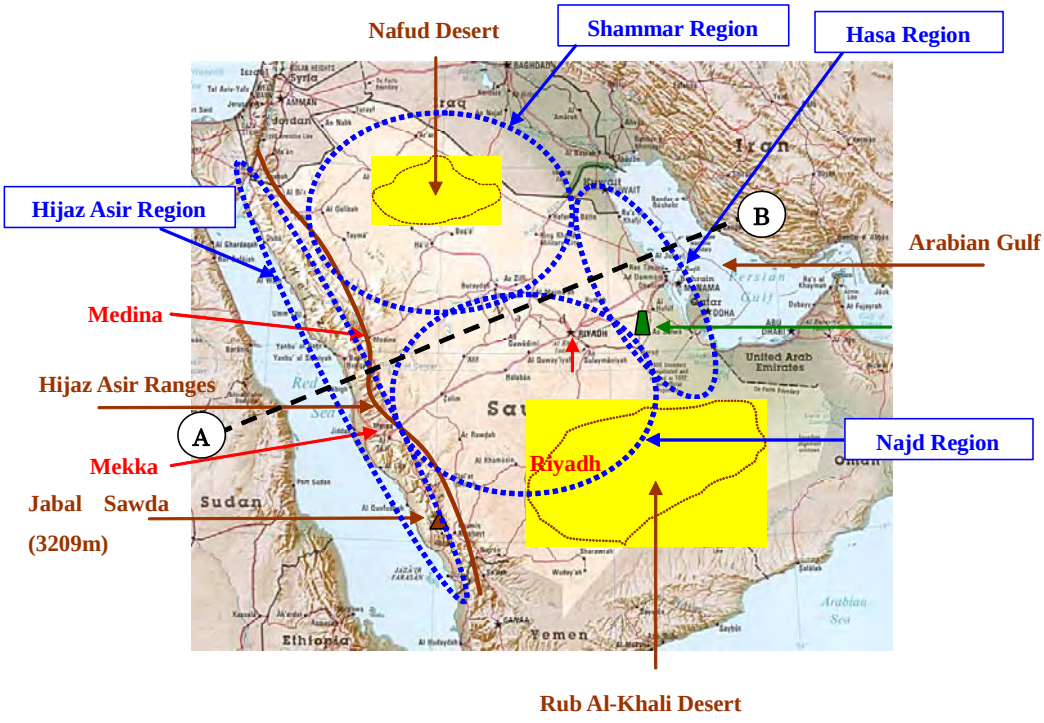


Figure 4-2 Geographical View of KSA

Table 4-1 Feature of Each Region

Hijaz Asir Region Hijaz Asir is coastal and mountainous region along the Red Sea of the western side of the Arabian Peninsula, where the Hijaz Asir Range lies to the north and south at a length of 1,400km. Jabal Sawdah is the highest summit at a height of 3,209m. From long ago this region has been the most advanced region in the peninsula in terms of culture and economy because two major holy places are located in the region, Mecca and Medina.
Shammar Region This region located near the borders of northern Jordan and Iraq. The Nafud Desert lies in this region.
Hasa Region The Hasa Region is the eastern province that faces the Arabian Gulf and is located south of Kuwait. This is the world's largest oil region, in which one-fourth of the proven global crude oil reserves exist, including the Ghawar Oil Field. This is the largest oasis zone and has developed into an agricultural area.
Ngjd Region Ngid Region is a hilly, inland area, where the capital city of Riyadh exists. From the western Hijaz Asir Ranges, the altitude of land gradually decreases towards the Arabian Sea in the east. The altitude around Riyadh is about 600m, surrounded by scattered oasis. Agricultural products are prosperously grown using abundant underground water.
Rub Al-Khali Desert Region Rub Al-Khali is the uninhabited southern desert region. This region is one of the driest regions in the world where it rains only once every ten years. To the south, it faces Oman and Yemen.

4.1.2 Natural Environment

(1) Climate

Blistering heat and dryness are the characteristic features of the Saudi Arabian climate in general. However, the climates between the coastal and inland areas are quite different from each other. The climate is grouped into 3 features as follows.

(a) Subtropical Climate

The coastal region along the Red Sea is a subtropical climate with high temperatures and high humidity. Temperature difference during the year is relatively small. The minimum temperature is more than 30 degree and the maximum temperature is more than 40 degree. In the summer, temperatures can rise to over 50 degree. Humidity is about 50-70 % around the year. It rains slightly from November to April and are mainly localized downpours. Sandstorms occur frequently.

(b) Continental Inland Climate

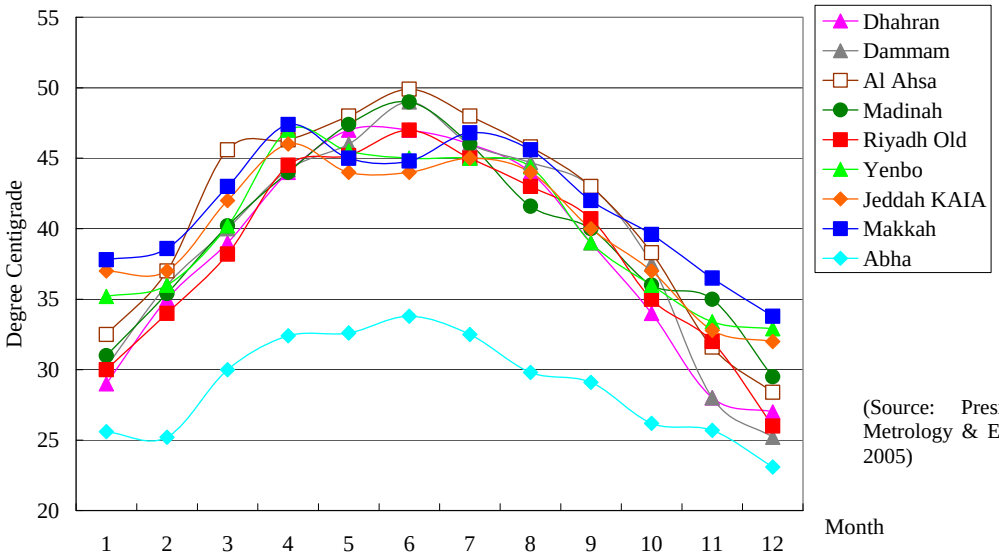
The interior of Saudi Arabia, such as Riyadh, has a dry climate. Daytime temperatures exceed 45 degree. On the other hand, the temperature and humidity at night are comfortable, 10-20 degree and 10-40 % respectively.

(c) Arabian Gulf Climate

The climate of the coastal region along the Arabian Gulf changes greatly by season and time zone. From June to September, the temperature sometimes rises to 50 degree. On the other hand, in the winter temperatures can decrease to minus zero. Temperatures from November to January are comfortable, slightly exceeding 30 degree. May and July have frequent sandstorms. Although it does not rain much, localized thunderstorms tend to occur.

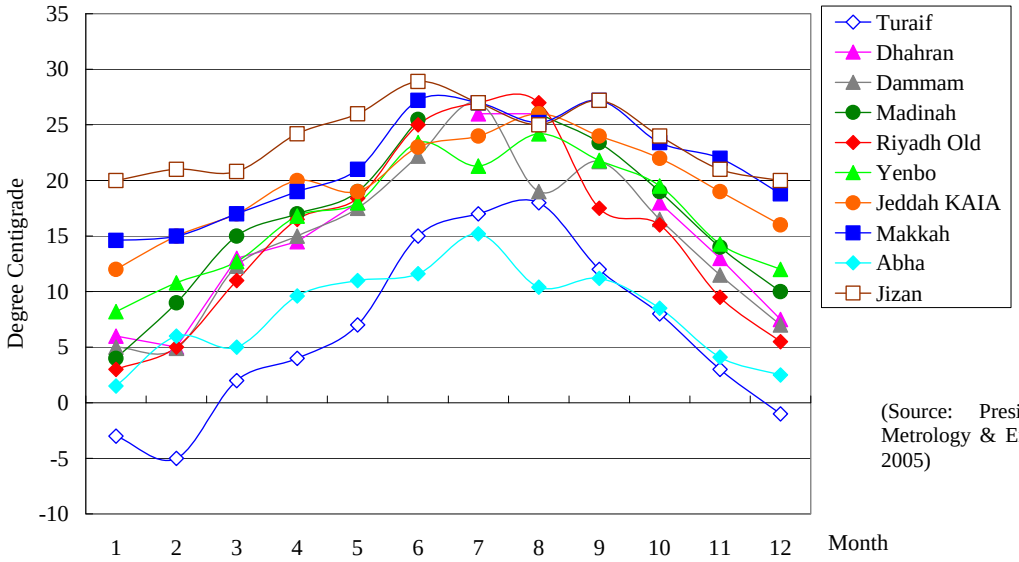
(2) Weather

Meteorological stations continuously monitor the climatic condition of each region. Temperature (maximum and minimum), humidity, and rainfall data for 2005 are shown in the following figures.



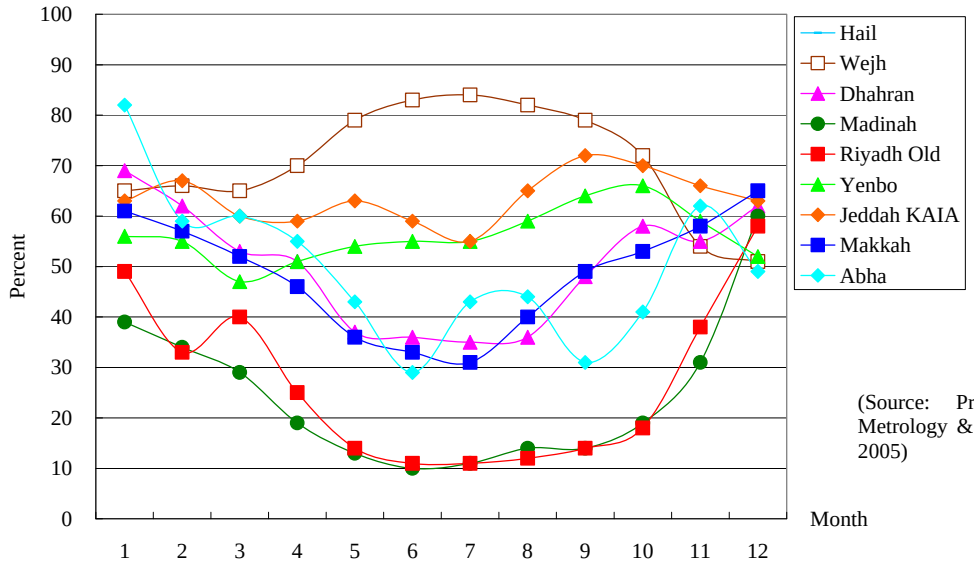
(Source: Presidency of Metrology & Environment 2005)

Figure 4-3 Maximum Temperature (degree) by Month in 2005



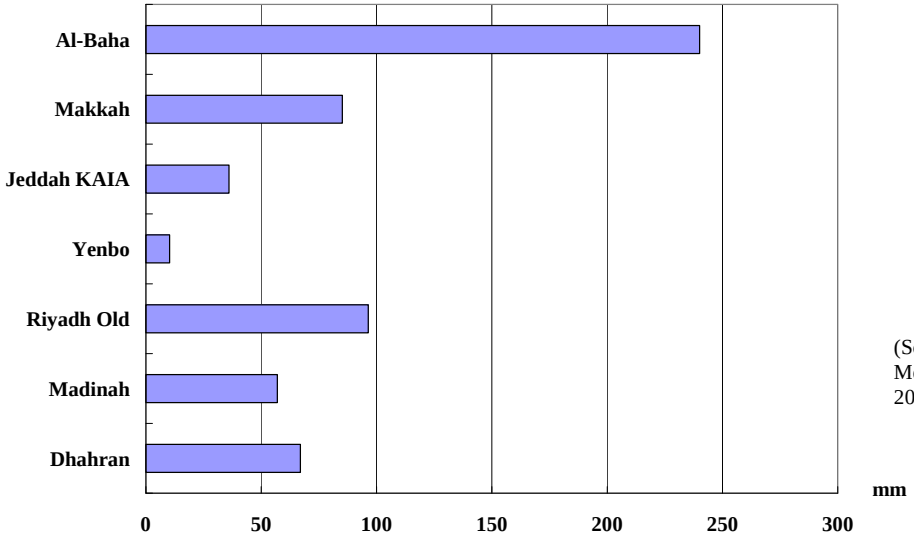
(Source: Presidency of Metrology & Environment 2005)

Figure 4-4 Minimum Temperature (degree) by Month in 2005



(Source: Presidency of Metrology & Environment 2005)

Figure 4-5 Monthly Average Relative Humidity (%) in 2002



(Source: Presidency of Metrology & Environment 2005)

Figure 4-6 Yearly Rainfall (mm) in 2002

4.2 Economic Activity and Life Pattern

4.2.1 Yearly Economic Activity

According to the Islamic calendar, there are two public holidays when public offices, private companies, and schools are completely closed. Other than those public holidays, there are several long weeks of vacation in the summer and winter.

(1) Eid Al-Fitr Festival

According to the Islamic calendar, public holidays start from the 25th day of the month of Ramadan, during which time there is month of fasting, and last until the 5th day of the month of Shawwal. During Ramadan, a person is not allowed to eat, drink, or smoke during the daytime. The Government and most businesses take 5 days off before and after the day of the Eid Al-Fitr Festival.

(2) Eid Al-Adha Festival

Public holidays start from the 5th day and last until the 15th day of Dhu al-Hijja (Islamic calendar December) when Al-haji is at its climax. During this period, millions of Muslims make a pilgrimage to Mecca (Kaabba). The Government and most businesses take 5 days off before and after the day of the Eid Al-Adha Festival.

(3) National Holidays

Other than the holidays mentioned above, there is a national holiday on September 23rd.

(4) School Holidays

The following table lists the Saudi Arabian school holidays for 2007. Winter vacation (one week) is much shorter than summer vacation (three and half months).

Table 4-2 School Holidays (2007)

Semester	Starting Day	Items	Period
First Semester	September 8th	National Day	September 23rd
		Eid Al-Fitr Festival	October 3rd – October 20th
		Eid Al-Adha	December 12th – December 27th
		(Semester Examination)	January 26th – February 5th
		Semester Vacation	February 6th – February 15th
Second Semester	February 16th	(Semester Examination)	June 14th – June 24th
		Semester Vacation	June 25th – October 10th

(5) Vacation Duration

People take vacation time depending on the employment contract with their employers. Many families prefer to take a long vacation in summer together with their children.

4.2.2 Weekly and Daily Economic Activity

(1) Working Hours

Friday is a holiday and a week starts from Saturday. Working hours of each sector are as follows:

Public Offices	From Saturday to Wednesday 7:30AM to 2:30 PM (no lunch time)
Banks	From Saturday to Thursday 8:00 AM to Noon and 5:00 PM to 7:00 PM (For Thursday: 8:00 AM to Noon)
Private Companies	From Saturday to Wednesday 8:00 AM to 1:00 PM and 4:00 PM to 7:00 PM (Some companies open at Thursday: 8:00 AM to 1:00 PM)
Shops	From Saturday to Thursday 9:00 AM to Noon and 4:00 PM to 8:00 PM (Some supermarkets are open 24 hours)

(2) Working Hours in Ramadan

During Ramadan, normal working hours are shortened by 2 hours.

4.2.3 Pattern of Daily Life

Saudi Arabian people live according to Islamic teachings and the conventional world. Daily life is designed to harmonize with customs, the calendar, and the structure of western society. Every organization is managed according to the Muslim schedule.

Islamic people pray five times a day: before sunrise, noon, afternoon, before sunset, and at night before going to bed. The daily newspaper of KSA lists the prayer times of mosques at various locations, which change according to the season. During the praying time, public offices, shops, public facilities, and restaurants are interrupted.

First Prayer (Fajr):	From daybreak to sunrise
Second Prayer (Zuhr):	From when sun is transmeridional, to Asr
Third Prayer (Asr):	From when the shadow of things becomes same length with body, to sunset
Fourth Prayer (Maghreb):	From just before sunset to Isha
Fifth Prayer (Isha):	From when after light disappears, to Fajr

4.3 Social and Economic Data

4.3.1 Social Data

From the aspect of energy utilization, social characteristics of the KSA are symbolized by the words of “Low energy price” and “Desert climate”. Judging from recent social data and the electricity situation, the following points should to be recognized:

- Ambient temperature from May to October can reach a maximum of 50 degrees centigrade. Under such extreme climate conditions, the people of KSA secure a standard of living that is comparable to other developed nations.
- Saudi government has been employing a policy of Saudization over a period of time, which promotes the nation’s development by Saudi Arabians instead of foreign workers. In the future, although the population of foreign workers will decrease, it is estimated that the population of KSA will grow at an annual rate of 2 %. In other words, the high-income portion of the population will increase more rapidly than that those with a low-income. Accordingly, the historically high annual growth rate of 10 % annually is expected to continue in the future.
- The KSA electricity tariff is relatively cheap compared with other countries, in spite of several price hikes in the past. Therefore, people and industry lack energy conservation consciousness. Both in the construction and utilization stages of commercial and office buildings, energy conservation awareness has not emerged, leading to an increase in electricity demand.
- Due to the high ambient temperature during the daytime, household air conditioners might not be turned off, even when all family members are out of the home. If the air conditioner is turned off, it takes a long time to reach a comfortable temperature, causing an increase in electricity demand.
- On the contrary, an energy conservation strategy on current utilization of electricity in the private (residential and commercial) sector should be established, such as the use of air conditioners. Measures such as improving the efficiency of equipment, promoting the installation of high-efficiency equipment, and establishing energy conservation measures for buildings will be effective.

Former trends in key social indicators are shown in the table below.

Table 4-3 Population Trend and Social Data

			1990	1995	2000	2001	2002	2003	2004	2005
Economic data	Exchange rate	Riyal/US$	3.745	3.745	3.750	3.750	3.750	3.750	3.750	3.747
Population	Country number	Million persons	15.7	18.1	20.4	20.9	21.4	22.0	22.5	23.1
	Growth rate	%		2.5	2.0	2.6	2.5	2.5	2.5	2.4
	Urban number	Million persons	11.1	13.6	17.7	18.1	19.3	19.9	20.5	21.1
	Urban population share	%		75.1	87.0	86.6	89.8	90.4	90.9	91.4
Household	County Number	Million HH	2.55	3.00	3.43	3.53	3.64	3.74	3.85	3.96
	Growth rate	%		2.8	2.4	3.0	2.9	2.9	2.9	2.8
	Urbun Number	Million HH	1.80	2.25	2.99	3.06	3.27	3.38	3.50	3.62
	Urban HH rate	%		4.2	6.5	2.5	6.7	3.5	3.5	3.4
Labor number	Agriculture	1,000 persons	316	484	551	564	591	593	597	605.0
(Including Foreigners)	Mining (Oil, Gas & Others)	1,000 persons	49	83	103	108	108	112	118	127.0
	Manufacturing	1,000 persons	388	528	638	623	662	649	650	660.0
	Services & Others	1,000 persons	3,896	5,146	5,864	6,286	6,883	6,924	6,916	7,127.0
	Total	1,000 persons	4,649	6,241	7,156	7,581	8,244	8,278	8,281	8,519
	Labor force share to Pop	%	29.6	34.4	35.1	36.3	38.5	37.7	36.8	36.9
Labor shares	Agriculture	%	6.8	7.8	7.7	7.4	7.2	7.2	7.2	7.1
	Mining (Oil, Gas & Others)	%	1.0	1.3	1.4	1.4	1.3	1.4	1.4	1.5
	Manufacturing	%	8.3	8.5	8.9	8.2	8.0	7.8	7.8	7.7
	Services & Others	%	83.8	82.5	81.9	82.9	83.5	83.6	83.5	83.7
	Total	%	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

(Source: MOEP Website)

4.3.2 Economic Data

The economy of the KSA has mainly been established on crude oil production and export. Therefore, economic diversification and human development were the main issues of the First Development Plan (1970 to 1974) and continue to remain the current issues of the Eighth Five-Year Development Plan (EDP) (2005 to 2009). The construction of infrastructure, such as desalination plants, highways, commercial buildings, and office buildings, are important for economic diversification and have been vigorously implemented.

The average annual growth rate of the economy from 2000, starting the year of the Seventh Development Plan, to 2003 was 2.7 %. From 2003, when the crude oil price started rising to 2006, the rate increased to 4.3 % of relatively appraisable value. In KSA, crude oil stimulates the domestic economy, which in turn increases electricity demand.

Former trends of key economic indicators are shown in the table below.

Table 4-4 Statistics of KSA Economy

		Unit	1995	2000	2001	2002	2003	2004	2005
Nominal GDP	nGDP at current price	Billion SR	526.0	697.0	679.1	699.7	796.6	930.6	1,145.0
	Growth rate	%	6.3	17.4	-2.6	3.0	13.8	16.8	23.0
Inflation	GDP deflator at 1999 price	1999=100	95.2	111.8	107.9	111.1	117.5	130.7	150.9
	Growth rate	%	5.7	11.9	-3.5	2.9	5.7	11.2	15.5
Gross Domestic Expenditure	Private consumption	Billion SR	246.3	264.1	267.0	268.5	274.3	282.7	299.0
(at 1999 price)	Government consumption	Billion SR	128.8	186.2	187.5	185.4	194.2	208.8	250.5
	Private Fixed Formation	Billion SR	60.7	93.3	94.5	96.5	106.7	113.8	125.0
	Govermental Fixed Formation	Billion SR	24.4	16.4	17.5	17.9	21.2	22.3	23.5
	Oil sector Fixed Formation	Billion SR	14.3	14.1	14.3	15.6	17.2	18.3	19.5
	Stocks	Billion SR	9.2	9.1	3.4	9.9	9.8	12.1	10.3
	Exports	Billion SR	213.6	222.6	216.3	210.8	255.6	288.0	313.9
	Imports	Billion SR	144.6	182.6	171.3	174.8	200.8	233.9	282.9
	Total	Billion SR	552.7	623.2	629.2	629.8	678.2	712.1	758.8
Gross Domestic Products	Agriculture & Fishery	Billion SR	32.5	35.8	36.0	36.5	36.8	37.9	39.5
(at 1999 price)	Mining (Oil, Gas & Others)	Billion SR	188.1	188.3	179.9	164.9	195.1	206.5	219.0
	Manufacturing (Refinery & Chemical	Billion SR	20.3	24.8	24.8	24.8	26.9	29.6	31.2
	Manufacturing (Elec, Const & Others	Billion SR	68.5	91.3	95.4	99.4	105.3	110.5	118.3
	Transportation & Communucation	Billion SR	24.5	29.0	31.3	33.5	35.0	37.9	41.6
	Service (Government)	Billion SR	124.5	142.8	146.6	150.8	154.9	158.3	169.3
	Service (Trade, Hotels & Others)	Billion SR	94.3	111.3	115.2	119.9	124.2	131.5	140.0
	Total	Billion SR	552.7	623.2	629.2	629.8	678.2	712.1	758.8
Crude oil	Production	ktoe	406,253	418,676	405,307	384,567	442,293	451,782	461,475
	Domesitc consumption	ktoe	87,686	102,016	99,646	96,695	104,376	99,859	105,475
	Export	ktoe	318,567	316,660	305,661	287,872	337,917	351,923	356,000

(Source: MOEP Website)

4.3.3 Electricity Demand and Supply

In 1999, the maximum power supply hit the installed capacity resulting in compulsory power stoppage in the summer. The mass media seriously reported on the importance of a stable supply of electricity. Currently, both the maximum power supply and demand has increased at a high growth rate. Since 2004, the peak load of the system has exceeded the actual generation capacity. To meet the high growth of maximum peak demand, peak demand management has become the most critical issue in recent years.

The demand and supply trend is shown below.

Table 4-5 Electricity Demand and Generation

	Unit	2000	2001	2002	2003	2004	2005
Electricity Demand	1,000 GWh	114.2	122.9	128.6	142.2	145.5	153.3
Growth Rate	%		7.6	4.6	10.6	2.3	5.4
Actual Generation Capacity	MW	22,060	23,230	25,457	27,018	27,423	28,640
Growth Rate	%		5.3	9.6	6.1	1.5	4.4
Maximum Peak Demand	MW	21,673	23,582	23,938	26,272	27,847	29,913
Growth Rate	%		8.8	1.5	9.8	6.0	7.4

(Source: Electricity 2005, MOWE)

4.3.4 Energy Supply Structure

(1) Domestic Energy Supply in KSA

The domestic energy supply in KSA was 556 million toe in 2004. Oil production, including NGL, was 503 million toe and natural gas production was 54 million toe. The share of oil production in the Primary Energy supply is 90 % and the share of the natural gas production was only 10 %. In KSA, there is coal production and no nuclear or hydropower generation systems. In 2004, KSA exported 414 million toe, the energies exported are crude oil and petroleum products. The majority of the natural gas produced is consumed by the domestic market and no natural gas is exported. Energy imports to KSA are negligible, although a small amount of renewable energy is imported. Crude oil production in 2004 was 503 million toe and the growth rate compared to the previous year was 4.1 %. KSA exports 70 % (352 million toe) of the crude oil and petroleum products it produces. The remaining is consumed by the domestic market. The balance of energy supply is shown below.

Table 4-6Primary Energy Supply Balance in KSA

Items	Items	Unit	1999	2000	2001	2002	2003	2004
(+)Production		kTOE	456,470	489,841	480,247	474,779	532,540	556,212
	Crude oil & NGL	kTOE	418,755	449,282	436,405	427,976	483,494	502,576
	Natural gas	kTOE	37,715	40,559	43,843	46,803	49,046	53,636
(+)Imports		kTOE	4	4	4	4	4	4
	Renewable Energy	kTOE	4	4	4	4	4	4
(-)Exports		kTOE	345,261	374,528	358,557	346,908	400,189	413,641
	Crude oil & NGL	kTOE	289,646	316,660	305,661	298,000	343,399	351,923
	Petroleum Products	kTOE	55,614	57,869	52,897	48,908	56,790	61,717
(-)Int. Marine Bunkers		kTOE	2,052	2,052	2,083	2,131	2,147	2,163
	Petroleum Products	kTOE	2,052	2,052	2,083	2,131	2,147	2,163
Total Primary Energy Supply		kTOE	109,162	113,265	119,611	125,744	130,209	140,413
(Petroluem Products Production)		kTOE	81,160	83,933	83,360	82,405	90,800	98,426

(Source: IEA Database in 2006)

(2) Final Energy Consumption Structure

From 1999-2004, the demand for crude oil (except for refineries) and petroleum products, accounted for 65 % of the total amount of energy consumed. During the same period, the dean for natural gas accounted for 22 %. The level of demand for both types of energy remained stable throughout that term. In 1998, the demand for oil products temporarily decreased due to the export of oil products; however the market began recovering in 1999. The average amount of oil consumed during that period was 6.3 %. Demand for natural gas in the domestic market increased steadily during this period. One aim of the Saudi Arabian energy policy is to increase the consumption of natural gas. The average growth rate in the demand for natural gas from 1999-2004 was 6.7 %. That is slightly high compared to the annual growth rate of crude oil and petroleum products. The average growth rate of electricity consumption was 6.0 % during the period from 1999-2004. That rate is high compared to other developed countries, although it is lower than the growth rate of oil and gas in the KSA.

Final energy consumption in the KSA is shown in the following table.

Table 4-7 Final Energy Consumption in KSA (Unit: ktoe)

Final Energy Consumption		1999	2000	2001	2002	2003	2004
	Crude oil & NGL	2,300	1,755	2,336	1,104	722	1,173
	Petroleum Products	39,999	41,588	45,459	50,183	51,576	55,846
	Natral gas	14,170	14,272	15,981	15,849	16,594	19,616
	Electricity	8,286	8,550	9,312	9,818	10,857	11,076
	Renewable Energy	4	4	4	4	4	4
	Total	64,759	66,169	73,093	76,958	79,756	87,717

(Source: IEA Database in 2006)

(3) Energy Demand / Supply by Sector

(a) Industrial Sector

The average growth rate of final energy demand in the industrial sector was 5.9 % during 1999-2004, slightly higher than the growth rate of the overall final energy consumption. The share of oil, gas, and electric power consumption respectively were 40 %, 55 %, and 5 % in 2004. While the share of gas consumed by the industrial sector was the highest, the share of electric power consumption was comparatively small. The demand for gas was 55 % in 2004. The demand for electric power during that period remained flat at 4.9 %. The following table and figure show the demand structure of the industrial sector.

Table 4-8 Demand Structure in the Industrial Sector (Unit: ktoe)

Industry Sector		1999	2000	2001	2002	2003	2004
	Crude oil & NGL	2,300	1,755	2,336	1,104	722	1,173
	Petroleum Products	6,849	7,082	7,630	9,238	10,449	10,475
	Natral gas	11,636	11,547	13,035	12,704	13,299	16,012
	Electricity (1)	1,072	1,111	1,167	1,277	1,500	1,410
	Total (2)	21,858	21,494	24,168	24,323	25,971	29,071
	Electricity rate (%) =(1)/(2)	4.9	5.2	4.8	5.3	5.8	4.9

(Source: IEA database in 2006)

(b) Residential Sector

In general, Saudi Arabian households do not use natural gas, instead they petroleum products and electric power. LPG petroleum products are used mainly in the kitchen for use with high caloric cookers. However, most Saudi Arabian households have electric heaters and microwave ovens. Regarding consumption of petroleum products and electricity during 1999-2004, the demand for petroleum products in 1999 was 18 % and electricity was 80 %. While the 2004, the demand for petroleum products was 18 % and electricity was 82 %. The rate of energy consumption in the residential sector increased at an average annual rate of 5.8 % and the demand for electricity increased at a rate of 6.5 %. The electricity demand in the residential sector rapidly increased during this term.

The following table shows the demand structure in the residential sector.

Table 4-9 Demand Structure in the Residential Sector (Unit: ktoe)

Residential Sector		1999	2000	2001	2002	2003	2004
	Petroleum Products	1,160	1,203	1,236	1,281	1,327	1,348
	Electricity (1)	4,613	4,821	5,275	5,630	6,052	6,309
	Renewable Energy	4	4	4	4	4	4
	Total (2)	5,777	6,029	6,516	6,915	7,384	7,662
	Electricity rate (%) =(1)/(2)	79.9	80.0	81.0	81.4	82.0	82.3

(Source: IEA database in 2006)

(c) Demand Structure in Other Sectors

As shown in the following table, electricity consumption in the agriculture sector accounted for about 1.8 % of total generation during 1999-2004 and experienced an annual growth rate of 6.2 %. That growth rate is comparatively higher than other sectors. A change in the work style of agricultural fields has been cited as the reason for the high growth rate. High growth of electricity consumption in the agricultural industry is expected to continue.

The commercial and public sectors account for 23% electric power consumption in KSA. The average growth rate of electric consumption was 5.2 % in the sector during 1999-2004. It is lower than the average growth rate of the total power demand. While the growth rate of consumption of diesel, gasoline, and fuel oil in the transportation sector was 4.4 % during 1999-2004. The transportation sector accounted for 26 % of the overall demand for petroleum products from 1999 to 2004. That percentage remained steady throughout the term.

Table 4-10 Demand Structure in Other Sectors

Sector	Energy	Unit	1999	2000	2001	2002	2003	2004	Growth Rate (%)
Agriculture	Electricity	ktoe	185	195	205	227	229	250	6.2
	(Share in Generation)	%	1.8	1.8	1.8	1.9	1.7	1.8	
Commercial & Publics	Electricity	ktoe	2,416	2,423	2,665	2,684	3,076	3,107	5.2
	(Share in Generation)	%	23.6	22.3	23.2	22.0	23.4	22.6	
Transportation	Petroleum Products	ktoe	20,881	21,607	22,117	23,356	24,126	25,895	4.4
	Shares in Production	%	25.7	25.7	26.5	28.3	26.6	26.3	

(Source: IEA database in 2006)

(4) Fuel Consumption Structure in the Electricity Sector

Regarding the consumption of fossil fuels in the electricity sector, crude oil, petroleum products, and natural gas are used in the KSA. Crude oil consumption in the electricity sector accounted for 4.0 % of total fuel consumption in the electricity sector in 2004. Such crude oil consumption (crude oil directly consumed in electricity sector) is different in countries where fuel is imported. Consumption of petroleum products by the electricity sector in 1999 was 44 % (52 % including crude oil) and 40 % in 2004. Inversely, the natural gas accounted for 41 % in 1999 and 50 % in 2004. This shift reflects the Government's energy policy strategy to switch from the use of oil to natural gas.

The fuel consumption structure is shown as follows.

Table 4-11 Fuel Consumption Structure in the Electricity Sector

Power entity	Energy	Unit	1999	2000	2001	2002	2003	2004
SEC	Total	ktoe	26,780	28,722	30,029	30,869	32,974	36,166
	Crude oil & NGL	ktoe	9,618	9,507	7,239	6,625	5,816	5,917
	Petroleum Products	ktoe	9,527	9,918	10,759	10,281	12,159	13,329
	Natural gas	ktoe	7,635	9,297	12,031	13,963	14,999	16,920
	(Power Generation)	GWh	97,292	103,546	111,160	117,865	128,371	135,812
Other Producers	Total	ktoe	8,564	8,927	8,876	9,410	9,709	9,445
	Crude oil & NGL	ktoe	825	838	685	707	602	265
	Petroleum Products	ktoe	818	874	1,018	1,097	1,260	598
	Natural gas	ktoe	6,921	7,215	7,173	7,606	7,847	8,582
	(Power Generation)	GWh	21,723	22,645	22,513	23,872	24,629	24,063
Fuel for Electricity	Total	ktoe	35,344	37,649	38,905	40,279	42,683	45,611
	Crude oil & NGL	ktoe	10,443	10,345	7,924	7,332	6,418	6,182
	Petroleum Products	ktoe	10,345	10,792	11,777	11,378	13,419	13,927
	Natural gas	ktoe	14,556	16,512	19,204	21,569	22,846	25,502
	(Power Generation)	GWh	119,015	126,191	133,673	141,737	153,000	159,875
Consumption ratio	Total	%	32.4	33.2	32.5	32.0	32.8	32.5
to energy supply	Crude oil & NGL	%	8.1	7.8	6.1	5.6	4.6	4.1
in Power sector	Petroleum Products	%	44.0	44.9	41.5	36.3	42.1	40.3
	Natural gas	%	40.8	42.9	46.0	48.3	48.7	49.5
	Electricity ratio to TPES	%	9.4	9.6	9.6	9.7	10.1	9.8

(Source: IEA Database in 2006)

4.4 National Development Plan

4.4.1 The Eighth Development Plan

(1) General

The Ministry of Economy and Planning (MOEP) prepares development plans in five-year increments with a wide strategic vision of achieving sustainable development. The Eight Development Plan (EDP), which covers from 2005 to 2009, was made based on an integrated set of general objectives and strategic bases that have been approved by the Council of Ministers' in Decision No. (175) of 27/6/1424 (2003).

The EDP places emphasis on several priorities. Key among them are:

- Upgrading of the quality of life and providing job opportunities to all Saudi citizens
- Expansion of education, training, health, and social services,
- Expansion of applied and technological sciences both quantitatively and qualitatively,
- Furtherance of initiatives and creativity in all spheres.

In addition, the EDP lays stress on keeping pace with the fast momentum of global economic and technological developments, diversification of its economic base, as well as improving productivity and boosting the competitiveness of the national economy.

The Seventh Development Plan targeted only 2000-2004, however the EDP includes a Long-Term Strategy for the next 20 years (2004 - 2024) and it designs the first 5 of the 20 years.

That is, the Long Term Strategy lays out the direction for the next four “Five-year Development Plans”. The EDP (2005-2009) is the first five-year development plan of the Long-Term Strategy. Thus, the EDP is also expected to coincide with the completion and approval of more national and sectoral strategies, including the Long-Term Strategy of the National Economy.

(2) Long-Term Strategy of the National Economy

In Chapter 3 of the EDP, there is “Long-Term Strategy for The Saudi Economy”. The Strategy lays out a social economic plan for 20 years from 2004 to 2024.

The main contents of the Long-Term Strategy of the National Economy are as follows:

- Increase the standard of living
  Double the 2004 GDP (SR 40,000 per capita) within 20 years.
- Maintain sustainable development
  Enhance the export of non-oil products. Increase the previous target of 51 % to 73.4 %.
- Roles of oil income
  Move capital investment from oil income to non-oil resources, especially human resources.
- Human resources and employment
  Enforcement of the human development based on the achievement in the past 20 years.
- Keep national resources
  Protection of agricultural fields
- Regional development
  Construction of infrastructure and improvement of public services in regional areas
- Enlarging the competitiveness theory in business sectors
  Promote globalization and enforce competitiveness in the industrial sector
- Enhance cooperative relations in the Middle East
  Implementation of the roles in the area

(3) Key Economic Forecasts

In the EDP, some key economic indicators include the following:

(a) Population

An increase in the KSA population is expected due to the implementation of the Saudization policy. On the other hand, the non-Saudi population is expected to decrease. The Saudization policy increases employment opportunities for Saudi people, which may lead to wage increases, improvements in the standard of living, and an increase in energy consumption per capita.

Table 4-12 Population Outlook (Million Persons)

	2004	2009	2014	2019	2024	2030*
Saudis	16.53	18.57	20.79	23.21	25.81	29.24
Non-Saudis	6.14	5.82	5.66	4.94	4.05	3.19
Total	22.67	24.39	26.45	28.15	29.86	32.43

*The values of 2030 are estimated by the JICA Study Team by extending the trends for 2024 (Source: EDP)

Table 4-13 Growth Rate of Population (%)

	2009/2004	2014/2009	2019/2014	2024/2014	2030/2024*
Saudis	2.4	2.3	2.2	2.1	2.1
Non-Saudis	-1.1	-0.6	-2.7	-3.9	-3.9
Total	1.5	1.6	1.3	1.2	1.2

*The growth rate after 2024 are applied with growth rate of 2014-2024

(b) GDP and GDP per Capita

According to the Long-Term Strategy, GDP per capita (SR 43,300 per capita at 1999 price) is increased to around double 20 years later. In other words, the GDP per capita in 2024 will be become SR 98,500 per capita (based on the 1999 price) in 2024.

Table 4-14 Economic Outlook（Billion SR at 1999 Price）

	Unit	2004	2009	2014	2019	2024
GDP	Billion SR	716	895	1,189	1,675	2,543
GDP per Capita	SR/person	43,250	48,200	57,000	71,800	98,500

(Source: EDP)

Table 4-15 Economic Growth Rate (%)

	2009/2004	2014/2009	2019/2014	2024/2014	2024/2004
GDP	4.6	5.8	7.1	8.7	6.6
GDP per Capita	2.2	3.5	4.8	6.4	4.2

(c) GDP by Sector

Via the Industry Diversification Policy of KSA, the growth rate of the non-oil industry sector is expected to be 7.8 % higher than the predicted GDP growth rate. The service sector is expected to experience a high growth rate of 8.8 % between 2004 and 2024. According to the plan, high growth rates are expected in Information technology, Communication, Tourism, and Trade. Whereas the service sector accounted for 27 % of the GDP in 2004, it is expected to account for 42 % in 2024. The average growth rate in the oil/gas sector is expected to be 4.3 % between 2004 and 2024. The share of GDP in 2004 was 27 % and it expected to decrease to 18 % in 2024. However, it is noted that the GDP share of Oil & Gas might be changed at around 30 % due to the recent high oil price.

Table 4-16 Sectoral GDP Outlook (billion SR at 1999 price)

	2004	2009	2014	2019	2024
Agriculture	38	44	50	57	63
Oil & Gas	197	225	262	336	455
Industry	140	189	272	389	633
Service	196	225	262	336	455
Public + Import Duty	144	178	195	242	324
Total	715	895	1,189	1,675	2,544

Industry: Petrochemical, Oil refinery, Other, Building, Construction, Electricity and Mining
Service: Trade, Transportation, Banking, Insurance Real estate (Source: EDP)

Table 4-17 Sectoral GDP Growth Rate (%)

	2009/2004	2014/2009	2019/2014	2024/2019	2024/2004
Agriculture	3.0	2.6	2.7	2.0	2.6
Oil & Gas	2.7	3.1	5.1	6.3	4.3
Industry	6.2	7.6	7.4	10.2	7.8
Service	2.8	3.1	5.1	6.3	4.3
Public + Import Duty	4.3	1.8	4.4	6.0	4.1
Total GDP	4.6	5.8	7.1	8.7	6.6

(d) Savings and Investment

The KSA total investment during the LTS period (20 years) in the GDP has been estimated at SR 8.3 trillion (US$ 2.3 trillion). Capital funds for the investment will come from the Government and Private sector. The savings rate (share to GDP) was 39.8 % in 2004, and it is predicted to increase to 45.6 % in 2024. Most governmental savings will be generated by income from oil exports. As the crude oil price is expected to remain high in the future, governmental savings are expected to be sufficient.

Table 4-18 Savings and Investment Outlook

	2004	2009	2014	2019	2024
Savings Rate	39.8%	40.8%	33.3%	39.2%	45.6%
- Private Savings	26.1%	33.3%	28.1%	32.3%	37.2%
- Public Savings	13.7%	7.5%	5.2%	6.9%	8.4%
Investment rate in GDP	20.5%	27.3%	28.0%	28.4%	34.0%

(Source: EDP)

(e) Labor Force and Number of Employees

The labor ratio (Labor Force in Population)in 2004 was estimated to be 37 %, and is expected to increase to 56 % by 2024. By setting the population growth rate at 2-3 %, the labor ratio increases by 3-4 % during the period for 2004-2024. By promoting the current labor force policy, the percentage of foreign workers can be decreased by 2 % per year, this means the Saudization policy will be strengthened. An average growth rate of 2.8 % is predicted for the total labor force. The labor force is expected to increase from 8.55 million in 2004 to 15 million in 2024.

Table 4-19 Labor Force and Number of Employees (1,000 Persons)

	2004	2009	2014	2019	2024	2030
Total man power	8550	9360	11129	12814	15005	18,134
Saudi manpower	3804	4886	6757	8984	11850	16,520
Total employment	8282	9221	11029	12764	15004	18,134
Foreign	4746	4474	4372	3829	3155	1,614
Saudis	3536	4747	6657	8934	11850	16,520
Unemployment	268	139	100	50	0	0
Manpower ratio	36.9%	39.2%	45.3%	50.4%	56.3%	64.3%
Saudi unemployment	7.0%	2.8%	1.5%	0.6%	0	0
Saudization	42.7%	51.5%	60.4%	70.0%	79.0%	91.0%

(Source: EDP)

Table 4-20 Labor Force and Growth Rate of Employees (%)

	2009/2004	2014/2009	2019/2014	2024/2019	2030/2024	2030/2004
Total man power	1.8	3.5	2.9	3.2	3.2	2.9
Saudi manpower	5.1	6.7	5.9	5.7	5.7	5.8
Total employment	2.2	3.6	3.0	3.3	3.2	3.1
Foreign	-1.2	-0.5	-2.6	-3.8	-10.5	-4.1
Saudis	6.1	7.0	6.1	5.8	5.6	6.1

(4) Electricity

The EDP also describes the development plan regarding the electricity sector in Chapter 28 “Electricity”. This development strategy has 3 objectives, 5 policies to facilitate the achievement of those objectives, and 2 targets, as described below:

(Objectives)

- Providing electricity service at an adequate technical level to all population settlements and economic facilities.
- Providing electricity service at minimum economic, social and environmental costs.
- Continuing to encourage the conservation of energy and rationalization of electricity consumption.

(Policies)

- Providing electricity service at a high level of quality and reliability and achieving full service coverage.
- Allowing competition in the field of generation.
- Rationalizing the electricity tariffs with due consideration to the social dimension in the pricing process.
- Studying the possibility of utilizing the electricity industry to maximize the value added by oil resources and to enhance regional and international integration.
- Transfer, indigenize and develop electricity technologies.

(Targets)

- 100 % electricity service coverage by 2009 (1.16 million additional customers).
- Kingdom's national network will be completed and linked with the Gulf and Arab networks as a regional grid.

In the EDP, energy conservation is set forth as one of the objectives. However, no specific policy or target has been prepared yet.

(5) Environment

The EDP describes the development plan regarding the environmental sector in Chapter 12 “Environment and Sustainable Development”. Regarding environmental aspects, the EDP provides 4 general objectives and 6 policies to achieve the objectives as follows:

(General Objectives)

- Protect and safeguard the environment against pollution.

- Improve the quality of life and public health.
- Achieve sustainable development through a closer harmony between human activities and the protection of natural resources; the conservation of non-renewable natural resources, as well as, searching for additional and alternative resources.
- Develop and protect wildlife to ensure sustainability.

(Policies)

- Enhance the efficiency of protective mechanisms, which are necessary for the protection of the environment and natural resources.
- Review and update environmental standards.
- Enhance the databases on the weather, climate, and environment.
- Enhance the private sector's role in the protection of the environment, natural resources, and wildlife conservation, and especially the adoption of "green" technologies and environmentally friendly processes in industry.
- Develop the institutional capacities of the environmental agencies.
- Introduce environmental consciousness and awareness issues into the school curricula and the media.

4.4.2 Long-Term Strategy 2025

(1) General

The Long-Term Strategy 2025 (LTS 2025) marks the culmination of an extensive process of consultation, analysis, and thinking. In effect, the work on this strategy began with the Royal Consent on 7/3/1419 (July 2, 1998) giving the responsibility to the MOEP to organize a National Symposium on the "Future Vision for the Saudi Economy." It was expected that this Symposium would review the past performance of the Saudi economy and develop strategic options for dealing with current and future challenges facing the Saudi economy. This, in turn, was expected to provide the foundation for designing a long-term strategy to achieve the future vision for the Saudi Economy. The Symposium organized in Riyadh on October 19-23, 2002 fulfilled these expectations.

The LTS 2025 is supported by three pillars as follows:

- First Pillar: Clear articulation of Vision 2025 that defines the direction and destination for the Saudi economy for the next twenty years
- Second Pillar: Policies required to achieve Vision 2025
- Third Pillar: Follow-up and implementation mechanisms to ensure that aspirations articulated in Vision 2025 are converted into reality on the ground

The EDP will take the process of indicative planning initiated during the Fifth Plan to a more advanced level. In addition to indicating the expected outcomes for the next five years in the EDP, the LTS provides a vision for the next twenty years. That is, LTS 2025 extends the horizon of indicative planning to twenty years. While each development plan gives the details of five years

covered by that plan, it is intended as part of a logical sequence to achieve the aspirations articulated in Vision 2025.

(2) First Pillar (Vision 2025)

The LTS 2025 is inspired by the following Vision for the Saudi economy:

> *"By the will of Allah, the Saudi economy in 2025 will be a more diversified, prosperous, private-sector driven economy, providing rewarding job opportunities, quality education, excellent health care and necessary skills to ensure the well-being of all citizens while safeguarding Islamic values and the Kingdom's cultural heritage."*

To ensure that the economy moves in the right direction and to make appropriate changes in the strategy to keep the economy marching towards the Vision, two yardsticks have been proposed as follows:

- Doubling of Real Per Capita GDP by 2025

  The per capita GDP will double from its current level of SR 43,300 (2005) to SR 98,500 in 2025 at constant 1999 prices.

- Commensurate increase in the quality of life for Saudi citizens

  For comprehensive development of the Saudi economy and society, it is important to ensure that the increase in per capita income of Saudi citizens is accompanied by a matching increase in their quality of life. To measure the progress on this front, a multi-dimensional Saudi Quality of Life Index has been proposed.

(3) Second Pillar (Policies)

A core set of 81 policies are considered essential for achieving Vision 2025 as follows:

Table 4-21 Policies for Achieving Vision 2025

Strategic Goal	Category	No. of Policy
Challenge of Job Creation	SME Development	5
	Tourism Development	5
	Oil & Gas Development	5
	FDI Promotion	6
	Labor Market Reforms	5
Challenge of Poverty Reduction	-	4
Challenge of Enhancing Quality of Life	Education Reform	5
	Health Reform	5
Challenge of Sustainable Development	Diversification: Services Sector	5
	Diversification: Exports Promotion	5
	Prudent Water Management	6
	Balanced Regional Development	5
	Sustainable Government Finances	7
Challenge of Effective Implementation	Improving Project Implementation	3
	Improving Policy Implementation	5
	Improving Administrative Efficiency	5

(4) Third Pillar (Follow-up and Implementation Mechanisms)

In order to conduct follow-up and monitoring of implementation, LTS 2025 proposes the following measures:

- First, LTS 2025 creates several indices to measure success in key strategic areas. For example, new measures and indices are proposed to measure the degree of diversification of the economy and degree of balanced regional development.
- Second, the strategy proposes that clear targets and success indicators be used for measuring progress of the individual five year plan.
- Third, it is proposed that an annual follow-up report on progress in the implementation of the strategy will be prepared by MOEP and presented to the cabinet. After Cabinet approval, it will be made public.

Chapter 5 Overview of Electricity Sector of KSA

5.1 Overview of Electricity Sector

5.1.1 Structure of Electricity Sector

(1) History

Electricity development of KSA can be divided into 3 phases. The first phase was the period before 1970 where electricity generation was limited in small national companies, but absolutely of commercial nature. These companies existed in cities and villages respectively. Electricity tariff during that period was different from one company to another company due to actual cost and satisfactory revenue. On the other hand, in 1961, the first Department of Electricity Affairs was established in the Ministry of Commerce to establish rules and regulations, to issue permits and licenses to electric companies, and to encourage national investment.

The second phase was the period after 1970 where the Department of Electricity Services was established in 1972. The function of the new department was separated from the Ministry of Commerce, with the additional responsibility for planning electrical services for the entire KSA. In 1974, the Ministry of Commerce and Industry was divided into 2 main sectors, namely the Commerce Agency and the Industry and Electricity Agency. During the same year, the electricity tariff fixed at standard prices for all such companies at levels below their actual costs. In 1975, the Ministry of Industry and Electricity was established which included the Industrial Affairs Agency and Electricity Affairs Agency. The Electricity Agency expanded planning and coordination roles and standards for providing electrical services to all KSA regions.

The General Electricity Corporation was also established in 1976, to undertake the tasks of coordination and supervision of ambitious electricity plans. During the period from 1976 to 1981, all community electricity generation companies were gradually subsumed under the four regional (Eastern, Central, Southern, and Western regions) companies in Saudi Consolidated Electricity Companies (SCECO). The isolated remote area in the Northern region continued to be served by small companies.

The third phase was implemented after 1998. The Council of Ministers issued Decision No. 169 (November 30, 1998) stating the merger of ten electric companies and the electric projects of the General Electricity Corporation into a single company called Saudi Electricity Company (SEC), to perform its role for serving the country and citizens and to convert it into a profitable company. SEC became operational on April 6, 2000. On November 13, 2001, the Council of Ministers issued Decision No. 236 establishing the Electrical Services Regulatory Authority (former Electricity and Co-generation Regulatory Authority (ECRA)). The Authority aims to ensure the provision of electrical services at high quality and reliability levels and at appropriate prices. The Authority regulates the electricity sector, proposes the rules, conducts periodic reviews, and works on achieving competition in the sector and diminishing monopolies to encourage private sector investment in the sector.

(2) Structure

In KSA, electricity is mainly generated by SEC (82 % of the total generation as of 2006). The remaining portion is supplied by the Saline Water Conversion Corporation (SWCC) (10 % of the total generation as of 2006) and some big customers which have their own generation systems.

SWCC's main task is the desalinization of seawater. Through the production of water, electricity can also be generated by utilizing exhaust heat. Thus, the electricity generated from SWCC is a sub-product of the desalination plants that is out of the control of SEC's dispatching.

Big customers, such as Saudi Arabian Oil Company (ARAMCO) and other companies, also supply electricity through the single buyer, SEC.

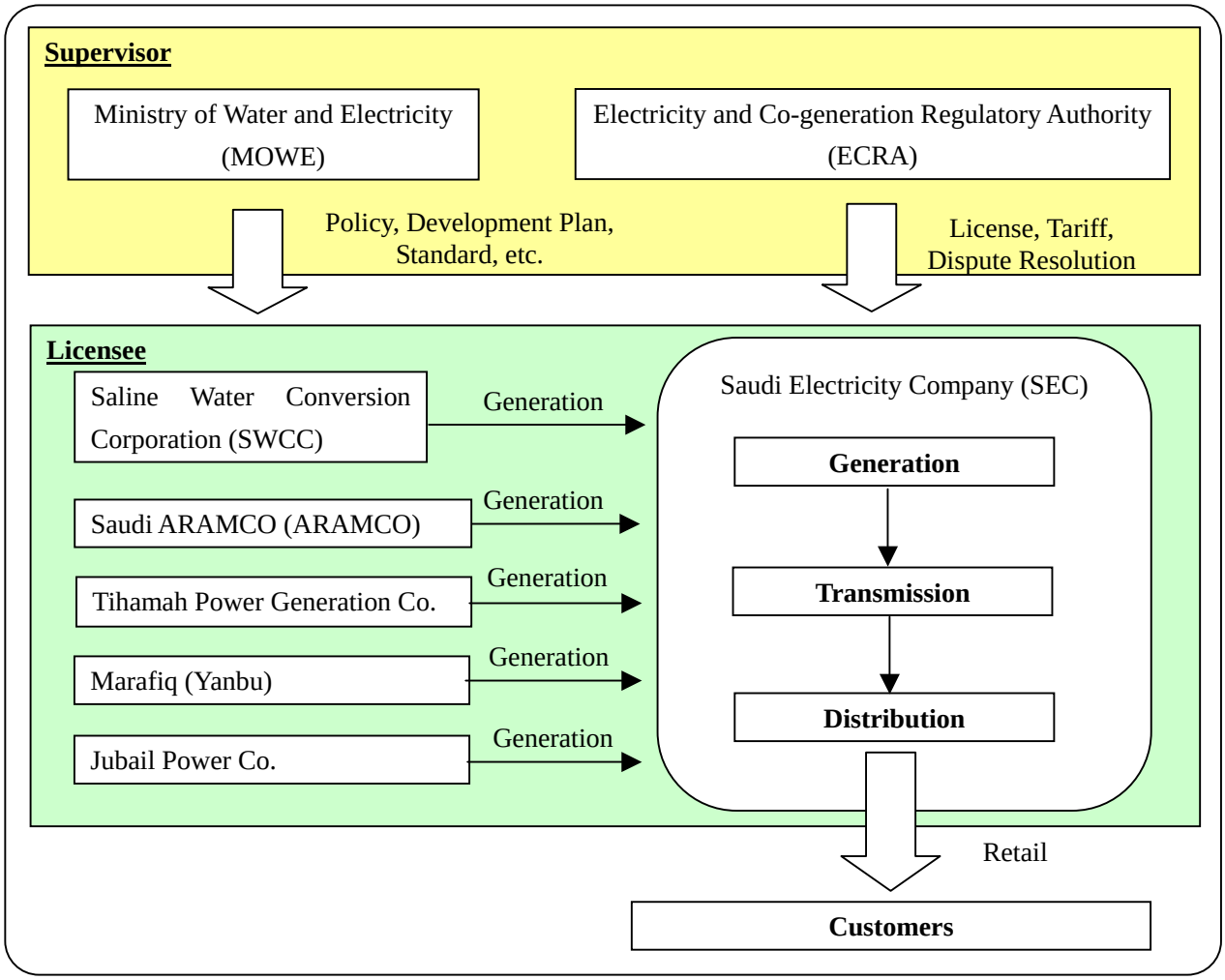


Figure 5-1 Current Structure of Power Supply

5.1.2 Ministry of Water and Electricity (MOWE)

(1) MOWE Responsibility in the Electricity Law

The Electricity Law (Royal Decree No. M/56) was established on November 22, 2005. The Electricity Law is central in the regulation and development of the electricity sector in KSA. The general features of the Law cover the provision of reliable services, protecting consumer's rights including reasonable prices, while protecting the rights of investors to receive a fair return.

MOWE responsibilities are stipulated in the Electricity Law as follows:

Article 3:

Ministry shall undertake to:

1. *propose policies relating to the Electricity Sector and supervise their implementation, following endorsement;*
2. *prepare, issue, and update the development plans and programs for the Electricity Sector and ensure their implementation. These include, but not limited to, the following:*
   a. *Interconnecting, reinforcement, and developing of the transmission network in the Kingdom and providing electricity services to consumers including the endorsed non-electrified remote areas;*
   b. *Ensuring the availability of acceptable generation reserve margin and adequate transmission and distribution capacities;*
3. *respect the Kingdom and promote the Kingdom's interests in the Electricity Sector in domestic, regional and international bodies, including electrical interconnections and electricity trading with other countries. The Ministry may delegate such mandate to other official entities;*
4. *exercise emergency powers that are temporarily granted to the Ministry where there exists or is imminent in the Kingdom an actual emergency or a threat that may affect the supply of fuel, electricity of co-generation, which necessitates that the Ministry should temporarily have at its disposal exceptional powers for controlling the resources of electricity and co-generation and fuel that are available to the Licensee;.*
5. *promote employment of nationals and ensure enforcement of policies in this respect;*
6. *support research and development activities in relation to the Electricity Industry by specialized institutions, universities and relevant private sector entities;.*
7. *prepare a long term plan, in coordination with parties concerned, to support national industries associated with the Electricity Industry and to adapt modern technologies to local condition;.*
8. *prepare, endorse and follow-up the execution of electricity conservation programs in cooperation with the Authority (ECRA), research centers and other relevant parties and prepare a public awareness plan in coordination with the Ministry of Culture and Information and other related entities;*
9. *document statistical data and technical information and make it available to the Electricity Sector;*
10. *propose, in coordination with the Authority, amendments to this Law; and*
11. *issue, by a decision of the Minister, Implementing Regulations of this Law in relation to the duties of the Ministry.*

(2) Implementing Regulation of MOWE

(a) General

Based on Article 3.11 of the Electricity Law, MOWE established "The Implementing Regulation of the Electricity Law", to clarify the MOWE's duties. The following articles in the Regulation are the basis of the implementation for the Study.

(b) Task of Making Policy (Article 4)

According to Article 4 of the Implementing Regulation, it is stipulated that the MOWE shall undertake the preparation and proposal of policies in a particular field to the Electricity Sector. After approving the proposed policy, MOWE shall also notify the policy and supervise the implementation.

(c) Tasks for Energy Conservation (Article 11)

Article 11 of the Implementation Regulation stipulates that the MOWE shall prepare and supervise the details related to the formulation of energy conservation programs, including available energy conservation choices, incentives for customers and electricity industry licenses, procedures ensuring high efficiency equipment/appliances, and an awareness program. MOWE is also charged with continuous follow-up efforts regarding energy conservation. It must also submit a report on achievements, barriers, and solutions to the Minister.

(3) Organization Chart

MOWE consists of Water Affairs and Electricity Affairs. With regard to the Electric Affairs, the Minister, Deputy Minister, and Assistant Deputy Minister supervise 5 departments, namely (i) Conservation and Awareness, (ii) Planning, (iii) Studies and Research, (iv) Information and Statistics, and (v) Specification and Rules, each of which is headed by a director.

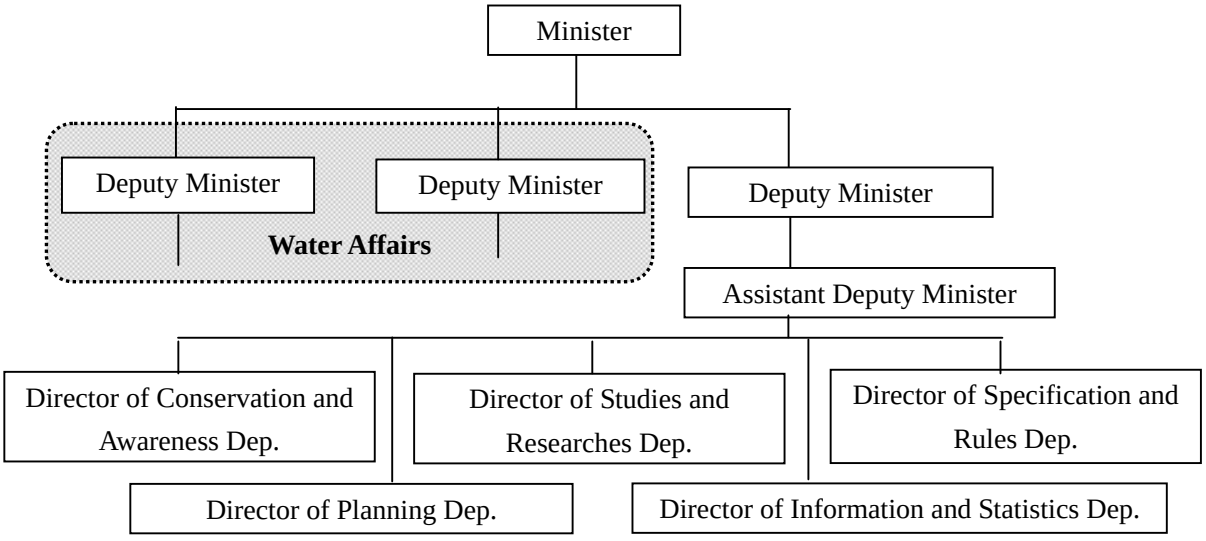


Figure 5-2 Organization Chart of Electricity Affairs of MOWE

(4) Current Tasks of Each Department

Tasks of each department of Electricity Affairs are summarized as follows:

Table 5-1 Tasks of Department of Electricity Affaires

Department	Tasks
Conservation and Awareness Department	- Raising energy conservation awareness - Developing policies and programs - Coordination with other implementing agencies - Evaluation of programs already carried out, etc.
Planning Department	- Planning of a long term power development plan and follow up - Monitoring regional power development and follow up - Forecasting a long term power demand - Monitoring rural electrification, etc.
Studies and Research Department	- Implementing various studies - Report the results of studies to related agencies - Cooperation in international activities, etc.
Information and Statistics Department	- Colleting data and information - Issuing the annual MOWE report - Implementation of training programs, etc.
Specification and Rules Department	- Standardization of equipment and facilities in generation, transmission, and distribution fields - Drafting regulations and laws regarding electricity affairs, etc.

(Source: JICA Preparatory Study Report, 2006)

(5) Human Resources of Energy Conservation and Awareness Department

As of September 2007, the Energy Conservation and Awareness Department has 6 staff members consisting of 1 director, 1 deputy director, 1 engineer, 2 permanent consultants, and 1 secretary.

5.1.3 Electricity and Cogeneration Regulatory Authority (ECRA)

(1) General

The Electricity and Cogeneration Regulatory Authority (ECRA), which was formed on November 13, 2001 by Council of Ministers in Decision No. 236, is an independent government agency, which regulates the electricity industry in KSA to ensure provision of adequate, high quality, and reliable services at reasonable prices. Its mission is to develop and pursue a regulatory framework, in accordance with government laws, regulations, policies, and standards, as well as international best practices, in order to guarantee the provision of safe, reliable, and efficient electric power to the consumers of KSA.

(2) Main Scope of Work

ECRA's work covers a wide range of responsibilities described as follows:

Tariff:

- ✓ Developing a tariff-setting methodology and periodic review.
- ✓ Designing and preparing a tariff structure.
- ✓ Developing an overall tariff policy statement for KSA.

- ✓ Preparing a standardized financial reporting system to be utilized by all licensed service providers in order to assess their costs, which ultimately affect the tariff paid by the consumers.

Licensing:

- ✓ Issuing licenses for generation, transmission, distribution, and trading providers.
- ✓ Monitoring performance, with penalties for non-compliance.

Standards, Quality of Service, and Performance Monitoring:

- ✓ Monitoring reliability of electricity supply, minimization of brownouts, and ensuring the absence of voltage spikes.

Complaints, Arbitration, and Dispute Resolution:

- ✓ Dealing with consumer complaints associated with electricity and cogeneration covering Application of tariffs, Quality of supply, Quality of service, and Billing.
- ✓ Dealing with disputes arising between the various participants in the electricity industry.
- ✓ Arbitration to resolve consumer complaints, as well as disputes, that arise between the industry participants.

Encouragement of the Private Sector Participation and Investment:

- ✓ Encouraging private sector participation and investment opportunities including:
  - Independent power projects and independent water and power projects
  - Building, leasing, and/or operating transmission lines
  - Formation of power generation companies
  - Obtaining a concession or a lease for existing generation and water production facilities
  - Obtaining facility management contracts
  - Establishing power supply companies

(3) Organization

ECRA is supervised by a board of directors chaired by the Minister of Water and Electricity with the Governor of ECRA as deputy chair, six members comprised of senior government officials, and five members selected on their own merits.

Under the Board, a Governor and 3 Vice-Governors supervise 9 departments, namely Consumer Care, Service Provider Affairs, Economy & Tariff Affairs, Legal & Licensing Affairs, Technical Affairs, Financial Affairs, Human Resources, Information Technology, and Administrative Support. The total number of employees within the 9 departments is 106 out of 2006.

5.1.4 King Abdulaziz City for Science and Technology (KACST)

(1) General

King Abdulaziz City for Science & Technology (KACST) is an independent scientific organization of the Saudi Arabian Government, established in 1977.

KACST is governed by a Supreme Committee, which is chaired by the Prime Minister and is composed of the ministers of the major ministries.

From its inception in 1977, KACST had been carrying out its mission to promote science & technology in KAS by coordinating and cooperating with various universities, agencies, and institutions concerned with research and technology, and encouraging Saudi experts to undertake research that will help promote the development and evolution of the society. Additionally, KACST, through cooperative agreements with international science and technology institutions/organizations, encourages closer ties with friendly countries.

KACST has established several national research institutes, the Institute for Petroleum and Petrochemical Research, the Institute of Energy Research, the Institute of Natural Resources and Environmental Research, the Institute of Space Research, the Institute of Astronomy and Geophysics, the Institute of Computer and Electronics, and the Institute of Atomic Energy Research.

(2) Institute of Energy Research

In KACST, the Institute of Energy Research plays a main role in R&D of energy conservation. The Institute has pursued applied research in the fields of conventional and renewable energies through national projects and international co-operation programs. The mission of the Institute is to transfer and develop energy-related technologies appropriate to the needs and requirements of KSA, its resource and long-term plans, and to provide practical solutions in the drive towards energy conservation, load management, and increased energy efficiency.

(3) Organization

The Institute of Energy Research has 4 research centers to implement each project as follows.

Table 5-2 Research Center of Institute of Energy Research

Research Center	Research Item
Energy Management Center	- Power factor improvement for large consumers - Performance of thermal insulation in different climatic conditions of KSA - Quality of power in the utility grid - The shading study and trace on the energy consumption guidance in the AL-Riyadh buildings
Renewable Energy Center	- Renewable energy resource assessment- Solar Radiation & Wind Energy - Solar absorption cooling - Improving the coefficient of performance for central air conditioning equipment
Fuel Cell Center	- Fuel cell R&D activities
Engine Efficiency Center	- No description

(Source: KACST Website)

5.1.5 Saudi Electricity Company (SEC)

(1) History

The establishment of the Saudi Electricity Company (SEC) came as a result of the Council of Ministers' Resolution No. 169 dated November 29, 1998. The resolution stipulated the reorganization and restructuring of the power sector in KSA by merging all the former public utility

joint stock companies (10 public companies covering almost the whole KSA) and Generation Electricity Corporation projects (11 projects covering different areas in the northern region) into the SEC.

SEC was formed by Royal Decree No. M/16 on December 6, 1999 as a Saudi Joint Stock Company and then incorporated in KSA under Commercial Registration No. 1010158683 dated May 3, 2000. The capital share capital of the SEC (as of December 31, 2005) is 41,665,938,150 SR consists of 833,318,763 shares and the shareholders are comprised of Government 74.31 %, the Saudi Arabian Oil Company (ARAMCO) (6.93 %), and other shareholders 18.76 %.

(2) Activities and Commitment

The SEC's principle activity is the generation, transmission, and distribution of electric power. SEC is the major provider of electric power to its consumers all throughout the KSA, serving governmental, industrial, agricultural, commercial, and residential consumers. In order to implement such activities, the SEC's commitment to strategic goals, its vision, and mission are outlines as follows.

Table 5-3 SEC Strategic Goals, Vision and Mission

Our Strategic Goals
■ Taking joint ventures and capital investment in electricity generation, transmission and distribution projects within and outside the Kingdom. ■ Working towards completing the interconnected national grid to provide highly reliable electricity supply. ■ Achieving a high and dominant level of customer satisfaction by meeting their needs, exceeding expectations and positively interacting with them. ■ Promoting the level of electricity supply provision for all customer segments. ■ Ensuring continuous interaction in providing community services and contributing to charity projects. ■ Preparing and tailoring required training programs and mode of implementation to develop the Company's human resources. ■ Conducting and supporting research to raise the Company's performance level in all activities and to protect the environment.
Our Vision
To help and improve the standards of living and enhance the economic competitiveness of the Kingdom of Saudi Arabia.
Our Mission
We are committed to provide our customers with safe and reliable electricity services, to meet the expectations of our shareholders, caring for our employees, and ensuring optimum utilization of available resources.

(Source: 2005 Annual Report)

(3) Organization

(a) Company Profile and Performance Indicators

SEC's company profile and performance indicators are shown in the next table. For reference, one of the Japanese power utilities, Tokyo Electric Power Company (TEPCO), is also compared. Both companies have a similar feature, that is, both companies cover generation, transmission, and distribution.

Table 5-4 Company Profile and Performance Indicators in FY 2005

	Item	SEC	TEPCO
Company Profile	Sales Electricity	153,284 GWh	286,700 GWh
	Generation Electricity	150,214 GWh	261,800 GWh
	Maximum Demand	29,913 MW (August 27, 2005)	64,300 MW (July 24, 2001)
	Generation Capacity	29,051 MW	62,825 MW
	Annual Total Revenue	18,761 million SR (5.00 billion US$)	4.851.7 billion Yen (40.4 billion US$)
	Electricity Revenue	17,430 million SR (4.65 billion US$)	4,637.2 billion Yen (38.6 billion US$)
	Net Income	1,483 million SR (395 million US$)	384.5 billion Yen (3.2 billion US$)
	Non-current Asset (Year average)	86,095 million SR (22,959 million SR)	9,517 billion Yen (79.3 billion US$)
	No. of Customer	4,727,371	27.74 million
	No. of Employee	28,895	38,510
Performance Indicators	Return on Asset	1.7 %	4.0 %
	Electricity Sold per Employee	5.3 GWh/employee	7.4 GWh/employee
	Electricity Sold per Customer	32,425 kWh/customer	10,335 kWh/customer
	Average Sold Price	3.0 US cent/kWh	13.4 US cent/kWh

(Source: 2005 SEC Annual Report, Illustrated TEPCO 2005)

(b) Organization Chart

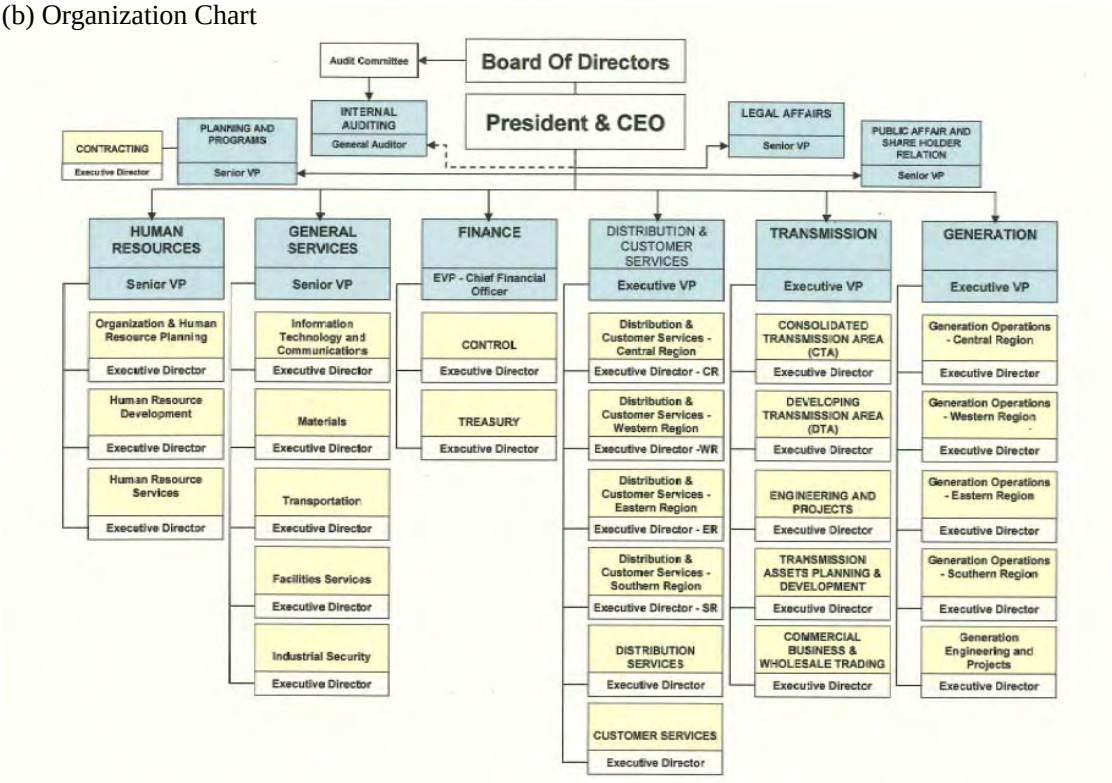


Figure 5-3 Organization Chart of SEC

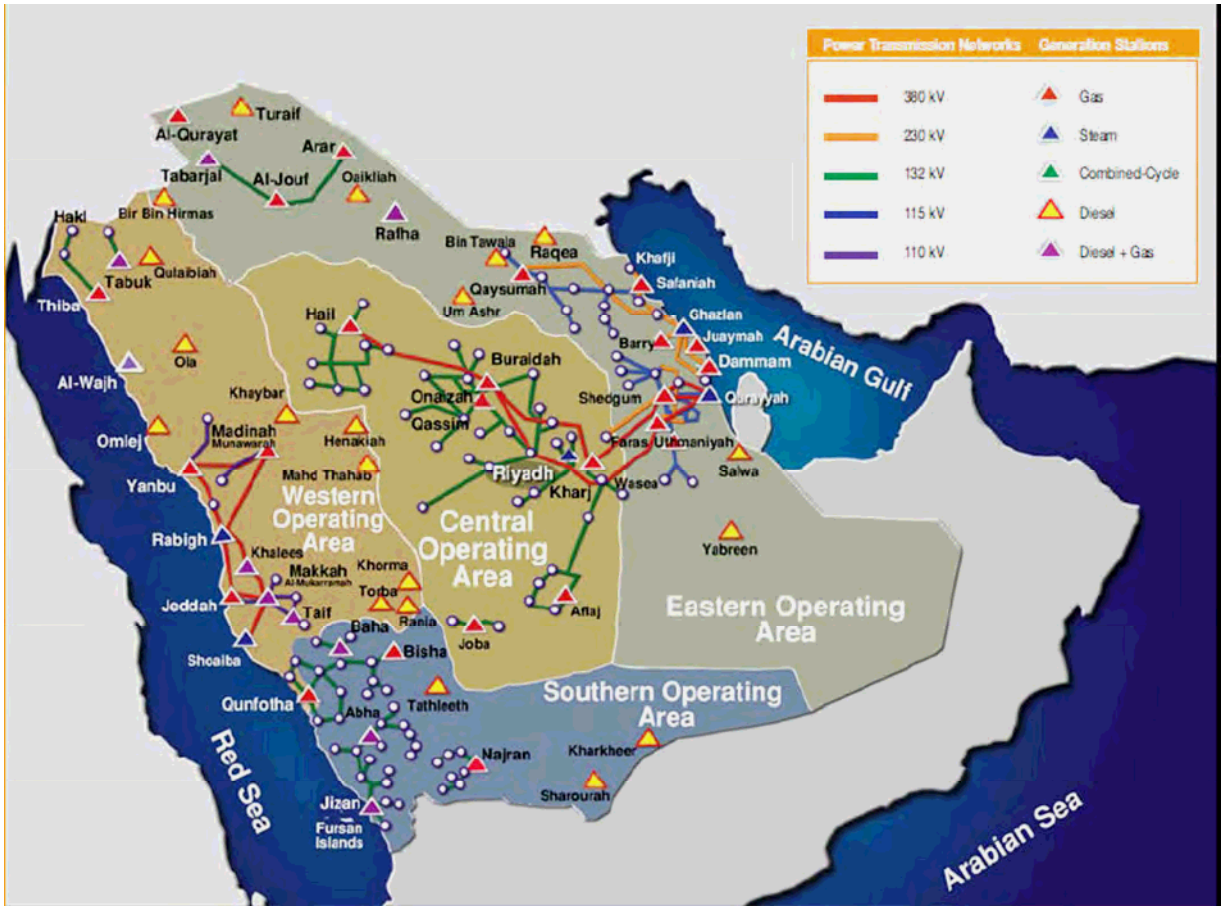
5.2 Power Demand and Supply

5.2.1 Power System

(1) Power Network

The KSA power network is owned and operated by the Saudi Electricity Company (SEC). The following figure shows the power network of Saudi Arabia as of 2005. The power network is divided into the Eastern Operating Area (EOA), Central Operating Area (COA), Western Operating Area (WOA), and Southern Operating Area (SOA). EOA and COA are connected to each other by 380 kV double-circuit two-route transmission lines and a 230 kV double-circuit. Each region has several relatively small isolated systems.

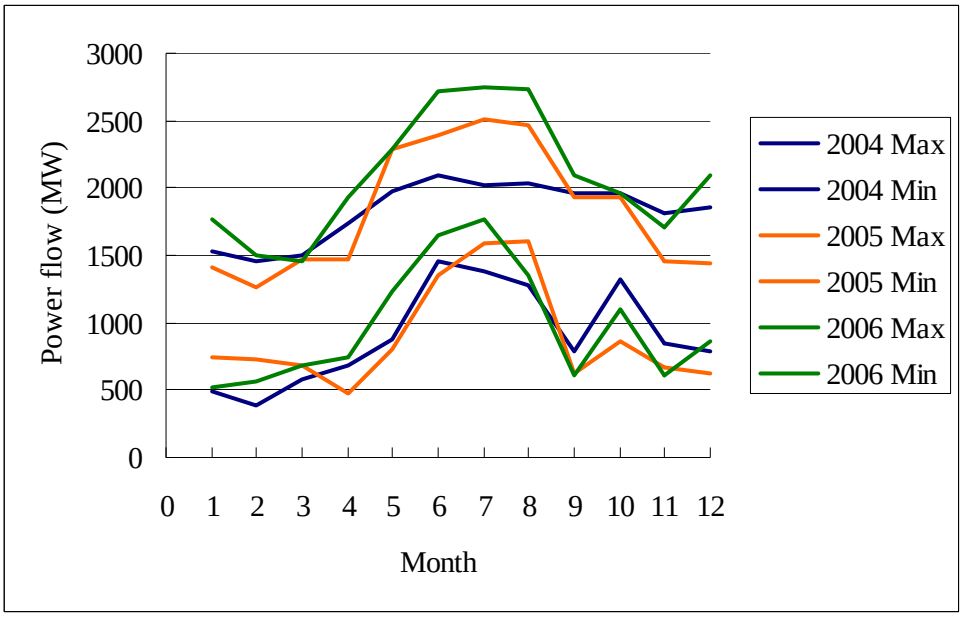
The electrification rate for villages was 79.1 %, however, it rose to 90 % in 2003, meaning that 10,059 villages were electrified.



(Source: SEC Annual Report 2005)

Figure 5-4 Power System of the KSA

Power from the interconnection line between EOA and COA is around 500 MW-2,500 MW. The next figure illustrates the power flow from EOA to COA from 2004 to 2006, showing the maximum and minimum power in respective years. The power flow has increased year by year.



(Source: SEC COA&EOA Central Load Dispatching Center)

Figure 5-5 Power Flow from EOA to COA from 2004 to 2006

(2) Grid Code

A common power network utilization rule is often generally required for power network users because there are multiple users, such as electric power utilities, IPP (Independent Power Producers), or large electric consumers. The rule is called the “Grid Code” prescribing the technical requirements for reliable, safe, and efficient operation of power systems, the fair utilization of the power network, and methodology of information exchange. At present, SEC is preparing the KSA Grid Code. The draft Grid Code, as of November 2005, describes the condition for the grid connection, criteria for power network planning and operation, power supply planning, and the type of data/information to be arranged.

5.2.2 Generation Facilities

(1) Power Plants in the KSA

The power plants in the KSA are all operated with thermal power and categorized into SEC’s power plants, desalination plants, and IPP. The Saline Water Conversion Corporation (SWCC) and the Power and Water Utilities Company for Jubail and Yanbu operate desalination plants. the Saudi Petrochemical Company (SADAF) and ARAMCO operate an IPP.

SEC shared the capacity of power plants at 89.9 %, desalination plants at 7.9 % and IPP at 2.2 % in 2005. The list of SEC power plants in EOA and COA as of the summer of 2007, is shown as

follows.

Table 5-5 Power Plants in COA (Summer 2007)

COA Existing Generation Capacity

Area	Plant	Manufacture	No. of Units	Unit Capacity (MW)	Plant Capacity (MW)	Total Capacity (MW)
RIYADH	PP9 GT	GE	16	59.9	959	1,850
	PP9 ST	GE	4	100	400	
	PP9 E	GE	8	61.4	491	
	PP8	ABB	20	46.2	924	1,627
	PP8X	GE	10	70.3	703	
	PP7	GE	16	47.1	753.9	1,259
	PP7X	GE	6	55.8	335	
	PP7E	SIEMENS	2	85	170	
	PP5	ABB-D4	10	43.6	436	524
		ABB-D5	2	44	88	
	PP4	ABB	4	21.8	87	87
	PP4X	HITACHI	5	39.2	196	221
	PP4Xs	HITACHI	2	12.5	25	
	RPP3		5		55	45
	LAYLA	AEG	6	14.6	87.6	88
QASSIM	QPP2	ABB	5	17.8	89	89
	QPP3	WH	9	64.1	576.9	985
	QPP3X	GE	6	68	408	
HAIL	HAIL 2	WH	5	66.6	333	333
	HAIL 1	ALTH	2	14.5	29	43
		GEC	2	7	14	
Total			145		7,160.4	7,151

COA Additional Generation Capacity

Plant	No. of Units	Total Capacity (MW)	Commencement Date
PP9 Cooling (E Block)	8	120	11-May-07
Hail 2	1	51	1-Jun-07
PP9 C-Block	10	555	10-Jun-07
PP9 Cooling (C Block)	10	139	10-Aug-07

(Source: SEC, Consolidated Transmission Area, System Operation and Control, Summer 2007)

Table 5-6 Power plants in EOA (Summer 2007)

EOA Existing Generation Capacity

Owner	Plant	Manufacture	No. of Units	Unit Capacity (MW)	Plant Capacity (MW)	Total Capacity (MW)
SEC Steam	Qurayyah	MHI	4	635	2,540	2,540
	Ghazlan I	WH	4	405	1,620	4,340
	Ghazlan II		4	680	2,720	
SEC Gas	Shed (10-17)	GE	8	59.8	478.5	1,062
	Shed (1-9)	WH	9	64.8	583.3	
	Faras (1-8)	GE	8	61.8	494.6	794
	Faras (9-13)	WH	5	59.9	299.7	
	Dammam	FIAT	4	9.9	39.7	339
		FIAT	4	18.1	72.2	
		FIAT	4	19.5	78.1	
		WH	1	27.1	27.1	
		MHI	3	40.5	121.5	
	Uthmaniyah	MHI	5	44.3	221.3	266
		MHI	3	15	45.1	
	Berri	WH	3	66.7	200	200
	Qaisumah	GE	4	16.9	67.5	123
		GE	2	27.8	55.6	
	Juaymah	MHI	1	15.5	15.5	114
		MHI	2	45	90	
		PR/GEC	1	8	8	
	Safaniyah	MHI	1	15.8	15.8	56
		MHI	1	40	40	
SEC Total EOA			81			9,834
Sadaf	Sadaf		2	125	250	250
ARAMCO	Abqaiq				76	1475
	Qatif				138	
	Berri				252	
	Ras Tanura R				34	
	Uthmaniyah				275	
	Shedgum				275	
	Ras Tanura				150	
	Juaymah				275	
SWCC	Jubail				980	980
	Aziziyah				780	1,760
EAST Total						13,319

(Source: SEC, Consolidated Transmission Area, System Operation and Control, Summer 2007)

The breakdown of power generated in 2005 is shown in the following table. The total amount of power generated was 171,890 GWh. SEC generated 84.9 %, desalinization plants 12.2 %, and IPP 2 %. The power loss, including power plant consumption, was around 13%. Excluding power plant consumption, the rate was around 11 %.

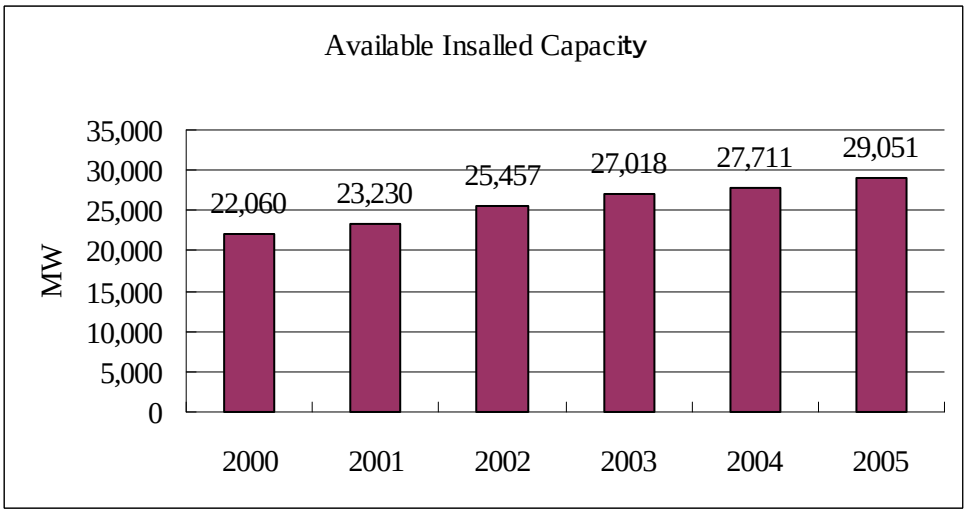
Table 5-7 Breakdown of Generated Power Energy in 2005

	Total Produced Energy Consumption in Power Plant Sent Energy on Network	SEC Plants Total Produced Energy Consumption in Power Plant Sent Energy on Network	Desalination (Sending Point)	IPP (Sending Point)	Sold Energy	Loss (including Power Plants Consumption)	Loss (Excluding Power Plants Consumption)
Electricity (GWh)	176,123 4,233 171,890	150,214 4,233 145,981	21,025	4,884	153,283	22,840	18,607
Share	100.0 %	84.9 %	12.2 %	2.8 %	89.2 %	13.0 %	10.8 %

(Source: Electricity 2005, MOWE)

(2) SEC's Available Capacity

The following figure illustrates the available installed capacity of SEC's power plants from 2000 to 2005. Available installed capacity increased by 27.7% from 2000 to 2004. The available capacity reached 27, 111 MW in 2004 and 29,051 MW in 2005.



(Source: Electricity 2005, MOWE)

Figure 5-6 Available Installed Capacity of SEC's Power Plants from 2000 to 2005

The next table shows the list of main power plants installed during 2005.

Table 5-8 Main Power Plants Installed during 2005

Generation Station	Type	Number of Units	Capacity (MW)
PP7 in Riyadh	Gas	2	170
PP8 in Riyadh	Improvement in generation unit's cooling system	-	140
Central Plant in Qaissim	Improvement in generation unit's cooling system	-	90
PP3 in Riyadh	Gas	8	480
Tabuk PP2	Gas	2	120
Central Plant in Asir	Gas	1	70
Central Plant in Bsiha	Gas	2	146
Central Plant in Jizan	Gas	2	132
Central Plant in Fursan	Diesel	6	30

(Source: SEC Annual Report 2005)

The following table shows the regional generation capacity of the SEC as of 2005. EOA has the largest amount of capacity.

Table 5-9 Regional Generation Capacity of SEC as of 2005 (Unit: MW)

EOA	COA	SOA	WOA	Total
10,419	7,413	2,677	8,542	29,051

(Source: Electricity 2005, MOWE)

(3) Desalination Plants

The desalination plants connected to the power grid are Jubail, Al Aziziyah in EOA, and Jeddah、Yanbu in WOA、and Ash-Shuaibah, Ash-Shuqayg in SOA. The next table shows the imported peak load from desalination plants. Desalination plants are operated in a flat pattern and the SEC does not control output for that their objective is not electricity supply but rather desalinization of seawater.

Table 5-10 Imported Peak Load from Desalination Plant (Unit: MW)

		East			West		South
Year	Maximum Load	Jubail	Al-Aziziyah	Jeddah	Yanbu	Ash-Shuaibah	Ash-Shuqayg
2002	3,250	1,236	869	549	359	515	83
2003	3,434	1,239	918	533	373	528	78
2004	2,966	1,065	842	451	334	550	86
2005	2,811	1,063	845	494	342	536	74

(Source: Electricity, MOWE, 2005)

(4) IPP

Recently, private sectors have been participating in Saudi Arabia's power sector. The National Energy Company (NEC) established in 2002 constructed the 240 MW steam turbine plant in the Jubail industrial zone as a BOO (Build-Operate-Own) plant which began operating in 2005. In 2004, a contract was made between ARAMCO and a private company for the construction of four generators with total capacity of 1,047 MW as a BOO plant. Presently, some power plants are

operated as IPP, such as Ras Tanura, Juaimah, Shudgum, or Uthmaniah, selling surplus power to SEC. Recently, the amount of power generated by IPP has increased.

(5) Available Generation Capacity

The following graph illustrates the change in available generation capacity from 2000 to 2005. The value of desalination plants indicates the power generation at peak demand.

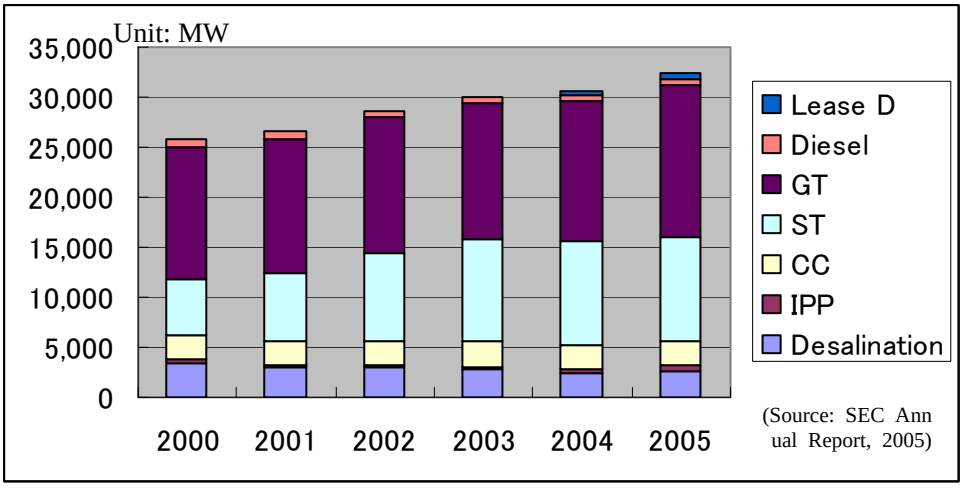


Figure 5-7 Available Generation Capacity in KSA

(6) Maximum Power Generation

The next table shows the regional maximum power generation records from 2002 to 2005. Since regional power demands were recorded at a different time, there is a difference between the total amount of regional power demand and the total peak demand. The maximum power generated in 2005 reached to 29,913 MW. As mentioned previously, EOA and COA are connected by transmission lines and power is sent from EOA to COA, thus, the power demand of EOA is larger than the amount of power generated. On the other hand, the power demand of COA is less than the amount of power generated. The following table includes the power generation for each isolated system.

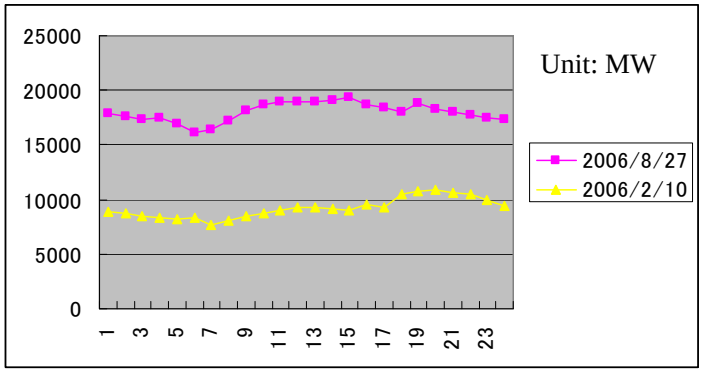
Table 5-11 Regional Maximum Power Generation Records at Peak Demand

	East	Center	South	West	Total	Date of Total Peak
2002	9,576	7,552	1,704	7,236	23,938	Aug 3
2003	11,042	8,566	1,891	8,002	26,272	Jun 17
2004	10,828	8,382	2,032	8,505	27,847	Sep 11
2005	11,964	9,023	2,138	9,115	29,913	Aug 27

(Source: Electricity 2005, MOWE)

5.2.3 Power Demand

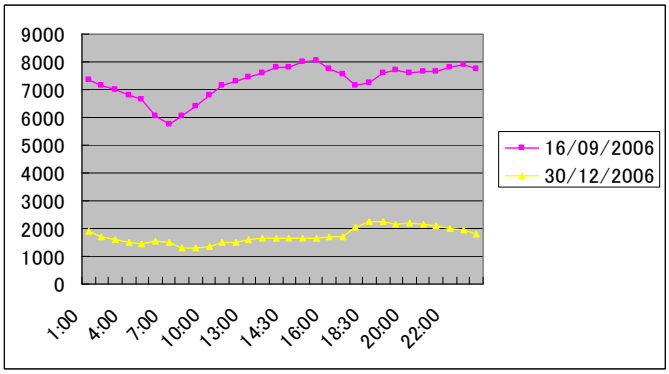
The following figure illustrates the daily load curve of EOA and COA on August 27, 2006, when the highest maximum power demand was recorded and the daily load curve on Feb 10, 2006, when the minimum amount of peak power demand was recorded. The maximum power demand was 19,324 MW. Load changes during the peak day were in the range of 2000 to 3000 MW or around 10 to 15 % of the peak demand. Load changes during a peak day in Tokyo are around 40 % to 60 % of the peak demand. Therefore, load change speed during the day is relatively small in the KSA when compared to Tokyo.



(Source: Data from SEC COA&EOA Central Load Dispatching Center)

Figure 5-8 Daily Load Curve of EOA and COA in 2006

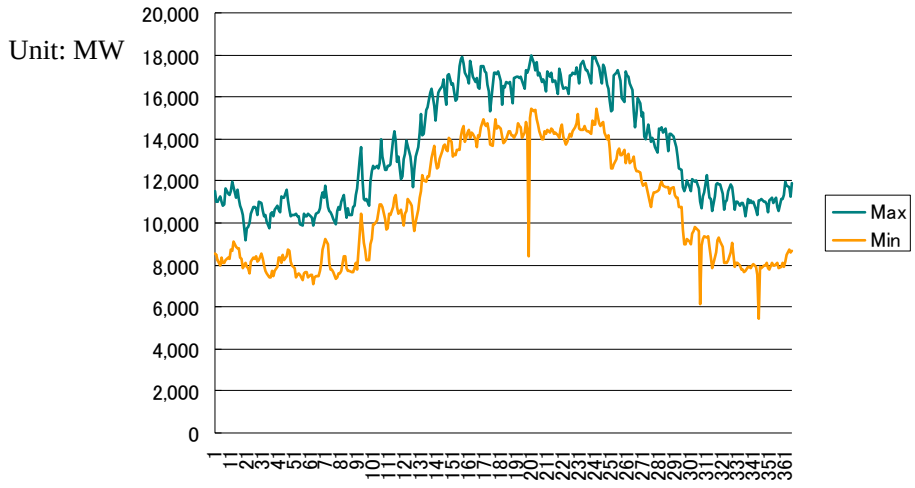
The following figure illustrates the daily load curve of WOA on Sep 16, 2006 where the maximum power demand was recorded and the daily load curve on Dec 30, 2006 where the minimum peak power demand was recorded. The changes in the load during the peak day were in the range of around 2000 that was around 25 % of the peak demand. The speed of the change in the load during the day is relatively small in comparison with the case in Tokyo in the same manner as the case of EOA and COA.



(Source: Data from WOA Central Load Dispatching Center)

Figure 5-9 Daily Load Curve of WOA in 2006

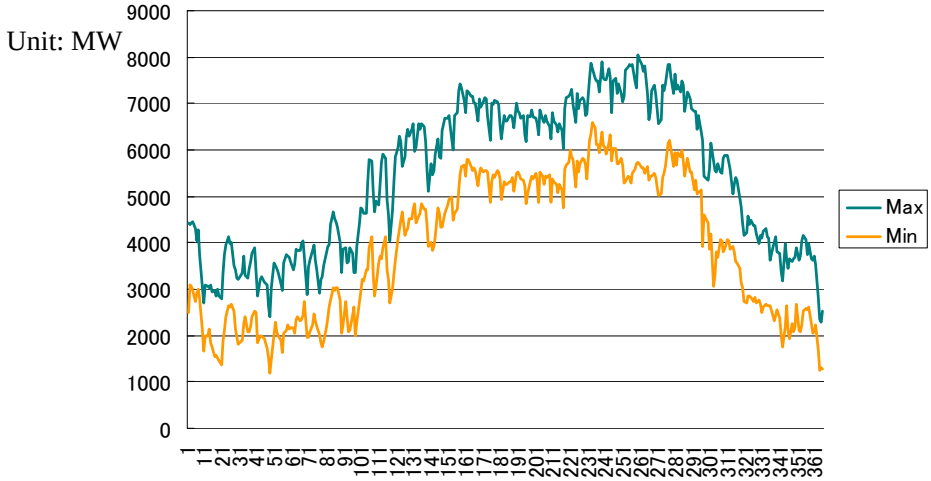
The next figure shows the load curve of EOA and COA plotting the points of daily maximum and minimum power demand for 2006. As already mentioned, the change in the load during a day is small, however, the large seasonal load change was recorded. Data colleted from COA includes a zero value at certain points.



(Source: Data from SEC COA&EOA Central Load Dispatching Center)

Figure 5-10 Daily Maximum and Minimum Power Demand of EOA and COA in 2006

The next figure shows the load curve of WOA plotting the points of daily maximum and minimum power demand over the year of 2006. In the same manner as EOA and COA, the change in the load during a day is small, however, the huge seasonal change in the load was recorded.



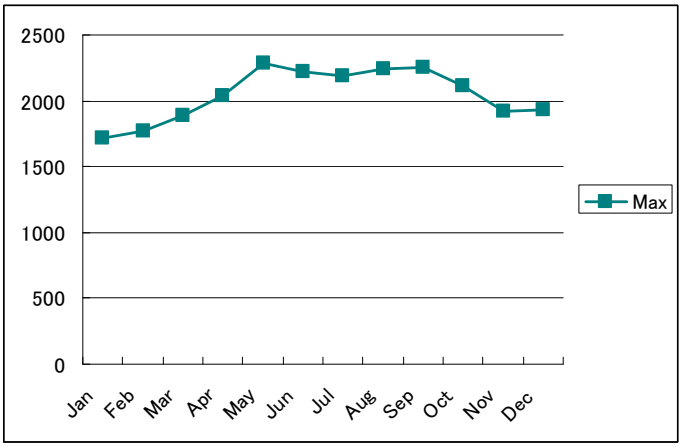
(Source: Data from WOA Central Load Dispatching Center)

Figure 5-11 Daily Maximum and Minimum Power Demand of WOA in 2006

As can be seen from the daily load curve and the annual load curve, application of a seasonal tariff system seems to be effective for energy conservation.

However, SOA has the smaller change in the seasonal load curve than EOA and COA as shown

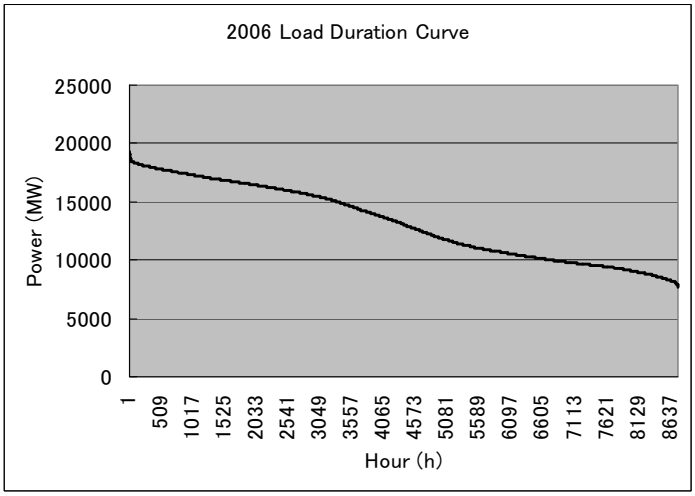
in the following figure due to the different climate.



(Source: Data from SOA Central Load Dispatching Center)

Figure 5-12 Daily Maximum Power Demand of SOA in 2006

As shown in the following graph, arranging the hourly load in descending order over the year gives the load duration curve. The load duration curve of COA and EOA in 2006 is as follows. The load factor, that is the ration of averaged load to the maximum load, is 68.2 %.



(Source: Data from SEC COA&EOA Central Load Dispatching Center)

Figure 5-13 Load Duration curve of COA and EOA in 2006

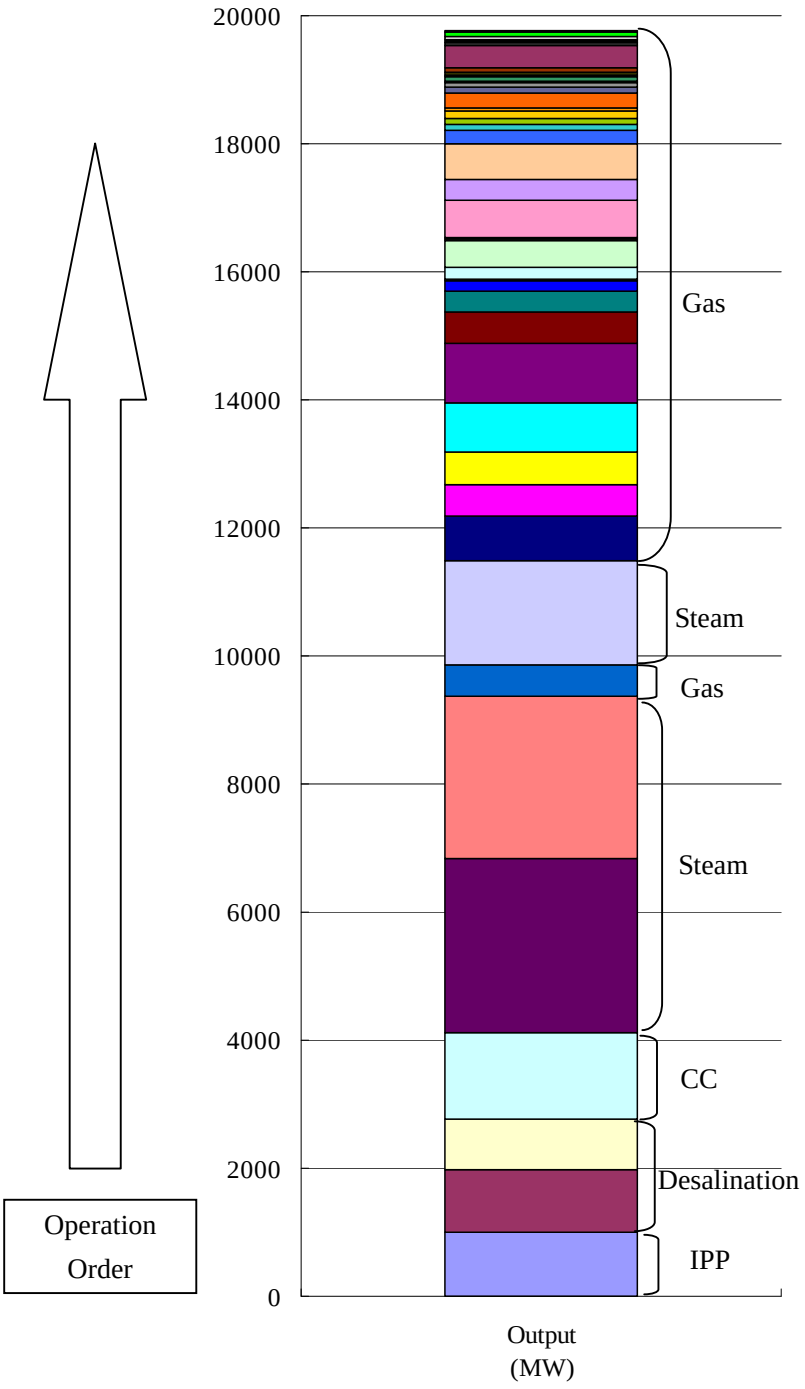
5.2.4 Operation of Generation

(1) Power Plant Operation

IPPs and desalination plants are operated according to their contracts. However, SEC power plants are operated according to the “Merit Order Table” showing the prioritized order of power plants. The merit order table is the list that arranges the power plants in ascending order of their variable costs. In general, combined cycle power plants or steam turbine power plants have low

variable costs. The variable cost of the power system would increase when the power demand increases because the operating generators are assigned in ascending order of their variable costs.

The Merit Order Table of 2006 for EOA and COA is shown in the following graph. The graph illustrates the operating capacity of the power plants accumulated from the bottom line according to the Merit Order Table. Power plants located lower on the list have more chances for operation. Power plants located higher on the graph have fewer operation chances and are operated demand exceeds the available output.



(Source: Data from SEC COA&EOA Central Load Dispatching Center)

Figure 5-14 Operating Capacity Accumulated by Merit Order Table of EOA and COA Grid

(2) Incremental Fuel Cost of Generators

Higher power demand generally means higher fuel costs because of the assignment of power plants in descending order of fuel cost. Actually, due to the probability of forced outages or facility inspection, where the generator is stopped, generators with lower fuel cost cannot always be operated. Thus, incremental fuel costs are given as an average of the expected values. Here, we calculated the expected incremental fuel costs of generators installed in EOA and COA in 2006 based on the Merit Order Table on the condition that output of IPPs, Jubail, and the Aziziyah desalination plant are 1,000 MW, 980 MW, and 780 MW respectively.

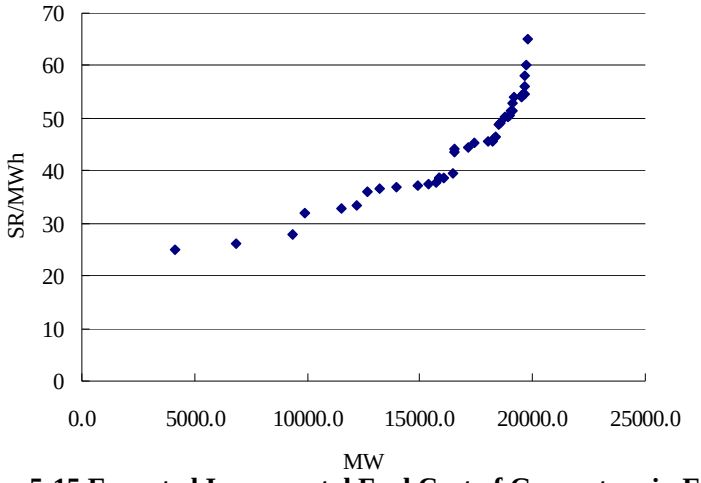
The probabilities of stop and required inspection duration of SEC's generators are assumed as shown in the table below. Since the combined cycle generators, PP9, and the steam turbine generators, Ghazlan II, Qurayyah and Ghazlan I are operated so as to generate for almost all the time.

Table 5-12 Assumed Fault Ratios of Generator Unit

Type	Probability of Stop of Generator Units	Required Inspection Duration
ST	6%	6 weeks (12%)
GT	8-9%	4 weeks (8%)

(Source: Updated Generation Planning for the Saudi Electricity Sector, Center for Engineering Research, Mar 2006)

The result is shown in the following figure. The maximum expected power output of the system is 19,800 MW. The incremental fuel cost of generators of the system is 30 SR/MWh where power demand is up to around 10,000 MW. The incremental fuel cost reaches 40 SR/MWh when the power demand becomes around 80 % of the peak demand. When power demand exceeds 80 % of the peak, the incremental fuel cost rapidly increased. It increases to 60 SR/MWh during peak demand. The duration where the power demand exceeds 80 % of the peak load shares around 30 %, as can be seen from the load duration curve.



* 1SR is almost equial to 0.27USD.

Figure 5-15 Expected Incremental Fuel Cost of Generators in EOA and COA

(3) Averaged Fuel Cost of Generators

Averaged fuel cost of generators in EOA and COA is roughly estimated for each level of power demand. The result is shown below.

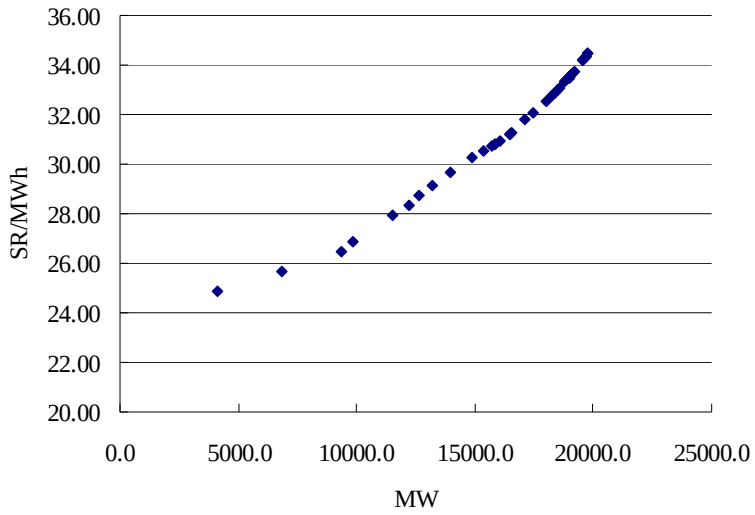


Figure 5-16 Averaged Fuel Cost of Generators in EOA and COA

The total averaged fuel cost of the system over for 2006 is calculated as 29.8 SR/MWh by applying the averaged fuel cost to the load duration curve of 2006.

(4) SEC Operating Expenses

SEC operating expenses are shown in the table below.

Table 5-13 SEC Operating Expenses in 2005 (Unit: thousand SR)

	Depreciation	Fuel	O&M	Purchased Power	Total
Generation	1,907,365	4,573,978	2,401,043	-	8,882,386
Transmission	1,675,751	-	779,147	-	2,454,898
Distribution	1,751,124	-	2,586,230	-	4,337,354
Purchased power	-	-	-	1,151,615	1,151,615
General property	289,704	-	386,173	-	675,877
Total	5,623,944	4,573,978	6,152,593	1,151,615	17,502,130

(Source: SEC Annual Report 2005)

On the assumption that fuel cost is in proportion to output energy of power plants of SEC and the cost of purchased power is in proportion to the purchased energy of IPP and desalination plants, the unit costs are calculated. The result is shown below.

Table 5-14 Unit Cost of Operating Expenses

	Depreciation (SR/MW/year)	Fuel (SR/MWh)	O&M (SR/MWh)	Purchased Power (SR/MWh)
Generation	65,656	30.4	15.7	-
Transmission	57,683	-	5.1	-
Distribution	60,278	-	16.9	-
Purchased Power	-	-	-	44.4
General Property	9,972	-	2.5	-
Total	193,589	30.4	40.1	44.4

The fuel cost corresponds to the cost calculated from the Merit Order, outage probability, and load duration curve described before.

5.2.5 Future Power Development Plan

In KSA, the future power development plan was studied in “Updated Generation Planning for the Saudi Electricity Sector, ECRA/Center for Engineering Research, Mar. 2006”.

This report recommended the least cost plan to meet the required loss of load probability by the comparison of the required generation capacities between the case with and without the WOA-COA and WOA-SOA interconnection lines. The result is shown in the following figure.

Table 5-15 Generation and Interregional Connection Plan up to 2023

Region	EOA	COA	WOA	SOA	Interregional Connection (WOA-COA, WOA-SOA)	Total
Incremental Capacity up to 2023 (MW)	6,300	9,628	8,506	4,698	-	29,132
Incremental Cost (Discount rate 5%, total present value) (million SR)	7,964	9,389	12,828	5,742	2,373	38,296

(Source: Updated Generation Planning for the Saudi Electricity Sector, Center for Engineering Research, Mar 2006)

The generation plan of the main grid of KSA according this report is shown in the table below.

Table 5-16 Generation Plan of the Main Grid of KSA (Unit: MW)

	EOA	COA	WOA	SOA	Total
GT	1375	9628	2706	3198	16907
ST	4800	-	2800	1500	9100
Total	6175	9628	5506	4698	26007

(Source: Updated Generation Planning for the Saudi Electricity Sector, Center for Engineering Research, Mar 2006)

5.2.6 Effects of Demand Side Energy Conservation on Power Supply System

Demand-side energy conservation can reduce the power supply cost. If the benefits brought by the power consumption with energy conservation are the same as without energy conservation, the effects of demand-side energy conservation are estimated by the amount of reduction in the power supply cost.

The power supply cost can be categorized into fixed cost and variable cost. Fixed cost is the cost of power system facilities installed corresponding to the maximum power demand. Variable cost is the cost, such as fuel cost or O&M cost, changed in proportion to the amount of energy.

The effects of energy conservation on the demand side are different between the short-term and the long-term because short-term energy conservation achievements are not reflected by power facilities. However, they can be reflected in the long term.

In the short-term, demand-side energy conservation does not change power system facilities, however variable cost is reduced. In this case, the reduction in power output of generators with the most expensive fuel cost would reduce the power supply cost. On the other hand, the energy conservation of the demand side can reduce the fixed cost of power facilities through the revision of power system planning, as well as the variable cost of generation.

Cost reduction evaluation of the power supply side, achieved by the demand side energy conservation, is studied by using the following assumptions.

- Desalination plants and IPP are used for base generation. The plan and the operation of those power plants are not under the control of SEC and not effected by the energy conservation of the demand side. Thus, the effects of demand-side energy conservation can be achieved through the cost reduction of SEC power facilities and operation.
- The unit prices of future power plants are set out as fixed costs of power plants according to the “Updated Generation Planning for the Saudi Electricity Sector, ECRA/Center for Engineering Research, Mar. 2006”. The capital cost per 1 MW of peak demand is calculated from the increase of peak demand in the main grid from 2008 to 2023 and the capital cost of generation and main interconnection facilities estimated from 2009 to 2023 in the main grid. The depreciation is calculated on the condition that the discount rate is 5% and the lifetime of facilities is set out 30 years.
- The fixed cost of transmission lines, distribution lines, and other fixed costs are estimated from

the ratio of depreciation in 2005.

- The fuel cost is estimated from the correlation between the ratio of the demand to the peak demand and the fuel cost calculated from the Merit Order Table.
- The short-term range where energy conservation does not have an effect on the fixed cost of power system is assumed to be around 5 years. In this term, demand-side energy conservation can reduce power output of the generators with the most expensive fuel costs.
- For the long-term, the plans of power plants can be adequately revised in correspondence with the demand pattern of energy conservation. The effects are represented by the fixed cost and the reduction in the fuel cost with the energy conservation is represented by the averaged fuel cost at each level of power demand.
- O&M cost is assumed to be in proportion to the power demand. The unit cost is set at 40.1 SR/MWh, as described in operating expenses of SEC in 2005.

The effects of the demand side energy conservation per MWh on supply side costs are summarized in the table below. The effects are different according to the amount of power demand. The amount of power demand is represented by the ratio to peak demand in a year.

Table 5-17 Effects of Demand Side Energy Conservation on Supply Side Cost

Ratio (Demand/Peak Demand in a Year	**Short-term effect (Coming 5 years)**	**Long-term effect （After 5 years）**	
	Variable Cost	Variable Cost	Fixed Cost
	SR/MWh	SR/MWh	1,000 SR/MW/year
100%	99	75	525
90%	85	72	
80%	80	71	
70%	77	70	
60%	74	68	
50%	70	67	
40%	67	66	
30%	66	65	
20%	65	65	

Assuming peak demand can be reduced by energy conservation in a long period, it is said that 525 thousand SR/MW of the fixed cost can be saved.

5.3 Structure of Electricity Consumption

5.3.1 Sector-wise Electricity Consumption

(1) Number of Customers

As shown in the following table, SEC has 9 customer categories, while the tariff system has 5 types.

Table 5-18 Category of Customer and Tariff Type

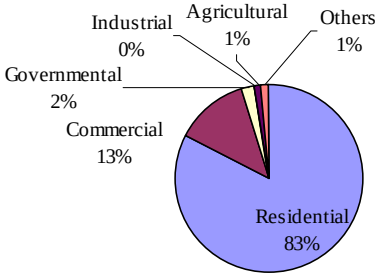
Category of Customer	Tariff Type
Residential	Residential
Commercial	Commercial
Governmental	Governmental
Streets	Governmental
Mosques	Governmental
Hospitals	Governmental
Charity Association	Agricultural
Industrial	Industrial
Agricultural	Agricultural

* Private enmities such as private hospitals, private schools, etc apply for the tariff of Industrial.
* Private mosques are categorized into Agricultural.

The number of customers by category is shown below. The Residential sector occupies more than 80 % of all the customer contracts.

Table 5-19 Number of Customers

	2002	2003	2004	2005	2006
Residential	3,340,417	3,511,431	3,700,161	3,897,916	4,083,830
Commercial	497,271	534,274	577,797	606,708	641,092
Governmental	85,744	88,231	91,188	95,462	100,358
Streets	14,956	15,795	16,930	17,844	18,853
Mosques	36,708	38,649	41,095	41,418	43,110
Hopsitals	3,305	3,356	3,462	5,296	5,955
Charit. Associat.	1,863	2,198	2,505	1,970	1,882
Industrial	6,180	5,943	6,791	6,154	6,273
Agricultural	42,875	47,021	51,788	51,787	54,553
Total	4,029,319	4,246,898	4,491,717	4,724,555	4,955,906



(Source: Electricity 2006, MOWE)

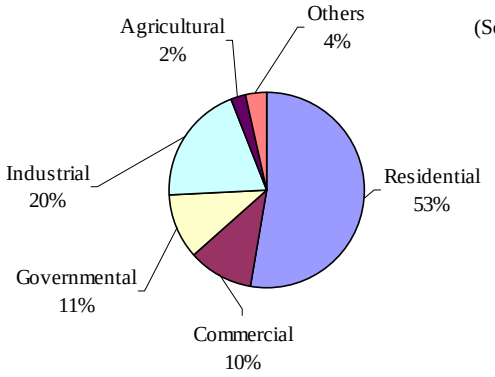
Figure 5-17 Share of Customers in 2006

(2) Sold Consumption by Category

Next table shows the amount of sold consumption by category. The Residential sector occupies 53 % of all consumption. Industrial, Government, and Commercial are followed by Residential.

Table 5-20 Sold Consumption by Category (Unit: GWh)

	2002	2003	2004	2005	2006
Residential	65,460	70,373	73,364	78,304	86,028
Commercial	11,112	14,315	14,301	15,580	17,073
Governmental	15,330	16,131	16,772	16,675	18,004
Streets	1,537	1,821	1,693	1,675	1,688
Mosques	1,213	1,348	1,380	1,480	1,677
Hopsitals	1,857	1,984	1,799	2,462	2,604
Charit. Associat.	161	173	178	142	145
Industrial	29,319	33,383	33,059	33,801	32,548
Agricultural	2,640	2,666	2,920	3,164	3,380
Total	128,629	142,194	145,466	153,283	163,147



(Source: Electricity 2006, MOWE)

Figure 5-18 Share of Sold Consumption in 2006

(3) Consumption per Customer by Category

The following table shows the average consumption per customer by category. Consumption in the Industrial sector is huge compared to other categories.

Table 5-21 Consumption per Customer by Category (Unit: kWh/customer)

	2002	2003	2004	2005	2006
Residential	19,596	20,041	19,827	20,089	21,066
Commercial	22,346	26,793	24,751	25,680	26,631
Governmental	178,788	182,827	183,928	174,677	179,398
Streets	102,768	115,290	100,000	93,869	89,535
Mosques	33,045	34,878	33,581	35,733	38,900
Hopsitals	561,876	591,180	519,642	464,879	437,280
Charit. Associat.	86,420	78,708	71,058	72,081	77,046
Industrial	4,744,175	5,617,197	4,868,061	5,492,525	5,188,586
Agricultural	61,574	56,698	56,384	61,096	61,958
Average	31,923	33,482	32,385	32,444	32,920

(Source: Electricity 2006, MOWE)

5.4 Tariff System

5.4.1 Regulatory Body

Electricity tariffs are determined by the Council of Ministers based on recommendations from ECRA.

5.4.2 Current Tariff System

(1) Tariff Structure

The current tariff came in to effect on October 28, 2000 under the Council of Ministers Decision No. 170. (October 9, 2000). The tariff is comprised of 3 structures, namely: (i) Electricity Tariff (that is a bill based on monthly electricity consumption), (ii) Meter Reading and Maintenance and Bill Preparation Tariff (that is a bill based on meter breaker capacity) and (iii) Electricity Service Connection Tariff (that is an initial connection service fee). The cost of the (i) and (ii) is taken on the monthly basis. However, the cost of (iii) is taken at one time when the meter is installed. The calculation sample is as follows:

Electricity Bill = Monthly Electricity Consumption (kWh) x Rate of Each Bracket of (i)
+ Meter Breaker Capacity (Amps) x Rate of Each Capacity of (ii)
(+ Electricity Service Connection Tariff of (iii))

(2) Current Tariff

The current tariff (as of 2007) is as follows.

Table 5-22 Electricity Tariff (Unit: Halala/kWh)

Consumption Brackets kWh/Month	Residential	Commercial	Governmental	Industrial	Agricultural
0-1,000	5	5	5	12	5
1,001-2,000	5	5	5	12	5
2,001-3,000	10	10	10	12	10
3,001-4,000	10	10	10	12	10
4,001-5,000	12	12	12	12	10
5,001-6,000	12	12	12	12	12
6,001-7,000	15	15	15	12	12
7,001-8,000	20	20	20	12	12
8,001-9,000	22	22	22	12	12
9,001-10,000	24	24	24	12	12
Over 10,000	26	26	26	12	12

Table 5-23 Meter Reading and Maintenance and Bill Preparation Tariff

Monthly Tariff (SR)	Meter Breaker (Amps)
10	60
15	100
21	200
22	300
25	400
30	Over 400

Table 5-24 Electricity Service Connection Tariff

Connection Tariff (SR)	Meter Breaker (Amps)
1,380	60
3,800	100
11,400	200
18,800	300
26,600	400
26,600+250 x (Additional kVA)	Over 400

(Source: Electricity 2006, MOWE)

*100Halala = 1SR

1SR is almost equial to 0.27USD.

(3) Distribution of Annual Sold Energy and Number of Customers

The following graph shows the distribution of annual sold energy and number of customers by monthly consumption. It indicated that the following two groups are large customers: (i) customers of over 10,000 GWh per month are assumed to be large factories and buildings and (ii) customers of less than 4,000 GWh that are assumed to be residential customers.

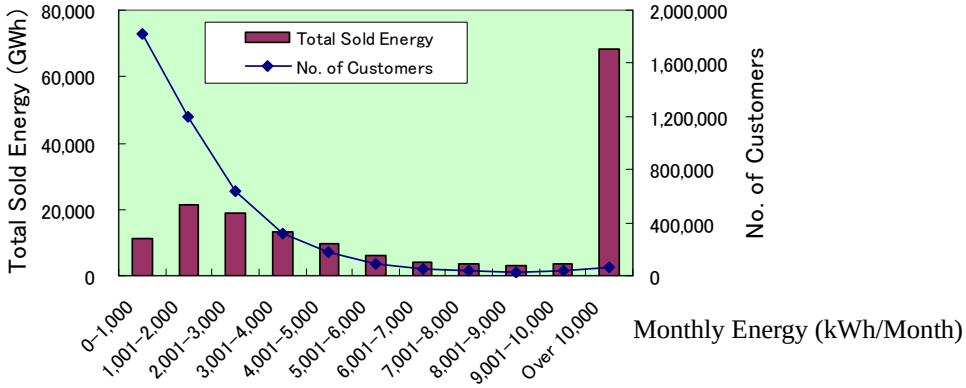


Figure 5-19 Distribution of Annual Sold Energy and Number of Customers (2006)

Chapter 6 Current Situation of Energy Conservation in KSA

6.1 Current Basic Principle in Electricity Sector

6.1.1 Existing Principle

(1) Principle from the EDP

The basic principle of the electricity sector is described in “Chapter 28 Electricity” of the Eighth Development Plan (EDP). According to the EDP, the following objectives are articulated. Energy conservation is also one of the objectives of the EDP.

- Providing electricity service at an adequate technical level to the population and economic facilities.
- Providing electricity service at minimum economic, social, and environmental costs.
- Continuing to encourage the conservation of energy and rationalization of electricity consumption.

(2) Principle from the Council of Ministers Decree

The third part of the Council of Ministers Decree No. 169 (November 30, 1998) also included energy conservation in the SEC of as follows:

> *“The Saudi Electricity Company, in collaboration with universities, institutes and specialized centers, shall formulate a sustained, comprehensive program for electric energy conservation in order to achieve the Government's objectives. The Ministry of Industry and Electricity shall collaborate with the Ministry of Information to develop a public awareness plan to explain the program highlights/milestones. The plan shall emphasize conservation issues and the importance of conservation”.*

6.1.2 National Energy Efficiency Program (NEEP)

(1) General

NEEP was a program designed to assist the energy sector in the KSA to meet rapidly growing power and energy demand by introducing an efficient means of utilization and rational consumption patterns, while protecting the local environment and providing a sustainable alternative to increasing generation, transmission, and distribution capacity.

NEEP includes several aspects such as:

- Supporting energy auditing in the industrial and commercial sectors
- Utility load management
- Setting policies and regulations for residential buildings and the efficiency of energy-consuming appliances
- Improving the exchange of information on energy efficiency
- Promoting private sector investments in energy services
- Encouraging utilization of efficient technologies

NEEP started in March 2003 and successfully ended in 2008. NEEP has been implemented by KACST in collaboration with SEC, ARAMCO, Saudi Arabian Basic Industries Corporation (SABIC), MOWE, Ministry of Petroleum and Mineral Resources (MOPMR), Saudi Arabian Standards Organization (SASO), ECRA, Ministry of Minucipal and Rural Affairs (MOMRA), and the United Nations Development Program (UNDP).

(2) Strategy

According to the implementation plan report prepared by UNDP, NEEP projects have been designed and implemented in accordance with the following strategy.

1. *The technical programs are based on the local needs in the country and for the benefit of the energy producers and consumers. They are/will be designed taking into consideration the existing and evolving relationships between all actors in the energy sector and the reform and restructuring that is taking place.*
2. *Phased implementation: the project has been designed in two main phases with step-by-step approach so that by completing one step the accrued gains could be realized and disseminated, and so forth. Measurable goals and targets to be set at the beginning and distinct outputs will allow close monitoring of the progress and objective evaluation of the results.*
3. *Application of proven technologies: NEEP will utilize technologies and practices that have been successfully applied and demonstrated in other parts of the world under similar conditions as those in KSA.*
4. *Training of local experts and officials.*
5. *Active involvement and coordination among relevant institutions: the project is designed to involve all stakeholders in setting up the national energy efficiency strategy through the 'Energy Efficiency Council", to utilize the skills in many institutions, avoid duplication of efforts, and encourage better coordination of activities. This will facilitate a strong embedding of energy efficiency policy in the policies of relevant Ministries/agencies.*
6. *Well-defined implementation plans: pre-set and detailed work plans together with good communication among all parties will permit efficient monitoring and tracking and provide flexibility in dealing with unforeseen obstacles or delays.*
7. *Links with international/regional projects and institutions: extensive experience can be gained in Saudi Arabia when links are established with other energy efficiency projects and activities.*

(3) Expected Outcomes at the End of the NEEP

According to the UNDP report, the following outcomes were expected.

- ✓ An enhanced institutional infrastructure for improving energy efficiency as an important strategic energy policy objective to affect a widespread uptake of more efficient techniques and technologies.
- ✓ Active and sustained processes and programs to enhance energy efficiency in industrial, Government, commercial, and residential sectors (the transport sector will be tackled in Phase II).
- ✓ An increased awareness at the national level and conviction of the tangible benefits of managing energy usage and maintaining a high level of efficiency.
- ✓ Involvement of the private sector (banks, consultants, equipment manufacturers, suppliers, importers, etc.) in stimulating the market for energy efficiency as regards specialist skills, access to finance and supply of technologies. Start up of energy service companies will be an indicator of private sector participation.
- ✓ Energy efficiency labels and standards for air conditioners, electric motors and lighting.
- ✓ Energy efficiency codes for new residential buildings.
- ✓ An "Energy Efficiency Information & Awareness Center" that promotes energy and load management to reduce per capita consumption of electricity and other energy sources and to reduce the peak power demand.
- ✓ Ongoing policy development, regulation and project implementation aimed at further improved energy efficiency consistent with national development objectives.
- ✓ A cadre of professionals both in Government and supporting institutions capable of mapping out further assessments, initiatives, policies, and action plans to foster energy efficiency.
- ✓ A set of linkages between Saudi and international institutions will be established through the assistance of UN/DESA and UNDP. These linkages will promote and perpetuate an energy efficiency policy dialogue and action after the project is completed.

6.1.3 Study of World Bank for Energy Conservation

(1) General

World Bank (WB) has also assisted with the establishment of the "National Energy Conservation Strategy" of KSA. The study covers:

- ✓ Grasping the current situation, including energy demand and supply and the status of energy conservation
- ✓ Identifying barriers to energy conservation
- ✓ Drafting energy conservation strategy
- ✓ Developing the concept for a permanent energy conservation institution, "Saudi Energy Efficiency Center"
- ✓ Development of a legal framework concept

(2) Proposed Policy in the WB Study

In the WB report, a specific policy is identified among workshop participants as follows.

> *"Ensure reliable power supply and improve efficiency in key end-use consuming sectors by scaling up a combination of energy conservation programs sufficient to reduce peak demand growth by 50% within 5 years"*

In other words, the numerical target above represents an 850 MW peak demand reduction in comparison with the forecasted 1,700 MW increase per year within 5 years.

The report mentioned that the target above can be achieved by focusing on two electricity consuming sectors which together account for 3/4 of total electricity sales and perhaps even a larger fraction of summer time peak demand, household air conditioning, and commercial and government buildings.

According to the WB report, to realize the target, the following strategies were also proposed by MOWE's advisors.

Table 6-1 Strategy Proposed by MOWE's Advisors

Strategy	Contents
Retrofit Performance Improvement for Household and Small Enterprise Air Conditioner	Development of an air conditioning goods network and services providers catering to the household and small business sectors
Development of Improved Air Conditioner for Hot and Dry Conditions	Research on air conditioner operating under extremely hot and dry weather conditions, and development and commercialization of improved efficiency air conditioner
Government Buildings	Introduction of ESCO for government buildings
Commercial Buildings	Implementation of a building code and incentive program for load management (seasonal and TOU tariff)

(Source: Draft Report of National Energy Conservation Strategy, WB)

6.2 Current Energy Conservation Measures

6.2.1 NEEP Measures

(1) Programs

In accordance with the strategies of NEEP, 8 objectives have been started since 2003 as follows.

Table 6-2 Purpose of Each Objective in NEEP

Objective Name	Purpose	Executing Agency
Objective 1 Energy Audit Services and Industry Support	To facilitate the reduction in electricity demand through a 3.5-year program to foster continued growth of Saudi Arabia's energy services industry by removing key barriers to customer awareness, business transformation, and capital financing that currently impair the energy efficiency industry.	KACST
Objective 2 Energy Efficiency Information and Awareness	To facilitate the achievement of a total reduction in energy demand through a three-year program to promote increased awareness of and strategic action on energy efficiency issues, both within SEC, and among energy service industry providers, equipment manufacturers, other energy industry professionals, and energy users.	KACST and SEC
Objective 3 Load Management and TOU Tariff	To develop, seek approval for, and notify a time-of-use tariff (TOU) schedule/structure for large industrial customers. The tariff will encourage load shifting from peak to off peak periods.	SEC and MOWE
Objective 4 Efficient Utilization of Oil and Gas	To develop a high efficiency boiler/furnace and steam system through energy audit, advertisement and campaign.	KACST
Objective 5 Promotion of Energy Service Industry	To encourage the formation of ESCOs and provide project experience to the newly formed ESCOs, demonstrate the concepts and use of project development tools, and begin the process of improving the efficiency in industrial, government, and commercial facilities.	KACST
Objective 6 Energy Efficiency Labels & Standards For New Equipment	To develop energy efficiency standards and labeling for three classes of major energy-consuming equipment, that will be fully supported by the government, and implemented prior to the end of the project.	SASO
Objective 7 Energy Efficient Design and Construction for New Buildings	To develop and apply a voluntary professional code of practice for energy efficient design in newly-constructed residential buildings, to be later adopted as a mandatory standard. (Voluntary implementation should commence by 2005. A plan will be developed for enforcement of a mandatory standard by 2007 or 2008. Energy use in new residential buildings covered by the code will be reduced by an estimated 20 %. Phase II of the project will cover the code for commercial buildings.)	SASO
Objective 8 Technical And Management Training	To generate broad understanding and development of institutional capability in the various disciplines of energy efficiency policies, measures and technologies in order to be able to formulate, design and implement energy savings projects.	KACST

(Source: NEEP Website)

(2) Project Implementation

KACST assigns a full-time National Project Director (NPD) who holds the overall responsibility for execution of the project. The NPD was selected based upon technical expertise, knowledge of national policy-making procedures, familiarity with energy efficiency issues, and the ability to

work well with institutions involved in the project.

NEEP is organized into 6 work groups, namely (i) Auditing & Industry Support, (ii) Load Management, (iii) Standards & Labels, (iv) Building Code, (v) Market Support, and (vi) Training. Those work groups are composed of technical staff from one or more of the participating organizations.

The NPD is supervised by a steering committee that is responsible for reviewing the overall project status and progress. The committee consists of members from all participating organizations including KACST, MOPMR, MOWE, SEC, ECRA, ARAMCO, SABIC, and UNDP.

(3) Progress of Each Objective

As of September 2007, the progress of each objective of NEEP is summarized as follow.

Table 6-3 Progress of NEEP (1)

Program	Expected Output	Progress
Objective 1 Energy Audit Services and Industry Support	40 "Quick Savings Program" in the industrial, commercial and Government sectors	**Done** Simple audit services were provided to such customers.
	15 energy audits performed at the facilities of medium and large-scale customers in the industrial sector and another 15 audits in the commercial sector	**Done** Detailed audit services were provided to medium and large consumers for industry and commercial sector.
	A reduction of custom duties on approximately three major classes of industrial, commercial, and residential energy efficient equipment	**Done** A study for reduction of custom duties was made.
	CFL Lease Program (Leasing from SEC to customers)	**Done** A study for leasing scheme for CFL and air conditioner among SEC, retail shops and customers was done. It is expected to start the scheme by SEC.
Objective 2 Energy Efficiency Information and Awareness	Information management and dissemination for energy services industry (collection of energy data of industry, potential of energy conservation and load management technology, etc.)	**Under implementing** Database is under developing.
	Information management and dissemination for Energy End-Users (establishment of information and dissemination network)	**Under implementing** Network such as website is under developing.
	Establishment of national and regional information center	**Not yet** It is now making a concept of SEEC by WB study.
Objective 3 Load Management and TOU Tariff	Procurement of TOU meters and establishment of procedure	**Done** As a pilot project, SEC has already introduced the TOU option for large industries and buildings. As of 2007, total 70 customers apply for the TOU option.
	Definition of peak and off-peak period	
	Financial analysis to determine effect on the long run marginal cost of generation	
	Establishment of Time of Day tariff for industrial sector	
	Usage of TOU meters by SEC industrial customers	
Objective 4 Efficient Utilization of Oil and Gas	Boiler/Furnace Efficiency Program (development of a boiler/furnace energy audit, training, campaign, and implementation)	**Done** Foreign consultants conducted survey for factories of ARAMCO, SABIC, etc. and gave training programs to ARAMCO, SABIC, etc.
	Steam Systems Efficiency Program (development of steam system energy audit, training, campaign, and implementation)	
Objective 5 Promotion of Energy Service Industry	Business Advisory Services (provision of seminar, meeting arrangement with ESCOs, etc.)	**Done** Two workshops were held.

Table 6-4 Progress of NEEP (2)

Program	Expected Output	Progress
Objective 6 Energy Efficiency Labels & Standards For New Equipment	Establishment of target classes of equipment	**Under implementing** Drafting Energy Efficiency Labels and Standards System have been completed in terms of technical matter (such as test method, standard, etc.). However, administration matters such as implementation, dissemination, market research are now studying.
	Formation of well-qualified teams of experts assigned to develop standards	
	Proposal of minimum technical specifications for energy efficiency standards and/or a related quality mark system	
	Planning strategy and recommendation to ensure local manufacturers will be able to produce or assemble equipment that complies with efficiency standards	
	Establishment of testing and certification methods and facilities for equipment subject to standards	
	Government adoption of cost-effective energy efficiency labels and standard and implementation plan	
	Promotional plan for equipment that exceeds the minimum energy efficiency standards	
Objective 7 Energy Efficient Design and Construction for New Buildings	Development of voluntary code of practice for energy efficiency in the design and construction of new buildings	**Done** Draft building code has already been prepared. Now it is under approval stage.
	Implementation of training materials and technical tools to assist building designers, builders, and building permit officials to apply the energy code	
	Awareness promotion of the voluntary code of practice to increase adoption by designers, owners, and builders	
	Planning of implementation, compliance and enforcement for a mandatory code	
Objective 8 Technical And Management Training	Preparation for training courses and seminars	**Done** Some external consultants provided training courses to ARMCO, SABIC, as well as general people.
	Completion and evaluation of training courses, seminars/workshops and study tours	**Under implementing** An evaluation study is now under implementing. It expects to be completed by December 2007.

(4) Barriers Identified

Through implementation of the above objectives, the following barriers have been identified.

- ✓ For energy audit and making database, there were barriers that some customers do not have engineers who have enough capacity, or are reluctant to provide data.
- ✓ For custom duties, almost import products levy 5 % duty at present. It was found that custom duties are not so high incentive even if the duty is reduced.
- ✓ For ESCO business, tariff change might be a risk for a guarantee contract of ESCO project.

6.2.2 MOWE Measures

(1) Tasks of MOWE

In accordance with the Implementation Regulation of MOWE, MOWE shall prepare and supervise the following items. These items are mainly implemented by the Conservation and Awareness Department.

- Introduction of alternative energy conservation choices
- Creating incentives for customers and electricity industry licensed
- Ensuring high efficiency equipment and appliances
- Awareness program

- Reporting of achievements, barriers, and solutions to the Minister

(2) Implemented Programs

The following is a list of programs launched by the Conservation and Awareness Department since 2001, when the MOWE was established.

Table 6-5 Implemented Programs

Item	Contents
Various Leaflet 	Leaflet 1: Bright ideas for energy conservation ➢ Switch off any electric machine that you do not use anymore, and remember saving energy is important. ➢ Paint your wall with bright colors, which will limit the need for lighting. ➢ Use energy efficient bulbs and electrical appliances. ➢ Take advantage of natural lighting as much as possible Leaflet 2: By switching-off, you save money. ➢ Energy conservation does not require difficult procedures. ➢ Switch off the air conditioning and lights when leaving. ➢ Switch off unnecessary heaters and electrical appliances. ➢ Switch off unnecessary lighting in the daytime. Take advantage of natural lighting. ➢ Switch off any appliance after using it. Leaflet 3: Saving electricity reduces your monthly bill. Following the instructions below will help reduce your monthly invoice for electricity consumption by at least 30 % - 40 %: ➢ Periodically clean the air conditioner filter and set it at a suitable temperature. Place the outside unit of air conditioner is a shaded spot. ➢ Use energy efficient light bulbs and appliances. ➢ Add insulation to walls and ceilings. Use curtains and glass heat reflectors. ➢ Replace electric stoves with gas stoves.
Instruction Booklet 	User's Guide for Rationalization of Electricity and Load Displacement 1. Methods of rationalization of electric consumption 1.1 Air conditioner 1.2 Thermal insulation in building 1.3 Lighting 1.4 Other devices 1.5 Building design 2. Methods of Load Shifting 2.1 Thermal storage 2.2 Electric devices usage away of peak times 3. Deductions and General Instructions
Campaign	Advertisement of energy conservation through TV, Radio, Newspaper, etc.

(3) Programs to be Operated in 2007

Energy conservation programs conducted by the Conservation and Awareness Department in 2007 are summarized as follows. All of them are continuous programs from the previous year.

Mass Media Energy Conservation Campaign

This is an advertisement campaign using mass media, such as TV, radio, newspaper, and so on. Advertisements are used to raise energy conservation awareness amongst the citizens. A budget of 30 million SR was set aside for this effort.

Educational Textbooks to Students

This educational program is aimed at secondary school students. MOWE develops and distributes

an energy education textbook to students. MOWE together with SEC and KACST teaches the subject of energy using the textbook for teachers as well as students.

Instruction Booklet and Small Booklet Distribution

This is another awareness improvement program. MOWE has printed and distributed such booklets through local SEC offices.

Reduction of Street Lighting

MOWE is assisting with the conservation of energy related to street lighting in cooperation with MOMRA, an operation and maintenance body for street lighting within cities. MOWE promotes the lighting of every other street lamp on the street.

Study for Energy Conservation in the Industrial Sector and for Buildings

MOWE implements studies on how to set a target for energy efficient lamps and how to implement energy conservation in the residential sector.

6.2.3 SEC Measures

(1) Task of SEC

SEC is one of the most important key players in energy conservation. SEC corporate missions are committed to providing reliable electricity. Therefore, SEC has promoted both energy conservation and peak demand management. However, due to the current shortage of power, SEC now gives priority to peak shift or peak cut measures.

Especially during 2007, SEC plans to shift 800 MW (200 MW in the central region and 600 MW in the eastern region where big factories exist), targeting big consumers to meet generation capacity.

(2) SEC Programs

(a) Time of Use (TOU) Tariff for Industrial and Commercial Sectors

Since 2006, as a NEEP pilot project, SEC adopted a TOU tariff targeting large consumers (electricity consumption: over 50,000 kWh/month) from the industrial and commercial sectors. For this pilot project, SEC prepares TOU option tariffs and new meters to count peak and off-peak time electricity for customers who wish to try using TOU tariffs.

Customers can choose either a TOU tariff or normal tariff after calculation of the monthly electricity bill and select the cheaper one.

A comparison table of the current TOU tariff (as of 2007) and the normal tariff is shown below. The TOU tariff is applied weekdays 13:00 to 17:00 from June to September.

Table 6-6 TOU Tariff (Unit: Halala /kWh)

	Industrial		Commercial	
	TOU	**Normal**	**TOU**	**Normal**
Peak Time (13:00-17:00)	35	12	76	26
Off Peak Time (17:00-next 13:00)	9	12	19	26

In 2006, 45 customers used the TOU tariff. Out of 45, 32 customers benefited from the TOU tariff. Such customers make an effort to shift their demand during the peak time by not only adoption of the thermal storage system, but also shifting their work or operation pattern.

In 2007, there were 25 additional TOU applicants. That means a total of 70 consumers are using the TOU tariff in the central region. In addition, as of 2007, 20 companies began using the TOU tariff in the eastern region.

(b) Thermal Storage System Promotion

SEC also promotes the introduction of thermal storage systems which can shift day time electricity (peak time) to night time electricity (off-peak time). However, currently there is no subsidy for the introduction of thermal storage systems. SEC simply distributes information regarding the systems as a promotional activity.

According to SEC, 9 large consumers have thermal storage systems. Their total peak shift capacity is 20 MW. The largest one (4 MW peak shift capacity) is owned by the Al Faisaliyah Center. However, it has not joined the TOU project yet.

(c) Use of Stand-by Generators for the Industrial and Commercial Sectors

In coordination with the Chamber of Commerce, SEC conducts negotiations with large consumers who have stand-by generators, and asks them to use their generators for emergency purposes only. This is a voluntary agreement and the consumers are asked to honor their promise. SEC is ready to compensate for the fuel cost based on consumers' request.

(d) Remote Control Air Conditioning

The compressors of air-conditioning systems in 90 governmental and commercial facilities in Riyadh can be stopped remotely by the SEC. When necessary, the SEC is capable of remotely controlling 80 MW of capacity from June to September between the hours of 1 PM and 5 PM. Notification letters are sent one week ahead on a rotational basis or phone calls are made in urgent situations.

(e) Education

The SEC and MOWE run a program that visits secondary/high schools or colleges with gifts and teaches the students about energy conservation and ask the Ministry of Education to include this topic in their curriculum.

(f) Instruction Booklet

Instruction booklets are printed jointly with MOWE.

(g) Museum

A museum does not presently exist, but SEC is considering one in the future.

(h) Campaign

MOWE and SEC have a plan for a national campaign.

6.2.4 KACST Measures

(1) Task of KACST in Energy Conservation

The Institute of Energy Research under KACST plays to the role of transfer and develop energy-related technology appropriate to the needs and requirements of KSA. In particular, the Energy Management Center conducts research and studies in the rational use of electrical energy for adapting and implementing related technologies on the supply and demand sides. Tasks of the center include the following fields: electrical energy conservation, load management, building energy technology, and power system technology.

(2) Programs

KACST positively cooperates with NEEP as mentioned in 6.2.1. Other than NEEP, the following projects are conducted by the Energy Management Center of KACST.

- Power factor improvement for large consumers.
- Performance of thermal insulation in different climatic conditions of Saudi Arabia.
- Power quality of the utility grid.
- Shading study and trace on energy consumption guidance in the AL-Riyadh buildings.

6.2.5 Measures by Saudi Arabian Standards Organization (SASO)

(1) SASO Overview

Saudi Arabian Standards Organization (SASO), which is the governmental standardization body in the KSA, was established in 1987, It has about 600 employees. Other than the HQ in Riyadh, there are two branches in Dammam and Jeddah.

SASO is entrusted with all activities relating to standards and measurements which include the following:

- Formulation and approval of national standards for all commodities and products as well as standards concerned with metrology, calibration, marking, and identification of commodities and products, methods of sampling, inspection, and testing.
- Publishing Saudi standards by the most proper means.
- Promoting standardization awareness through publicity and other means and coordinating all

activities related to standards and measurements in the Kingdom.

- Rule-setting for granting certificates of conformity and quality mark, and regulating their issuance and use

(2) Tasks of SASO in Energy Conservation

Concerning energy conservation, SASO is involved in labeling and the creation of system standards for household appliances, as well as energy conservation oriented building codes. The Electrical and Electronics Department and the Construction and Building Department are in charge of standardizing household appliances for the labeling and standardization system and the building code respectively.

SASO also joins the NEEP to assist with the standardization of those two 2 programs.

(3) Energy Efficiency Labels and Standards

(a) Concept

In KSA, the labeling and standard system called Energy Efficiency Labels and Standards (EELS) affixes information labels (as shown in the figure) to manufactured products and describes a product's energy performance (usually in the form of energy use, efficiency, or energy cost) to provide consumers with the data necessary for making informed purchases. The standards outline procedures and regulations concerning the energy performance of manufactured products, sometimes prohibiting the sale of products that are less energy efficient than the minimum standard.

Figure 6-1 Sample Labeling Sheet

(b) History of Study

Phase 1 of EELS study began in 1998 in KSA. During Phase 1, only air conditioners were targeted. From the beginning, a label with the Minimum Energy Performance Standard (MEPS) was regulated. However, it is said that enforcement is not very effective and that energy conservation is not a priority when consumers make decisions.

Phase 2 of EELS study began in 2003 at the same time as NEEP. As of September 2007, publication of the entire EELS plan is in preparation as a result of Phase 2. Targets will be enlarged to include 4 appliances, namely air conditioners, washing machines, refrigerators, and freezers. The classes of air conditioners covered by the system will also be enlarged.

The outline of EELS study is summarized as follows.

Table 6-7 Summary of the EELS Study

	Phase 1	Phase 2
Start Year of Study	1998	2003 (by NEEP)
Target Appliances	Air conditioners	Air conditioners, Washing machines, Refrigerators, and Freezers
Minimum Standard	Air conditioners: EER=6.6 (COP=1.9)	Air conditioners: EER=6.0 (COP=1.8) Others: Under preparation for publication
Key Performance Label Data	Air conditioners: EER	Air conditioners: EER Washing machines: kWh/time Refrigerator and Freezers: kWh/day

(c) Testing Method

Testing methods for EELS are proposed by the SASO Standards Committee and finalized through public comment. Although those testing methods are specified in the regulations made by the SASO, there are no certified laboratories in KSA. Under the system currently proposed, manufacturers/importers must conduct certification tests on their products at internationally qualified laboratories at their own cost.

(d) Implementation

SASO is the sole body responsible for standardizing test and performance indicators in KSA. In addition, SASO is expected to be responsible for the implementation and monitoring of EELS.

After finalization of the EELS proposal, SASO will primarily conduct pilot implementation of EELS on a voluntary basis. Then mandatory implementation, especially for air conditioners will be carried out. Awareness raising campaigns for consumers will also carry out at the same time.

For implementation of EELS, the following procedures are now in the planning process.

Application from Manufactures/Importers

1. General product information
2. Testing results; and/or
3. Energy performance results in accordance with the SASO standards.
    1) Submission of the report to SASO;
    2) Registration on a special database to raise consumer awareness.

(e) Issues and Recommendation

The following issues were raised by SASO.

- The new system is ready to begin, but the KSA lacks implementation and enforcement bodies. Even though SASO is expected to act as the responsible implementing body, SASO has little experience on the implementation side since it was originally a standardization body. For example, the mechanism for enforcing labeling in shops, which costs money, has yet to be solidified.

- Another challenge is how to raise public awareness regarding EELS.

The JICA Study Team also proposed the following initial recommendations:

- Who will be responsible for affixing the label sheet, manufactures/importers, or retail shops? If it is the former, might the label be put on every product, even on the same products? However, it might be easier to implement if a consensus regarding the cost can be reached by manufactures/importers.
- If it is the latter, retail shops should be allowed to only place labels on exhibited products. This results in a reduction of label sheet costs. In this case, a consensus from retail shops is needed. To bring about a consensus of retail shops and for effective implementation, the government (or SASO) should prepare a database that is easily accessible for labeled data and sheet printing. In Japan, retail shops can easily access data via a website and print the designated label from their computer. If such a database with an easily accessible system were developed, retail shops will be more cooperative concerning EELS.
- For development of the database, a legal basis is necessary for the enforcement of testing and for sending data to SASO. As for retail shops, enforcement might be considered (in Japan, retail shops are encouraged to indicate the performance of designated household appliances according to the energy conservation law, but it is carried out on a voluntary basis.)
- Inspection without prior announcement is an effective means of enforcing the labeling system in retail shops.

6.2.6 Measures by Ministry of Municipality and Rural Affairs (MOMRA)

(1) Overview of MOMRA

No local government exists in KSA, therefore Ministry of Municipality and Rural Affairs (MOMRA) local offices provide local administration services such as road maintenance, garbage treatment, lighting, building/housing affairs, etc.

(2) Tasks of MOMRA in Energy Conservation

As the central body for governing regulations over citizens and society, MOMRA is responsible for implementing wide range of regulations, which include regulations related to energy conservation. Building insulation rules have been developed as a part of these requirements.

MOMRA and SASO developed original insulation regulation and enshrined in 1985. Six months later, the regulation was enforced to stipulate selected insulation materials. In 1988, requesting letter of thorough regulation enforcement to governmental, commercial and high-rise buildings was sent to local offices. MOMRA announced not to accept construction plan without insulation material. However, insulation could not be widely acknowledged at that time. In 1993, new regulation was introduced, which is the basis of the current 2002 version. The regulation became

mandatory in 1997.

Regarding energy conservation, other existing regulations or requirements governed by MOMRA as below:

- "Technical specifications and requirements for street lighting, roads and squares"
- "Building record form"
- "Engineering checking manual for residential and commercial buildings"
- "Guide for sustainable development in planning",
- "Building permit application form"
- "Requirements for municipal housing units".

(3) Saudi Building Code (SBC)

The Saudi Building Code National Committee (SBCNC) was assembled from related governmental organizations, and a representative of MOMRA serves as the chairman of this committee. The final draft has been prepared and is awaiting approval. After the approval, MOMRA will be responsible for implementing the code.

SBC is a modification of the International Building Code (IBC) developed by the International Code Council (ICC), a US-based organization, to fit local conditions. One whole chapter is dedicated to Energy Conservation, together with chapters on architectural, structural, electrical, mechanical, sanitary and fire protection chapters.

Requirements outlined in the energy conservation chapter establish minimum perspective and performance-related regulations for the design of energy-efficient buildings for public assembly, educational, business, mercantile, institutional storage, and residential occupancies, as well as part of factories that apply to those fields. Existing buildings and installations are exempted from the code, but added or renovated parts should comply.

The chapter is divided into two parts. One is the requirement for residential buildings and the other is those for commercial buildings. Mid-to-high-rise apartments are designated commercial buildings.

Residential buildings should comply with assessment thorough either by Systems Approach or Components Approach. The System Approach is a total energy consumption analysis procedure for buildings utilizing renewable energy sources. Simulation results by the System Approach should prove more energy efficient than the "standard design" as a result of calculation through Components Approach.

The Components Approach defines the minimum performance value and requirements for the 'Building Envelope' (building enclosure) and mechanical systems, such as heating, ventilation, air-conditioning, water heating, electrical power, and lighting.

Commercial building requirements are a Components Approach, but with more detailed criteria, and the total energy performance should be made and specific factors should be reported.

6.3 Challenges and Future Steps

6.3.1 Challenges

Through a survey of the current situation, several challenges were identified by the WB study, as well as the JICA study, as follows.

Table 6-8 Challenges Identified

Category	Challenges	Identified by
Technology and Skills	Lack of energy efficiency technologies suited to Saudi needs and operating conditions	WB Study
	Lack of technological information and an available database.	JICA Study
Organization	Lack of a central institution to develop, adopt and implement a national energy efficiency strategy	WB Study
	Lack of a skilled cadre of energy efficiency managers, engineers and technicians	
	Lack of delivery, distribution, and after-sales service networks for appliances and equipment	
	Lack of a mandatory framework for energy management of large consumers and providing equipment to the market.	JICA Study
Finance	Tariffed energy prices below SEC's average costs for most consumers	WB Study
	Environmental costs and carbon benefits are not reflected in energy tariffs	
	Lack of incentives which trigger the replacement of inefficient equipment with energy efficient equipment or promote energy conservation services (ESCO, energy audit, maintenance improvement, etc.).	JICA Study
Awareness Level	Lack of awareness of the benefits of energy efficiency	WB Study
	Market survey difficulty, especially in the residential sector.	JICA Study

6.3.2 Future Steps

In order to tackle the challenges above, the following direction is proposed as the basic principle for energy conservation in the KSA.

Technology and Skills

- ✓ Promotion of energy efficient technology and peak shifting technology suited to Saudi needs and operating conditions.
- ✓ Formulation of a database for an energy conservation project, equipment, and practices.

Organization

- ✓ Development of a central institution to implement and monitor energy conservation measures.
- ✓ Development of a training scheme.
- ✓ Assistance with after sales activities.
- ✓ Development of a mandatory scheme for crucial measures.

Finance

- ✓ Development of an incentive scheme.

- ✓ Assistance with energy conservation services.

Awareness

- ✓ Further development of education to propagate an energy conscious society.
- ✓ Development of effective survey methods.

Chapter 7 Current Situation of Energy Conservation by Sector

7.1 Industrial Sector

7.1.1 Basic Information

(1) Definition of Industrial Sector in Tariff

In the SEC tariff, the industrial tariff is applied for some types of customer category, industry, private hospital, private clinic, private institution or school.

(2) KSA Large Companies

The top 20 Saudi Arabian enterprises and the amount of annual sales are represented as follows.

Table 7-1 Top 20 Enterprises in KSA 3.75 SR= $ 1

Ranking	Name of enterprise	Amount of Sales (SR)	Category of Business
1	SAUDI ARABIAN OIL CO.	152,000,000,000	Oil refinery
2	KINGDOM HOLDING CO.	35,600,000,000	Multiple farming
3	SAUDI BASIC INDUSTRIES CORP.	34,000,000,000	Petrochemical
4	DALLAH ALBARAKA GROUP	17,374,000,000	Multiple farming
5	SAUDI ELECTRICITY CO.	15,929,577,000	Electricity supply
6	ABDULLATIF JAMEEL CO., LTD.	12,375,000,000	Multiple farming
7	SAUDI ARABIAN AIRLINES	11,761,265,000	Aviation
8	SAUDI ARAMCO MOBIL REFINERY CO., LTD.	11,508,655,000	Petrochemical
9	THE NATIONAL COMMERCIAL BANK	5,478,052,000	Finance / Insurance
10	RIYADH BANK	4,970,696,000	Finance / Insurance
11	ALRAJHI COMMERCIAL FOREIGN EXCHANGE	4,600,000,000	Finance / Insurance
12	YUSUF BIN AHMED KANOO GROUP OF COMPANIES	4,390,000,000	Multiple farming, Marine transportation
13	THE SAVOLA GROUP	4,099,400,000	Farm and marine products processing
14	SAMBA FINANCIAL GROUP	3,143,416,000	Finance / Insurance
15	BAKRI TRADING CO., LTD.	3,000,000,000	Trading
16	THE SAUDI BRITISH BANK	2,604,773,000	Finance / Insurance
17	AL FAISALIAH GROUP	2,500,000,000	Multiple farming
18	AL FADL GROUP OF COMPANIES	2,000,000,000	Construction
19	ARAB NATIONAL BANK	1,718,406,000	Finance / Insurance
20	ALJOMAIH HOLDING CO.	1,600,000,000	Multiple farming

(Source: Top 1000 Saudi Companies 7th Edition, 2003-2004 by IIT (International Information and Trading Services Co.)

Saudi Arabian Oil Company (ARAMCO) is stupendously big, with sales of more than 4 times that of the second ranking enterprise. Most of the top 20 enterprises are in the field of finance/insurance, oil related businesses, and multiple farming. In addition, most of them are one of the national enterprises and plutocratic groups that are related with the king's family.

The top 100 companies were summarized by sector and are listed in the next table. The Manufacturing sector is the largest, with 31 companies. The Distribution/Service sector follows. However, from the viewpoint of total sales, the electricity/oil/petrochemical sector and the finance/insurance sector are dominating. Average sales per enterprise equal US$ 5,900 million in the electricity/oil/petrochemical sector and US$ 2,930 million in the finance/insurance sector. On the other hand, the average sales per enterprise in the manufacturing sector equal only US$ 230 million, then lowest in the table. This shows that manufacturing enterprises in the KSA is smaller than other sectors.

Table 7-2 Summary of Top 100 Saudi Arabian Companies by Sector in 2005

	No. of Enterprise	Amount of Sales (mil. US$)	Benefit (mil. US$)	Capital (mil. US$)	No. of employee
Manufacturing	31	7,235	1,237	5,859	32,236
Distribution/Service	23	13,086	2,878	5,859	43,334
Finance/Insurance	13	27,128	4,609	33,064	19,013
Construction/Engineering	12	7,522	266	1,894	115,850
Agricultural Products/ Food Processing	8	3,553	273	1,154	26,038
Multiple Farming	8	6,778	83	1,060	74,595
Electricity/Oil/Petrochemical	5	29,317	4,199	16,983	32,399
Total	100	94,620	13,545	65,871	343,465

(Source: http://www2.pf-x.net/~informant/saudi/sauditop100-2005.htm)

From the viewpoint of sales, oil refinery and petrochemical industries are prominent. ARAMCO is the biggest Saudi Arabian enterprise, and it has some joint ventures. The center of the petrochemical industry is Saudi Arabia Basic Industries Corporation (SABIC), which operates many plants in the eastern and western industrial areas. SABIC makes big profit through the influence of cheap raw material, energy, and land.

(3) National Enterprises

Since the beginning of industrialization in the KSA, the Saudi government has prioritized industrialization and development of the petroleum sector. The size and significance of ARAMCO is directly related to this policy.

After the petroleum industry, the second most significant industry is the petrochemical industry. SABIC established 100 % if its own affiliate companies in addition to joint ventures with foreign countries. The petrochemical sector holds a special position and has been fostered by governmental support.

The remaining sectors, the electricity supply, potable water supply, and other backbone industries, were also established as national enterprises.

(a) Saudi Arabian Oil Company (ARAMCO)

ARAMCO is a pillar of the national economy and contributes significantly to the increase in GDP, generation of public revenue, and increased exports. The company is considered a vital center for spreading advanced operation and management systems, and has vast links to the outside world due to the substantial size of its oil production and exports.

A brief profile of each domestic refinery is included below.

* ***Ras Tanura Refinery:***

The Refinery went on stream in 1360 (1941) with a capacity of 30,000 BPD of crude oil, while the production capacity currently stands at 325,000 BPD in addition to 200 thousand barrels of condensates.

**** Jeddah Refinery:***

This refinery went on stream in 1388 (1968), with a production capacity of 12,000 BPD of crude oil. It underwent several expansion processes to boost production to its current capacity of 84,000 BPD.

**** Riyadh Refinery:***

Production commenced in 1394 (1974) with a capacity of 15,000 BPD. The refinery has undergone several expansion works, thereby bringing the production capacity to 122,000 BPD. The refinery obtains its crude oil feedstock from the East-West Pipeline.

**** Yanbu Refinery:***

Production started in 1403 (1983). Its current production capacity is 235,000 BPD.

**** Rabigh Refinery:***

The refinery went on stream in 1410 (1989) as a joint-venture. The foreign partner's 50% share was acquired in 1416 (1995). Its current production capacity is 370,000 BPD.

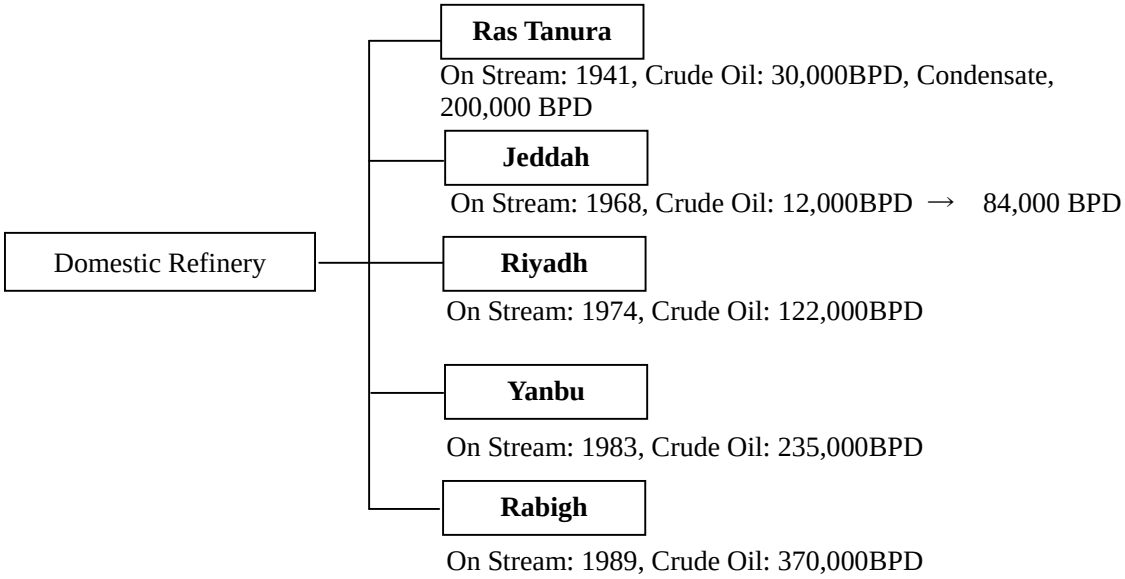


Figure 7-1 Domestic Joint Venture Refineries of ARAMCO

(b) Saudi Arabian Basic Industries Corporation (SABIC)

SABIC was established in 1976 with a paid up capital of SR 10 billion, which later increased to SR 15 billion, of which 70 % is owned by the Saudi government and 30 % by Saudi and GCC countries' citizens. SABIC's capital has been raised, as it currently stands at SR 25 billion.

By the end of 2005, SABIC had 16 world-class industrial companies in Jubail and Yanbu, most of which are joint ventures with international companies such as Shell, Exxon/ Mobil, Mitsubishi Chemicals etc., with actual production of about 46.7 million metric tons of basic chemicals, intermediate chemicals, fertilizers, metals, and polymers.

Total manpower employed by SABIC and its subsidiary companies by the end of 2005 reached over 16 thousand of which Saudi nationals account for 85 %.

In the domain of industrial and marketing cooperation, particularly with GCC countries, SABIC has a 20 % share in the Bahrain Aluminum Company (ALBA) and has 31.3 % share in the Gulf Aluminum Rolling Mill Company (GARMCO).

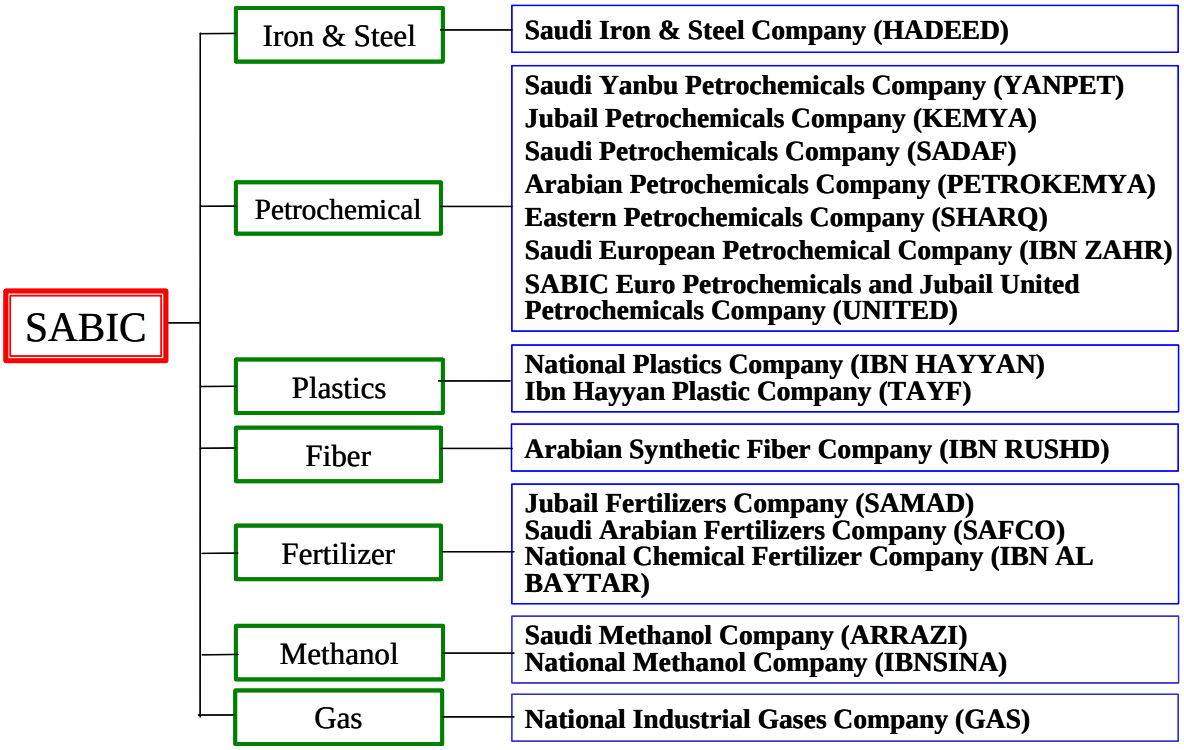
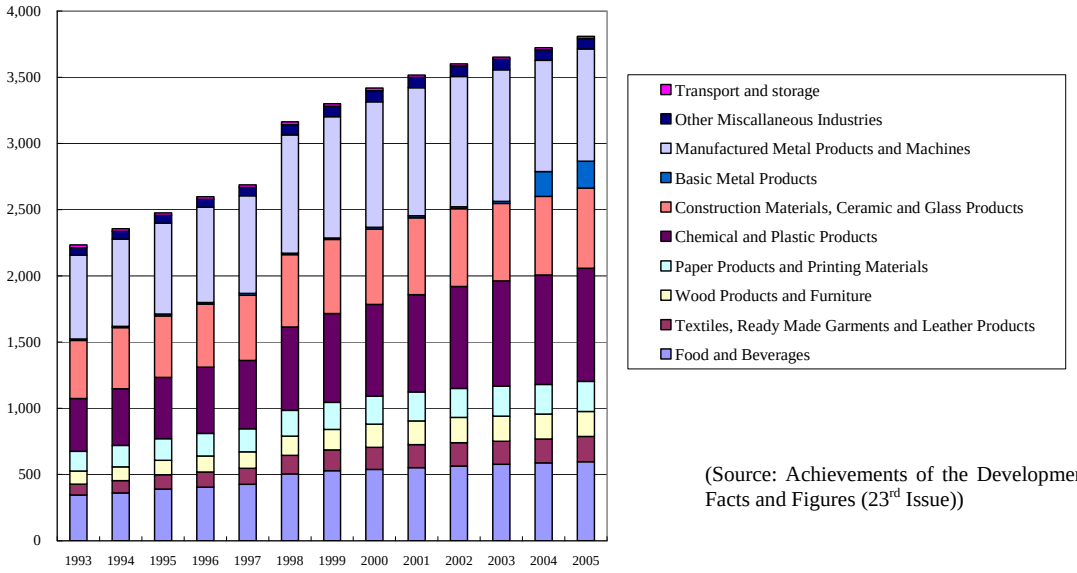


Figure 7-2 SABIC Group Subsidiary Companies

(4) Private Manufacturing Enterprises

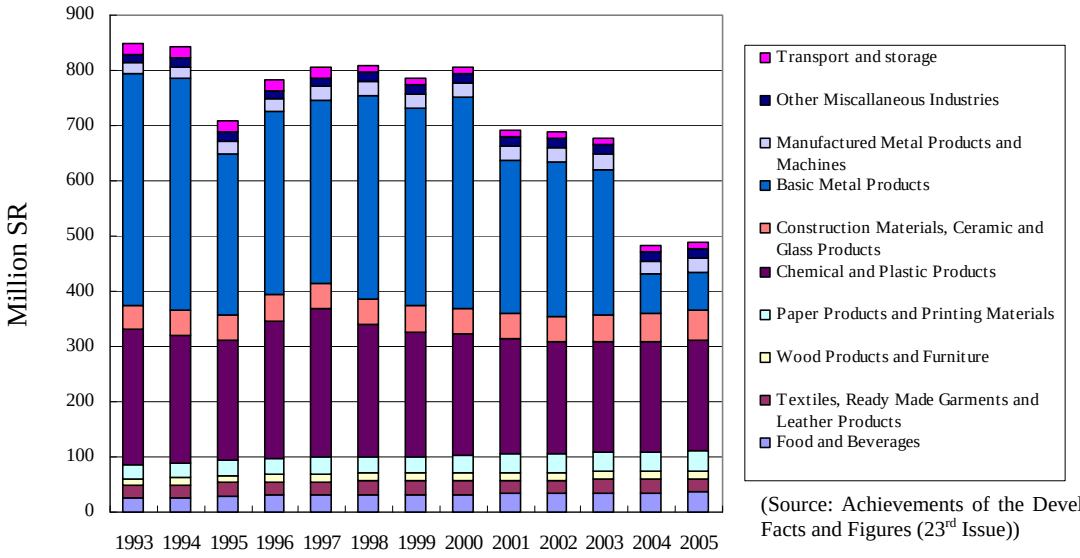
The Saudi Arabian Government has been trying to multi-lateralization the economy through industrialization of the non-petroleum private sector. This policy is expected to lead to greater employment opportunity. Development of the non-petroleum sector has been slow, but steady. The following figure shows the increase in the number of private enterprises operating in the KSA.



(Source: Achievements of the Development Plans Facts and Figures (23rd Issue))

Figure 7-3 Trend in the Number of Manufacturing Enterprises

The next figure shows that the average capital of each enterprise in the manufacturing sector is decreasing. This means that entry of new, small enterprises is increasing. Especially capital of the basic metal production sub-sector significantly shrinks. However, the average capital of other sub-sectors does not change significantly. An increase of small basic metal product companies causes the decrease of accumulated average capital.



(Source: Achievements of the Development Plans Facts and Figures (23rd Issue))

Figure 7-4 Trend of Average Capital of Each Enterprise in the Manufacturing Sector

7.1.2 Site Visit Survey Results

The JICA Study Team visited several enterprises during this study period. The objective is to comprehend the basic outline of each industry in energy use and energy conservation and to grasp potential for energy conservation.

(1) National Enterprises

(a) Site Visit

The JICA Study Team visited several representative national enterprises shown in the table below. Each of these national enterprises is a leading company, especially in regards to energy conservation activities. The JICA Study Team selected three big and effective enterprises from all of the organizations in the KSA.

Table 7-3 Outline of National Enterprises Visited

No.	Name	Product	Location	Characteristics
1	Saudi Arabian Oil Company (ARAMCO)	Oil refinery	Dhahran	Top oil refinery in the world
2	Saudi Iron and Steel Company (HADEED) ［SABIC］	Iron and Steel	Al-Jubail	Top iron and steel manufacturer in the Middle East
3	Saline Water Conversion Corporation, Al-Khobar plant	Sweet water and electricity	Al-Khobar	Sweet water supplier to all KSA

(b) Energy Conservation Activities Conducted

Three national enterprises visited are renowned, not only in the KSA, but worldwide. They have a high awareness of energy conservation and how to implement energy conservation activities. They also have sufficient energy conservation information, skilled technicians, the necessary tools, company organization, and a budget.

Of these three enterprises, ARAMCO is implementing the most effective energy conservation activities. The activities are as follows:

ARAMCO's Energy Conservation Activities:

1) Energy Conservation Policy Statement

- Policy statement is issued by the President and CEO of the company. Therefore energy conservation activity is acknowledged on a company-wide basis.
- ARAMCO is committed to the efficient production and use of energy.
- Company's vision: To be internationally recognized as a world leader in the efficient use of energy in hydrocarbon production processes and operations.
- ARAMCO established an Energy Management Steering Committee that is responsible for the Energy Conservation Program.

2) Energy Conservation Strategy

- To develop energy management programs for improving energy efficiency.
- To optimize facility design and operation through deployment of the best practices and leading-edge technologies.
- To promote energy conservation awareness.
- To introduce energy accountability to all levels of the organization.
- To develop in-house technical capabilities.
- To support the national effort through NEEP.

3) Current Energy Conservation Activities

- Conducting Detailed Energy Assessments (DEAs)
- Quick Energy Audits for industrial & non-industrial facilities.
- Identifying and introducing energy conservation technologies.
- Introducing energy standards, procedures, and best practices.
- Developing Energy Performance Indices (EPIs) for all ARAMCO operating facilities.
- Gathering/Reporting corporate annual energy performance and presenting results to the management.
- Organizing energy conservation campaign.
- Publishing a quarterly newsletter dealing with energy conservation issues.
- Organizing yearly, two-day energy conservation forums.

4) Future Plan

- To develop Corporate Energy Conservation Award (CECA).
- Continue to identify and implement more projects to ensure meeting the 2010 targets.

5) Best Practice

- It is important to institutionalize energy conservation activities.
- 16 teams, one from every refinery, including a joint venture compete in Best Practices (BP), exchange ideas with each other and the BPs are reported to the Refinery plant manager.
- The final results are entered into a Database and effectively utilized as RTSD (Refinery Technology Support System) on the network.
- Driving forces of energy conservation are:
  - High cost (energy cost accounts for 40-60 % of operation expenses (OPEX));
  - Savings of 15-30 % could be achieved;
  - ARAMCO has the company-wide target of decreasing energy cost index by 50% from 2000 by 2010; and
  - Always conscious of the worldwide benchmark: Refining Solomon Energy Intensity Index (EII).

(c) Status of Energy Conservation Implementation

Implementation of energy conservation and the circumstances at the enterprises visited were evaluated by the JICA Study Team as shown in the following tables.

Evaluation items are as follows:

- Implementation of energy conservation activities
- Leadership by top management
- Existence of energy conservation organization: Implementation organization established in the plants
- Power data collection: Electric power data is colleted by each enterprise in order to comprehend power use and analyzed to discover problematic energy issues.
- Power management: Systematic energy conservation management is implemented.
- Use of outside consultant: Accept advice from outside consultants such as ESCO's
- Energy conservation education for employees: Implement energy conservation education program for employees
- Awareness movement: Movement to raise awareness regarding implementation of energy conservation within the firm and/or the greater society as a whole

Table 7-4 Implementation Status of Energy Conservation (1)

No.	Name	Implementation of EC activities	Leadership by top management	Existence of EC organization	Power data collection
1	Saudi Arabian Oil Company (ARAMCO)	**Yes**	**Yes**	**Yes**	**Yes**
2	Saudi Iron & Steel Co. (HADEED) [SABIC]	**Yes**	**Yes**	**Yes**	**Yes**
3	Saline Water Conversion Corporation (SWCC)	**Yes**	**No**	**Yes**	**Yes**

Table 7-5 Implementation Status of Energy Conservation (2)

No.	Name	Power Management	Use of outside consultant	EC education for employees	Awareness movement
1	Saudi Arabian Oil Company (ARAMCO)	**Yes**	**Yes**	**Yes**	**Yes**
2	Saudi Iron & Steel Co. (HADEED) [SABIC]	**Yes**	**Yes**	**Yes**	**Yes**
3	Saline Water Conversion Corporation (SWCC)	**Yes**	―	**Yes**	**Yes**

(d) Recommendation

Over the years, large national enterprises have accumulated energy conservation knowledge and experience. Using the know-how accumulated thus far, large national enterprises are expected to be leaders in the implementation of energy conservation. For example, they are expected to engage in various energy conservation -related activities, including, energy conservation dissemination, education, energy audit consultation, publication and dissemination of energy conservation brochures, and assistance for energy conservation organization establishment.

(2) Private Manufacturing Enterprises

(a) Site Visit

The JICA Study Team picked up seven typical manufacturing sectors. Representative enterprises in each industrial sector were selected. Most of the selected enterprises are the top manufacturers in their respective sector or are amongst the top group of their sector. An outline of the selected enterprises is shown in the table below. All of these enterprises are private and representatives their sectors.

Table 7-6 Outline of Private Manufacturing Enterprises Visited

No.	Name	Product	Location	Characteristics
1	Saudi Lighting Company	Electric appliances	Riyadh	Top light fixture manufacturer in the KSA.
2	Yamama Saudi Cement Co.	Cement	Riyadh	One of the top cement manufacturers in the KSA.
3	Al Safi Danone	Dairy products	Riyadh	Top dairy manufacturer in the Middle East.
4	Al-Sharq Plastic Company	Plastic products	Riyadh	Plastic injection and blow molding, and inflation
5	Saudi Carpet Factory	Carpet	Riyadh	Top carpet manufacturer in the KSA.
6	Unicharm Gulf Hygienic Industries Ltd	Paper diaper	Riyadh	Joint venture between the KSA and Japan
7	Zamil Air Conditioners	Air conditioner	Damman	Top air conditioner manufacturer in Middle East.

(b) Energy Conservation Activities Conducted by External Consultants

Several private manufacturing enterprises implemented energy conservation activities based on advice from outside consultants. An outline of their implemented energy conservation measures is explained below.

Al-Sharq Plastic Industries Company (SPI)

At the request of SPI, a consulting company at the request by conducted energy analysis of the Factory. The company measured active power, reactive power, apparent power, and the power factor of installed transformers.

Saudi Carpet Factory (SCF)

In 2006 March, a consulting company named Marwan A. El-Ajou Est. conducted energy analysis on the factory at the request of SCF.

- Annual kWh (AKWH) consumed was estimated using average kVA, kW, and a diversity factor of 0.85 based on 24-hour operation and 365 working days per year. The consultant recommended that SCF introduce a power factor improvement system, with the following benefits:
  - Complete protection against possible surges and transients;
  - Reduced heat loss in motors and cables;
  - Extended equipment life;
  - Reduced maintenance cost and downtime; and
  - Indirect savings as a result of improvement mentioned above.
- With an investment of 52,000-60,000 SR/transformer, SCF started to install energy saving systems, which included the following estimated benefits:
  - Power factor average increase from 0.80 up to 0.97;
  - Expected savings of 6 %; and
  - Estimated 3 year payback period based on the industrial power tariff; i.e. 12 halala/kWh.
- Actual results were:
  - Power factor improvement to 0.97 from 0.76–0.77;
  - 7 % reduction in electricity consumption;
  - Stabilization of the electric power supply system; and
  - A 1-year actual payout time.

Zamil Air Conditioners (ZAC)

Energy conservation measures proposed by external consultants

- ZAC used “ZESCO” as an external consultant. ZESCO recommended 15 measures for energy conservation measures. A conservation rate of 14 % is expected as a result of implementation of these 15 measures.

A successful practical example on an autonomous basis without external consultant’s advice is also introduced as follows.

Saudi Lighting Company (SLC)

SLC introduced automatic Power Factor Controllers (PFCs) in 2004. (2 units in the manufacturing line; and 1 unit in the laboratory.) Harmonic distortion was reduced below the allowable limit. Balance control of 3 phases of transformer is well done. By introducing PFCs,

power factor was improved from 0.85 to 0.99 at best. Energy saving is estimated at 0.5 million SR/year that accounts for 6 % of the total energy cost. Although the number of equipment was increased, electricity consumption was reduced.

(c) Implementation Status of Energy Conservation

Implementation of energy conservation and the circumstances at the enterprises visited were evaluated by the Study Team as shown in the following tables. Visited private manufacturing enterprises are interested in implementing energy conservation activities at their own companies, but lack sufficient information, skills, tools, organization, and budget. Consequently, they are not able to fulfill several energy conservation measures.

Table 7-7 Implementation Status of Energy Conservation (1)

No.	Name	Implementation of EC activities	Leadership by top management	Existence of EC organization	Power data collection
1	Saudi Lighting Company	**Yes**	**No**	**No**	SEC meter
2	Yamama Saudi Cement Co.	**Yes**	**—**	**No**	—
3	Al Safi Danone	**Yes**	**Yes**	**No**	Own meter
4	Al-Sharq Plastic Company	**Yes**	**No**	**No**	SEC meter
5	Saudi Carpet Factory	**Yes**	**No**	**No**	SEC meter
6	Unicharm Gulf Hygienic Industries Ltd	**No**	**No**	**No**	SEC meter
7	Zamil Air Conditioners	**Yes**	**No**	**No**	Own meter

Table 7-8 Implementation Status of Energy Conservation (2)

No.	Name	Power Management	Use of outside consultant	EC education for employees	Awareness movement
1	Saudi Lighting Company	**No**	**No**	**Yes**	**No**
2	Yamama Saudi Cement Co.	**—**	**—**	**—**	**—**
3	Al Safi Danone	**No**	**No**	**Yes**	**Yes**
4	Al-Sharq Plastic Company	**No**	**Yes**	**No**	**No**
5	Saudi Carpet Factory	**No**	**Yes**	**No**	**No**
6	Unicharm Gulf Hygienic Industries Ltd	**No**	**No**	**No**	**No**
7	Zamil Air Conditioners	**Yes**	**Yes**	**Yes**	**Yes**

(d) Recommendation

Collecting energy consumption data continuously is indispensable for executing electricity conservation activity. Installation of power measuring equipment, measurement, and data analysis are important steps. Such activities provide useful information on how to improve power consumption at the plant. Most private enterprises do not possess equipment for measuring the use of electric power however, they can use meter data printed on the bill provided by the SEC.

This data is useful for evaluating the company's energy conservation activities and the results can be obtained immediately. New ideas for improving energy consumption will be born by sharing energy information among all factory workers. Power data collection and analysis is the first step toward the implementation of energy conservation activities.

(3) Summary

The JICA Study Team visited 10 typical enterprises in KSA and studied their energy conservation status. Their present situation and expected direction are summarized as below.

Table 7-9 Summary of Energy Conservation Status of National Enterprises

Company	Energy Conservation Activities		Next Step Recommended
	Present Activities	Evaluation	
Saudi Arabian Oil Company (ARAMCO)	EC is the core theme of factories and implemented successfully	Excellent	• Model and leader of energy conservation in all sectors.
Saudi Iron & Steel Co. (HADEED) [SABIC]			• Model and leader of energy conservation in the Industrial Sector.
Saline Water Conversion Corporation			• Model of energy conservation in the Industrial Sector.

Table 7-10 Summary of Energy Conservation Status of Private Manufacturing Enterprises

Company	Energy Conservation Activities		Next Step Recommended
	Present Activities	Evaluation	
Saudi Lighting Company	•Power factor control •Periodic check of SEC bill	Good	•Employment of Consultant
Yamama Saudi Cement Co.	•Dependence on own generators	Not disclosed	•Benchmark analysis •Transfer of Japanese technologies
Al Safi Danone	•Modern facilities •Employees well trained in energy conservation implementation measures.	Very Good	•Application of thermal storage for peak shift
Al-Sharq Plastic Co.	•Power factor analysis by consultant •Active maintenance manager for energy conservation	Good	•Energy conservation of each machine
Saudi Carpet Factory	•Energy audit by consultant •Power factor improvement	Good	•Conducts power data collection on its own.
Unicharm Gulf Hygienic	•Comparison with Parent Company •Planning data collection for energy conservation	Good	•Energy conservation activities based on Japanese experience (know-how)
Zamil Air Conditioners	• Implementation of proposed various measures for energy conservation by ESCO	Very Good	•Continuous power monitoring for evaluating energy conservation measures.

7.1.3 Challenges and Future Steps

(1) Challenges

Manufacturing industries in the KSA are in the initial stage of development. In the future, the number and scale of enterprises in KSA is expected to increase. Important challenges are included in quality management, productivity, environmental protection. In addition, accumulation of experience is necessary.

(2) Future Steps

Based on the plant visit, it is evident that plant workers are aware of quality management and productivity and understand the importance of environmental protection and energy conservation. The next step is to establish a scheme to attain these targets through daily activities. In particular, daily power management is very useful for energy conservation.

7.2 Commercial Sector

7.2.1 Basic Information

(1) Definition of Commercial Sector in Tariff

In the SEC tariff, the commercial tariff is applied for only commercial customer.

(2) Typology of Commercial Buildings

Commercial buildings in Riyadh can be classified according to size, use and nature shown as below.

(a) Large Complex Facility

Monumental buildings like Kingdom Tower or Al Faisaliyah Center have diverse functions such as offices, hotels, shopping malls, or parking lots inside. It is as though the facility itself is a town. Since people can stroll around the air-conditioned space, they are filled with many visitors. In particular, these two towers were built with advanced technology and are said to be equipped with devices such as thermal storage tanks.

Figure 7-5 Large Complex Facility

There were notices advertising the new development of other large complexes. Those complexes attract much attention and are the main field of activity in Riyadh today.

(b) Shopping Malls

Several shopping malls exist in the large complex mentioned above. Possessing trendy shops and restaurants found in other countries, these malls have a large amount of space that visitors can enjoy strolling through. During certain hours of the day, men are prohibited from entering, this is known as family hour. Due to the large and spacious interior, the use of a glass façade, and a large amount of store lighting, these facilities are without a doubt large consumers of energy.

Figure 7-6 Shopping Mall

Many of these facilities are new and attract many visitors. There is a high probability that this type of facility will continue to increase in the central area of Riyadh.

(c) Supermarkets

Supermarket chains such as Tamimi or Carrefour have number of stores throughout the city. They are placed along major roads and basically one story buildings with a large parking area. Specialty stores, such as large electric appliance stores, are also in this category.

Figure 7-7 Supermarkets

(d) Other Shops

This picture shows that many small shops exist in older buildings as well. On some streets, small shops stand continuously along the perimeter of the street. Cars are parked on the road in front of these shops. Most of them are 2 stories building and each neighborhood tends to have the same type of store.

Figure 7-8 Small Shops

(e) Hotels

Major hotels include international brands such as Sheraton, Marriott, Four Seasons, etc. The facilities are like ordinary hotels with a lobby, guest rooms, restaurants, party rooms, sports gym, etc.

Figure 7-9 Hotel

(f) Office Buildings

Tenant office buildings exist, such as the JETRO office in this picture. However, it is difficult to distinguish between an office district and typical office buildings, as mentioned before. As in the case of MOWE, it seems to happen often that offices reside in not necessarily proper office type buildings.

Figure 7-10 Office Building

(g) Private Hospitals

Other than governmental hospitals, private hospitals exist and are growing in number.

7.2.2 Site Visit Survey Results

(1) Site Visit

The JICA Study Team visited several commercial entities below.

- Sheraton Riyadh Hotel
- MOWE Building (it is categorized as a commercial building)
- Al Khozama Hotel

(2) Site Survey Summary

(a) Sheraton Riyadh Hotel

(i) General Profile

The hotel opened in 1984 as one of first major hotels in the city. It has 186 guest rooms and villas (condominiums) with such facilities as party rooms, restaurants and a sports gym. Guest rooms were renovated 5 years ago. The site area is 220,000 m2.

(ii) Building Equipment

This hotel uses central chillers as its heat source. Five air-cooling chillers of 250 RT capacity are placed outside on the roof. Four of them are in operation and one is for backup. They are Trane France manufactured and have been operating since the facility opened. Guest rooms are air conditioned with fan coil units in the ceiling. For the party rooms there are 11 Air Handling Units (AHU). Villas use separate package air conditioners. 13,800V receiving electricity is transformed into 220 and other voltages by hotel-owned transformers. They possess an emergency diesel generator, but it is only used in case of emergency for limited appliances. Electricity is the energy source used for all purposes, including water heating, with the exception of cooking, for which LPG is used.

(iii) Facility Management and Operation

Under the Director of Engineering, 18 internal staff members in the maintenance department carry out facility management of all equipment, except elevators. Machines and mechanical rooms are well kept and maintained. They keep the record of electricity load daily and monthly.

(iv) Energy Conservation Activities Conducted

High efficiency lamps were introduced at the time of renovation. Although present measures are restricted to careful manual management, such as an internal energy conservation guidebook, confirmation that lights are switched off, and appropriate setting of the cooling water temperature (8 to 10 degrees), the director has a large interest in improving their energy efficiency through additional investment. Since energy costs comprise a large part of their expenditure (4.3 % of their revenue is used for electricity and water). Air conditioning uses 60 % of their electricity load. The

lifetime of the present chillers will end soon. Therefore, they are considering the introduction of BEMS in order to optimize energy use. Also, thermal storage system can limit their chiller numbers and is a possible measure if beneficial tariff system is instituted.

(v) Recommendation

Management of Sheraton hotels is well organized and the staff is energy conscious. They also possess an eagerness to learn more about energy conservation and new technology. This type of customer often seeks measures from the government such as a tariff system, subsidy, or training courses.

At the same time, they can become an initiative force in the commercial sector for the development of such measures by approaching the government. However, commercial sector businesses are competing with each other, especially the hotel sector.

To tackle this barrier, an award system to encourage disclosure of top runner practices and information, is recommended. However, regardless of whether an award system is adopted, they may not disclose all data and information. Even when such cases arise, an award system seems to become a trigger to encourage the disclosure of information that enlightens other customers.

(b) MOWE Building

(i) General Profile

The building was originally built as a complex of shopping malls and apartments with underground parking 10 years ago (judging from air conditioners manufacturing date). Now MOWE occupies three floors of what used to be in large part the shopping arcade. Part of the building is still occupied by shops. Apartments occupy the top four floors of the building. Total floor area of the base is approximately 11,500 m2.

(ii) Building Equipment

Since the building was designed to hold many tenants, air conditioning, water supply, and electricity systems are all divided according to the tenants. In general, central systems do not exist. There are 180 outdoor units of air conditioners on the roof and from these cooled air is supplied to each tenant zone. Watt-hour meters are also as many as the number of tenants and governed by SEC. They are placed in several electrical rooms on backside of the building. Air conditioners are US Trane machines of 3 to 12 RT capacity with no heating function. There are no total heat exchangers. Air conditioners for the common space (halls) of the building are not functioning. Air leaking from office rooms cools the halls.

CFL lamps have been introduced in the MOWE office area. Other parts use ordinary fluorescent or incandescent lighting.

There are elevators, escalators, ventilation fans for parking, smoke exhaust fans, and pumps.

(iii) Facility Management and Operation

The equipment of MOWE office area is managed by an outside company. Their duties consist of

simple maintenance jobs such as, cleaning filters once a year, fixing and checking if the lights and air conditioners are turned off.

Users start, stop, and set the air conditioner temperature. From November to February, they are rarely used because its wintertime.

(iv) Energy Conservation Activities Conducted

Since the MOWE uses the building, several measures were carried out, such as changing lamps to high efficiency ones, or putting up posters regarding energy conservation. However, from the standpoint of building management, this hardly qualifies as a basis for energy conservation

The maintenance staff members do not possess building equipment document and monitoring of electricity use has not been conducted. This is partly because meters are under the control of the SEC. Incentives for the maintenance staff members seem to be needed to be aware energy conservation efforts.

(v) Recommendation

MOWE is the organization responsible for initiating energy conservation. They should practice energy conservation activities aggressively. Since the building is owned by a private company, it is difficult for the MOWE to renovate equipment. However, the MOWE can practice energy conservation through the following operational methods:

- Gradually increasing the temperature setting of air conditioners (0.5 degrees at first, and if there are no complaints, move it up to 1.0 degree for the next stage, etc.) and distribution of handy fans for cooling support.
- Turning off the lights during prayer time in the workrooms.
- Assign staff members to each workroom to turn off lighting during prayer time.
- Monitoring MOWE electricity bills and consumption

(c) Al Khozama Hotel

Al Khozama Hotel is one part of the King Faisaliyah Complex. It consists of several hotels, shopping centers, a sport center, a mosque, etc. The Study Team collected information from the Al Khozama Management Company (AKMC) that conducts maintenance work on 3 facilities in the complex, namely the Al Faisaliyah Hotel, Al Khozama Hotel, and Al Khozama Center.

(i) General Profile

The entire structure of the King Faisaliya Complex is outlined below.

King Faisaliya Complex	-Al Khairia Complex	-King Faisal Foundation (KFF: Charity Association)
		-Al Khozama Hotel
		-Al Khozama Center
		-Al Khairia Apartment
	-Al Faisaliyah Center	-Al Faisaliyah Tower
		-Al Faisaliyah Shopping Mall
		-Al Faisaliyah Hotel

All facilities are owned by KFF. KFF entrusts operation of the facilities mentioned above to the AKMC.

Operation of the hotels is under the direction of the Rosewood group. Part of the commercial income goes to KFF and is used for their charity activity.

(ii) Electricity Supply for the Complex

There is only one SEC electric power meter for the entire complex. From this, each facility separately receives electricity and transforms it for its own use. The ALMC pays the electricity bill of the whole facilities, and then each facility shares a certain ratio of the cost.

(iii) Complex Heat and Water Resources

The complex does not possess a central heat source. Each facility possesses its own chillers or boilers. The complex owns it own water well that serves as a source of water. At the start of the 1st phase of construction, much water came out from underground.

(iv) Facility Management

A subsidiary company of AKMC, AKMC Engineering Co., is a facility management team and takes care of all equipment, except elevators.

(v) Energy Conservation Activities of Al Khozama Hotel

Al Khozama Hotel has adopted efficient lamps and routinely checks to be sure that lights are turned off and doors are closed. Although the staff is experienced and has vast knowledge of the equipment, energy conservation does not seem to be a priority (not taken as seriously as it is at the Sheraton Hotel). The temperature is set at 21-23 degrees at the Al Khozama Hotel. As the comfort of the guests is the foremost concern. They keep record of energy use and will use it as a basis for developing further energy conservation. If financial support were to be offered in the form of a free audit or subsidy, they are ready to utilize such schemes.

(vi) Recommendation for Al Khozama Hotel and AKMC

Although AKMC staff is experienced and confident about their management, they seem to lack keen concern about energy conservation. This could be because of their favorable acquisition of energy source and satisfactory business operation. It means there is much potential for more saving by energy conservation activities.

Without making discomfort to their guests, measures can be taken such as optimum operation of chillers, pumps and fans by controlling temperature or operating numbers. When the energy conservation potential will be realized numerically by monitoring, they will further promote energy conservation.

7.2.3 Questionnaire Survey Results (Local Consultant Work)

(1) Survey Period

A local consultant, “MABDA Engineering”, conducted an interview survey from June to October of 2007. In November, the survey results were assembled and reorganized (Details are attached in Annex 1).

(2) Survey Location

The survey was conducted in four major cities from different regions in the KSA; Riyadh, Jeddah, Abha and Dammam.

Riyadh is the capital and has the largest population in the KSA. Situated away from the coasts in a desert climate, Riyadh experiences large temperature differences within a day and also between summer and winter. The air is dry especially in summer and heating is required in some winter periods.

Figure 7-11 Survey Location

The port city of Jeddah has long been the center of trade and commerce in the Red Sea area. It has the second largest population in the KSA, and welcomes a large number of Islamic pilgrims to Mecca. The temperature and humidity are high throughout the year.

Dammam is the core city in the eastern megalopolis region on the Gulf Coast, where major petrochemical industries are concentrated. The temperature is similar to Riyadh through the year, but the humidity is higher.

Abha is the capital of southwestern Asir Province, which rests on a high plateau and receives more rainfall than the rest of the country. Because of its altitude, Abha has a cooler climate compared to other cities.

(3) Surveyed Sites and Methods

Hospitals, hotels, shopping centers, and office buildings were surveyed in the commercial sector. From an obtained list of these facilities, small, medium, and large samples of each were chosen randomly. In each city 12 sites were surveyed. One school survey was conducted in Riyadh.

(4) Surveyed Items

Questionnaires were prepared concerning; 1) General information of facility and its activity 2) Structure and insulation of building 3) Used energy 4) Equipped appliances and their use 5) Awareness and practice on energy conservation (management of equipment) 6) Dissemination of energy conservation campaign.

Through discussion with the local consultant, necessary amendments were made on questions to suit local conditions.

(5) General Information

In the commercial sector, major facilities with different (small, medium and large) sizes were chosen from four cities. In all, 48 sites were surveyed. The following table is the list of visited sites.

Table 7-11 Surveyed Commercial Sector Facilities

	Riyadh	Jeddah	Abha	Dammam
Hospital	1. Al-Mubarak Hospital 2. Saudi German Hospital 3. Adma Hospital	1. Abo Zanadah Hospital 2. Al-Hamra Hospital 3. Al-Jada'any Great Hospital	1. Abha Private Hospital 2. Specialized Hospital for Woman and Children 3. Al-Rahma Hospital	1. Al-Muasa Hospital 2. Al-Mane' Hospital 3. World Health Hospital
Hotel	1. Al-Khuzamy Hotel 2. Al-Faisalia Hotel	1. Al-Khaiyam Hotel 2. Alhamra Softile Hotel 3. Al-Attass Hotel	1. Kasr Al-Salam Hotel 2. Shafa Abha Hotel (with Offices) 3. Kaser Abha Hotel (with Offices)	1. Zahrat Alkhaleej Hotel 2. Sheraton Dammam Hotel and Towers 3. Alhamra Golden Tulip Hotel
Shopping	1. Al-Othim 2. Mead Commercial Markets 3. Al-Faisalia Shopping Center (with Offices)	1. Al-Badriya towers (with Offices) 2. Panda 3. Mead	1. Benda 2. Ghnim Trade Center 3. Bin Shtoy for Marketing	1. Dana Compound 2. Benda 3. Mead
Office	1. 3rd. Aqaryyah, Manafeth Co. 2. Altathniyah Co. 3. Al-Jurasy Group of Co.	1. Nadar Office for Law & Translation 2. Muhammad Mandour Advisary Office 3. Omer Shkeb Al-Omaoi Corp.	1.Alnadwa Newspaper Office 2. National Development Group 3. Almadina Corp. for Press and Publication	1. Saed AbdElkarim Al-Muamer Towers-Al-Qatary Office 2. The Executive Office of Development 3. Al-Gazawi company for Law and Legal Advice
School	1. Al-Maordy Secondary School			

The three typical types of commercial buildings are described below.

(a) Al-Faisaliah Shopping Mall (Riyadh)

Built in 2003, Al-Faisaliah Shopping Mall is one of the largest shopping malls in KSA. It is a part of A-Faisaliah complex, which includes an office tower, hotels, apartments, mosque, and other facilities. This 70,668m2 shopping mall has four floors above ground and one underground floor. It operates from 9am until 11:30pm with a prayer break time (Fridays have a different opening hour). In the evening and on weekends, the mall is crowded with many visitors. Electricity is the main energy source, with some LPG used. The building is equipped with emergency diesel generators.

(b) Al-Jeraisy Group Office Building (Riyadh)

This 17,100m2 building in central Riyadh was built in 1997 and is owned by Al-Jeraisy Group. It is used for offices and showrooms of group companies, and also rented to tenants. There are 200 rooms in 3 above ground floors and 1 basement floor. Electricity is the only energy source. There is no in-house generation system.

(c) Abuzinadah Hospital (Jeddah)

This is a private general hospital in Riyadh. The building was built in 1979 and is owned by the hospital itself and used only for hospital and pharmacy purposes. The four floor building has 74 rooms in its 4,766m2 total floor area. Electricity and LPG are both used. Emergency generator operates with diesel oil.

(6) Survey Results

(a) Building Structure

(i) Main Building Frame

Almost all buildings are made with steel reinforced concrete. Tall towers which, in Western Countries would be made with steel are also made with concrete in this country.

(ii) Wall Materials

Major materials for walls are blocks (concrete blocks or bricks) and reinforced concrete. There is only one sample with a glass curtain wall in our survey.

(b) Building Insulation

(i) Wall Insulation

The figure below shows that 59% of surveyed buildings do not have wall insulation. Riyadh buildings comparatively have a higher rate of wall insulation. Commercial buildings use large amount of energy for air-conditioning. Although there is recent dissemination of information, this should improve further. The quality of insulation is also an essential issue.

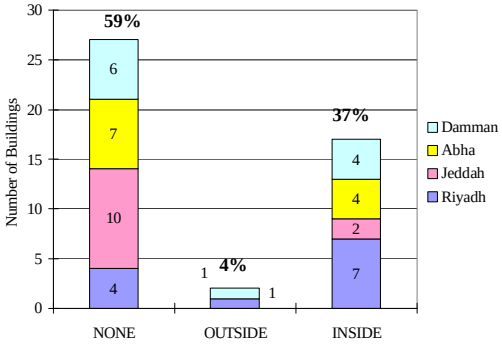


Figure 7-12 Wall Insulation of Commercial Buildings

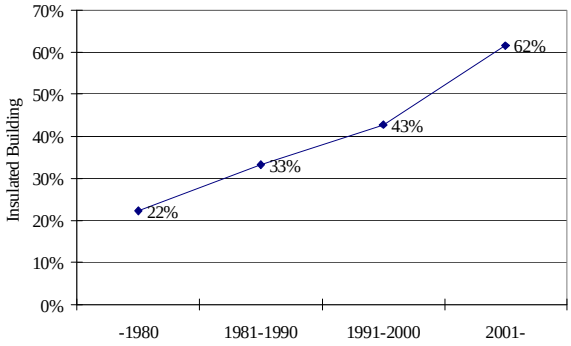


Figure 7-13 Trend of Wall Insulation Use

(ii) Roof Insulation

The rate of roof insulation use is slightly higher than wall insulation. It can be due to large roof areas resulting from the large footprint of KSA buildings. Also, low growth in roof insulation use can be because of recent increase in high-rise buildings with a limited roof area.

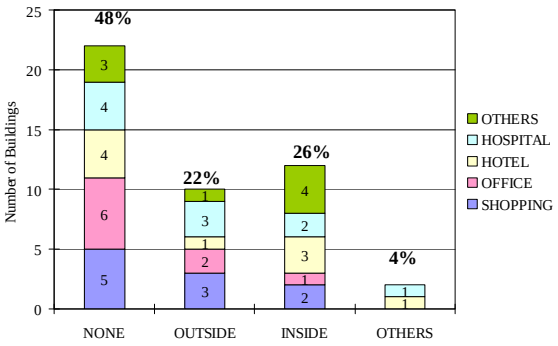


Figure 7-14 Roof Insulation of Commercial Building

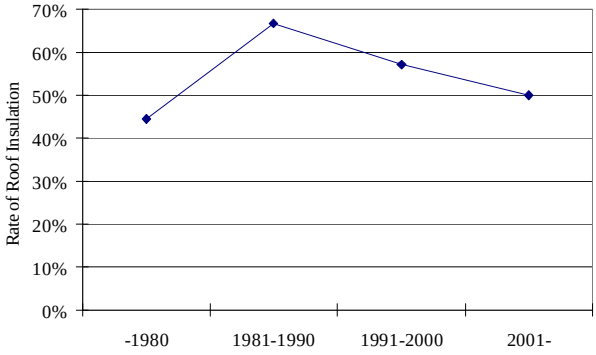


Figure 7-15 Trend of Roof Insulation Use

(c) Used Energy

Major energy sources in Saudi commercial buildings are; electricity, LPG (tanked or bottled), kerosene, and diesel oil. Electricity, LPG and other sources are used respectively, 37%, 41%, and 22%. Use of gas is more popular than Japanese buildings where fire protection issues and regulations are in favor of electricity use.

For heating in winter, electricity is the major energy source. Buildings in Jeddah do not have heating equipment. High temperatures throughout the year is most likely the reason.

(d) Lighting

Fluorescent lamps, CFLs, incandescent lamps, sodium lamps, metal halide lamps, and mercury lamps are used in commercial buildings. A questionnaire survey of lamp lighting lifetime was made and the results are shown below. Incandescent lamps have a short lifetime of 1 to 2 years. Other types of lamps should last for 3 to 5 years. Nevertheless, this result shows the short lifetime of these lamps.

1) Poor quality of lamps 2) Poor quality of lighting equipment 3) Effect of unstable electricity supply (e.g. fluctuation, harmonic disturbance) can be the causes for this short lifetime. This needs careful investigation and improvement.

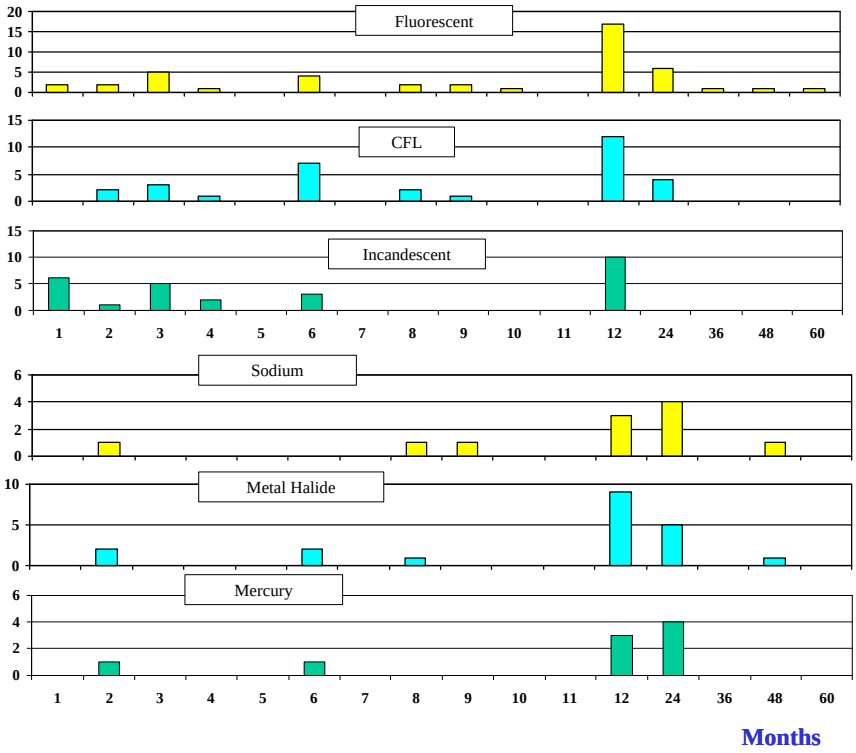


Figure 7-16 Lifetime of Lamps

(e) Air-Conditioning

(i) Types of Air-Conditioners

Small ACs (window type and split type) are widely used in the commercial buildings. Refrigerant types such as Variable Refrigerant Volume (VRV) system are rarely used. Instead, package ACs transferring air is used as middle-size machines. Lower initial cost and easier setting/maintenance is probably the reason of their dominance. Use of these machines means high electricity consumption.

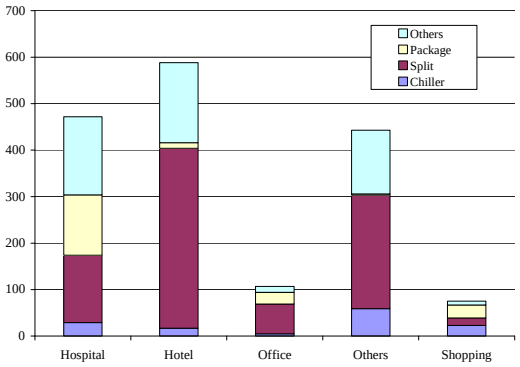


Figure 7-17 Type and Numbers of ACs

At many sites, old low-efficient machines continue to be used. Cheap electricity prices makes it difficult to renovate into a new high-efficient system. Some incentive measure is necessary to promote this renovation.

It depends on each facility's use and operation, whether a central chiller system or other individual system is suitable for a commercial building. Building Codes need to be practiced properly to optimize AC energy use in every commercial facility.

(ii) AC Operation Period

At many commercial sites, ACs continue to be used throughout the year. However, a considerable number of samples in Riyadh stop ACs during wintertime. This means interior emitting heat from appliances is enough to warm up in the Riyadh climate.

Long time daily operation is unavoidable in hospitals or hotels. Shopping centers should be able to limit their operation time by scheduling with their opening hours.

(iii) Maintenance of ACs

Many sites answered that ACs are frequently inspected. The dominant 'others' as the purpose of this maintenance is guessed to be mainly responding to operational complaints from users. It is difficult to believe that maintenance operation for optimal energy efficiency is being conducted.

(iv) Temperature Setting of ACs

The figure below shows the cooling temperature setting at each site. Some of them are set excessively low. This must be the result of malfunctioning of ACs or imbalance between room volume and AC capacity. In many hotels, hospitals, and shopping centers, standard setting temperature is 22ºC degrees. It is now common practice in KSA, but gradual rising of this temperature along with campaigning of awareness should be possible.

Figure 7-18 AC Cooling Temperature

(f) Energy Conservation Awareness and Practice

The left figure below shows opinions on lights-off activities from building facility managers. Many agree on the practice after hours and for unnecessary lights. Prayer time lights-off is opposed by many facility managers. Shortness and vicinity of prayer hour probably is the reason.

The right figure below show answers to the question of if facility managers agree on practicing mentioned energy conservation activities or not. Improvement measures for promoting the importance of energy conservation is definitely necessary for building owners and managers.

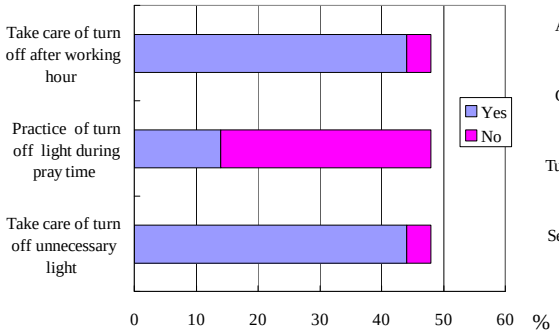


Figure 7-19 Approval on Light-Off

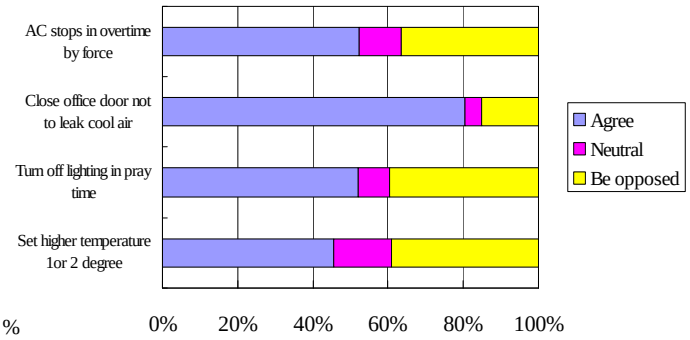


Figure 7-20 Approval on EC Activities

(g) Energy Conservation Campaign and Electricity Tariff System

(i) Energy Conservation Campaign

Both the Saudi government and the Saudi Electric Company (SEC) conduct energy conservation campaigns. The survey result shows these campaigns are not well recognized among facility managers of commercial buildings. On one hand, dissemination in Jeddah needs special attention. It is necessary to investigate the reasons in Jeddah, and improve future campaign measures.

(ii) Electricity Tariff System

As shown below, the Time of Use (TOU) tariff system is not well known in KSA. Since the electricity demand structure is different from Japan, careful discussion for a suitable tariff system that leads to energy conservation, as well as publicity of TOU, is necessary.

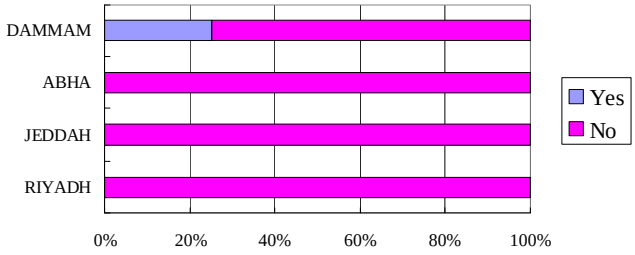


Figure 7-21 How Well TOU is known

(h) Summary and Issues on Commercial Sector Energy Conservation

(i) Building Structure, Insulation and Equipment

Similar to the residential sector, there is a large potential for improvement of building and equipment energy conservation performance. As economic entities, the commercial sector will enhance its energy conservation activity if it leads to their benefit. Policymaking and publicity campaigns should utilize measures of this nature.

(ii) Cooperation within Sector and Information Exchange

In KSA, organization and information sharing in industrial and commercial entities need to develop further. Presently, it is often difficult to obtain reliable information in these sectors. This survey faced this difficulty while selecting sites that agree to provide information.

(iii) Lack of Energy Consumption Data and Skills

Difficulties in statistical analysis of commercial survey were partly due to a limited number of samples. It implies lack of basic energy data and monitoring skills in building facility management. Improvement of these basic skills, parallel to the establishment of energy data collection system is essential.

(i) Survey Outcome and Issues for the Future

This survey enabled quantitative data collection of representative KSA commercial buildings. It faced difficulty in the beginning, in selecting sites due to the lack of reliable facility lists.
Obtaining of electricity consumption trend data is one important step. Evaluation of energy conservation is only possible through comparing building management activity and the resulting energy consumption.

In the commercial sector, the survey focused on obtaining sample data from different uses and size. Therefore, the number of samples for each commercial use was not large enough for a statistical treatment or for highlighting the average nature in each use. The next step survey needs a larger number of samples from each type. Also, a more detailed investigation on facility management will be necessary.

Continuation and improvement of the survey will contribute to the development of actual energy conservation schemes, through clarifying issues step by step.

7.2.4 Challenges and Future Steps

(1) Challenges

Thorough these site visits and other occasions, the following barriers to improvement of energy conservation in the commercial sector of the KSA were found.

- ✓ Awareness of energy conservation is low among the majority of the people, including the management staff.
- ✓ Government announcements regarding energy conservation are well-publicized or

recognized.

- ✓ Management divisions do not exist in smaller buildings. Maintenance of machinery is limited to basic matters as the cleaning of filters by an outside maintenance company.
- ✓ Even in buildings with maintenance divisions, a lack of drawings and documents and an inability to record trends makes it difficult to implement energy conservation activities.
- ✓ Level of maintenance in mid-sized buildings is low. The present status of energy consumption is unknown.
- ✓ For large facilities with internal management staff, energy conservation training is not carried out, even though they have the ability to do so.
- ✓ For customers who are willing to introduce energy conservation measures, lack of incentives, such as subsidies, a tariff system, or governmental loans, is a barrier to improvement.
- ✓ Energy efficient equipment is not common, except for CFLs.
- ✓ Many old machines with low energy efficiency are still in use.
- ✓ Buildings are not designed with optimized energy efficiency, for example the use of a large glass façade for new buildings.
- ✓ The sector lacks data of overall energy consumption according to building type etc.
- ✓ Apart from a low electricity price, some facilities lack energy conservation consciousness because due to beneficial access to the energy source.

(2) Future Steps

To tackle the challenges above, the following steps are expected to be taken.

- ✓ Strengthening of the government's energy conservation campaign, targeting 1) building users 2) owners and 3) engineers.
- ✓ Development of a training program for building managers that targets 1) engineers who lack basic skills in regard to energy conservation measures and 2) engineers with experience and the capacity to learn advanced energy conservation measures.
- ✓ Publication of an energy management booklet could be an effective measure.
- ✓ Regulations are needed to set the basis for energy conservation and to develop an energy database in the sector, such as the appointment of an energy manager for large facilities and the recording and reporting of energy consumption.
- ✓ Enlargement of energy auditing through incentives offered by the government.
- ✓ Assistance for energy conservation promotion is necessary, either through incentives or by ESCO companies.
- ✓ Incentives, such as a subsidy is required for 1) replace old equipment with new energy efficient models, 2) strict maintenance of air conditioners and 3) installation of new air conditioners or other energy consuming equipment in new buildings.
- ✓ Proper and swift implementation of the Saudi Building Code (now in draft) should be processed.
- ✓ Associative organizations need to be developed in order to share information and collaborate on energy conservation.

7.3 Residential Sector

7.3.1 Basic Information

(1) Definition of Residential Sector in Tariff

In the SEC tariff, the residential tariff is applied for only residential customer.

(2) Typology of Houses

According to the eighth development plan, 32.7 % of families live in 'Apartments', 29.8 % in 'Conventional houses', 20.2 % in 'Villas', and the remaining in different types of housing units. Although in Riyadh, conventional homes (detached houses) seem to account for the larger proportion. There is another important term that applies to the gathering of houses, 'compounds'.

(a) Apartments

Examples such as the one on the right are found mostly along the Ulaya district, not outside city center. Usually they are around 6 stories high. Wall-through air conditioners protrude from the walls. Windows are small and few, presumably because of climate conditions and privacy issues.

Figure 7-22 Apartment

By the late 1950s, apartment buildings started spreading in Riyadh. Apartments in Riyadh are designed facing public areas, such as a square or a wide main street, but do not face the one- and two- story single-family houses.

Dwellers in these apartments are said to be mainly people whose families live in other cities or are foreigners.

(b) Conventional Houses

Houses tend to be large, 500 to 1000 m2, and surrounded by tall walls. There are generally two-stories high. Some have basement or semi-underground floors, mainly used for storage and servant's rooms. Each floor has an area of 250-500 m2.

Figure 7-23 Detached House

One family usually consists of 7-10 family members and incorporates several generations. For this reason, the house is divided into two parts. Composition of a house according to function is shown in the diagrams below.

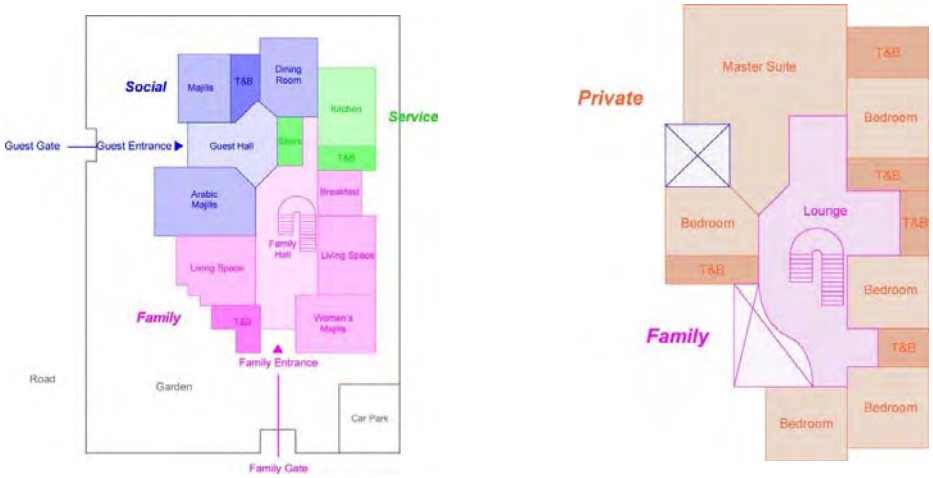


Figure 7-24 Ground Floor Plan (left) and First Floor Plan (right)

The ground floor serves three main functions: social, service, and family. There are separate entrances for guests and family members. Social function is served by Majilis (a meeting room) and dining room. The kitchen is situated next to the dining room. Alignment is planned in such a manner that no guest can see the activity of the women in the family area.

Bedrooms with attached bathrooms are located on the first floor. Some of the bedrooms, such as children's rooms, may share one bathroom. Sometimes there is a small kitchen in the common area on the first floor.

(c) Villas and Compounds

In Saudi Arabia, the term 'Villa' does not connote a luxurious country house. Rather, the term refers to collective housing from several family units with low roofs. In this sense, they are multi-family houses or townhouses in British terminology.

Groups of villas are referred to as compounds. Compounds are enclosed areas with common facilities and space for all residents. Foreign workers' families from developed countries often live in compounds.

Figure 7-25 Villa

Figure 7-26 Compound

7.3.2 Site Visit Survey Results

(1) Interview Survey

An interview survey was conducted on a middle scale house.

(a) General Profile

Features of the house are as follows:

Structure:	Reinforced concrete with concrete blocks
Site Area:	1,500-2,000 m2 (*assumption)
Total Floor Area:	600-800 m2 (*assumption)
Year of Construction:	20 years ago (*assumption)
Year of Purchase:	10 years ago
Number of Floors:	3
Number of Rooms:	17
Outside:	Entrance Gate, Garden around the house, Swimming Pool, Parking
Ground Level:	Maid's room, Driver's room, Storage
1st Floor:	Reception room, Dining room for guests, Living room, Family Dining room, Women's area
2nd Floor:	Bedrooms
Inhabitants:	8-10

(b) Energy Source

Except for LPG for cooking, electricity is the main energy source.

(c) Major Electricity Consuming Appliances

(i) Air Conditioning

Three package units (large, medium, and small) are on the roof. They have been used since construction of the house. As for maintenance, an air conditioning manufacturer (Korean LG) services the equipment twice a year although they did not manufacture it. These package units are used for cooling and heating in the summer and winter.

In the reception room, temperature was set at the lowest possible temperature – 60 ºF (15.6 ºC), however the air was much warmer, about 25 ºC. This implies that the load is exceeding the capacity, and/or the equipment is old and operating at low efficiency.

(ii) Lighting

A chandelier with many incandescent lamps is the main lighting equipment in the reception room. Chandeliers also seemed to be used in the other rooms. These chandeliers emit a considerable amount of heat and become a heavy load for the air conditioning system.

(iii) Water Heating

An electrical water heater is used for the hot water supply. Once, the house owner considered introducing a solar water heater. However, it has not been installed yet because of the high price.

(iv) Refrigerators

There are 2 refrigerators and 2 freezers in the house.

(v) Water Pumps

There are 6 water pumps for the house use, the garden, the pool, etc.

(d) Awareness regarding Energy Conservation

The house owner is very concerned about energy conservation because of his high electricity bill. The owner inspects all the rooms in the house to be sure that lights have been switched off in rooms that are not being used.

(e) Recommendation

Several measures can be applied to a house of this type, for example introduction of new and efficient air conditioners. However, the lack of an incentive system prevents the house owner from doing so. In addition, small high efficiency lamps should be used (or developed) for chandeliers which emit a considerable amount of heat.

(2) Measurement Survey

A measurement survey was conducted on a larger scale house than the house described the above. Power meters were installed for measurement of electricity consumption.

(a) General Profile

Feature of the house are as follows:

No. of Floors:	2 floors
Site Area:	1,250 m2
Total Floor Area:	1,200 m2
SEC Meter:	2 (The left measures electricity use on the ground floor, the right one measures electricity use on the 1st floor)

Figure 7-27 SEC Meters

(b) Electricity Consumption

The ground floor does not consume so much electricity because it is mainly used for guests. The kitchen is located on the ground floor. The SEC meter of the ground floor covers 2 refrigerators, 2 freezers, lighting, 4 air conditioners (1 split, 3 windows), a washing machine, a parking door, a pump, etc.

More electricity is consumed on the 1st floor because the living and sleeping area are located on

the 1st floor. The SEC meter of the 1st floor meter covers 2 washing machines and 5 air conditioners (1 split, 4 windows).

(c) Energy Conservation Practice

Several energy conservation measures have already been put into practice. For example,

- ✓ CFL has been installed.
- ✓ There are no chandeliers.
- ✓ Rock wool insulation has been installed in the walls.
- ✓ Lamps are turned off

(d) Measurement Mode

The measurement was made in 4 modes, a baseline mode (Baseline) and an energy conservation practice mode (EC Mode) in weekday and weekend. The energy conservation practice mode is adopted after giving advice on energy conservation methods. Data was taken during the following period.

Table 7-12 Measurement Mode

Mode	Condition	Duration
Mode 1	Baseline and weekday	May 26-30
Mode 2	Baseline and weekend	May 24-25, May 31-June 1
Mode 3	EC Mode and weekday	June 3-6, June 9-13
Mode 4	EC Mode and weekend	June 7-8, June 14-15

(e) Measurement Results

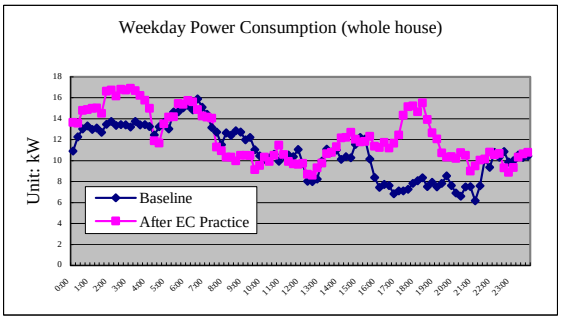
The summary table is shown below. The results show that more energy was consumed during energy conservation practice mode than the baseline mode, regardless of the advice given on energy conservation.

Table 7-13 Summary of Measurement Data

	Weekday (Mode 1)			Weekend (Mode 2)		
	Ground Floor	1st Floor	Total	Ground Floor	1st Floor	Total
Average Daily Consumption in Baseline	57 kWh	203 kWh	260 kWh	51 kWh	191 kWh	242 kWh
Average Outside Temp. during Measurement	36.5 ℃			36.3 ℃		
	Weekday (Mode 3)			Weekend (Mode 4)		
	Ground Floor	1st Floor	Total	Ground Floor	1st Floor	Total
Average Daily Consumption in EC Mode	77 kWh	217 kWh	294 kWh	73 kWh	181 kWh	254 kWh
Average Outside Temp. during Measurement	37.8 ℃			37.5 ℃		
Difference	+ 20 kWh	+14 kWh	+34 kWh	+22 kWh	-10 kWh	+ 12 kWh

The following graphs show the average daily load curve during the measurement period. Both graphs show the following common features in electricity consumption:

- ✓ Nighttime load is higher than daytime
- ✓ Weekends are lower than weekdays



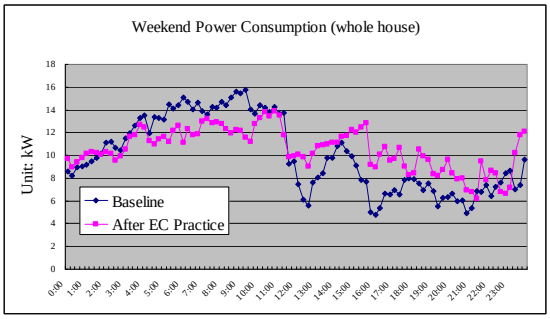


Figure 7-28 Average Weekday Daily Load Curve Figure 7-29 Average Weekend Daily Load Curve

(f) Consideration

The comparison between the baseline mode and the energy conservation practice mode showed unexpected results. Assumed reasons for that outcome are as follows:

- ➢ Children began preparing for a school examination during the daytime, which may have raised the amount of electricity used after the energy conservation practice mode was applied.
- ➢ Outside temperature during the energy conservation mode became higher than during the baseline mode days.
- ➢ Since the house owner is originally regarded as an energy conservation oriented person, therefore the advice may not have been effective.

(g) Recommendation

The amount of power consumption is related to the air conditioning load. Operation of the air conditioner during the nighttime may offer potential energy conservation. For example, the use of a timer might be effective (automatic switch off while sleeping).

7.3.3 Questionnaire Survey Results (Local Consultant Work)

(1) Survey Period

A local consultant, “MABDA Engineering”, conducted an interview survey from June to October of 2007. In November, survey results were assembled and reorganized (Details are attached in Annex 1).

(2) Survey Location

The survey was conducted in four major cities from different regions in KSA; Riyadh, Jeddah, Abha and Dammam.

(3) Surveyed Sites and Methods

25 residences were selected randomly and surveyed in each city, so that there would be no regional bias. Two conditions were adopted in the selection so that samples included different types of houses; 1) small and large apartments, small, medium, and large detached houses should be included in each city 2) 5 of 25 sites should be rural (suburban) houses.

(4) Surveyed Items

Questionnaires were prepared concerning; 1) General information of family and its activity 2) Structure and insulation of building 3) Used energy 4) Equipped appliances and their use 5) Awareness and practice on energy conservation (management of equipments) 6) Dissemination of EC campaign.

Through discussion with the local consultant, necessary amendments were made to questions to suit local conditions.

(5) Survey Results

(a) General Information

(i) Type and Size of Houses

Apartments, detached houses and villas are three major types of houses in KSA. Villas are houses larger than average detached houses. Houses get smaller in the order of villa, detached house, then apartment. Apartment houses generally accommodate smaller members. Villas do not necessarily have larger family members compared to detached houses.

(ii) Year of Houses Being Built

Sorting by the year built clearly shows that construction of houses is increasing rapidly, reflecting population and urban growth. This result shows the importance of building energy performance in the residential sector, since the demand and supply of houses will continue to grow in the foreseeable future.

(iii) Structure of Houses

The structure of houses is almost singular in all types of houses. That is, steel-reinforced concrete framework of columns, beams and slabs, with filled walls of either concrete blocks or bricks.

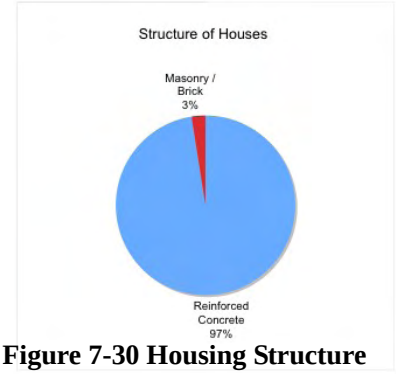


Figure 7-30 Housing Structure

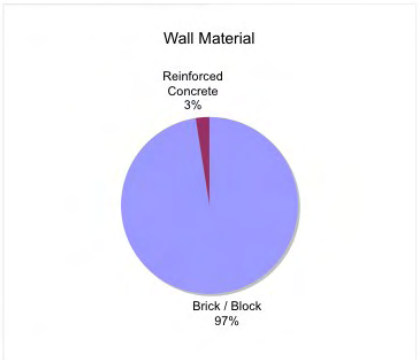


Figure 7-31 Housing Walls

(iv) Family Members

The table below shows average and median size, annual income and family member of each housing type. Median value can be considered typical, since every type includes excessively large samples.

Apartment size and residents are similar to other countries. The large size of detached houses and villas is one of the major reasons for prominent residential electricity use in KSA.

Table 7-14 Standard Family and Housing

	Average (Median) Total Floor Area	Average (Median) Annual Income	Average (Median) Family Member
Apartment	160 m^2 120 m^2	74,000 SR 48,000 SR	5.98 5
Detached House	1,072 m^2 650 m^2	206,000 SR 144,000 SR	8.75 8
Villa	2,402 m^2 1,400 m^2	1,815,000 SR 162,000 SR	11.71 8
Japan (per Family Unit)	92.5 m^2 (Statistics Bureau Japan, 2003)	201,200 SR (Statistics Bureau Japan, 2007)	2.83 (Statistics Bureau Japan, 2007)

(v) Used Energy

Energy used in households is as follows.

1) Cooking

Broiling is a popular way of local cooking. LPG gas is a major energy source for household cooking. “Others” answers implies use of both gas and electricity

2) Water Heating

Almost all houses use electric (not heat pump) water heaters for hot water supply.

3) Cooling

All sample houses use air conditioners with electricity.

4) Heating

Many houses use electricity. “Others” are supposed to indicate kerosene stoves.

(vi) Life Pattern in Households

In each sample, life pattern on weekdays and weekends were surveyed. Two distinctive features relating to energy use arise from this survey.

1) Peak Lunchtime

Lunchtime concentrates around 2:30 pm on both weekdays and weekends. This should come from the Islamic habit of 1) strict daily prayer time after high noon and before sunset 2) lunchtime as the most important occasion for daily family gathering. Therefore, peak electricity use in the residential sector around this lunch hour is inevitable.

2) Late-Night Life Pattern

Dinner and sleeping times are late. On weekends, they become even later. Large nighttime use of electricity should have a strong connection with this late-night lifestyle in KSA.

(b) Insulation and Windows

(i) Use of Insulation

The graphs below show use of insulation in surveyed houses. The result of the low percentage of insulation poses a grave problem on residential energy use in a harsh climate.

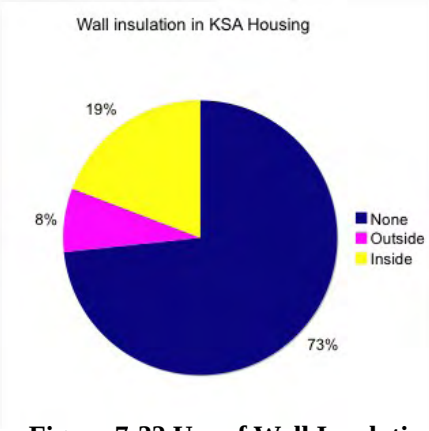


Figure 7-32 Use of Wall Insulation

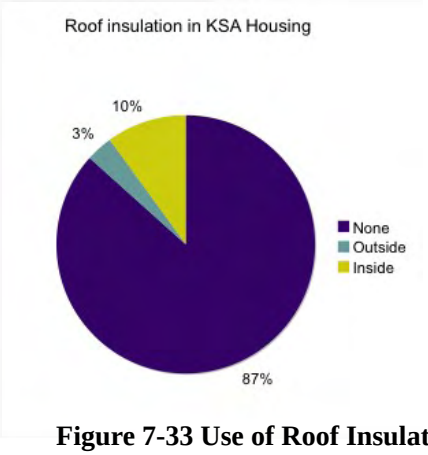


Figure 7-33 Use of Roof Insulation

If we look at the trend of insulation use for houses, dissemination has been proceeding. At the same time 1) half of the houses built after 2000 do not have wall insulation 2) roof insulation use is still low. These need to be tackled and improved through measures such as implementation of Saudi Building Code, and/or incentives for dissemination.

(ii) Window Area of Houses

The window area in KSA houses has been steadily growing in recent years. Although windows can utilize renewable energy such as natural light and air-flow, in Saudi climate air-conditioning electricity use for heat load should exceed this benefit. Designing and construction with optimal total energy performance need to be developed.

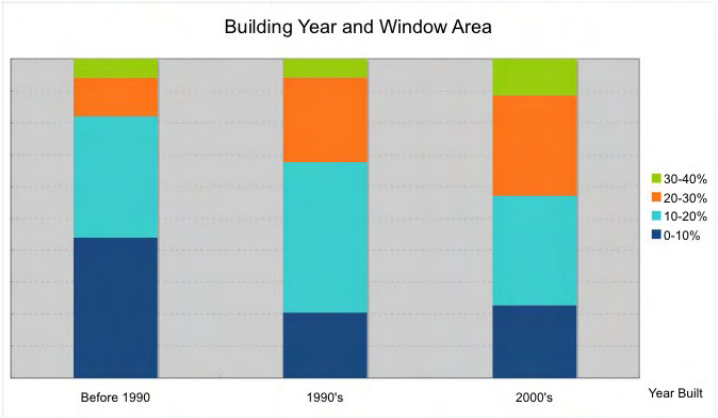


Figure 7-34 Change of Window Area

(c) Lighting

The graph below shows the wattage ratio of different lamp types in all the samples. Lifetimes of fluorescent lamps and CFLs are unnaturally short as shown in the below table. The reasons can be 1) low quality of lamps 2) low quality of lighting equipments 3) instability of supplied electricity.

Low reliability of appliances can easily hinder social consensus on energy saving. Quality standard and measures to control market products are most necessary. Also, opinions declare that consumers buy cheaper products, half knowing their possible deficiency. Campaigns to address lifecycle advantage is also necessary

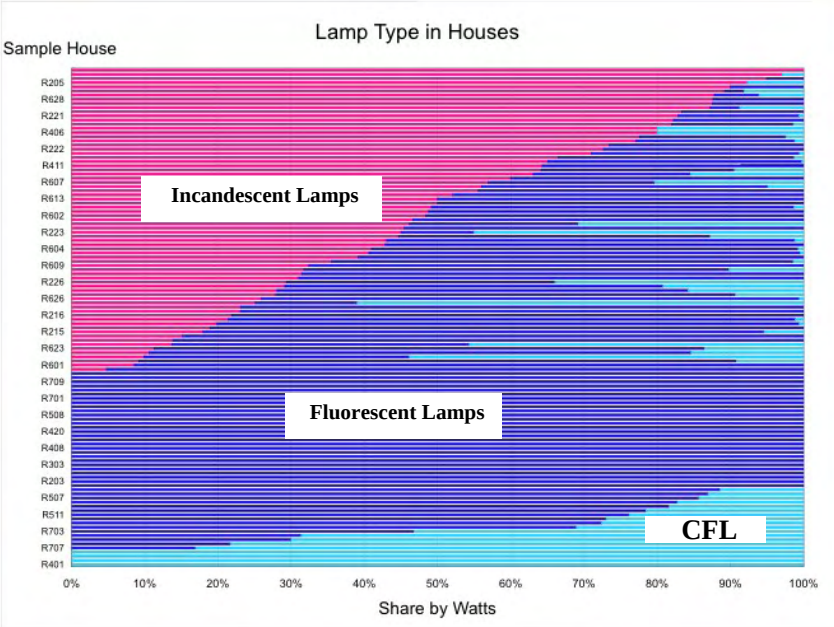


Figure 7-35 Lamp Types in Houses

Table 7-15 Lamps Type and Expected Lifetime

	Expected Lifetime (years)
Incandescent Lamps	1.02
Fluorescent Lamps	1.39
CFLs (Compact Fluorescent Lamps)	1.66

(d) Air-Conditioning

(i) Types of Air-Conditioners

The graphs below show the equipped average cooling capacity of a house per floor area in each surveyed city, with different colors for AC types.

Apartments only have small ACs, most of which are window types. Split types that have more energy efficiency need to be disseminated for EC improvement.

Even in detached houses, the share of window type is nearly half of the total. Concrete block walls with no steel rods, as well as the cheap price, enable easier installation of window type ACs after construction.

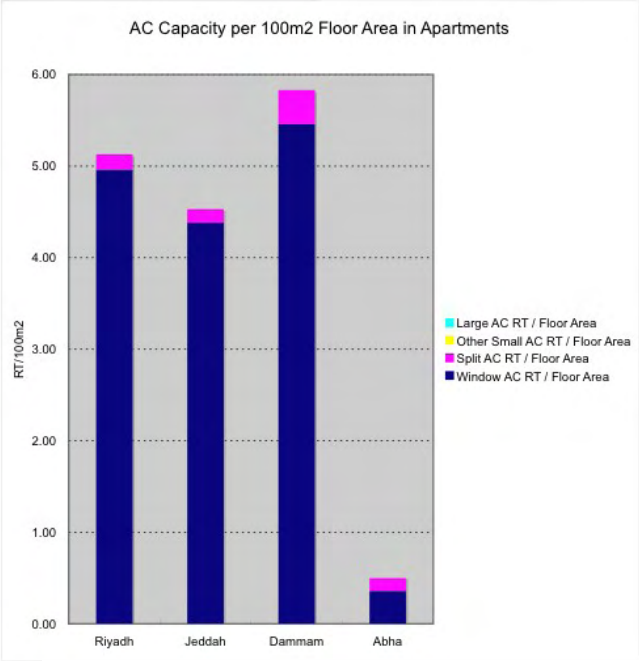


Figure 7-36 Cooling Capacity in Apartments

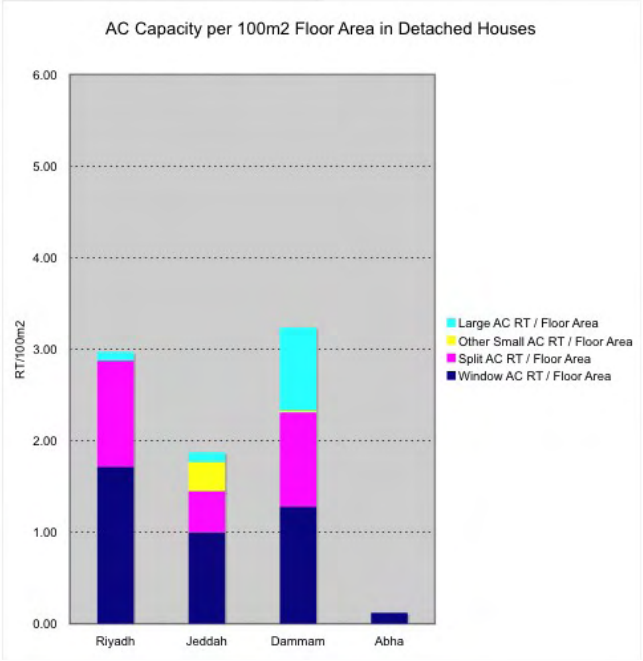


Figure 7-37 Cooling Capacity in Detached Houses

(ii) Air Conditioner Manufacturer

Small ACs that dominate the market are mostly made by foreign manufacturers. This leads to 1) importance of import product testing regarding EC performance 2) importance of optimal design for dry hot climate and long operation.

(iii) AC Operation Period

1) AC Operation Period in a Year

The following figure is the operation period of ACs in major cities. In Jeddah where the temperature is high throughout the year, ACs operate from January to December. Although Dammam has a similar temperature change as Riyadh with more humidity, the operation period is shorter. Some opinions say westernized Dammam region practice a more organized lifestyle e.g. in operation manner. If that is the case, Riyadh has a large potential for energy conservation through campaigning importance and promoting awareness.

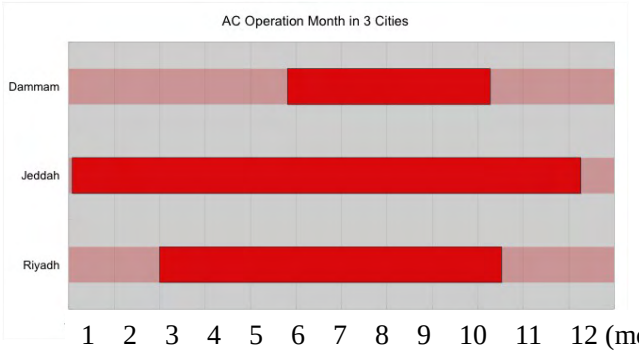


Figure 7-38 Yearly AC (Cooling) Operation in Each City

2) AC Operation Time in a Day

In Jeddah and Riyadh, many houses keep ACs running 24 hours. The reason for continuous operation can be high temperature in houses caused by the emission of stored heat during daytime. Also it is most likely that Riyadh is experiencing “heat island effect” with high nighttime temperatures as with other modern large cities in the world.

(iv) Temperature Setting of AC

The temperature setting of ACs is often kept excessively lower (using more energy) than a comfortable sensible temperature. This result, shows a large potential of energy conservation, because it means ACs are not operated at their optimum conditions. Lack of maintenance, use of malfunctioning machines, energy loss through air leakage, or unbalance between AC capacity and room volume can be the reasons and need to be tackled.

(e) Awareness and Practice of Energy Conservation

House owners were asked in which of 5 groups they think they belong to, concerning energy conservation awareness.

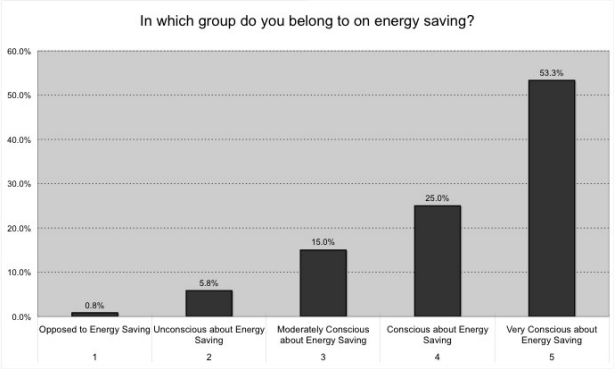


Figure 7-39 Energy Conservation Awareness Group

Questions were also answered concerning energy efficient use of household appliances. By weighing coefficients on energy conservation practice activities, we investigated the correlation between awareness and practice. Three groups of activities emerge as a result of this analysis.

○Activities Practiced/Not practiced Regardless of Awareness Group

Family members gather for meals in the KSA, and the cooling temperature are set low in every awareness group. External causes such as culture, climate, and building hardware dominates awareness in practicing these activities. This result suggests that the penetration of energy saving activity, as a cultural virtue, will bring about great effects. Also improvement of energy performance of houses and AC equipment is a crucial issue in this country.

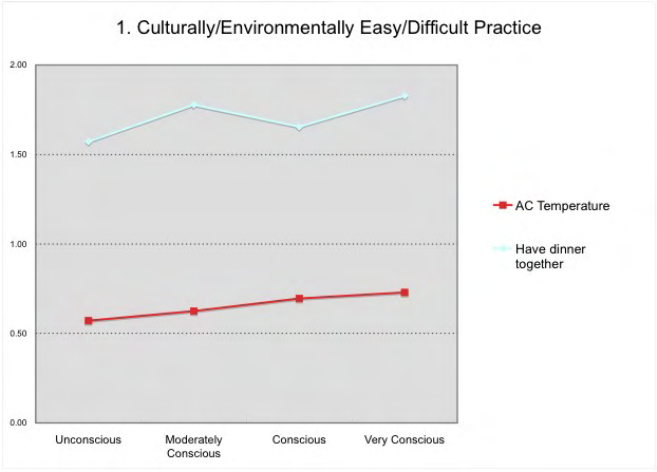


Figure 7-40 Invariable Activities

○Activities Practiced in Awareness Groups

Correlation between awareness and practices are clear in such activities as careful switching off of and closing refrigerator doors. A fostering of energy conservation awareness in a wider range of society through various campaigns is indispensable for energy conservation.

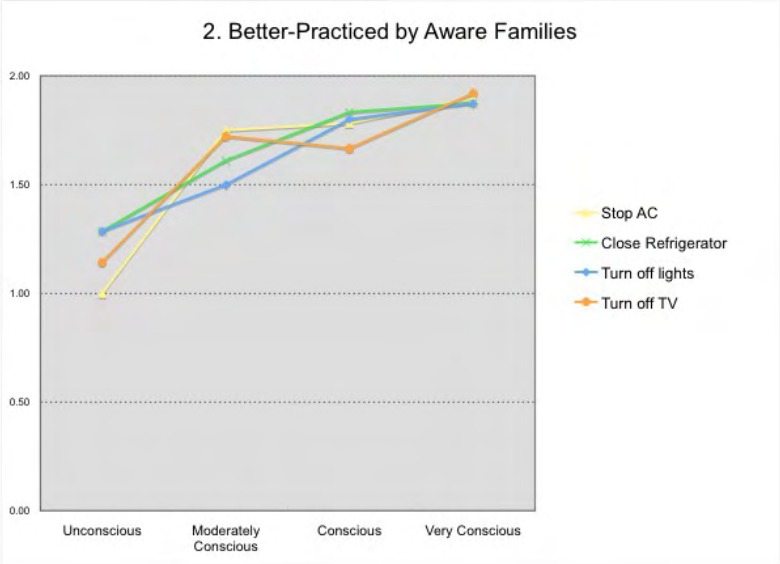


Figure 7-41 Activities with Direct Correlation

○Activities with No Correlation

1) Not storing refrigerators full 2) Not to leave water running in the shower 3) To do bulk washing 4) To dry clothes outside, are activities with little correlation to awareness in their practice. The advantages should be addressed since this result shows the EC effects of these activities are not well known.

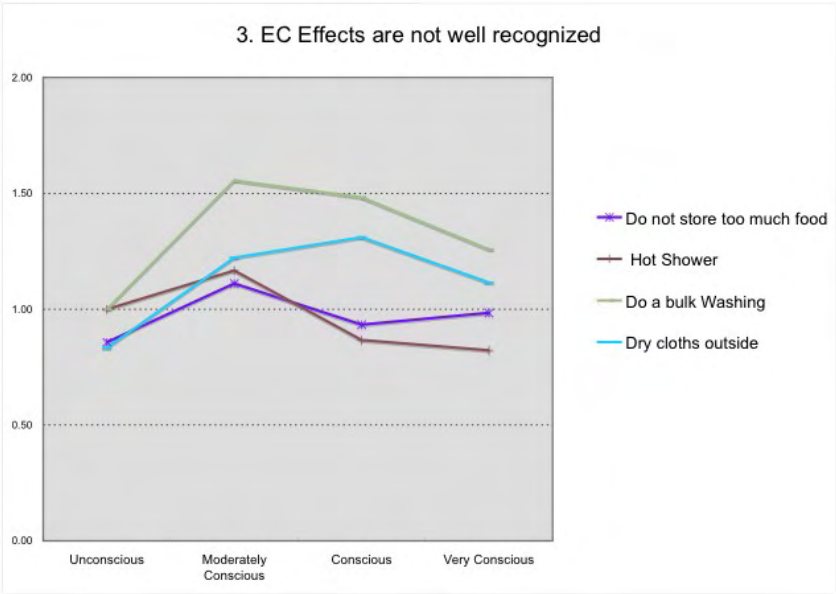


Figure 7-42 Less Recognized EC Activities

(f) Dissemination of Energy Conservation Campaigns

As shown below, both governmental and SEC campaigns are only known to less than half of surveyed house owners. Strengthening and effective improvements are necessary.

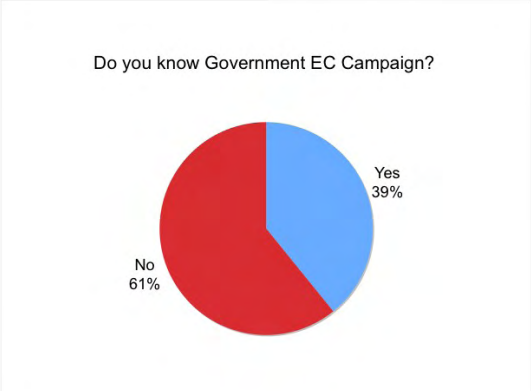


Figure 7-43 Penetration of Government Campaign

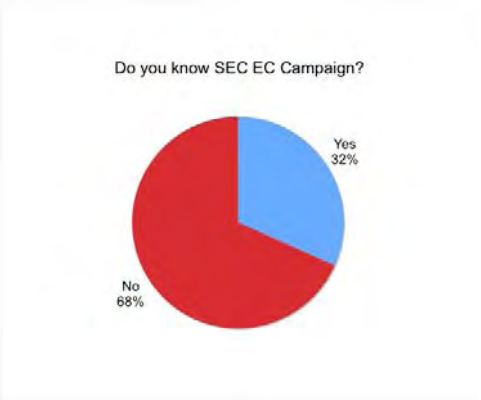


Figure 7-44 Penetration of SEC Campaign

(g) Summary and Issues on Residential Sector Energy Conservation

(i) Housing Structure

A large size of detached houses means the residential sector fundamentally has an energy consuming nature. Other than air-conditioning, the number of lightings or electric appliances increase with house size. Since the size of supplying houses is related to many factors and cannot be simply controlled, promotion of proper insulation use and energy efficient houses is important.

In the KSA, structure and construction is almost uniform. This should be a favorable condition for standardization and dissemination of housing energy performance.

(ii) Electricity Demand Peak

Peak time during lunch hour is inevitable because of cultural tradition. If energy conservation can be implemented in line with cultural habits such as this, the effect will be fruitful in the KSA.

It is ironic to note that the late-night life pattern may be contributing to the leveling of electricity demand. Night consumption needs much attention in the future, because it is the core of residential electricity consumption and population growth continues to be high.

(iii) Promotion of High Efficiency Appliances

It is clear that air-conditioning (cooling) composes a large portion of electricity demand. Lighting is also critical due to life patterns and housing size. Controlling schemes for appliances, such as labeling, and promotion incentives should be improved.

(iv) Promotion of Energy Conservation Awareness and Measures

Many replies claimed to have high consciousness towards energy conservation. It is doubtful though, if energy conservation activities are practiced well in families. This is because interviews were conducted only to male house owners, and excessive setting of AC temperature does not show this awareness. Fostering of energy conservation awareness throughout every age and class of

society, with teaching of actual energy conservation measures, is most essential.

(h) Survey Outcome and Issues for the Future

There was scarce new information concerning energy use or conservation in KSA housing. In this respect, this survey should have the value of quantifying information only supposed as common understanding before. Obtaining of electricity consumption trends of surveyed sites was not possible. If this data was provided, the outcome would have become more fruitful by comparing the relation between equipment, activities, and the electricity use result.

In the residential sector, a sample number allowed us statistical analysis. The number is not yet large enough and a wider survey will lead to a more accurate evaluation. Also, a more detailed survey is necessary regarding the use of appliances in houses. The answers were obtained from husband owners who are absent in the daytime. If housekeeping activities can be monitored, the information will bring more effective and realizable measures for residential energy conservation.

The residential sector's activity, which consumes more than half of the national electricity supply, is deeply related to lifestyle habits and culture. Continuation and improvement of surveys will play an important role in dissemination of energy conservation.

7.3.4 Challenges and Future Steps

(1) Challenges

Through site survey, the following challenges were identified in the residential sector.

- Insufficient awareness of energy conservation issues in the residential sector.
- Old, inefficient air conditioners are still in use because existing air conditioner systems can still be used and there is a lack of financial incentives to promote installation of more energy efficient air conditioners.
- Consumers tend to select cheaper appliances without knowing the future electricity consumption.
- For lighting, chandeliers with many incandescent lamps consume a large amount of energy in addition to emitting a considerable amount of heat.
- Conducting site survey of the residential sector is difficult because of privacy issues.
- Use of air conditioners during nighttime increases electricity consumption.

(2) Future Steps

To tackle the challenges above, the following steps are expected:

- Raise energy conservation awareness through education, campaigns, museums, the release of information, etc.
- Air conditioner renewal incentives.
- Promotion of labeling and a standards system to calculate the life cycle cost of appliances.
- Promotion of CFL.
- Proper implementation of the Saudi Building Code.

- Development of an effective survey method for the residential sector.
- Automatic switch off function of air conditioners for nighttime.
- Easy monitoring equipment to see real electricity consumption.

7.4 Government Sector

7.4.1 Basic Information

(1) Definition of Government Sector in Tariff

In the SEC tariff, the government tariff is applied for some types of consumers, government buildings, large customer, public lighting, public mosques and public hospitals.

(2) Typology of Governmental Buildings

(a) Ministries and Governmental Office Buildings

Many KSA governmental and ministerial office buildings are located in Riyadh. Many of them are situated in the northern part of Old Riyadh. They tend to have a recognizable outer design. Several are equipped with BEMS.

Figure 7-45 Building of MOMRA

(b) Institutes and Foundations

In Islamic countries, the practice of endowment is important and honorable act. Institutes or foundations for social contribution are established through endowments. Mosques are also constructed through this practice. Many of them are located in Riyadh. Examples include research centers, such as KACST, or charity foundations, such as the King Faisal Foundation are examples.

They tend to occupy large amounts of land and have a distinctive design of buildings.

Figure 7-46 King Faisal Foundation (KFF)

(c) Universities

King Saud University is the oldest and premier university in the KSA. It has large campus in the western part of Riyadh, with many departmental buildings. It offers student housing in Sakan At-Tulab. The women's campus is situated at another site. Other universities were founded in Riyadh, mainly on the western part or the suburbs of the city.

Figure 7-47 King Saud University

(d) Schools

Local schools are located throughout the city. There is also a considerable number of international or foreign schools. This is due to the fact that no foreigners are admitted to enter Saudi schools, and also because many foreign workers reside in Riyadh.

(e) Hospitals

Healthcare is an important issue in the KSA. Riyadh and Jedda rank as cities with good healthcare and sanitation according to one international survey.

Large medical centers and mid-size hospitals are major infrastructural elements.

Figure 7-48 King Fahad Medical City

7.4.2 Site Visit Survey Results

(1) Sites Visited

The following governmental agencies were surveyed for building energy management and their own energy conservation activities.

- Ministry of Municipalities and Rural Affiars
- Ministry of Petroleum and Mineral Resources
- Riyadh Chamber of Commerce and Industry
- Al-Mawardy Secondary School

(2) Site Survey Summary

(a) Ministry of Municipalities and Rural Affiars (MOMRA)

(i) General Profile

The KSA does not adopt a local government system. Instead, 200 local municipalities are under the control of the Ministry of Municipalities and Rural Affairs (MOMRA) which precedes the local administration. The planning department of the MOMRA is in charge of the building forecast, city planning, new town construction, and the promotion of the housing supply.

MOMRA is also in charge of street lighting management with electricity supplied by the SEC. MOMRA consumes 2 % of SEC electricity sales.

(ii) Building Facility and Operation

MOMRA's building was constructed in 1995. It has a site area of 8,000 m2, eight floors (each 6,400 m2), and one basement 1,200 m2. A staff of 1,300 people works in the building. The building is insulated and adopts a CFL system. There is one meter and four transformers. SEC possesses 8 transformers (1 MVA). Voltages of upstream and downstream are 13.8 kV and 127V/220V respectively. Seven chillers, each with a capacity of 240 RT is operating in the building. Each chiller has three compressors of 80 RT (a total 21 compressors). In winter, all compressors are

stopped.

In summer, operation of chillers and compressors depends on the temperature: At night one compressor is used for each chiller and in the daytime, three compressors are used for one chiller. The total number of operating compressors is between 10 to 12 units at one time. Shift operation of all 21 compressors is conducted. There are 36 AHU units. Air conditioners are only for cooling. Temperature setting apparatuses in each room are locked and centrally controlled. The maintenance department is called when a temperature change is necessary.

(iii) Energy Management

Building Energy Management System (BEMS) of Johnson Control was installed from the beginning of operation. It supervises and controls air-conditioning, fire-fighting equipment, pumps, lightings, and water. The air conditioner temperature setting is not controlled by BEMS. However, air conditioner switches are installed in BEMS. A certain target in their energy management has not been established yet. Monthly electricity consumption is 600,000 kWh in winter and 1,000,000 kWh in summer.

(iv) Recommendation

Electricity data has been properly collected. To utilize such data more effectively, it is recommended that an internal energy target value be introduced and monitored periodically. For advancement, a competition and award system among HQ and local offices is expected.

(b) Ministry of Petroleum and Mineral Resources (MOPMR)

(i) General Profile

Ministry of Petroleum and Mineral Resources (MOPMR) was established in 1960 to implement the general policy related to oil, gas, and minerals. MOPMR supervises its affiliate companies working in the fields of petroleum and minerals by observing and monitoring exploration, development, production, refining, transportation, and distribution activities related to petroleum and petroleum products.

(ii) Building Facitily and Management

MOPMR HQ has two buildings. The main building has 3 basements, a ground floor, and 9 floors. The area of each floor is 2,824 m2. The annex building is for parking and has a floor area of 3,000 m2.

The main building is equipped with 4 chillers located on the top of the parking building and 16 AHUs. Each chiller has a capacity of 300 RT. Independent package-type air conditioners are installed on the 8th and 9th floor. Every room has a damper to control air flow rate. The annex building only has a ventilation system and there are two 400 kW emergency generators. In addition the facility has glass windows and a closed glass roof, which makes the 9th floor as hot as a furnace.

One chiller is running continuously to maintain the inside temperature. Others operate from 7:00

to 15:00 and are manually turned off after working hours. At maximum, 3 chillers operate at the same time and one remains stopped on stand-by. Room temperature is permanently set at 22 degrees.

(iii) Electric Power Consumption and Conservation Measures

MOPMR stores the records of electric power consumption of the buildings for at least 6 years. The building is equipped with BEMS supplied by Honeywell, which also has a security and fire protection system. There is not a function for monitoring room temperature. Using BEMS, a 50 % reduction in energy was achieved in the annex building. They do not plan to replace lamps with CFL's. An energy manager is not appointed for the facilities. The maintenance department is in charge of energy conservation.

In addition, based on an agreement between MOPMR and SEC, chillers can be switched off remotely by the SEC without prior announcement. MOPMR thinks it is acceptable, although they prefer to receive an announcement in advance.

(c) Riyadh Chamber of Commerce and Industry

(i) General Profile concerning Electricity Use

The Chamber is responsible for receiving and dealing with the complaints of the citizens. A consultant is employed to resolve the issues brought up in the complaints.

A tariff hike is one of the major recent complaints (from 12 to 15 Halala for the industrial sector). For example:

- Industry is the primary target for the tariff increase.
- Favorable treatment is given to citizens and the commercial sector that will not face an increase. This is in fact indirect taxation of the industry sector.

(ii) Building Facitily and Management

Constructed 24 years ago, the facility houses a two-story basement for parking and 6 stories of offices. Citizens applying for commercial stamps line up on the ground floor.

Six chillers are located on the rooftop. The air conditioning system of the floors used for offices does not function properly, causing an unevenness of temperature distribution. Basement parking floors have ventilation fans.

Toll bars are housed in 2 rooms, one has two 220V's ones and the other has three 110 V's ones and one 220 V.

(d) Al-Mawardy Secondary School

(i) General Profile

Al-Mawardy is a public, government-run secondary school (equivalent to high school) for boys from 15 to 18 years old. It does not have a dormitory.

It was constructed and opened in 1991. The school was named Al-Mawardy after a famous Saudi scientist. The government secured financing from the commercial sector and paid back the amount

it borrowed within 10 years. This is one of the first examples where the KSA government borrowed money from the commercial sector to finance the construction of a school. There are about 900 students, 300 in each grade.

The school has three courses;

- Morning course for all students from 6:30 to 13:00
- Evening course to support students with difficulties from 16:00 to 18:00
- Night course for people of all ages people from 18:30 to 21:00

Also during summer holidays, they have a program for the local children who are not students at the school. Many children join this program.

A school custodian lives at the school with his family; his house is located on the school grounds. He is probably not paid for the job, but happy to have to be allowed to live there. This is one example of a charity activity in KSA. A shop sells drinks and food to the students. Revenue from the store is used to facilitate operation of the school.

(ii) Building Facitily and Equipment

The area of the school is roughly 7,000 m2. The building is 2 stories tall and consists of an inner court, 30 classrooms, laboratories, a gymnasium, a library, 20 office rooms, toilets etc.

There are 57 rooms in all placed around an inner court. There are 3 blocks of classrooms per floor, which means there are 6 blocks of classrooms. A rough plan of the building is shown below.

The school is made of reinforced concrete. Insulation has been applied between the double walls. Roof insulation is made from foam material. Windows are small and without curtains or shading.

As seen in the pictures, equipment is hung directly from the ceiling. This means that the ceiling is finished on the surface of the concrete slab with no air space. If the ceiling has the same structure, the heat load of the rooms from the roof is estimated as very large.

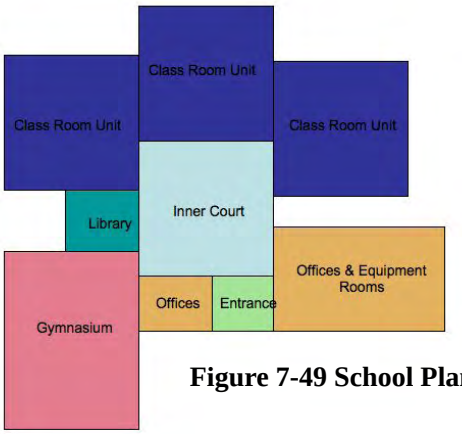


Figure 7-49 School Plan

All the lamps are German made fluorescent lamps (not with inverter). Mercury and sodium lamps are used in the gymnasium and inner court.

Regarding air conditioning, every room has ceiling fans. Chillers on the roof are the thermal source of the system. The system has a heating function as well. However, in the winter, only a few rooms use heating. As mentioned above, the gymnasium is the exception and uses evaporative air conditioning.

Figure 7- 50 Ceiling Fan of Air Conditioner

(iii) Rooms

Classroom units consist of an inner corridor and several classrooms. There are no lockers for students. Regulations stipulate there should be 1m2/student per classroom. The average number of students per classroom in the KSA is 40. Windows are small.

Figure 7-51 Classroom Unit Corridor

Figure 7-52 Classroom

There is an inner court at the center of the building. It is used for many purposes such as gatherings, prayer, and exercising because is too hot outside. There is a playground located outside. There is a steel structure on the roof with top-lights in the center and on the corners, however it is not transparent.

Figure 7-53 Inner Court

(iv) Energy

Except for laboratory purposes, electricity is the main source of energy for the school. There are two switch rooms; one inside and another outside.

There is a 2,000 liter LPG tank in a separate house. This is only used for laboratory purposes, not as energy source. The family of the school custodian uses a small amount of gas for themselves. Full LPG tank can provide gas for two years.

(v) Energy Conservation Education

In the entrance hall, there is a letter from the MOWE promoting the conservation of water and electricity. While no energy conservation education sessions are currently being held at the school, the director says he would welcome a school visitation program because it is one of the topics taught in the course of ‘National Study’.

(vi) Recommendation

The promotion of energy conservation awareness through schools is essential and effective. In addition, there is considerable potential for energy conservation in schools themselves, since they are all air conditioned, etc.

Concerning energy conservation activities, to begin teachers should lead the effort by switching

off lights and air conditioners. Moreover, installation of visible electricity meters in the rooms is recommended to raise energy conservation awareness and educate the students on energy use.

7.4.3 Challenges and Future Steps

(1) Challenges

Through the site survey of government buildings, the following items were identified as challenges.

- ✓ Governmental agencies usually reside in monumental buildings with large interior space and much equipment. They are basically equipped with advanced equipment. However, energy efficient management or operation is not seriously conducted due to a lack of awareness.
- ✓ Formation of an internal committee for energy conservation is not a common practice.
- ✓ Every agency is well aware of the critical situation regarding the energy supply and measures that have been to taken or future steps. However, no leading force or organized body exists to enforce implementation or development of energy conservation.

(2) Future Steps

To tackle the challenges above, the following steps are expected to be taken.

- ✓ The Governmental sector should initiate national energy conservation in terms of mechanical efficiency improvement, as well as operational manners, and be the leader for every sector.
- ✓ Great potential exists for energy conservation in their buildings. Therefore, various measures should be introduced and data regarding improvements in energy conservation should be collected.
- ✓ Information and data related to the installation of high efficiency equipment should be made available to the public and other sectors and be used to further encourage their own energy conservation activities.
- ✓ In addition to the measures mentioned above, initiate collection of energy use data should be conducted and reported in order to play an exemplar role in society.
- ✓ In order to advance this effort, an energy audit of all government facilities is recommended. Pilot ESCO practice in governmental buildings will promote the field of energy auditing and improvement.
- ✓ Development of a central organization or body to promote a nationwide energy needs campaign.

7.5 Mosque Sector

7.5.1 Basic Information

(1) Definition of Mosque Sector in Tariff

In the SEC tariff, mosque sector apply for two types of tariff. Public mosques apply for

government tariff. Private mosques apply for agricultural tariff.

(2) Numerical Data on the Mosque

There are 63,000 mosques in the KSA, out of which roughly 45,000 are public entities under the jurisdiction of the Ministry of Islamic Affairs (MOIA). The remaining are private mosques on which the MOIA does not possess accurate information.

In general, such mosques are categorized into 3 types: Jama (Friday mosques), large mosques, and small mosques.

7.5.2 Site Visit Survey Results

(1) Site Visit

The Al–Haigail mosque in Riyadh was surveyed. It is a private, Jama (Friday mosque) mosque.

(2) Interview Survey

(a) General Profile

General profile is shown below.

- Site Area: 4,700m2 (*assumption)
- Total Floor Area: 2,300m2 (*assumption)
- Hall Area: 1,300m2 (*assumption)
- Hall Volume: 9,000m3 (*assumption)
- Floor Number: 1 (partial mezzanine for women Salat (prayer))

There are 5 prayers practiced on a daily basis, called “Fard Salat” (the five compulsory daily prayers), as listed below. In addition, special prayers are practiced on Friday “Jumu’ah” and on the day of a funeral “Janazah”.

- Fajr (dawn to sunrise)
- Dhuhr (after true noon until Asr)
- Asr (before sunset)
- Maghrib (after sunset until dusk)
- Isha’a (Dusk until dawn)

According to the mosque staff, there are generally 30 people that pray at Isha’a, 150 at Maghrib, and more than 1,000 (filling the hall, courtyard, and outer areas) at Jumu’ah.

The mezzanine floor is for women. However, on Fridays, men are sometimes allowed on the mezzanine because the number of people is so great.

Figure 7-54 Mosque

(b) Facility and Operation

(i) Air Conditioner

6 package units (each with 2.5 RT of cooling capacity) are placed on the roof for the prayer hall. Cooled air is supplied from ducts around the sky light. Air returns through ducts located on the corners of the ceiling.

There are 8 pendant fans in the hall and a few window-type air conditioners for back rooms. The temperature of 4 thermostats for the package units is set at 22 degrees. Two of the six units run 24 hours a day, even when prayer is not being conducted. The remaining 4 units are run from 11:00 to 21:00 (before Dhuhr to Isha'a).

(ii) Lighting

There are 9 large chandeliers in the hall, but they are not used because of the radiating heat. Instead, fluorescent lamps (not highly efficient) on the ceiling are turned on during prayers.

(c) Recommendation

It is recommended that air conditioning operation be used only for prayer time. The temperature should be set at more than 22 degrees at all times.

Besides, currently cooled air is supplied and returned to ducts located at the same place on the ceiling. However, most of prayers stay at floor area in mosque. To reduce the air conditioning load, a low layer air conditioning zone can be designed.

(3) Measurement Survey

Since the beginning of September, a power meter has been installed for the measurement of electricity consumption. The daily load curve for September 3rd is shown below. The graph also suggests potential energy saving by stopping 2 air conditioning units when prayers are not being conducted.

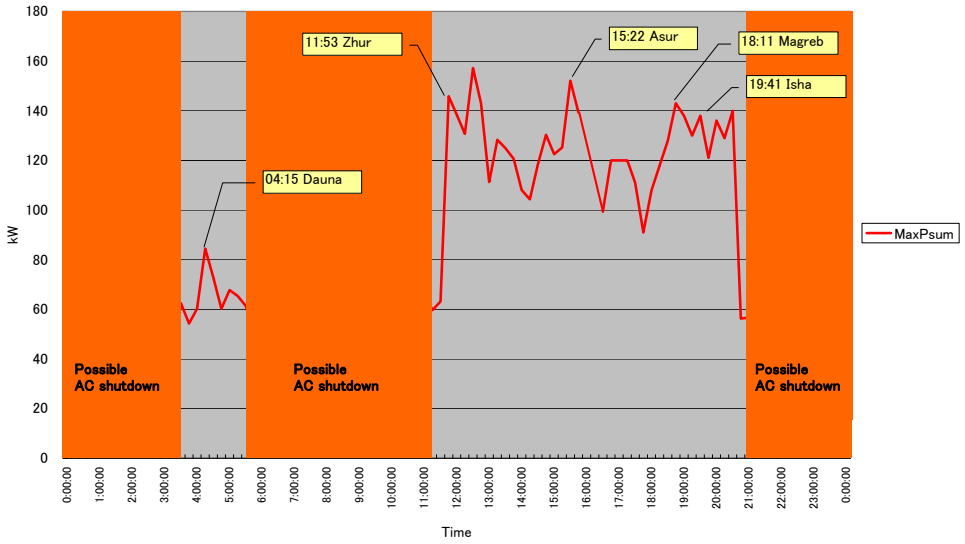


Figure 7-55 Daily Load Curve of the Mosque (September 3rd)

7.5.3 Challenges and Future Steps

(1) Challenges

Air conditioning accounts for the majority of energy consumption. Potential for energy savings exists if 2 units of the air conditioners are turned off when prayers are not being conducted and by setting the temperature a bit higher. This operational manner also would not have an affect on prayers. To implement such energy conservation activities, cooperation is required from the mosque staff.

(2) Future Steps

Two measures to tackle these challenges and encourage energy conservation are as follows:

- Request mosques to practice efficient use of air conditioners and lamps.
- Request Imam (mosque leader) to encourage efficient use of air conditioners and lamps during prayer time.

7.6 Public Lighting

7.6.1 Basic Information

(1) Definition of Public Lighting in Tariff

In the SEC tariff, public lighting is categorized as a governmental tariff.

(2) Numerical Data of Public Lighting

Public lighting is maintained by 2 agencies, namely the Ministry of Municipality and Rural Affairs (MOMRA) and the Ministry of Transportation (MOT). MOMRA covers public lighting within city. MOT covers intercity public lighting on highways. Public lighting of MOMRA is much more extensive than that of MOT.

According to MOMRA officials, the HQ of MOMRA does not have statistical data for public lighting, because the lighting works are managed by each local office. However, the officials estimated that:

- About 10,000 distribution boards presently exist at
- One distribution board connects to 70 lighting poles
- This means there are 700,000 lighting poles (1 pole has 1 or 2 lamps)

7.6.2 Site Visit Survey Results

(1) Site Visit

An interview survey was made for the HQ of MOMRA.

(2) Interview Survey

(a) General

MOMRA with local offices manages road lighting within municipality, including public gardens, public parks, markets, etc. Electricity is supplied from SEC to the distribution boards of MOMRA. There are about 200 local offices that manage lighting in each allocated area.

Lamps use mercury or sodium type bulbs ranging from 100 W to 400 W. Most lamps automatically switch on and off by sunlight sensor. However, these lamps can also be put on a timer setting.

(ii) Energy Conservation Measures Conducted

In 1997, the HQ sent a letter to the local offices asking them to begin energy conservation efforts for lighting. However, energy monitoring using indicators such as total electricity consumption, electricity consumption per road length, etc. has not been introduced yet.

Load switching from one distribution board to another when the board exceeds 10,000 kWh in a month is the only energy conservation method that has been adopted. The reason is the electricity rate increases when consumption exceeds 10,000 kWh.

Currently, MOMRA is studying the possibility of turning off every other lamp along road, together with MOWE.

7.6.3 Challenges and Future Steps

(1) Challenges

Regarding electricity consumption, statistical data has not been prepared yet. However, the preparation of such data is important for energy conservation.

(2) Future Steps

Collection of electricity consumption data and monitoring by each region are expected from the public lighting sector. To begin monitoring efforts, a data collection system should be arranged in coordination with local offices.

7.7 Others

7.7.1 City Structure

(1) Riyadh City

The city of Riyadh is situated on flat land. No rail transit exists; therefore the transportation infrastructure of the city consists of roads and highways. Highways lead to other major cities in the north, south, west, and east. There is a so called ring road around the city, although it is only partially built.

Old Riyadh or Al-Bathaa, with monumental ruins, is the historical district which began to

develop in early 20th century. This area is the southern center of Riyadh. Souks (old style marketplaces) are characterized by brown dots on the map and as the map shows, they exist in this area.

Roads in Old Riyadh are tangled, however the remainder of the city is laid out in a grid pattern. This section of the city was developed by city planning in the later 20th century. Most square block of a little less than 1km in length rotate by 25 degrees in the direction of Mecca.

Within the newly developed city, the strip between Al Ulaya street and the King Fahad road is a symbolical and central axis (pink zone on the map). In this zone are such monumental landmarks as Kingdom Tower and Al Faisaliyah Center. Around this strip is the northern central district, called Ulaya District.

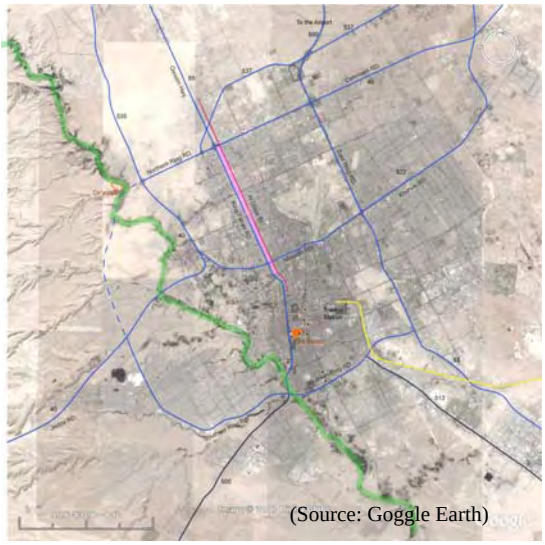


Figure 7-56 Map of Riyadh City

(2) Districts and Distribution of Commercial Buildings

The Ulaya district and Old Riyadh are the busiest centers with many attractions. After the sunset and on weekends, roads are heavily crowded with the cars of visitors. Orange dots on the map show the distribution of major shopping centers. Hotels and major facilities are also situated in around these districts.

However, strict zoning of commercial buildings is not visible in the city. For example, there seems to be no business district with only office related facilities as seen in other major cities. Several streets are lined with shops; however there are few pedestrians on the streets. The extreme heat makes travel by car more convenient. Therefore, the adjacency of buildings is not as advantageous as it is for cities with milder climates.

Perimeters of urban blocks are occupied by retail or office buildings. Houses are built within the perimeters of these areas, even in the central area. The north and east part of the city are primarily developed residential area, while the western residential area developed only recently. Many factories and warehouses lie to the south.

7.7.2 Insulation and Air Conditioner

(1) Structure and Insulation of Buildings

Except for preserved historical monuments, no traditional adobe buildings are seen in the city. Most of the buildings are made of reinforced concrete. There was one concrete building with no steel in Old Riyadh, but it was scheduled to be demolished.

Reinforced concrete is only used for the frame of architecture, columns, beams, and slabs. Walls including, outer ones are made with concrete blocks which they call ‘infill’. This basic

configuration is standard and common in all types of buildings, for houses or tall buildings.

In many large construction sites, insulation panel were placed on the outside of the wall, as shown below (violet color zone). Various types of finishing materials are used such as stone, tiles, glass etc. Pair glasses are often used for retail buildings. According to a picture of a housing construction site that was obtained, concrete blocks with sandwiched styrofoam seems to be the major insulating material used for houses.

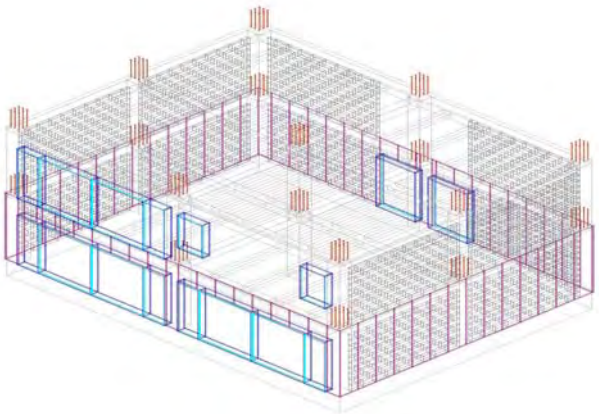


Figure 7-57 Insulation Panel Position

Figure 7-58 Insulation Block

(2) Air Conditioning

(a) Air Conditioner for Large Scale Buildings

For a typical large-scale commercial building, a central chiller system is the most popular. In most cases, they are placed outside on the roof and either air-cooled or water-cooled. Electricity is the main energy source. Manufacturers such as TRANE or Carrier are popular. Some larger buildings, such as Al Faisaliyar Tower, have interior heat source rooms, but this seems to be a rare case.

Some of them are almost 30 years-old. Since they are located in major facilities, internal staff members take care of maintenance and continued to be used. This type of central system cannot be maintained without professional operation. However, replacement of old equipment with highly energy efficient machines seems to produce considerable electricity savings.

Figure 7-59 Roof of Sheraton Riyadh Hotel

Additionally, some costumers do not concern about an energy efficient manner, such as monitoring of coolant temperature or control of operational numbers.

Since it is a custom to place machines on the roof in KSA, they need to be designed to operate efficiently in the harsh sun and desert dust.

(b) Air Conditioner for Middle Scale Buildings

To demonstrate a typical air-conditioning system for a middle-size building in Riyadh, the roof

plan of a mosque is shown below. There are as many package air conditioners as the number of interior zones. Otherwise, several units serve a large space and supply building with cool air. Commercial buildings (MOWE HQ building) have also basically the same system. American manufacturers are also popular for this duct-type system. Several large houses also have this duct-type system.

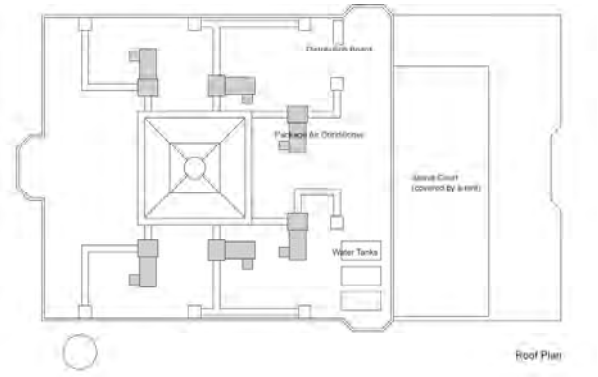


Figure 7-60 Plan of Mosque Roof

Figure 7-61 Roof of MOWE Building

Unlike facilities with chillers, the machines seem to be poorly maintained. The system also seemed to function poorly in the house we visited with this system. Their fresh air intake openings are often closed. Total heat exchangers are not introduced. This is possibly due to the large interior space per person and air leakage, the level of CO2 inside does not increase and is not a major issue.

Operation (on/off, setting temperature) of these air conditioners seem to be done freely by building users to meet their comfort needs.

(c) Air Conditioner for Small Scale Buildings or Houses

In small buildings or houses, window or separate air conditioners are used. Window types are still common and sold in stores by major Japanese and Korean manufactures. The fact that outside walls are made of concrete blocks with no steel rods makes it easy to install additional units after construction. They are also used for multi story apartments or cheaper hotels.

Cassette-type ceiling indoor units are not used in this country. Because room ceilings are often finished directly on the concrete slab and have no attic space to install these types.

Evaporative coolers are also used for houses. Low humidity makes them effective for electricity conservation, but cost of water use is another problem.

Figure 7-62 Window Air Conditioner

Figure 7-63 Evaporative Cooler