No. 2-1

Japan International Cooperation Agency (JICA)

Instituto Nacional de Electrificación

The Republic of Guatemala

Amatitlan Geothermal Development Project

FINAL REPORT

Main Report

December 2001

West Japan Engineering Consultants, Inc.

Japan International Cooperation Agency (JICA)

Instituto Nacional de Electrificacion,

The Republic of Guatemala

Amatitlan Geothermal Development Project

FINAL REPORT

Main Report

December 2001

West Japan Engineering Consultants, Inc.

PREFACE

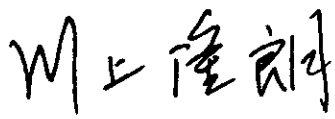
In response to a request from the Government of the Republic of Guatemala, the Government of Japan accepted to carry out the Study on the Amatitlan Geothermal Development Project. The study was implemented by the Japan International Cooperation Agency (JICA).

From September 1998 to December 2001, JICA dispatched to Guatemala six missions of study team led and organized by Mr. Toshio Fujino of West Japan Engineering Consultants, Inc. (West JEC). During the missions, the teams conducted related field surveys and held discussions with the officials concerned of the Government of the Republic of Guatemala. In Japan, the teams conducted further studies and lastly they compiled the all results in this final report.

It is our wish that this report will contribute to devise the optimum strategy for geothermal exploitation in the Amatitlan area and to enhance the friendly relations between our two countries.

I express my sincere appreciation to the officials concerned of the Government of the Republic of Guatemala for their close cooperation throughout the study.

December 2001



Takao Kawakami
President
Japan International Cooperation Agency

December 2001

Mr. Takao Kawakami
President
Japan International Cooperation Agency
Tokyo, Japan

Dear Mr. Kawakami

Letter of Transmittal

We are pleased to submit to you the Final Report on "Amatitlan Geothermal Development Project". Under the contract with your esteemed organization, the subject study was carried out during 40-month period from September 1998.

With due consideration of the current situation of energy supply/demand and electricity production in Guatemala, the present study has been done to determine the extension of the Amatitlan geothermal field and to assess, from the technical, economical and financial points of views, the viability of optimum exploitation in a sustainable manner. In addition, the essential technical co-operation was set to carry out " on the job" training to INDE's officers and the technical transferring seminar to the geothermal related personnel in Guatemala.

This report compiles the field potential based upon a geothermal conceptual model updated by the results of various field surveys. This report also proposes a program for the construction of power facilities. Also reflected are the comments of the officials of energy related institutions through the discussions in the counterpart team meetings held in Guatemala from time to time in the study period.

We wish to take this opportunity to express our sincere gratitude to the officials concerned of JICA, the Ministry of Foreign Affaires, and Ministry of Economy, Trade and Industry. We also wish to express our deepest gratitude to the Ministry of Energy and Mines, Instituto National de Electrificacion (INDE), the Embassy of Japan in Guatemala and the JICA Guatemala office for the close cooperation and assistance extended to us during the period.

Very truly yours,

Toshio Fujino
Team Leader
The Amatitlan Geothermal Development Project

Contents

1 OUTLINE OF THE PROJECT ····· 1- 1
1.1 Background ····· 1- 1
1.2 Objectives of the Study ····· 1- 1
1.3 Outline of the Study and Work Content of Each Stage ····· 1- 1
1.3.1 Outline of the Study ····· 1- 1
1.3.2 Description of the Services for the 2001 Fiscal Year (F/S Survey) ····· 1- 2
1.4 Survey Team ····· 1- 3
1.5 Acknowledgements ····· 1- 3

2 SUMMARY OF THE SURVEYS DONE IN PREVIOUS YEARS ····· 2.1- 1
2.1 The Amatitlan Project within the Electric Sector of Guatemala ····· 2.1- 1
2.1.1 Overview of the electric sector of Guatemala ····· 2.1- 1
2.1.2 The Generation System ····· 2.1- 7
2.1.3 The Transmission System ····· 2.1- 8
2.1.4 The Distribution System ····· 2.1- 8
2.1.5 Demand Forecast for the SNI ····· 2.1- 9
2.1.6 Update of Economy and Political Aspects ····· 2.1-10
2.1.7 Political Situations ····· 2.1-11
2.1.8 Actions to improve the Coverage and to secure the Electricity Supply 2.1-11
2.1.9 Alternatives for Power Generation in Guatemala ····· 2.1-12
2.1.10 Conclusion ····· 2.1-13
2.2 Geoscientific Studies ····· 2.2- 1
2.2.1 Geological Survey ····· 2.2- 1
2.2.2 Geochemical Survey ····· 2.2- 4
2.2.3 Gravity Survey ····· 2.2- 7
2.2.4 Magnetotelluric Survey ····· 2.2- 9
2.3 Exploratory Well Drilling ····· 2.3- 1
2.3.1 Well AMJ-1 ····· 2.3- 1
2.3.2 Well AMJ-2 ····· 2,3- 3
2.4 Well Survey ····· 2.4- 1
2.4.1 Well Geology ····· 2.4- 1
2.4.2 Well Geochemistry ····· 2.4- 8
2.4.3 Completion Testing and Bore hole Surveys ····· 2.4-11

2.5 Geothermal Conceptual Model 2.5-1
2.5.1 Geological Structure 2.5-1
2.5.2 Heat Source 2.5-3
2.5.3 Temperature Distribution 2.5-3
2.5.4 Geochemical Model 2.5-4
2.5.5 Conceptual Model 2.5-5

3 DEVELOPMENT PROGRAM 3.1- 1
3.1 Resource Assessment 3.1- 1
3.1.1 Numerical Model 3.1- 1
3.1.2 Natural State Calibration 3.1- 2
3.1.3 History Matching Calibration 3.1- 3
3.1.4 Forecasting and Field Potential 3.1- 5
3.1.5 Results of Forecasting 3.1- 6
3.2 Development Plan of Power Plant 3.2- 1
3.2.1 Condition for Planning 3.2- 1
3.2.2 Fluid Collection and Reinjection System 3.2- 4
3.2.3 Power Plant Facilities 3.2- 5
3.2.4 Transmission Line and Substation 3.2-11
3.2.5 Project Implementation 3.2-12
3.2.6 Project Cost Estimate 3.2-15
3.3 Envionmental Impact Assessment 3.3- 1
3.3.1 Object of the Exaination 3.3- 1
3.3.2 Environmental Regulation and Guidelines in Guatemala 3.3- 1
3.3.3 Outline of the Field Survey Results 3.3- 3
3.3.4 Environmental Monitoring during the Wells Drilling & Well Tests 3.3- 3
3.3.5 Environmental Impact Assessment 3.3- 5
3.3.6 General Recommendation for Next Project 3.3- 9
3.4 Economical and Financial Evaluation 3.4- 1
3.4.1 Necessity of Project 3.4- 1
3.4.2 Least Cost Solution 3.4- 3
3.4.3 Financial Evaluation 3.4- 6

4 INTEGRATION AND RECOMMENDATION 4- 1
4.1 Integration 4- 1
4.1.1 Geothermal Conceptual Model 4- 1

4.1.2 Resource Assessment 4- 2
4.1.3 Forecasting and Field Potential 4- 3
4.1.4 Development Plan of Power Plant 4- 4
4.1.5 Environmental Impact Assessment 4- 5
4.1.6 Economic and Financial Evaluation 4- 5
4.2 Recommendation 4- 7
4.2.1 Exploitation in Amatitlan Geothermal Field 4- 7
4.2.2 Site of Power Plant 4- 7
4.2.3 Educative Activities and Understanding to Local Communities 4- 8
4.2.4 Geothermal Potential in Surrounding Areas 4- 8

Figure

Fig. 2-1-1(a) Structure of the Guatemalan Power Sector 2.1-15
Fig. 2-1-1(b) Market of the Guatemalan Power Sector 2.1-16
Fig. 2-1-2 Daily Piling of Energy Costs 2.1-17
Fig. 2-1-3 Average Whole Sale Market Price 2.1-18
Fig. 2-1-4 Structure of the Power Sector in Guatemala 2.1-19
Fig. 2-1-5 The Transmission System of Guatemala 2.1-20
Fig. 2-1-6 Distribution Regions in Guatemala 2.1-21
Fig. 2-1-7 Number of Connected Customers 2.1-22
Fig. 2-1-8 Map of the Electrification Coverage 2.1-23
Fig. 2-1-9 Electrification Growth Ration in Guatemala 2.1-24
Fig. 2-1-10 Installed Capacity and Energy Demand 2.1-25
Fig. 2-2-1 Volcanic Chain in Central America 2.2-13
Fig. 2-2-2 Regional Tectonic Map 2.2-14
Fig. 2-2-3 Geological Map 2.2-15
Fig. 2-2-4 Stratigraphy of the Amatitlan Geothermal Field 2.2-16
Fig. 2-2-5 Geological Structure 2.2-17
Fig. 2-2-6 Location Map of Fluid Samples for Analysis 2.2-18
Fig. 2-2-7 Geochemical Model of Hydrothermal System 2.2-19
Fig. 2-2-8 Compiled Map of Permeable Zone by Soil-Gas Survey 2.2-20
Fig. 2-2-9 Gravity Interpretation Map 2.2-21
Fig. 2-2-10 Magnetic Interpretation Map 2.2-22
Fig. 2-2-11 Resistivity Discontinuities Distribution Map 2.2-23
Fig. 2-2-12 Resistivity Structure in Shallow Zone 2.2-24
Fig. 2-2-13 Resistivity Structure in Deep Zone 2.2-25
Fig. 2-3-1 AMJ-1 Well Completion Diagram 2.3- 5
Fig. 2-3-2 AMJ-2 Well Completion Diagram 2.3- 6
Fig. 2-3-3 AMJ-1 Well Drilling Diagram 2.3- 7
Fig. 2-3-4 AMJ-2 Well Drilling Diagram 2.3- 8
Fig. 2-4-1 Geological Integrated Column of Well AMJ-1 ..... 2.4-21
Fig. 2-4-2 Geological Integrated Column of Well AMJ-2 ..... 2.4-22
Fig. 2-4-3 Correlation of Geological Column 2.4-23
Fig. 2-4-4 Homogenization Temperature versus Ice Melting Point of Fluid Inclusion from Well AMJ-1 ..... 2.4-24
Fig. 2-4-5 Homogenization Temperature versus Ice Melting Point of Fluid Inclusion from Well AMJ-2 ..... 2.4-25

Fig. 2-4-6 Enthalpy versus Cl Diagram ····· 2.4-26
Fig. 2-4-7 Variation Diagram of Water Chemistry of the Well AMJ-2 ····· 2.4-27
Fig. 2-4-8 Trend Diagram of Monitoring Data on Water Chemistry of the Wells AMJ-1 and AMJ-2 ····· 2.4-28
Fig. 2-4-9 Trend Diagram of Monitoring Data on Gas Chemistry of the Wells AMJ-1 and AMJ-2 ····· 2.4-29
Fig. 2-4-10 Well AMJ-1 Temperature – Pressure Surveys: 800 m ····· 2.4-30
Fig. 2-4-11 Well AMJ-1 Temperature Build up Surveys: 1,700 m ····· 2.4-31
Fig. 2-4-12 Well AMJ-1 Pressure Build up Surveys: 1,700 m ····· 2.4-32
Fig. 2-4-13 Flow Rate and Pressure Data during Injectivity Tests: Well AMJ-1 ····· 2.4-33
Fig. 2-4-14 Well AMJ-2: Static temperature profiles ····· 2.4-34
Fig. 2-4-15 Well AMJ-2: Static pressure profiles ····· 2.4-35
Fig. 2-4-16 Flow rate and pressure data, Well AMJ-2 injectivity test ····· 2.4-36
Fig. 2-4-17 Well setup for the "James" Lip Pressure Method ····· 2.4-37
Fig. 2-4-18 Results of the first flow testing on well AMJ-1 ····· 2.4-38
Fig. 2-4-19 Well characteristic curve for the first flow testing on well AMJ-1 ····· 2.4-39
Fig. 2-4-20 Results of the second flow testing on well AMJ-1 ····· 2.4-40
Fig. 2-4-21 Well characteristic curve for the second flow testing on well AMJ-1 ····· 2.4-41
Fig. 2-4-22 Results of the first flow testing on well AMJ-2 ····· 2.4-42
Fig. 2-4-23 Well characteristic curve for the first flow testing on well AMJ-2 ····· 2.4-43
Fig. 2-4-24 Results of the second flow testing on well AMJ-2 ····· 2.4-44
Fig. 2-4-25 Well characteristic curve for the second flow testing on well AMJ-2 ····· 2.4-45
Fig. 2-5-1 Geothermal Structural Model (Horizontal Section) ····· 2.5- 7
Fig. 2-5-2 Geothermal Structural Model (A-A' Section) ····· 2.5- 8
Fig. 2-5-3 Geothermal Structural Model (B-B' Section) ····· 2.5- 9
Fig. 2-5-4 Geochemical Model of Hydrothermal System ····· 2.5-10

Fig. 3-1-1 Reservoir simulation methodology ····· 3.1- 8
Fig. 3-1-2 Control volume and grid used to represent the Amatitlan reservoir ····· 3.1- 9
Fig. 3-1-3 Layers of the control volume ····· 3.1-10
Fig. 3-1-4 Contour map of field and calculated temperatures, layer 4 (AB, +150 m) ····· 3.1-11
Fig. 3-1-5 Contour map of field and calculated temperatures, layer 3 (AC, +450 m) ····· 3.1-12
Fig. 3-1-6 Contour map of field and calculated temperatures, layer 2 (AD, +750 m) ····· 3.1-13
Fig. 3-1-7 Contour map of field and calculated temperatures, layer 1 (AE, +1050 m) ····· 3.1-14
Fig. 3-1-8 Well AMF-1 Production history and enthalpy matching ····· 3.1-15
Fig. 3-1-9 Well AMF-1 Power production history ····· 3.1-16

Fig. 3-1-10 Well AMF-2 Production history and enthalpy matching 3.1-17
Fig. 3-1-11 Well AMF-2 Power production history 3.1-18
Fig. 3-1-12 Well AMF-3 Injection history 3.1-19
Fig. 3-1-13 Temp. (C) distribution after history matching calibration, Layer 1 (AE, +1050) .. 3.1-20
Fig. 3-1-14 Pressure (ksc) distribution after history matching, Layer 1 (AE, +1050) 3.1-21
Fig. 3-1-15 Satur. (%) distribution after history matching calibration, Layer 1 (AE, +1050) .. 3.1-22
Fig. 3-1-16 Temp. (C) distribution after history matching calibration, Layer 2 (AD, +750) 3.1-23
Fig. 3-1-17 Pressure (ksc) distribution after history matching, Layer 2 (AD, +750) 3.1-24
Fig. 3-1-18 Satur. (%) distribution after history matching calibration, Layer 2 (AD, +750) ... 3.1-25
Fig. 3-1-19 Temp. (C) distribution after history matching calibration, Layer 3 (AC, +450) 3.1-26
Fig. 3-1-20 Pressure (ksc) distribution after history matching, Layer 3 (AC, +450) 3.1-27
Fig. 3-1-21 Satur. (%) distribution after history matching calibration, Layer 3 (AC, +450) ... 3.1-28
Fig. 3-1-22 Exploitation Scenarios for the Amatitlan Reservoir 3.1-29
Fig. 3-1-23 Drilling pads and targets of existing and additional wells 3.1-30
Fig. 3-1-24 Scenario-1: 20 MW results of forecasting 3.1-31
Fig. 3-1-25 Scenario-1: Forecasted well production 3.1-32
Fig. 3-1-26 Scenario-2: 20MW + 20 MW results of forecasting 3.1-33
Fig. 3-1-27 Scenario-2: Forecasted well production-a 3.1-34
Fig. 3-1-28 Scenario-2: Forecasted well production-b 3.1-35
Fig. 3-1-29 Scenario-3: 40 MW results of forecasting 3.1-36
Fig. 3-1-30 Scenario-3: Forecasted well production-a 3.1-37
Fig. 3-1-31 Scenario-3: Forecasted well production-b 3.1-38
Fig. 3-2-1 Route of Steam and Brine Pipelines (Outside Caldera) 3.2-16
Fig. 3-2-2 Route of Steam and Brine Pipelines (Inside Caldera) 3.2-17
Fig. 3-2-3 Conceptual Diagram of Fluid Collection and Reinjection System (Outside Caldera) 3.2-18
Fig. 3-2-4 Conceptual Diagram of Fluid Collection and Reinjection System (Inside Caldera) 3.2-19
Fig. 3-2-5 Layout of Power Plant 3.2-20
Fig. 3-2-6 Heat & Mass Balance Diagram 3.2-21
Fig. 3-2-7 Single Line Diagram 3.2-22
Fig. 3-2-8 Route Map of 138kV Transmission Line 3.2-23
Fig. 3-2-9 Transmission Network Diagram 3.2-24
Fig. 3-2-10 Construction Schedule (Case 1) 3.2-25
Fig. 3-2-11 Construction Schedule (Case 2) 3.2-26
Fig. 3-2-12 Construction Schedule (Case 3) 3.2-27
Fig. 3-3-1 H2S Abatement Process/ Technology for Geothermal Application 3.3-10

Fig. 3-4-1 Demand and Installed Capacity 3.4- 2
Fig. 3-4-2 Sensitivity to Capacity Factor 3.4- 9
Fig. 3-4-3 Sensitivity to Project Cost 3.4- 9
Fig. 3-4-4 Sensitivity to Power Rate 3.4-10
Fig. 3-4-5 Sensitivity to Steam Rate 3.4-10
Fig. 3-4-6 Sensitivity to Interest Rate 3.4-11

Table

Table 1-1-1 Activities Schedule in 2001 Fiscal year 1- 4
Table 2-1-1 The Wholesale Market Members 2.1-26
Table 2-1-2 Load Dispatch Program (MW): Thursday May 31, 2001 ..... 2.1-27
Table 2-1-3 Spot Price of Energy at the Reference Node (GUATEMALA SUR 230 KV) in US$/MWh, Period from May 01 to May 31, 2001 ..... 2.1-28
Table 2-1-4 Interconnected National Grid (SNI): Installed Capacity (December 2000) 2.1-29
Table 2-1-5 Present Coverage and Growth Rate of Electrification per Departments 2.1-30
Table 2-1-6 Demand Forecast (Medium Scenario) 2.1-31
Table 2-1-7 Interconnected Grid (SNI): Scenarios for Energy Demand Forecast 2.1-32
Table 2-1-8 Country Overview 2.1-33
Table 2-1-9 Economic Overview 2.1-34
Table 2-1-10 Environmental Overview 2.1-35
Table 2-3-1 Rig Time Distribution on Well AMJ-1 ..... 2.3- 9
Table 2-3-2 Rig Time Distribution on Well AMJ-2 ..... 2.3-10
Table 2-3-3 Drilling Equipment for Well AMJ-1 ..... 2.3-11
Table 2-3-4 Drilling Equipment for Well AMJ-2 ..... 2.3-12
Table 2-3-5 Drift-angle Survey Data of Well AMJ-1 ..... 2.3-13
Table 2-3-6 AMJ-2 Directional Drilling Data 2.3-14
Table 2-3-7 Record of the Loss of Circulation Zones of Well AMJ-1 ..... 2.3-15
Table 2-3-8 Record of the Loss of Circulation Zones of Well AMJ-2 ..... 2.3-16
Table 2-3-9 Hydro-fracturing Data of Well AMJ-1 ..... 2.3-17
Table 2-3-10 Hydro-fracturing Data of Well AMJ-2 ..... 2.3-18
Table 2-3-11 Cementing Data of Well AMJ-1 ..... 2.3-19
Table 2-3-12 Cementing Data of Well AMJ-2 ..... 2.3-20
Table 2-3-13 Bit Record of Well AMJ-1 ..... 2.3-21
Table 2-3-14 Bit Record of Well AMJ-2 ..... 2.3-22
Table 2-3-15 List of Used Materials of Well AMJ-1 ..... 2.3-23
Table 2-3-16 List of Used Materials of Well AMJ-2 ..... 2.3-25

Table 2-4-1 Morphological Data on Zircon ····· 2.4-46
Table 2-4-2 Volcanic and Alteration Age around the Amatitlan Geothermal Field ····· 2.4-47
Table 2-4-3 Results of X-ray Diffraction Analysis of Well AMJ-1 ····· 2.4-48
Table 2-4-4 Results of X-ray Diffraction Analysis of Well AMJ-2 ····· 2.4-49
Table 2-4-5 Result of Chemical and Isotope Analyses of Hot Water Samples ····· 2.4-50
Table 2-4-6 Result of Chemical and Isotope Analyses of Gas Samples ····· 2.4-51
Table 2-4-7 Specifications of borehole surveys for well AMJ-1 and AMJ-2 ····· 2.4-52
Table 2-4-8 Specifications of Water loss temperature test in AMJ-1 ····· 2.4-53
Table 2-4-9 Specifications of Water loss temperature test in AMJ-2 ····· 2.4-54
Table 2-4-10 Specifications of Injection and Transient Tests for well AMJ-1 ····· 2.4-55
Table 2-4-11 Specifications of Injection and Transient Tests for well AMJ-2 ····· 2.4-55
Table 2-4-12 Results of the curve matching and hydraulic properties for well AMJ-1 ····· 2.4-56
Table 2-4-13 Results of the curve matching and hydraulic properties for well AMJ-2 ····· 2.4-56
Table 2-4-14 Pre-heating up, stimulation and well testing ····· 2.4-57
Table 2-4-15 Specification for the dynamic pressure, temperature surveys ····· 2.4-58

Table 3-1-1 Physical properties of materials in the numerical model ····· 3.1-39
Table 3-2-1 Selection of Generating Technology ····· 3.2-28
Table 3-2-2 Estimated Project Cost (Plant Site I, Outside Caldera) ····· 3.2-29
Table 3-2-3 Estimated Project Cost (Plant Site II, Inside Caldera) ····· 3.2-30
Table 3-3-1 Hot Water Volume of Each Wells ····· 3.3-11
Table 3-3-2 Chemical Components of Hot Water ····· 3.3-11
Table 3-3-3 Chemical Components of Condensed Water ····· 3.3-11
Tavle 3-3-4 Contamination Concentrations in Selected Geothermal Fluids and Gases and in a World Average Freshwater ····· 3.3-12
Table 3-3-5 Comparison on Total H2S Emission and H2S Concentration with Other Existing P/P 3.3-13
Table 3-4-1 Existing Power Facilities ····· 3.4- 1
Table 3-4-2 Demand Forecast ····· 3.4- 2
Table 3-4-3 Project Base Cost ····· 3.4- 4
Table 3-4-4 Geothermal Plant Operating Conditions ····· 3.4- 5
Table 3-4-5 kW Unit Construction Cost and Generating Cost ····· 3.4- 5
Table 3-4-6 Project Cost ····· 3.4- 7
Table 3-4-7 Loan Term ····· 3.4- 7
Table 3-4-8 FIRR ····· 3.4- 8
Table 3-4-9 Accumulated Profit ····· 3.4- 8

<Appendix>

Appendix 1: Financial Evaluation: Inside Caldera

Appendix 2: Financial Evaluation: Outside Caldera

Appendix 3: Sensitivity Analysis

1 OUTLINE OF THE PROJECT

1.1 Background

1.2 Objectives of the Study

1.3 Outline of the Study and Work Content of Each Stage

1.4 Survey Team

1.5 Acknowledgements

1. OUTLINE OF THE PROJECT

1.1 BACKGROUND

In September 1997, the Guatemalan Government requested to the Japanese Government, through the Japanese Embassy in Guatemala, technical assistance to define the extension of the Amatitlan geothermal field. This assistance would also be to provide Instituto Nacional de Electrificacion (INDE) with the advice on the most appropriate operative scheme of a geothermal power plant to exploit the geothermal resource in this field.

In May 1998, The Japan International Co-operation Agency (JICA) and INDE entered an agreement to fulfil the request and the present project entitled "**Amatitlan Geothermal Development Project**" was officially admitted. The studies commenced on September 1998.

1.2 OBJECTIVES OF THE STUDY

The objective of the study is to determine the extension of the Amatitlan geothermal field and to assess, from the technical, economical and financial points of views, the viability of exploiting, in a sustainable manner, the geothermal resources for electricity production. In addition, as an important component of the present Technical Co-operation, the objective was set to carry out "on the job" technical training and transfer of technology to INDE's personnel.

1.3 OUTLINE OF THE STUDY AND WORK CONTENT OF EACH STAGE

1.3.1 OUTLINE OF THE STUDY

The basic plan for the project was agreed on May 18, 1998 between The Ministry of Mines and Energy, Instituto Nacional de Electrificacion and the Japan International Cooperation Agency. The detailed structure and contents were defined in the Terms of Reference published on July 17, 1998.

The activities for the project, which included the drilling of two exploratory wells, were originally accommodated into three stages, Each of these stages were scheduled to be carried out during the Japanese fiscal years 1998, 1999 and 2000, respectively. However during the execution of Stage-1, the time line for the project was modified to allow the drilling of one well during the Fiscal Year 1999 and to postpone the drilling of the second well to the Fiscal Year 2000.

i) STAGE-1: Preliminary Survey Stage (Fiscal Year 1998)

- i-1 Preparation in Japan (Inception Report & Preparation of Field Logistic)
- i-2 First Term of Services in Guatemala (Focus Mission & Geoscientific Field Survey)
- i-3 First Term of Services in Japan (Data Processing Integration & Preparation for Drilling)
- i-4 Second Term of Services in Guatemala (Progress Report & Presentation of Results)

ii) STAGE-2: Detailed Survey Stage (Fiscal Year 1999)

- ii-1 Second Term of Services in Japan (Bid Document, Draft Contract)
- ii-2 Third Term of Services in Guatemala (Bidding, Drilling of one vertical

well, Approval of total depth, Well completion testing, Well Geology).

ii-3 Third Term of Services in Japan: Progress Report

iii) STAGE-3: Detailed Survey Stage (Fiscal Year 2000)

iii-1 Fourth Term of Services in Guatemala (Bidding for drilling works, Flow Testing of well No.1 and Technical Seminar in Guatemala, Drilling of No.2 well and its completion testing, Flow Testing of wells No.1 and No.2, Well Geology of well No. 2, Environmental Studies)

iii-2 Fourth Term of Services in Japan (Data Analysis, Resource Assessment, Study for Optimum size and basic layout of power plant, Interim Report)

iii-3 Fifth Term of Services in Guatemala (Presentation of Interim Report, Technical Seminar in Guatemala, Data Collection for the Feasibility Study)

iv) STAGE-4: Feasibility Study Stage (Fiscal Year 2000)

iii-2 Fifth Term of Services in Japan (Exploitation Scheme, Feasibility Study & Draft Final Report)

iii-3 Sixth Term of Services in Guatemala (Presentation of the Draft Final Report)

iii-4 Sixth Term of Services in Japan (Final Report)

1.3.2 Description of the Services for the 2001 Fiscal Year (Feasibility Study)

1. Fifth Term of Services in Japan:

*Data analysis for acquired data in Guatemala and forecasting of the reservoir response

*Layout of the generation facilities

*Construction plan of power plant

*Calculation for construction cost

*Environmental impact assessment

*Economical and financial evaluation

*Integration, consideration and recommendation

*Preparation for the draft of the Final Report

2. Sixth Term of Services in Guatemala

JICA team carried out the explanation and discussion on the draft of the Final Report and collected the comments from the Guatemalan side.

*Explanation and discussion on the draft of the Final Report

3. Sixth Term of Services in Japan

Following the comments from Guatemala side, the draft report was revised at the necessary part and the Final Report was prepared for.

*Preparation for the Final Report

1.4 SURVEY TEAM

In accordance with the scope of work, the following organizations were in charge of the study.

Japan : Japan International Cooperation Agency (JICA)
West Japan Engineering Consultants, INC. (JICA Team)

Guatemala : Ministry of Energy and Mines
National Institute of Electrification (INDE)

The JICA Team, and INDE were organized into the following staff to carry out the study.

JICA Team	
Project Manager	Toshio FUJINO
Reservoir Engineer	Enrique LIMA
Reservoir Engineer	Tetsuya YAHARA
Electrical Engineer	Kenji SAKEMURA
Mechanical Engineer	Takeshi YAMAMOTO
Environmental Engineer	Kazuo HIROWATARI
Economist	Kenji FUJII
INDE	
General Manager	Eng. Julio Palma Ayala
Geologist	Eng. Victor Ortiz Corzo
Geochemist	Eng. Alfredo Roldan Manzo
Geophysicist	Dr. Juan Pablo Ligorria
Civil Engineer	Eng. Juan Torres Bernabes
Reservoir Engineer	Eng. Haroldo Cuevas

1.5 ACKNOWLEDGEMENTS

JICA team wishes to express their sincere appreciation for the support and assistance given by Ministry of Energy and Mines, INDE and Japanese Embassy and JICA office in Guatemala.

Table 1-1-1 Activities Schedule
作業実施工程

Activities \ Fiscal year / Month	2001 Fiscal Year 7	8	9	10	11	12	1
3. Feasibility Study Stage							
(1) 5th Term of Services in Japan							
①Analysing of the collected data and forecasting of reservoir response	July. 2 July. 16						
②Conceptual Design of Power Plant	July. 2 July. 16						
③Construction Plan of Power Plan	July. 2 July. 16						
④Cost Estimation	July. 2 July. 16						
⑤Environment Impact Assessment		Aug. 1 Aug. 15					
⑥Economical and Financial Evaluation		Aug. 1 Aug. 30					
⑦Evaluation and Integration			Sep. 3 Sep. 17				
⑧Preparation for the Draft of the Final Report			Sep. 16 Sep. 30				
(2) 6th Term of Services in Guatemala				Oct. 21 Oct. 29 △——△ Draft			
①Explanation and Discussion about the Content of the Draft Report				■			
(3) 6th Term of Services in Japan					△——△ F/R		
①Preparation of the Final Report							

Legend : ■ Work in Guatemala ▭ Work in Japan △——△ Report

2 SUMMARY OF THE SURVEYS DONE IN PREVIOUS YEARS

2.1 Update of the Power Sector

2.2 Geoscientific Studies

2.3 Exploratory Well Drilling

2.4 Well Survey

2.5 Geothermal Conceptual Model

2.1 Update of the Power Sector

2.1.1 Overview of the electric sector of Guatemala

2.1.2 The Generation System

2.1.3 The Transmission System

2.1.4 The Distribution System

2.1.5 Demand Forecast for the SNI

2.1.6 Update of Economy and Political Aspects

2.1.7 Political Situations

2.1.8 Actions to improve the Coverage and to secure the Electricity Supply

2.1.9 Alternatives for Power Generation in Guatemala

2.1.10 Conclusion

2. SUMMARY OF THE SURVEYS DONE IN PREVIOUS YEARS

2.1 THE AMATITLAN PROJECT WITHIN THE ELECTRIC SECTOR OF GUATEMALA

The success of a geothermal development for electricity production in Amatitlan will depend not only on the quantity and quality of the geothermal resource but also it will depend factors, such as those mentioned below, that will influence the economy and operation of the power facilities.

- The structure of the Guatemalan electric sector and its trend of evolution,
- Power present and future supply and demand
- Policies devised by the government to allow adequate response (private and public) to the power demand
- Participation of alternatives for a balanced energy mix in satisfying the power demand.

These factors were discussed in the Progress Report of March 1999. The following sections are intended to provide a complementary insight and a review of the most important changes since 1999.

2.1.1 Overview of the electric sector of Guatemala

1. The General Electricity Law

The government of Guatemala enacted three decrees upon which the Electric Sector of the country has been reformed. Reforms started in November 15, 1996 when the General Electricity Law (here after referred as to "the Law"), Decree No. 93-96 was enacted to provide the general frame to the present structure of the sector. To provide a means to enforce the Law, the Government enacted the Regulatory Decree on April 2nd, 1997 (Decree No. 256-97). These two decrees established the rules for private and public entities to participate and do business in the generation, transmission and distribution of electricity in the Republic of Guatemala. At the same time, these two decrees established rules to enhance the service and to protect the costumers. On June 1st, 1998 the Regulatory Laws for the Wholesale market were enacted to complete the rules and framework under which the Guatemalan Electric Sector is erected.

The Law was aimed to promote demonopolization of the power sector by enforcing the separation of the generation, transmission and distribution activities. These activities were traditionally in the hands of public or semi-public institutions. The general coordination was responsibility of the Ministry of Energy and Mines and the National Institute of Electrification (INDE) the Empresa Electrica de Guatemala, S.A. (EEGSA) and a group of municipal electricity utilities were the sole players in the electricity business. In fact, INDE was a monopoly dictating the trends and future of the power sector of the country.

At the enactment of the Law, monopolies were set apart and the free market principles were allow to dictate the trends of development of the power sector.

However to ease the transition and to give a kind of protection to the poorest sector of the society, the Municipal Electricity Utilities were excluded of the obligation of separating the activities (generation, transmission and distribution) if the capital to do this business were 100% municipal. The Law also permits exceptions for enterprises with generation up to 5 MW.

The Law created a Wholesale Market to integrate all these activities under two basic precepts:

- Freedom to build and operate power facilities and
- Fair competition to allocate generating energy in the market upon freedom to set the price of generated electricity.

The only requirements and limitations to build and operate power facilities in Guatemala are:

- Comply with the environmental regulations
- Comply with the regulations of utilization of public resources, land and facilities
- Transmission capacity
- Stability of the National Interconnected System (SNI)

The Ministry of Energy and Mines of Guatemala is held responsible for the planning and coordination of policies for the electric sector. To watch over and exert regulatory activities, the Law created the National Commission of Electric Energy (Comisión Nacional de Energía Eléctrica, CNEE). To do the dispatching and general management of the Power sector, the Law and its regulations created an Administrator of the Wholesale Electric Market (Administrador del Mercado Mayorista, AMM). This relationship is depicted in Figure 2-1-1-a..

2. The National Commission of Electric Energy (CNEE)

The mission of the National Commission of Electric Energy is to create the environment for the free and fair participation of any entity (individual or legal) in the generation, transmission, distribution and commercialization of electric energy in Guatemala. CNEE's functions are:

- To enforce the Law, its regulations and norms
- To apply sanctions to those infringing the Law.
- To watch over the fulfillment of obligation of those awarded concessions
- To protect the rights of consumers and to prevent abuse of discriminations
- To define the obligations of energy transmission and distribution companies supplying the regulated market and to define the methodologies for their regulation.
- Settle debates or arbitrate in disputes between the members of the Electric Sector
- Issue norms for the free access of transmission and distribution network

3. Wholesale Market Administrator (AMM)

Clause 44 of the Law establishes the creation of the Wholesale Market Administrator as a non-lucrative private entity responsible of the:

- Coordination of the dispatching of all power plants connected to the National Interconnected System (SNI), coordination of the international exports and imports and coordination of the national transmission system to ensure a supply of electricity in Guatemala of the minimum cost,
- To ensure free contracting between the different agents of the electric sector for the trading of energy and to ensure non-discriminatory transmission and distribution of electricity.
- To establish, contract schemes for the regulated market for the short-term supply of energy and capacity.
- To secure and guarantee the supply of energy in the Republic of Guatemala.

The AMM is a private entity conformed by representatives of the seven agents of the Guatemalan electric sector (government and private);

- Electricity generation (those with capacity larger than 10 MW),
- Electricity transmission (those showing contracted Capacity > 10 MW),
- Electricity distribution (those showing more than 20,000 customers),
- Brokers ("Comercializadoras in Spanish" those with contracted capacity > 10 MW),
- Large consumers (> 100kW),
- Importers (trading more than 10 MW),
- Exporters (trading more than 10 MW).

Table 2.1.1 shows the list of companies listed as members of the Wholesale Market. These members play the role in either one of the seven groups of agents. The AMM has the functions of operator and manager of the electric sector of Guatemala.

1) **System Operation**: The AMM has the responsibility of planning the annual capacity and energy needs. Upon his planning the AMM is in charge of the daily energy dispatch in terms of operation costs and available energy mix.

   The AMM, based upon a real time supervision of the SNI, daily and weekly checks the annual programming to accommodate the available capacity and energy mix to the actual conditions.

   The AMM is in charge of the forecasting of energy demand and based on these forecasts the AMM is in charge of planning strategies for the adequate energy supply and of the dispatch of power plants as well as the planning of strategies for an optimal utilization of the transmission system.

   The AMM physically does the checking on every parameter controlling the operation of the electrical system.

2) **Market Operation Manager**: The AMM is in charge of metering the

energy and capacity exchanges (transactions) between the members and agents of the Wholesale market.

The AMM does the management of the moneys derived from all the transactions and is in charge of the respective payment to the agents for their respective participation in the daily operations.

The AMM functions as scheduler for the dispatch of energy and as a manager of the transactions between agents.

4. Operation of the Wholesale Market

Basically there are two groups of customers, one group is ***regulated*** and other ***non-regulated***. The first one is overseen by the CNEE and the second depends on the private contracts between generation agents and consumer agents. In the regulated market, the CNEE dictates the rules for a fair participation, the toll for transmission using public facilities and the final distribution prices. In the non-regulated market the parties freely set their own rules and prices (refer to Fig. 2-1-1a).

One peculiar characteristic of the Guatemalan electricity market is a separated market of capacity and energy. This is because upon the Law, the three main activities of the electricity business; generation, transmission and distribution were separated and because to be accredited as a distributor agent or as a broker agent (including importers or exporters), the Law imposes on them the necessity of securing, through contracts, a minimum of 10 MW in capacity. Therefore, generating companies enter contracts with distributors and/or brokers to provide them with the capacity they need to be accredited by the Law and separately these generation agents can sell their energy through contracts with other agents or customers (refer to Fig. 2-1-1-b).

Capacity can be contracted separately from energy and the price will depend of the typo of contract. The AMM has a reference price of 8.9 $/kW-month The prices are determined so as to allow amortization of capital in 8 to 10 years at a discount rate of 10% and a grace period of 1 year for thermal plants and 3 years for hydro plants. There is not any specific provision for geothermal energy but it is said that provisions for the Hydro power plants would apply for all other renewables.

Distribution companies and brokers purchase energy ($/kWh) from the wholesale market through private Power Purchase Agreements (PPA) with other agents or at the spot market (also called opportunity market). Early PPA's and Energy Conversion Agreements (ECA) entered by INDE with different generating companies were agreements for purchasing both, capacity and energy in a "Take or Pay" fashion. These "Take or Pay" agreements are not longer in use and the energy has to be sold upon demand.

It is in the spot market where generators compete with their price of energy. The generators present every week to the AMM their intended total supply and the expected variable costs for the energy the generators intend to put in the market. With this information, the AMM makes the weekly dispatch program from the cheapest to the most expensive.

For executing the program the AMM dispatches the programmed energy. In the generator agent with contracts to fulfill is duly dispatched, he will receive

the payment that was agreed in his contract. In case of energy, if the generation agent is not dispatched he will have to buy energy from the dispatched agent or agents. In case of the capacity, if the generation agent is not dispatched, the AMM will supply the capacity to the customer at the reference price. To supply the rest of demand and if a generation agent has remaining energy and capacity, these can be marketed in the spot market where the price will be the highest generation prices of that hour (variable costs of the most expensive generator agent which are revised every hour). Figure 2-1-2 schematically depicts the form of dispatching plants. Table 2-1-2 shows as example, the dispatching program for May 31, 2001. Table 2-1-3 shows the average hourly energy price of the spot market at "Guatemala Sur" substation for the month of May, 2001. The monthly average of the maximum hourly price was US$ 88.87/MWh which would become the average payment to generators for their energy. The average price of energy for the month of May 2001 was US$52.58/MWh.The three bottom rows of Table 2-1-3 shows the daily average, maximum and minimum price of energy.

Figure 2-1-3 depicts the variation of the monthly energy price for the years 1999 and 2000. There are usually two peaks both during the dry seasons, one from April to June and the other in October to November when the availability of hydro power plants is low and oil or diesel have to be burned to maintain the supply. International oil and diesel prices also impact the energy price.

Energy is allocated to either a Regulated or to a Non-Regulated Market.

a. Non-Regulated Market

Generators can negotiate their available capacity and energy with large consumers (those consuming above 100kW). The contracts are private and the government has no inherence in their terms. Prices of energy can be as low as US$ 0.020/kWh

b. The regulated Market

This market is for consumers of less than 100 kW, municipalities and government. The CNEE oversees and control the electric tariff (Selling Price per kWh to customers). The electric tariff is set in such way as to pass thru the cost of fuel to consumers. For example in January 2001, the composition of costs of this tariff in the National Interconnected Grid (Sistema Nacional Interconectado, SIN) for the case in which 50% of generation is done utilizing fossil fuels, is as follows.

- 8% transmission cost
- 24.6% distribution cost
- 16.6% taxes
- 20% generation cost (Capacity cost + generation cost without fuel cost)
- 30.8% fuel cost

For the same period, the supply to the grid was 60% private and 40% INDE. The government through INDE subsidized the regulated market

(the so called Social Tariff). The price without subsidy to the consumers was 1.19 Q/ kWh (@7.85 Q/$ this price was 0.15$/kWh), while the subsidized prices were 0.78 Q/kWh (0.094 $/kWh at the same exchange rate).

The subsidy is possible because the 40% contribution of INDE to the grid was with hydro generation, which has no fuel cost component.

The main characteristics of the regulated market are:

- Every 5 years the rules for regulating electric tariffs are revised.
- The distribution companies must purchase energy through a bidding process or through PPA's entered with generators in Guatemala or abroad.
- The distributor must have contracted at least 2 years of firm capacity with generators

5. Trading Electricity and Complementary Services

Trading electric energy and the necessary complementary services for the full operation of the Wholesale market has created three different markets.

- The Spot (Opportunity) Market
- The Market of Contracts of Limited Terms
- The Deviations Market

a. The Spot Market

Energy transactions are done at the hourly opportunity price

b. The Market of Contracts of Limited Terms

There are different types of contracts:

1) Contracting to cover the demand curve of a consumer

Under this type of contract a generator agent retains the obligation of covering the demand curve of the consumer during a given period of time (hours, days, etc.). For low demands, the generator agent must keep an spinning reserve or generate at full capacity selling energy to the spot market. When the demands from the customer rises, the generator agent can increase its output or he can purchase the excess energy in the spot market.

2) Contracting capacity without Energy

The generator contracts his capacity with other agents and to allocate its production to other agents of to the spot market.

3) Contracting capacity with Energy

In this mode, the capacity and energy of a generator agent is allocated to the contracting agent. This could work in two ways.

One modality is that in which to secure its supply at firm price the consumer agent accepts to purchase the energy at the contracted price

(average price of a period). In this case the generator agent can either generate the contracted energy or purchase from the spot market.

The other modality is that in which the consumer agent is supplied at a firm price during a period as long the contracted price is below or equal to the spot market price. When the contracted price is above the spot market price, the consumer agent purchase from the spot market as far as it is available.

4) Contracting the lack of offer

In this type of contracting, a generator agent is obliged to supply all the energy required by a consumer agent up to a agreed amount, in case when there is no other means for the consumer agent to obtain the required energy.

5) Contracting Reserve Capacity

In this type of contracting the generator agent is obliged to supply reserve capacity to the Wholesale Market in case of need. This reserve capacity can be the total or partial capacity of the generator.

c. The Deviations Market

This market exists in order to permit the generators to honor the contracted obligations when they are not in conditions to supply capacity or energy due to temporary problems.

d. Other Transactions

The power sector requires of other type of services (special transactions between agents or services of agents to the Wholesale market) for its full operation

- Transport services: Provided by the public or private transmission line operators
- Complementary services: Such us
  - ◆ Supply of reactive power
  - ◆ Frequency regulation
  - ◆ Cold capacity reserve
  - ◆ Spinning capacity reserve
  - ◆ Black-outs starts

2.1.2 The generation System

The generation system is conformed of all public and private generation facilities. INDE represents the public sector. The private sector is represented by companies with ECA's entered with INDE, companies with PPA's entered with other agents and companies operating as merchant plants. Fig. 2-1-4 shows the inter-relation between the generation system and the other agents of the electric sector in Guatemala. Table 2-1-4 shows a detail of the composition of the generation system

2.1.3 The Transmission System

The transmission system is own by the State of Guatemala. INDE holds the Transmission and Control of Electric Energy (Empresa de Transporte y Control de Energía Eléctrica, ETCEE), which is in charge of the transmission of electricity in Guatemala. EEGSA operates its own transmission system in the central part of Guatemala.

The transmission system is divided into the primary (230 kV, 138 kV and 69 kV) and secondary (230kV and 69 kV) systems (Fig. 2-1-5). The primary system is shared by generating companies while the secondary system is servicing group of private generators. In terms of geography the transmission system is divided into the Central, Western and Eastern systems and in terms of transmission capacity it is divided into 230kV, 138 kV and 69kV systems. ETCEE charges for the use of the primary and secondary systems.

ETCEE administrates and controls the following infrastructure:

- 647 km of 230 kV transmission lines
- 222 km of 138 kV transmission lines
- 1216 km of 69 kV transmission lines
- 6 substations of 230 kV
- 4 substations of 138 kV
- 32 substations of 69 kV

The 230 kV system operated by ETCEE is the trunk line of the whole transmission system in Guatemala and it interconnects the main generation plants as well as the substations of larges energy demand in the SNI (Guatemala Sur, Guatemala Este, Guatemala Norte, Escuintla and Los Brillantes) and the Salvadoran transmission system.. The interconnection to el Salvador is through a 230 kV line from Guatemala Este to Ahuachapan (geothermal facilities) in El Salvador.

The 138 kV system reinforce the transmission of energy between Escuintla and Guatemala Sur.

The 69 kV system extends from the central system to the eastern and western systems, interconnecting the substations feeding the distribution circuits of the Guatemala's country side.

EEGSA operates the following infrastructure:

- 65 km of 230 kV transmission lines
- 558 km of 138 kV transmission lines
- 44 substations of 69 kV with an installed capacity of 760 MVA

2.1.4 The distribution System

The distribution system changed when EEGSA was privatized and separated into a distribution company and a generation company. The generation facilities of the old EEGSA were sold to Constellation of the USA and the distribution assets to Iberdrola of Spain. The new EEGSA serves the capital city and the surrounding areas. The distribution assets and areas of service of INDE were sold to Union Fenosa of Spain. The service area of Union Fenosa is divided into a western and eastern areas, refer to Fig. 2-1-6. The number of customers serve by the electric

sector of Guatemala has drastically increased thanks to the aggressive policy to incorporate rural areas and to improve the infrastructure. Fig. 2-1-7 shows the change in the total number of customers in the SNI. Fig. 2-1-8 shows the ration of growth in the electricity servicing in the different areas of Guatemala.. Table 2-1-5 show this increment in more detail. Fig. 2-1-9 depicts the growth in the electrification rate since 1991. Guatemala lagged in the rate of electrification compared to other Latin-American countries, the opening of the electric sector to private investments in the generation and distribution systems produced a positive impact which still keep pace.

The electricity distribution system of Guatemala is formed of the following companies:

1. **Empresa Eléctrica de Guatemala**

   Own by IBERDROLA of Spain, this company serves the central part of the country ; Departments of Guatemala, Escuintla and Sacatepequez.

2. **Distribuidora de Electricidad de Occidente, S. A. DEOCSA.**

   Serves the western departments of Guatemala: Escuintla, Suchitepequez, Retalhuleu, San Marcos, Quetzaltenango, Totonicapan, Solola, Chimaltenango, Quiche y Huehuetenango.

3. **Distribuidora de Electricidad de Oriente, S. A. DEORSA.**

   Serves the eastern departments of Guatemala: Peten, Alta Verapaz, Baja Verapaz, El Progreso, Zacapa, Izabal, Chiquimula, Jalapa, Jutiapa and Santa Rosa

4. **Municipal Electric Utilities**

   There are 16 municipal electric utilities serving different parts of the country. Huehuetenango, Santa Eulalia, San Marcos, San Pedro, Sacatepequez, Tacana, Quetzaltenango, Retalhuleu, Joyabaj, Playa Grande, Sayaxche, Guastatoya, Jalapa, San Pedro Pinula, Zacapa, Gualan y Puerto Barrios

2.1.5 Demand forecast for the SNI

The growth in the install capacity in the Guatemalan electric sector has been one of the highest in Central America. The conditions of the market and its characteristics have been incentive for the private sector. Recently a slow down have been noticed, due to uncertainties in the political and economical systems and the variation in price of fossil fuels. Nevertheless, in global terms, the growth has been positive. Figure 2-1-10 presents the growth rate in the install capacity until year 2000.

To date there are two published demand forecasts, one done by the Administrator of the Wholesale Market and other by the Ministry of Energy and Mines. The forecast proposed by the AMM, presented in Table 2-1-6, is for a scenario of medium development and done up to the year 2015. The one proposed by MEM, Table 2-1-7, is base upon an econometric model setting the relationship between recorded history of the demand and consumption with economic variables of the GNP and variables representing the growth of the energy demand.

The model was run under three scenarios depending on the GNP

1. LOW DEMAND SCENARIO: Based upon an annual GNP growth of 3.5%

2. EXPECTED DEMAND SCENARIO: Based upon an annual GNP growth of 4.0%

3. HIGH DEMAND SCENARIO: Based upon an annual GNP growth of 5.0%

With whichever scenario to be present in the future, 20 MW or even 50 MW geothermal in Amatitlán connected to the grid will be easy absorbed by the system as base load.

2.1.6 Up date of economy and political aspects

Alfonso Portillo of the Frente Republicano Guatemalteco (FRG) political party was inaugurated as President of Guatemala in mid-January 2000. He proposed a budget that would use some tax increases, in addition to other measures, to reduce the fiscal deficit. The budget that was eventually approved uses further spending cuts and earnings from privatizations to reduce the country's fiscal deficit. Some economic indicators have improved in recent months, with interest rates lower and less volatile, inflation is under control, and the country's currency, the quetzal is stronger. The important coffee sector is suffering in the first quarter of 2001, however, with lower international coffee prices likely to mean million dollars in losses and unemployment for up to 120,000 of Guatemala's 800,000 coffee sector workers, according to the National Coffee Association of Guatemala. The January 2001 increase in the minimum wage by 16% may help the poor, although some economists see it as an inflation risk. With Guatemala's population growth rate of 2.1%, stronger GDP growth is needed to reduce poverty.

In addition to economic concerns, Guatemala faces significant political and social uncertainty, stemming in large part from the country's bloody, 36-year civil war, which concluded in 1997. Crime has become a major issue, with soaring gun sales and the army called into the street to supplement police protection, and the country continues to face serious problems in the areas of health, education, security, among others.

In mid-October 1999, Guatemala, Costa Rica, El Salvador, Honduras, Nicaragua, and Chile signed a framework agreement to liberalize trade between their countries. Guatemala has signed the Mexico-Northern Triangle free-trade agreement with Mexico, El Salvador, and Honduras, which went into effect March 15, 2001. Guatemala also received NAFTA parity for clothing exports in October 2000 as part of the Caribbean Basin Initiative. A territorial dispute with Belize continues.

The Guatemalan Congress approved legislation in December 2000 that would allow foreign-currency denominated salaries, bank accounts, and financial instruments as of May 1, 2001. This is expected to moderate interest rates and allow the quetzal to fall without a crisis of confidence. It is not clear whether this is a step towards dollarization.

Table 2-1-8 shows updated information on the country facts. Table 2-1-9 some updates of the economy facts of the country and Table 2-1-10 some environmental facts of Guatemala

2.1.7 Political situation

Guatemala is a democratic republic that during 36 years fought a fratricide internal war. These 30 years prevented the country of a study and sustained development. In 1997, finally the peace agreement between the belligerent parties was reached. The authority of the country deposited in the executive power and assisted to govern by the legislative and judicial powers are now clearly defined.

As a young country with a defined racial heterogeneity, Guatemala still faces problems. However the determination of the authorities and the promise of future development give to Guatemala an air of peace and prosperity.

The present administration is the fifth civil administration in row. This continuity allows the private investor to feel relaxed in the respect of law and private property. This circumstance and the end of the cold war liberated capitals that flown to the developing world.

The approval of laws like the General Law of Electricity and the vision of responsible administrators of the past opened the door to the inflow of capitals to build new infrastructure. From 1991 this inflow of capital is evident in the construction of buildings, supermarkets, new roads, etc.. The continuation of this growth will drive even higher the need of additional electrical infrastructure

2.1.8 Actions to improve the coverage and to secure the electricity supply

1. Rural Electrification

The aim of the government of Guatemala is to increment the electrification coverage to a 90% by the year 2004 and to a 96% by the year 2006. INDE is administration a Revolving Fund to reach these goals through the construction of Transmission and Distribution lines and the installation of Solar Panels in remote areas. As indicated in Table 2-1-10 the residential component of the energy utilization is very high, therefore growth in the electrification rate will impact the electricity demand.

2. Utilization of Renewable Resources

The recent growth in the installed capacity has been mainly through private investments in fossil fuels power facilities. More than the 50% of the demand is satisfied by power facilities burning fossil fuels. The fossil fuels alternatives, although comparatively cheap and of rapid deployment, represents an unbalanced energy mix. Guatemala depends excessively in imported fuels. To sustain the forecasted economy growth, Guatemala must reduce this dependence and promote the utilization of domestic resources.

Unfortunately, Guatemala does not possess coal, or gas to exploit. Oil is being exploited in the northern Peten area. The proven reserves are of more than 20 million of barrels and the total reserves are estimated in more than 100 million barrels. The current production from the oil fields is about 22,000 barrels per day, equivalent to the 35% of the domestic consumption. Excepting asphalt, most of the crude oil production is for exportation. Due to the proximity of Mexican oil refineries, there is limited refining capacity in Guatemala and most of the oil required to drive the thermal power plants is imported.

On the other hand, Guatemala is a country where still there are untapped natural renewable resources. The Ministry of Energy and Mines estimates 5,000 MW of hydraulic resources and 1,000MW of geothermal resources for power generation. Of these resources only the 11% of the hydraulic and 3% of the geothermal are in exploitation at present. Wind and solar resources are under evaluation.

Renewable resources compete with disadvantage respect fossil fuels. For countries such ah Guatemala, there are two alternatives in this regard; one is that governments take the lead in the development and exploitation of these resources or the other is to devise policies to promote incentives for the private sector to take the lead.

The ministry of Energy and Mines is promoting a decree to promote fiscal, financial and administrative incentives. To the date of writing this report, this decree was about to be sent for discussion to the Congress of the Republic.

The principal promoted incentives in the said Law of Fiscal Incentives are:

a. Exemption in custom duties in the importation of equipments and materials for the facilities and exemption in related charges, Sales Tax (VAT), consular charges and rights on construction machinery all related only to projects utilizing renewable resources.

b. Income tax exemption to foreign consultants (approved and/or registered in the Ministry of Energy) involved in the study, development and construction or renewable resources projects.

c. Ten years income tax exemption from the commissioning date of facilities to companies exploiting natural renewable resources

d. Ten years exemption from the date the Tax Office issue authorization, of any other related taxes, bonds or special contributions.

e. Property tax exemption or exemption of another taxes that may affect the competitiveness of project utilizing renewable resources.

The state of Guatemala is sovereign owner of all natural resources. However, to assess and develop these natural resources the Electricity Law allows temporary concessions. Concessions can be granted by the Ministry of Energy and Mines, to private and/or public enterprises. In case of geothermal, a maximum of 10,000 km^2 can be given in concession for field assessments and a maximum of 100 km^2 for exploitation. In the case the private enterprise accepts to limit the exploitation to 5 MW no special concession is required. The Electricity Law stipulates a maximum of one year for the private or public enterprise to assess the geothermal potential..

2.1.9 Alternatives for power generation in Guatemala

Guatemala possesses geothermal and renewable non-geothermal alternatives to cover the future demand of electricity. However a sound energy mix minimizing the meteorological risks due to disorders such as those caused by El Niño o La Niña Phenomena is what Guatemala needs. Thought the carbon emissions of

Guatemala are less than the 0.1% (refer to Table 2-1-10), the utilization of natural resources friendly to the environment will be welcomed by the international community.

1. Geothermal alternatives

Guatemala is blessed with geothermal resources, from North to South, the San Marcos, Zunil-I, Zunil-II, Totonicapan, Atitlan, Michatoya Valley, Palencia, Tecuamburro, Moyuta and Laguna Retana are geothermal areas that in addition to Amatitlan from where Guatemala can draw much of the energy the country needs. All these areas are related to active volcanism and strong tectonic fracturing. Depending on the success of efforts to enact the Fiscal Incentives Law, geothermal developments of from 20 to 50 MW can be competitive and can fill the gap in the future power supply.

2. Non-geothermal alternatives

Several private investors have pursued in the development of small to medium hydroelectric resources. However this natural resource is highly dependent on the hydrological cycle and thus turns the utilization factor very low. The friendliness to the environment of this resource is also questionable and concerning o the economy of exploitation, the investment per MW is larger than that for geothermal. Nevertheless, the abundance of this primary resource of energy for small developments in remote areas turns attractive its exploitation.

Natural gas represents a fast track competing alternative for geothermal developments in Guatemala. Until recently there was a plan to pipe natural gas from Mexico. Combined cycle technology is of high thermal efficiency, low generating cost, short leading construction time and friendly to the environment, thought not at the degree geothermal is. However, the political situation and the economy in Mexico has delayed investments and now Mexico is a net importer of natural gas from the USA. Seems that the alternative of piping gas from Mexico will not represent a serious competitor for geothermal developments in Guatemala.

2.1.10 Concluding remarks.

The following items can be selected as the most important aspects of the electric sector in Guatemala.

1. The changes in the electric sector of Guatemala have been addressed to promote demonopolization and a fair participation of the private sector

2. Civil institutions and governments prevail. Though democracy is still young in general terms there is confidence in the political situation.

3. There is experience and confidence in Guatemala to handle private participation not only in the power sector but also in other sectors of the society. The confidence is reflected in the considerable investments done to date.

4. The Guatemalan State will maintain presence in the electric sector through the transmission and the generation subsidiaries of INDE Holding until the

decision of selling these companies to the private sector is made and executed.

5. The determination of the electric sector authorities to incorporate the rural areas to the grid might propel the increment of the demand to the levels forecasted for the High Demand Scenario.

6. According to the experience of the Guatemalan Wholesale Market, the price paid for energy (from US$0.02 to US$0.10 per KWh) permits to carry out investments with internal rate of return attractive at international level.

7. For small capacity plants, less then 50 MW using renewables resources such as geothermal, these variable pricing might hinder their competitive participation in the Wholesale market, but the enact of the Fiscal Incentive Law will make the resources competitive and attractive for investments.

8. From the alternatives to fill the gap in the energy supply with renewable resources, Geothermal is the best.

9. The generation cost at Laguna bunker fired power plant (owned by Constellation of the USA) was over US$0.10 per KWh and produced, in addition a negative environments impact to the lake of Amatitlan. The plant is scheduled to be retired. Therefore a geothermal development in Amatitlan (Laguna Calderas) might represent a keen interest of Constellation to purchase capacity and or energy to substitute that of Laguna plant eventual from a development at Amatitlan.

10. Unión Fenosa of Spain with the purchase DEOCSA and DEORSA from INDE also acquire a 240 MW capacity agreement. This agreement will expire on December 2003. Unión Fenosa has already secure additional 140 MW and might be interested in purchasing capacity as well as energy from an eventual development at Amatitlan.

11. With whichever scenario (low, medium or high) to be present in the future, 20 MW or even 50 MW geothermal in Amatitlán connected to the grid will be easily absorbed by the system as base load.

Fig.2-1-1(a) Structure of the Guatemalan Electric Sector
グァテマラ電力産業の組織

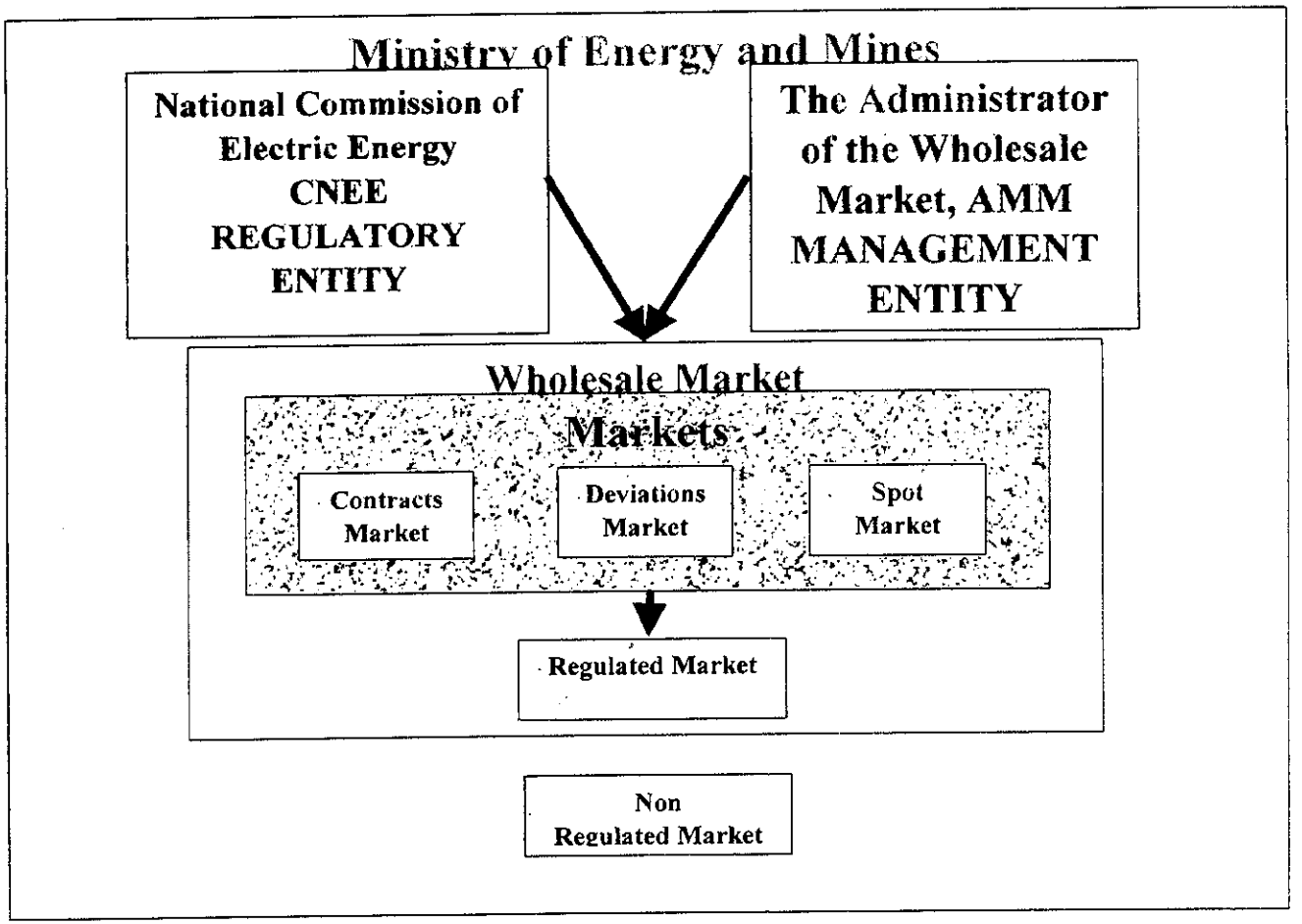


Fig. 2-1-1(b) Markets of the Guatemalan Power Sector
グァテマラ電力産業の市場構造

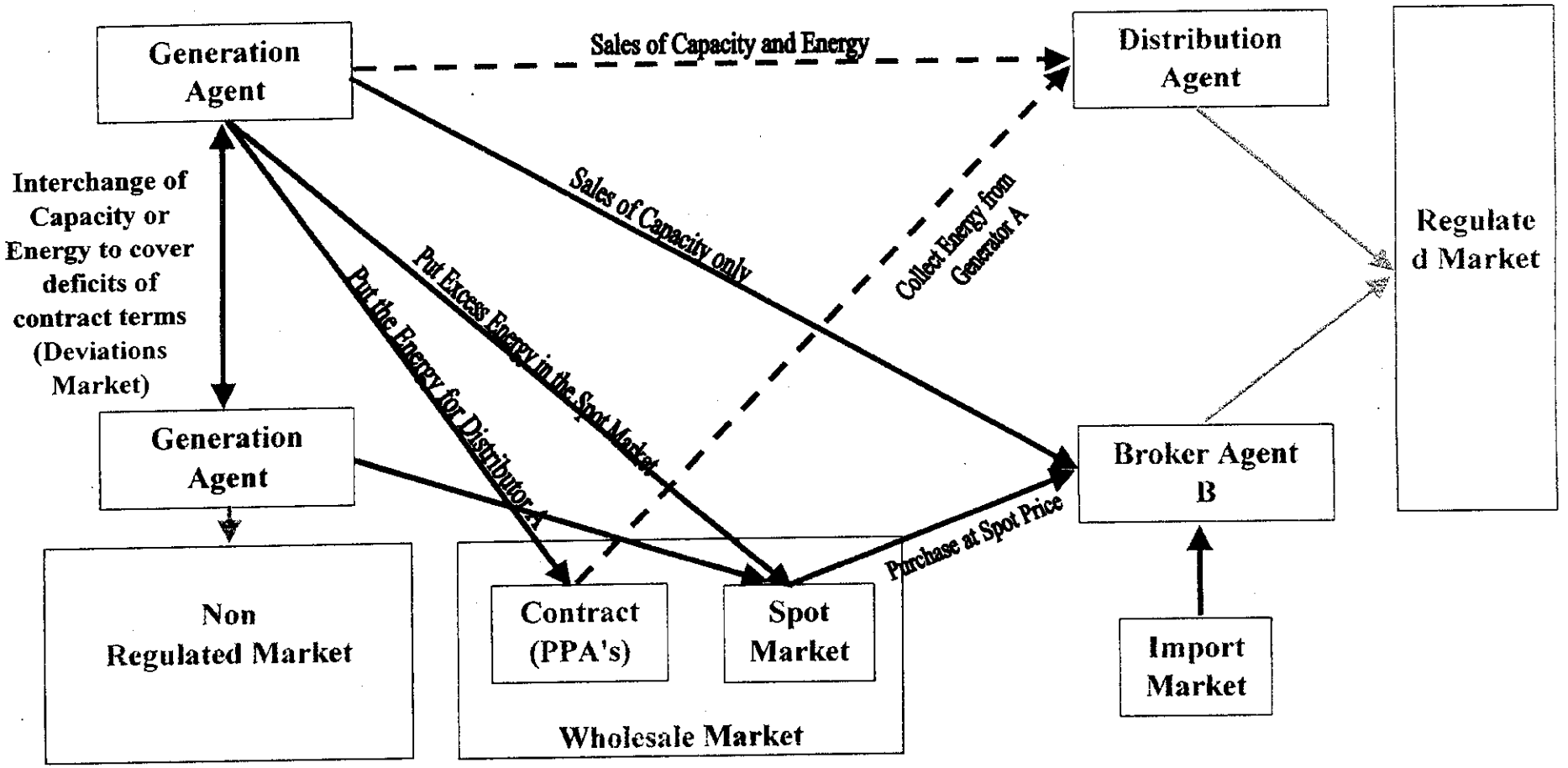
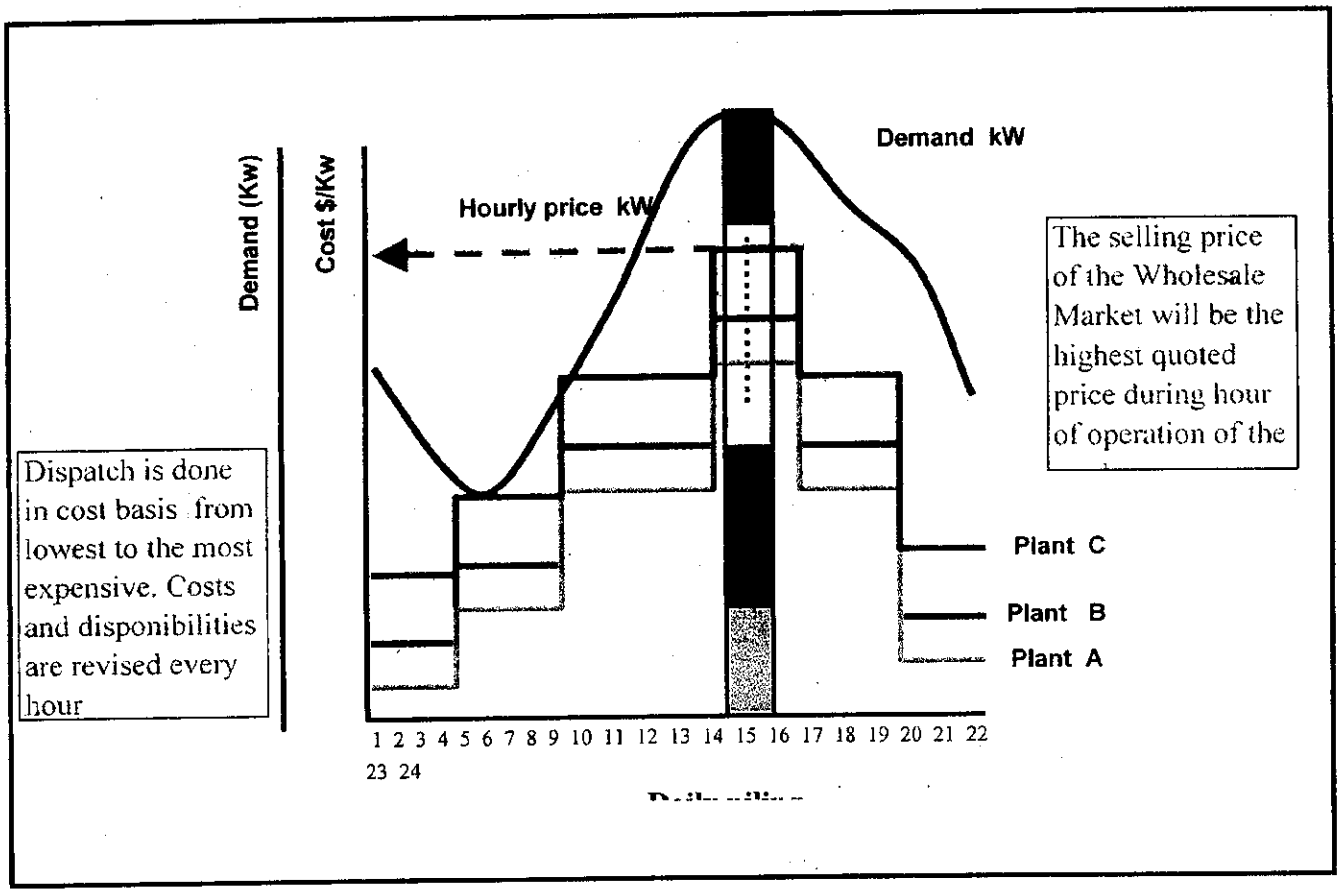
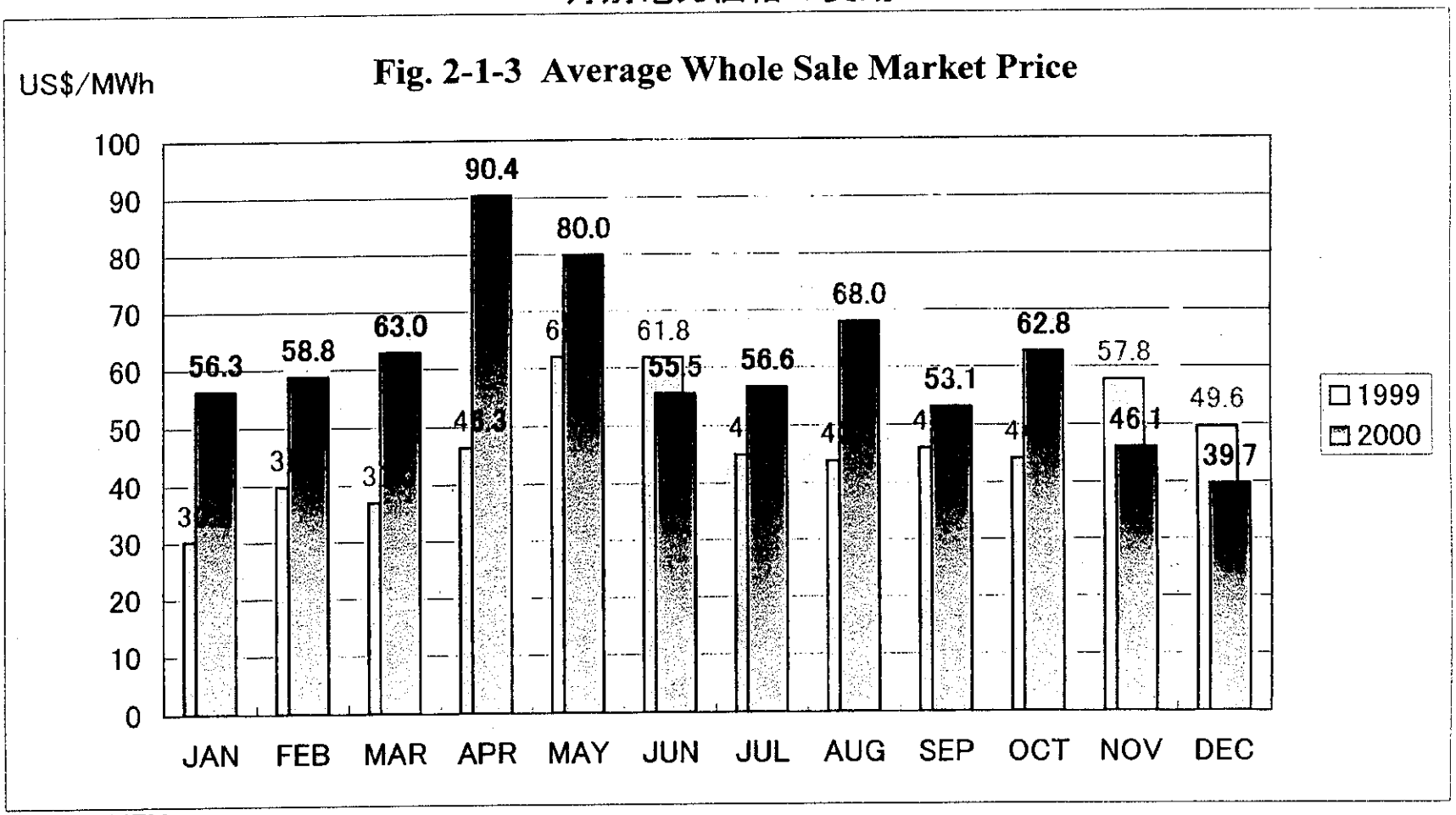


Fig. 2-1-2 Daily piling of energy costs
エネルギーコストの日変化



月別電力価格の変動

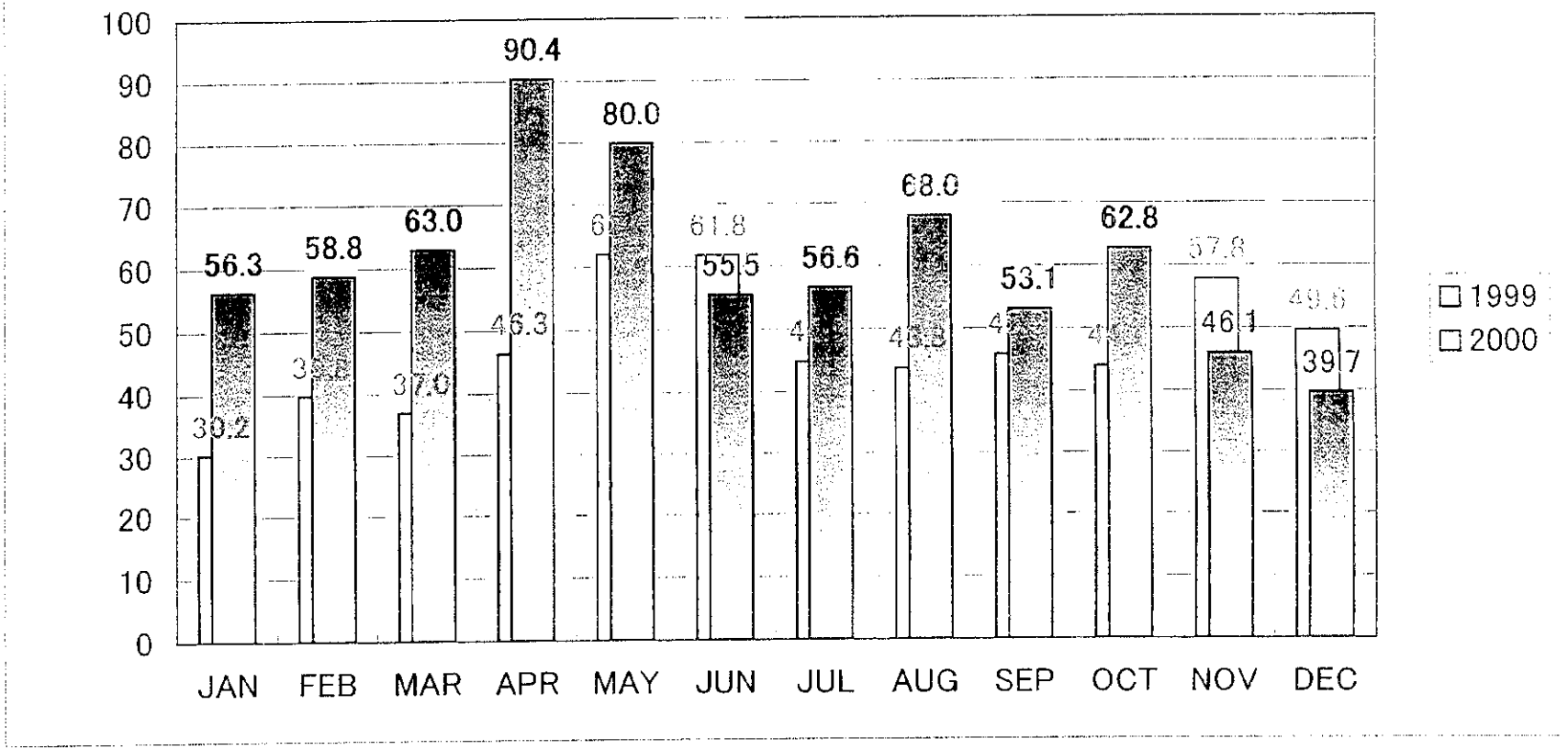
Fig. 2-1-3 Average Whole Sale Market Price



Source: MEM

月別電力価格の変動

Fig. 2-1-3 Average Whole Sale Market Price



Source: MEM

Fig. 2-1-4 Structure of the Electricity Supply in Guatemala
グァテマラ国内の電力供給システム

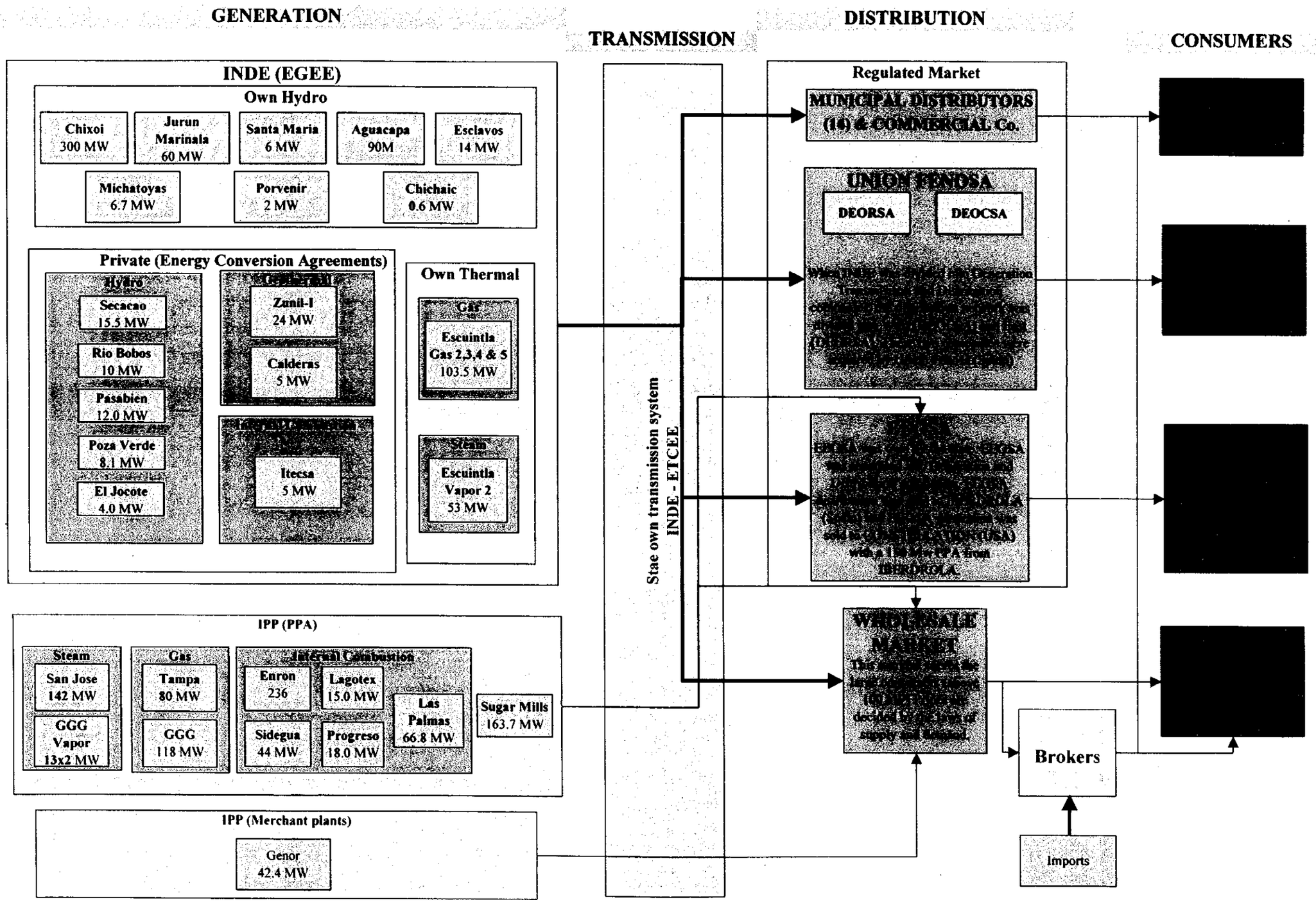


Fig. 2-1-4 Structure of the Electricity Supply in Guatemala
グァテマラ国内の電力供給システム

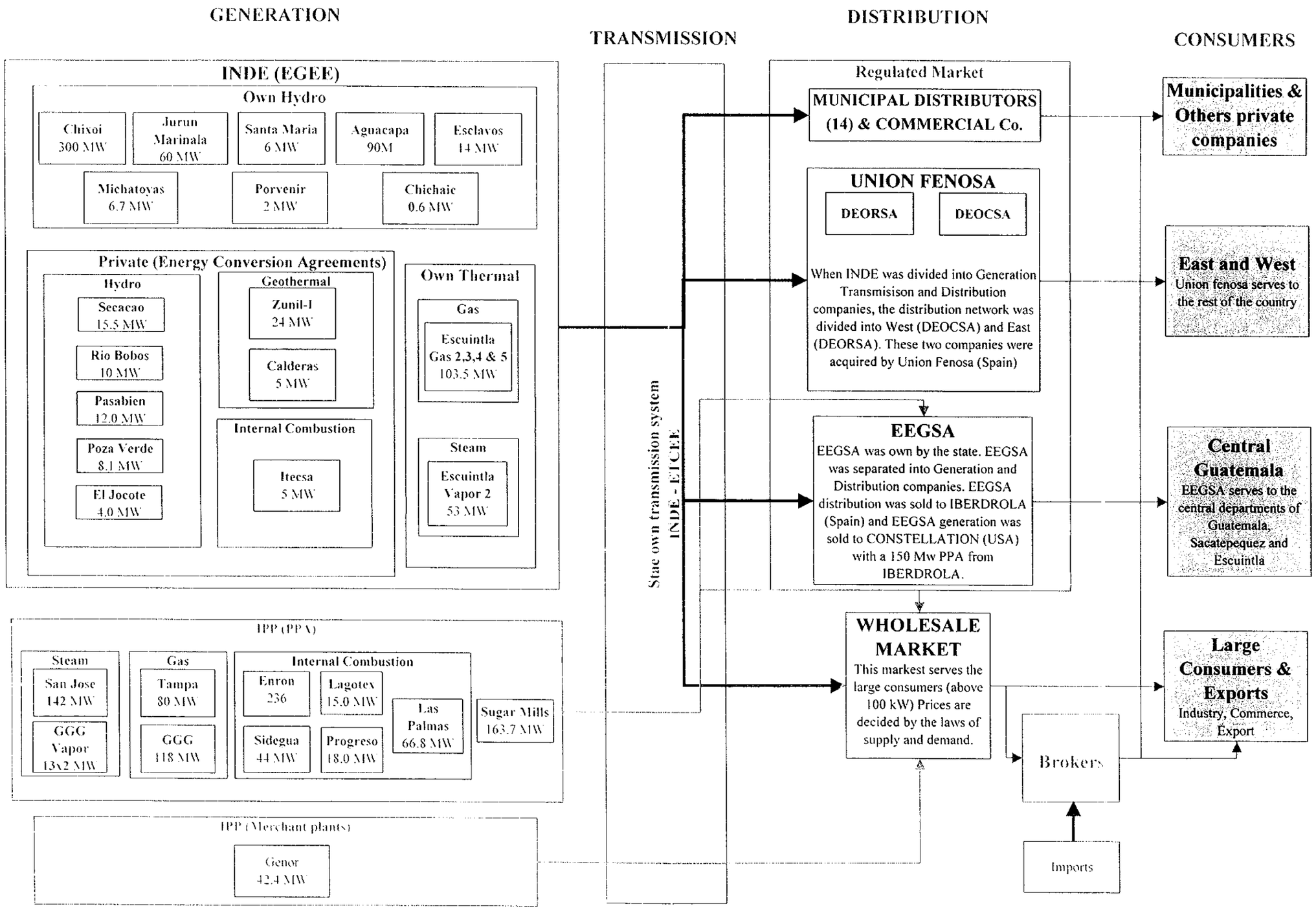
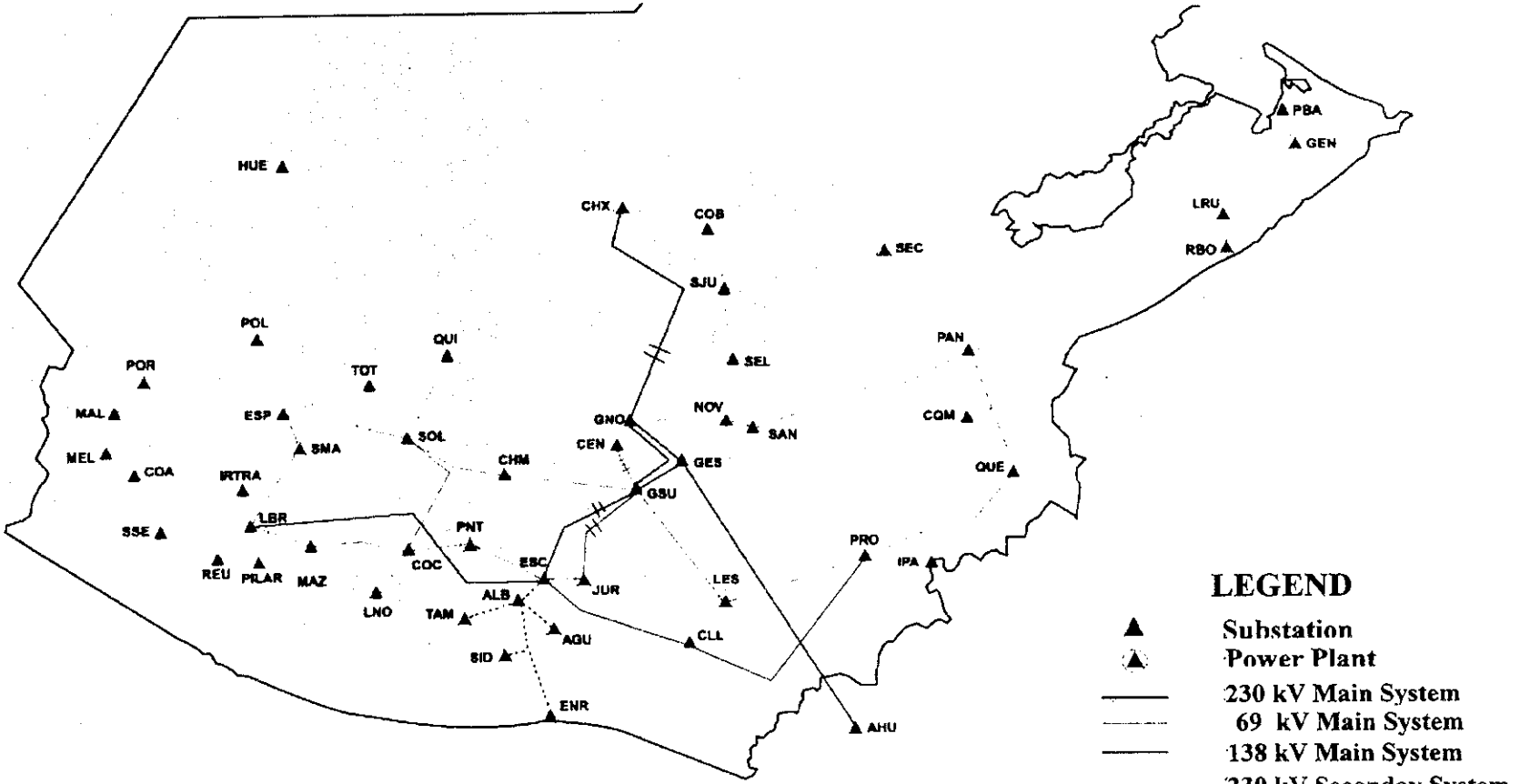
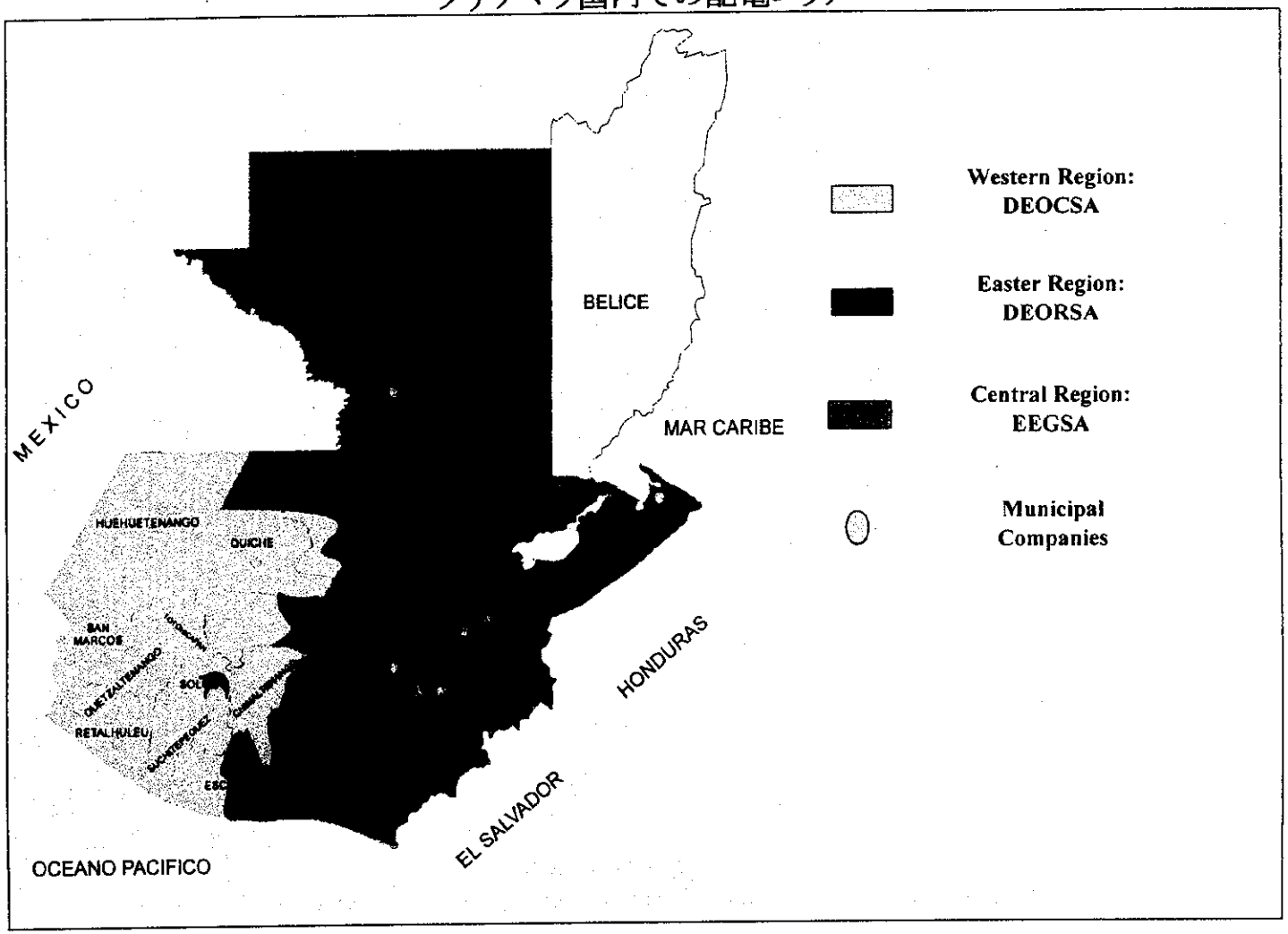


Fig. 2-1-5 The transmission System of Guatemala
グァテマラ国内の送電システム



Source: MEM

Fig. 2-1-6 Distribution Regions in Guatemala
グァテマラ国内での配電エリア



Source : MEM

国家電力供給網に連結している顧客数

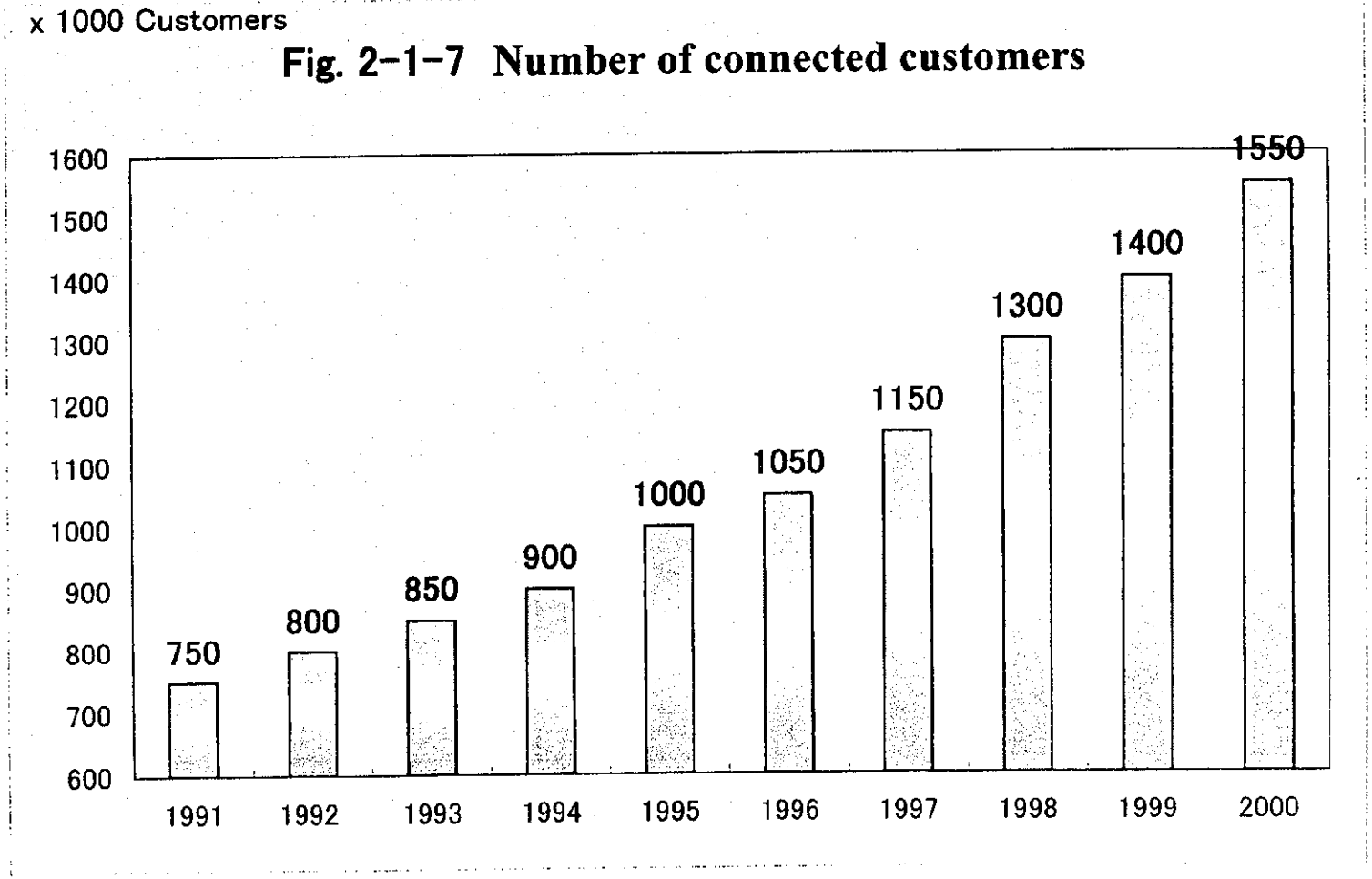
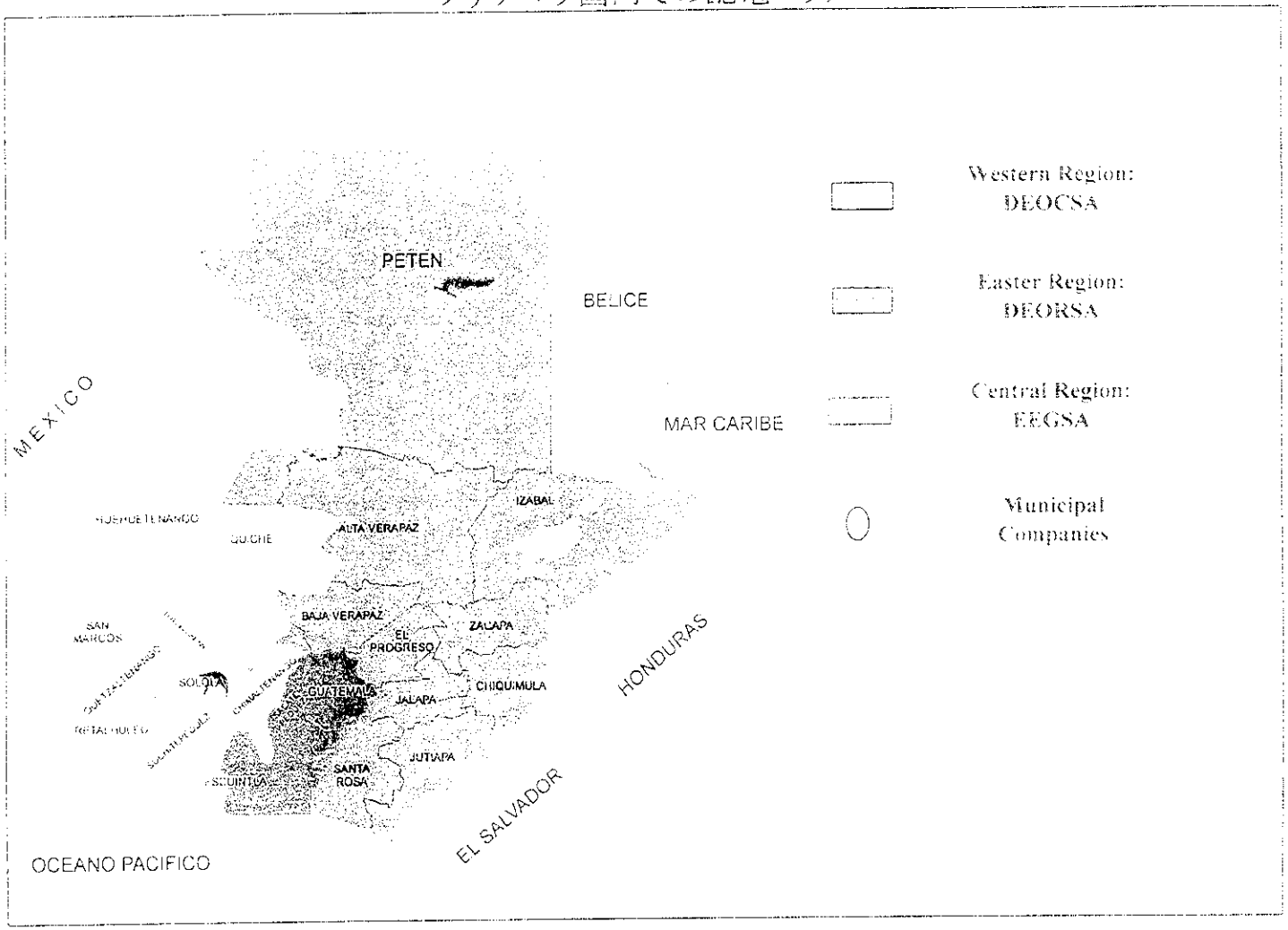


Fig. 2-1-7 Number of connected customers

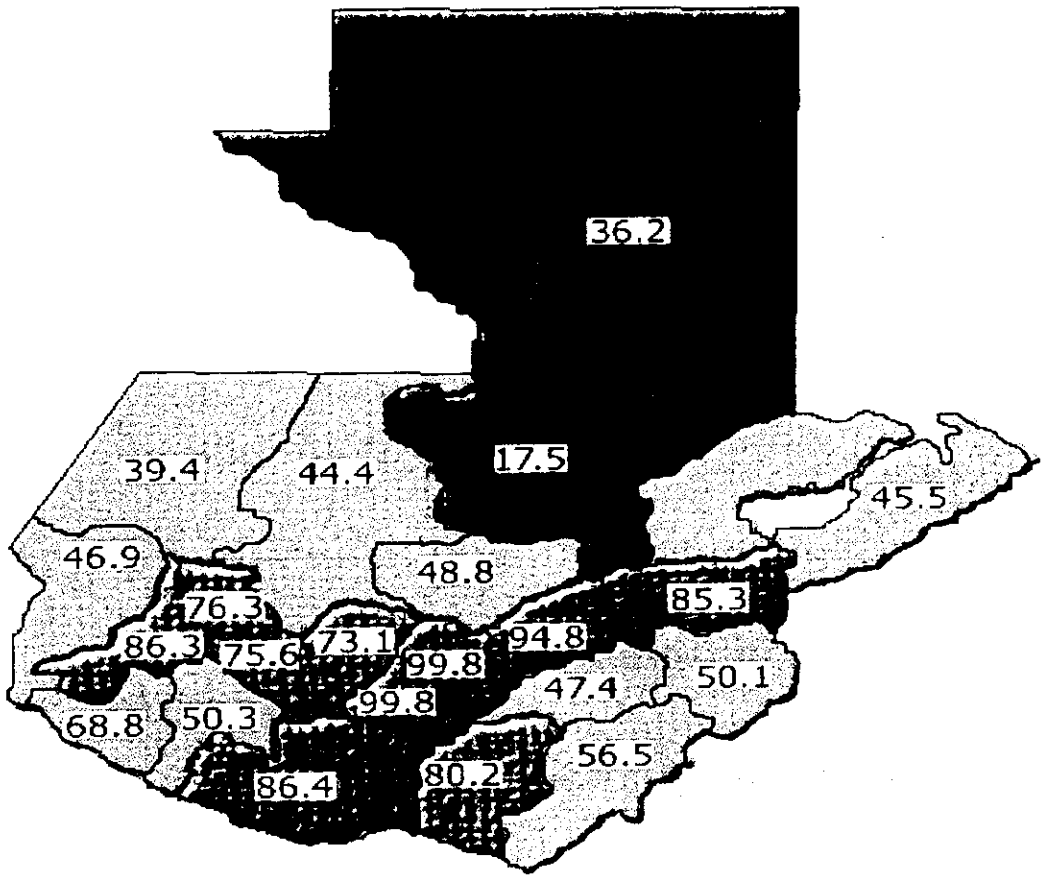
Fig. 2-1-6 Distribution Regions in Guatemala
グァテマラ国内での配電エリア



Source MEM

グァテマラ国内の地域別電化率

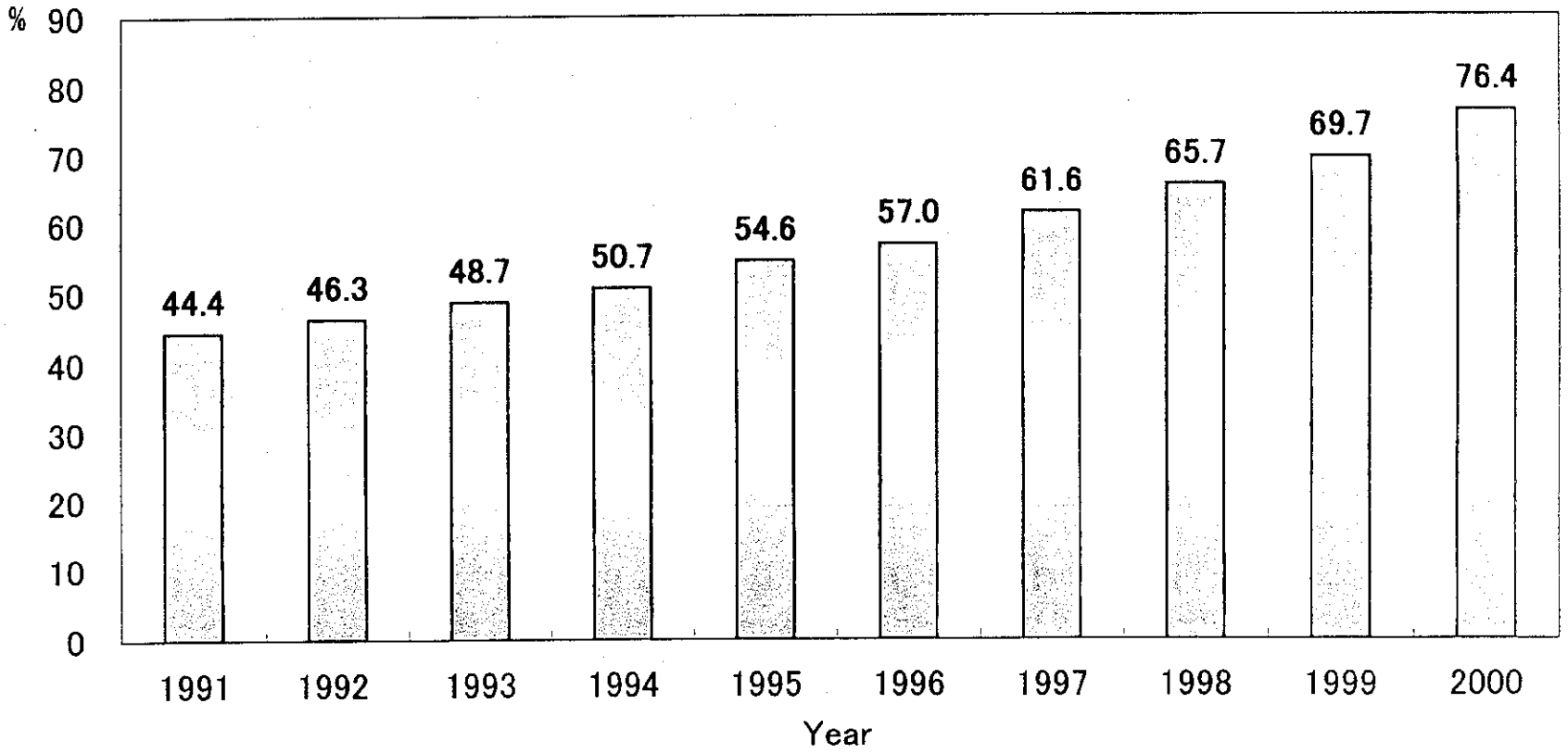
Fig. 2.1.8 Map of the Electrification Coverage (%)



Source: MEM

グァテマラ国の電化率の推移

Fig. 2-1-9 Electrification Growth Ratio in Guatemala



設備容量と電力需要の推移

MW

Fig. 2-1-10 Installed Capacity and Energy Demand

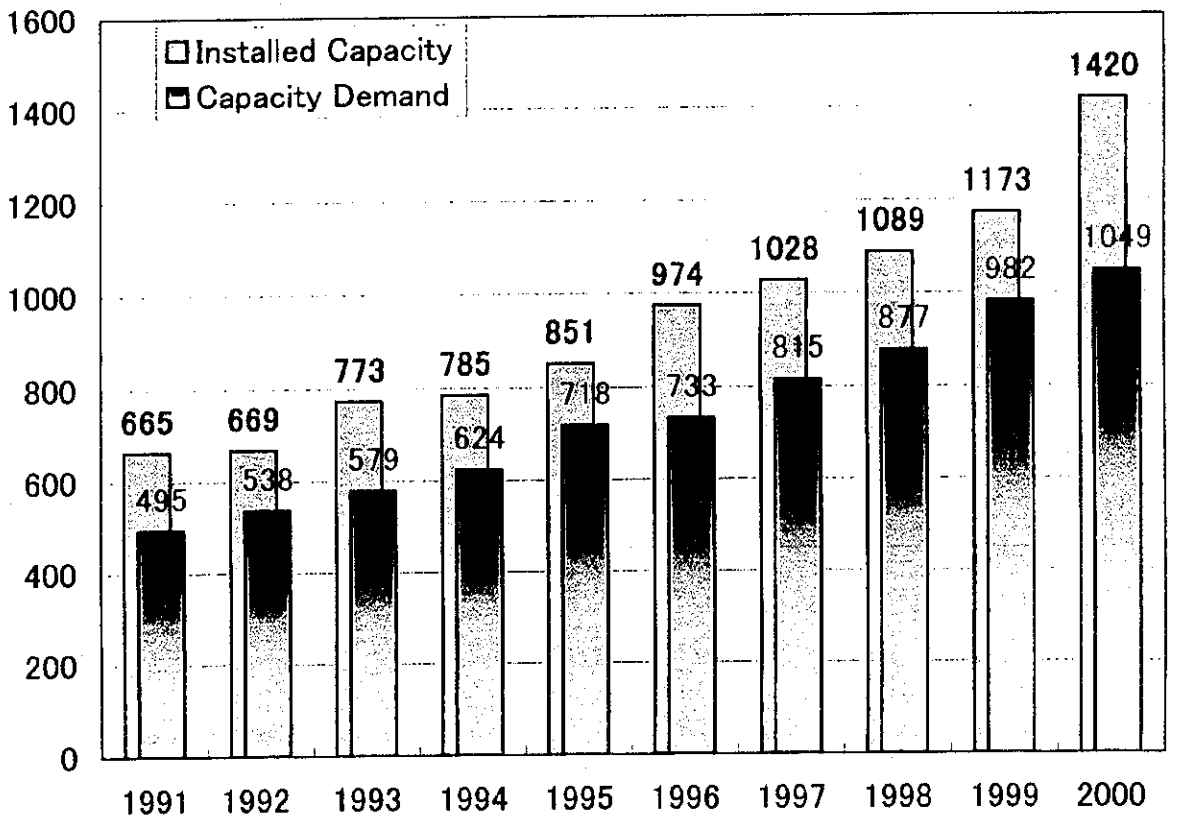


Table 2-1-1 Wholesale Market Members
全国電気卸売事業会の構成員リスト

Generators

	Member
1	Siderúrgica de Guatemala (SIDEGUA)
2	Tampa Centroamericana de Electricidad Ltda. (TCAE)
3	Puerto Quetzal Power LLC (PQP LLC)
4	Grupo Generador de Guatemala y Cía. S. C. A. (GGG)
5	Empresa de Generación de Energía Eléctrica del INDE (EGEE)
6	Generadora Eléctrica del Norte S. A. (GENOR)
7	Hidroeléctrica Secacao S.A.
8	Lagotex S. A.
9	Fabrigas S.A.
10	Central Generadora Eléctrica San José Ltda
11	Orzunil 1 de Electricidad Ltda.
12	Central Agro Industrial Guatemalteca S. A. (Madre Tierra)
13	Inversiones Pasabien S. A.
14	Concepción S.A.
15	Cía. Agrícola Industrial Santa Ana S. A.
16	Pantaleón S.A.
17	Ingenio Magdalena S.A.
18	Ingenio La Unión S.A.

Transporters

	Member
1	Empresa de Transporte y Control de Energía Eléctrica del INDE

Distributors

	Member
1	Empresa Eléctrica de Guatemala S. A. (EEGSA)
2	Distribuidora de Electricidad de Occidente S. A. (DEOCSA)
3	Distribuidora de Electricidad de Oriente S. A. (DEORSA)

Commercial Members

No.	Member
1	Comercializadora Eléctrica de Guatemala S. A. (COMEGSA)
2	Comercializadora de Electricidad Centroamericana S. A. (CECSA)
3	Empresa Eléctrica de Nororiente S. A. (ELECNO)
4	Inversiones JACSA, S. A.
5	Mayoristas de Electricidad (MEL)
6	Poliwatt Limitada
7	Conexión Energética Centroamericana, S. A.
8	Comercializadora de Electricidad Internacional, S. A. (CEI)

Major Users

No.	Member
1	Maderas El Alto S. A.
2	Industrias del Atlántico
3	Bandegua Fincas
4	Bandegua Cuartos Fríos
5	Cementos Progreso S. A.
6	Consultora Integral Atlanta
7	Compañía Agrícola Diversificada (COAGRO)
8	Corrugadora Guatemalteca S. A.
9	Embotelladora del Atlántico S.A.
10	J & R Ropa Deportiva de C.A. S. A. (JR Sports)
11	Empresa Portuaria Nacional Sto. Tomás de Castilla
12	Productos de la Tierra S. A. (PROTISA)
13	Amatique Bay Resort & Marina
14	Cía. Bananera Guatemalteca Independiente (COBIGUA)
15	Standard Fruit of Guatemala (DOLE)
16	Pichilingo Resort & Marina S. A.
17	Telefónica Sam de Guatemala S. A.

Municipal Companies (Distributors)

No.	Member
1	EEM de Huehuetenango
2	EEM de Zacapa
3	EEM de Gualán
4	EEM de Jalapa
5	EEM de Puerto Barrios
6	EEM de Guastatoya
7	EEM de Retalhuleu
8	EEM de Quetzaltenango
9	EEM de San Pedro Sac., San Marcos
10	EEM de San Marcos
11	EEM de Santa Eulalia
12	EEM de Joyabaj
13	EEM de San Pedro Pinula, Jalapa

Table 2-1-2 LOAD DISTPACH PROGRAM (MW), THURSDAY MAY 31, 2001

2001年5月31日の給電プログラム

Source www.amm.org.gt

ENRON & SAN JOSE: FORCED TO SATISFY OBLIGATIONS OF MINIMUM PURCHASE

CONCEPCION, SANTA ANA Y PANTALEON: RESTRICTIONS AT START - STOP

GAS ESCUINTLA: FORCED DUE TO RESTRICTIONS IN THE MAIN TRANSMISSION SYSTEMA

PRIMARY REGULATION: GENERATORS MUST KEEP A REGULATING RESERVE OF 3% GENERATED ENERGY

INTERCHANGE

		Hydro											CT. ESCUINTLA			GEO		LAGUNA				LAS PALMAS																			GEN	DEM	DEM
		CHX	AGU	JUR	LES	SMA	POR	M	RBO	SEC	PAS	PVE	G3,4	G,5	VAP	ORZ	CAL	VAP	TG1	TG2	TG4	W2,5	W4	W3	W1	GAS	PNT	CON	MAG	LUN	MTI	SAA	TUL	LTX	SJO	ENR	ESP	TAM	SID1	SID2	GEN	SNI	INT	SNI
MAX. CAPACITY		275	80	60	14	6	2	2	10	15	12	8	44	30	40	24	5	24	10	17	27	20	15	15	15	34	38.5	26	15.4	30	19	25	14	10	122	110	124	79	18	18	42	1494.9		
AVAIL. CAPACITY		220	75	60	7	5	2	2	10	7.5	10	2	22	15	35	22	5	24	0	0	27	15	IN	15	15	24	39	22	16	24	17	20	14	10	121	102	124	79	18	18	42	1285.5		
GENERATION		3730	544	948	50	96	35	18	90	312	142	48	50	35	0	480	120	0	0	0	78	480	0	360	360	66	417	447	0	0	0	495	72	30	2836	1677	2843	77	51	51	380	17418	786	16632
DE	A																																											
0:01	1:00	73	LL	LL	LL	4	1	0	LL	13	4	2	R	R	RF	20	5	RF	IN	IN	R	20	IN	15	15	R	17	18	M	RF	RF	20	3	R	118	R	120	R	R	R	10	478	24	454
1:01	2:00	70	LL	LL	LL	4	1	0	LL	13	4	2	R	R	RF	20	5	RF	IN	IN	R	20	IN	15	15	R	17	18	M	RF	RF	20	3	R	118	R	119	R	R	R	10	474	24	450
2:01	3:00	70	LL	LL	LL	4	1	0	LL	13	4	2	R	R	RF	20	5	RF	IN	IN	R	20	IN	15	15	R	17	18	M	RF	RF	20	3	R	118	R	109	R	R	R	10	465	24	441
3:01	4:00	70	LL	LL	LL	4	1	0	LL	13	4	2	R	R	RF	20	5	RF	IN	IN	R	20	IN	15	15	R	17	18	M	RF	RF	20	3	R	118	13	120	R	R	R	10	488	24	464
4:01	5:00	71	LL	16	LL	4	1	0	LL	13	4	2	R	R	RF	20	5	RF	IN	IN	R	20	IN	15	15	R	17	18	M	RF	RF	20	3	R	118	50	120	R	R	R	10	542	12	530
5:01	6:00	124	LL	40	LL	4	1	0	2	13	4	2	R	R	RF	20	5	RF	IN	IN	R	20	IN	15	15	R	17	18	M	RF	RF	20	3	R	118	50	120	R	R	R	10	621	15	606
6:01	7:00	141	15	50	LL	4	1	0	2	13	4	2	R	R	RF	20	5	RF	IN	IN	R	20	IN	15	15	R	17	18	M	RF	RF	20	3	R	118	50	120	R	R	R	10	664	16	648
7:01	8:00	200	15	50	LL	4	2	2	4	13	6	2	R	R	RF	20	5	RF	IN	IN	R	20	IN	15	15	R	17	18	M	RF	RF	20	3	R	118	72	120	R	R	R	10	751	15	736
8:01	9:00	200	16	40	LL	4	2	2	4	13	6	2	R	R	RF	20	5	RF	IN	IN	R	20	IN	15	15	R	17	18	M	RF	RF	20	3	R	118	102	120	R	R	R	10	772	24	748
9:01	10:00	200	23	40	3	4	2	2	4	13	6	2	R	R	RF	20	5	RF	IN	IN	R	20	IN	15	15	R	17	18	M	RF	RF	20	3	R	118	102	120	R	R	R	10	782	24	758
10:01	11:00	200	19	60	7	4	2	2	4	13	6	2	R	R	RF	20	5	RF	IN	IN	R	20	IN	15	15	R	17	18	M	RF	RF	20	3	R	118	102	120	R	R	R	20	812	24	788
11:01	12:00	200	39	60	7	4	2	2	4	13	6	2	R	R	RF	20	5	RF	IN	IN	R	20	IN	15	15	R	17	18	M	RF	RF	20	3	R	118	102	120	R	R	R	20	832	35	797
12:01	13:00	200	18	60	7	4	1	0	2	13	6	2	R	R	RF	20	5	RF	IN	IN	R	20	IN	15	15	R	17	18	M	RF	RF	20	3	R	118	95	120	R	R	R	10	789	36	753
13:01	14:00	200	15	56	LL	4	1	0	2	13	6	2	R	R	RF	20	5	RF	IN	IN	R	20	IN	15	15	R	17	18	M	RF	RF	20	3	R	118	90	120	R	R	R	10	770	34	736
14:01	15:00	200	19	49	LL	4	1	0	2	13	6	2	R	R	RF	20	5	RF	IN	IN	R	20	IN	15	15	R	17	18	M	RF	RF	20	3	R	118	102	120	R	R	R	10	779	28	751
15:01	16:00	200	28	55	LL	4	1	0	2	13	6	2	R	R	RF	20	5	RF	IN	IN	R	20	IN	15	15	R	17	18	M	RF	RF	20	3	R	118	102	120	R	R	R	10	794	26	768
16:01	17:00	200	19	40	LL	4	1	0	2	13	6	2	R	R	RF	20	5	RF	IN	IN	R	20	IN	15	15	R	17	18	M	RF	RF	20	3	R	118	102	120	R	R	R	20	780	24	756
17:01	18:00	200	45	40	LL	4	1	0	2	13	6	2	R	R	RF	20	5	RF	IN	IN	R	20	IN	15	15	R	17	18	M	RF	RF	20	3	R	118	102	120	R	R	R	20	806	24	782
18:01	18:15	190	37	50	LL	4	2	2	10	13	12	2	R	R	RF	20	5	RF	IN	IN	26	20	IN	15	15	10	20	23	M	RF	RF	25	3	10	118	102	120	R	17	17	40	928	98	830
18:16	18:30	190	45	50	7	4	2	2	10	13	12	2	10	10	RF	20	5	RF	IN	IN	26	20	IN	15	15	14	20	23	M	RF	RF	25	3	10	118	102	120	10	17	17	40	977	98	879
18:31	18:45	200	39	60	7	4	2	2	10	13	12	2	19	15	RF	20	5	RF	IN	IN	26	20	IN	15	15	24	20	23	M	RF	RF	25	3	10	118	102	120	20	17	17	40	1025	98	927
18:46	19:00	200	73	60	7	4	2	2	10	13	12	2	19	15	RF	20	5	RF	IN	IN	26	20	IN	15	15	24	20	23	M	RF	RF	25	3	10	118	102	120	35	17	17	40	1074	98	976
19:01	19:15	200	70	60	7	4	2	2	10	13	12	2	19	15	RF	20	5	RF	IN	IN	26	20	IN	15	15	24	20	23	M	RF	RF	25	3	10	118	102	120	40	17	17	40	1076	98	978
19:16	19:30	200	72	60	7	4	2	2	10	13	12	2	19	15	RF	20	5	RF	IN	IN	26	20	IN	15	15	24	20	23	M	RF	RF	25	3	10	118	102	120	40	17	17	40	1078	98	980
19:31	19:45	201	73	60	7	4	2	2	10	13	12	2	19	15	RF	20	5	RF	IN	IN	26	20	IN	15	15	24	20	23	M	RF	RF	25	3	10	118	102	120	40	17	17	40	1080	98	982
19:46	20:00	203	73	60	7	4	2	2	10	13	12	2	19	15	RF	20	5	RF	IN	IN	26	20	IN	15	15	24	20	23	M	RF	RF	25	3	10	118	102	120	40	17	17	40	1082	98	984
20:01	20:15	200	73	60	7	4	2	2	10	13	12	2	19	15	RF	20	5	RF	IN	IN	26	20	IN	15	15	24	20	23	M	RF	RF	25	3	10	118	102	120	32	17	17	40	1071	98	973
20:16	20:30	200	73	60	7	4	2	2	10	13	12	2	19	15	RF	20	5	RF	IN	IN	26	20	IN	15	15	24	20	23	M	RF	RF	25	3	10	118	102	120	21	17	17	40	1060	98	962
20:31	20:45	200	73	60	7	4	2	2	10	13	12	2	19	10	RF	20	5	RF	IN	IN	26	20	IN	15	15	24	20	23	M	RF	RF	25	3	10	118	102	120	15	17	17	40	1050	98	952
20:46	21:00	200	73	60	7	4	2	2	10	13	12	2	19	R	RF	20	5	RF	IN	IN	26	20	IN	15	15	24	20	23	M	RF	RF	25	3	10	118	102	120	15	17	17	40	1039	98	941
21:01	22:00	151	68	60	7	4	2	2	10	13	4	2	R	R	RF	20	5	RF	IN	IN	R	20	IN	15	15	R	17	18	M	RF	RF	20	3	R	118	55	120	R	R	R	10	759	24	735
22:01	23:00	90	15	40	LL	4	2	0	10	13	4	2	R	R	RF	20	5	RF	IN	IN	R	20	IN	15	15	R	17	18	M	RF	RF	20	3	R	118	55	110	R	R	R	10	606	15	591
23:01	24:00:00	74	LL	18	LL	4	2	0	4	13	4	2	R	R	RF	20	5	RF	IN	IN	R	20	IN	15	15	R	17	18	M	RF	RF	20	3	R	118	25	110	R	R	R	10	517	20	497

REMMARKS: M=MAINTENACE, LL=FILLING, R=RESERVE, IN=UNAVAILABLE, SIN=NO INFORMATION, RF=COLD RESERVE

COLORED: FORCED GENERATION

OUT OF SERVICE:

ESCUINTLA VAP 2, GAS 2,4, 5B	0:00	TO	0:00	HOURS
QUIXAL 1	0:00	TO	0:00	HOURS
LAGUNA GAS 1 & 2	0:00	TO	0:00	HOURS
LAS PALMAS 4	0:00	TO	0:00	HOURS
MARINALÁ 1	8:00	TO	10:00	HOURS

Time 16:46

MANUEL MEDINA
OPERATION IN REAL