FEASIBILITY STUDY REPORT
ON
UTILIZATION OF SMALL-SCALE NATURAL GAS
IN
JAMBI PROVINCE
THE REPUBLIC OF INDONESIA

NOVEMBER, 1988

JAPAN INTERNATIONAL COOPERATION AGENCY

PREFACE

In response to a request from the Government of the Republic of Indonesia, the Government of Japan has decided to conduct a study on the utilization of small-scale natural gas in the Jambi Province of the Republic of Indonesia, and has entrusted the study to the Japan International Cooperation Agency (JICA). JICA sent to Indonesia a study team headed by Mr. Nobuo Ishii, Techno Consultants, Inc. from January 31 to February 28, 1988.

The team had discussions on the study with the officials concerned of the Government of Indonesia and conducted field surveys in the study-related areas. After the team returned to Japan, further studies were made and the present report was prepared.

I hope that this report will contribute to the social and economic development of the Jambi Province and to the promotion of friendly relations between our two countries.

I wish to express my appreciation to the officials concerned of the Government of the Republic of Indonesia for their close cooperation extended to the team.

November 1988

Kensuke Yanagiya

Kensuke Yanagiya
President
Japan International Cooperation Agency

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Conversion Table

(1) Length

1 ft	=	0.3048	m
1 in	=	0.0254	m

(2) Volume

1 ft^3	=	0.02832	m^3
1 gal(USA)	=	0.003785	m^3
1 Barrel	=	0.15897	m^3

(3) Weight

1 lb	=	0.4536	kg
1 grain	=	0.064799	g

(4) Velocity

1 knot	=	1.852	km/h

(5) Degree

°F	=	$32 + \frac{9}{5}$ °C

(6) Pressure

1 psig	=	0.07031	kg/cm^2g

(7) Flow Rate

1 MMSCFD	=	1,116	Nm^3/h

(8) Energy

1 kcal	=	0.001163	kWh
1 BTU	=	0.000293	kWh

(9) Power

1 kcal/h	=	0.001163	kW
1 N	=	0.10197	kgf
1 HP	=	0.74569	kW
1 PS	=	0.73549	kW

1. INTRODUCTION

1-1 Background of Study

The government of the Republic of Indonesia has been executing its national policy by issuing five-year national development programs, which are guidelines for each province on solving its problems and directions and measures to be taken, in order to develop and enhance the overall economy on national level as well as provincial level.
The current five-year plan has placed stress on, among others;

(1) Balanced economic development, focusing on development of rural regions for increasing food products for coping with increase of population.

(2) Fair distribution of wealth by creating employment opportunities.

(3) National stability through promotion of economic growth, especially in regions where development is below the average of the the Republic, by means of transmigration from highly populated areas.

Jambi Province, located in the central part of the Island of Sumatra, is one of the regions where social and industrial infrastructures are still to be developed, in comparison with other parts of the Republic. A considerable amount of its economy is dependent on agriculture including forestry and fisheries. However, Jambi Province is gifted with unused natural resources such as oil, natural gas and coal and its population is growing by a rapid rate, partially attributed to transmigration from the Island of Java. Taking those promissing factors into consideration and by effective utilization of natural and human resources, Jambi Province is expected to develop greatly in the future.

Under these circumstances, the government of the Republic of Indonesia requested the government of Japan to conduct a feasibility study on the subject of promoting regional development by utilization of unused small-scale natural gas in Jambi Province.
In response to this official request from the government, Japan International Cooperation Agency dispatched Preliminary Survey Team consisted of JICA officials and experts of each field to the Republic of Indonesia in September, 1987. The Team had a series of discussions about details for the implementation of the Feasibility Study with the Counterpart of the Indonesian Government. The team agreed upon and signed with the Indonesian Counterpart the Scope of Work which defined the contents and conditions of implementation of the Feasibility Study.

This Feasibility Study has been conducted in accordance with the Scope of Work. The original request from the Indonesian Counterpart on this study was Feasibility Study of the utilization of small-scale natural gas for executing four projects, namely,

- Power generation
- LPG production
- Fertilizer production
- Adhesive production

It was made clear by JICA Preliminary Survey Mission through discussions with the Authorities of the government of Indonesia that;

(1) *Regarding the adhesives, the present supply suffices the demand* of Jambi Province. Furthermore, since production of adhesives and fertilizer using small-scale natural gas is not economical, the necessity to construct new plants has decreased.

(2) Regarding electricity generation, Jambi Province depends on isolated electric distribution systems consisted of small diesel engine generators and approximately one half of the household in Jambi City and its surrounding area are not electrified yet.

In the light of the current situation described above, it is acknowledged that the feasibility study of a project to construct a power plant is required, using inexpensive unused gas as its fuel to promote electrification in the region.

(3) Regarding LPG, it is understood that a feasibility study is required regarding a project to construct LPG production plant, in view of the rate of increase on consumption of LPG in Jambi Province.

Because of the present situation as mentioned above, it was agreed between the JICA Preliminary Survey Team and the Indonesian Counterpart that the feasibility study for power generation and LPG production would be carried out within the framework of this program.

This project is in line with "balanced economic growth", one of the policies launched by the government of Indonesia, and can be used as a development model for utilization of gas produced from small-scale natural gas fields, applicable to other regions where similar small-scale gas fields are confirmed in various parts of the Indonesian Archipelagoes.

1-2 Purpose of the Study

The purpose of the study is to investigate technical, financial and economic feasibility of the project for power generation and LPG recovery by utilizing small-scale natural gas to be produced in Sengeti gas field, the vicinity of Jambi City and to consolidate all results of findings and assessment into the Feasibility Study Report as follows:

(1) To formulate a construction plan for a power plant which uses natural gas as its main fuel as well as to prepare a plan for electric transmission and distribution lines related to the power plant.

(2) To formulate a construction plan for a gas pipeline to supply fuel gas to the proposed power plant.

(3) To formulate a construction plan for an LPG recovery plant as well as to prepare a plan for a pretreating facility to treat the natural gas to suit to pipeline transmission.

(4) To evaluate the viability of the project from the technical, financial and economical viewpoints, based on a project scheme determining whether the capacity of each plant meets the scale of demand defined by market study and to complete F/S Report by incorporating all of the above.

1-3 Scope of Study

The Feasibility Study is to study and analyze the following items:

(1) Background Study of Project

(A) Study on the social and economic states of Jambi Province
(B) Study on the regional development plan of Jambi Province
(C) Understanding of the purpose and present conditions of development

(2) Technical Study

(A) Survey of the gas field and candidate sites for plants
(B) Confirmation of volume of reservoirs and compositions of gas used for the Project
(C) Technical study of power generation project and LPG recovery project

(3) Market Study

(A) Study of supply and demand of energy in Jambi Province
(B) Study of supply and demand of electricity and LPG in Jambi Province
(C) Forecast on balance of supply and demand of electricity and LPG in Jambi Province

(D) Study on price of electricity and LPG (past trends and present values)

(E) Study on sales and distribution system of electricity and LPG

(4) Conceptual Design of Project

(A) Study on comparison of plant sites

(B) Determination of method and route of gas transmission pipeline

(C) Determination of the optimum scale and system of plants

(D) Environmental consideration and discussion about pollution control facilities as deemed necessary

(E) Determination of required conditions of gas and utilities

(F) Conceptual design of plants and related facilities

(5) Implementation Plan

(A) Preparation of implementation program on project construction and operation

(B) Preparation of plan for procurement and transportation of equipment and materials for construction of the Project

(6) *Estimation of Construction Cost*

(A) Cost estimation of plant construction

(B) Cost estimation of construction of related facilities and utilities

(7) Financial and economic analysis

1-4 Field Survey

Japan International Cooperation Agency dispatched the team for field survey to the Republic of Indonesia from January 31 to February 28, 1988. The list of members of the field survey team and their survey schedule are attached in Appendix.

2. CONCLUSION AND RECOMMENDATION

There are a number of large and small gas fields in Indonesia and to date, the utilization of large scale gas fields is promoted for the purpose of exporting LNG and LPG. Conversely, small-scale gas fields, scattered in various parts of Indonesian Archipelagoes and some of associated gas have not been developed or utilized. However, a system to promote regional developments by the effective utilization of natural resources indigenous to the country will be discussed as a new endeavor for the balanced economic development in Indonesia which would ease population concentration in the Java Island.

The purpose of this project is to supply electricity and LPG needed in Jambi district by utilizing the natural gas in Sengeti, which is left unused at present. And once this project is implemented, the project will have far-reaching influence on the economic development of the region. If the utilization of the small-scale gas fields proves effective to the regional development, the concept of this project can be used as the model for the areas similar to Jambi where small-scale gas fields are yet untapped.

The results of the study are summarized as follows:

1. Market

. The amount of electricity consumed in Jambi Province in 1986 was 57.0 GWh and 85% of it was consumed in Jambi City and surrounding areas.

. The rate of electrification, is only 9% for the entire Jambi Province and 49% for Jambi City and surrounding areas, and is attributed to the lack of an electric transmission and distribution network.

. A number of factories located in unelectrified areas and in areas with unstable electric supply have equipped themselves with independent power generating facilities. Most of these factories will change from their self-generating units to the PLN electric supply system as the electrification program by PLN proceeds.

. The electricity demand for industrial use and household use are forecasted to increase. In order to cope with this increase of the electricity demand, PLN plans to construct a 10 MW diesel generating power plant in 1992.

. According to the market study, even if this 10 MW generating facility is added, the construction of a power plant of 20 MW output range will be necessary by the end of the fiscal 1994.

. The supply of LPG to Jambi City was commenced in 1984 and became full scale in 1986.

. The average consumption of LPG in Jambi Province in 1987 was 57.7 tons/month and 80% was consumed in Jambi City. Of the total consumption of LPG in Jambi Province, 85% was for household use and 15% was for industrial use. The LPG demand in 1995 and 2000 is forecasted as follows:

In 1995 : 1,540 tons/year (128 tons/month)
In 2000 : 2,640 tons/year (220 tons/month)

2. Natural gas production

. Ten layers of gas reserves exist in Sengeti. According to the data of PERTAMINA, the recoverable remaining gas is approximately 1.33×10^9 m^3 (47.0 BSCF).

. Based on the engineering assumption derived from PERTAMINA data, it is judged that the life of the gas reserves will last more than 20 years if the gas production rate is in the range of 2 to 4 MMSCFD.

3. Power generation system

. In view of the results of the market study and the suppliability of the gas, the rated capacity of 20 MW (17 MW of the normal generating capacity) was determined.

. Regarding power generating systems, three methods of the gas turbine generation, the steam turbine generation and the dual-fuel engine generation were compared from the technical and the financial viewpoints and the dual-fuel engine generating system was selected.

. Regarding the site for the proposed power plant, three locations of Sengeti, a location between Setiti and Jambi City, and Payo Selincah were compared in terms of the overall economics which include the construction costs for the pipeline and the transmission and distribution lines as well as the energy loss due to the electricity transmission.

Payo Selincah was selected as the candidate site for the power plant from the above comparison.

4. Natural gas pretreating facility

. In order to transport the natural gas from the gas source to the proposed power plant by pipeline, a natural gas pretreating facility is necessary to remove the heavy hydrocarbons and water contained in the gas.

. The process to utilize the self cooling effect by adiabatic expansion of the gas itself is adopted.

. The installation site will be at the inlet of the pipeline, namely, at Sengeti.

5. LPG recovery system

. For the LPG recovery system, there are two possible processes: one is the process to recover LPG from the gas separated at the GOSP, and the other is the process to recover LPG from the condensate separated at the GOSP. Both the processes were compared in this study and the system to recover LPG from the condensate was adopted.

. It is possible to recover 10 tons per day of LPG from the condensate and the amount will suffice to cover the LPG demand in Jambi district for some time.

. The site for LPG Recovery Plant will be Sengeti.

6. Pipeline

. The construction of the pipeline will be necessary to transport the natural gas continuously from Sengeti to Payo Selincah where the proposed power plant is to be erected.

. The route of the pipeline will be in the northern area of the Batang Hari river where the population density is low. The length of the pipeline is 20 km.

7. Transmission and distribution lines

. In order to interchange electricity and facilitate the parallel running with the existing power station, the 0.3 km distance between the proposed power plant and the existing power station and the 9 km distance from the proposed power plant to the switching station in the central part of the city are interconnected by the cables. Both tie lines are underground cables of 20 kV voltage.

. To supply the electricity to the industrial zone in the east part of the city, one distribution line from the proposed power plant and two lines from the existing Payo Selincah power station will be installed. Two lines also will be installed from the switching station to the residential and the cultural areas in the south-western part of the city. All of these distribution lines are of the overhead suspension type of 20 kV voltage.

8. Total investment cost

. Total investment cost based on a soft loan of 3.5% p.a. interest is as follows:

	Unit: Million Yen
- Plant construction cost	4,673.8
- Pre-operation cost	47.7
- Initial working capital	19.2
- Interest during construction	139.8
Total:	4,880.6

9. Financial and Economic Analysis

. In the financial analysis of LPG Recovery Plant, the LPG production is set at 2,792 tons per year. It is assumed that the LPG corresponding to the demand of Jambi Province will be sold at 240 US Dollars per ton and the balance will be sold to Palembang area at 45 US Dollars per ton. ROI before tax in this case is 3.6%. If the soft loan is applied, the financial conditions are good and the debt can be repaid without any financial difficulty.

. Regarding the power plant project, the financial analysis was conducted with three gas prices since the gas price has not been established yet. A comparison was also made with the case of using a diesel engine generator. ROI before tax for each case and the unit electricity costs for the interest of 3.5% p.a. are shown below.

Gas Price (US$/MMBTU)	ROI (%)	Electricity Cost (Rp/kWh)
2.53	0.0	91
2.10	2.9	85
1.50	6.2	75
Diesel generation	0.3	90

. The national benefits that can be expected by the implementation of this project are mainly the savings of diesel oil to be replaced by using the gas instead and the kerosene to be replaced by the recovered LPG. The diesel oil and the kerosene saved are projected as 28,432 kl/year and 2,588 tons/year, respectively. The foreign currency saved by the implementation of this project will be 44 million US Dollars in total, of which 38 million US Dollars is contributed by the power generation project. In the final analysis, the project is assessed as reasonable and viable from viewpoints of market and the availability of raw material feed gas. Most of the facilities intended for use by this project have actually been used in Indonesia and the generating facility of the dual-fuel engine generator has proven itself technically viable.

Therefore, in implementing this project in Jambi district, it can be stated that there will be no technical obstacles other than the normal and foreseeable works which can be overcome by the cooperation and dedicated efforts of a group of competant engineers. From viewpoints of finance and economy, if the gas price is set below 2.1 US$/ MMBTU and the soft loan as described in the financial analysis is applied, the proposed power plant can be operated independently in terms of finance, as a separate entity. The LPG recovery project is small in scale and a program dependable to the power plant project; however it has significance from the viewpoint of conservation and effective utilization of precious natural resources.

In the light of the results of the study coupled with the social and regional significance of the project, the study team members for this Feasibility Study are convinced themselves that this project should be promoted and implemented as quickly as possible.

Because the detailed data concerning the gas reservoir are of confidential nature for PERTAMINA, the owner of the gas fields, and sufficient data are not made available to the study team, the technical evaluation and discussion on the gas reserves are based fundamentally on engineering assumption and judgment. Furthermore, this project uses Sengeti gas reservoir as the only gas resource, thus the recoverable reserve of the gas, the gas production plan and gas compositions have crucial influence on the entire project. Therefore, in proceeding with the actual implementation of the project, a detailed survey on gas reservoirs will be needed as the first step of the work.

It is also necessary to establish an appropriate organization for project execution after in-depth discussions are conducted among BPPT, the Provincial Government of Jambi, PERTAMINA and PLN.

3. THE CURRENT CONDITION OF JAMBI PROVINCE

3-1 Summary of Jambi Province

Jambi Province, located nearly in the middle of the Island of Sumatra, has an area of approximately 53,400 sq.km, and consists of Jambi City and five regencies: Batang Hari, Bungo Tebo, Sarolangun Bankgo, Kerinci, and Tanjung Jabung. The total population is approximately 1.8 million as of 1986, and population density is approximately 34 per sq.km. The average population growth rate from 1980 to 1986 was approximately 3.7% per year, indicating quite a high rate compared to the Indonesian average of 2.3% per year.

The rate is high because Jambi Province is designated as a preferential province for transmigration, and is progressively absorbing migrants from overpopulated areas such as Java, Madura, Bali Island and so on. The climate is generally tropical and humid, and with the exception of the mountaneous zone (Kerinci regency), the highest temperature for the area is 32°C and the lowest temperature is 23°C. The annual rainfall is 2,000 to 2,800 mm. In general, the dry season is from May through October and the rainy season is November through April.

The Batang Hari River (total length: 1,740 km) runs through Jambi Province, and many people live along this river. Jambi City is a developed city with a population of 280,000, 140 km upstream from this river's mouth. Government offices, markets, and the major residential areas are on the south side of the river. The city roads are well-maintained. By contrast, the north bank area of the river is prone to floods, and thus only has houses with raised floors in scattered places, and the roads are hardly maintained. Since there are no bridges in the area, barges and boats are the only means of transporting vehicles or anything to the other bank. Separation by the river is one cause of the delayed development of the north bank area. A bridge is under construction on the west end of Jambi City but it probably will still take many years before its completion.

3-2 The Economy of Jambi Province

3-2-1 The Economic Overview of Jambi Province

As shown in Table 3-1 (Configuration of Jambi Province's GRDP by Sector), the economy of Jambi Province is heavily dependent on agriculture (including forestry and fisheries), accounting for a high percentage (30.0%) of the GRDP. From Table 3-2, it is also clear that Jambi Province's agricultural percentage is high compared with the contribution of agriculture to Indonesia's GRDP. Edible crop production, mainly shared by rice, developing toward virtual self-sufficiency, has the largest share in agriculture. The cash crop production such as gum, palm oil, cinnamon, coffee, etc., is also quite high even when compared with the percentage for the whole of Indonesia. Partially due to Indonesia's forest preservation policies, the contribution ratio of forestry is not high, increasing at a rate of only 0.64% in 1983 through 1986. However, plywood board, square timber, and such wood products have high production increases of 14.1% and 16.3% respectively, and contribute to acquisition of foreign currency. On the other hand, manufacturing in this province is restricted to things such as gum processing, lumbering, and plywood board which are made from agricultural products, and thus the contribution ratio of manufacturing to GRDP, 10.7% is lower than the national average (12.6%). However, its increase rate is as high as 15.1% p.a. for the period from 1983 to 1986.

Table 3-1 Configuration of Jambi Province's GRDP by Sector
(1983 fixed prices)

Industrial Sector	1983	1984	1985	1986
1. Agriculture	32.14%	31.85%	30.51%	29.96%
2. Mining & Quarrying	13.48	13.41	13.70	13.50
3. Manufacturing	9.38	10.18	10.73	11.98
4. Electricity & Water Supply	0.50	0.50	0.54	0.57
5. Construction	2.46	2.38	2.25	2.18
6. Trade, Restaurant & Hotel	16.41	16.80	16.44	16.17
7. Transport & Communication	8.27	7.78	7.44	7.67
8. Banking & Financial Service	6.38	6.35	6.39	5.86
9. Others	10.98	10.70	12.00	12.11
Total	100.00	100.00	100.00	100.00

(Source: Statistical Office Jambi Province)

Table 3-2 Comparison of GRDP Configurations of Indonesia and Jambi Province (1985)
(1983 fixed prices)

Industrial Sector	Indonesia	Jambi Province
1. Agriculture	24.22%	30.51%
1.1 Farm Food Crop	15.27	15.24
1.2 Farm non Food/Estate Crop	3.79	6.33
1.3 Livestock	2.42	1.83
1.4 Forestry	1.10	3.63
1.5 Fishery	1.64	3.47
2. Mining & Quarrying	17.52	13.70
3. Manufacturing	12.61	10.73
4. Electricity & Water Supply	0.75	0.54
5. Construction	5.70	2.25
6. Trade, Restaurant & Hotel	15.42	16.44
7. Transport & Communication	5.77	7.44
8. Banking & Financial Service	3.05	6.39
9. Others	14.96	12.00
Total	100.00	100.00

(Source: Statistical Year Book of Indonesia 1986
Statistical Year Book Jambi Province 1986)

3-2-2 Regional Development Plan for Jambi Province

Indonesia has been conducting five-year national development plans since 1969, and is currently in their fourth five-year plan for the 1984/85 - 1988/89 period. The current plan, a guideline of each provinces' problems, and the directions and measures to be taken, is founded on the following three principles:

(1) Balanced economic development
(2) Fair distribution of wealth
(3) National stability through high economic growth

Based on the above national plan, Jambi Province's development plan is being implemented with BAPPEDA-1, the province's regional development planning commission, in the forefront.

Jambi Province's developmental goals are:

(1) The improvement of the standard of living of residents,
(2) The transition from a traditional economic structure to a modernized economic structure.

Therefore, the development and diversification of agriculture is prioritized even more, since 70% of the employment of residents and approximately 30% of the GRDP is from agriculture. The fourth five-year plan now in progress emphasizes the following programs: the continued, increased production of foodstuffs; promotion of plantations, mainly through the NES (Nucleus Estate and Smallholder) program for the increased production of palm oil; promotion of livestock production; promotion of fisheries; and promotion of industries which use farm products and lumber resources. In order to aid these industry-promotion programs, societal resources such as roads, harbors, and bridges as well as communications, and electricity, and education are being improved.

Table 3-3 shows Jambi Province's fourth five-year plan annual growth target by sector and the actual growth rate for three years.

Table 3-3 Jambi Province's Fourth Five-Year Plan Annual Growth Target and Actual Growth Rate

Industrial Sector	Planned (1984/85-1988/89)	Actual (1983-1986)
1. Agriculture	4.0 %	4.0 %
2. Mining & Quarrying	2.0	6.1
3. Manufacturing	7.0	15.1
4. Electricity & Water Supply	17.0	10.9
5. Construction	15.0	1.8
6. Trade, Restaurant & Hotel	9.0	5.5
7. Transport & Communication	6.0	3.4
8. Banking & Financial Service	20.0	3.1
9. Others	10.0	9.6
Total	6.0	6.1

(Source: Statistical Office Jambi)

3-3 The Energy Situation of Jambi Province

3-3-1 Past Primary Energy Consumption and Future Prospects

With the exception of wood-related energy such as charcoal and firewood, Jambi Province has up to now expanded mostly petroleum-related energy as its primary energy. Since at present electricity is secondary energy generated from diesel fuel, it also depends on petroleum-related energy.

Table 3-4 and Figure 3-1 display the past primary energy consumption in Jambi Province. From them, the following can be inferred:

(1) Gasoline consumption has been increasing annually by an average of approximately 7%, but its share of the total primary energy sources has been at a constant level of 7%.

(2) Kerosene consumption has been increasing at a small annual rate, averaging approximately 2%, and its share of the total primary energy sources may even decrease (from 12.4% in 1982 to 10.3% in 1986).

(3) Diesel fuel consumption is the largest among petroleum-related energy sources, and is increasing annually by an average of 9%, and consumption for electricity generation has been increasing by a high rate of 16%, in particular. However, the share of diesel fuel among the sources of primary energy has been constant at approximately 27%.

Table 3-4 Past Primary Energy Consumption in Jambi Province

Fiscal Year		1982	1983	1984	1985	1986
Gasoline	(Kl)	27,575	27,458	31,145	32,417	35,769
	(billion Kcal)	237.1	236.1	267.8	278.8	307.6
(Share in Total)	(%)	7.1	6.6	7.1	7.0	7.1
Kerosene	(Kl)	46,593	46,566	45,316	44,747	49,980
	(billion Kcal)	414.7	414.4	403.3	398.2	444.8
(Share in Total)	(%)	12.4	11.5	10.7	10.0	10.3
Diesel Oil	(Kl)	94,614	113,193	114,901	122,615	133,300
	(billion Kcal)	832.6	996.1	1,011.1	1,079.0	1,173.0
(Share in Total)	(%)	24.9	27.7	26.7	27.1	27.2
for Power Generation*	(Kl)	11,028	13,160	14,597	17,066	19,998
for Others	(Kl)	83,586	100,033	100,304	105,549	113,302
Fuel Oil**	(Kl)	19,866	23,761	29,607	35,403	43,220
	(billion Kcal)	196.7	235.2	293.1	350.5	427.9
(Share in Total)	(%)	5.9	6.5	7.8	8.8	9.9
LPG	(t)	0.0	0.0	0.0	0.0	318.7
	(billion Kcal)	0.0	0.0	0.0	0.0	3.8
(Share in Total)	(%)	0.0	0.0	0.0	0.0	0.1
Sub Total	(billion Kcal)	1,681.1	1,881.9	1,975.4	2,106.5	2,357.1
(Share in Total)	(%)	50.3	52.3	52.2	52.9	54.6
Charcoal***	(t)	36,600	37,700	39,700	41,200	43,100
	(billion Kcal)	256.2	263.9	277.9	288.4	301.7
(Share in Total)	(%)	7.7	7.3	7.3	7.2	7.0
Firewood****	(cubic meter)	914,000	944,000	992,000	1,029,000	1,077,000
	(billion Kcal)	1,407.6	1,453.8	1,527.7	1,584.7	1,658.6
(Share in Total)	(%)	42.1	40.4	40.4	39.8	38.4
Sub Total	(billion Kcal)	1,663.8	1,717.7	1,805.6	1,873.1	1,960.3
(Share in Total)	(%)	49.7	47.7	47.8	47.1	45.4
Total	(billion Kcal)	3,344.9	3,599.6	3,781.0	3,979.6	4,317.4
(Share in Total)	(%)	100.0	100.0	100.0	100.0	100.0

Note : * These figures are estimated from the unit consumption rate of the power generation in Jambi City.

** These figures are of the industrial sector,and the figure in 1986 is estimated by extrapolation.

*** These figures are estimated based on a 2.0 Kg/month/capita charcoal unit consumption rate.

**** These figures are estimated based on a 0.6 cubic meter/year/capita firewood unit consumption rate.

Energy conversion factors used are the following:

1 liter of Gasoline = 8,600 Kcal
1 liter of Kerosene = 8,900 Kcal
1 liter of Diesel Oil = 8,800 Kcal
1 liter of Fuel Oil = 9,900 Kcal
1 Kg of LPG = 11,900 Kcal
1 Kg of Charcoal = 7,000 Kcal
1 cubic meter of Firewood = 1,540 thousand Kcal

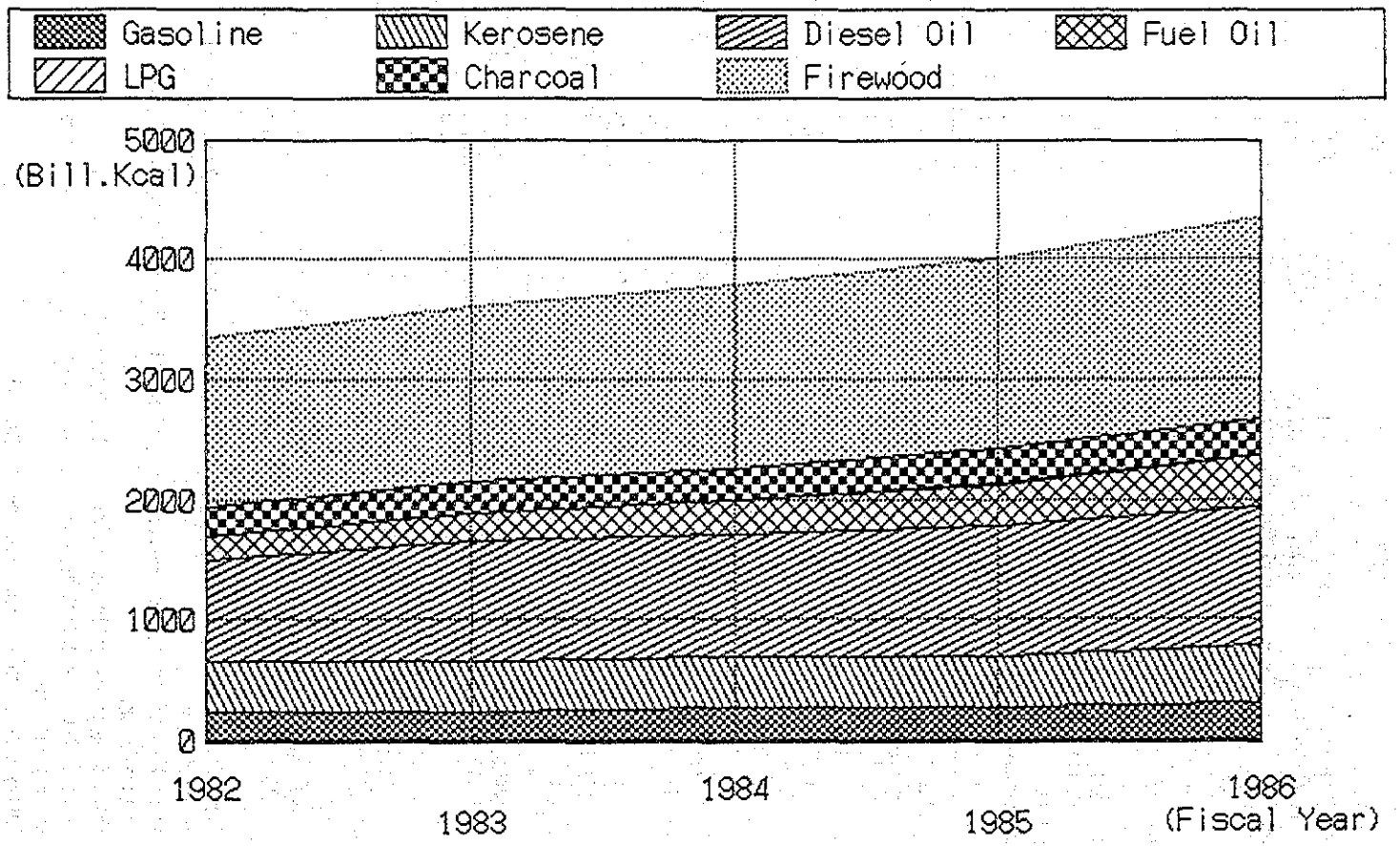


Figure 3-1 Past Primary Energy Consumption in Jambi Province

(4) Data on the consumption of fuel oil is only available for that of the industrial sector, and the 1986 records were not available, but the average annual growth rate from 1982 through 1985 was very high (approximately 21%). Its percentage among the total primary energy sources is also increasing: from 5.9% in 1982 to 9.9% in 1986.

(5) Since LPG has been started marketing only since about 1984, its percentage among the total primary energy sources is small, but it is increasing rapidly (the actual performance of 318.7 t in 1986 grew to 692.5 t in 1987 (not shown on Table 3-4)).

(6) The average annual growth rate of petroleum-related energy sources, including LPG, is approximately 9%, and its percentage among the total primary energy sources is increasing (share grew from 50.3% in 1982 to 54.6% in 1986).

(7) Data on the consumption of wood-related energy sources was not available, but according to estimates based on very broad hypotheses, wood-related sources account for approximately half of the total primary energy sources. The share is decreasing though, as seen in the decline from 49.7% in 1982 to 45.4% in 1986.

(8) Firewood is the most used form of wood-related energy source in Jambi Province, accounting for approximately 40% of the total primary energy sources. This percentage is decreasing yearly, however, reflecting the change in the province's structure of energy consumption.

From the above, the following conclusions can be drawn concerning the economic condition and structure of energy consumption of Jambi Province.

(a) The consumption of petroleum-related energy sources will increase while the consumption of wood-related energy sources will decrease.

(b) Reflecting the changing household energy consumption structure, the growth rate of kerosene consumption will be slow down, and consumption may even start to decline.

(c) As long as diesel-generated power plants increase in Jambi Province, diesel fuel consumption will increase mainly in proportion to the increase of electricity consumption.

(d) Fuel oil consumption may slow down in direct proportion to the growth rate of the industrial sector, the main user of fuel oil, but the annual growth rate would still be at least around 8%.

(e) Since consumption of LPG has just begun, a high growth rate compared to other energy sources is expected for some time.

3-3-2 Energy Resources of Jambi Province

(1) Petroleum and Natural Gas

Jambi Province has a group of oil fields called the "Jambi oil fields". They were developed by NIAM {Nerderlandische Indische Aardolie Maatschappij (Dutch-Indonesian Petroleum Co.)}, and oil was first struck at Betung oil field, about 50 km west-southwest of Jambi City, in 1923. This was followed by the discoveries of Tempino and Bajubang oil fields in 1931. Table 3-5 shows operators that were or are currently doing petroleum exploration in Jambi Province and their contract areas.

Table 3-5 Operators and Contract Areas for Petroleum Exploration in Jambi Province

Operators	Contract Areas
Asamera Oil Indonesia	Tempino
Chevron Jambi	South Jambi B
Huffco	Hangunjaya-Kapahian
Jambi Oil Development	Jambi A
Jambi Shell BV	North East Jambi
PERTAMINA	Jambi

A considerable amount of natural gas has also been discovered either with petroleum (i.e. associated gas) or by itself (i.e. dry gas) at the areas mentioned above. The main gas fields among these areas include Kuang, Bajubang, Tempino, Kenali Asam, Sengeti (the gas field for this project), and Setiti.

Data on the oil and gas reserves in Jambi Province was not available, but the oil and gas reserves for the entire South Sumatra area including Jambi Province are reported in Tables 3-6 and 3-7, respectively.

Table 3-6 Estimated Oil Reserves in South Sumatra

(As of January 1985)

(Unit: Million barrels)

Basin	Original Oil in Place	Cumulative Production	Confirmed Reserves	Confirmed Ultimate Recovery	Recovery Efficiency (%)
South Sumatra	7,075	1,499	205	1,704	24.1

Source: US Department of Energy, Information Administration

Table 3-7 Recoverable Gas Reserves in South Sumatra

(Unit: Billion cubic feet)

	Confirmed Remaining Reserves (A)	Probable* Reserves (B)	Future** Discoveries (C)	Total (D) = (A)+(C)
PERTAMINA II	3,833	1,205	1,090	4,923
Ex-Stanvac	393	111	280	673
Asamera	36	50	28	64
Total	4,262	1,366	1,398	5,660

Source: MIGAS Indonesia Gas Utilization Study Final Report

Note: * Estimated by MIGAS-PERTAMINA

** Estimated by BEICIP

(2) Other Energy Resources

Jambi Province is considered one of the provinces of Indonesia that has not been fully developed, and the discovery of abundant resources is expected. This includes the development of energy resources such as hydro-power and geo-thermal energy being considered in Kerinci and Sarolangun Bangko regencies respectively. Rio Tint of Great Britain also explored and discovered approximately 70 million tons of recoverable coal around the Bangko area in 1973. Table 3-8 shows coal reserves as reported in the fourth five-year plan (Repelita IV) original draft. Since over 10 billion tons of coal exist in the promising coal fields of Sumatra Island, such as Umbilin, Bukit Assam and others, the existence of abundant coal in Jambi Province is considered highly probable.

Table 3-8 Confirmed Coal Reserves in Indonesia

Coal Field	Confirmed Reserves (thousand tons)
Umbilin	100,000
Bukit Assam	200,000
South Sumatra	10,000,000
South and East of Kalimantan	Under Exploration

Source: Repelita IV Draft

As mentioned above, the exploration in Jambi Province for energy resources other than petroleum and natural gas, such as coal, has just scratched the surface, and the general outline will become clear as the exploration proceeds. Even if the existence of abundant energy resources is confirmed, it would be necessary to set up an infrastructure which can make practical use of them.

3-3-3 The Energy Policy of Jambi Province

According to the fourth five-year plan (Repelita IV), the measures for increasing the energy demand in Jambi Province are being considered as part of an overall national energy policy. Petroleum has been the most important energy source of Jambi Province. Since it is a source of foreign currency, the national energy policy stipulates the conservation of petroleum. Jambi Province is endowed with a lot of potential energy such as hydro-power and geothermal energy. Research into their possible utilization is planned under the fourth five-year plan, in an effort to meet the increasing energy demand in Jambi Province with alternative forms of energy. In terms of hydro-power, Kerinci regency with the Raya mountain area, and Sarolangun Bangko regency with the Maru River area have the potential to generate 232 MW and 85 MW, respectively. Plans are also being made for the practical use of an approximately 1.33 billion cubic meters of remaining recoverable natural gas reserves in the Sengeti area of the Batang Hari river district. (Plan for the practical use of this natural gas are being considered in this project.) The Indonesian government established the following guidelines for diversifying energy within ten years, in connection with this national energy policy:

1) The internal supply of petroleum will be regulated, and with the exception of meeting petrochemical needs and supplying areas which cannot use non-petroleum sources of energy, petroleum will be exported as much as possible.

2) Natural gas shall be allotted partially for domestic needs through city gas, power generation, and petrochemical needs, and partially for export.

3) Coal will be used as fuel for power generation and heavy industry, or converted into gas for household and city gas use. It will also be exported.

4) Solar energy and wind energy shall be developed in accordance with domestic needs and technological conditions.

4. MARKET STUDY

4-1 Market Study on Electricity

4-1-1 Electricity Supply and Demand Situation

This Chapter summarizes the situation of the electricity supply and demand of the entire Jambi Province and then of Jambi City and surrounding areas.

(1) Electricity Supply and Demand Situation of Jambi Province

(a) Electricity Consumption Structure of Jambi Province

Jambi Province has a population of 1,800,000 and 380,000 households in 1986 (fiscal year), and only approximately 9% (35,000) of these households was electrified. Electrified households in Jambi City and surrounding areas numbered 26,700 the same year. This means that nearly eighty percent of the total number of electrified households in Jambi Province are located in Jambi City and its surrounding areas. Each sector accounted for the following proportions of the approximately 57.0 GWh of electricity consumed in 1986 (fiscal year): residential sector, 51.3%; commercial sector, 13.4%; public and other sector, 12.0%; and industrial sector, 23.3%. There are notable increases in consumption in the industrial sector (38.4% p.a.) in recent electricity consumption trends of each sector shown in Table 4-1. Summaries of electricity consumption by sector of Jambi Province follow.

(i) Residential Sector

The number of consumer-households has been increasing annually by an average of approximately 23.9%, but the yearly electricity consumption per household has been diminishing. This has been explained as the

Table 4-1 Past Population, Electric Energy Demand & Real GRDP Indices Record by Sector of Jambi Province

Fiscal Year	1982	1983	1984	1985	1986	Average*	Average**
Residential Sector							
Population	1,524,104	1,572,701	1,653,698	1,715,436	1,795,190	-	-
Growth Rate (%)	2.29	3.19	5.15	3.73	4.65	4.18	3.80
No.of Household	318,206	326,579	345,626	352,815	381,234	-	-
Household Size	4.79	4.82	4.78	4.86	4.71	-	4.79
No. of Consumers	14,700	18,936	22,857	28,849	34,623	-	-
Growth Rate (%)	N.A.	28.82	20.71	26.22	20.01	23.88	23.94
Electr. Ratio (%)	4.62	5.80	6.61	8.18	9.08	-	-
Unit Consump.(KWh)	1,155.2	1,117.0	979.7	900.6	845.1	-	-
Energy Consump.(GWh)	16.98	21.15	22.39	25.98	29.26	-	-
Growth Rate (%)	N.A.	24.56	5.87	16.02	12.62	14.57	14.77
Commercial Sector							
No. of Consumers	2,493	2,782	3,071	3,490	4,034	-	-
Growth Rate (%)	N.A.	11.59	10.39	13.64	15.59	12.79	12.80
Energy Consump.(GWh)	5.11	6.48	6.83	7.28	7.64	-	-
Growth Rate (%)	N.A.	26.86	5.37	6.55	4.97	10.58	10.94
Constituent Ratio	N.A.	1.09	0.91	0.41	0.39	0.73	0.74
Sector GRDP(1983=100)	94.31	100.00	108.64	112.91	117.56	-	-
Growth Rate (%)	5.61	6.04	8.64	3.93	4.12	5.66	5.67
Elastisity	N.A.	4.45	0.62	1.67	1.21	1.87	1.93
Public & Other Sector							
No. of Consumers	606	760	873	1,085	1,240	-	-
Growth Rate (%)	N.A.	25.41	14.87	24.28	14.29	19.60	19.71
Energy Consump.(GWh)	4.46	4.69	5.37	6.44	6.83	-	-
Growth Rate (%)	N.A.	5.36	14.33	19.96	6.14	11.28	11.45
Constituent Ratio	N.A.	0.22	2.44	1.25	0.49	0.77	0.78
Sector GRDP(1983=100)	96.09	100.00	103.48	123.31	131.70	-	-
Growth Rate (%)	6.80	4.07	3.48	19.17	6.80	8.20	8.06
Elastisity	N.A.	1.32	4.12	1.04	0.90	1.38	1.42
Industrial Sector							
No. of Consumers	132	143	126	138	154	-	-
Growth Rate (%)	N.A.	8.33	-11.89	9.52	11.59	3.93	4.39
Energy Consump.(GWh)	3.62	4.26	6.42	10.47	13.29	-	-
Growth Rate (%)	N.A.	17.61	50.84	62.98	26.97	38.42	39.60
Sector GRDP(1983=100)	91.41	100.00	115.13	128.87	152.35	-	-
Growth Rate (%)	13.03	9.40	15.13	11.93	18.22	13.62	13.54
Elastisity	N.A.	1.87	3.36	5.28	1.48	2.82	2.92
Total							
No. of Consumers	17,931	22,621	26,927	33,562	40,051	-	-
Growth Rate (%)	N.A.	26.16	19.04	24.64	19.33	22.25	22.29
Energy Consump.(GWh)	30.17	36.59	41.02	50.17	57.03	-	-
Growth Rate (%)	N.A.	21.28	12.10	22.31	13.68	17.26	17.34
GRDP(1983=100)	94.82	100.00	106.12	112.72	119.32	-	-
Growth Rate (%)	3.17	5.46	6.12	6.22	5.86	5.91	5.36
Elastisity	N.A.	3.89	1.98	3.59	2.34	2.92	3.23

Note : * Exponential average
** Arithmetical average

Source : PLN Wilayah IV Cabang Jambi
Kantor Statistik Propinsi Jambi

remarkable increase of small-demand consumers. Electricity consumption has been growing annually by an average of 14.6%.

(ii) Commercial Sector

The number of consumers have been steadily increasing annually by an average of about 12.8% but the growth of electricity consumption has slowed down since 1984 (fiscal year): the average annual growth rate from 1984 (ditto) through 1986 (ditto) was 5.6%. This also has been explained as the increase of small consumers.

(iii) Public and Other Sector

The average annual growth of the number of consumers was very high (19.6%) and electricity consumption has also been growing at a relatively high rate, averaging 11.3%.

(iv) Industrial Sector

In spite of a low average annual growth in the number of consumers (3.9% to 4.4%), electricity consumption has been growing at a very high rate, averaging 38.4%. This has been explained by this sector's large-demand consumers, in contrast with other sectors. The growth rate of this sector's GRDP averaged a high 13.6%; because of the extremely high growth in electricity consumption mentioned above, the energy elasticity was also an exceptionally high average of 2.8.

(b) Power Generating Facilities in Jambi Province

With the exception of self-generating facilities at industrial plants, Jambi Province's power is supplied by the Jambi branch (Cabang Jambi) of Region IV (Wilayah IV) of

the State Electricity Corporation (PLN). The power transmission and distribution systems of each area are not connected each other by transmission lines; they are all independent systems that generate power by diesel. As shown in Table 4-2 which summarizes the power generating facilities of Jambi Province, there are fifteen medium and small-size power plants in Jambi Province. The total installed capacity of these plants as of July 1987 is approximately 47.6 MW, and the total available capacity (capacity of actually possible power generation which takes into account capacity decrease ((PLN's annual declining percentage estimate: 2.5%)) due to age deterioration) is 42.9 MW. About 86% of this capacity is of power plants installed in Jambi City and other power plants only produce approximately 14%. (Note: The facilities of the Pasar power plant of Jambi City (installed capacity 1,920 kW: 800 kW; Worthington and 1,120 kW; Skoda)) are virtually unusable and thus are excluded).

(c) Power Supply and Demand Record in Jambi Province

Table 4-3, which shows the past record of electric power supply and demand in Jambi Province, is a compilation of data from the separate transmission and distribution systems scattered about in the province. According to the table, Jambi Province's installed power generation capacity increased from 26,090 kW in 1985 (fiscal year) to 47,760 kW in 1986 (ditto). This is due to the establishment of the Payo Selincah power plant (installed capacity: 5,218 kW x 5 units) in Jambi City. The regions of Jambi Province other than Jambi City and its surrounding areas began full-scale operation of power plants in about 1981. Consequently, the data for matters concerning power supply and demand in 1981 (fiscal year) is not a complete survey for the entire Jambi Province. The electricity consumption for the province has been at approximately 80% of the electricity

Table 4-2 Outline of Power Generating Facilities in Jambi Province

Name of Power Station	No. of Unit	Installed Capacity (kW)	Available Capacity (kW)	Operation Commencement (Year)	Energy Production (kWh/Month)
PLTD Kasang	1	1,340	1,000	1975	108,510
	2	1,340	1,000	1975	102,180
	3	2,295	1,750	1977	331,846
	4	2,500	2,000	1976	0
	5	2,500	2,100	1983	0
	6	2,500	2,100	1983	203,600
	7	2,500	2,100	1984	51,600
Sub-total		14,975	12,050	-	797,736
PLTD Payo Selincah	1	5,218	5,000	1987	153,790
	2	5,218	5,000	1987	2,221,560
	3	5,218	5,000	1987	0
	4	5,218	5,000	1987	1,756,900
	5	5,128	5,000	1987	1,361,480
Sub-total		26,090	25,000	-	5,493,730
Total	12	41,065	37,050	-	6,291,466
PLTD Muara Bungo	4	1,950	1,640	1979-1982	286,200
PLTD Kuala Tungkal	6	1,960	1,845	1982	326,800
PLTD Bangko	2	540	500	1982	144,770
PLTD Saro Langun	2	440	400	N.A.	72,920
PLTD Muara Bulian	2	600	600	1983	130,880
PLTD Muara Sabak	2	200	180	1982	25,880
PLTD Muara Tebo	2	200	98	N.A.	23,900
PLTD Sei Bangkal	1	40	40	N.A.	5,608
PLTD Nipah Panjang	1	220	200	N.A.	36,308
PLTD Meresam	1	100	100	N.A.	3,055
PLTD Rt. Panjang	1	100	100	N.A.	10,245
PLTD Rt. Pandan	1	100	100	N.A.	1,950
PLTD Jembatan Mas	1	40	40	N.A.	924
Total	26	6,490	5,843	-	1,069,440
Grand Total	38	47,555	42,893	-	7,360,906

Source: PLN Wilayah IV Cabang Jambi

Note: These figures are the figures as of July, 1987.

Table 4-3 Past Record of Electric Power Supply and Demand in Jambi Province

Fiscal Year		1979	1980	1981	1982	1983	1984	1985	1986
Installed Capacity	(KW)	7,335	9,835	N.A.	16,235	21,925	21,565	21,670	47,760
Gross Production	(KWh)(A)	24,346,820	27,246,466	31,536,236	38,138,347	46,238,889	51,251,189	60,518,491	70,331,153
Energy Consumption	(KWh)(B)	18,214,356	21,318,051	26,199,646	30,170,235	36,590,024	41,018,405	50,170,658	57,052,745
(B)/(A)x100	(%)	74.8	78.2	83.1	79.1	79.1	80.0	82.9	81.1
Self Consumption	(KWh)(C)	916,227	893,459	1,063,085	1,141,185	1,690,770	1,939,740	2,086,848	2,246,799
(C)/(A)x100	(%)	3.8	3.3	3.4	3.0	3.7	3.8	3.4	3.2
Losses	(KWh)(D)	5,216,237	5,034,956	4,273,505	6,826,927	7,958,095	8,293,044	8,260,985	11,031,609
((C)+(D))/(A)x100	(%)	25.2	21.8	16.9	20.9	20.9	20.0	17.1	18.9
Peak Load	(KW)	4,840	5,550	7,144	8,977	9,815	10,897	12,733	15,405
Mean Load	(KW)	2,779	3,110	3,600	4,354	5,278	5,851	6,909	8,029
Load Factor	(%)	57.4	56.0	50.4	48.5	53.8	53.7	54.3	52.1
No. of Consumers		9,779	10,583	13,061	17,931	22,621	26,927	33,562	40,051
Contract Capacity	(VA)	13,393,000	14,731,000	18,427,000	20,951,660	27,599,270	35,209,060	41,552,230	47,424,026

Source : PLN Wilayah IV Cabang Jambi

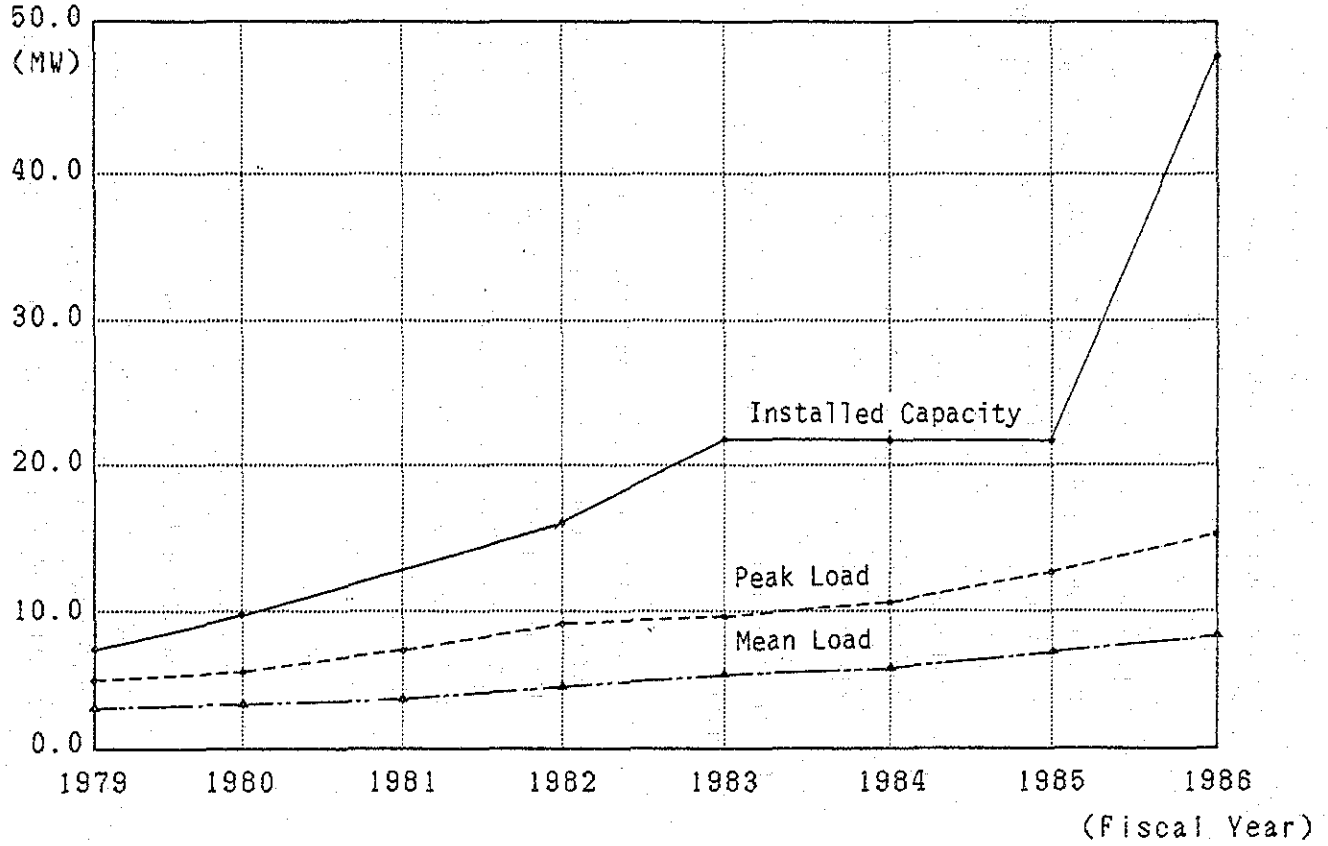
production for the past five years. The average self-consumption rate of power plants for the past eight years was approximately 3.5%. The average sum of the above figure and the loss rate due to power transmission, distribution, and transformation for the same period came to about 20.2%.

These sum figures fluctuate but are gradually diminishing. The annual growth rate for the peak load from 1979 (fiscal year) through 1986 (ditto) increased at an average of about 18.0%. The average load factor for the same seven-year period was approximately 53.3%. Changes in installed capacity, peak load, and mean load in Jambi Province are shown in Figure 4-1.

(2) Electricity Supply and Demand Situation of Jambi City and Surrounding Areas

(a) Jambi City is spread over the banks of the Batang Hari river, the second largest river in the Island of Sumatra. The river embraces the Pasar Jambi ward, the commercial area located nearly in the center of the city. On the north side of the river, there is an agricultural area, on the west and south side, a residential area, and on the east side and along both banks of the river, a sprawling industrial area.

As shown in Table 4-4 (Past Population and Electricity Consumption by Sector of Jambi City and Surrounding Areas), the population and number of households in Jambi City and surrounding areas in 1986 (fiscal year) were 284,000 and 55,000, respectively. Of these 55,000 households, approximately 49% (27,000) were electrified. Jambi City and surrounding areas are highly electrified compared with the electrification percentage for the whole Jambi Province.



Source: PLN Wilayah IV Cabang Jambi

Figure 4-1 Installed Capacity, Peak Load and Mean Load in Jambi Province

Table 4-4 Past Population & Electricity Consumption Record by Sector of Jambi City and Surrounding Areas

Fiscal Year	1982	1983	1984	1985	1986	Average*	Average**
Residential Sector							
Population	230,986	241,435	249,189	249,450	284,036	-	-
Growth Rate (%)	-1.63	4.52	3.21	0.10	13.86	5.30	4.01
No. of Household	N.A.	N.A.	N.A.	48,721	54,615	-	-
Household Size	N.A.	N.A.	N.A.	5.12	5.20	-	5.16
No. of Consumers	13,121	16,394	19,688	24,881	26,689	-	-
Growth Rate (%)	N.A.	24.94	20.09	26.38	7.27	19.42	19.67
Electr. Ratio (%)	N.A.	N.A.	N.A.	51.07	48.87	-	49.97
Unit Consump.(KWh)	1,242.2	1,178.6	1,024.7	936.6	908.6	-	-
Energy Consump.(GWh)	16.30	19.32	20.17	23.30	24.25	-	-
Growth Rate (%)	N.A.	18.55	4.41	15.52	4.05	10.44	10.63
Commercial Sector							
No. of Consumers	1,930	2,081	2,259	2,647	2,506	-	-
Growth Rate (%)	N.A.	7.82	8.55	17.18	-5.33	6.75	7.06
Energy Consump.(GWh)	4.86	5.74	5.91	6.24	6.15	-	-
Growth Rate (%)	N.A.	18.21	3.02	5.52	-1.48	6.07	6.32
Constituent Ratio	N.A.	0.98	0.68	0.36	-0.37	0.58	0.59
Public & Other Sector							
No. of Consumers	508	615	690	878	815	-	-
Growth Rate (%)	N.A.	21.06	12.20	27.25	-7.18	12.54	13.33
Energy Consump.(GWh)	4.34	4.48	5.06	6.04	5.79	-	-
Growth Rate (%)	N.A.	3.06	13.15	19.28	-4.13	7.46	7.84
Constituent Ratio	N.A.	0.16	2.98	1.24	-1.02	0.71	0.74
Industrial Sector							
No. of Consumers	120	127	104	111	102	-	-
Growth Rate (%)	N.A.	5.83	-18.11	6.73	-8.11	-3.98	-3.41
Energy Consump.(GWh)	3.59	3.67	5.77	9.84	12.48	-	-
Growth Rate (%)	N.A.	2.40	57.19	70.50	26.83	36.59	39.23
Total							
No. of Consumers	15,679	19,217	22,741	28,517	30,112	-	-
Growth Rate (%)	N.A.	22.57	18.34	25.40	5.59	17.72	17.97
Energy Consump.(GWh)	29.08	33.21	36.92	45.43	48.67	-	-
Growth Rate (%)	N.A.	14.19	11.18	23.03	7.14	13.74	13.88

Note : * Exponential average
** Arithmetical average

Source : PLN Wilayah IV Cabang Jambi
Kantor Statistik Propinsi Jambi

Each sector accounts for the following proportions of the approximately 48.7 GWh of electricity consumed in 1986 (fiscal year); residential sector, 49.8%; commercial sector, 12.6%; public and other sector, 11.9%; and industrial sector, 25.6%. Because of their many industrial plants, Jambi City and surrounding areas have an industrial sector percentage 2.3 points higher than the corresponding ratio for the entire Jambi Province. The electricity demand of the industrial sector displays remarkable growth.

Summaries of electricity consumption by sector of Jambi City and surrounding areas follow.

(i) Residential Sector

The number of consumer-households have been increasing steadily at an annual rate averaging 19.4%, but the annual electricity consumption per household has been diminishing, resembling the entire Jambi Province (see Table 4-1). This has been explained as the increase of small-demand consumers. This diminishing trend is slowing down considerably, so an eventual change to an increasing trend similar to other countries can be expected. The electricity consumption has been growing at an average annual rate of 10.4%.

(ii) Commercial Sector

The number of consumers has been growing at an average annual rate of 6.8%, about 6 points lower than the rate for the whole of Jambi Province. Electricity consumption has also shown sluggish growth: with the exception of high growth rate in 1982, the average annual growth rate from 1984 (fiscal year) through 1986 (ditto) was 2.4%.

(iii) Public and Other Sector

The consumers have been increasing rapidly at an average annual rate of 12.5%, and electricity consumption has been also increasing correspondingly at an average annual rate of 7.5%.

(iv) Industrial Sector

The growth rate of consumers in the industrial sector has been declining in spite of the steady increase seen in other sectors; the average annual growth rate is negative four percent (-4%). In contrast, electricity consumption is increasing steadily, at an average annual rate of 36.6%. This has been explained as the decrease of small-demand consumers coupled with the increase of consumption by the large-demand consumers.

(b) Power Generation Facilities in Jambi City and Surrounding Areas

Excluding self-generation facilities, Jambi City and the surrounding areas have three power plants, Pasar, Kasang, and Payo Selincah, controlled by the Jambi branch (Cabang Jambi) of PLN Wilayah IV. Since Pasar, the oldest of these plants, is currently not operating (Pasar's units No.1, No.2, and No.3 began operation in 1953, 1964, and 1965 respectively), the two Kasang and Payo Selincah plants are supplying the power to Jambi City and surrounding areas, as shown in Table 4-2. As stated in the above table, the installed capacity and available capacity of Jambi City and surrounding areas as of 1987 are 41,065 kW and 37,050 kW, respectively.

(c) Electricity Supply and Demand Record of Jambi City and Surrounding Areas

Table 4-5 shows past record of electricity supply and demand in Jambi City and surrounding areas. According to the table, the installed power generation capacity of Jambi City and surrounding areas increased from 15,775 kW in 1985 (fiscal year) to 41,065 kW in 1986 (ditto). This is the sum increase of the installed capacity of the newly constructed Payo Selincah power plant (26,090 kW) with the virtually unusable installed capacity of Pasar plant (800 kW) subtracted.

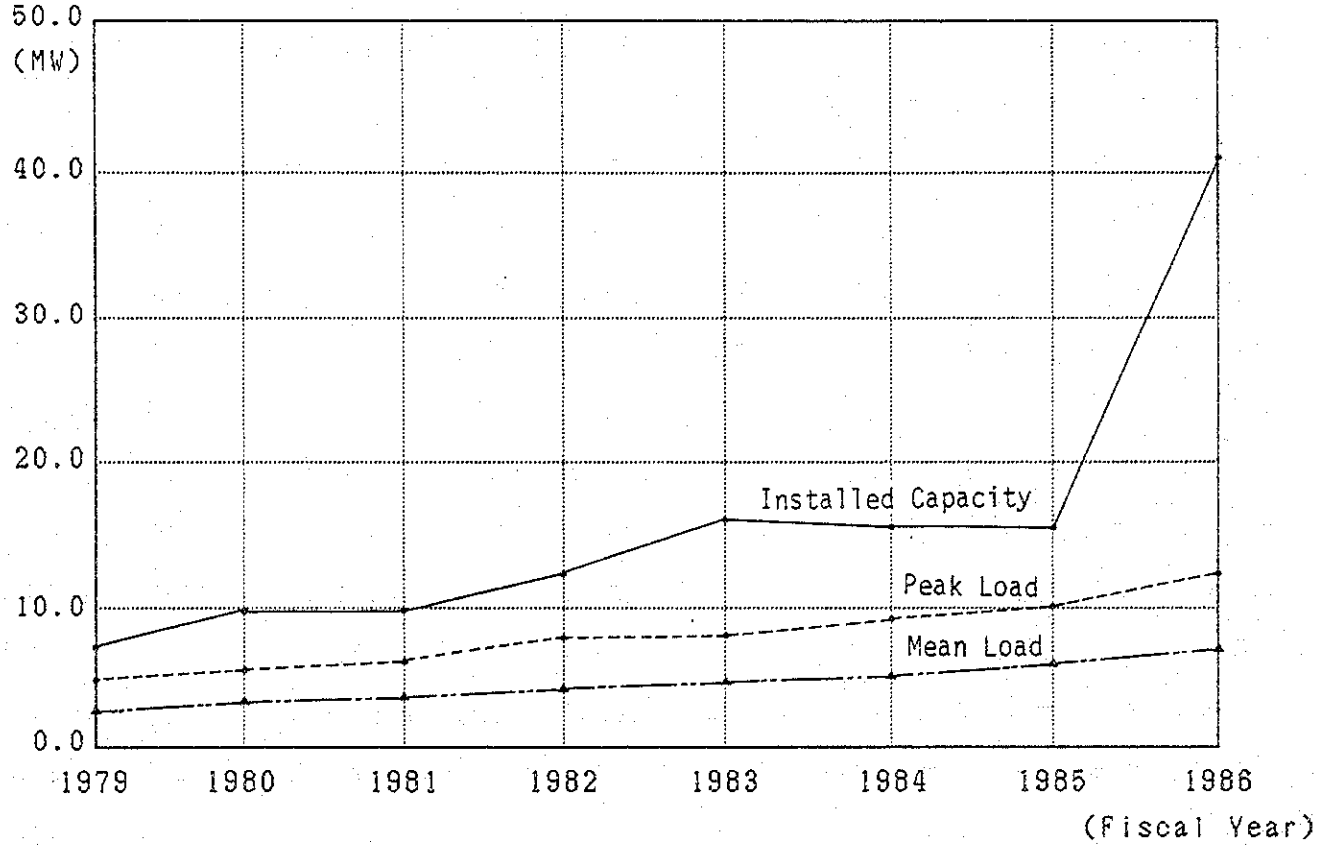
With the exception of the high growth rate in 1985 (fiscal year) (annual growth rate 23.0%), the electricity consumption of Jambi City and surrounding areas has been at approximately the same level (81%) in relation to production for the past five years. The self-consumption rate of plants has been gradually decreasing from 1983 (fiscal year). It went below the 3% level for the first time in 1986 (fiscal year) due to improvements, reflecting the recent establishment of Payo Selincah power plant. The average self-consumption rate for the last eight years is about 3.3%. The average sum of the self-consumption rate and loss rate during operation (electricity transmission, distribution, and transformation) for the same period is about 19.1%. These sum values fluctuate but are declining in general. The average annual growth rate of the peak load from 1979 (fiscal year) through 1986 (ditto) is about 14.5%. The power plant installed capacity, peak load, and mean load of Jambi City and surrounding areas are shown in Figure 4-2.

Table 4-5 Past Record of Electric Power Supply & Demand in Jambi City & Surrounding Areas

Fiscal Year		1979	1980	1981	1982	1983	1984	1985	1986
Installed Capacity	(KW)	7,335	9,835	9,835	12,335	16,335	15,775	15,775	41,065*
Gross Production	(KWh)(A)	24,346,820	27,246,466	30,669,393	36,713,751	40,988,971	44,821,779	52,087,743	59,706,034
Energy Consumption	(KWh)(B)	18,214,356	21,318,051	25,537,893	29,082,894	33,209,452	36,922,870	45,425,492	48,668,193
(B)/(A)x100	(%)	74.8	78.2	83.3	79.2	81.0	82.4	87.2	81.5
Self Consumption	(KWh)(C)	916,227	893,459	1,049,623	1,084,748	1,418,216	1,577,613	1,602,601	1,697,869
(C)/(A)x100	(%)	3.8	3.3	3.4	3.0	3.5	3.5	3.1	2.8
Losses	(KWh)(D)	5,216,237	5,034,956	4,081,877	6,546,109	6,361,303	6,321,296	5,059,650	9,339,972
((C)+(D))/(A)x100	(%)	25.2	21.8	16.7	20.8	19.0	17.6	12.8	18.5
Peak Load	(KW)	4,840	5,550	6,370	7,750	8,080	9,200	10,180	12,500
Mean Load	(KW)	2,779	3,110	3,501	4,191	4,679	5,117	5,946	6,816
Load Factor	(%)	57.4	56.0	55.0	54.1	57.9	55.6	58.4	54.5
No. of Consumers		9,779	10,583	N.A.	15,679	19,217	22,741	28,517	30,112
Contract Capacity	(VA)	13,393,000	14,731,000	N.A.	21,906,790	26,233,150	31,030,010	36,594,210	38,592,380

Note : * This figure excludes the installed capacity of PLTD Pasar.

Source : PLN Wilayah IV Cabang Jambi



Source: PLN Wilayah IV Calang Jambi

Figure 4-2 Installed Capacity, Peak Load abd Mean Load in Jambi City & Surrounding Areas

4-1-2 Electricity Demand Forecast

This Section forecasts the electricity demand of Jambi City and surrounding areas directly related to this project, and then of the entire Jambi Province.

(1) Electricity Demand Forecast for this Project

As mentioned above, there are no large transmission networks in Jambi Province; the electricity demand is concentrated in Jambi City and surrounding areas. Therefore, subsequent forecasting is premised on the electricity supply target area restricted to Jambi City and surrounding areas.

(a) Preconditions:

(i) The electricity supply target area of this Project:
The electricity supply target area is restricted to Jambi City and surrounding areas, as mentioned above.

(ii) Forecast period: Until year 2000.

(iii) Forecast method:
Two electricity demand forecasts (by summation of sectors) compiled by the head office (Pusat) and by Region IV (Wilayah IV) of the State Electricity Corporation (PLN) respectively are reviewed from an even more practical standpoint.

(iv) Content under reconsideration:
Various factors of determination underlying the above two electricity demand forecasts compiled by PLN-Pusat and PLN-Wilayah IV (see Tables 4-6 and 4-7) are reconsidered, and six cases are chosen among the possible combinations (three resembling to

Table 4-6 Electricity Demand Forecast of Jambi City and Surrounding Areas by PLN Pusat

Fiscal Year	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Residential																
Population(10^3)	249.5	259.2	269.3	279.8	290.8	302.1	310.6	319.3	328.2	336.7	345.5	354.5	363.7	373.1	382.8	392.8
Person/Household	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Household(10^3)	49.9	51.8	53.9	56.0	58.2	60.4	62.1	63.9	65.6	67.3	69.1	70.9	72.7	74.6	76.6	78.6
No.of Consumers	22,700	24,500	26,460	28,577	30,863	33,332	35,999	38,878	41,989	44,928	48,073	51,438	55,039	58,891	63,014	67,425
Electr. Ratio(%)	45.5	47.3	49.1	51.1	53.1	55.2	58.0	60.9	64.0	66.7	69.6	72.6	75.7	78.9	82.3	85.8
Unit Consump.(KWh)	987.6	980.0	981.4	982.8	984.3	985.7	987.1	988.5	990.0	991.4	992.8	994.3	995.7	997.1	998.6	1,000.0
Energy Consump.(GWh)	22.2	24.0	26.0	28.1	30.4	32.9	35.5	38.4	41.6	44.5	47.7	51.1	54.8	58.7	62.9	67.4
Commercial																
Constituent Ratio	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Energy Consump.(GWh)	5.9	6.4	6.9	7.5	8.1	8.7	9.4	10.2	11.0	11.8	12.7	13.6	14.6	15.6	16.7	17.9
Public & Others																
Constituent Ratio	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Energy Consump.(GWh)	5.8	6.3	6.8	7.3	7.9	8.6	9.3	10.0	10.9	11.6	12.5	13.4	14.3	15.3	16.4	17.6
Industry																
Captive Energy (GWh)	0.0	0.0	3.9	9.0	13.5	18.0	22.3	27.0	32.0	37.0	41.0	43.4	44.0	44.0	44.0	44.0
Energy Consump.(GWh)	9.5	12.8	17.7	24.2	30.7	37.6	44.9	53.2	62.5	72.5	82.3	91.3	99.2	107.1	115.7	124.9
Total																
Energy Consump.(GWh)	43.4	49.5	57.4	67.1	77.1	87.8	99.2	111.9	126.0	140.5	155.2	169.4	182.9	196.8	211.8	227.9
Growth Rate (%)	0.0	13.9	16.0	17.0	14.8	13.9	13.0	12.8	12.5	11.5	10.4	9.1	8.0	7.6	7.6	7.6
Losses+Plant Use (%)	13.8	17.2	17.0	16.5	16.0	15.5	15.0	14.5	14.0	13.5	13.0	13.0	13.0	13.0	13.0	13.0
Energy Product.(GWh)	50.4	59.7	69.1	80.4	91.7	103.9	116.7	130.9	146.5	162.4	178.4	194.7	210.2	226.2	243.4	261.9
Load Factor (%)	56	55	55	55	55	55	55	55	55	56	56	56	56	56	57	57
Peak Load (MW)	10.2	12.5	14.3	16.7	19.0	21.6	24.2	27.2	30.4	33.1	36.4	39.7	42.8	46.1	48.7	52.5

DKL, October,1987

Table 4-7 Electricity Demand Forecast of Jambi City and Surrounding Areas by PLN Wilayah IV

Fiscal Year	1986*	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Residential															
Population(10^3)	239.6	248.9	258.6	268.7	279.2	290.1	301.4	313.1	325.3	338.0	351.2	364.9	379.1	393.9	409.3
Growth Rate (%)		3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9
Household Size	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Household(10^3)	47.9	49.8	51.7	53.7	55.8	58.0	60.3	62.6	65.1	67.6	70.2	73.0	75.8	78.8	81.9
Electr. Ratio(%)	55.1	57.1	59.3	61.6	63.9	66.3	68.9	71.5	74.2	77.0	79.9	83.0	86.1	89.4	92.8
No. of Consumers(10^3)	26.4	28.4	30.7	33.1	35.7	38.5	41.5	44.8	48.3	52.1	56.2	60.6	65.3	70.4	76.0
Unit Consump.(KWh)	930.1	941.3	952.7	964.2	975.8	987.6	999.5	1,011.5	1,023.7	1,036.1	1,048.5	1,061.2	1,074.0	1,086.9	1,100.0
Energy Consump.(GWh)	24.5	26.8	29.2	31.9	34.8	38.0	41.5	45.3	49.4	53.9	58.9	64.3	70.1	76.6	83.6
Commercial															
No. of Consumers	2,290	2,597	2,946	3,341	3,789	4,297	4,874	5,528	6,269	7,110	8,064	9,146	10,373	11,765	13,343
Constituent Ratio	0.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Energy Consump.(GWh)	6.1	6.6	7.3	7.9	8.6	9.4	10.3	11.2	12.3	13.4	14.6	15.9	17.4	19.0	20.7
Public & Others															
No. of Consumers	801	881	969	1,066	1,173	1,290	1,419	1,561	1,717	1,889	2,078	2,285	2,514	2,765	3,042
Constituent Ratio	0.0	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Energy Consump.(GWh)	5.8	6.2	6.6	7.1	7.7	8.2	8.8	9.5	10.2	10.9	11.7	12.5	13.5	14.5	15.5
Industry															
No. of Consumers	102	108	115	121	129	136	145	153	163	172	183	194	205	218	231
Captive Energy (GWh)	0.0	6.1	11.3	15.7	20.1	24.5	28.9	33.3	37.7	42.1	46.5	50.9	55.3	55.3	55.3
Energy Consump.(GWh)	11.9	19.2	26.3	33.3	41.0	49.5	58.9	69.2	80.5	92.9	106.6	121.7	138.3	152.1	167.3
Total															
No. of Consumers	29.6	32.0	34.7	37.6	40.8	44.2	47.9	52.0	56.4	61.2	66.5	72.2	78.4	85.2	92.6
Energy Consump.(GWh)	48.3	58.8	69.4	80.3	92.1	105.2	119.5	135.1	152.3	171.2	191.8	214.5	239.3	262.1	287.1
Growth Rate (%)	0.0	21.8	18.1	15.6	14.8	14.2	13.6	13.1	12.7	12.4	12.1	11.8	11.6	9.5	9.5
Losses+Plant Use (%)	18.6	17.0	16.0	15.0	14.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0
Energy Product.(GWh)	59.1	70.8	82.6	94.4	107.1	120.9	137.3	155.3	175.1	196.7	220.5	246.5	275.0	301.3	330.0
Load Factor (%)	58	58	58	59	60	60	60	61	61	62	63	64	65	65	65
Peak Load (MW)	11.7	13.9	16.3	18.3	20.4	23.0	26.1	29.1	32.8	36.2	39.9	44.0	48.3	52.9	58.0

* Actual

PLN WILAYAH IV

the Pusat report: 1-L, 1-M, and 1-H, and three to the Wilayah IV report: 2-L, 2-M, and 2-H). These cases are compiled in Table 4-8 (Major Assumptions for Electricity Demand Forecast of Jambi City and Surrounding Areas). The following are supplementary explanations of the major factors of determination shown in Table 4-8.

-a- Population forecast:

Statistics from 1979 through 1986 are analyzed using regression analysis. The population forecast results of the exponential regression curve having the highest correlative coefficient (R=0.955) are employed.

-b- Household size:

Assumed household size is 5.2 per household, based upon statistics shown in Table 4-4.

-c- Annual residential electricity consumption per household:

According to statistics shown in Table 4-4, the annual residential electricity consumption per household in Jambi City and surrounding areas has been diminishing over the years, but is expected to increase like other developing countries. Based upon comparisons with Indonesia's other cities, PLN Pusat and PLN Wilayah IV set the fiscal year 2000 annual residential electricity consumption per household target for Jambi City and surrounding areas at 1,000 kWh and 1,100 kWh respectively; these are employed in this forecast.

Table 4-8 Major Assumptions for Electricity Demand Forecast of Jambi City and Surrounding Areas

Case	1-L	1-M	1-H	2-L	2-M	2-H	PLN-Pusat	PLN-Wilayah IV
Growth Rate of Population (% p.a.)								
1987	-1.3	-1.3	-1.3	-1.3	-1.3	-1.3	3.9	3.9
1988-1990	3.6	3.6	3.6	3.6	3.6	3.6	3.9	3.9
1991-1993	3.6	3.6	3.6	3.6	3.6	3.6	2.8	3.9
1994-2000	3.6	3.6	3.6	3.6	3.6	3.6	2.6	3.9
Growth Rate of Residential Consumers (% p.a.)								
1987-1993	7.0	8.0	9.0	7.0	8.0	7.85	8.0	7.85
1994-2000	6.0	7.0	8.0	6.0	7.0	7.85	7.0	7.85
Target Unit Consumption Rate of Electricity in 2000 (KWh/year/household)	1,000	1,000	1,000	1,100	1,100	1,100	1,000	1,100
Constituent Ratio of Commercial Sector	0.6	0.8	1.0	0.6	0.8	1.0	1.0	1.0
Constituent Ratio of Public Sector	0.7	0.8	1.0	0.7	0.8	0.8	1.0	0.8
Captive Energy of Industrial Sector (GWh/year)								
1987	3.9	3.9	3.9	6.1	6.1	6.1	3.9	6.1
2000	44.0	44.0	44.0	55.3	55.3	55.3	44.0	55.3
Energy Growth Rate in Industrial Sector excluding Captive Power (% p.a.)	6.0	7.0	8.0	6.0	8.0	10.0	8.0	10.0
Losses & Plant Use (%)								
1987	18.0	18.0	18.0	17.0	17.0	17.0	18.0	17.0
1988-1991	17.5-16.0	17.5-16.0	17.5-16.0	16.0-13.0	16.0-13.0	16.0-13.0	17.5-16.0	16.0-13.0
1992-1997	15.5-13.0	15.5-13.0	15.5-13.0	13.0	13.0	13.0	15.5-13.0	13.0
1998-2000	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0
Load Factor (%)								
1987-1993	55.0	55.0	55.0	55.0	55.0	55.0	55.0	58.0-61.0
1994-1998	56.0	56.0	56.0	56.0	56.0	56.0	56.0	61.0-65.0
1999-2000	57.0	57.0	57.0	57.0	57.0	57.0	57.0	65.0

-d- Constituent ratio:

The constituent ratio is the ratio of the growth rate of the residential electricity demand to the growth rate of the commercial sector and the public and other sector, and is considered as an indication of energy elasticity. According to the statistics for five fiscal years (1982 - 1986), the commercial sector constituent ratio was about 0.6 and the public and other sector ratio was about 0.7. Both these averages are lower than the PLN-Pusat version (commercial: 1.0; public and other: 1.0) and the PLN-Wilayah IV version (commercial: 1.0; public and other: 0.8). Therefore, it is assumed that these averages constitute the minimum figures and the PLN-Pusat figures the maximum figures for this forecast.

-e- Captive energy:

A considerable number of self-generation facilities exist in Jambi City and surrounding areas. Since they are expected to eventually become recipients of PLN service, they could be considered latent supply-targets of PLN electricity. PLN calls such electricity, "captive energy." This forecast refers to the separate PLN-Pusat and the PLN-Wilayah IV forecasts on captive energy.

-f- Industrial sector electricity demand growth rate:

This represents the growth rate of industrial sector electricity consumption excluding captive energy discussed above, and is estimated a 6.0 to 10.0% annual rate. PLN generally compares the electricity demand increase represented in the above-mentioned growth rate and the increased

electricity supply to those consumers who were waiting to be supplied (called "waiting consumers") and makes the larger of the two that year's electricity demand increase excluding captive energy. Since the former has been always larger in Jambi City and surrounding areas, this forecast assumes that the former will be larger every year.

-g- Energy loss and self-consumption rate of power plants:

According to statistics shown in Table 4-5, these figures for the Jambi City and surrounding areas are decreasing yearly due to the construction of new power transmission and distribution networks and plants. The rate of decrease is higher according to the PLN-Wilayah IV version than the PLN-Pusat version because the former assumes early improvement of power transmission and distribution networks. Figures of either version are used in this forecast as seen appropriate.

-h- Load factor:

The PLN-Wilayah IV version predicts a seven-point load factor increase, from 58.0% in 1987 (fiscal year) to 65.0% in year 2000 (ditto), while the PLN-Pusat version predicts only a two-point increase, from 55.0% in 1987 (fiscal year) to 57.0% in year 2000 (ditto). Since the mean change of statistics (a 54.1% to 58.4% range) for the past five years (Table 4-5) is 56.1%, and the economic environment of Jambi City and surrounding areas is not expected to change greatly, the PLN-Pusat figure (two-point increase from 55.0% in 1987 (fiscal year) to 57.0% in year 2000 (fiscal year)) is used in this forecast.

(b) The Results of Electricity Demand Forecast for this Project:

Figure 4-3 compiles the peak loads in the electricity demand forecast results from six cases (cases 1-L, 1-M, 1-H, 2-L, 2-M, and 2-H) based on preconditions in (a). This demand forecast chose Cases 1-M and 2-L as the most probable among the six. The main reasons are the following:

1) The industrial-sector electricity demand, which has the greatest impact on the electricity demand of Jambi City and surrounding areas, is determined in this forecast from the forecasts of captive energy and of the growth rate of above electricity demand excluding captive energy. Since large growth is not expected in the industrial sector of Jambi City and surrounding areas according to current estimates, a 6.0% - 7.0% annual growth rate for electricity consumption excluding captive energy seems appropriate.

2) Among the six cases, Case 1-L was established based on the most conservative standpoints on all factors of determination, so a more realistic estimate is probably larger.

3) A constituent ratio 0.8 or less appears appropriate, considering the averages of past statistics shown in Table 4-4.

4) Although the number of electricity consumers in the residential sector showed an annual growth rate over 20% from 1983 (fiscal year) to 1985 (ditto), the growth rate fell to the seven-percent level in 1986 (ditto). Even with changes in the future, it is expected to stabilize to a mark of 8% at most, due to an economic slowdown for the whole of Indonesia caused by factors such as crude oil prices.

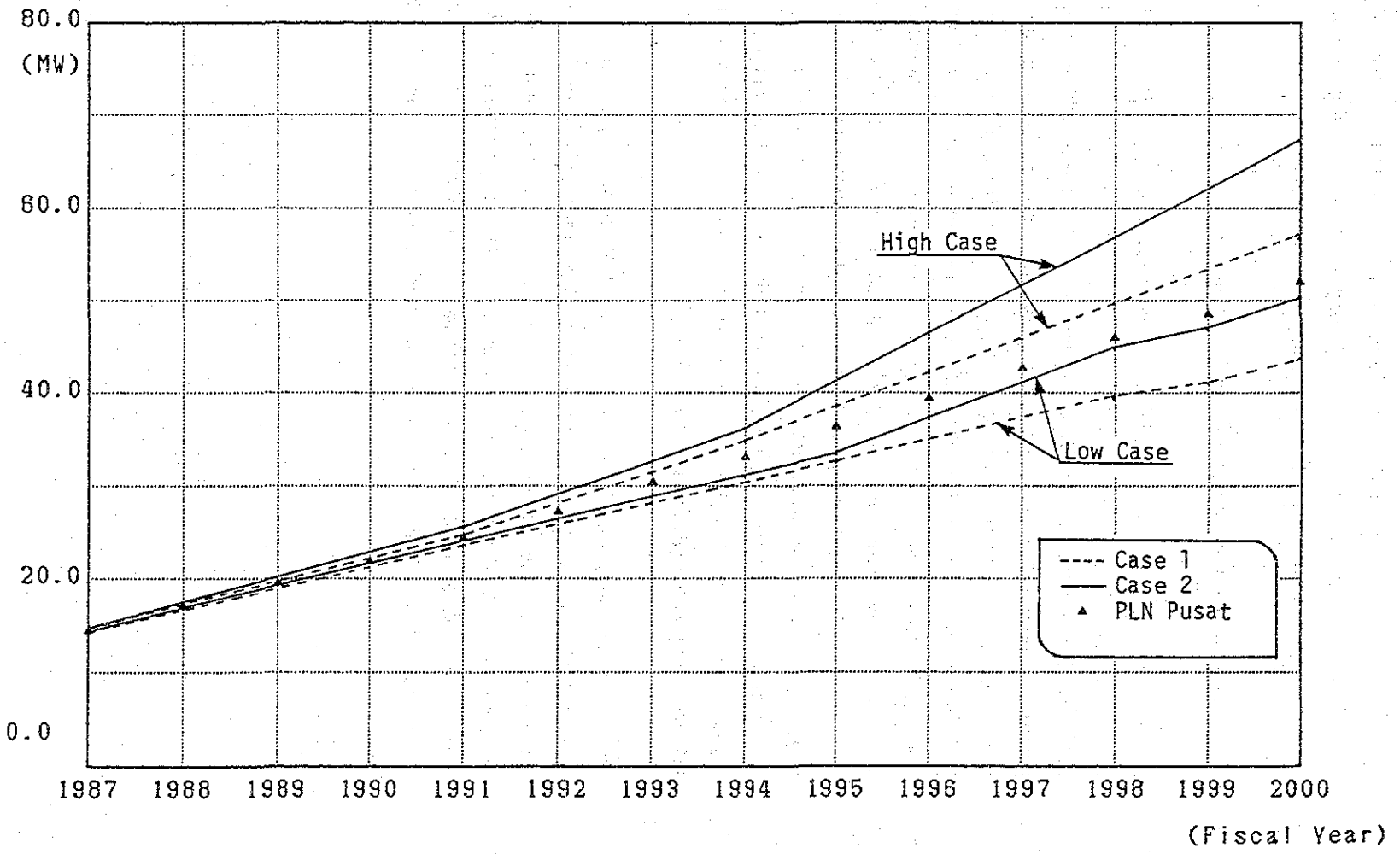


Figure 4-3 Electric Power Demand (Peak Load) Forecast of Jambi City and Surrounding Areas

Tables 4-9 and 4-10 show the electricity demand forecast results of Jambi City and surrounding areas based on Case 1-M and Case 2-L respectively.

(2) Electricity Demand Forecast of Jambi Province

As mentioned in (1) "Electricity Demand Forecast for this Project", no large-scale power transmission and distribution network yet exists in Jambi Province, and all areas within the province depend for their power supply on a power system consisting of independent diesel generators. Therefore, in terms of the electricity demand forecast of Jambi Province, the view that the electricity demand in the province will increase in accordance with the expansion of each individual power transmission and distribution system in the province (i.e., increase of electrification) seems appropriate. Consequently, it must be recognized that the electricity demand of Jambi Province is simply a summation of the electricity demands of each individual power transmission and distribution system.

The forecast shown in Table 4-11 which PLN-Pusat made for the province's electricity demand based on the above factors is reconsidered in this study from a more practical viewpoint and electricity demand forecast is carried out. Major premises are as shown in Table 4-12, and methodology of analysis is same as that applied to Jambi City and surrounding areas as mentioned previously.

Table 4-9 Electricity Demand Forecast of Jambi City and Surrounding Areas (Case 1-M)

Fiscal Year	1985*	1986*	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Residential Sector																
Population(10^3)	249.5	284.0	280.4	290.4	300.7	311.4	322.5	333.9	345.8	358.1	370.9	384.1	397.7	411.9	426.6	441.7
Growth Rate (%)	0.1	13.9	-1.3	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6
Household Size	5.1	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2
Household(10^3)	48.7	54.6	53.9	55.8	57.8	59.9	62.0	64.2	66.5	68.9	71.3	73.9	76.5	79.2	82.0	84.9
No. of Consumers(10^3)	24.9	26.7	28.8	31.1	33.6	36.3	39.2	42.4	45.7	48.9	52.4	56.0	60.0	64.2	68.6	73.4
Electr. Ratio(%)	51.1	48.9	53.5	55.8	58.1	60.6	63.2	65.9	68.8	71.1	73.4	75.9	78.4	81.0	83.7	86.5
Unit Consump.(KWh)	936.6	908.6	914.8	921.1	927.4	933.8	940.2	946.7	953.2	959.7	966.3	973.0	979.7	986.4	993.2	1,000.0
Energy Consump.(GWh)	23.3	24.2	26.4	28.7	31.2	33.9	36.9	40.1	43.6	47.0	50.6	54.5	58.7	63.3	68.2	73.4
Growth Rate (%)	15.5	4.1	8.7	8.7	8.7	8.7	8.7	8.7	8.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7
Commercial Sector																
Constituent Ratio	0.4	-0.4	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Energy Consump.(GWh)	6.2	6.1	6.6	7.0	7.5	8.1	8.6	9.2	9.9	10.5	11.1	11.8	12.5	13.3	14.1	15.0
Growth Rate (%)	5.5	-1.5	7.0	7.0	7.0	7.0	7.0	7.0	7.0	6.2	6.2	6.2	6.2	6.2	6.2	6.2
Public & Other Sector																
Constituent Ratio	1.2	-1.0	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Energy Consump.(GWh)	6.0	5.8	6.2	6.6	7.1	7.6	8.1	8.7	9.3	9.9	10.5	11.1	11.8	12.5	13.3	14.1
Growth Rate (%)	19.3	-4.1	7.0	7.0	7.0	7.0	7.0	7.0	7.0	6.2	6.2	6.2	6.2	6.2	6.2	6.2
Industrial Sector																
Captive Energy (GWh)	0.0	0.0	3.9	9.0	13.5	18.0	22.3	27.0	32.0	37.0	41.0	43.4	44.0	44.0	44.0	44.0
Energy Consump.(GWh)	9.8	12.5	17.3	23.6	29.7	36.3	43.1	50.9	59.4	68.6	77.4	85.2	91.7	98.2	105.0	112.4
Growth Rate (%)	70.5	26.8	38.2	36.6	26.1	22.1	18.8	17.9	16.8	15.4	12.8	10.1	7.7	7.0	7.0	7.0
Total																
Energy Consump.(GWh)	45.4	48.7	56.4	65.9	75.5	85.8	96.7	108.9	122.2	135.9	149.6	162.7	174.9	187.3	200.7	215.0
Growth Rate (%)	23.0	7.1	15.9	16.9	14.6	13.7	12.7	12.5	12.2	11.2	10.1	8.7	7.5	7.1	7.1	7.1
Losses+Plant Use (%)	12.8	18.5	18.0	17.5	17.0	16.5	16.0	15.5	15.0	14.5	14.0	13.5	13.0	13.0	13.0	13.0
Energy Product.(GWh)	52.1	59.7	68.8	79.9	91.0	102.8	115.2	128.8	143.7	158.9	173.9	188.0	200.9	215.3	230.6	247.1
Load Factor (%)	58.4	54.5	55.0	55.0	55.0	55.0	55.0	55.0	55.0	56.0	56.0	56.0	56.0	56.0	57.0	57.0
Peak Load (MW)	10.2	12.5	14.3	16.6	18.9	21.3	23.9	26.7	29.8	32.4	35.5	38.3	41.0	43.9	46.2	49.5

Note * The figures in 1985 and 1986 are actual.

Table 4-10 Electricity Demand Forecast of Jambi City and Surrounding Areas (Case 2-L)

Fiscal Year	1985*	1986*	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Residential Sector																
Population(10^3)	249.5	284.0	280.4	290.4	300.7	311.4	322.5	333.9	345.8	358.1	370.9	384.1	397.7	411.9	426.6	441.7
Growth Rate (%)	0.1	13.9	-1.3	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6
Household Size	5.1	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2
Household(10^3)	48.7	54.6	53.9	55.8	57.8	59.9	62.0	64.2	66.5	68.9	71.3	73.9	76.5	79.2	82.0	84.9
No. of Consumers(10^3)	24.9	26.7	28.6	30.6	32.7	35.0	37.4	40.1	42.9	45.9	49.1	52.5	56.2	60.1	64.3	68.8
Electr. Ratio(%)	51.1	48.9	53.0	54.7	56.5	58.4	60.4	62.4	64.4	66.6	68.8	71.1	73.4	75.9	78.4	81.0
Unit Consump.(KWh)	936.6	908.6	921.1	933.7	946.6	959.6	972.8	986.2	999.7	1,013.5	1,027.4	1,041.5	1,055.8	1,070.4	1,085.1	1,100.0
Energy Consump.(GWh)	23.3	24.2	26.3	28.5	30.9	33.6	36.4	39.5	42.8	46.5	50.4	54.7	59.3	64.3	69.8	75.7
Growth Rate (%)	15.5	4.1	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5
Commercial Sector																
Constituent Ratio	0.4	-0.4	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Energy Consump.(GWh)	6.2	6.1	6.5	6.8	7.1	7.5	7.9	8.3	8.7	9.1	9.6	10.1	10.6	11.1	11.7	12.3
Growth Rate (%)	5.5	-1.5	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1
Public & Other Sector																
Constituent Ratio	1.2	-1.0	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
Energy Consump.(GWh)	6.0	5.8	6.1	6.5	6.9	7.3	7.7	8.2	8.7	9.2	9.7	10.3	10.9	11.6	12.2	13.0
Growth Rate (%)	19.3	-4.1	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9
Industrial Sector																
Captive Energy (GWh)	0.0	0.0	6.1	11.3	15.7	20.1	24.5	28.9	33.3	37.7	42.1	46.5	50.9	55.3	55.3	55.3
Energy Consump.(GWh)	9.8	12.5	19.3	25.7	31.6	37.9	44.6	51.7	59.2	67.1	75.6	84.5	94.0	104.0	110.2	116.8
Growth Rate (%)	70.5	26.8	54.9	32.9	23.1	19.9	17.6	15.9	14.5	13.4	12.6	11.8	11.2	10.7	6.0	6.0
Total																
Energy Consump.(GWh)	45.4	48.7	58.2	67.5	76.6	86.3	96.6	107.6	119.4	131.9	145.3	159.6	174.8	191.0	204.0	217.8
Growth Rate (%)	23.0	7.1	19.7	15.9	13.5	12.6	12.0	11.4	10.9	10.5	10.1	9.8	9.5	9.3	6.8	6.8
Losses+Plant Use (%)	12.8	18.5	17.0	16.0	15.0	14.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0
Energy Product.(GWh)	52.1	59.7	70.1	80.4	90.1	100.3	111.0	123.7	137.2	151.6	167.0	183.4	200.9	219.5	234.4	250.3
Load Factor (%)	58.4	54.5	55.0	55.0	55.0	55.0	55.0	55.0	55.0	56.0	56.0	56.0	56.0	56.0	57.0	57.0
Peak Load (MW)	10.2	12.5	14.6	16.7	18.7	20.8	23.0	25.7	28.5	30.9	34.0	37.4	40.9	44.8	46.9	50.1

*Note * The figures in 1985 and 1986 are actual.*

Table 4-11 Electricity Demand Forecast of Jambi Province by PLN Pusat

Fiscal Year	1985*	1986#	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Urban																
Population (10^3)	247.5	257.0	266.8	277.0	287.6	298.6	310.0	321.8	334.1	346.9	360.1	373.9	388.2	403.0	418.4	434.4
Household Size	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Household (10^3)	49.5	51.4	53.4	55.4	57.5	59.7	62.0	64.4	66.8	69.4	72.0	74.8	77.6	80.6	83.7	86.9
No. of Consumers (10^3)	21.5	24.0	26.5	29.1	31.8	34.6	37.5	40.6	43.9	47.5	51.4	55.5	60.1	64.9	70.3	76.0
Electrific Ratio (%)	43.5	46.6	49.7	52.5	55.3	57.9	60.5	63.1	65.7	68.5	71.3	74.3	77.4	80.6	84.0	87.5
Unit Consumption (KWh)	1,036.3	1,040.4	1,040.4	1,040.4	1,040.4	1,050.8	1,061.3	1,071.9	1,082.6	1,093.5	1,104.4	1,115.4	1,126.6	1,137.9	1,149.2	1,160.7
Energy Consumption (GWh)	22.3	24.9	27.6	30.3	33.1	36.4	39.8	43.5	47.5	51.9	56.7	62.0	67.7	73.9	80.7	88.3
Rural																
Population (10^3)	1,462.6	1,511.4	1,561.9	1,614.1	1,668.0	1,723.7	1,781.2	1,840.7	1,889.4	1,939.3	1,990.5	2,043.1	2,097.0	2,152.2	2,208.9	2,267.0
Household Size	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Household (10^3)	292.5	302.3	312.4	322.8	333.6	344.7	356.2	368.1	377.9	387.9	398.1	408.6	419.4	430.4	441.8	453.4
No. of Consumers (10^3)	7.3	8.9	10.5	12.2	13.9	15.7	17.5	19.5	21.6	23.9	26.4	29.1	32.0	35.1	38.5	42.2
Electrific Ratio (%)	2.5	2.9	3.4	3.8	4.2	4.5	4.9	5.3	5.7	6.2	6.6	7.1	7.6	8.1	8.7	9.3
Unit Consumption (KWh)	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500
Energy Consumption (GWh)	3.7	4.4	5.2	6.1	6.9	7.8	8.8	9.8	10.8	12.0	13.2	14.5	16.0	17.5	19.2	21.1
Residential																
Population (10^3)	1,710.1	1,768.4	1,828.7	1,891.1	1,955.6	2,022.2	2,091.2	2,162.5	2,223.5	2,286.2	2,350.7	2,417.0	2,485.1	2,555.2	2,627.3	2,701.3
Growth Rate (%)		3.4	3.4	3.4	3.4	3.4	3.4	3.4	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8
Electrific Ratio (%)	8.4	9.3	10.1	10.9	11.7	12.4	13.2	13.9	14.7	15.6	16.5	17.5	18.5	19.6	20.7	21.9
No. of Consumers (10^3)	28.8	32.8	37.0	41.3	45.7	50.3	55.0	60.1	65.6	71.4	77.8	84.6	92.0	100.0	108.7	118.2
Unit Consumption (KWh)	900.1	894.4	887.1	881.1	876.1	879.1	882.5	886.3	890.3	894.7	899.2	904.0	909.0	914.2	919.5	925.0
Energy Consumption (GWh)	26.0	29.4	32.8	36.4	40.0	44.2	48.6	53.3	58.4	63.9	69.9	76.5	83.6	91.4	100.0	109.4
Commercial																
No. of Consumers	3,490	3,826	4,221	4,656	5,137	5,666	6,251	6,896	7,607	8,531	9,568	10,730	12,034	13,496	15,464	17,718
Elastisity	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7
Growth Rate of Sector GDP (%)	3.57	3.57	3.82	3.82	3.82	3.82	3.82	3.82	3.82	4.5	4.5	4.5	4.5	4.5	5.4	5.4
Energy Consumption (GWh)	7.3	7.7	8.2	8.7	9.3	9.9	10.5	11.2	11.9	12.8	13.7	14.8	15.9	17.1	18.6	20.3
Public & Other																
No. of Consumers	1,085	1,235	1,391	1,552	1,718	1,891	2,070	2,261	2,465	2,686	2,925	3,182	3,461	3,761	4,089	4,447
Constituent Ratio	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Energy Consumption (GWh)	6.4	7.1	7.8	8.5	9.1	9.9	10.7	11.5	12.4	13.3	14.3	15.4	16.6	17.8	19.1	20.6
Industrial																
No. of Consumers	138	148	160	175	191	210	229	250	274	299	327	358	392	428	468	512
Elastisity	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
Growth Rate of Sector GDP (%)	2.8	2.8	3.15	3.5	3.5	3.85	3.57	3.57	3.57	3.6	3.6	3.6	3.6	3.6	3.6	3.6
Captive Energy (GWh)	0.0	0.0	3.0	6.4	10.4	14.3	19.0	24.3	30.0	35.0	40.0	45.0	50.5	56.8	63.5	70.8
Energy Consumption (GWh)	10.5	12.8	16.2	20.3	25.1	30.0	35.9	42.7	50.0	57.0	64.3	71.9	80.3	89.8	100.1	111.4
Total																
No. of Consumers (10^3)	33.6	38.1	42.8	47.7	52.7	58.0	63.6	69.5	75.9	82.9	90.6	98.9	107.9	117.7	128.7	140.9
Energy Consumption (GWh)	50.2	57.0	65.1	73.8	83.5	94.0	105.7	118.6	132.7	147.1	162.3	178.6	196.4	216.1	237.8	261.6
Growth Rate (%)	22.3	13.7	14.1	13.5	13.1	12.6	12.4	12.2	11.9	10.8	10.4	10.0	10.0	10.0	10.0	10.0
Losses+Plant Use** (%)	17.1	18.9	18.5	18.0	17.5	17.0	16.5	16.0	15.5	15.0	14.5	14.0	13.5	13.5	13.5	13.5
Energy Production**(GWh)	60.5	70.3	79.8	90.1	101.2	113.2	126.6	141.2	157.1	173.1	189.9	207.7	227.1	249.9	275.0	302.6
Load Factor** (%)	54.3	52.1	53.3	53.3	53.3	53.3	53.3	53.3	53.3	53.3	53.3	53.3	53.3	53.3	53.3	53.3
Peak Load** (MW)	12.7	15.4	17.1	19.3	21.7	24.3	27.1	30.3	33.7	37.1	40.7	44.5	48.6	53.5	58.9	64.8

* Actual
\# Target
** Assumed for this study by JICA study team.

October, 1987

Table 4-12 Major Assumptions for Electricity Demand Forecast of Jambi Province

Case	Low	Middle	High	PLN-Pusat
Growth Rate of Population (% p.a.)				
1985*	3.7	3.7	3.7	N.A.
1986*	4.6	4.6	4.6	3.4**
1987	3.4	3.4	3.4	3.4
1988-1992	4.0	4.0	4.0	3.4
1991-2000	4.0	4.0	4.0	2.8
Growth Rate of Residential Consumers (% p.a.)				
1985*	26.2	26.2	26.2	26.2
1986*	20.0	20.0	20.0	13.7**
1987	14.0	14.5	15.0	12.8
1988	8.0	9.0	10.0	11.6
1989-1993	8.0	9.0	10.0	10.7-9.2
1994-1995	7.0	8.0	9.0	8.8-9.0
1996-2000	7.0	8.0	9.0	8.7
Target Unit Consumption Rate of Electricity in 2000 (KWh/Year/Household)	925	925	925	925
Constituent Ratio of Commercial Sector	0.6	0.7	0.8	N.A.
Constituent Ratio of Public Sector	0.7	0.8	0.9	0.8
Captive Energy of Industrial Sector (GWh/Year)				
1987	3.0	3.0	3.0	3.0
2000	70.8	70.8	70.8	70.8
Energy Growth Rate in Industrial Sector excluding Captive Power (% p.a.)	4.0	6.0	8.0	N.A.
Losses & Plant Use (%)				
1987	18.5	18.5	18.5	18.5#
1988-1997	18.0-13.5	18.0-13.5	18.0-13.5	18.0-13.5#
1998-2000	13.5	13.5	13.5	13.5#
Load Factor (%)				
1987-1993	53.3	53.3	53.3	53.3#
1994-1998	53.3	53.3	53.3	53.3#
1999-2000	53.3	53.3	53.3	53.3#

Note : * Actual
** This figure should be corrected.
# These figures were assumed for this study by JICA study team.

A compilation of the peak loads in the electricity demand forecast results of three cases (Low case, Middle case, and High case) based on the preconditions mentioned in (a) is shown in Figure 4-4.

This demand forecast selected Middle Case as the most probable among the three cases. The main reasons are the following:

1) As in the case of the electricity demand of Jambi City and surrounding areas, the industrial-sector electricity demand has the greatest impact on the electricity demand of Jambi Province. This value is determined in this forecast by estimates of captive energy and the growth rate of the electricity demand excluding captive energy, also. Since the industrial sector of Jambi City and surrounding areas accounts for over 90% of Jambi Province's industrial sector, a 6.0% annual growth rate of electricity demand excluding captive energy, resembling that of Jambi City and surrounding areas, seems an appropriate long term view.

2) Among the three cases, Low Case was established based on the most conservative standpoints on all factors of determination, so a more realistic estimate is probably larger.

3) A constituent ratio 0.7 for the commercial sector, and 0.8 for the public and other sector appears appropriate, considering the averages of past statistics shown in Table 4-1.

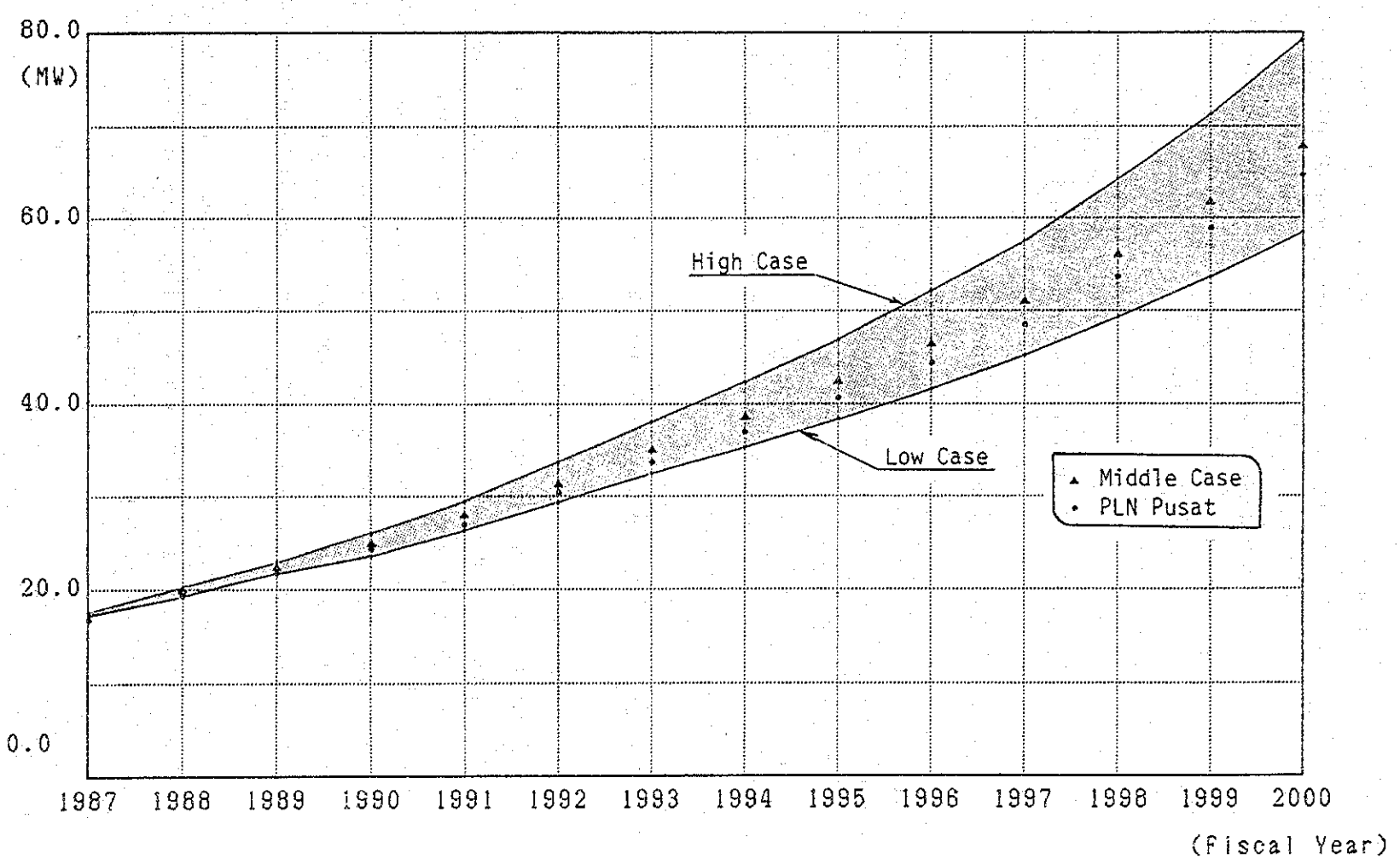


Figure 4-4 Electric Power Demand (Peak Load) Forecast of Jambi Province

4) Although the number of residential sector electricity consumers increased by an average annual growth rate of 23.9% as shown in Table 4-1, this value for the whole province is expected to be a little under the PLN Pusat estimate, influenced by the decline of the growth rate in the urban area.

Table 4-13 shows the electricity demand forecast results of Jambi Province based on Middle Case.

4-1-3 Electricity Supply and Demand Balance Forecast

In this section, a forecast of the electricity supply and demand balance of Jambi City and surrounding areas which relates directly to this project is first made, followed by a forecast of the demand hypothesis for the power plant in this project. Then, the electricity supply and demand balance forecast of Jambi Province is made based on the above considerations.

(1) Electricity Supply and Demand Balance Forecast for this Project

As mentioned in "4-1-2 Electricity Demand Forecast; (1) Electricity Demand Forecast for this Project", cases 1-M and 2-L have the highest probability in terms of the expected demand for this project. They consequently were used as the bases for a forecast of the demand hypothesis for the power plant made in the course of determining the electricity supply and demand balance forecast. The demand hypothesis for the power plant was made this way because the transmission and distribution systems of Jambi City and surrounding areas form a loop by achievement of a parallel-running operation of the power plants, and the balance of electricity supply and demand within this loop could therefore be determined en masse.

Table 4-13 Electricity Demand Forecast of Jambi Province (Middle Case)

Fiscal Year	1985*	1986*	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Residential Sector																
Population(10^3)	1,715	1,795	1,856	1,930	2,008	2,088	2,172	2,259	2,350	2,445	2,543	2,645	2,751	2,862	2,976	3,096
Growth Rate (%)	3.7	4.6	3.4	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Household Size	4.9	4.7	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8
Household(10^3)	352.8	381.2	386.6	402.1	418.3	435.1	452.5	470.7	489.6	509.3	529.7	551.0	573.1	596.1	620.1	645.0
No. of Consumers(10^3)	28.8	34.6	39.6	43.2	47.1	51.3	56.0	61.0	66.5	71.8	77.5	83.8	90.5	97.7	105.5	113.9
Electr. Ratio(%)	8.2	9.1	10.3	10.7	11.3	11.8	12.4	13.0	13.6	14.1	14.6	15.2	15.8	16.4	17.0	17.7
Unit Consump.(KWh)	900.6	845.1	850.6	856.1	861.6	867.2	872.8	878.5	884.2	889.9	895.6	901.4	907.3	913.1	919.1	925.0
Energy Consump.(GWh)	26.0	29.3	33.7	37.0	40.6	44.5	48.8	53.6	58.8	63.9	69.5	75.5	82.1	89.2	97.0	105.4
Growth Rate (%)	16.0	12.6	15.2	9.7	9.7	9.7	9.7	9.7	9.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
Commercial Sector																
Constituent Ratio	0.4	0.4	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
Energy Consump.(GWh)	7.3	7.6	8.5	9.0	9.6	10.3	11.0	11.7	12.5	13.3	14.1	15.0	15.9	16.9	17.9	19.0
Growth Rate (%)	6.5	5.0	10.7	6.8	6.8	6.8	6.8	6.8	6.8	6.1	6.1	6.1	6.1	6.1	6.1	6.1
Public & Other Sector																
Constituent Ratio	1.2	0.5	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Energy Consump.(GWh)	6.4	6.8	7.7	8.3	8.9	9.6	10.3	11.1	12.0	12.8	13.7	14.7	15.7	16.8	18.0	19.2
Growth Rate (%)	20.0	6.1	12.2	7.8	7.8	7.8	7.8	7.8	7.8	7.0	7.0	7.0	7.0	7.0	7.0	7.0
Industrial Sector																
Captive Energy (GWh)	0.0	0.0	3.0	6.4	10.4	14.3	19.0	24.3	30.0	35.0	40.0	45.0	50.5	56.8	63.5	70.8
Energy Consump.(GWh)	10.5	13.3	17.1	21.5	26.8	32.3	39.0	46.6	55.1	63.4	72.2	81.5	91.9	103.7	116.7	131.0
Growth Rate (%)	63.0	27.0	28.6	25.9	24.6	20.5	20.5	19.6	18.2	15.1	13.9	12.9	12.7	12.9	12.5	12.3
Total																
Energy Consump.(GWh)	50.2	57.0	66.9	75.8	85.9	96.7	109.1	123.1	138.4	153.4	169.5	186.7	205.6	226.6	249.5	274.6
Growth Rate (%)	22.3	13.7	17.4	13.2	13.4	12.6	12.8	12.8	12.5	10.8	10.5	10.1	10.1	10.2	10.1	10.1
Losses+Plant Use (%)	17.1	18.9	18.5	18.0	17.5	17.0	16.5	16.0	15.5	15.0	14.5	14.0	13.5	13.5	13.5	13.5
Energy Product.(GWh)	60.5	70.3	82.1	92.5	104.2	116.6	130.7	146.5	163.8	180.5	198.3	217.1	237.7	262.0	288.5	317.5
Load Factor (%)	54.3	52.1	53.3	53.3	53.3	53.3	53.3	53.3	53.3	53.3	53.3	53.3	53.3	53.3	53.3	53.3
Peak Load (MW)	12.7	15.4	17.6	19.8	22.3	25.0	28.0	31.4	35.1	38.7	42.5	46.5	50.9	56.1	61.8	68.0

Note * The figures in 1985 and 1986 are actual.

Since the installed capacity per generator-unit of power plants recently established in Jambi City and surrounding areas is 5 MW, the desirable number of these units to be installed and the desirable period in which the operation of plants be commenced were taken into consideration in the interests of balancing the electricity supply and demand. Finally, it was decided in the scope of this forecast that commencement of operation of a power plant with an installed capacity of 20 MW around late 1994 (fiscal year) would be highly pragmatic. The final compilation of the electricity supply and demand balance forecast of Jambi City and surrounding areas is shown in Figure 4-5 and Table 4-14. As Figure 4-5 indicates, it would be necessary to construct another some 20 MW-scale power plant in late 1997 (fiscal year) or late 1998 (ditto), even after this project is executed.

This forecast views this project as the substitute for the PLN-Pusat projection of a natural gas-fired steam power generation plant with 50 MW-installed capacity commencing operation around late 1995 (fiscal year) and other natural gas power-generation is considered unrealistic at present in view of gas reserves in this area.

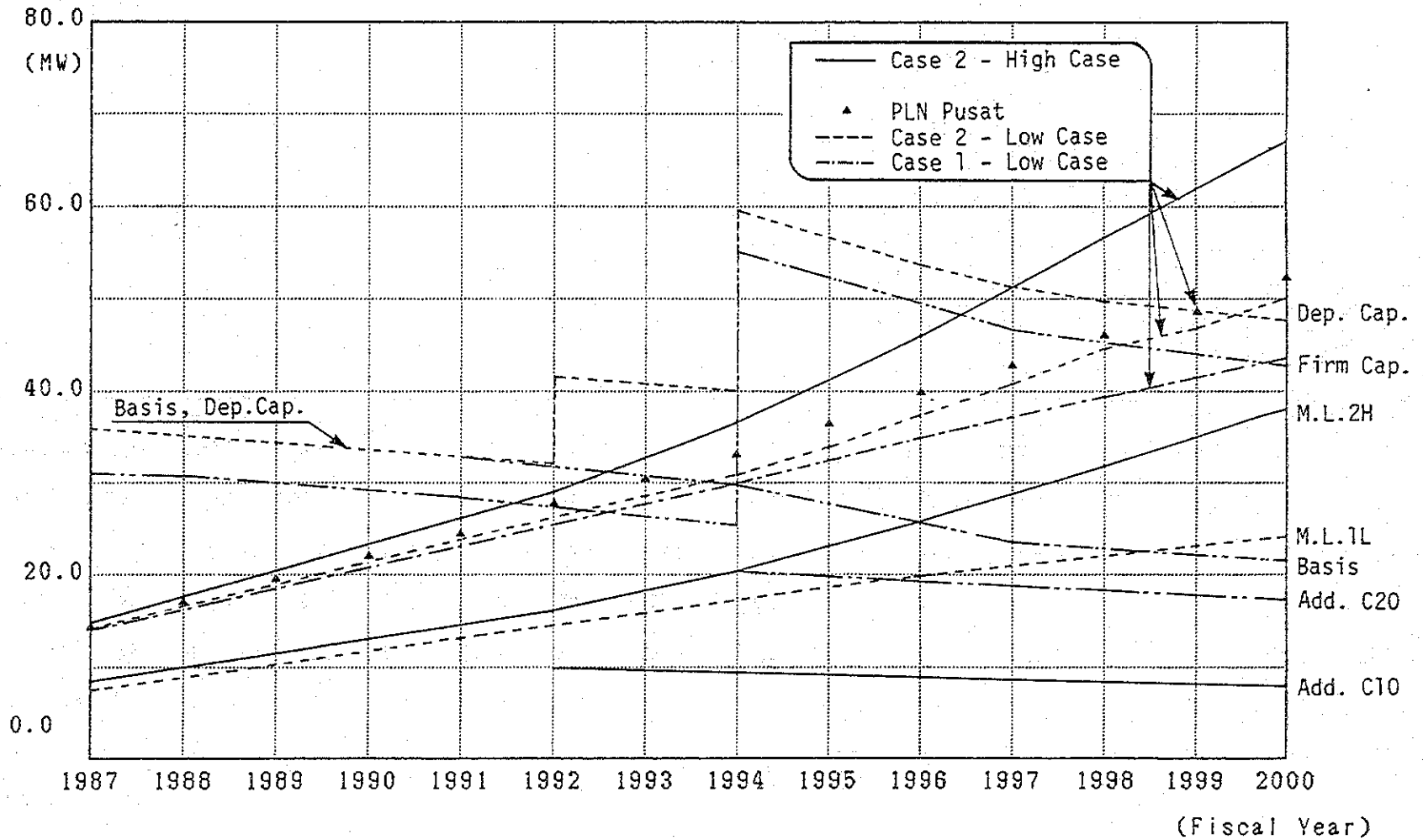


Figure 4-5 Electric Power Supply and Demand Balance Forecast of Jambi City and Surrounding Areas

Table 4-14 Electric Power Supply and Demand Balance Forecast of Jambi City and Surrounding Areas

Fiscal Year		1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Basis	(MW)	36.12	35.22	34.34	33.48	32.64	31.83	31.03	30.26	27.91	25.66	23.69	23.10	22.52	21.96
Add. Capacity	(MW)														
-Diesel		-	-	-	-	-	10.00	9.75	9.51	9.27	9.04	8.81	8.59	8.38	8.17
-Dual Fuel (Gas)		-	-	-	-	-	-	-	20.00	19.50	19.01	18.54	18.07	17.62	17.18
Depend. Capacity	(MW)	36.12	35.22	34.34	33.48	32.64	41.83	40.78	59.76	56.68	53.71	51.04	49.76	48.52	47.31
Firm Capacity	(MW)	31.12	30.35	29.59	28.85	28.13	36.83	35.91	54.76	51.80	48.95	46.41	45.25	44.11	43.01
Peak Load	(MW)	14.6	16.7	18.7	20.8	23.0	25.7	28.5	30.9	34.0	37.4	40.9	44.8	46.9	50.1
Growth Rate	(%)	16.5	14.6	12.1	11.3	10.7	11.4	10.9	8.5	10.1	9.8	9.5	9.3	4.9	6.8
Load Factor	(%)	55.0	55.0	55.0	55.0	55.0	55.0	55.0	56.0	56.0	56.0	56.0	56.0	57.0	57.0
Gross Production	(GWh)	70.1	80.4	90.1	100.3	111.0	123.7	137.2	151.6	167.0	183.4	200.9	219.5	234.4	250.3

(2) Electricity Supply and Demand Balance Forecast of Jambi Province

As mentioned in "4-1-2 Electricity Demand Forecast; (2) Electricity Demand Forecast of Jambi Province", the province's electricity demand is a simple summation of the electricity demand of each individualized power transmission and distribution system. Consequently, the peak load with regard to the electricity demand forecast is also simply a summation, and as long as the power of Jambi Province's independent transmission and distribution systems remains inflexible, the electricity demand for the whole province does not have much meaning. Taking these things in account, the electricity supply and demand balance forecast of Jambi Province is discussed below.

The new power plants that will be built in Jambi Province are a 10 MW-installed capacity power plant for Jambi City and the surrounding areas supposedly commencing operation in late 1992 (fiscal year), and a 20 MW-installed capacity power plant planned in this project to commence operation in late 1994, in place of a 50 MW-installed capacity natural gas-fired steam power plant for Jambi City and the surrounding areas supposedly commencing operation in late 1995 (fiscal year). It was not possible to acquire information this time on the construction of new power plants in other areas. Therefore, the electricity supply and demand balance forecast of Jambi Province was made on the assumption that the above two power plants were the only new ones being built (see Figure 4-6 and Table 4-15).

The construction of a 20 MW-scale installed capacity power plant in late 1997 (fiscal year) or late 1998 (ditto), even after this project is executed, appears necessary according to Middle Case in Figure 4-6 (the most probable case according to the electricity demand forecast results of Jambi Province mentioned

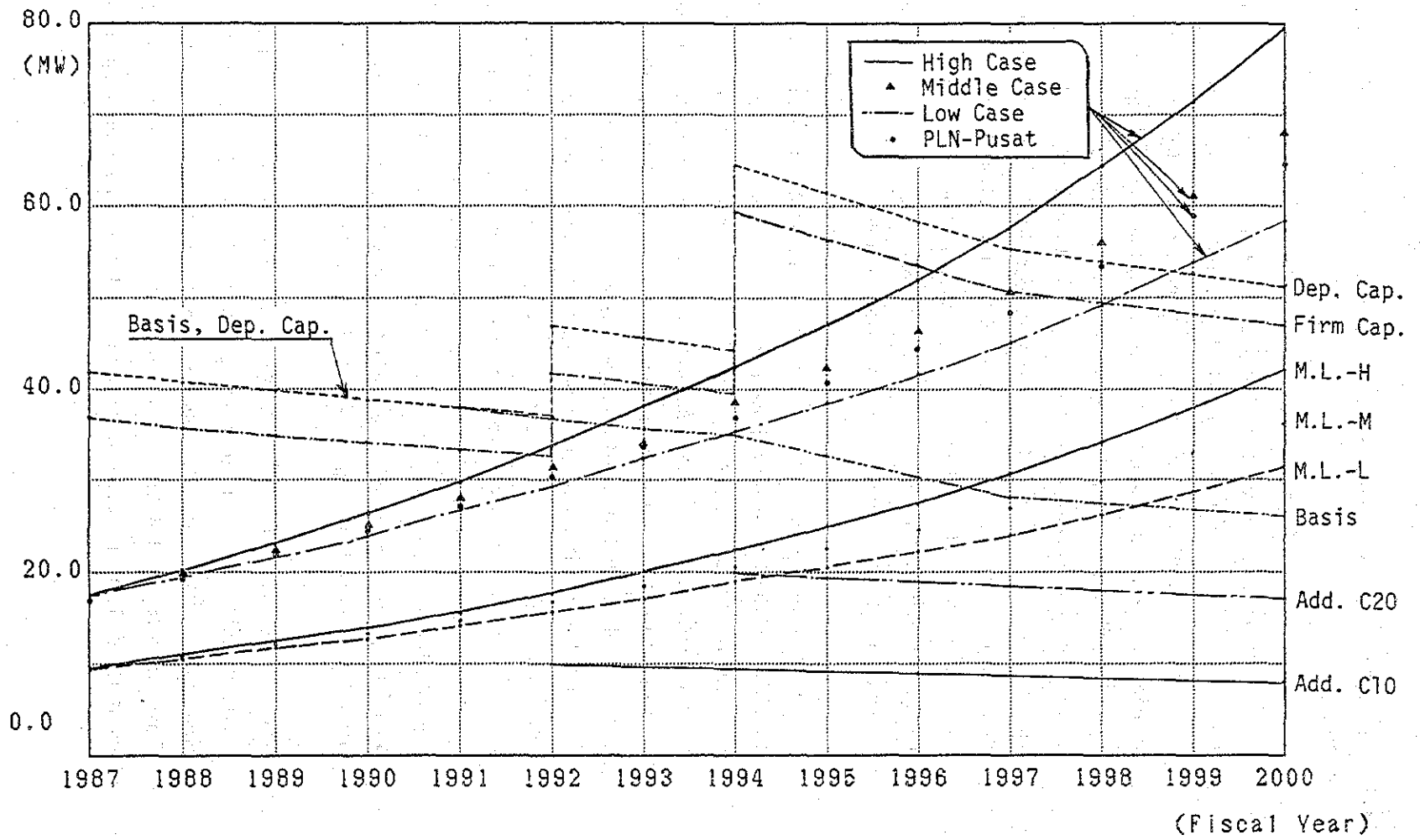


Figure 4-6 Electric Power Supply and Demand Balance Forecast of Jambi Province

Table 4-15 Electric Power Supply and Demand Balance Forecast of Jambi Province

Fiscal Year		1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Basis	(MW)	41.82	40.78	39.76	38.76	37.79	36.85	35.93	35.03	32.56	30.19	28.11	27.41	26.73	26.06
Add. Capacity	(MW)														
-Diesel		-	-	-	-	-	10.00	9.75	9.51	9.27	9.04	8.81	8.59	8.38	8.17
-Dual Fuel (Gas)		-	-	-	-	-	-	-	20.00	19.50	19.01	18.54	18.07	17.62	17.18
Depend. Capacity	(MW)	41.82	40.78	39.76	38.76	37.79	46.85	45.68	64.53	61.33	58.24	55.46	54.08	52.72	51.41
Firm Capacity	(MW)	36.82	35.90	35.00	34.13	33.27	41.85	40.80	59.53	56.45	53.49	50.83	49.56	48.32	47.11
Peak Load	(MW)	17.6	19.8	22.3	25.0	28.0	31.4	35.1	38.7	42.5	46.5	50.9	56.1	61.8	68.0
Growth Rate	(%)	14.2	12.6	12.7	11.9	12.1	12.1	11.8	10.2	9.8	9.5	9.5	10.2	10.1	10.1
Load Factor	(%)	53.3	53.3	53.3	53.3	53.3	53.3	53.3	53.3	53.3	53.3	53.3	53.3	53.3	53.3
Gross Production	(GWh)	82.1	92.5	104.2	116.6	130.7	146.5	163.8	180.5	198.3	217.1	237.7	262.0	288.5	317.5

above); it also appears so in the electricity supply and demand balance forecast of Jambi City and surrounding areas.

4-1-4 Electricity Tariff

(1) Electricity Tariff System

The electricity tariff is controlled by the Directorate of General Electricity and New Energy of the Ministry of Mine and Energy, and a strandardized electricity tariff system is employed throughout Indonesia. The electricity tariff system was thoroughly revised in 1980, followed by partial revisions, giving it the present form. Tables 4-16 and 4-17 list explanations for the 1986 electricity tariff codes.

When a consumer is supplied electricity from PLN, electrical connection work to the consumer by PLN is of course necessary. PLN does this according to rates set for each region. Jambi Province is under the control of PLN Wilayah IV, and the regions's connection charges are listed in Table 4-18.

(2) Electricity Sales Revenue and Average Unit Price of Electricity

Changes in electricity sales revenue, sold electricity, average unit price of electricity of Jambi Province, and of Jambi City and surrounding areas are shown in Tables 4-19 and 4-20. Comparing the two tables, it is recognized that there has been almost no difference between each table's average unit price over the years, since Jambi City and surrounding areas account for about 85% of the sold electricity. From Figure 4-7, a compilation of the change of average unit price in Table 4-20 (latter includes aggregate data of April through December, 1987), it is seen that an almost uniform increase from 1981 (fiscal year) through 1984 (ditto), a peak reached in 1984 (ditto), and an almost uniform decrease until 1987 (ditto).

Table 4-16 Explanation of Tariff Category on Basic Tariffs of Electricity 1986

No.	Code Tariff	Contracted Power	Explanation of Tariff Category
1	S_1	to 200 VA	Tariff S_1 for Small Consumer (Low Voltage)
2	S_2	250 VA to 200 kVA	Tariff S_2 for Social Institutions (Low Voltage)
3	R_1	250 VA to 500 VA	Tariff R_1 for Simple Residential Service (Low Voltage)
4	R_2	501 VA to 2,200 VA	Tariff R_2 for Small Residential Service (Low Voltage)
5	R_3	2,201 VA to 6,601 VA	Tariff R_3 for Medium Residential Service (Low Voltage)
6	R_4	6,600 VA & Over	Tariff R_4 for Big Residential Service (Low Voltage)
7	U_1	250 VA to 2,200 VA	Tariff U_1 for Small Commercial Service (Low Voltage)
8	U_2	2,201 VA to 200 kVA	Tariff U_2 for Medium Commercial Service (Low Voltage)
9	U_3/MV	201 kVA & Over	Tariff U_3/MV for Big Commerical Service (Medium Voltage)
10	U_4	-	Tariff U_4 for Temporary Service (Low Voltage)
11	I_1	Up to 99 kVA	Tariff I_1 for Industrial & Hotel Service (Low Voltage)
12	I_2	100 kVA to 200 kVA	Tariff I_2 for Industrial & Hotel Service (Low Voltage)
13	I_3/MV	201 kVA & Over	Tariff I_3/MV for Industrial & Hotel Service (Medium Voltage)
14	I_4/HV	5,000 kVA & Over	Tariff I_4/HV for Industrial Service (High Voltage)
15	G_1	250 VA to 200 kVA	Tariff G_1 for Office Service (Low Voltage)
16	G_2/MV	201 kVA & Over	Tariff G_2/MV for Office Service (Medium Voltage)
17	J	-	Tariff J for Street Lighting Service (Low Voltge)

Source: Directorate of General Electricity & New Energy

Table 4-17 Tariff Schedule of Electricity (1986)

No.	Code of Tariff	Contracted Power	Demand Charge	Consumption Charge (Rp/kWh)	Additional Charge (Rp/kWh)
1	S_1	to 200 VA	*)	-	N.A.
2	S_2	250 VA to 200 kVA	2,100	43.50	N.A.
3	R_1	250 VA to 500 VA	2,100	70.50	N.A.
4	R_2	501 VA to 2,200 VA	2,100	84.50	N.A.
5	R_3	2,201 VA to 6,600 VA	3,680	126.50	N.A.
6	R_4	6,601 VA & Over	3,680	158.00	N.A.
7	U_1	250 VA to 2,200 VA	3,680	134.00	N.A.
8	U_2	2,201 VA to 200 kVA	3,680	150.00	N.A.
9	U_3	201 kVA & Over	2,300	WBP=158.00 LWBP= 99.00	N.A.
10	U_4	-	-	307.00	N.A.
11	I_1	Up to 99 kVA	2,300	WBP= 97.50 LWBP= 60.50	N.A.
12	I_2	100 kVA to 200 kVA	2,300	WBP= 92.50 LWBP= 57.50	N.A.
13	I_3	201 kVA & Over	2,100	WBP= 90.50 LWBP= 56.00	N.A.
14	I_4	5,000 kVA & Over	1,970	WBP= 77.00 LWBP= 48.50	N.A.
15	G_1	250 VA to 200 kVA	3,680	96.00	N.A.
16	G_2	201 kVA & Over	1,970	WBP= 99.00 LWBP= 65.00	N.A.
17	J	-	-	76.50	N.A.

Source: Directorate of General Electricity & New Energy

Note: *) Tariff Subscription

	(Rp/Month)
60 VA :	1,550
75 VA :	1,940
100 VA :	2,510
125 VA :	3,200
150 VA :	3,765
175 VA :	4,350
200 VA :	5,025

WBP : Peak Load Hours (18.00 - 22.00 Local time)
LWBP: Off Peak Load Hours (22.00 - 18.00 Local time)

Table 4-18 Standard of Connection Charge (PLN Wilayah IV)

No.	Code of Tariff	Contracted Power	Connection Charge (Rp/kVA)
1	S_1	to 200 VA	Rp 20,000 / Connection
2	S_2	250 VA to 200 kVA	30
3	R_1	250 VA to 500 VA	Rp 30,000 / Connection
4	R_2	501 VA to 2,200 VA	45
5	R_3	2,201 VA to 6,600 VA	45
6	R_4	6,601 VA & Over	45
7	U_1	250 VA to 2,200 VA	45
8	U_2	2,201 VA to 200 kVA	45
9	U_3	201 kVA & 1,000 kVA 1,101 kVA & Over	45 *)
10	U_4	-	**)
11	I_1	Up to 99 kVA	25
12	I_2	100 kVA to 200 kVA	20
13	I_3	201 kVA & 1,000 kVA 1,101 kVA & Over	20 *)
14	I_4	5,000 kVA & Over	*)
15	G_1	250 VA to 200 kVA	35
16	G_2	201 kVA & 1,000 kVA 1,101 kVA & Over	35 *)
17	J	-	***)

Source: Directorate of General Electricity & New Energy

Note:

* Consultation by PLN Management
** 50% Material Charge + 100% Service Charge
*** 100% Material Charge

Table 4-19 Sales Revenue, Sold Electricity & Averaged Unit Price of Electricity for Jambi Province

Fiscal Year	Sales Revenue (Rp)	Sold Electricity (kWh)	Averaged Unit Price of Electricity (Rp/kWh)
1981	1,390,773,842	26,199,646	53.1
1982	2,088,663,275	30,170,235	69.2
1983	3,381,166,620	36,590,024	92.4
1984	4,804,444,330	40,783,558	117.8
1985	5,693,675,650	49,949,157	114.0
1986	6,324,438,545	57,052,745	110.9

Source: PLN Wilayah IV Cabang Jambi

Table 4-20 Sales Revenue, Sold Electricity & Averaged Unit Price of Electricity for Jambi City & Its Outskirts

Fiscal Year	Sales Revenue (Rp)	Sold Electricity (kWh)	Averaged Unit Price of Electricity (Rp/kWh)
1981	1,251,696,458	23,579,681	53.1
1982	1,879,796,694	27,153,211	69.2
1983	2,873,991,627	31,101,520	92.4
1984	4,083,777,680	34,666,024	117.8
1985	4,839,624,302	42,456,783	114.0
1986	5,335,834,965	48,689,018	109.6
1987*	5,191,469,630	50,015,649	103.8

Source: PLN Wilayah IV Cabang Jambi

Note: These figures are the sum total of the figures from April to December.

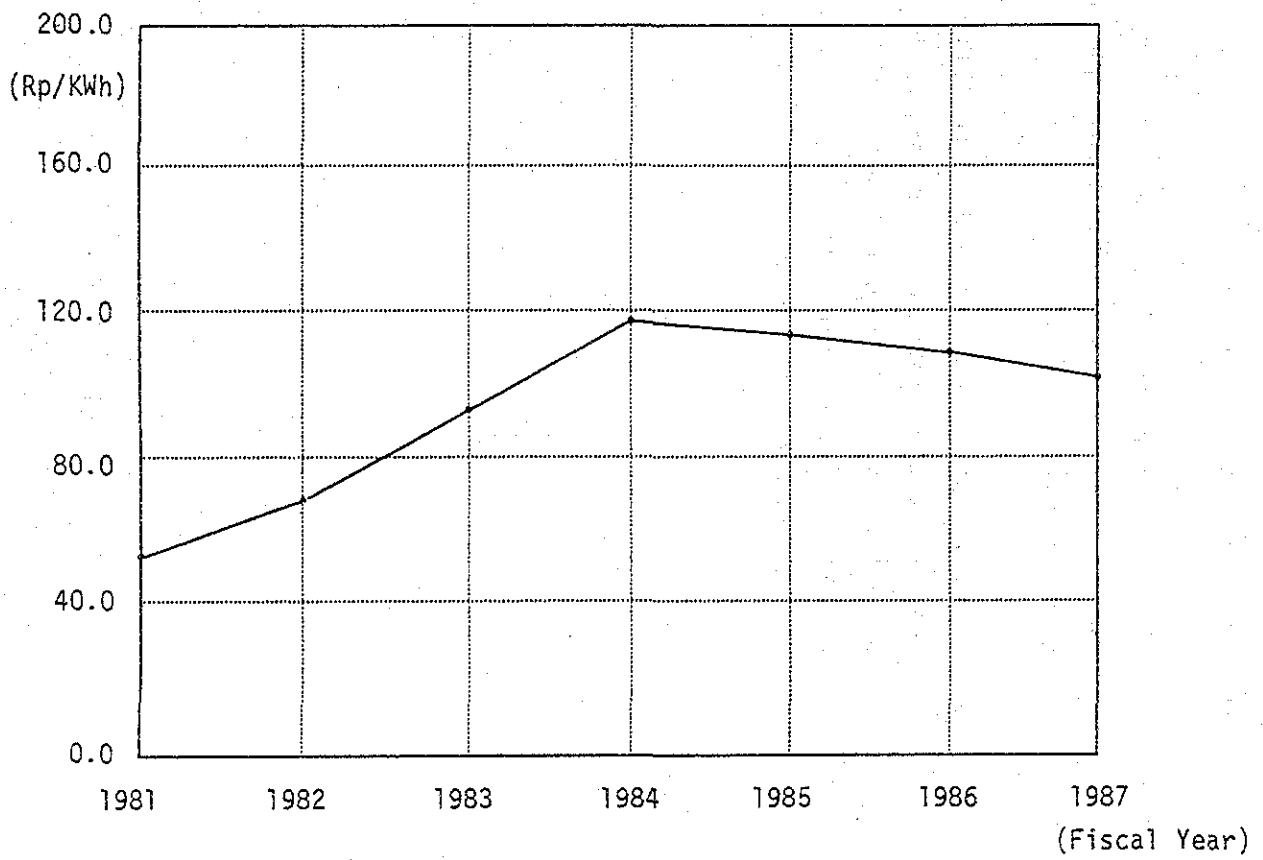


Figure 4-7 Past Averaged Unit Price of Electricity in Jambi City and Surrounding Areas

The main reasons for the above are the following:

1) The increases in 1980 (fiscal year) through 1984 (ditto) of the average unit price of electricity were caused in part by the increased revenue due to the revisions of electricity tariffs of 1980 through 1983.

2) There were small time lags between the implementation of the revisions of the electricity tariffs and the actual revenue increase.

3) Average unit price decreased since 1984 (fiscal year) because the electricity tariffs presumably were not revised in 1984 (ditto) and 1985 (ditto), and revised relatively little in 1986 while the number of small-demand consumers, who have a low contract price and are not profitable for PLN, increased remarkably.

4-2 LPG Market Study

4-2-1 Supply and Demand Situation of LPG

(1) LPG Consumption Structure of Jambi Province

Table 4-21 shows shares of population (as of 1986) and LPG consumption (as of January 1988) by regencies. As the above table indicates, population share of each regency has no relation to LPG consumption share: Jambi City accounts for approximately 80%; Tanjung Jabung and Batang Hari Regencies relatively close to the City account for approximately 13% and 6% respectively, while Bungo Tebo, Sarolangun Bangko, and Kerenci Regencies relatively far from the City, account for approximately 2%, 1% and 0%, respectively. Consequently, the LPG consumption share of each regency is at present substantially influenced by transporting limitations rather than population.

Table 4-21 Shares of Population & LPG Consumption by Regency *in Jambi Province*

Regency / Municipality	Population* Share (%)	LPG Demand** Share (%)
Kerinci	15.4	0.0
Sarolangun Bangko	16.9	0.7
Batang Hari	14.0	5.5
Tanjung Jabung	20.0	12.7
Bungo Tebo	17.9	1.7
Kotamadya Jambi	15.8	79.4
Total	100.0	100.0

Note: * As of 1986
** As of January 1988

Table 4-22 shows shares of LPG consumption and applications by sector in Jambi Province. As the same table shows, LPG consumption for cooking by the residential sector accounts for 85% and LPG consumption for industry and other sectors, for 15%.

Table 4-22 Shares of LPG Demand & Application by Sector in Jambi Province

Sector	LPG Demand Share (%)	Application
Residential	85	Cooking
Ind. & Others	15	Welding, Can Printing, Lighting, Hospital, etc.
Total	100	-

Source: PERTAMINA, PDN, Jakarta

(2) LPG Supply in Jambi Province

The exploration and/or development, retining and/or processing, and sales of Indonesian petroleum and natural gas are monopolized by the state petroleum company, PERTAMINA, and the whole LPG supply of Jambi Province is also controlled by PERTAMINA's domestic supply department (PDN: Direktorat Pembekalan Dalam Negeri). Presently, Jambi Province has no LPG recovery plants or filling stations. Accordingly, all the LPG consumed in Jambi Province are transported from Palembang City (260 km south of Jambi City) which has the above filling stations, to Jambi City abroad PERTAMINA-owned 4.5-ton freight trucks. Plaju and Sungai Gerong refineries (referred together as Musi refinery) exist in Palembang City; there are LPG recovery plants on the Sungai Gerong refinery sites and LPG filling stations, on the both refinery sites. These stations comprise the LPG supply center of PERTAMINA's Palembang marketing Unit II (target regions: Jambi Province, South Sumatra (Sumatra Selatan) Province, Bengkulu Province, Lampung Province).

LPG is recovered at the Musi refinery from the gas produced in the refining process containing LPG fraction. The production capacity of LPG recovery plant of Sungai Gerong refinery declined to 11,000 tons per year as of 1985 due to renovation work of the refinery; a plant with 80-ton-per-day production is in operation among them for the domestic market. However, in the future, there is a plan to expand the plant production capacity to 120 tons per day by around 1990 for the domestic market. At the two LPG filling stations on the Musi refinery site, LPG sent from the LPG recovery plants are weighed and manually filled into 11-kg and 45-kg LPG cylinders.

The LPG mentioned above is picked up at a PERTAMINA PDN LPG collection and delivery depot in Jambi City by two LPG dealers in the City, P.T. Jambi Tongam (formerly: C.V. Johnson Jaya) and P.T. Perdata Kurnia, and supplied through them to LPG consumers in Jambi Province.

The supply of LPG in Jambi Province was commenced in about 1984 since the above depot did not exist, and it is believed that supplying on a routine business basis began from about 1986. Consequently, the LPG sales of Jambi Province are only recorded for the last two years. Table 4-23 shows this sales record.

1) From 1986 to 1987, LPG sales in Jambi Province grew a large 117.3%

2) The average monthly growth rate of LPG sales in 1987, however, was approximately 1.8%; the converted annual rate was only approximately 23.9%; thus, a growth rate as high as in 1986/1987 cannot be expected in the future.

3) According to the 1987 monthly LPG sales, the ratio of sales of LPG in 11-kg cylinders to that in 45-kg cylinders was approximately 86:14; this ratio is getting close to the

Table 4-23 Sales Record of LPG in Jambi Province

	11 kg Cylinder (Cylinders)	Sub Total (t)	45 kg Cylinder (Cylinders)	Sub Total (t)	Total (t)	
1986 Jan. - Sep.*	11,943	155.259			N.A.	
Oct. - Dec.	11,022	121.242	937**	42.165**	N.A.	Average
Total	22,965	276.501	937	42.165	318.666	26.56 (t/mon)
1987 Jan.	4,443	48.873	138	6.210	55.083	
Feb.	3,760	41.360	165	7.425	48.785	
Mar.	3,998	43.978	150	6.750	50.728	
Apr.	5,355	58.905	170	7.650	66.555	
May	4,096	45.056	165	7.425	52.481	
Jun.	4,704	51.744	170	7.650	59.394	
Jul.	4,903	53.933	175	7.875	61.808	
Aug.	3,840	42.240	180	8.100	50.340	
Sep.	4,868	53.548	195	8.775	62.323	
Oct.	4,750	52.250	220	9.900	62.150	
Nov.	4,175	45.925	220	9.900	55.825	
Dec.	5,221	57.431	214	9.630	67.061	Average
Total	54,113	595.243	2,162	97.290	692.533	57.71 (t/mon)

Source: PERTAMINA, PDN, Jambi

Note: * These figures are of 13 kg cylinders.

** These figures are for the total year of 1986.

85:15 ratio of residential LPG consumption to LPG consumption for industry and other use. Therefore, 11-kg cylinder LPG is believed to be generally supplied in Jambi Province for residential use and 45-kg cylinder LPG, for industry and other use.

4) Wide monthly fluctuations for 11-kg cylinder residential LPG and stability for 45-kg cylinder LPG for industry and other use are observed in the 1987 monthly LPG sales.

Table 4-24 shows the sales record of LPG for Palembang (PERTAMINA Unit II) and the LPG production record in Sungai Gerong refinery for reference. As it is observed from the above-mentioned table that LPG sales for Unit II (i.e., domestic consumption) has been growing at quite a high rate averaging 45.4% per year. Unit II is, as mentioned above, covering the four provinces: Jambi, South Sumatra (Sumatera Selatan), Bengkulu, and Lampong. By comparing this table with Tables 4-23) it is clear that Jambi Province's LPG sales (approximately 692.5 tons in 1987) accounts for about 10% of LPG sales for Unit II (6,331 tons in 1986). A sharp decline in LPG production since 1985 is observed in Table 4-24; this is due to the temporary stoppage of operation for the expansion of LPG recovery plants.

Table 4-24 Sales Record of LPG for Palembang (PERTAMINA Unit II) & LPG Production Record in Sungai Gerong Refinery

Fiscal Year	Sold LPG (T/Year)	Growth Rate (% p.a.)	LPG Production* (T/Year)	Growth rate (% p.a.)
1981	975	-	N.A.	-
1982	1,282	31.5	36,199	-
1983	1,727	34.7	36,986	2.2
1984	2,486	43.9	20,090	-45.7
1985	3,734	50.2	3,690	-81.6
1986	6,331	69.6	9,373	154.0
	Average	45.4	Average	-29.0

Source: PERTAMINA, PDN, Jakarta,
The Petroleum Report, Indonesia

Note: * These figures are in the calendar year.

4-2-2 LPG Supply and Demand Forecast

(1) Future LPG Supply Prospects of Jambi Province

As mentioned in 4-2-1, "Supply and Demand Situation of LPG", Jambi Province currently has no LPG production and is being supplied from the LPG supply center within Musi refinery in the Palembang region of South Sumatra (Sumatera Salatan Province). Therefore, the future LPG supply possibilities in Jambi Province depend upon the LPG supply capacity of the above-mentioned LPG supply center. This LPG supply center currently has an LPG production capacity of 80 tons per day for domestic market, as mentioned; there is a plan to increase this to 120 tons per day since future growth in domestic demand is expected. If there is this increase, and assuming that the future proportion of LPG supplied to Jambi Province remains at the current level of approximately 10%. Jambi Province presumably can secure at least 1.5 times the present LPG supply (692.5 t in 1987), i.e., more than 1,000 tons per year, from the above LPG supply center.

(2) LPG Demand Forecast of Jambi Province

The Indonesian Government is recommending to its people the use of LPG as the substitute fuel for kerosene, and by year 2000 LPG is expected to replace 20% of the kerosene demand. In spite of the terminal points of the LPG distribution system not being sufficiently developed, the domestic LPG demand is increasing yearly, showing an average annual growth of 33% in the period between 1980 through 1986. The 1986 domestic LPG sales also increased by 22% compared to the previous year.

Conversely, the LPG demand in Jambi Province has just begun, and the trend of its growth is expected to resemble that of the LPG demand for the whole of Indonesia. However, as mentioned above, the 1987 monthly LPG sales growth (average monthly rate: 1.8%; converted annual rate: 23.9%) has slowed down compared to the large growth of LPG sales from 1986 to 1987 (annual rate: 117.3%); therefore, the province's future growth of LPG sales is expected to stabilize at the 10%-per-year level, a little below the growth rate of the 1986 domestic LPG sales for the whole of Indonesia.

As seen in Table 4-23, LPG is not necessarily used throughout Jambi Province, but starting from the city area, it is expected to be eventually used in the provincial areas. Therefore, in the following, an LPG demand forecast is made on the assumption that the entire Jambi Province will be the supply target of LPG produced by this project.

(a) Preconditions

(i) LPG supply target area for this project:
The entire Jambi Province, as mentioned above.

(ii) Forecast period: Until year 2000

(iii) Forecast methods:

As mentioned above, since LPG depots did not exist in Jambi City, LPG sales in Jambi Province was commenced around 1984, and the sales on a routine business basis began around 1986. Consequently, LPG sales for Jambi Province has only been recorded for the past two years (see Table 4-23). Therefore, it is concluded meaningless to conduct regression analysis.

From the above, the sums of the LPG demands for residential use and industry and other use are obtained for this study.

a) Residential use:

For the residential LPG demand forecast, first, a population forecast of Jambi Province is made using regression analysis, the number of households are sought; then, the income-group share of households, the share of LPG consumption by households within each income group, and the consumption unit of LPG by households of each income groups are established. The following are the assumptions for the forecast method.

i) Population forecast for Jambi Province:

Using past statistics relating to population and number of households of Jambi Province, the population forecast is made by the exponential regression curve.

ii) Household size of Jambi Province:

A size of 4.8 persons per household is assumed for Jambi Province, based upon past statistics.

iii) Share by household income group in Jambi Province:

Since it was not possible to obtain data concerning the share of households by income group in Jambi Province, values reflecting the whole of Indonesia used by the Arthur D. Little International Co. of the U.S.A in the Indonesia LPG Feasibility Study (July, 1986) is employed here (Table 4-25).

Table 4-25 Assumption of Share by Household Income Group

Household Income Group	Share (%)
Upper	1
Middle	7
Lower & Traditional	92
	100

iv) Future LPG consumption share by household income group in Jambi Province:

Only a portion of the upper household income group and a fraction of the middle household income group are believed to be using LPG in Jambi Province at present. Since data concerning the LPG consumption share for each household income group was not available, information concerning LPG consumption unit and number of LPG consumer-households obtained from the 1987 LPG sales record and hearing surveys was considered for postulating the future share of LPG consumption by household income group, shown in Table 4-26.

Table 4-26 Shares Forecast in Jambi Province of LPG Consumption in Upper & Middle Income Groups

Upper Income Group			Middle Income group		
1987	2000	Regression Curve	1995	2000	Regression Curve
50 %	90 %	Logarithmic	4 %	10 %	Exponential
55	"	"	6	15	"
60	"	"	8	20	"
65	"	"			
70	"	"			

There are a total fifteen cases from the combinations of the above.

v) LPG unit consumption by household income group in Jambi Province:

LPG is sold in Jambi Province in two types of cylinders, an 11-kg and 45-kg cylinder; the 11-kg is believed to be used for residential use and the 45-kg, for industry and other use, generally. Accordingly, assuming that LPG in 11-kg cylinders is all for residential use and the LPG in 45-kg cylinders is all for industry and other use, the LPG unit consumption rate by the middle and upper household income groups based upon the 1987 LPG sales record shown in Table 4-23 are used for the residential LPG demand forecast. These LPG unit consumption rates are shown in Table 4-27. Further, although these LPG unit consumption rates presumably change yearly, they are assumed constant, since the rates of change are unknown.

b) Industry and other use:

As mentioned above, the LPG consumption for industry and other use is believed to equal the consumption of LPG in 45-kg cylinders. Based on this assumption, the 1987 LPG consumption for industry and other use (97.3 t) accounts for only approximately 14% of the total (692.5 t). Also, considering that large increases cannot be expected in the LPG consumption for industry and other use in Jambi Province in the future, the consumption of LPG for industry and other use has little impact on Jambi Province's entire LPG consumption. Therefore, the industry and other use LPG consumption forecast is made assuming two cases of annual growth rate of High Case (8%) and Low Case (4%).

c) Case Categories:

From the above, this LPG demand forecast is conducted on a total of 30 cases.

(b) LPG Demand Forecast Results

Figure 4-8 shows four cases of summation out of 30 cases employed in the LPG demand forecast results based on the preconditions mentioned , largest (Case 50.20H), smallest (Case 70:10L), and two mean cases (Case 60.15L and Case 60.15H). Although it is not easy to decide which of these forecast results has the highest probability, the above two mean cases appear realistic in the light of the LPG unit consumption rate and the number of consumers in the whole of residential sector in Jambi Province in 1987, shown in Table 4-27.

The LPG demand forecast results in terms of these cases are shown in Tables 4-28 and 4-29, respectively. The LPG demand in 1995 and 2000 are selected from these results and shown in Table 4-30.

Table 4-27 Unit Consumption Rates and Consumers of LPG for LPG Demand Forecast in Residential Sector in Jambi Province

Case	Upper Income Group (figures in 1987)				Middle Income Group (figures in 1987)				Total (figures in 1987)		
	Share %	Consumers 10^3	Unit Cons. kg/month	Consumption t/year	Share %	Consumers 10^3	Unit Cons. kg/month	Consumption t/year	Consumers 10^3	Unit Cons. kg/month	Consumption t/year
50.10	50.0	1.9	23.6	547.0	0.9	0.2	16.5	48.2	2.2	22.8	595.2
50.15	50.0	1.9	22.6	523.4	1.4	0.4	15.8	71.8	2.3	21.5	595.2
50.20	50.0	1.9	21.8	506.0	1.8	0.5	15.3	89.3	2.4	20.5	595.2
55.10	55.0	2.1	21.6	551.1	0.9	0.2	15.1	44.2	2.4	20.9	595.2
55.15	55.0	2.1	20.7	529.2	1.4	0.4	14.5	66.0	2.5	19.8	595.2
55.20	55.0	2.1	20.1	513.0	1.8	0.5	14.1	82.3	2.6	19.0	595.2
60.10	60.0	2.3	19.9	554.5	0.9	0.2	13.9	40.8	2.6	19.4	595.2
60.15	60.0	2.3	19.2	534.2	1.4	0.4	13.4	61.1	2.7	18.4	595.2
60.20	60.0	2.3	18.6	519.0	1.8	0.5	13.1	76.3	2.8	17.7	595.2
65.10	65.0	2.5	18.5	557.4	0.9	0.2	12.9	37.8	2.8	18.0	595.2
65.15	65.0	2.5	17.9	538.4	1.4	0.4	12.5	56.8	2.9	17.2	595.2
65.20	65.0	2.5	17.4	524.1	1.8	0.5	12.2	71.1	3.0	16.5	595.2
70.10	70.0	2.7	17.2	560.0	0.9	0.2	12.1	35.3	2.9	16.8	595.2
70.15	70.0	2.7	16.7	542.1	1.4	0.4	11.7	53.1	3.1	16.1	595.2
70.20	70.0	2.7	16.3	528.6	1.8	0.5	11.4	66.6	3.2	15.5	595.2

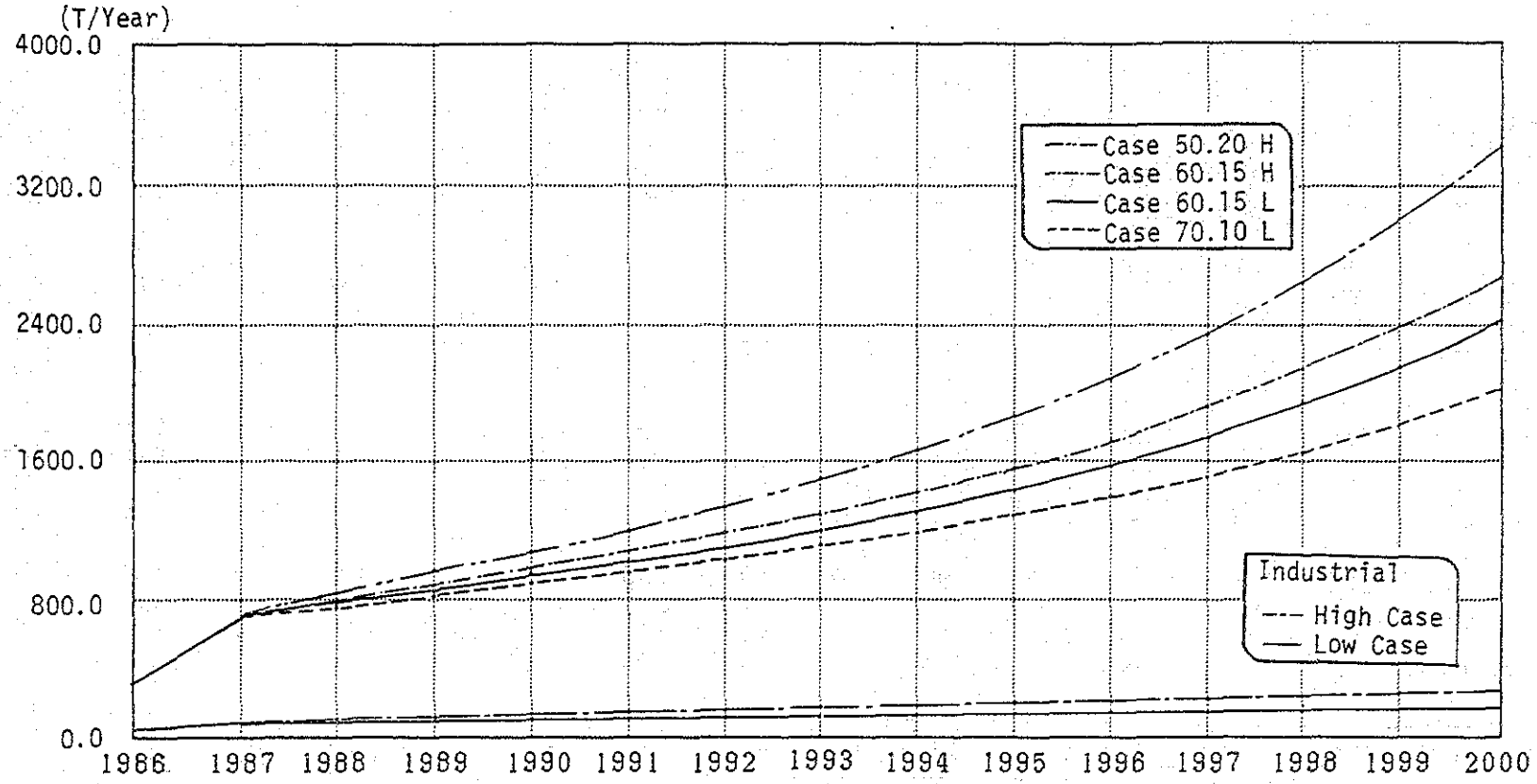


Figure 4-8 Summary of LPG Demand Forecast for Jambi Province

Table 4-28 LPG Demand Forecast of Jambi Province (Case 60.15L)

	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Residential Sector															
Population (10^3)*	1,795.2	1,855.6	1,930.2	2,007.7	2,088.3	2,172.2	2,259.4	2,350.2	2,444.5	2,542.7	2,644.8	2,751.0	2,861.5	2,976.4	3,096.0
Growth Rate (% p.a.)	4.6	3.4	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Household Size	4.7	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8
No.of Household (10^3)	381.2	386.6	402.1	418.3	435.1	452.5	470.7	489.6	509.3	529.7	551.0	573.1	596.1	620.1	645.0
Upper Income Group(%)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Share in U.I.G.(%)	49.7	60.0	66.0	70.3	73.6	76.4	78.7	80.6	82.4	84.0	85.4	86.7	87.9	89.0	90.0
U.I. Consumers (10^3)	1.9	2.3	2.7	2.9	3.2	3.5	3.7	3.9	4.2	4.4	4.7	5.0	5.2	5.5	5.8
U.I.Cons.Rate(kg/mon.)	12.2	19.2	19.2	19.2	19.2	19.2	19.2	19.2	19.2	19.2	19.2	19.2	19.2	19.2	19.2
U.I.Consump.(t/year)	276.5	534.2	611.5	677.5	737.8	796.6	853.5	909.2	966.9	1,025.2	1,084.2	1,144.9	1,207.3	1,271.5	1,337.5
Middle Income Group(%)	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
Share in M.I.G.(%)	0.0	1.4	1.7	2.0	2.4	2.9	3.5	4.2	5.0	6.0	7.2	8.7	10.4	12.5	15.0
M.I. Consumers (10^3)	0.0	0.4	0.5	0.6	0.7	0.9	1.2	1.4	1.8	2.2	2.8	3.5	4.3	5.4	6.8
M.I.Cons.Rate(kg/mon.)	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4
M.I.Consump.(t/year)	0.0	61.1	76.9	94.2	117.5	147.7	185.4	231.5	286.6	357.8	446.6	561.3	697.9	872.5	1,089.0
Total Consumers(10^3)	1.9	2.7	3.1	3.5	3.9	4.4	4.9	5.4	6.0	6.7	7.5	8.5	9.6	10.9	12.6
Growth Rate (% p.a.)	-	42.4	16.1	12.6	11.5	11.3	11.0	10.9	11.0	11.6	12.1	13.1	13.2	14.2	24.8
LPG Cons.Rate(kg/mon.)	12.2	18.4	18.3	18.2	18.1	18.0	17.8	17.6	17.5	17.3	17.0	16.8	16.6	16.3	16.1
Total Consumption (t)	276.5	595.2	688.4	771.6	855.3	944.3	1,039.0	1,140.7	1,253.5	1,383.0	1,530.7	1,706.1	1,905.2	2,144.0	2,426.5
Growth Rate (% p.a.)	-	115.3	15.7	12.1	10.8	10.4	10.0	9.8	9.9	10.3	10.7	11.5	11.7	12.5	13.2
Ind. & Other Sector															
LPG Consumption (t)	42.2	97.3	101.2	105.2	109.4	113.8	118.4	123.1	128.0	133.1	138.5	144.0	149.8	155.8	162.0
Growth Rate (% p.a.)	-	130.7	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
LPG Grand Total**(t)	318.7	692.5	789.6	876.9	964.7	1,058.1	1,157.3	1,263.8	1,381.5	1,516.1	1,669.2	1,850.1	2,055.0	2,299.8	2,588.5
Growth Rate (% p.a.)	-	117.3	14.0	11.1	10.0	9.7	9.4	9.2	9.3	9.7	10.1	10.8	11.1	11.9	12.6

Note * The figure of population in 1986 is actual.
** The figures of LPG consumption in 1986 and 1987 are actual.

Table 4-29 LPG Demand Forecast for Jambi Province (Case 60.15H)

	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Residential Sector															
Population (10^3)*	1,795.2	1,855.6	1,930.2	2,007.7	2,088.3	2,172.2	2,259.4	2,350.2	2,444.5	2,542.7	2,644.8	2,751.0	2,861.5	2,976.4	3,096.0
Growth Rate (% p.a.)	4.6	3.4	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Household Size	4.7	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8
No.of Household (10^3)	381.2	386.6	402.1	418.3	435.1	452.5	470.7	489.6	509.3	529.7	551.0	573.1	596.1	620.1	645.0
Upper Income Group(%)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Share in U.I.G.(%)	49.7	60.0	66.0	70.3	73.6	76.4	78.7	80.6	82.4	84.0	85.4	86.7	87.9	89.0	90.0
U.I. Consumers (10^3)	1.9	2.3	2.7	2.9	3.2	3.5	3.7	3.9	4.2	4.4	4.7	5.0	5.2	5.5	5.8
U.I.Cons.Rate(kg/mon.)	12.2	19.2	19.2	19.2	19.2	19.2	19.2	19.2	19.2	19.2	19.2	19.2	19.2	19.2	19.2
U.I.Consump.(t/year)	276.5	534.2	611.5	677.5	737.8	796.6	853.5	909.2	966.9	1,025.2	1,084.2	1,144.9	1,207.3	1,271.5	1,337.5
Middle Income Group(%)	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
Share in M.I.G.(%)	0.0	1.4	1.7	2.0	2.4	2.9	3.5	4.2	5.0	6.0	7.2	8.7	10.4	12.5	15.0
M.I. Consumers (10^3)	0.0	0.4	0.5	0.6	0.7	0.9	1.2	1.4	1.8	2.2	2.8	3.5	4.3	5.4	6.8
M.I.Cons.Rate(kg/mon.)	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4
M.I.Consump.(t/year)	0.0	61.1	76.9	94.2	117.5	147.7	185.4	231.5	286.6	357.8	446.6	561.3	697.9	872.5	1,089.0
Total Consumers(10^3)	1.9	2.7	3.1	3.5	3.9	4.4	4.9	5.4	6.0	6.7	7.5	8.5	9.6	10.9	12.6
Growth Rate (% p.a.)	-	42.4	16.1	12.6	11.5	11.3	11.0	10.9	11.0	11.6	12.1	13.1	13.2	14.2	24.8
LPG Cons.Rate(kg/mon.)	12.2	18.4	18.3	18.2	18.1	18.0	17.8	17.6	17.5	17.3	17.0	16.8	16.6	16.3	16.1
Total Consumption (t)	276.5	595.2	688.4	771.6	855.3	944.3	1,039.0	1,140.7	1,253.5	1,383.0	1,530.7	1,706.1	1,905.2	2,144.0	2,426.5
Growth Rate (% p.a.)	-	115.3	15.7	12.1	10.8	10.4	10.0	9.8	9.9	10.3	10.7	11.5	11.7	12.5	13.2
Ind. & Other Sector															
LPG Consumption (t)	42.2	97.3	105.1	113.5	122.6	132.4	143.0	154.4	166.7	180.1	194.5	210.0	226.8	245.0	264.6
Growth Rate (% p.a.)	-	130.7	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0
LPG Grand Total**(t)	318.7	692.5	793.5	885.1	977.8	1,076.7	1,181.9	1,295.1	1,420.2	1,563.1	1,725.2	1,916.2	2,132.0	2,389.0	2,691.1
Growth Rate (% p.a.)	-	117.3	14.6	11.5	10.5	10.1	9.8	9.6	9.7	10.1	10.4	11.1	11.3	12.1	12.6

Note * The figure of population in 1986 is actual.
** The figures of LPG consumption in 1986 and 1987 are actual.

Table 4-30 LPG Demand Forecast in Jambi Province in 1995 & 2000

(Unit: t/year)

Case	1995	2000
60.15L	1,516.1	2,588.5
60.15H	1,563.1	2,691.1

4-2-3 LPG Price

(1) LPG Price System

In Indonesia, depending upon if it is for export or the domestic market, different methods are used in deciding the prices of LPG, as in the case of prices of other petroleum products. The LPG prices for export are decided by first determining the CIF price through negotiations with the nation exported to, and then determining from this the FOB price excluding freight expense and insurance. The LPG export price (FOB) as of February 1988 is 120 - 130 US$/t.

A standard national pricing system regulated by the government determines the LPG prices for the domestic market and the LPG unit price does not depend on the size of the container. Consequently, the same type of system applies to LPG prices for Jambi Province. Table 4-31 shows the LPG price by point of sales up to the LPG consumer in Jambi Province as of February 1988.

Table 4-31 LPG* Price by Point of Sales up to LPG Consumers in Jambi Province (As of February, 1988)

Point of Sales	Sales Price	Unit Price (Rp/kg)
Ex-Refinery	120 US$/T (1 US$ = 1,665 Rp)	199.80
PERTAMINA's depot in Jambi City	5,515.07 Rp** for 11 kg Cylinder 22,561.65 Rp** for 45 kg Cylinder	501.37** 501.37**
Dealers in Jambi Province	6,500 Rp for 11 kg Cylinder 26,550 Rp for 45 kg Cylinder	590.91*** 590.00***

Source: PERTAMINA, PDN, Jakarta

Note: * Propane & butane mixture
** Including transportation cost and 10% sales tax
*** This figure will be changed when distribution distance exceeds 60 km.

(2) Change of LPG Prices

The changes in the retail prices of LPG and kerosene, the alleged substitute fuel for LPG, in Jambi Province are shown in Table 4-32. The retail prices per thermal unit are also shown in the same table: as of 1988, the LPG retail price per thermal unit is approximately 2.2 times that of kerosene. Since the burners for kerosene and LPG (such as cooking stoves, etc.) have differences in heat efficiency, they can not be compared simplistically, yet, the regulatory control over kerosene prices is believed to contribute to this trend. In order to promote LPG demand just from the price dimension, in the future, either kerosene prices must be raised or LPG prices lowered to close the gap between their relative prices per thermal unit.

Table 4-32 Record of Retail Prices of LPG & Kerosene in Jambi Province

Year	1983	1984	1985	1986	1987	1988
Kerosene (Rp/Liter)	60	100	150	165	165	200
(A) (Rp/MMBTU)	1,698.9	2,831.4	4,247.1	4,671.8	4,671.8	5,662.8
LPG (Rp/kg)	N.A.	453.33-461.54	N.A.	N.A.	370.00	590.00-590.91
(B) (Rp/MMBTU)	N.A.	9,599.8-9,773.6	N.A.	N.A.	7,835.2	12,493.9-12,513.2
(B) / (A)	N.A.	3.39-3.45	N.A.	N.A.	1.68	2.21

Note: Energy conversion factors used are the following:

1 liter of kerosene = 8,900 kcal

1 kg of LPG = 11,900 kcal

1 kcal = 3.968311 BTU

4-2-4 LPG Sales and Distribution System

(1) Outline of the LPG Sales and Distribution System

As mentioned above, the development, processing, and sales of petroleum and natural gas in Indonesia are monopolized by the state petroleum company, PERTAMINA. Accordingly, PERTAMINA controls LPG sold in Jambi Province up to the point of the end dealer. The schematic flow of the LPG sales and distribution system is shown in Figure 4-9. As this figure shows, LPG produced at the LPG plant in Sungai Geron is sent to the two LPG filling stations (Sungai Gerong and Plaju) on the site of Musi refinery by LPG pipelines, and at this point filled into 11-kg or 45-kg cylinders. These LPG cylinders are transported by PERTAMINA's 4.5 t trucks to an LPG depot of PERTAMINA PDN in Jambi City. Two LPG dealers in Jambi City (P.T. Jambi Tongam and P.T. Pertada Kurnia) go to this depots by small, 750-kg freight trucks to pick up the LPG cylinders.

The above dealers transfer the LPG cylinders they picked up to consumers in Jambi Province. Used-up, empty LPG cylinders as well as LPG orders are transported or delivered to the LPG filling stations by the reverse route of what was mentioned.

(2) LPG Specification

Indonesia's specifications on LPG differ in the cases of export and domestic market. The specifications on LPG for the domestic market differ depending on where it was produced or the characteristics of the source-gas, although control evidently is not that strict. The standard specification of LPG for Indonesia's domestic market are shown in Table 4-33. LPG currently sold in Jambi Province is said to be LPG with a lot of butane fraction ("butane-rich LPG").

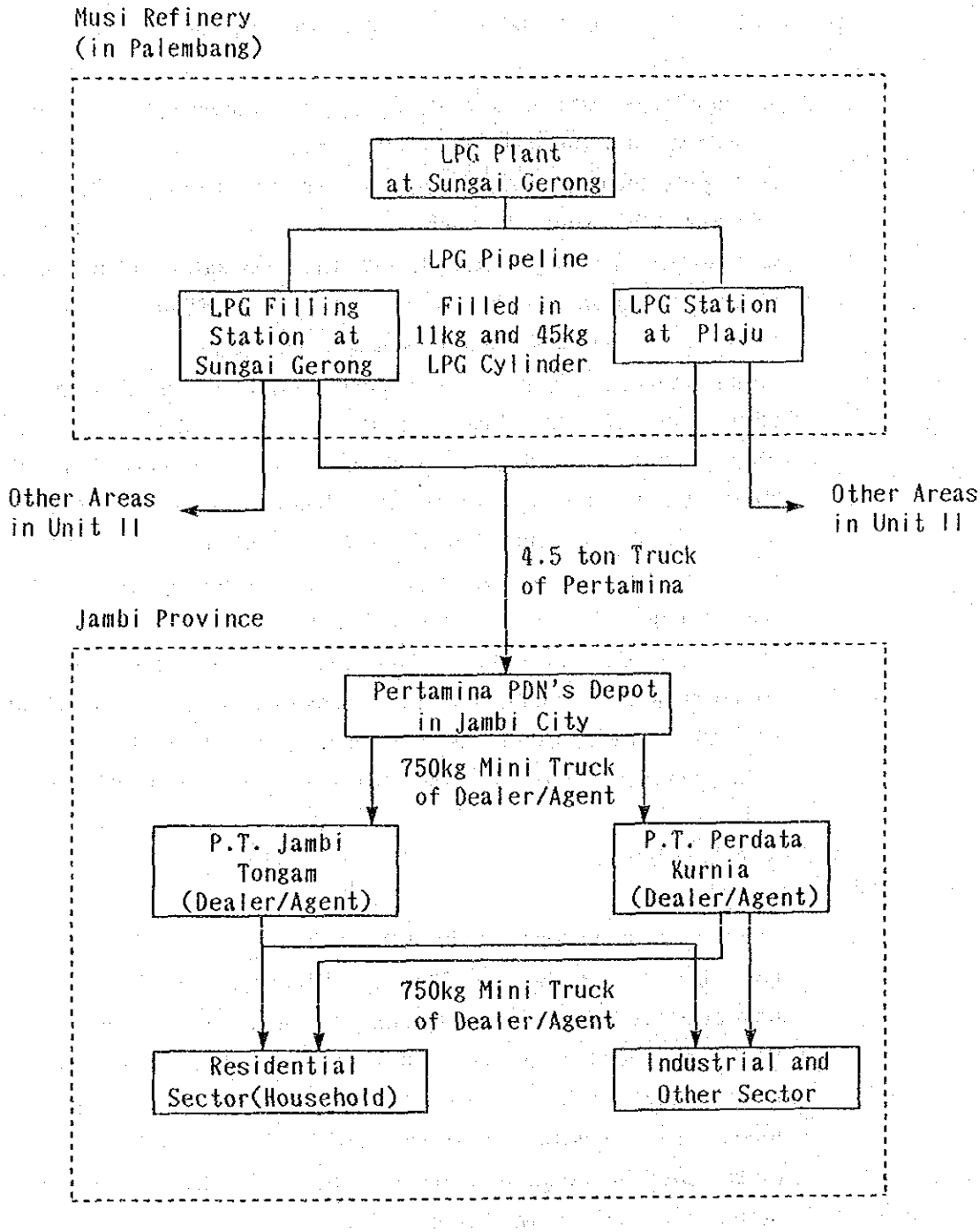


Figure 4-9 Schematic Flow of Sales/Distribution System of LPG of Jambi Province

Table 4-33 Standard Specification of LPG for Indonesia's Domestic Market

Characteristics	Limitation		Test Method	
	Minimum	Maximum	ASTM	Others
Specific Gravity at 60°/60°F	To be reported		D-1657	-
Reid Vapor Pressure 100°F, psig	-	120	D-1267	-
Wheathering Test at 36°F, % Vol	95	-	D-1837	-
Copper Corrosion 2 hrs, 100°C	-	No.1 strip	D- 484	-
Color	Marketable			
Total sulphur grains/100 cuft	-	15	D-1266	-
Water Content	No free water		-	Visual
				D-2163
C_1 % wt.	-	nil		
C_2 % wt.	-	0.2		
C_3, C_4 % wt.	97.5	-		
C_5^+ % wt.	-	2.5		
Ethyl or buthyl mercaptan added	50 ml/ 1,000 US Gallon			

Source: PERTAMINA, PDN, Jakarta

(3) Transport and Packing of LPG

(a) Transport of LPG

As mentioned above, LPG sold in Jambi Province is filled in 11-kg and 45-kg cylinders at two filling stations on the site of Musi refinery, and then transported. This filling is presently done manually while looking at a weight scale. The above cylinders are loaded onto PERTAMINA's 4.5 t freight trucks: approximately 200 cylinders in the case of the 11-kg LPG cylinders, and approximately 50 cylinders in the case of 45-kg LPG cylinders; they are transported to the various LPG depots of PERTAMINA's sales Unit II, which includes Jambi Province. Conversely, LPG delivered to PERTAMINA PDN's LPG depot in Jambi City is loaded onto small, 750-kg freight truck owned by LPG dealers mentioned above: about 35 cylinders, in the case of 11-kg LPG cylinders and about 10 cylinders, in the case of 45-kg LPG cylinders; they are then delivered to the various consumers in Jambi Province.

The transportation cost between the LPG filling stations to the LPG depot of PERTAMINA PDN in Jambi City is included with tax in the sales price of LPG to the LPG dealers mentioned above; they are shown in Table 4-34 for reference.

Table 4-34 LPG Transportation Cost between LPG Filling Station in Palembang and LPG Depot in Jambi City

Cylinder Type	Cost (Rp/Cylinder)	Unit Cost (Rp/LPG Net kg)	Unit Cost (Rp/LPG Cylinder Gross kg)
11 kg	1,313.71	124.88	52.43
45 kg	4,221.50	93.81	50.14

Source: PERTAMINA, PDN, Palembang

Accurate information concerning the distance between the LPG filling stations and LPG depots were not obtainable, but assuming that it is 260 km, it is calculated from Table 4-34 that the unit transportation cost per unit distance of LPG, in the case of a 4.5 t freight truck, is 0.36 - 0.48 Rp/LPG Net kg/km or 0.19 - 0.21 Rp/LPG Cylinder Gross kg/km.

(b) LPG Cylinders

There are currently two types of LPG cylinders used in Jambi Province as mentioned above: an 11-kg and a 45-kg. Table 4-35 shows an outline of them.

Table 4-35 Outline of LPG Cylinders used in Jambi Province

Dimension	Unit	11 kg Type	45 kg Type
Net Weight	kg/Cylinder	15.2	39.2
Gross Weight	kg/Cylinder	26.2	84.2
Diameter	cm	30.0	36.8
Length	cm	58.9	132.0
Net Price*	Rp/Cylinder	55,000	110,000

Source: PERTAMINA, PDN, Jakarta

Note: * Including 10% sales tax

(3) Miscellaneous (Residential LPG Stoves)

Two types of residential LPG stoves are currently sold in Jambi Province, a large type and a small type. Stores and LPG dealers sell the small type at 80,000 Rp per unit, and the large type, at 100,000 Rp per unit.

5. NATURAL GAS PRODUCTION

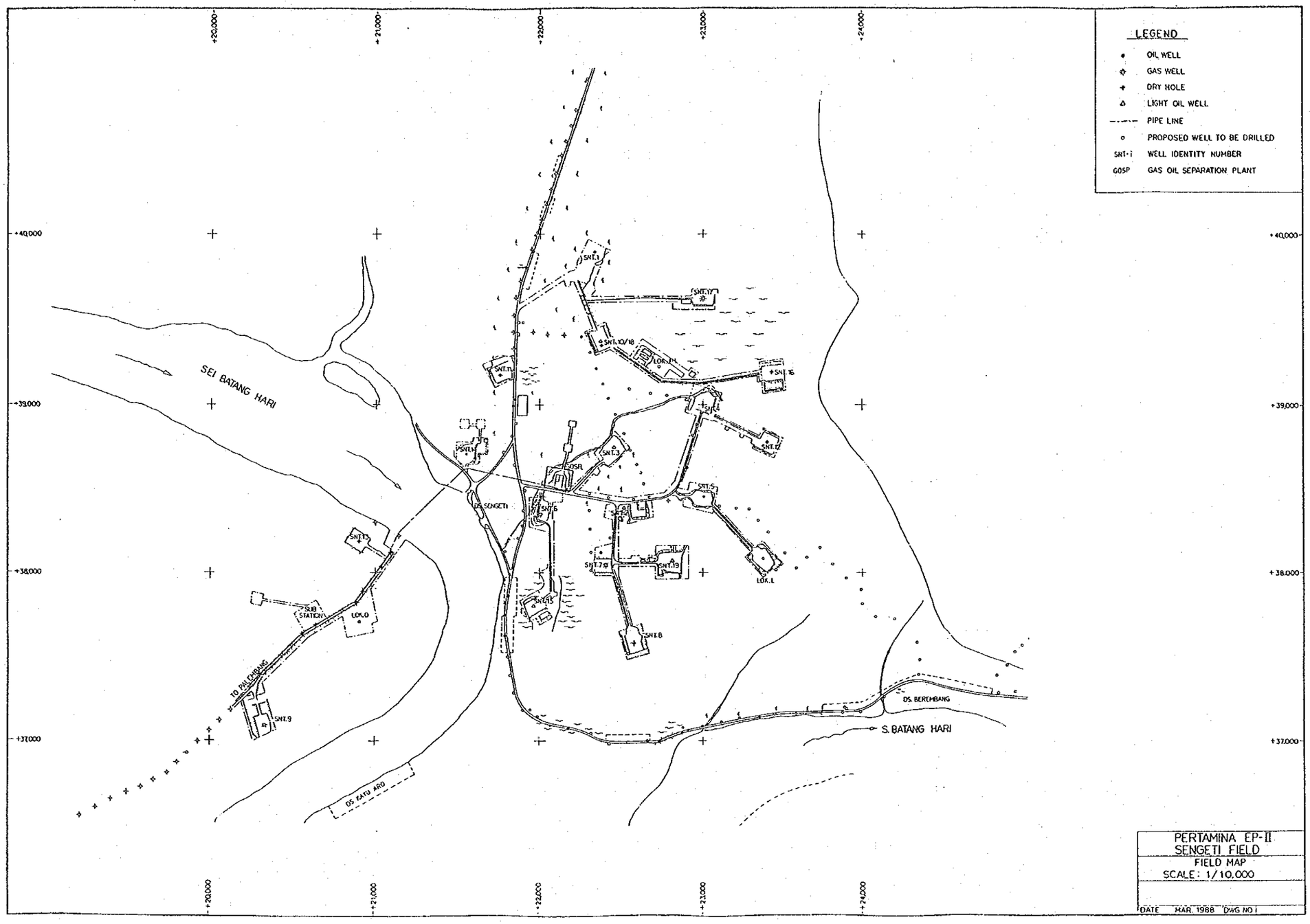
Summarized below in this chapter are the technical study results on the natural gas production at Sengeti district in the province of Jambi. At this stage of the project, however, data concerning the underground resources were not available to a sufficient detail for any complete technical study, as they belong to a confidential matter of PERTAMINA. Therefore, it should be noted that in its fundamental part the entire study stands on the assumptions and presumptions derived from sound engineering judgment.

5-1 Current Status of Sengeti Field

Sengeti oil/gas field, the operatorship of which is held by PERTAMINA, the national oil company of Indonesia, is located in Jambi mining area held by the company. The first discovery well, SNT-1, located 18 km north-northwest of the City of Jambi was drilled in October, 1971. 19 wells in total had been drilled by the year 1980, although seven of them were dry-holes. The production base is located on the left bank of the Batang Hari river represented as (X = +22,100, Y = +39,500) in Jambi UTM coordinates (Ref. Figure 5-1).

In Sengati field, oil and gas were produced from 1979 to 1982, but the production has been suspended. Also, in the vicinity of the City of Jambi a number of other oil/gas fields, such as Setiti, Kenari Asam, Gelam, Tempimo, and Bajubang, have been developed.

Figure 5-1 Well Location Map of Sengeti Field



5-1-1 Gas Reserves

As is shown in Figure 5-2, Sengeti field is located in the northern area of the South Sumatra Sedimentary Basin in the southern part of Sumatra Island. The main part of the stratigraphy of the sedimentary basin is Cenozoic Tertiary formation. The area of this sedimentary basin is about 150,000 km^2 and the thickness is 2,400 - 3,000 m. The major oil formation are found in Talang Akar quartz sandstone. In some limited areas, Air Benakat sandstone and Batu Raja limestone also form oil bearing formations. In regard to geological structure, there can be observed many faults and unconformities and there are a number of oil/gas fields of comparatively small scale in the basin.

In Sengeti field, there are ten target gas zones in Talang Akar sandstone formation. According to the data furnished by PERTAMINA, their total non-associated gas reserves are as follows;

1) Original Gas-in-Place : Approx. 1.51 x 10^9 m^3 (53.5 BSCF)
2) Recoverable Reserve : Approx. 1.44 x 10^9 m^3 (50.8 BSCF)
3) Cumulative Production : Approx. 0.11 x 10^9 m^3 (3.8 BSCF)
4) Remaining Recoverable Reserve : Approx. 1.33 x 10^9 m^3 (47.0 BSCF)

Other than the above, the original gas-in-place for associated gas is reported to be about 0.34 x 10^9 m^3 (11.9 BSCF), but other values such as remaining recoverable reserve are not given. Associated gas is the one which is dissolved in crude oil under a high reservoir pressure, and it is separated from the oil as the pressure is decreased at the surface. It is considered not appropriate to take account of the contribution of the associated gas to this project, due to the lack of data as mentioned above.

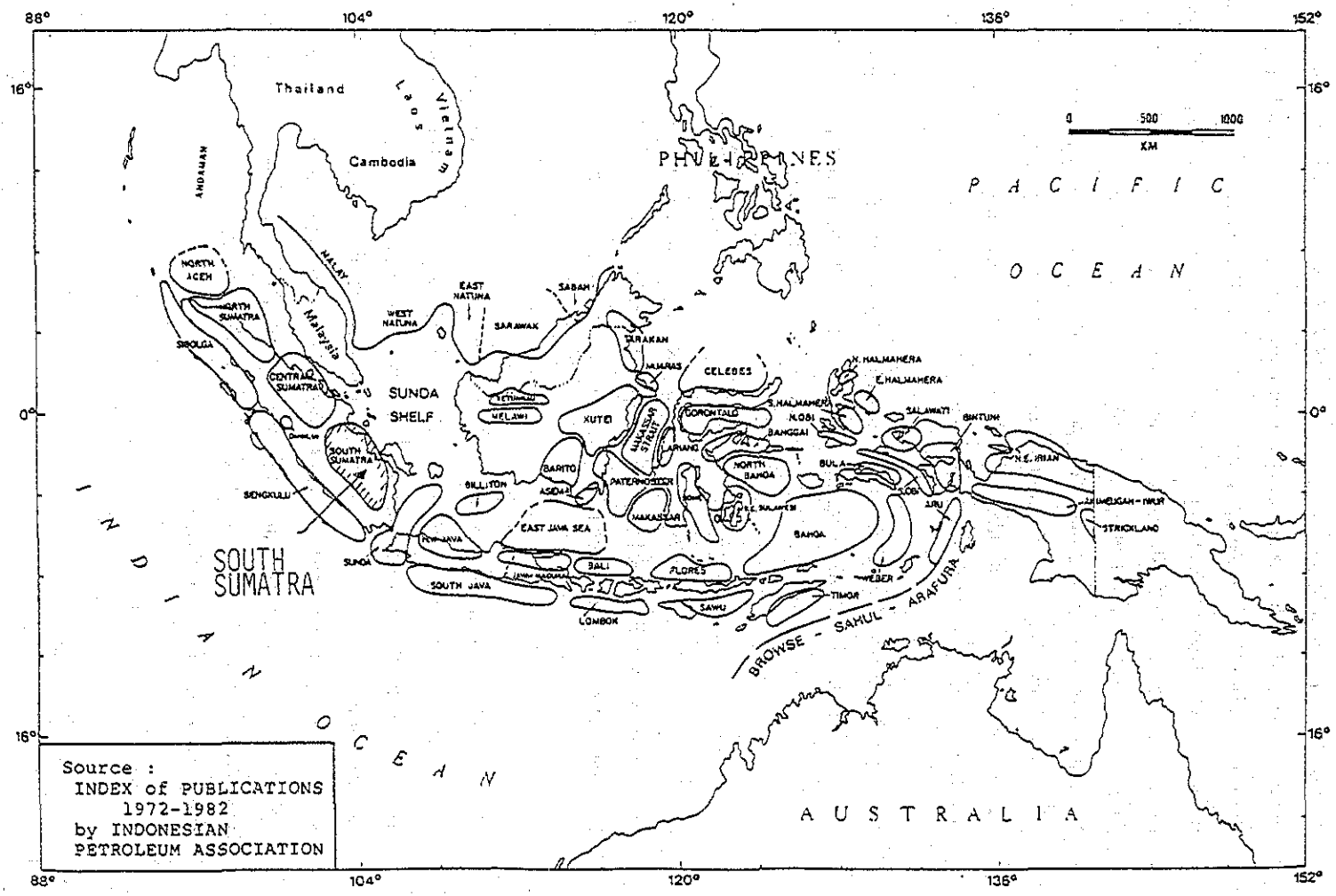


Figure 5-2 Basin Map of Indonesia

In the above data, the recoverable reserve is considered to be about 95% of the original gas-in-place. This figure also agrees with the PERTAMINA's information on the field life (15 years with daily gas production of 10 MMSCFD). In general, the recovery factor of gas reservoirs without water drive mechanism will range from 80 to 90% (50 to 80% for those with strong water-drive mechanism). Compared to this, the estimated recovery factor is rather high. As it can vary with such factors as separator operating pressures and wellbore pressure losses, it is quite possible that the actual recovery factor turns out to be less than the estimated 95%.

According to the production data over the past three years, the cumulative gas production is about 0.31×10^9 m^3 (10.9 BSCF), which greatly differs from the pre-listed figure. The difference could be attributed to the associated gas production, because the production at that time was aimed at the production of crude oil.

The remaining reserve (whole reserve remaining underground) at present can be obtained by subtracting the cumulative production from the original gas-in-place, and thus, it is to be about 1.40×10^9 m^3 (49.7 BSCF). The prediction of the natural gas reservoir behavior is conducted based on this figure. Since the gas production rate required for this project is comparatively small, the remaining reserve is considered to be sufficient in its amount (Ref. Section 5-2).

5-1-2 Production History

The 19 wells drilled from 1971 to 1980 were completed for the ten target zones in Talang Akar sandstone formation, and production test and fluid sampling/analysis of crude oil/gas condensate were conducted. Seven of them were dry-holes but the rest showed some oil/gas indications. It is not clear how many wells were able to be used for commercial production. According to the production test data in the period from 1979 to 1982, at least five wells (SNT-2, SNT-5, SNT-7, SNT-10 and SNT-15) seem to have possessed sufficient gas/condensate production capacity (Ref. Table 5-1).

Table 5-1 Latest Production Test Results

Well No.	Choke Beam size (mm)	Production Rates: Condensate (m^3) Gross	Condensate (m^3) Net	Gas ($\times 10^3 m^3$) *1 HP	Gas ($\times 10^3 m^3$) *1 MP	Gas ($\times 10^3 m^3$) *1 LP	Well Pressures (kg/cm^2G) *2 PC	PT	FL	Test Separator Pressures (kg/cm^2G) *1 HP	MP	LP	Test Dates
SNT-02	13	18.1	16.3	158.2	42.4	4.2	110	73	45	27	9	2.5	4 Feb. '82
03	13	0.7	0.7	-	-	12.2	30	25	-	-	-	-	28 Sep. '79
05	13	12.1	10.1	41.8	35.6	3.4	74	38	34	17	7	4.5	25 Nov. '80
07	13	15.3	13.9	107.7	37.1	6.1	89	69	29	19	10	6.0	20 Dec. '80
10	13	8.5	7.6	33.4	11.3	2.0	98	70	30	25	9	4.5	3 Feb. '81
15	7	6.3	3.5	45.9	18.4	9.7	128	123	19	17	10	4.0	15 Feb. '81

Prepared Date 30 August 1982
(Data Source by PERTAMINA)

Notes:

*1) Separator Pressure : HP = High pressure separator
MP = Medium pressure separator
LP = Low pressure separator

*2) Well Pressure : PC = Casing Pressure
PT = Tubing Pressure (at Tubing-top)
FL = Flow line Pressure (at Choke Outlet)

The production operation was started in March, 1979, but was suspended in February, 1982. The cumulative production over the three year period and the daily average production (from three wells at that time) just before the production suspension were as follows;

	Cumulative Production	Daily Average Production
Oil	37.9×10^3 kl (238 Mbbl)	19.5 kl/d (123 bbl/d)
Gas	306.7×10^6 m^3 (10.83 BSCF)	229.4×10^3 m^3/d (8.102 MMSCFD)

Although it is not possible to estimate the production history in this period merely from the above data, a typical example, which does not contradict the data, has been prepared as shown in Figure 5-3 for a reference purpose, assuming constant ratio decline for both oil and gas. The tendency, the decline of oil/condensate production rate and the increase of gas/oil ratio, shown in the assumed production history is considered to reflect the actual production history.

Since the separated gas was not utilized but burnt at the flare stack at that time, the operation must have been started with the aim of producing crude oil and condensate. However, with time, the gas/oil ratio increased remarkably, and the crude oil/condensate production decreased. This seems to have aggravated the development and production economy considerably. During this production period the crude oil spot price recorded the highest in the past. When the production was suspended, however, the price began to fall gradually and that of Arabian-Light fell below 30 US dollars per barrel.

The gas reserve conservation policy is given as the reason of production suspension, in addition to the gas/oil ratio increase. In other words, since continuation of production under the high gas/oil ratio would have resulted in the waste of substantial amount of gas at the flare stack, it seems to have been judged better to avoid this waste and to conserve the gas for effective utilization in the future.

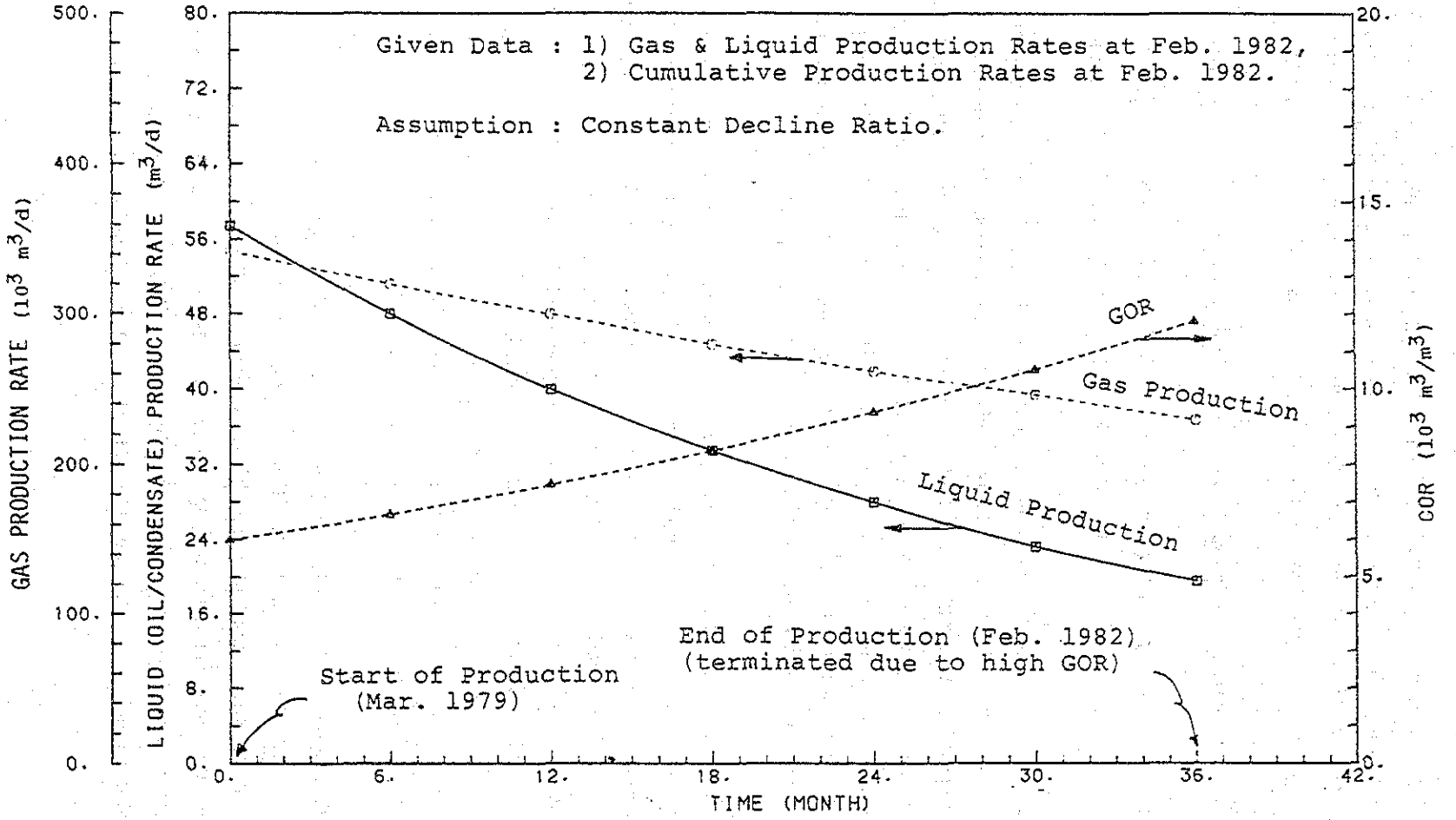


図５－３　　生産履歴（仮定）

Figure 5-3　Production History (Assumed)

5-1-3 Outline of Production Facilities

In this sub-section, the outline of the production facilities is described based on the existing conditions. The description of the process flow will follow that in the past production operation. It should be noted that, when the gas utilization program is implemented in this project, the process flow shall be slightly modified from that described below.

(1) Production Wells and Gathering Facilities

As described already, 19 wells in total were drilled at Sengeti field. Their locations are shown in Figure 5-1, and the well data are summarized in Table 5-2. As indicated in the table, seven wells were dry-holes. The other 12 production wells are completed with 2-7/8-inch (nominal size) tubing, and only SNT-6 is killed with mud.

The inlet manifold in the production base is designed for receiving 12 wells. These wells are connected to the production base by 4-inch pipeline called flowlines, individually. At the downstream of each wellhead is a short pipe (about 10 m) of about 2-inch in diameter. A check valve and a block valve (ANSI 300 PSI rating) are located in this section of the flowline.

After its pressure reduced and its flow rate adjusted by a choke equipped to the wellhead assembly, the well fluid flows into the inlet manifold through the flowline. Then, the well fluid flows into the test separator train (for measuring individual well production) or the production separator train, in which it is separated into oil and gas.

Table 5-2 Summary of Individual Well Data

Well Nos.	Flowline Length *1	Well Status *2	Producing Fluid *1	Manifold Connection *3
SNT-1	(1,900)	Dry-Hole		
SNT-2	400		Light Oil	Connected
SNT-3	500		Light Oil	Connected
SNT-4	1,200	Low press.	Oil	Connected
SNT-5	300		Gas	Connected
SNT-6	900	Killed	(Oil)	Connected
SNT-7	800		Gas	Connected
SNT-8	(1,200)	Dry-Hole		
SNT-9	2,700	Low press.	Gas	Connected
SNT-10	2,100		Light Oil	Connected
SNT-11	(1,000)	Dry-Hole		
SNT-12	(1,700)	Dry-Hole		
SNT-13	(1,500)	Dry-Hole		
SNT-14	700		Oil	
SNT-15	1,000		Light Oil	
SNT-16	(3,200)	Dry-Hole		
SNT-17	2,500	Low press.	Gas	
SNT-18	(2,100)	Dry-Hole		
SNT-19	1,100		Light Oil	Connected

Notes:

*1) Estimated from the field map (Figure 5-1).
Average flowline length excluding dry-hole wells: 1,200 m.

*2) Given by PERTAMINA.

*3) Connection observed from the field map (Figure 5-1).

(2) Gas Oil Separation Plant

Figure 5-4 shows the schematic flow diagram of the gas oil separation plant (hereafter called GOSP), which was drawn based on the information obtained during the site survey. A major equipment list is shown in Table 5-3. The names and tag numbers of the equipment are provided just for convenience and, therefore, are not official ones. A part of the equipment such as the oil transmission pumps and the power generator(s) were removed after the production suspension, and are being used in other fields.

Two separator trains are provided in the plant for gas and oil separation; one for test and the other for production. Each train is composed of three stages of gas liquid two-phase separators; high, medium and low pressure separators (hereafter called HP, MP and LP separators). A gas scrubber is equipped for each stage. At the downstream of these separator trains, a test tank and two storage tanks are provided.

Well fluid is collected at the inlet manifold and is sent to the test or production separator train. In each separator train the gas is separated from the oil, passes through the gas scrubbers, and is burnt at the flare stack. The oil is measured at the tank, and then is transported via oil pipeline by the oil transmission pump(s).

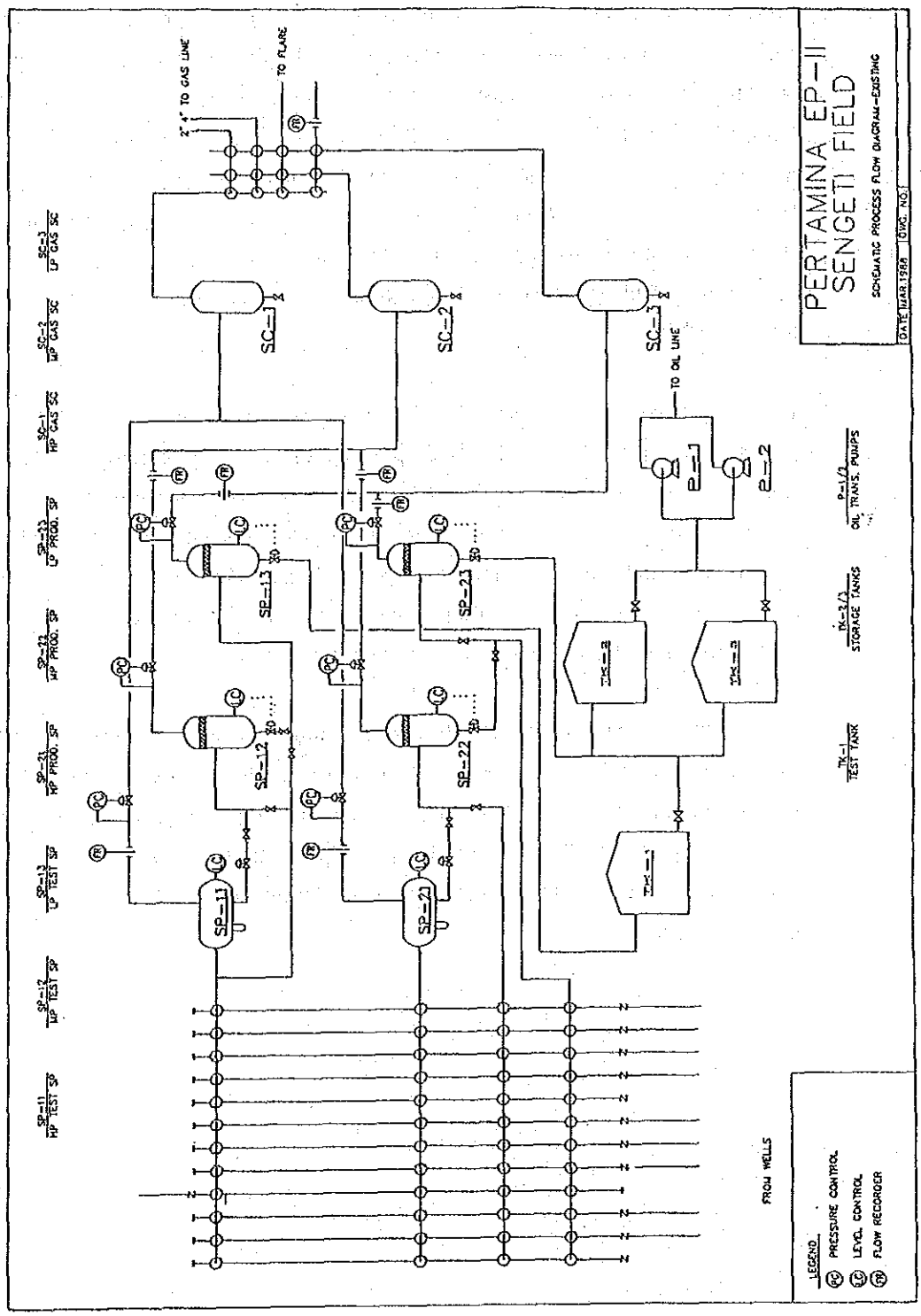


Figure 5-4 Schematic Flow Diagram of Existing Gas Oil Separation Plant

Table 5-3 Major Equipment List

Equipment No.	Equipment Name	Q'ty	Specifications
SP-11	High Pressure Test Separator	1	Design Press. = 550 psig, Volume = 11.5 ft^3
SP-12	Medium Pressure Test Separator	1	
SP-13	Low Pressure Test Separator	1	Design Press. = 142 psig, Temperature = 220°F
SP-21	High pressure Production Separator	1	Design press. = 1,000 psig, Volume = 21 ft^3
SP-22	Medium Pressure Production Separator	1	
SP-23	Low Pressure Production Separator	1	
SC-1	High Pressure Gas Scrubber	1	
SC-2	Medium Pressure Gas Scrubber	1	
SC-3	Low Pressure Gas Scrubber	1	
TK-1	Test Tank	1	
TK-2/3	Storage Tank	2	
P-1/2	Oil Transmission Pump	-	Removed
-	Power Generator	-	Removed
-	Fire Water Pump	-	Removed
-	Flare Stack	1	

(a) Inlet Manifold

The inlet manifold assembly consists of a test manifold and three production manifolds. This system has the function to change over the connection of each flowline to downstream by valve operation. Only one well is connected to the test separator train for production testing and the other production wells are connected to the production separator train. The three production manifolds are connected to the HP, MP, and LP production separators respectively, so that any well with low pressure can be directly connected to the MP or LP separator without passing through the HP separator.

(b) Test Separator Train

The test separator train is provided for measuring the production behavior and deliverability of individual wells. Production test for each well is periodically carried out, and the well selected for testing is connected to this train for a certain period. In usual tests, the amounts of produced gas and oil are measured at each of the HP, MP, and LP stages, and the pressure and temperature at the wellhead and the choke diameter are recorded at the same time. Gas, oil and water samples may be collected and analyzed occasionally.

The HP two-phase separator is a horizontal vessel mounted on a skid and equipped with a gas flowmeter, a liquid level control valve and a pressure control valve. The MP and LP two-phase separators are vertical liquid-cyclone type separators mounted on skids. They are also equipped with liquid level and pressure control valves. The train inlet piping from the manifold forks into two branch lines, which are directly connected to the upstream of the MP and LP separators.

In normal operation, well fluid flows into the HP two-phase separator and is separated into high pressure gas and liquid (containing oil and water). The separated gas is mixed with the gas separated at the HP two-phase production separator after being measured by the orifice flowmeter, and then is transmitted to the high pressure gas scrubber. The separated liquid is transmitted to the MP two-phase separator, and the evolved gas due to pressure reduction is again separated from the liquid. The separated gas is mixed with the gas separated at the MP two-phase production separator after being measured by the orifice flowmeter. The separated liquid, then, is further transmitted to the LP two-phase separator and is separated into gas and liquid. The separated gas is mixed with the gas separated at the LP two-phase production separator after being measured by the orifice flowmeter. The liquid separated at the LP two-phase separator is transmitted to the test tank and is measured there.

(c) Production Separator Train

Production separator train is provided for treating the producing fluid from all wells except a testing well. The HP two-phase separator is a horizontal vessel mounted on a skid and equipped with a gas flowmeter, a liquid level control valve and a pressure control valve. The MP and LP two-phase separators are vertical liquid-cyclone type separators mounted on skids. They are also equipped with liquid level and pressure control valves. As already mentioned in Item (a), the piping from the manifold is connected to each stage of the HP, MP, and LP separators.

In normal operation, well fluid flows into the HP two-phase separator and is separated into high pressure gas and liquid (containing oil and water). The separated gas is mixed with the gas separated at the HP two-phase test

separator, and then is transmitted to the high pressure gas scrubber. The separated liquid is transmitted to the MP two-phase separator and the evolved gas due to pressure reduction is separated from the liquid. Processing downstream is done in the same manner as in the test separator train, and the oil is finally transmitted to the storage tank.

(d) Gas Scrubber

The high, medium and low pressure gas scrubbers are provided to remove the liquid mist in the separated gas from each stage of both test and production separator trains.

(e) Tanks

For storage, settling, oil-water separation, and measurement of the oil after the gas separation, a test tank and two storage tanks are provided.

The test tank is mounted on a steel structure. The liquid processed through the test separator train is received by this tank, and is transferred into the storage tank(s) by gravity flow after measurement.

The storage tanks settle and store the oil from the test tank together with the liquid processed through the production separator train. While one of the tanks receives the fluid from the separator train, the other settles the liquid for oil-water separation. By the time the receiving tank becomes full, the separated water is drained out from the settling tank bottom, and the oil is shipped by the oil transmission pump(s). Then, the role of these two tanks is switched.

(f) Oil Transmission Pumps

Although two transmission pumps were installed for transporting the produced oil, they have been removed.

The oil in an oil storage tank is pressurized by the oil transmission pump and transmitted to the transporting pipeline, which is extended to the refinery in Palembang, after gathering crude oil from the oil fields of Setiti, Kenari Asam and other areas.

(g) Other Facilities

In addition to the above, the fire fighting facilities and the electric facilities for power generation and lighting were provided as utility facilities. Although some of the facilities were removed after the base operation was suspended, described in the following are the facilities utilized during the past production operation.

(i) Fire Fighting Facility

A 2-inch pipe is installed from the river near the operation base, and it seems that the water was supplied to five hydrants from a fire fighting pump. A hydrant is provided in each of the manifold area, the warehouse, and the tank yard area. The other two are located in the vicinity of the tank yard.

(ii) Power Generator

A gas-engine-driven generator was installed and supplied electricity to the oil transmission pump motors and the lighting, etc.