Chapter 8

Residential Gas Market

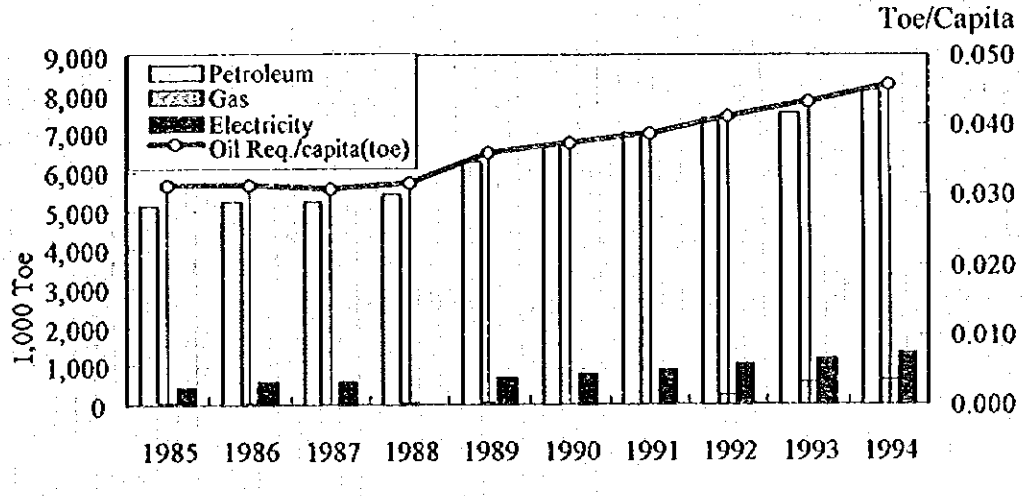
8. Residential Gas Market

8.1 Overview of Energy Consumption in the Residential Sector

8.1.1 Historical Trends of Energy Demand

In 1994, energy demand in Indonesia was 47.29 million toe (ton oil equivalent), with consumption of the residential sector accounting for 21.2% of the total. The annual growth rate of this sector's consumption was about 6.23% for the period 1985 to 1994, identical to the energy growth in industry during the same period. According to the IEA Energy Statistics and Balances table, the energy consumption per capita was 0.047 toe in 1994 (See Fig. 8-1-1)

Fig. 8-1-1 Energy Demand in the Indonesia Residential Sector



Source: IEA Energy Statistics and Balances of Non-OECD Countries 1985 to 1994

The number of households in 1994 was 40.86 million. Energy consumption per household was 0.64 toe including non-commercial energy. This figure is equal to about 1/4 to 1/5 of Japan's consumption for the same year.

According to Repelita VI (from 1994 to 1998), the industrial sector will continue to account for the bulk of energy demand growth in the latter half of the 1990s (at an annual rate of 13.6%), followed by the transportation (8.7%) and household (5.7%) sectors. The expected average annual rate of increase in total energy demand during this period is 9%.

PGN expects natural gas consumption in the residential and commercial sectors to grow at a rate of around 30% per year up to 2000 and 15% per year between 2000 to 2010.

8.1.2 Present Situation of Fuel Demand in the Residential Sector

(1) Structure of fuel demand

In Indonesia, the bulk of household fuel demand is mainly accounted for by home cooking. Table 8-1-1 shows the fuel-mix for cooking by source in both urban and rural households. The table indicates different fuel sources in each household, i.e., urban households depend on kerosene as a major fuel source, while rural households on firewood. Looking at energy sources for cooking in urban households, the whole of Indonesian urban households are accounted for by kerosene at 66%, followed by firewood 16%, and urban gas & LPG (hereinafter lumped together as "gas") 10%. On the other hand, households in DKI Jakarta depend on kerosene for 72% of total fuel consumption and on gas for 19%.

Table 8-1-1 Fuel-Mix for Cooking by Source

1994 (Unit :%)

Urban	Electricity	Gas/LPG	Kerosene	Firewood	Charcoal	Others	Total
DKI Jakarta	5.85	19.34	72.00	0.30	0.60	1.92	100
Jawa Barat	6.28	12.30	73.19	6.84	0.36	1.02	100
Indonesia	5.73	10.47	65.91	16.21	0.47	1.21	100
Rural	**Electricity**	**Gas/LPG**	**Kerosene**	**Firewood**	**Charcoal**	**Others**	**Total**
DKI Jakarta	-	-	-	-	-	-	-
Jawa Barat	3.71	0.56	7.47	87.67	0.15	0.43	100
Indonesia	2.85	0.71	14.37	81.37	0.36	0.33	100
Total	**Electricity**	**Gas/LPG**	**Kerosene**	**Firewood**	**Charcoal**	**Others**	**Total**
DKI Jakarta	5.85	19.34	72.00	0.30	0.60	1.92	100
Jawa Barat	5.03	5.27	49.18	39.74	0.21	0.58	100
Indonesia	3.85	4.10	32.24	58.78	0.40	0.63	100

Source: Housing and Settlement Statistics 1995

(2) Fuel-Mix for Cooking by Household Expenditure

Table 8-1-2 shows inter-relation between monthly urban household expenditure and cooking fuel sources. This table indicates that 42% of the households with expenditures over 500,000 Rupiah depend mainly on gas, while households with expenditures less than 40,000 Rupiah hardly depend on gas. This table suggests that the choice of energy source is inter-related with the economic level of household.

Table 8-1-2 Fuel-Mix For Cooking by Monthly Expenditure (1994)

Urban Area (Unit: %)

Monthly Expenditure Range Rupiah	Electricity	Gas/LPG	Kerosene	Firewood	Charcoal	Others
<30,000	-	-	29.11	69.03	-	1.86
30,000 - 39,999	2.51	-	45.33	52.16	-	-
40,000 - 49,999	5.96	0.84	32.81	55.72	-	4.67
50,000 - 74,999	4.42	0.75	42.46	50.45	0.98	0.95
75,000 - 99,999	5.99	0.54	47.15	42.36	0.65	3.31
100,000 - 149,999	5.89	0.96	58.23	32.23	0.40	2.29
150,000 - 199,999	5.18	1.37	68.28	23.25	0.21	1.71
200,000 - 299,999	6.35	3.76	74.50	13.98	0.26	1.15
300,000 - 399,999	6.32	9.46	75.52	7.70	0.38	0.61
400,000 - 499,999	4.68	19.59	69.87	4.63	0.68	0.54
>500,000	5.15	41.63	49.75	2.07	1.14	0.26
Indonesia	5.73	10.47	65.91	16.21	0.47	1.21

Source: Housing and Settlement Statistics 1995

Rural Area (Unit: %)

Monthly Expenditure Range Rupiah	Electricity	Gas/LPG	Kerosene	Firewood	Charcoal	Others
<30,000	2.39	-	-	94.72	1.13	1.75
30,000 - 39,999	0.98	-	3.01	93.90	-	2.10
40,000 - 49,999	1.69	0.25	3.33	94.21	-	0.52
50,000 - 74,999	2.05	0.08	5.05	92.06	0.13	0.64
75,000 - 99,999	2.47	0.07	5.86	91.13	0.16	0.30
100,000 - 149,999	2.35	0.25	9.85	87.08	0.24	0.23
150,000 - 199,999	2.74	0.37	14.00	82.26	0.39	0.24
200,000 - 299,999	3.80	0.56	22.98	71.60	0.66	0.40
300,000 - 399,999	3.96	2.97	33.62	58.60	0.50	0.36
400,000 - 499,999	5.32	7.11	38.79	47.61	1.09	0.09
>500,000	4.92	12.87	42.38	39.66	0.18	-
Indonesia	2.85	0.71	14.37	81.37	0.36	0.33

Source: Housing and Settlement Statistics 1995

8.2 Methods and Results of the Survey

8.2.1 Methods of the Survey

In this study, questionnaire and interview surveys were conducted in addition to collecting and analyzing statistical data on energy consumption. The results of this

Table 8-1-2 Fuel-Mix For Cooking by Monthly Expenditure (1994)

Urban Area

(Unit: %)

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30,000 - 39,999	2.51	-	45.33	52.16	-	-
40,000 - 49,999	5.96	0.84	32.81	55.72	-	4.67
50,000 - 74,999	4.42	0.75	42.46	50.48	0.98	0.95
75,000 - 99,999	5.99	0.54	47.15	42.36	0.68	3.31
100,000 - 149,999	5.89	0.96	58.23	32.23	0.40	2.29
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Source: Housing and Settlement Statistics 1995

8.2 Methods and Results of the Survey

8.2.1 Methods of the Survey

In this study, questionnaire and interview surveys were conducted in addition to collecting and analyzing statistical data on energy consumption. The results of this

survey were used as the basis for forecasting urban gas demand.

In DKI Jakarta, many residential estates were developed and are proceeded under laild development plan to result in population concentration to DKI Jakarta. Estates are particularly concentrated in south of Tangerang, West of Bekasi and South West of Jakarta. As the result, the population density is increasing in the regions above and three regions were selected for this study.

Following discussions with PGN, questionnaire sheets were distributed among 45 study areas considering the characteristic of each region (income level, family size, type of house, etc.). An overview of the results of the survey is provided in Table 8-2-1. Details are attached in the Appendix of this report.

For the interview survey of 207 families in 33 districts, research on consumption of fuels and electricity and energy using equipment was made, and the possibility of using urban gas was also discussed with each family. The results are shown in Table 8-2-2. Details are attached in the Appendix of this report.

The interview survey was divided into five income levels because there is a big difference in energy consumption between each income level in Indonesia. Table 8-2-3 shows distribution of the interview survey by income group.

Table 8-2-1 Results of Questionnaire Survey

1. Average of Fuel and Electricity Consumption				
Total Fuel Consumption per Capita per Year			kcal	759,587
Total Electricity Consumption per Capita per Year			kWh	1,608
Total Fuel Consumption per Family per Year			kcal	3,545,891
Total Electricity Consumption per Family per Year			kWh	7,135
2. Average Fuel Consumption by Source				
LPG Consumption per Month per Household			Kg	22.74
Kerosene Consumption per Month per Household			Ltr	40.76
Urban Gas Consumption per Month Per Household			m^3	30.50
3. Sampled Households				
Average Size of Families Sampled			Person	4.48
Number of Sampled Households			Family	1,050
4. Average Fuels and Electricity Consumption per Month per Household by Income Group				
Income	N. Sample			
<200,000 Rp	125	Fuel	kcal	215,602
		Electricity	kWh	121
>200,000 & <400,000	257	Fuel	kcal	241,774
		Electricity	kWh	158
>400,000 & <1,000,000	258	Fuel	kcal	244,617
		Electricity	kWh	291
>1,000,000&<5,000,000	283	Fuel	kcal	332,703
		Electricity	kWh	903
>5,000,000	67	Fuel	kcal	435,875
		Electricity	kWh	1,649
Missing	60			
5. Price of Fuels and Electricity				
Electricity			Rp/kWh	120
LPG			Rp/Kg	1,000
Kerosene			Rp/Ltr	400
Urban gas			Rp/m^3	300
6.Unit Conversion Table				
LPG			*1kg = 11,220 kcal*	
Kerosene			*1ltr = 8,840 kcal*	
Urban gas			*$1m^3$ = 8,800 kcal*	

Source: Household Survey by JICA Team, 1996

note) * This thermal value for LPG was used in an earlier stage of the Study. Normal value is 19,000~12,000kcal/kg; see appendix

Table 8-2-2 Results of Interview Survey

1. Average of Fuel and Electricity Consumption		
Total Fuel Consumption per Capita per Year	kcal	704,181
Total Electricity Consumption per Capita per Year	kWh	951
Total Fuel Consumption per Family per Year	kcal	3,254,952
Total Electricity Consumption per Family per Year	kWh	4,728
2. Average Fuel Consumption by Source		
LPG Consumption per Month per Household	Kg	22.57
Kerosene Consumption per Month per Household	ltr	26.93
Urban gas Consumption per Month Per Household	Nm3	26.04
3. Sampled Households		
Average of Size of Family Sampled	Person	4.64
Number of Sampled Households	Family	207
4. Distribution of Interview Survey		
DKI Jakarta	Location	4
Bekasi	Location	10
Tangerang	Location	19

5. Results of Principal Answers to Questions

Question	Results of Principal Answers
1. Why do you use LPG?	It is easy to get (89), is cheaper than other fuels (12), cooking with LPG is faster (34), is not dirty (57), others (11).
2. Do you want change to LPG from urban gas?	Yes (78), Yes, if cheaper than LPG (35), No(4).
3. Why do you use kerosene?	It is easy to get (55), is cheaper than other fuels (12), cooking with kerosene is faster (1), others (5).
4. Do you want substitute urban gas for kerosene?	Yes (62), Yes, if cheaper than LPG (11), No(2).
5. Why do you use urban gas?	Urban gas is cheaper than other fuels (23), urban gas does not dirty (15), was already connected (7)
6. Do you want to change from urban gas to LPG?	No(23)
7. Why do not you use urban gas?	Not yet available (184), afraid it would cause fires (3)

6.Unit Conversion Table	
LPG	*1kg = 11,220 kcal*
Kerosene	*1ltr = 8,840 kcal*
Urban gas	*1Nm3 = 8,800 kcal*

Source: Household Survey by JICA Team, 1996

Table 8-2-3 Distribution of Interview Survey by Income Group

Ranking Definition	Income Range (Rp)	Number of Household	Share (%)
Low Income	< 200,000	19	9
	200,000-400,000	75	36
Middle Income	400,000-1,000,000	61	29
	1,000,000-5,000,000	25	12
High Income	>5,000,000	27	13
	Total	207	100

Source: by JICA Team

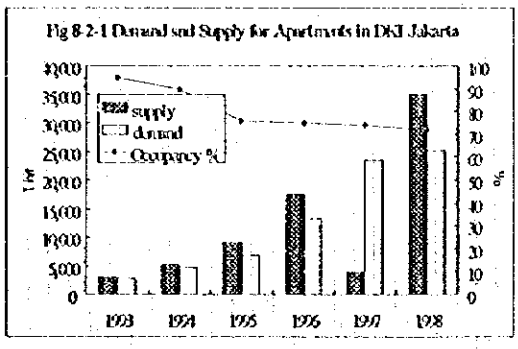
8.2.2 Characteristics of the Study Region

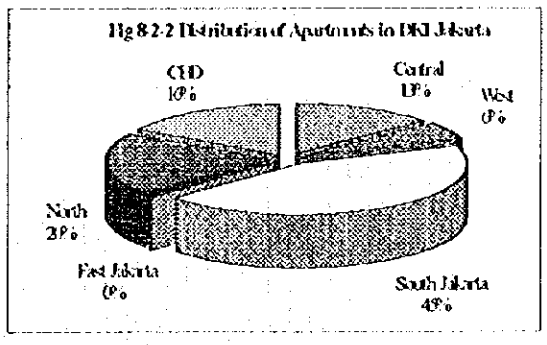
(1) DKI Jakarta

Since high demand for housing cannot be met by the available land specifically allocated for housing in the center of city , the government of DKI has allocated a fund of almost Rp. 60.6 billion for constructing seven blocks of apartments in three locations for the year 1996/97.

According to the data collected by Indonesia's Center for Property Data (PDBI) in Jakarta, there will be 138 high-rise apartment projects with capacity of 35,079 units by 1997/98. Within a period of 5-6 years, there will be a supply of apartments in Jakarta totaling 32,775 units, or an increase of almost 1,500 percent (See Fig.8-2-1).

Of the supply of apartments for mid-high income families by the end of 1995, 44.2% are in South Jakarta and 16.4 % in North Jakarta (See Fig. 8-2-2), and there are 17,959 (about 55%)apartment units for low-income families in North Jakarta .





Source: Indonesia's Center for Property Data (PDBI)

To specifically address the demand for apartments for low-income families, the Office of State Minister for Public Housing suggested the concept "1:2:3" i.e., apartment unit for high-income family should simultaneously be constructed with two apartment units for mid-income families and three apartment units for low-income families. Therefore if in 1998 there are 35,000 or apartment units for more high-mid-income families, about 100,000 or apartment units for more low-income families will have been developed at the same time.

(2) Bekasi and Tangerang Kabupaten (prefecture)

We considered giving priority to the two prefectures of Bekasi and Tangerang , rather than downtown Jakarta in the selection of a district. Although many residents live down town, this number will be reduced as economic development proceeds and re-development takes place. In addition, residential buildings in down town are rather scattered, and may be disadvantageous when laying pipelines.

8.2.3 Results of the Survey

(1) Results of the survey of potential urban gas customers based on income level

1) High-income families

High-income families accounted for13% of the sample. Per household income in this level was more than five million Rp per month (about 2,500US$). Most of houses are constructed privately, and are generally 2-3 floor stand-alone buildings with private parking space. Dwelling floor space covers over 120m², and the distance between houses is about 30 m. Both of bathroom and a toilet are located on each floor, and air conditioners are installed in the rooms. Two percent of total surveyed families utilize solar or electric water heaters while two families use LPG water heaters.

Electricity consumption per household averages 1,527 kWh/month. LPG was used by all high-income families surveyed this time. Average of 52 kg of LPG is consumed by the families every month. The number of persons in each family averages 5.2. Generally, those families employed 1 to 2 housemaids. If a family earns a higher income (more than Rp.20 million), special security personnel and a driver are also employed. These persons are included in calculating per capita fuel consumption and electricity consumption.

2) Mid-income families

Mid-income families accounted for 42% of the samples. Government employees constitute the majority of this level. Most of the middle-income residential districts were developed by the government and only a few were done by private companies. Average monthly income is from Rp.400 thousand to Rp.2 million.

The structure of residential house usually consists of two bedroom, a bathroom with toilet. They often take cold water shower. Basically, no space is left between two buildings. And the distance from front of building to back is less than 3 or 4m.

In terms of owned electric appliances, 96.8% of families own color televisions and refrigerators. Roughly 17.7% of the total sample owns air-conditioners and only 6.5% own hot water baths. As for the fuel consumption component, LPG is used by 78% of families. The remaining 18.5% families consume kerosene. It was noted that 19% of families uses both LPG and kerosene for cooking from economical stand point of view (as the price of LPG is higher than kerosene:Rp.1,000/1kg LPG and Rp.400/1ltr Kerosene).

Average electricity consumption is 342 kWh/month, and LPG consumption is 22.5kg/month (by each family an average of 4.36 persons). Some of household employ one housemaid (which accounts for 30.5% of total interview survey).

3) Low-income families

Low-income families accounted for 43.5% of the samples. Employees of small family enterprises or self-employed individuals make up the bulk of this group, with average monthly income being about Rp.0.2 million. A great part of residences of this group face streets and are rented. Some of residents also live in the house constructed by the government. The structure of houses is rather simple. Many have the kitchen and bed in the same room. Some have toilets inside. The distance from front to back is quite small. Some persons live in simply constructed buildings. Double layer beds are often used by families with many children.

Concerning the use of electric appliances, 92.2% of families own a color television while 72.5% of families have single-door refrigerator. 68% of fuel consumed is kerosene for cooking use while 32% is LPG. Electricity consumption and LPG consumption in this group average about 150 kWh/month and 21.4 kg/month respectively with each family made up of 4.57 persons.

(2) Results of the survey of existing urban gas customers based on income level

Existing urban gas users were also included in the interview survey, and the results were classified as follows:

1) High-income families

The survey for this level was mainly carried out by consulting housemaids. As a result, only data on urban gas consumption and electricity consumption could be obtained. Monthly, average of 85 m^3 urban gas is consumed, while electric power consumption is about 1,850 kWh .

2) Mid-income families

We only had five sample families in this group. They live in well-decorated houses with high quality electricity appliance. One family among five has air conditioner. The number of persons in a family is 4.56 persons in the average. Average electricity consumption and average urban gas consumption per month for this level are 640 kWh and 58 m^3 respectively. The reason behind such heavy urban gas consumption is that one of the families surveyed runs a catering business. Excluding energy consumed by this family, urban gas consumption averages about 25.8m^3/month.

3) Low-income families

The rate of ownership of electric appliances is similar to the low-income level families mentioned earlier. Urban gas consumption averages about 18.5m^3 per month for this particular group.

(3) Reflections from Actual and Potential Gas Users

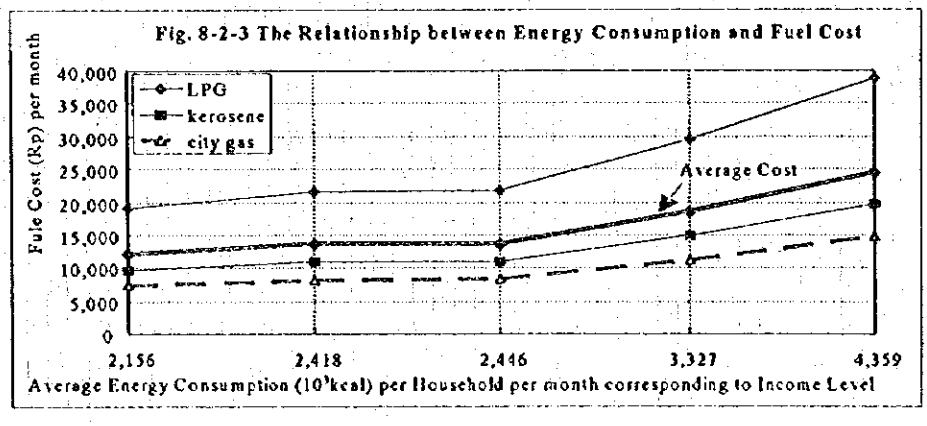
1) More than 98.5% of sampled households indicated a desire to use urban gas. Preparation by PGN may have partly affected this result; however, It is estimated that urban gas has vast market potential with not standing the influence of PGN ;

2) Actual and potential users worry about the supply reliability of urban gas. They are particularly concerned about gas cut off just as they are with electric power failures.

3) Potential users worry about initial costs (at least 90,000Rp, according to PGN staff) if they have no access to credit.

4) Figure 8-2-3 shows the relationship between energy consumption and fuel cost by income group. This figure shows urban gas to be lower than other fuels. Many families, especially in the middle and low income levels, have expressed interest in shifting to urban gas since its price (370Rp/m^3) is lower than that of LPG .

Fig. 8-2-3 The Relationship between Energy Consumption and Fuel Cost



Source: Household Survey by JICA Team 1996

5) 77% of families express an doubtful of safety on LPG treatment(LPG bottles are often located too close to a stove in residences of middle and low income families) and looking forward to shift to urban gas.

6) In the survey, many LPG users identified existing problems related to LPG supply, such as quality and quantity. For instance, the standard volume of one bottle of LPG is marketed as containing 12kg, but when users open it, only 10-11kg, and sometimes even 9kg, is in the bottle.

8.2.4 Characteristics of Energy Consumption in the Residential Sector

(1) Using the results of the questionnaire and interview surveys, the present situation of the energy demand is summarized in Table 8-2-4.
As shown in this table and Fig.8-2-5, high-income families(per household income in this level is more then 5 million Rupiah monthly), electricity consumption per household averages 1,527 kWh/month. Gas is consumed by families at an average of 335Mcal monthly. For low-income families (per household income in this level is less than 20 thousand Rupia monthly), electricity consumption per household averages 1,527 kWh/month. Fuel consumption per household averages 245Mcal monthly. LPG is used by 21% of families.

The actual rate of penetration of LPG is now at less than 50% in the Jakarta area according to the result of the survey (this figure is much higher than statistics released by the government). Even if the factor of sample selection is adjusted, the rate of LPG penetration is nearly 30% to 40%. Based on this figure as well as the number of families and average energy consumption per household, 262ktoe(thousand ton oil equivalent, assuming 35% penetration) of LPG is expected be consumed in this region annually.

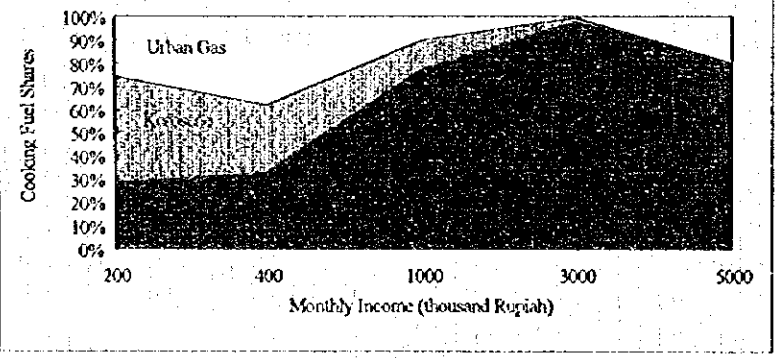
It is fairly easy to obtain LPG and kerosene due to the low overhead expense. Thus, it is very easy to select a fuel since the only consideration is economic.

Table 8-2-4 Results of Questionnaire Survey and Interview

Questionnaire Survey						
Monthly Income Range Thousand Rupia	Sample Size	Fuel Consumption per Household	Electricity Consumption Per Household	Share of each fuel		
				LPG	Kerosen	Urban Gas
		kcal	kWh	%	%	%
<200	125	215,602	121	28.45	45.69	25.86
>200 and <400	257	241,774	158	32.78	29.46	37.76
>400 and <1,000	258	244,617	291	76.92	12.82	10.26
>1,000 and <5,000	283	332,703	903	97.62	1.98	0.40
>5,000	67	435,875	1,649	80.00	0.00	20.00
Interview Survey						
Monthly Income Range Thousand Rupia	Sample Size	Fuel Consumption per Household	Electricity Consumption Per Household	Share of each fuel		
				LPG	Kerosen	Urban Gas
		kcal	kWh	%	%	%
<200	19	245,287	150	21.05	57.89	21.05
>200 and <400	75	269,874	160	40.00	53.33	6.67
>400 and <1,000	61	255,004	233	73.77	21.31	4.92
>1,000 and <5,000	25	266,356	450	88.00	12.00	0.00
>5,000	27	334,549	1,527	59.26	0.00	40.74

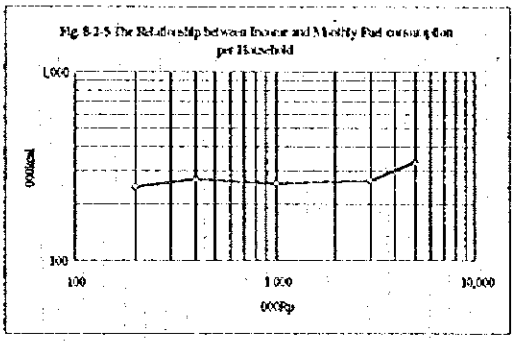
Source: By JICA Team

Fig. 8-2-4 Share of Cooking Fuel by Income Group

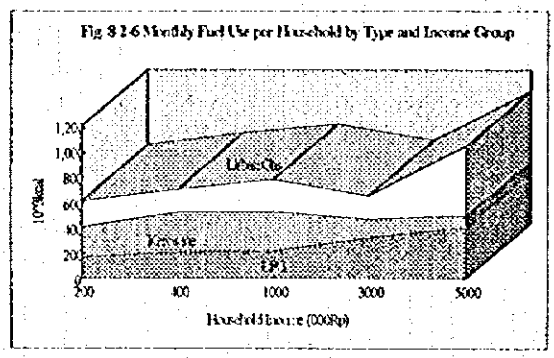


Source: Household Survey by JICA Team 1996

(2) Average fuel use per household in energy content (kcal), is shown in Figure 8-2-5. Comparing high-income and low-income households, fuel consumption varies significantly. In the high-income range, fuel consumption per house averages about 335Mcal monthly, but in the low-income range only 245Mcal is consumed. Fuel consumption of the high-income households is about 1.4 times larger than that of low-income families (See Fig. 8-2-5, Fig. 8-2-6).

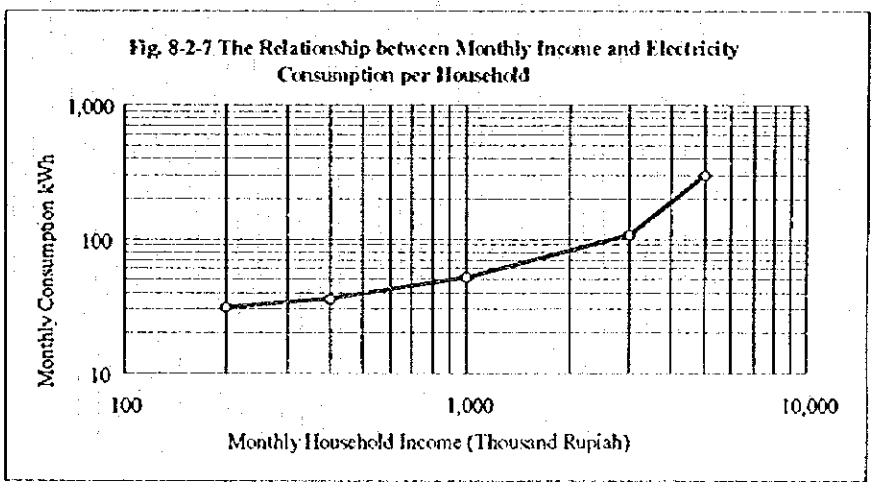


Source: Household Survey by JICA Team, 1996



Source: Household Survey by JICA Team, 1996

(3) Table 8-2-5 shows the rate of electric appliance possession based on family income. For low-income families, lighting accounts for half of electric use, but for high-income families, other electric appliances consume more electricity. Comparing high-income and low-income households, total electric consumption of high-income households is about ten times larger than that of low-income families(See Fig. 8-2-7).



Source: Household Survey by JICA Team, 1996

Based on the interview survey, the following characteristics of energy consumption were derived:

- Hot water shower is seldom used due to the local climate, and thus has no relationship with income level.

- Families usually cook only one meal a day between 4-6 o'clock in the morning, as most parents go to work. In the evening, they only heat up the meal which was prepared in the morning. As a result, fuel is used heavily used in the morning.

- Children go to school either in the morning or in the afternoon. Lamps, televisions and refrigerators are the only appliances accounting electricity consumption among the low and mid-income families.

- Local people have a habit of drinking tea. This being the case, water heating is also a major component in fuel consumption.

Table 8-2-5 Percentage of Ownership of Selected Electric Appliances by Income Group

Item	Very Low Income		Low Income		Middle Income		High Income		Very High Income	
	Ownership	%	Ownership	%	Ownership	%	Ownership	%	Ownership	%
Rice Cooker	2	10.53	18	24.00	32	52.46	13	52.00	19	70.37
Oven	1	5.26	5	6.67	7	11.18	3	12.00	7	25.93
Iron	18	94.74	67	89.33	60	98.36	25	100.00	27	100.00
Color TV	15	78.95	69	92.00	58	95.08	25	100.00	27	100.00
Refrigerator	10	52.63	49	65.33	49	80.33	24	96.00	26	96.30
Air Condition	0	0	4	5.33	6	9.84	11	44.00	20	74.07
Water Heater	0	0	0	0	2	3.28	4	16.00	13	48.15
Washing Machine	0	0	11	14.67	17	27.87	9	36.00	14	51.85
Lamp	19	100	75	100	61	100	25	100.00	27	100.00
Tape Record	14	73.68	49	65.33	49	80.33	20	80.00	23	85.19
Video	1	5.26	6	8.00	15	24.59	10	40.00	14	51.85
Fan	12	63.16	63	84.00	56	91.80	18	72.00	21	77.78
Toaster	0	0	2	2.67	5	8.20	4	16.00	4	7.41

Source: Interview Survey by JICA Team 1996

Note: Very Low Income :<200,000Rp per month

Low Income: >200,000Rp and <400,000Rp per month

Middle Income: >400,000Rp and <1,000,000Rp per month

High Income: >1,000,000Rp and <5,000,000Rp per month

Very High Income: >5,000,000Rp per month

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Item	Very Low Income		Low Income		Middle Income		High Income		Very High Income	
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Rice Cooker	2	10.53	18	24.00	32	52.46	13	52.00	19	70.37
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Iron	18	94.74	67	89.33	60	98.36	25	100.00	27	100.00
Color TV	15	78.95	69	92.00	58	95.08	25	100.00	27	100.00
Refrigerator	10	52.63	49	65.33	49	80.33	24	96.00	26	96.30
Air Condition	0	0	4	5.33	6	9.84	11	44.00	20	74.07
Water Heater	0	0	0	0	2	3.28	4	16.00	13	48.15
Washing Machine	0	0	11	14.67	17	27.87	9	36.00	14	51.85
Lamp	19	100	75	100	61	100	25	100.00	27	100.00
Tape Record	14	73.68	49	65.33	49	80.33	20	80.00	23	85.19
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Very High Income: >5,000,000Rp per month

8.3 Forecasting Energy Demand by the Residential Sector

8.3.1 Methodology of Forecasting Demand

There are two main methodologies for forecasting energy demand, namely, one called the engineering methodology, which is basically a bottom-up approach forecasting on energy efficiency and specific energy consumption, and econometrics, which uses macro energy indexes.

(1) Engineering Approach

Engineering models focus on the various uses of energy in each sector. In the residential sector, each major energy-using activity – cooking, space cooling, etc. – is identified and the corresponding energy consumption is specified.

The basic structure of an Engineering forecasting model centers around the relationship:

Energy Consumption by End Use = Number of Users in End Use × Energy Consumption Unit

Repeating this equation for the major end uses of gas in the residential, commercial, and industrial sectors, and summing up the results thus yields the energy requirements of the entire system.

The engineering approach has a strong appeal because energy consumption is directly associated with uses of energy, but it needs many kinds of data and is often subjective because of the many assumptions that have to be made. Also, it focuses only on physical factors and tends to overlook the emergence of new end uses and misses some other very important effects, such as the impact of rising energy prices as a stimulus to conservation.

(2) Econometric Approach

The econometric approach combines economic theory and statistical techniques to produce systems of equations for forecasting energy demand. The approach starts with estimating causal relationships between energy consumption – the dependent variable – and factors influencing consumption – the independent variables. The relationships are estimated by applying the ordinary least-squares method or other more sophisticated methods by the use of time-series or pooled data. Once a relationship has been established, inserting forecasts of independent variables into this equation yields projections of the dependent variable.

A primary advantage of the econometric approach is that it allows for the explicit

evaluation of separate impacts of changing factors, such as energy prices, net income, population, economic activity, and other independent variables on the dependent variable – like gas consumption. The econometric approach, therefore, is particularly useful in objectively evaluating the likely consequences of various policy options, provided, of course, that elements of such policy options have been correctly included as independent variables in the construction of econometric forecasting models.

A basic disadvantage of the econometric approach is the necessary and often implicit assumption that the relationships in historical time-series data and or cross-sectional data will remain unchanged in the future.

8.3.2 Model for Forecasting Energy Demand

In this study, Econometric approach was used for forecasting energy and urban gas demand.

(1) Framework of model

Basic framework of urban gas demand forecast is as follows:

- Forecasting scope: By region
- By-region economic scenarios: Low case Base case High case
- Period: Base year 1995 Target year 2020

(2) Scenario Setting

The model is simulated in three cases which are (a) Base case, (b) High case, and (c) Low case. Exogenous valuables are shown in the table 8-3-1.

Table 8-3-1 Scenario Setting

(unit: %, person)

	until 2000	2001-2010	2011-2020
	5.0	2.5	2.5
	8.1	8.3	10.3
	7.7	7.6	7.9
	7.3	6.7	5.3

Source: by JICA Team

1) Economic Indicator

In the base case, the economy of DKI Jakarta region will grow at an average of 7.7%/year for the period 1995-2000, 7.6% in the next ten years, and 7.9% over the longer-term. On the average, the economy will rise 7.7%/year for the period 1995-2020. GRDP of DKI Jakarta in real terms is expected to expand from Rp59.56 trillion in 1995 to Rp384 trillion in 2020. GRDP size of Bekasi and Tangerang (in constant

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The model is simulated in three cases which are (a) Base case, (b) High case, and (c) Low case. Exogenous valuables are shown in the table 8-3-1.

Table 8-3-1 Scenario Setting

(unit: %, person)

	av.annual 2000/1995	av.annual 2010/2000	av.annual 2020/2010
Population Growth Rate	5.0	2.5	2.5
GRDP Growth Rate			
High Case	8.1	8.3	10.3
Base Case	7.7	7.6	7.9
Low Case	7.3	6.7	5.3

Source: by JICA Team

1) Economic Indicator

In the base case, the economy of DKI Jakarta region will grow at an average of 7.7% year for the period 1995-2000, 7.6% in the next ten years, and 7.9% over the longer-term. On the average, the economy will rise 7.7% year for the period 1995-2020. GRDP of DKI Jakarta in real terms is expected to expand from Rp59.56 trillion in 1995 to Rp384 trillion in 2020. GRDP size of Bekasi and Tangerang (in constant

1993 price) will expand from Rp5,426 thousand million in 1995 to Rp.34.96 trillion in 2020 and from Rp.2,302 thousand million in 1995 to Rp.14.84 trillion in 2020 respectively.

2) Social Indicators

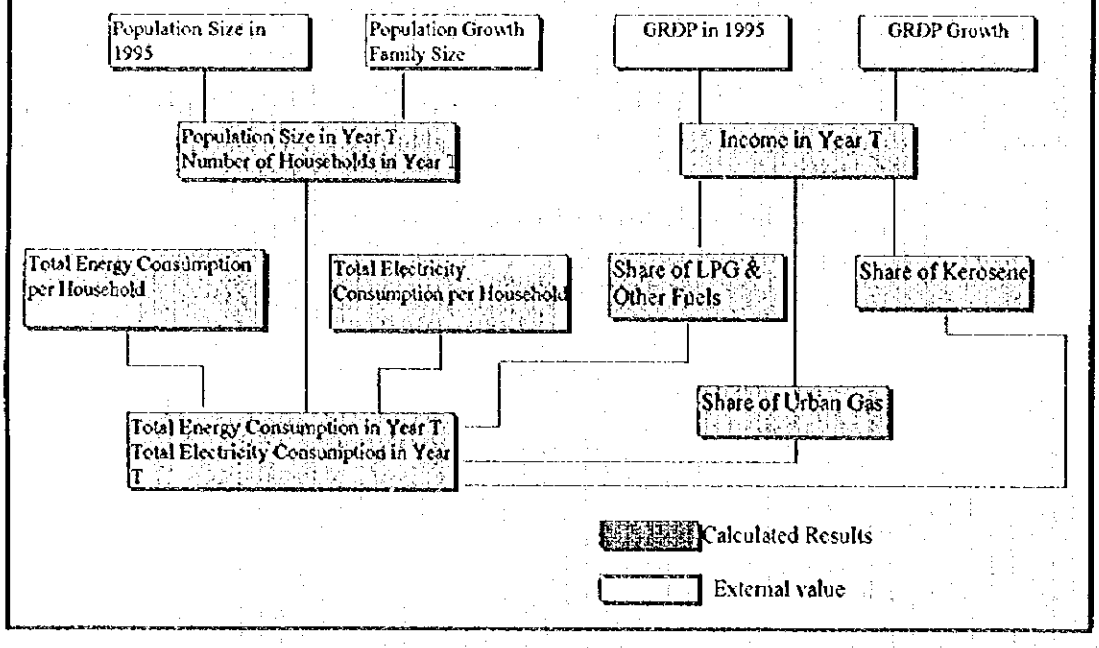
The population in the Jakarta region was 13.54 million in 1995. Assuming population growth rate of 5.0%/year, this figure will reach 17.28 million in 2000. Despite a declining trend in population growth, the population will reach 28.31 million by 2020.

In the Jakarta region, population per household was 4.81 persons in 1995. Due to urbanization and an increasing number of nuclear (two-generation) families, per household population has been on a gradual decline. This downward trend is likely to continue, dropping to 4.5 persons in 2010 and 4.42 persons in 2020. As a result, the number of households is expected to increase from 2.8 million in 1995 to 4.91 million in 2010, and further to 6.41 million in 2020. The assumptions of growth rate of population and household size are common for all cases.

(3) Flow of Model

Figure 8-3-1 shows the flow diagram for the demand forecast.

Fig. 8-3-1 Flow Chart of Urban Gas Demand Model



(4) Procedure and method of forecasting household energy demand

In forecasting energy demand, an bottom-up method was employed only for the volume on demand of urban gas demand for the period of 1997-2004. For other fuels, a functional formula on demand based on the figures of 1995 was used in forecasting.

The following procedures and methods were used in forecasting household energy demand:

1) Bottom-up model (Period for forecasting: 1997-2004)

- The following bottom-up method was applied only for the volume of urban gas demand .

  Urban gas demand = Σ (number of urban gas customers × the specific fuel consumption per household)

- Urban gas demand (1997-2004)forecast according to the above method is to be used as known figure for the econometric model below.

2) Econometric model (Period for forecasting: 1995-2020)
Energy demand in the residential sector is divided into electricity and fuel in the model. Demand for electricity and fuel is forecast, respectively, using the following functions:

- **Electricity Demand = F (GRDP per capita, family size, electricity consumption in the previous year)**

- **Fuel Demand = F (GRDP per capita, family size, the specific fuel consumption per household)**

- In summing up demand volumes of electricity and fuels, total energy demand for the household is obtained. Additionally, the total energy demand itself is forecast according to the following function:

  Total Energy Demand = F (GRDP per capita, family size, energy consumption in the pervious year)

- Taking competition among fuels into consideration, the shares of demand for LPG, kerosene, and other fuels are estimated according to the following function:

  Share of each fuel = F (GRDP per capita, LPG, kerosene, other fuels)

- Finally, under the constraint condition within which other fuel demand is computed, demand volume of urban gas in targeted areas is forecast according to the following function with yearly lags built-in for making a super-long-term

demand forecast.

Urban Gas Demand = F (GRDP per capita, family size, urban gas consumption in the previous year)

In this model, as described earlier in all of the three cases:

- The price of urban gas price is expected to be raised by the Indonesia's government in the near future. The price of urban gas will be higher than the cost of gas and distribution;
- Average fuel consumption per household by income group were used in the total fuel demand function, and;
- Fuel choice in each income group were set by use of the share function in the fuel demand model.

(5) Demand function

1) Electricity demand

Electricity consumption is calculated by using a regression formula against the same variables: income level (in the model, GRDP per capita was used instead of income), and family size. The following function was applied to forecast electricity consumption per household:

<1995-2020>

$$\ln(El_t) = -1.63+0.827*\ln(I_t)+1.47*\ln(F_t)$$

t_1=-0.775 t_2=10.9 t_3=1.16 (t_i = Student's "t"s)

R^2=.98 DW=2.28 (DW : Durbin -Watson ratio[1])

$$TEL_{tj} = EL_t * H_{tj}$$

Where:

EL:	Electricity elasticity in year t
I:	Income in year t
F:	Family size in year t
TEL:	Total electricity consumption in year t
H:	Number of household in year t
t:	a given year
j:	a given region

[1] NOTE: Explanation for DW as well as R^2 and t-values given in Acronyms and Abbreviations

2) Total Fuel Demand

The fuel consumption is regressed against the variables of income level (in the model, GRDP per capita was used instead of income), and family size. The following function was applied to forecast energy consumption per household:

<1995-2020>

$$\ln(E_t) = 5.18 + 0.201 * \ln I_t + 0.712 * \ln F_t$$

$t_1 = 17.8 \quad t_2 = 19.1 \quad t_3 = 4.04$

$R^2 = .98 \quad DW = 2.28$

$$TE = E_{tj} * H$$

Where:

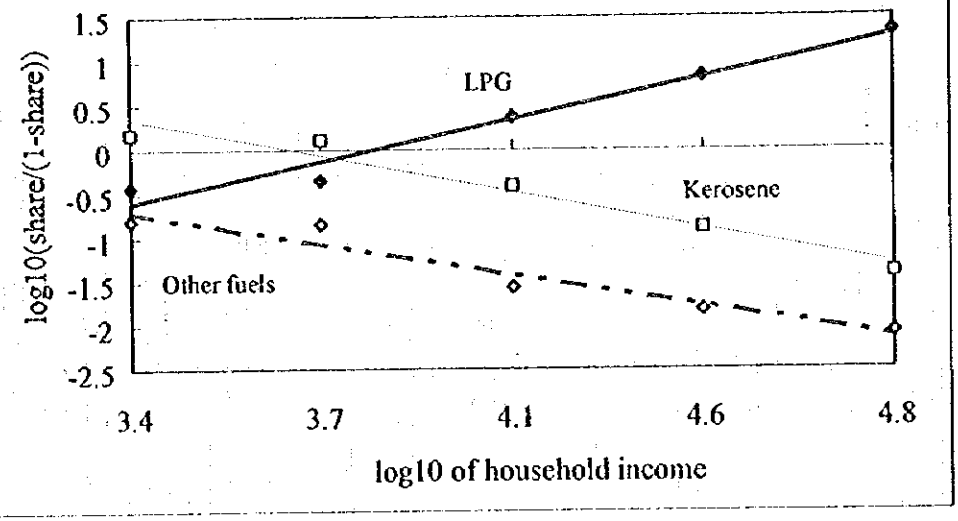
- E: Fuel consumption per household per year (Energy elasticity)
- I: Income in year t
- F: Family size in year t
- t: a given year
- TE: Total fuel consumption in year t
- H: Number of household in year t
- j: a given region
- t_i : Student's "t"s

3) Fuel(Urban Gas, LPG, Kerosene, Other Fuels) demand

The share of each fuel in the total fuel consumption was determined. The share in each of the five income groups at first was transformed using a logit transformation (logarithmic logistique curve). This technique is commonly used to describe growth phenomena like the introduction of a new technology.

After transformation, the illustrations of variation in cooking fuel shares by income is shown in Figure 8-3-2. For urban households with income higher than Rp.400 thousand per month, the share of LPG will reach 50% of total fuels. Kerosene reaches its maximum share of about 90% in the income category of Rp.200 thousand per month (kerosene share is shown as a dotted line).

Fig. 8-3-2 Cooking Fuel Substitution by Income



Source: by JICA Team

In figure 8-3-2, the logit transformation of the share of fuel consumption met by each fuel is displayed.

<LPG>

LS = -25.7 + 11.8*ln(I)
t_1=-8.17 t_2=8.43
R^2=.959 DW=2.5

Where, LS: share of LPG
I: Income

<Kerosene>

KS = 22.2 - 10.4*ln(I)
t_1=6.53 t_2=-6.86
R^2=.940, DW=1.89

Where, KS: share of Kerosene
I: Income

<Other Fuels>

OS = 16.8 - 9.0*ln(I)
t_1=6.07 t_2=-7.27
R^2=.946 DW=3.4

Where, OS: share of LPG
I: Income

<Urban Gas>

As the share of urban gas in the total fuel consumption is now very small, and has no

relationship with income, different methods for urban gas demand forecasting was used in the model. These are explained below.

Note: the share of Urban gas was subtracted from other fuels' share need

<1995-2020>

<LPG demand>

$$LPG_{tj} = TE_{tj} * LS_t$$

Where:

LPG: LPG demand in year t
TE: Total fuel demand in year t
LS: Share of LPG
t: a given year
j a given region

<Kerosene demand>

$$KD_{tj} = TE_{tj} * KS_{tj}$$

Where:

KD: Kerosene demand in year t
TE: Total fuel demand in year t
KS: Share of kerosene
t: a given year
j a given region

<Other Fuels demand>

$$OD_{tj} = TE_{tj} * OS_{tj}$$

Where:

OD: Other fuel demand in year t
TE: Total fuel demand in year t
OS: Share of other fuels
t: a given year
j a given region

4) Urban Gas demand :

<1996-1997>

The values are from urban gas supply plan of PGN.

<1998-2004>

- The function of energy consumption per household is used to project the energy consumption per household. The results are shown in Table 8-3-2.

- Based on the potential customers as described above the ability of PGN to supply; and macro economic data, the number of customers of urban gas were assumed in Table 8-3-3.

Table 8-3-2 Average Fuel Consumption per Household Forecasting in the Jakarta Area

Unit:10^3kcal

Area	Case	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Bekasi	Base	3,381	3,406	3,435	3,463	3,492	3,522	3,511	3,531	3,550	3,570
	High	3,381	3,412	3,444	3,476	3,509	3,541	3,537	3,564	3,590	3,617
	Low	3,381	3,400	3,425	3,451	3,476	3,502	3,485	3,498	3,511	3,523
Tangerang	Base	3,196	3,218	3,244	3,270	3,296	3,322	3,311	3,328	3,345	3,363
	High	3,196	3,224	3,253	3,282	3,311	3,341	3,336	3,359	3,383	3,407
	Low	3,196	3,212	3,235	3,258	3,281	3,304	3,287	3,297	3,308	3,319
DKI Jakarta	Base	3,121	3,161	3,201	3,242	3,283	3,325	3,358	3,391	3,425	3,458
	High	3,121	3,167	3,210	3,254	3,298	3,343	3,383	3,423	3,463	3,504
	Low	3,121	3,155	3,192	3,230	3,268	3,306	3,333	3,359	3,386	3,413

Source: by JICA Team

Table 8-3-3 Estimates for the Number of Urban Gas Customers in the Jakarta Area

Unit: 10^3Households

Area	Case	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Bekasi	Base	0	0	0	2.9	7.6	15.0	23.0	30.0	37.0	43.0
	High	0	0	0	2.9	7.6	15.0	24.0	31.0	37.0	44.0
	Low	0	0	0	2.4	6.5	14.0	22.0	28.0	35.0	42.0
Tangerang	Base	0.3	0.3	0.3	0.4	1.4	4.9	10.0	14.4	19.4	23.4
	High	0.3	0.3	0.3	0.4	1.4	4.9	10.0	15.1	20.1	24.1
	Low	0.3	0.3	0.3	0.4	1.3	4.4	9.5	13.4	18.5	22.6
DKI Jakarta	Base	8.8	9.4	10.8	11.1	15.1	24.1	33.0	41.8	50.5	59.0
	High	8.8	9.4	10.8	11.1	15.1	24.2	32.9	41.6	50.2	59.4
	Low	8.8	9.4	10.8	10.7	13.9	23.0	32.0	40.8	49.6	58.2

Source: by JICA Team

<2005-2020>

Results of statistical (OLS) procedure to estimate amount of urban gas are given below:

$$\ln(UGAS_{tj}) = a + a_1 * \ln(GRDP_{tj}) + a_2 * \ln(UGAS_{-1tj})$$

Where UGAS: Urban gas potential demand in t year
GRDP: Gross Regional Domestic Production
$UGAS_{-1}$: Urban gas potential demand in t-1 year
a,a1,a2: constant
t: a given year
j: a given region

a) Equation for estimating urban gas for residential use at DKI Jakarta

Ln(DKI.Gas) = -559,900+51,050*ln(DKI.GRDP)-1,246*Ln(lag1.DKI.Gas)
(7.7) (-0.83)

RS: 0.997 (R square)
DW: 1.77(Dubin-Watson ratio)
DKI. Gas: Urban gas demand at DKI Jakarta
DKI.GRDP: GRDP at DKI Jakarta
t value in ( )

b) Equation for estimating urban gas for residential use at Bekasi

ln(Bek.Gas)=-373,500+42,360*Ln(Bek.GRDP)-15.2*Ln(Lag1.Bek.Gas)
(38.4) (-0.09)

RS: 0.99
DW: 2.88
Bek.Gas : Urban gas demand at Bekasi
Bek.GRDP: GRDP at Bekasi
t value in ( )

c) Equation for estimating urban gas for residential use at Tangerang

ln(Tan.Gas)=-196,000+24,870*Ln(Tan.GRDP)-339*Ln(Lag1.Tan.Gas)
(16.1) (-1.8)

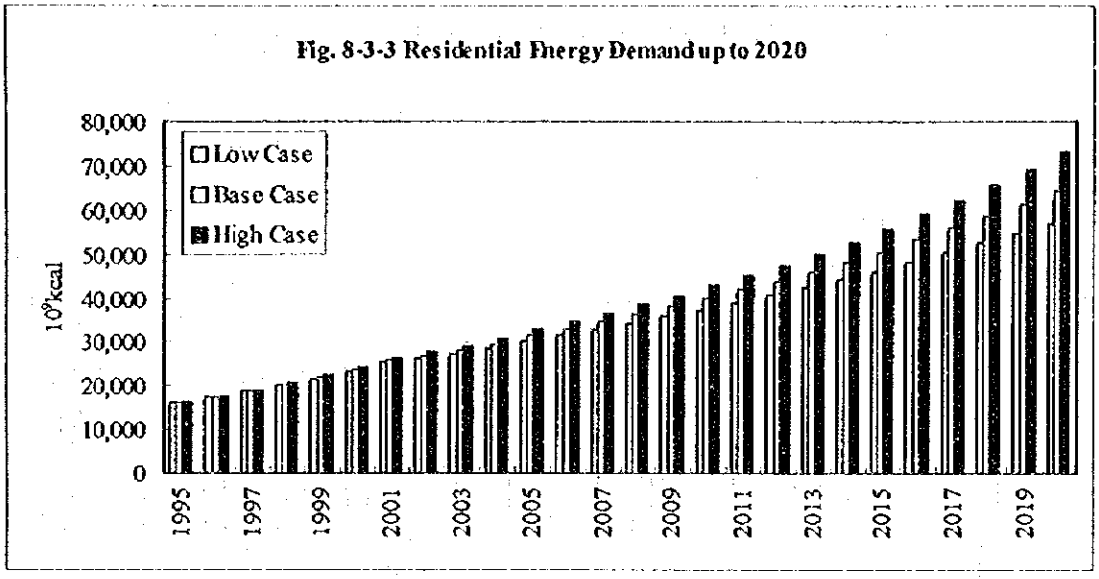
RS: 0.997
DW: 1.94
Tan.Gas: Urban gas demand at Tangerang
Tan.GRDP: GRDP at Tangerang
t value in ( )

8.3.3 Energy Demand Forecast

(1) Total Residential Energy Demand

Fig. 8-3-3 presents the total energy demand up to 2020. In the base case, total energy demand of the Jakarta region will reach 6.43Mtoe (ton oil equivalent, 1toe=10^7kcal).

Fig. 8-3-3 Residential Energy Demand up to 2020

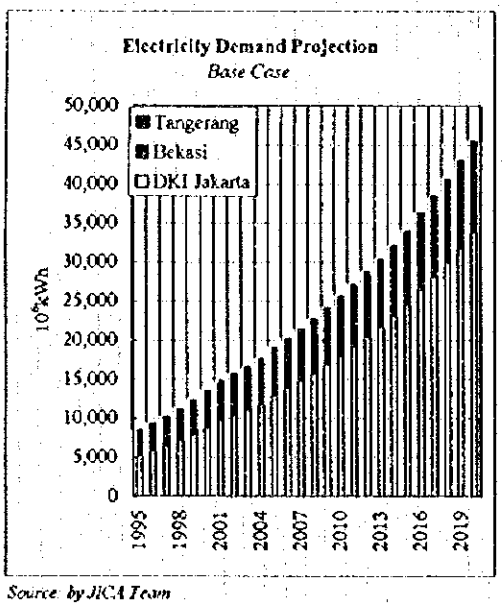


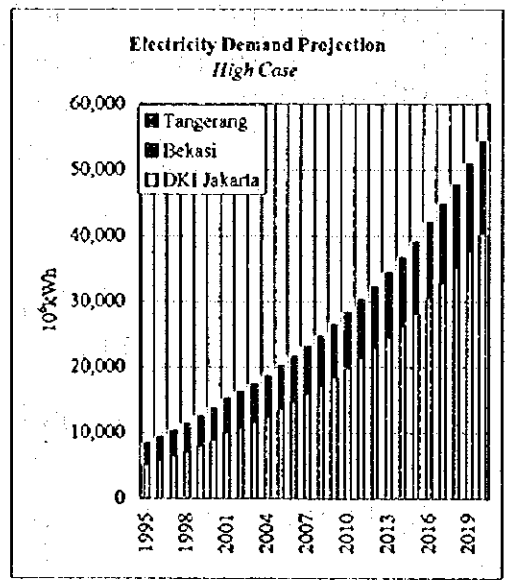
Source: by JICA Team

(2) Electricity Demand

Fig. 8-3-4 shows the forecast of demand until the year 2020 using each scenario (low, base and high case). In the base case, 8,389GWh recorded in 1995 is likely to rise to 45,468Gwh by 2020. The average growth rate is 6.9% per year.

Fig. 8-3-4 Residential Electricity Demand up to 2020



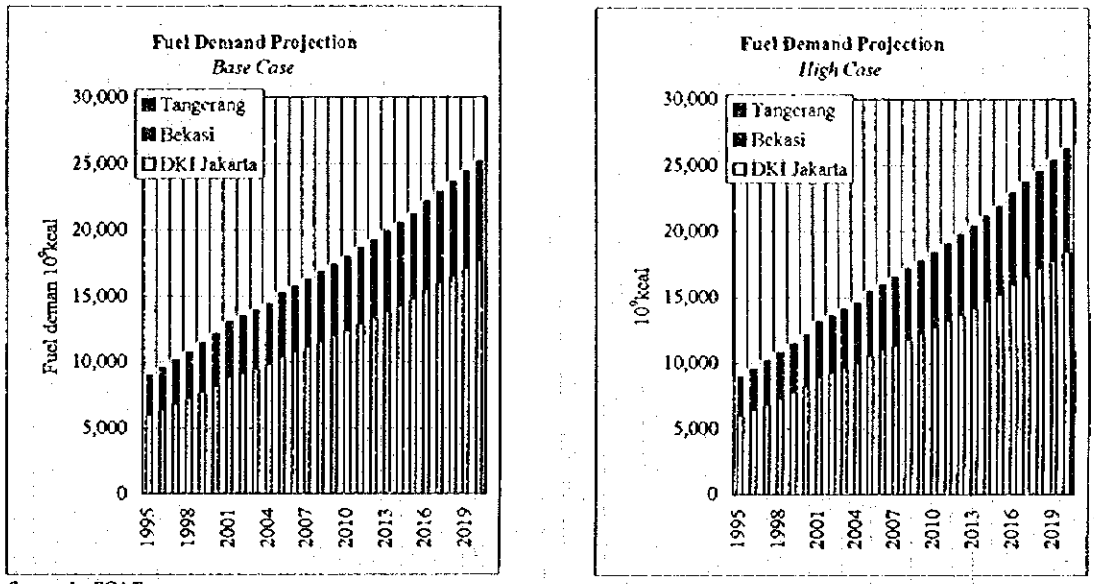


Source: by JICA Team

(3) Fuel Demand

The highest demand growth is noted in DKI Jakarta, where demand is likely to grow from 0.6Mtoe in 1995 to 1.4Mtoe by 2005(growing at 5.6% per year) and to 1.8Mtoe(growing at 3.6% per year) by 2020 in the base case (See Fig. 8-3-5).

Fig. 8-3-5 Residential Fuel Demand Forecast up to 2020

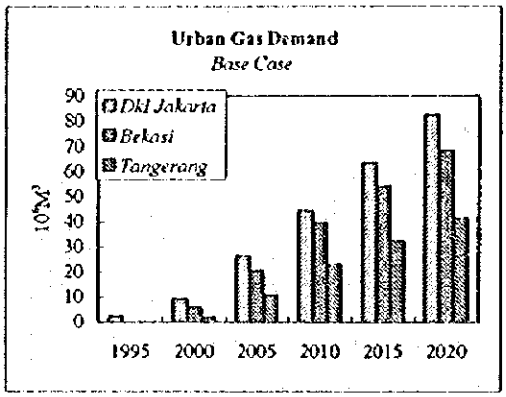


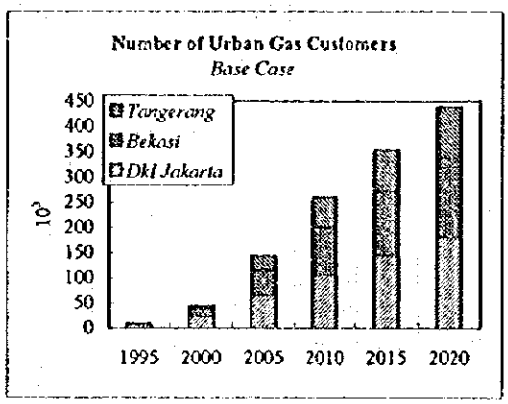
Source: by JICA Team

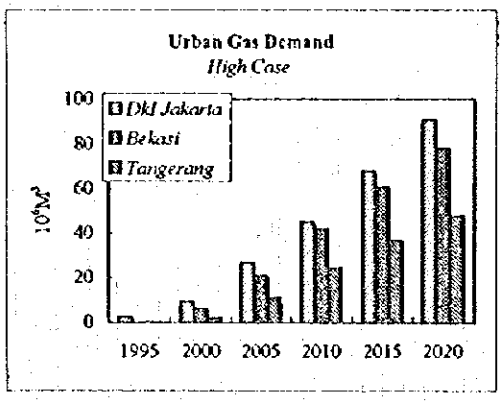
8.4 Urban Gas Demand

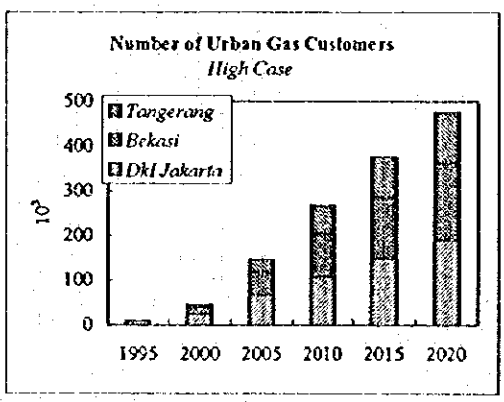
The forecast of demand is summarized in Figure 8-4-1, which shows demand forecast as well as the forecast of number of customers up to the year 2020 by scenario(low, base and high cases). Forecast of demand for urban gas by scenario is also shown in Fig. 8-4-2. Figure 8-4-3 shows demand forecast by region(base case) and Fig. 8-4-4 shows the structure of cooking fuel by base case and high case.

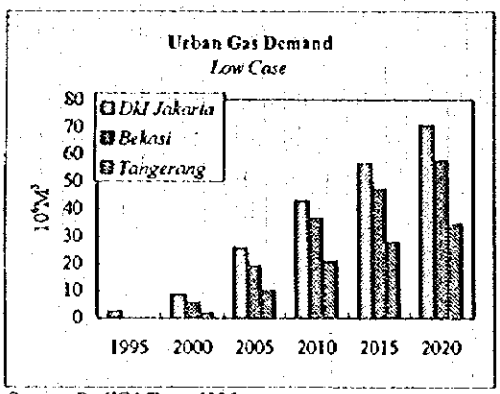
Fig. 8-4-1 Urban Gas Demand Forecast up to 2020

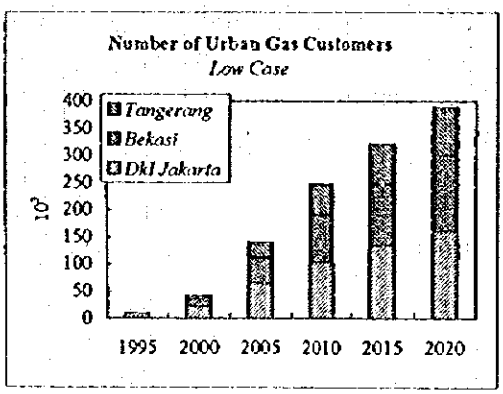






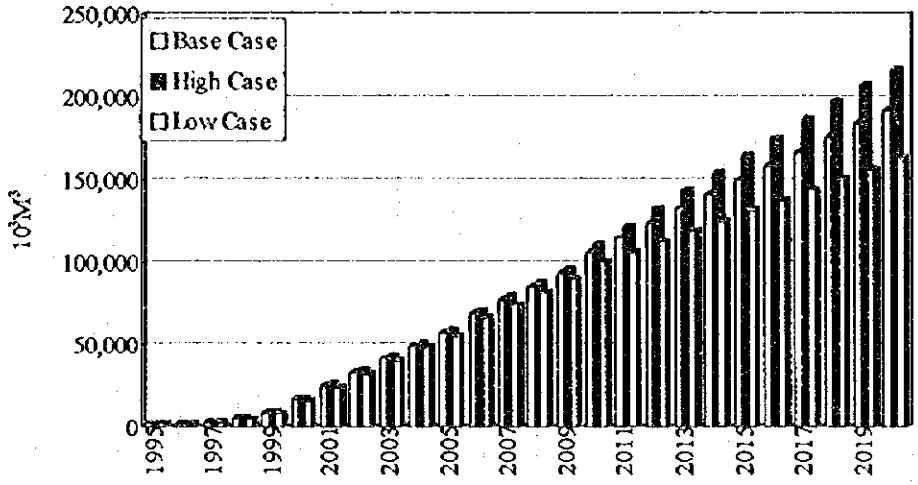






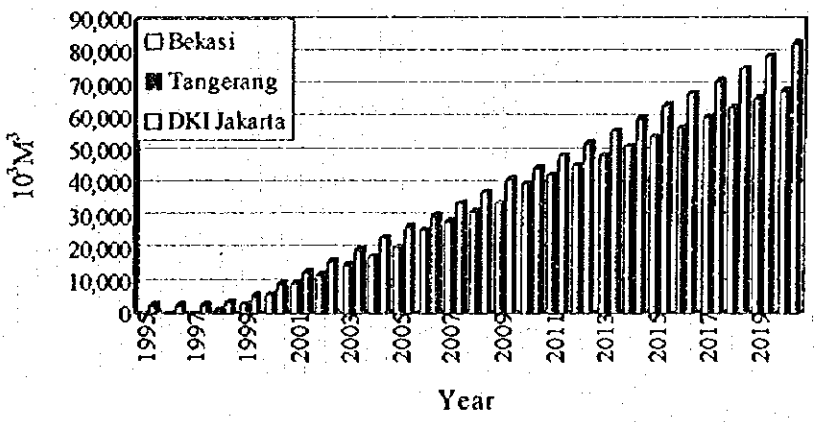
Source: By JICA Team 1996

Fig. 8-4-2 Urban Gas Demand up to 2020 (Residential Sector)



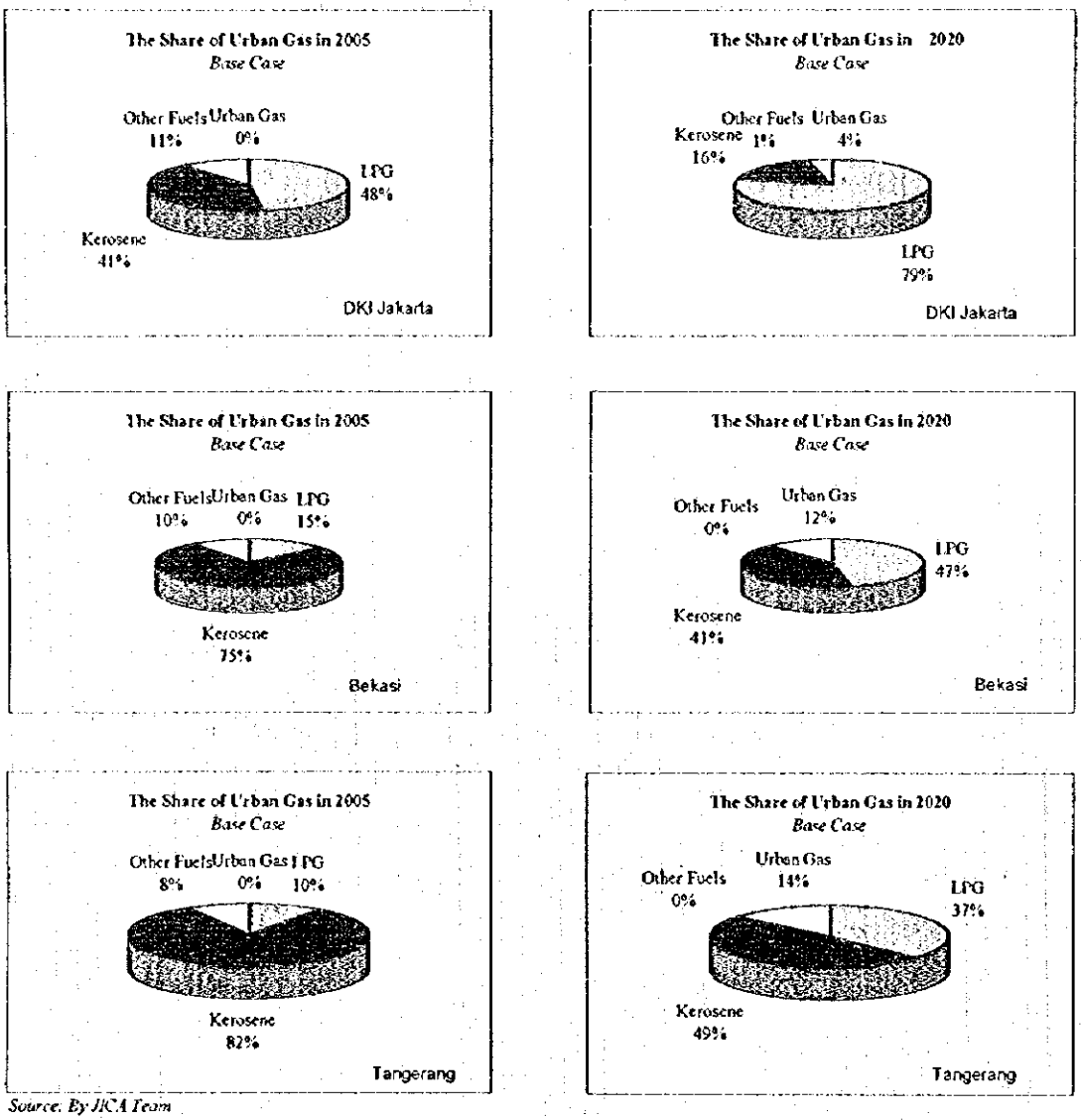
Source: by JICA Team

Fig. 8-4-3 Urban Gas Demand by Region (Base Case)



Source: by JICA Team

Fig. 8-4-4 Fuel-Mix for Cooking Fuel in 2005 and 2020



Source: By JICA Team

(1) Demand by Region

In the base case, the urban gas demand for the residential sector will grow 36.8% per year from 2.49Mm³ in 1995 and reach 57.19Mm³ by 2005. This represents 22.97 times over the 1995 level. From 2005 and on, the demand will be 8.4% per year and reach 192.04Mm³ by 2020, up 3.4 times over the 1995 record (See Table 8-4-1).

Table 8-4-1 Urban Gas Demand Estimates of Residential Sector in DKI Jakarta Area

Area	Case	Item	Unit	1995	2000	2005	2010	2015	2020	Growth Rate			
										2000/1995	2010/2000	2020/2010	2020/1995
Bekasi	Base	Urban Gas Demand	10^3M^3	0	6,003	20,298	39,415	54,096	68,182		5.6	2.3	
		Customers	Thousand	0	15.00	50	94	127	157		5.2	2.1	
	High	Urban Gas Demand	10^3M^3	0	6,036	21,016	41,875	60,532	78,083		6.4	2.6	
		Customers	Thousand	0	15.00	51	98	137	172		5.8	2.3	
	Low	Urban Gas Demand	10^3M^3	0	5,572	19,195	36,646	47,189	57,881		4.7	2.1	
		Customers	Thousand	0	14	48	90	114	139		4.4	2.0	
Tangerang	Base	Urban Gas Demand	10^3M^3	109	1,851	10,536	22,840	32,388	41,386	76.2	6.1	2.5	26.8
		Customers	Thousand	0.30	4.9	28	58	81	102	74.8	5.7	2.3	26.2
	High	Urban Gas Demand	10^3M^3	109	1,863	10,926	24,522	36,500	47,659	76.4	6.9	2.7	27.5
		Customers	Thousand	0.30	4.9	28	61	88	112	74.9	6.3	2.4	26.7
	Low	Urban Gas Demand	10^3M^3	109	1,645	10,062	20,835	27,678	34,469	72.1	5.2	2.2	25.9
		Customers	Thousand	0.30	4.4	27	54	72	88	71.0	5.0	2.1	25.5
DKI Jakart	Base	Urban Gas Demand	10^3M^3	2,381	9,110	26,353	44,474	63,412	82,475	30.8	6.4	2.7	15.2
		Customers	Thousand	8.76	24	66	107	145	181	22.5	5.4	2.2	12.9
	High	Urban Gas Demand	10^3M^3	2,381	9,143	26,585	44,993	67,782	90,713	30.9	7.3	3.0	15.7
		Customers	Thousand	8.76	24	67	108	150	191	22.5	5.9	2.4	13.1
	Low	Urban Gas Demand	10^3M^3	2,381	8,637	25,707	42,872	56,727	70,670	29.4	5.1	2.2	14.5
		Customers	Thousand	8.76	23	65	105	135	162	21.3	4.4	1.9	12.4
Total	Base	Urban Gas Demand	10^3M^3	2,490	16,963	57,188	106,729	149,896	192,043	46.8	6.1	2.5	19.0
		Customers	Thousand	9.06	44	144	259	353	439	37.2	5.4	2.2	16.8
	High	Urban Gas Demand	10^3M^3	2,490	17,042	58,527	111,387	164,813	216,454	46.9	6.9	2.8	19.6
		Customers	Thousand	9.06	44	146	267	376	474	37.2	5.9	2.4	17.2
	Low	Urban Gas Demand	10^3M^3	2,490	15,854	54,965	100,353	131,594	163,020	44.8	5.0	2.2	18.2
		Customers	Thousand	9.06	41	139	250	321	389	35.5	4.5	2.0	16.2

Source: By JICA Team 1996

(2) Demand by each area

The results of the urban gas demand forecast by region are summarized in table 8-4-2.

Table 8-4-2 Result of Simulation

Unit: 10^3M^3

Area	Case	Actual	Projection		Growth Rate	
		1995	2005	2020	05/95	20/05
Beksia	Base	0	20,298	68,182		8.4
	High	0	21,016	78,083		9.1
	Low	0	19,195	57,881		7.6
Tangerang	Base	109	10,536	41,386	58.0	9.5
	High	109	10,926	47,659	58.5	10.3
	Low	109	10,062	34,469	57.2	8.6
DKI Jakarta	Base	2,381	26,353	82,475	27.2	7.9
	High	2,381	26,585	90,713	27.3	8.5
	Low	2,381	25,707	70,670	26.9	7.0

Source: By JICA Team

1) DKI Jakarta

In the base case, regional demand for the residential sector will grow from 26.4Mm^3 at a projected growth rate of 27.18% per year in 2005. With a projected growth rate of 7.9% per year between 2005 and 2020, demand will reach 82.6Mm^3 in 2020 (See Table 8-4-3).

2) Bekasi

Bekasi is the largest prefecture in West Java. The area is characterized by the presence of many big low-mid income residential estates near the existing urban gas pipelines. The regional demand for the residential sector in this region is forecast to be 6Mm^3 in 2000, and 20.3Mm^3 in 2005. With a projected growth rate of 8.4% per year between 2005 and 2020, demand will reach 68.18Mm^3in 2020(See Table 8-4-4).

3) Tangerang

There are new towns in Tangerang close to DKI Jakarta. Many residential estates are being developed by private developers. The prefectural government is planning to develop four satelite-cities before the year 2010. Urban gas demand for the residential sector in this region is forecast to be 10.54Mm^3 in 2005, and 41.39Mm^3 in 2020. The expected average growth rate is 9.5% per year between 2005 and 2020 (See Table 8-4-5).

(2) Demand by each area

The results of the urban gas demand forecast by region are summarized in table 8-4-2.

Table 8-4-2 Result of Simulation

Unit: 10^3M^3

Area	Case	Actual	Projection		Growth Rate	
		1995	2005	2020	05/95	20/05
Beksia	Base	0	20,298	68,182		8.4
	High	0	21,016	78,083		9.1
	Low	0	19,195	57,881		7.6
Tangerang	Base	109	10,536	41,386	58.0	9.5
	High	109	10,926	47,659	58.5	10.3
	Low	109	10,062	34,469	57.2	8.6
DKI Jakarta	Base	2,381	26,353	82,475	27.2	7.9
	High	2,381	26,585	90,713	27.3	8.5
	Low	2,381	25,707	70,670	26.9	7.0

Source: By JICA Team

1) DKI Jakarta

In the base case, regional demand for the residential sector will grow from 26.4Mm^3 at a projected growth rate of 27.18% per year in 2005. With a projected growth rate of 7.9% per year between 2005 and 2020, demand will reach 82.6Mm^3 in 2020 (See Table 8-4-3).

2) Bekasi

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3) Tangerang

There are new towns in Tangerang close to DKI Jakarta. Many residential estates are being developed by private developers. The prefectural government is planning to develop four satelite-cities before the year 2010. Urban gas demand for the residential sector in this region is forecast to be 10.54Mm^3 in 2005, and 41.39Mm^3 in 2020. The expected average growth rate is 9.5% per year between 2005 and 2020 (See Table 8-4-5).

Table 8-4-3 Gas Demand Estimates of Residential Sector of DKI Jakarta

Item	Unit	1995	2000	2005	2010	2015	2020	Growth Rate			
								2000/1995	2010/2000	2020/2010	2020/1995
Projected Population	Thousand	9,328	11,905	13,470	15,240	17,242	19,508	5.0	2.5	2.5	3.0
Family Size	Member	4.81	4.81	4.50	4.50	4.48	4.42				
Number of Households	Thousand	1,939	2,475	2,993	3,387	3,849	4,414	5.0	3.2	2.7	3.3
Base Case											
GRDP(Constant 1993 Price)	10^9Rp	59,729	86,550	124,833	180,048	263,328	385,127	7.7	7.6	7.9	7.7
Total of Energy Demand	10^9kcal	6,053	8,230	10,454	12,424	14,762	17,699	6.3	4.2	3.6	4.4
Total of Electricity Demand	10^9kWh	5,308	8,787	13,012	18,025	24,599	33,875	10.6	7.4	6.5	7.7
Energy Consumption per Household	10^9kcal	3,121	3,325	3,493	3,669	3,836	4,010	1.3	1.0	0.9	1.0
Electricity Consumption per Household	kWh	2,737	3,550	4,347	5,322	6,391	7,675	5.3	4.1	3.7	4.2
LPG	10^9kcal	2,892	4,280	6,255	8,324	10,870	14,018	8.2	6.9	5.4	6.5
Kerosene	10^9kcal	2,470	3,065	3,237	3,162	3,025	2,771	4.4	0.3	-1.3	0.5
Other Fuels	10^9kcal	669	804	731	547	310	184	3.8	-3.8	-10.3	-5.0
City Gas	10^9M^3	2,381	9,110	26,353	44,474	63,412	82,475	30.8	17.2	6.4	15.2
Number of Customers of City Gas	Thousand	8.8	24	66	107	145	181	22.4	16.0	5.4	12.9
High Case											
GRDP(Constant 1993 Price)	10^9Rp	59,729	88,169	131,359	195,705	319,506	521,622	8.1	8.3	10.3	9.1
Total of Energy Demand	10^9kcal	6,053	8,275	10,611	12,730	15,268	18,478	6.5	4.4	3.8	4.6
Total of Electricity Demand	10^9kWh	5,308	8,991	13,836	19,920	28,259	40,453	11.1	8.3	7.3	8.5
Energy Consumption per Household	10^9kcal	3,121	3,343	3,545	3,759	3,967	4,187	1.4	1.2	1.1	1.2
Electricity Consumption per Household	kWh	2,737	3,632	4,622	5,882	7,343	9,166	5.8	4.9	4.5	5.0
LPG	10^9kcal	2,892	4,365	6,527	8,830	11,910	15,620	8.6	7.3	5.9	7.0
Kerosene	10^9kcal	2,470	3,032	3,146	3,013	2,527	1,927	4.2	-0.1	-4.4	-1.0
Other Fuels	10^9kcal	669	798	704	491	235	133	3.6	-4.7	-12.3	-6.3
City Gas	10^9M^3	2,381	9,143	26,585	44,993	67,782	90,713	30.9	17.3	7.3	15.7
Number of Customers of City Gas	Thousand	8.8	24	67	108	150	191	22.5	16.1	5.9	13.1
Low Case											
GRDP(Constant 1993 Price)	10^9Rp	59,729	84,955	117,492	162,492	210,365	272,342	7.3	6.7	5.3	6.3
Total of Energy Demand	10^9kcal	6,053	8,184	10,298	12,124	14,269	16,945	6.2	4.0	3.4	4.2
Total of Electricity Demand	10^9kWh	5,308	8,588	12,231	16,296	21,387	28,323	10.1	6.6	5.7	6.9
Energy Consumption per Household	10^9kcal	3,121	3,306	3,440	3,580	3,707	3,839	1.2	0.8	0.7	0.8
Electricity Consumption per Household	kWh	2,737	3,470	4,086	4,812	5,557	6,417	4.9	3.3	2.9	3.5
LPG	10^9kcal	2,892	4,196	5,954	7,754	9,672	12,088	7.7	6.3	4.5	5.9
Kerosene	10^9kcal	2,470	3,098	3,352	3,366	3,546	3,761	4.6	0.8	1.1	1.7
Other Fuels	10^9kcal	669	814	766	627	551	475	4.0	-2.6	-2.7	-1.4
City Gas	10^9M^3	2,381	8,637	25,707	42,872	56,727	70,670	29.4	17.4	5.1	14.5
Number of Customers of City Gas	Thousand	8.8	23	65	105	133	162	21.3	16.4	4.4	12.4

Source: by JICA Team 1996

Table 8-4-4 Gas Demand Forecast of Residential Sector in Bekasi

Item	Unit	1995	2000	2005	2010	2015	2020	Growth Rate			
								2000/1995	2010/2000	2020/2010	2020/1995
Projected Population	Thousand	2,697	3,442	3,894	4,406	4,985	5,640	5.0	2.5	2.5	3.0
Family Size	Member	4.81	4.81	4.5	4.5	4.48	4.42				
Number of Households	Thousand	561	716	865	979	1,113	1,276	5.0	3.2	2.7	3.3
Base Case											
GRDP(Constant 1993 Price)	10^9Rp	5,466	7,921	11,424	16,477	24,099	35,245	7.7	7.6	7.9	7.7
Total of Energy Demand	10^9kcal	1,896	2,520	3,092	3,596	4,178	4,889	5.9	3.6	3.1	3.9
Total of Electricity Demand	10^9kWh	2,132	3,219	4,129	5,235	6,515	8,121	8.6	5.0	4.5	5.5
Energy Consumption per Household	10^6kcal	3,381	3,522	3,573	3,673	3,755	3,832	0.8	0.4	0.4	0.5
Electricity Consumption per Household	kWh	3,803	4,498	4,771	5,347	5,855	6,364	3.4	1.7	1.8	2.1
LPG	10^6kcal	279	437	717	1,082	1,596	2,288	9.4	9.5	7.8	8.8
Kerosene	10^6kcal	1,422	1,805	1,999	2,059	2,061	1,996	4.9	1.3	-0.3	1.4
Other Fuels	10^6kcal	195	225	197	108	45	6	2.9	-7.1	-25.6	-13.2
City Gas	10^6M^3	0	6,003	20,298	39,415	54,096	68,182		20.7	5.6	
Number of Customers of City Gas	Thousand	0	15	50	94	127	157		20.2	5.2	
High Case											
GRDP(Constant 1993 Price)	10^9Rp	5,466	8,069	12,021	17,910	29,240	47,737	8.1	8.3	10.3	9.1
Total of Energy Demand	10^9kcal	1,896	2,534	3,138	3,685	4,321	5,105	6.0	3.8	3.3	4.0
Total of Electricity Demand	10^9kWh	2,132	3,293	4,391	5,786	7,484	9,698	9.1	5.8	5.3	6.2
Energy Consumption per Household	10^6kcal	3,381	3,541	3,626	3,763	3,883	4,000	0.9	0.6	0.6	0.7
Electricity Consumption per Household	kWh	3,803	4,602	5,073	5,909	6,726	7,599	3.9	2.5	2.5	2.8
LPG	10^6kcal	279	452	774	1,207	1,935	2,906	10.1	10.3	9.2	9.8
Kerosene	10^6kcal	1,422	1,800	1,978	2,011	1,830	1,509	4.8	1.1	-2.8	0.2
Other Fuels	10^6kcal	195	230	201	99	24	2	3.3	-8.1	-32.4	-16.8
City Gas	10^6M^3	0	6,036	21,016	41,873	60,532	78,083		21.4	6.4	
Number of Customers of City Gas	Thousand	0	15	53	98	137	172		20.6	5.8	
Low Case											
GRDP(Constant 1993 Price)	10^9Rp	5,466	7,775	10,752	14,871	19,252	24,924	7.3	6.7	5.3	6.3
Total of Energy Demand	10^9kcal	1,896	2,506	3,046	3,509	4,038	4,681	5.7	3.4	2.9	3.7
Total of Electricity Demand	10^9kWh	2,132	3,146	3,881	4,733	5,664	6,790	8.1	4.2	3.7	4.7
Energy Consumption per Household	10^6kcal	3,381	3,502	3,519	3,584	3,629	3,668	0.7	0.2	0.2	0.3
Electricity Consumption per Household	kWh	3,803	4,396	4,485	4,834	5,090	5,321	2.9	1.0	1.0	1.4
LPG	10^6kcal	279	422	656	946	1,249	1,646	8.7	8.4	5.7	7.4
Kerosene	10^6kcal	1,422	1,810	2,027	2,125	2,277	2,514	5.0	1.6	1.7	2.3
Other Fuels	10^6kcal	195	225	193	117	97	12	2.8	-6.4	-20.5	-10.6
City Gas	10^6M^3	0	5,572	19,195	36,646	47,189	57,881		20.7	4.7	
Number of Customers of City Gas	Thousand	0	14	48	88	114	139		20.2	4.7	

Source: By JICA Team 1996

Table 8-4-5 Gas Demand Estimates of Residential Sector in Tangerang

Item	Unit	1995	2000	2005	2010	2015	2020	Growth Rate			
								2000/1995	2010/2000	2020/2010	2020/1995
Projected Population	Thousand	1,513	1,931	2,185	2,472	2,797	3,164	5.00	2.50	2.50	3.00
Family Size	Member	4.81	4.81	4.50	4.50	4.48	4.42				
Number of Households	Thousand	315	401	486	549	624	716	5.00	3.19	2.68	3.34
Base Case											
GRDP(Constant 1993 Price)	10^9Rp	2,308	3,345	4,824	6,958	10,176	14,882	7.7	7.6	7.9	7.7
Total of Energy Demand	10^9kcal	1,005	1,334	1,633	1,896	2,198	2,568	5.8	3.6	3.1	3.8
Total of Electricity Demand	10^6kWh	949	1,421	1,808	2,274	2,808	3,472	8.4	4.8	4.3	5.3
Energy Consumption per Household	10^6kcal	3,196	3,322	3,364	3,451	3,522	3,587	0.8	0.4	0.4	0.5
Electricity Consumption per Household	kWh	3,016	3,539	3,724	4,140	4,498	4,850	3.2	1.6	1.6	1.9
LPG	10^9kcal	100	160	270	422	646	962	9.7	10.2	8.6	9.5
Kerosene	10^9kcal	820	1,050	1,186	1,226	1,254	1,237	5.1	1.6	0.1	1.7
Other Fuels	10^9kcal	84	108	84	47	13	4	5.1	-8.0	-21.4	-11.3
City Gas	10^6M^3	109	1,851	10,536	22,840	32,388	41,386	76.2	28.6	6.1	26.8
Number of Customers of City Gas	Thousand	0.30	4.9	28	58	81	102	74.8	28.1	5.2	26.2
High Case											
GRDP(Constant 1993 Price)	10^9Rp	2,308	3,407	5,076	7,563	12,347	20,157	8.1	8.3	10.3	9.1
Total of Energy Demand	10^9kcal	1,005	1,341	1,658	1,943	2,274	2,681	5.9	3.8	3.3	4.0
Total of Electricity Demand	10^6kWh	949	1,454	1,923	2,513	3,226	4,146	8.9	5.6	5.1	6.1
Energy Consumption per Household	10^6kcal	3,196	3,341	3,414	3,536	3,642	3,745	0.9	0.6	0.6	0.6
Electricity Consumption per Household	kWh	3,016	3,621	3,960	4,576	5,167	5,792	3.7	2.4	2.4	2.6
LPG	10^9kcal	100	165	294	477	808	1,280	10.5	11.2	10.4	10.7
Kerosene	10^9kcal	820	1,049	1,179	1,207	1,139	982	5.0	1.4	-2.0	0.7
Other Fuels	10^9kcal	84	111	89	43	6	0	5.6	-9.0	-43.6	-22.6
City Gas	10^6M^3	109	1,863	10,926	24,522	36,500	47,659	76.4	29.4	6.9	27.5
Number of Customers of City Gas	Thousand	0.30	4.9	28	61	83	112	74.9	28.7	6.3	26.7
Low Case											
GRDP(Constant 1993 Price)	10^9Rp	2,308	3,283	4,540	6,279	8,129	10,524	7.3	6.7	5.3	6.3
Total of Energy Demand	10^9kcal	1,005	1,326	1,609	1,850	2,125	2,458	5.7	3.4	2.9	3.6
Total of Electricity Demand	10^6kWh	949	1,388	1,700	2,056	2,441	2,903	7.9	4.0	3.5	4.6
Energy Consumption per Household	10^6kcal	3,196	3,304	3,314	3,368	3,404	3,434	0.7	0.2	0.2	0.3
Electricity Consumption per Household	kWh	3,016	3,459	3,501	3,743	3,911	4,055	2.8	0.8	0.8	1.2
LPG	10^9kcal	100	154	245	363	488	656	8.9	9.0	6.1	7.8
Kerosene	10^9kcal	820	1,051	1,195	1,263	1,369	1,496	5.1	1.9	1.7	2.4
Other Fuels	10^9kcal	84	107	80	40	24	4	5.0	-9.3	-21.2	-11.7
City Gas	10^6M^3	109	1,645	10,062	20,835	27,678	34,469	72.1	28.9	5.2	25.9
Number of Customers of City Gas	Thousand	0.30	4.4	27	53	72	88	70.6	28.3	5.2	25.5

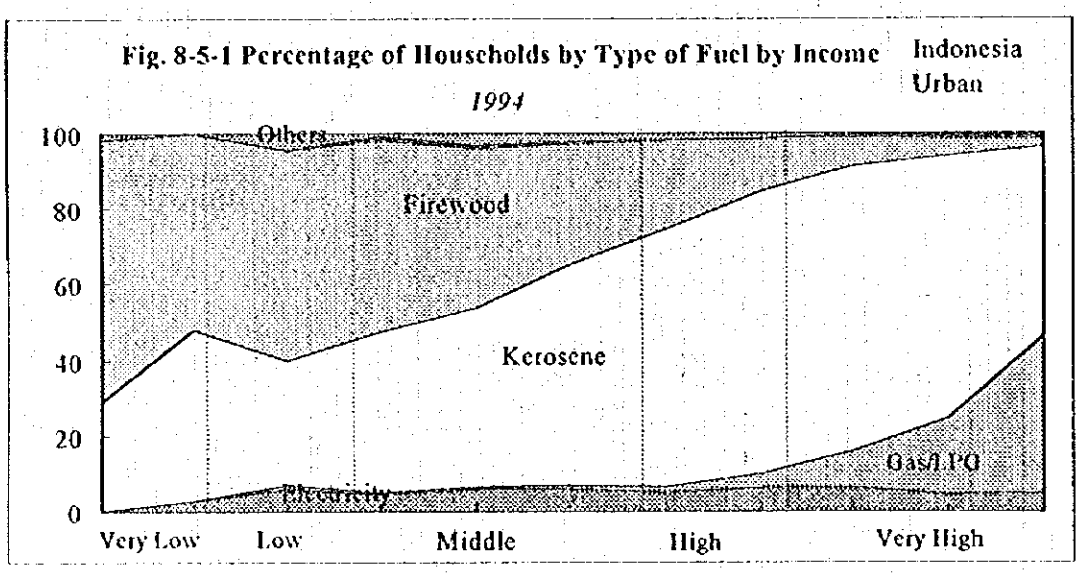
Source: by JICA Team 1996

8.5 Comments on the Survey

1) The data on the share of LPG in the residential sector obtained from this survey are much higher than those previously recorded (See Fig. 8-5-1). Part of the reason is that PGN selected more upper-income residential districts while conducting the survey. Although many middle low-income residential districts were selected and corrections were made to the results of survey, there is no way to make data more or less the similar to other statistical data.

2) Some questionnaires were not completed by non-users, leaving some doubt as reliability of information.

3) Concerns Raised by Customers
It is reflected in the survey that actual and potential users worry about the reliability of urban gas supply. They are particularly concerned about gas supply cut off just as they are with electric power failures.



Source: Housing and Settlement Statistics 1995

8.6 Recommendation for Expanding Gas in the Residential Sector

1) At present, the price of urban gas is too low. If we look at the price level that customers are willing to pay, the price is still lower than other fuels. The price of urban gas should be raised, as the price of other fuels will be closer to international levels. Raising the price will not only result in an increase in the level of investment, but also promote energy conservation to improve the environment.

2) In DKI Jakarta region, there were only about 10,000 customers at end of 1995, we

can not use econometric method to predict the future. So, it is important to select the potential areas or customers.

3) Based on the analysis of different income levels, it may be better to spread urban gas to middle and low income residences because, residential district of middle low-income level households have very large populations (4-5 times of upper-income level), with short distances between buildings. Thus the cost is relatively lower in the terms of investment in pipelines.

4) In DKI Jakarta, of the supply of mid-high apartments by the end of 1995, 44.2% are planned in the South Jakarta and 16.4 % in the north Jakarta, and there are 17,959 low-income apartment units developed in the North Jakarta . If PGN target this potential market, as the first step of developing urban gas, could choose one or two regions in the north and south before 2000. Since, some of apartments are very close to the pipelines of gas, the cost of construction will be lower than in other regions and demand of urban gas be larger.

5) Priority should be given to middle and low-income residential districts in making a selection in the Bekasi and Tangerang prefectures. Because there are many middle and low-income residential districts located near existing gas pipelines and over 50 districts can be selected. District selection plays a relatively important role in the urban gas demand forecast.

Chapter 9

Commercial Gas Market

9. Commercial Gas Market

9.1 Overview of Energy Consumption in the Commercial Sector

In the current commercial sector, urban gas is used mostly for cooking and the total sales volume is approximately 10 million m^3 a year. In order to understand how energy is consumed in commercial buildings, the Team conducted a questionnaire survey and a visit survey. Facts about energy usage in the commercial sector are as follows:

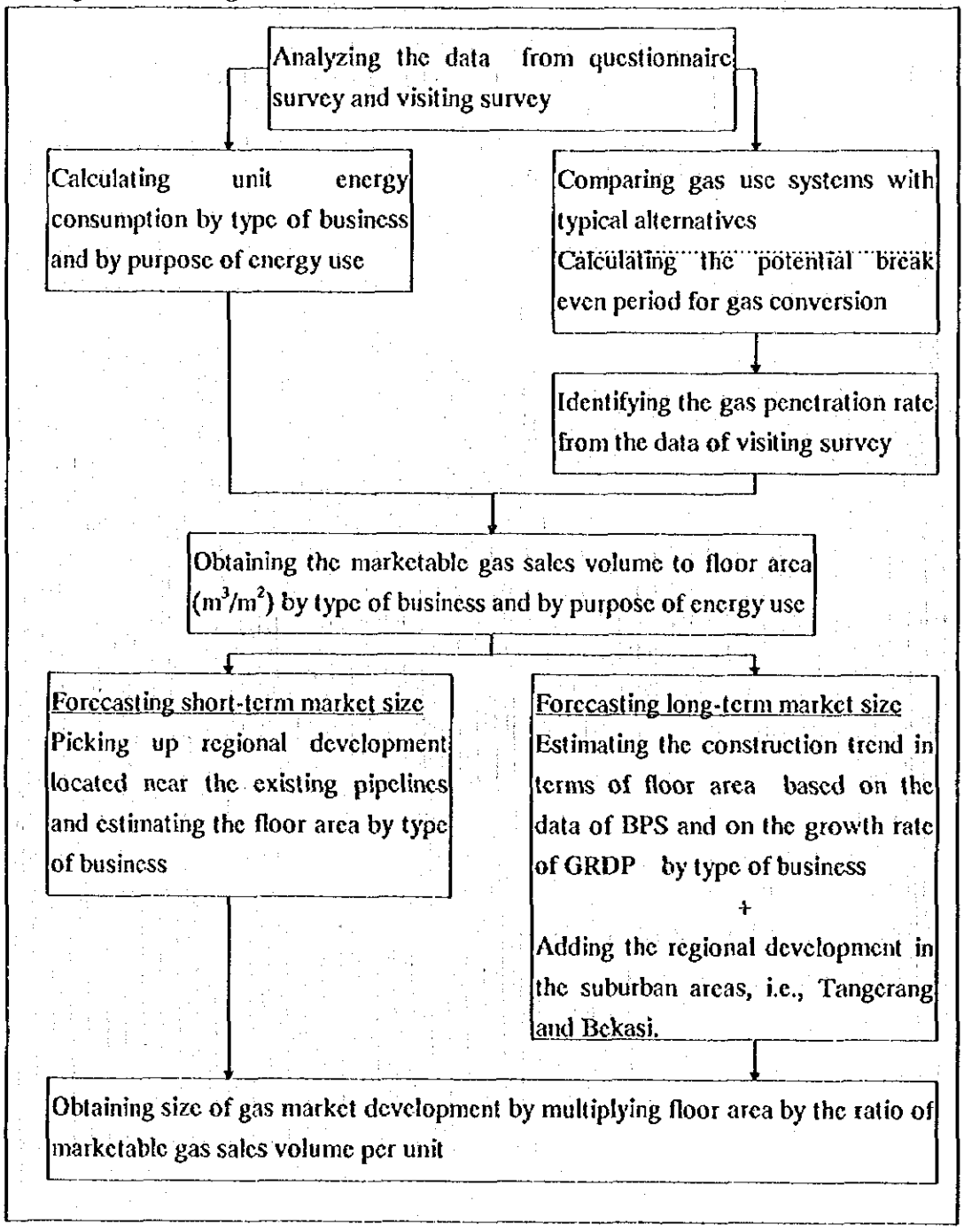
Cooking	In buildings located near the existing gas pipelines, urban gas is mainly used but in others, LPG is mostly used. A few Chinese restaurants use kerosene because of the preference for its high calorific input.
Boiler	In hotels and hospitals, hot water boilers and steam boilers are installed and most of them are IDO (industrial diesel oil) driven ones. In some small business hotels, solar-panel water heaters or electric water heaters are installed for baths.
Air conditioning	Despite the variety of air conditioning systems like centralized systems (reciprocated chiller, centrifugal chiller etc.) or decentralized (packaged air conditioner, separate type cooler etc.), almost all prime movers for the systems are electricity driven compression type heat generators.
Power generator	Most buildings are equipped with power generators for emergency and IDO is stockpiled. There exist a few self generators for continuous use while only one co-generation system (Mega Mal) was found in the commercial sector.

The Team estimated gas demand considering the competitiveness of gas systems against typical alternatives in newly constructed buildings mainly in the Jatabek region. An index of the competitiveness of gas system has been devised to quantitatively evaluate user preference from an economical view point.

9.2 Methodology of Gas Demand Forecasting in the Commercial Sector

The procedure of demand forecast in the commercial sector is shown in the diagram below. The central concept of the method is to link the gas demand to the floor area of commercial facilities.

Fig. 9-2-1 Diagram of Procedure of Demand Forecast



9.3 Findings in the Survey

The interview survey was carried out among approximately 100 customers and effective data for 63 samples were obtained. Sites were selected randomly both from PGN's existing customers and from potential ones, 32 and 31 respectively. The results of the interview survey are arranged in a table in the Appendix.

From the data of the questionnaire survey and the interview survey, the Team obtained the unit energy consumption by type of business and by purpose of energy use, converted to gas volume of calorific equivalence, taking into account the efficiency of each appliance. At the same time, the potential gas penetration rate was determined by analyzing the competitiveness of gas systems against the alternatives using the data from the surveys.

9.3.1 Unit Energy Consumption by Type of Business and Gas Use

(1) Cooking Market and Steam Market

Average unit energy consumption, i.e., energy consumption per unit floor area, was directly obtained from the data of the interview survey, and is shown as follows:

Table 9-3-1 Unit Energy Consumption for Cooking and Steam Market

	Cooking	Steam	
	Gas equiv. m3/m2.y	Capa. of boiler kg/m2	Gas equiv. m3/m2.y
Office	1.50	-	-
Hotel	3.45	0.14 kg/m2	15.93 m3/m2.y
Hospital	1.44	0.183 kg/m2	11.07 m3/m2.y
Shopping	3.09	-	-

Source: JICA Team

(2) Air Conditioning

Average unit capacity of air conditioning was directly obtained from the survey data.

Table 9-3-2 Unit Capacity of Air Conditioning

	Capacity of Air Con.
Office	102.18 kcal/m2
Hotel	90.78 kcal/m2
Hospital	86.00 kcal/m2
Shopping	106.94 kcal/m2

Source: JICA Team

It was impossible to readily obtain the energy consumption for air conditioning from the survey data because there were few such data of electricity consumption for air conditioning being segregate from the total electricity consumption in the buildings. We obtained, however, two hourly load patterns for air conditioning, one from a day-time operation mode and the other from a 24-hour operation mode. The air conditioner's load rate is calculated, by assuming that the coefficient of performance, i.e., COP, of a refrigerator is 4.0 (i.e., 400%) (0.9 kW/RTh), and by using the operation hours of air conditioner from the data of the questionnaire survey as shown in Table 9-3-3.

Table 9-3-3 Operation Hour

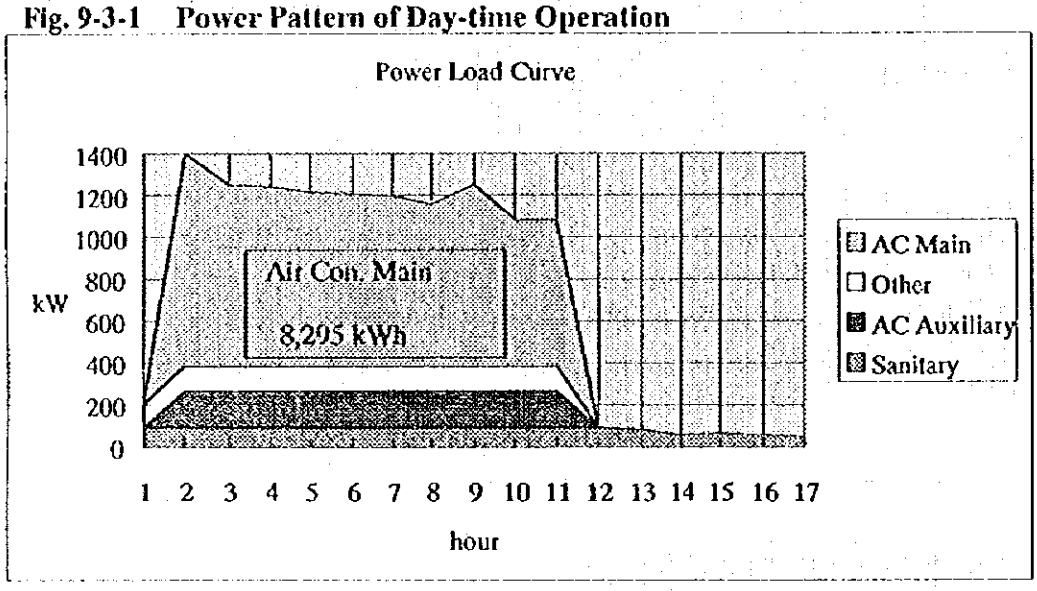
	Business Open	A.C. Operation
Office	10 h	10 h
Hotel	22 h	24 h
Hospital	14 h	24 h
Shopping	13 h	13 h

Source: JICA Team

The results:

(a) Day-time operation mode (1,375RT, for an air cooled package type air conditioner)

Fig. 9-3-1 Power Pattern of Day-time Operation



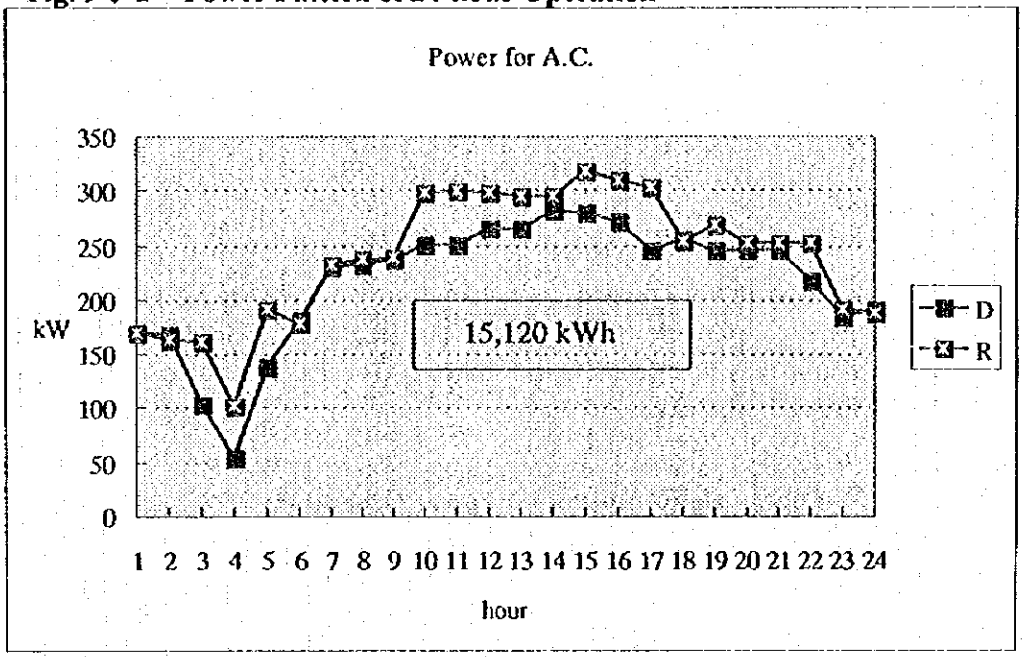
Source: JICA Team

Based on the figures:

Air conditioner load rate = 8,295kWh/(1,375RT*0.9kW/RT*10 hour) = 0.67

(b) 24-hour operation mode (700RT, for a water cooled turbo chiller)

Fig. 9-3-2 Power Pattern of 24-hour Operation



Source: JICA Team

Based on the figures:
Air conditioner load rate = 15,120kWh/(700RT*0.9kW/RT*24hour)= 0.36

Consequently, annual energy consumption for air conditioning by type of business is calculated by gas volume of calorific equivalence (Gas consumption for refrigerator: 0.343 m^3/RTh (8,800 kcal/m^3 natural gas)) and the result is shown in Table 9-3-4.

Table 9-3-4 Energy Consumption for Air Conditioning

	Cooling Load (kcal/m2h)	RT/m2 (C.I./3,024)	Annual full rate hours				Ene. consump. m3/m2.y
			Operation h	day/year	Load rate	hr	
Office	102.2	0.0338	10	300	0.67	2,010.0	23.303
Hotel	90.8	0.0300	24	360	0.36	3,110.4	32.006
Hospital	86.0	0.0284	24	360	0.36	3,110.4	30.299
Shopping	106.9	0.0354	13	360	0.67	3,135.6	38.073

Source: JICA Team

In the air conditioning market, it is necessary to distinguish centralized systems and decentralized ones because in centralized systems gas absorption chillers are more appropriate and in decentralized ones gas heat pumps, or GHP, may be better. From the interview survey data we determined the "degree of preference" of centralized air conditioning systems to decentralized ones.

Table 9-3-5 Degree of Preference of Centralized and Decentralized Air Conditioning Systems

	Office	Hotel	Hospital	Shopping
Centralized System	0.474	0.940	0.568	0.773
Decentralised Syster	0.526	0.060	0.432	0.227

Source: JICA Team

(3) Power Generator

Currently, most power generators owned by buildings are only for emergency use. But supposing the energy situation were to change and the generators were driven by urban gas, the gas consumption may be calculated as follows. Gas consumption coefficient for generator is 0.361 m^3/kWh (8,800 kcal/m^3 gas).

Table 9-3-6 Energy Consumption for Power Generator

	Operation hour	Load rate	day/year	W/m2	Energy consumptio m3/m2.y
Office	10	0.5	300	45.83	24.81
Hotel	22	0.5	360	51.57	73.72
Hospital	14	0.5	360	43.40	39.48
Shopping	13	0.5	300	83.84	70.83

Source: JICA Team

(4) Unit Energy Consumption by Type of Business and by Kind of Energy Use

Finally, from Tables 9-3-1, 9-3-4 and 9-3-6 unit energy consumption by type of business is indicated by thermally equivalent gas volume:

Table 9-3-7 Unit Energy Consumption by Type of Business (m^3/m^2.y)

	Cooking	Boiler	A.C.Abs.	Power Gen.
Office	1.50	-	23.303	24.81
Hotel	3.45	15.93	32.006	73.72
Hospital	1.44	11.07	30.299	39.48
Shopping	3.09	-	38.073	70.83

Source: JICA Team

9.3.2 Possibility of Gas Penetration by Type of Business

(1) Comparison of Gas Systems with Typical Alternatives

The pay back period, which is calculated by dividing the difference of investment costs between gas systems and typical alternatives by the difference of running costs between them, based on current energy prices, is shown below. The shorter the period, the more attractive it is to potential customers. The detailed calculation is shown in the Appendices.

Table 9-3-8 Pay Back Period (years)

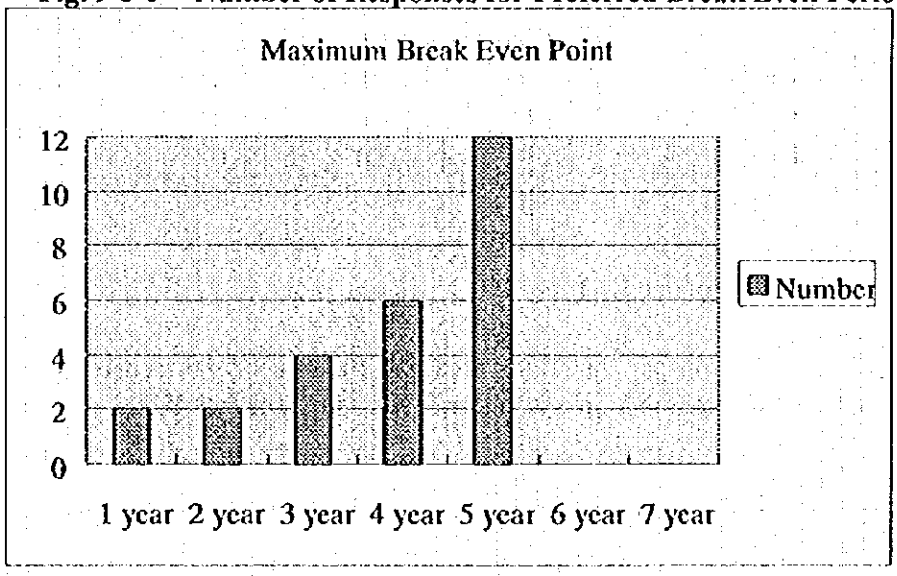
	Cooking	Boiler	AC Abs	AC GHP	Power gen.
Typical competing system	LPG	Solar(IDO)	Chiller	Package air condition	Solar(IDO) driven generator
Office	1.1	-	3.6	More than 5	More than 5
Hotel	1.1	2.7	2.7	More than 5	More than 5
Hospital	1.1	5.2	3.9	More than 5	More than 5
Shopping	1.1	-	2.1	5.1	More than 5
Restaurant	1.1	-	-	-	-

Source: JICA Team

(2) Customer Preference for Break Even Period for Investment

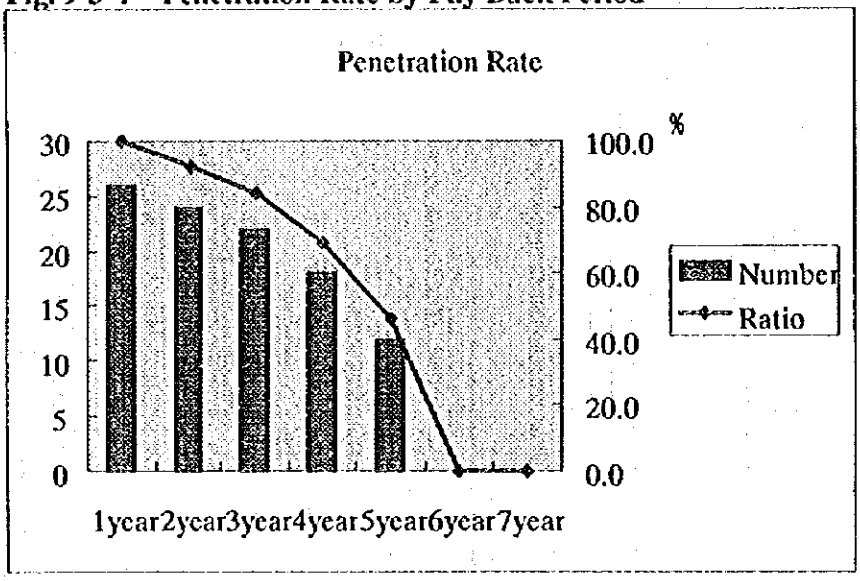
Based on the data of the visiting survey, the preferred maximum break even periods (pay back years) for gas conversion for all sub-sectors were determined as follows:

Fig. 9-3-3 Number of Responses for Preferred Break Even Period



Source: JICA Team

Fig. 9-3-4 Penetration Rate by Pay Back Period



Source: JICA Team

(3) Rate of Gas Penetration

Using the pay back period (Table 9-3-8) and the break even period for investment (Fig. 9-3-4), the rate of gas penetration was calculated.

Table 9-3-9 Rate of Gas Penetration (%)

	Cooking	Boiler	A.C.Abs.	A.C.GHP	Power Gen.
Office	100	-	85	0	0
Hotel	100	85	90	0	0
Hospital	100	40	80	0	0
Shopping	100	-	95	40	0

Source: JICA Team

(4) Marketable Gas Sales Volume Unit

Using the energy consumption per unit floor area and the rate of gas penetration, the marketable gas sales volume per unit area is determined as in Table 9-3-10.

Table 9-3-10 Marketable Gas Sales Per Unit Area ($m^3/m^2.y$)

	Cooking	Boiler	A.C.Abs.	A.C.GHP	Power Gen.
Office	1.50	-	9.39	0	0
Hotel	3.45	13.54	27.08	0	0
Hospital	1.44	4.43	13.77	0	0
Shopping	3.09	-	27.96	3.46	0

Source: JICA Team

9.4 Urban Gas Demand in the Commercial Sector

9.4.1 Projection of Gas Market Development until 2000 (Short-term Estimation)

For the time being, gas pipelines are not established to supply every commercial customer, and so gas sales will be limited until 2000. Assuming that PGN make maximum marketing efforts in the new land development areas near existing gas pipelines, within 10 km, the realistic ("possible") gas demand can be estimated.

(1) Composition of Land Development (A Typical Case)

Table 9-4-1 Composition of Land Development

Land Area		310 ha		
Housing Zone		5,322 units		
Commercial Zone	Type of business	Unit number	Floor area	Floor area per unit land area
	Office	2 buildings	9,100 m^2	29 m2/ha
	Hotel	1	8,000 m^2	26 m2/ha
	Hospital	1	10,000m^2	32 m2/ha
	Shopping	1	22,000m^2	71 m2/ha

Source: JICA Team

(2) Targeted Land Development

New land developments located near existing pipelines, within 10 km, have been selected for study. The figures for those land developments are arranged in Table 9-4-2.

Using the size and composition of a typical land development in Table 9-4-1, and the appliances' capacity per unit floor area and marketable gas sales per unit floor area in Section 9.3, the size of main gas appliances and the volume of gas sales are calculated as shown in Table 9-4-3 and Table 9-4-4.

Still, BSD is quite a different land development; that is, it is an exceptionally huge and is

commercially oriented differently from most others, which are residential developments. So, it is impossible to adopt the method mentioned above to calculate the volume of gas sales in BSD. We employed the floor areas estimated from the result of the feasibility study of BSD described in Chapter 19, i.e., offices: 1,947,200m^2, hotels: 48,000m^2, hospitals: 23,040m^2, shopping centers: 1,229,440m^2.

Table 9-4-2 Land Developments Located Near Existing Pipelines

	Number of sites	Average ha	Total ha	Estimated floor area (m2)			
				Office	Hotel	Hospital	Shopping
Tangeran	7	Over 1000	16,000	2,324,200	386,000	439,040	2,152,440
	3	750					
	2	357					
	4	175					
	4	75					
DKI	1	1,000	6,625	192,125	172,250	212,000	470,375
	5	750					
	1	375					
	6	175					
	6	75					
Bekasi	2	1,000	3,475	100,775	90,350	111,200	246,725
	1	750					
	2	175					
	5	75					

Source: RUMAH UNTUK ANDA 1195 (Note) Detail of the land development in Tangerang over 1,000 ha is shown in Appendices

Table 9-4-3 Size of Potential Gas Market in Land Developments (Typical Capacity)

		Floor area	Gas sales for cooking (m2*U.E.C.*R.G.P.)	Boiler (m2*U.C.*R.G.P)	Air Con. (m2*U.C.*R.C.D.*R.G.P.)		
		m2	m3/y through 20 years	Ton	Abs.Type (RT)	GHP Type (RT)	Total (RT)
Tangera	Office	2,324,200	3,486,300	0.0	31,651	0	31,651
	Hotel	386,000	1,331,700	45.9	9,797	0	9,797
	Hospital	439,040	632,218	32.1	5,666	0	5,666
	Shopping	2,152,440	6,651,040	0.0	55,955	6,919	62,873
	Total		12,101,257	78.1	103,068	6,919	109,987
DKI	Office	192,125	288,188	0.0	2,616	0	2,616
	Hotel	172,250	594,263	20.5	4,372	0	4,372
	Hospital	212,000	305,280	15.5	2,736	0	2,736
	Shopping	470,375	1,453,459	0.0	12,228	1,512	13,740
	Total		2,641,189	36.0	21,952	1,512	23,464
Bekasi	Office	100,775	151,163	0.0	1,372	0	1,372
	Hotel	90,350	311,708	10.8	2,293	0	2,293
	Hospital	111,200	160,128	8.1	1,435	0	1,435
	Shopping	246,725	762,380	0.0	6,414	793	7,207
	Total		1,385,378	18.9	11,514	793	12,307

Source: JICA Team

(Note)U.E.C. Unit Energy Consumption (Consumption per Unit Floor Area)
U.C. Unit Capacity of Appliance (Boiler: Ton/h m2, Air Con: RT per m2)
R.G.P. Rate of Gas Penetration
R.C.D. Ratio of Centralized and Decentralized Systems in Air Conditioning

Table 9-4-4 Size of Potential Gas Market in Land Developments

		Cooking	Boiler	AirCon.	Total
Tangerang	Office	3,486	0	21,821	25,307
	Hotel	1,332	5,227	10,452	17,010
	Hospital	632	1,944	6,045	8,621
	Shopping	6,651	0	67,621	74,272
	Total	12,101	7,171	105,939	125,211
DKI	Office	288	0	1,804	2,092
	Hotel	594	2,332	4,664	7,591
	Hospital	305	939	2,919	4,163
	Shopping	1,453	0	14,777	16,231
	Total	2,641	3,271	24,164	30,076
Bekasi	Office	151	0	946	1,097
	Hotel	312	1,223	2,446	3,982
	Hospital	160	492	1,531	2,184
	Shopping	762	0	7,751	8,513
	Total	1,385	1,716	12,675	15,776

Source: JICA Team

Note Volume: 1,000m3/y through 20 years

Assuming that a regional development lasts 20 years, annual gas demand is calculated as the total demand divided by 20.

As natural gas driven absorption chillers are not yet popular in Indonesia, it is assumed that the lead time for introduction is 1 year, and the penetration rate in the 2nd year is 25%, the next year 50%, the fourth year 75%. Base on this, short-term gas market development is estimated as follows:

Table 9-4-5 Short-term Gas Market Development (1,000m^3/y)

	Cooking	Boiler	Air Conditioner	Total
1997	0	0	0	0
1998	806	608	158	1,573
1999	806	608	317	1,731
2000	806	608	475	1,890

Source: JICA Team

9.4.2 Projection of Gas Market Development after 2005 (Long-term Estimation)

For a long-term estimation, we projected the demand in the commercial sector separately as in Jakarta DKI and in the suburban areas of Tangerang and Bekasi. As DKI has been experiencing an expanding construction boom, the floor area of new buildings will increase commensurately with the index of business activity, i.e., the growth rate of GRDP. In the areas with the existing pipeline network of DKI, together with an extra marketing effort by PGN, the gas demand estimated by a statistical method will most

likely be achieved. Namely, the gas demand from newly constructed buildings will be calculated using the gas penetration rate and the estimated market growth size multiplied by energy consumption per unit floor area by each type of business.

On the other hand, suburban areas will be developed mainly as residential areas supporting DKI. Therefore the gas demand in the commercial sector in the suburban areas should be steady and stable. So we estimate the volume of gas market development per year in the suburban areas as follows:

Table 9-4-6 Gas Market Development in Suburban Areas (1,000m3/y)

	Cooking	Boiler	Air Conditioner	Total
Tangerang	605	359	5,297	6,261
Bekasi	69	86	634	789
Total	674	444	5,931	7,049

Source: JICA Team

Below, we explain the demand estimation in DKI in (1),(2) and (3), and then we discuss the total gas market development adding the results of (1),(2) and (3) to the figures of Table 9-4-6 in Section 9.4.3.

(1) Estimation of Market Size in DKI

The data of the building construction trend (1991-1994) in DKI Jakarta is obtained from BPS statistics.

Table 9-4-7 Construction Data in DKI

ANGGOTA AKI

Floor area by ANGGOTA AKI (All INDONESIA) (m2)

	1991	1992	1993	1994	Total
Office	1,856,158	4,567,472	5,322,488	6,283,280	18,029,398
Hotel	211,865	245,997	285,627	320,262	1,063,751
Hospital	38,640	45,250	52,990	81,828	218,708
Shops	384,415	398,355	412,800	517,940	1,713,510

Sales by ANGGOTA AKI (All INDONESIA) (bil. Rp)

	1991	1992	1993	1994
DKI Jakarta	2,465	3,713	4,835	6,021
All INDONESIA	3,837	5,259	7,210	9,286

NON ANGGOTA AKI

Floor area by DKI JAKARTA (m2)

	1990	1991	1992	1993	1994
Office	1,416,452	1,143,138	16,522	25,675	34,230
Hospital	102,465	133,204	0	4,115	6,312
Commercial	1,695,102	1,032,840	180,620	205,062	398,738

Original Data

Breakdown of DKI by the proportion of RP(DKI)/RP(All INDONESIA)

DKI	1991	1992	1993	1994
Office	1,192,450	3,224,762	3,569,241	4,074,050
Hotel	136,108	173,681	191,540	207,656
Hospital	24,823	31,948	35,535	53,057
Shops	246,959	281,250	276,822	335,830

Total Floor Area in DKI

DKI	1991	1992	1993	1994
Office	2,335,588	3,241,284	3,594,916	4,108,280
Hotel	528,587	242,316	269,464	359,177
Hospital	158,027	31,948	39,650	59,369
Shops	887,320	393,234	403,961	583,047

"Commercial" is broken down into hotels and shops by the following proportion(ANGGOTA AKI data).
Hotel: 38% Shops: 62%

DKI	1991	1992	1993	1994
Office	1,143,138	16,522	25,675	34,230
Hotel	392,479	68,636	77,924	151,520
Hospital	133,204	0	4,115	6,312
Shops	640,361	111,984	127,138	247,218

Source: STATISTIK BANGUNAN KONSTRUKSI 1994

The figures for 1995 are based on the average of the floor areas of 1991 through 1994

times the growth rate of GRDP 1995/1994. From 1996 until 2020, the construction growth is expected to be linked to the growth rate of the GRDP. The elasticity of 0.6 was experienced in Japan from 1965 until 1985, just before the "bubble economy period," which is used here.

The growth rates of GRDP are projected as shown below.

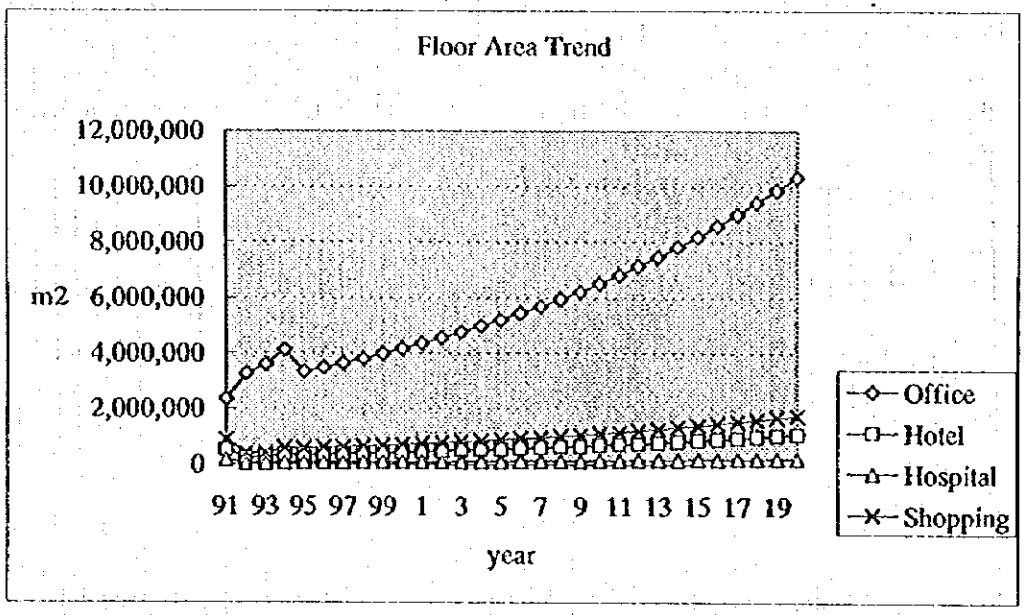
Table 9-4-8 GRDP Growth Rate

	until 2000	2001-2010	2011-2020
High Case	8.1	8.3	10.3
Base Case	7.7	7.6	7.9
Low Case	7.3	6.7	5.3

Source: JICA Team

The results of the estimation of floor areas are shown in Fig. 9-4-1 for the Base Case by type of business. The comparable numeric data in all cases are shown in the Appendices.

Fig. 9-4-1 Construction Forecast in the Base Case



source : STATISTIK BANGUNAN/KONSTRUKSI 1994

(2) Estimation of Gas Pipeline Density in DKI

If the pipeline network was perfectly installed to cover all customers, the gas demand could be directly calculated by the market size and the penetration rate. But in Jakarta the network will not be sufficient in 2005. So a new index named "pipeline density" is introduced. It is decided that the density in a metropolitan city in Japan, in which the

length of gas pipelines is 598 km in the area of 220 km^2 for the pressure over 1 bar, is taken as 100%. The length of gas pipelines in DKI, the area being about 670 km^2, is 210 km; and so the density is calculated as 11.5%.

It is assumed that 10 km of pipelines will be installed every year to meet with new gas development in a newly constructed regional development zone. In that case the density will increase by 0.5 percent per year and in 2005 the density will be 16%.

(3) Projection of Gas Market Development from 2005 until 2020 in DKI.

We calculate the long-term gas market development, which means the increase of gas sales each year, using the forecast of the floor areas by type of business (Fig. 9-4-1), unit of marketable gas sales (Table 9-3-10) and the density of gas pipelines. The result is shown in Table 9-4-9, and the detailed procedure is shown in the Appendices.

Table 9-4-9 Long-term Gas Market Development in DKI in Each Case (1,000m3/y)

Case	Item	2005	2006	2007	2008	2009	2010	2015	2020
Base	Cooking	2,016	2,174	2,343	2,520	2,710	2,913	4,168	5,879
	Boiler	1,268	1,367	1,472	1,585	1,704	1,832	2,621	3,697
	Air Conditionin	14,899	16,065	17,307	18,628	20,034	21,530	30,807	43,457
	Total	18,182	19,606	21,121	22,734	24,449	26,274	37,596	53,034
High	Cooking	2,080	2,252	2,436	2,632	2,842	3,067	4,698	7,096
	Boiler	1,308	1,416	1,532	1,655	1,787	1,929	2,955	4,462
	Air Conditionin	15,376	16,646	18,005	19,457	21,010	22,669	34,729	52,451
	Total	18,764	20,314	21,973	23,745	25,640	27,664	42,382	64,009
Low	Cooking	1,942	2,083	2,232	2,390	2,558	2,734	3,630	4,750
	Boiler	1,221	1,310	1,404	1,503	1,608	1,719	2,282	2,987
	Air Conditionin	14,353	15,396	16,500	17,669	18,904	20,210	26,828	35,109
	Total	17,515	18,789	20,137	21,562	23,070	24,664	32,740	42,846

Source: JICA Team

9.4.3 Projection of Gas Market Development from 1997 until 2020

The total gas development from 2005 until 2020 in Jatabek was calculated by adding the figures in Table 9-4-6 and those in Table 9-4-9.

We linked 2000 and 2005 by a strait line.

Gas market development by year from 1997 until 2020 is shown in Table 9-4-10 and in Fig. 9-4-2.

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We linked 2000 and 2005 by a strait line.

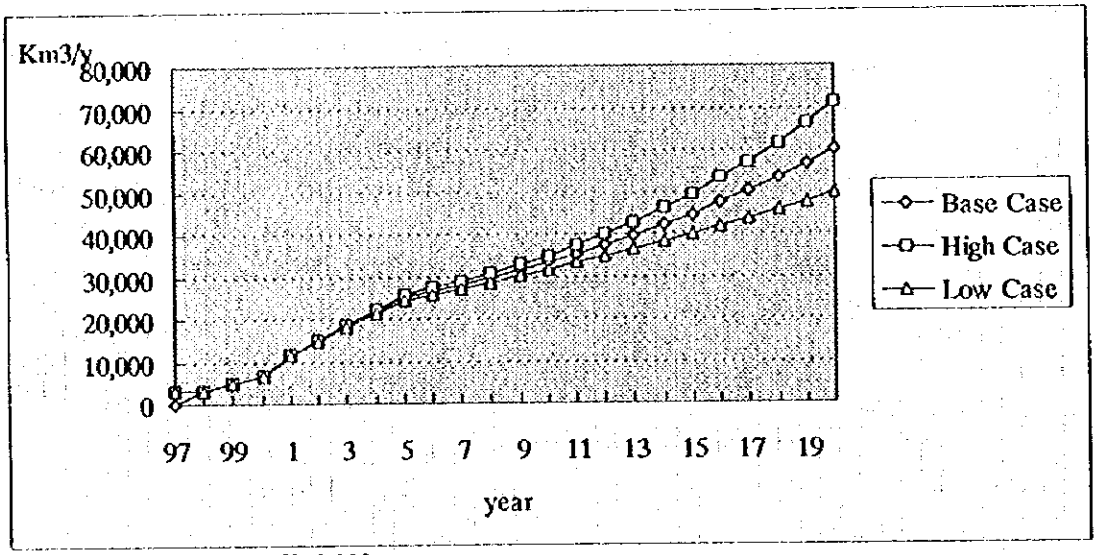
Gas market development by year from 1997 until 2020 is shown in Table 9-4-10 and in Fig. 9-4-2.

Table 9-4-10 Gas Market Development in Each Case (1,000m3/y)

Case	Item	1997	1998	2000	2005	2010	2015	2020
Base	Cooking	0	806	806	2,690	3,587	4,842	6,554
	Boiler	0	608	608	1,712	2,276	3,065	4,141
	Air Conditionin	2,978	1,785	5,354	20,830	27,461	36,738	49,388
	Total	2,978	3,199	6,768	25,232	33,324	44,645	60,083
High	Cooking	0	806	806	2,755	3,741	5,373	7,770
	Boiler	0	608	608	1,752	2,373	3,399	4,907
	Air Conditionin	2,978	1,785	5,354	21,307	28,599	40,659	58,381
	Total	2,978,000	3,199	6,768	25,814	34,714	49,431	71,058
Low	Cooking	0	806	806	2,616	3,409	4,304	5,424
	Boiler	0	608	608	1,665	2,164	2,727	3,431
	Air Conditionin	2,978	1,785	5,354	20,283	26,141	32,759	41,040
	Total	2,978	3,199	6,768	24,565	31,713	39,790	49,895

Source: JICA Team

Fig. 9-4-2 Gas Market Development in Each Case



Source: JICA Team; K=1,000

9.4.4 Cumulative Gas Demand Projection

In 1996 gas sales volume for the commercial sector was 10 million m^3 and that in 1997 is estimated as 13.212 million m^3 by PGN. From 1998 until 2020, using the result of the estimation of gas development, cumulative gas demand is calculated and the result is shown in Table 9-4-11 in each case, the composition of the demand in Base Case in Fig. 9-4-3 and the demand in each case in Fig. 9-4-4.

Table 9-4-10 Gas Market Development in Each Case (1,000m3/y)

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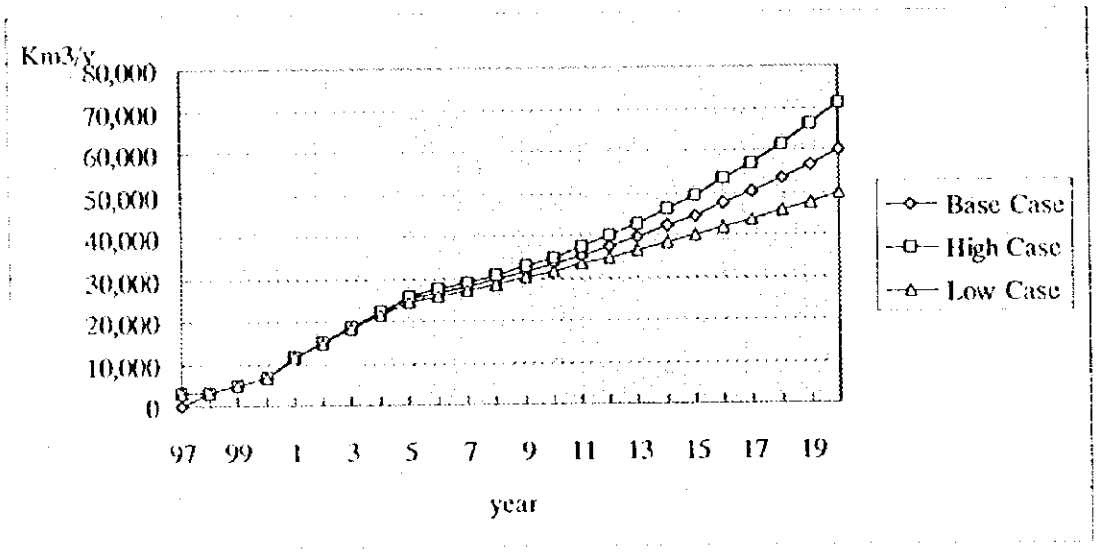

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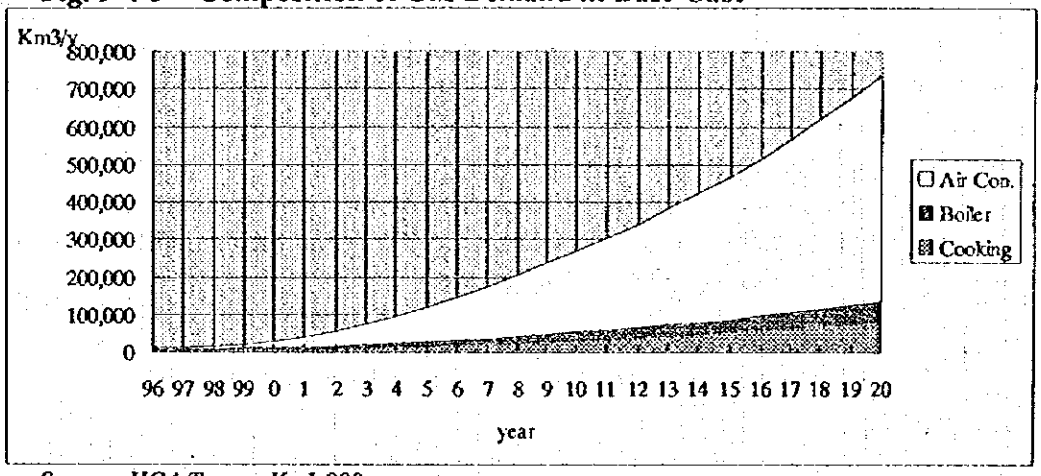
Table 9-4-11 Projection of Gas Demand in Each Case (1,000m3/y)

Case	Item	1996	1997	1998	2000	2005	2010	2015	2020
Base	Cooking	4,564	4,564	5,370	6,983	16,666	32,696	54,240	83,376
	Boiler	2,670	2,670	3,278	4,494	10,845	21,027	34,676	53,098
	Air Conditionin	3,000	5,978	7,763	16,686	92,850	216,068	380,042	600,131
	Total	10,234	13,212	16,411	28,163	120,361	269,791	468,958	736,605
High	Cooking	4,564	4,564	5,370	6,983	16,860	33,461	56,809	90,501
	Boiler	2,670	2,670	3,278	4,494	10,967	21,507	36,291	57,579
	Air Conditionin	3,000	5,978	7,763	16,686	94,280	221,720	399,027	652,792
	Total	10,234	13,212	16,411	28,163	122,106	276,688	492,126	800,871
Low	Cooking	4,564	4,564	5,370	6,983	16,444	31,813	51,461	76,243
	Boiler	2,670	2,670	3,278	4,494	10,706	20,471	32,928	48,613
	Air Conditionin	3,000	5,978	7,763	16,686	91,210	209,542	359,502	547,405
	Total	10,234	13,212	16,411	28,163	118,360	261,827	443,891	672,260

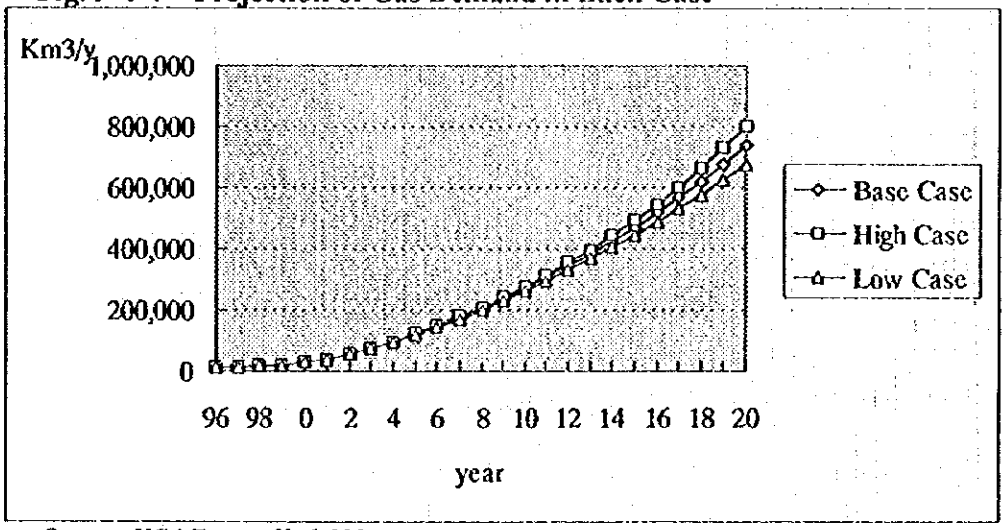
Source: JICA Team

Fig. 9-4-3 Composition of Gas Demand in Base Case



Source: JICA Team K=1,000

Fig. 9-4-4 Projection of Gas Demand in Each Case



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High	Cooking	4,564	4,564	5,370	6,983	16,860	33,461	56,809	90,501
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	Total	10,234	13,212	16,411	28,163	118,360	261,827	443,891	672,260

Source: JICA Team

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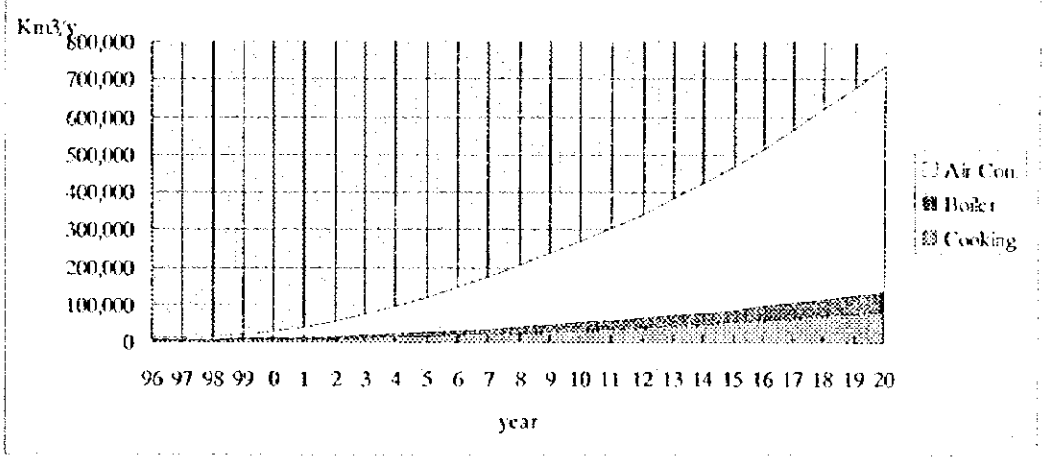
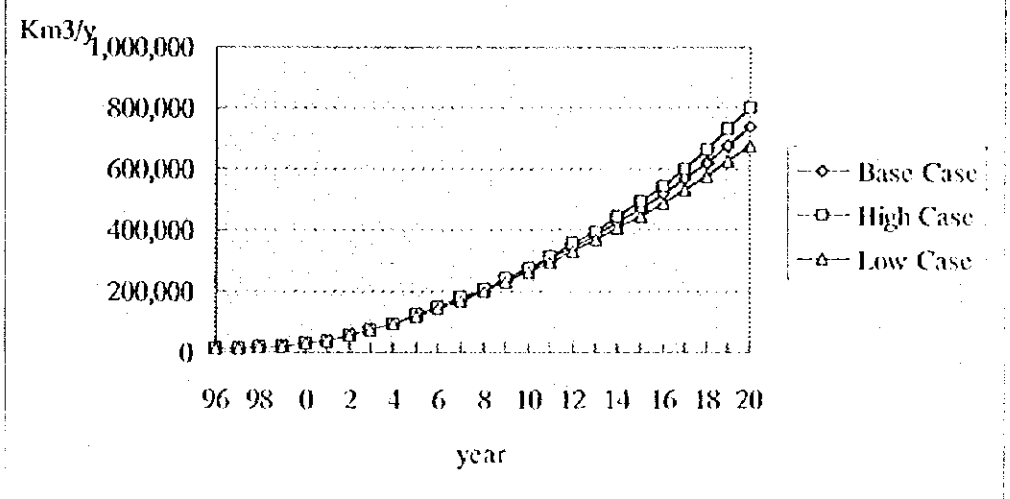


Source: JICA Team K=1,000

Fig. 9-4-4 Projection of Gas Demand in Each Case



Source: JICA Team K=1,000

9.4.5 Assumption on Major Commercial Gas Appliances

(1) Cooking

Based on the data in a metropolitan city in Japan, the average annual full rate hours (operating hours as of full load operation) of a restaurant is approximately 1,000 hr/year. So, maximum capacity required for cooking is calculated by dividing the gas sales volume by 1,000.

(2) Boiler

Using the data obtained in the visiting surveys we have determined the required boiler capacity installation per area of floor space, e.g., hotel:0.14 kg/h.m2 and hospital:0.183 kg /h.m2. The capacity of the boilers is obtained by multiplying the floor area by the coefficient capacity per area. And the gas flow rate is calculated by using the figure of 75.43 m3/h /Ton.h (Efficiency on lower thermal value(L.H.V.)=0.9).

(3) Air Conditioning

In the same way as in the boiler market, the capacities of air conditioners to be installed are calculated using the coefficient of capacity of RT per area and the figure of maximum gas flow rate of 0.343 m3/RTh (COP=1.11 on L.H.V.)

(4) Result

The result is shown in Table 9-4-12.

Table 9-4-12 Assumption on Major Gas Appliances

			1997	1998	2000	2005	2010	2015	2020
Cooking	Max. gas flow rate m3/h	Increase	0	806	806	2,690	3,587	4,842	6,554
		Cumulative	0	806	2,419	12,102	28,132	49,676	78,812
Boiler	Ton/h	Increase	0	6.6	6.6	16.6	21.8	29.2	39.2
		Cumulative	0	6.6	19.9	83.0	181.0	311.3	485.9
	Max. gas flow rate	Increase	0	502	502	1,253	1,648	2,200	2,953
		Cumulative	0	502	1,505	6,257	13,656	23,482	36,649
Air Con.	RT	Increase	0	1,822	5,466	24,055	32,039	43,211	58,443
		Cumulative	0	1,822	10,932	96,941	240,180	432,492	692,374
	Max. gas flow rate	Increase	0	625	1,875	8,251	10,990	14,821	20,046
		Cumulative	0	625	3,750	33,251	82,382	148,345	237,484

Source: JICA Team

9.4.6 Projection of Numbers of Customers

We were unable to obtain data pertaining to the distribution of the size of buildings in Jakarta, and so used the data of a metropolitan city in Japan

Table 9-4-13 Distribution of the Size of New Buildings in Japan (1993-1995)

Type of Business	Sample Number	Average Floor Area (m2)
Office	145	9,000
Hotel	8	6,000
Hospital	6	24,500
Shopping	4	32,500

Source: JICA Team

The number of gas customers is calculated by dividing the floor area of the target buildings for marketable gas by the average floor area. The result is shown in Table 9-4-14.

Table 9-4-14 Projection of Numbers of Customers

		1997	1998	2000	2005	2010	2015	2020
Cooking	Increase	0	27	27	126	172	237	324
	Cumulative	0	27	80	511	1,274	2,320	3,755
Boiler	Increase	0	4	4	7	9	11	15
	Cumulative	0	4	11	39	79	130	198
Air Con.	Increase	0	3	10	57	77	105	143
	Cumulative	0	3	20	215	556	1,021	1,656

Source: JICA Team

9.5 Recommendations for Expanding Gas Use in the Commercial Sector

(1) Marketing

Currently, gas use in the commercial sector is limited to cooking and only a few customers adopt gas driven boilers. So gas boilers and gas air conditioners are not yet popular in Jakarta. Gas use systems are generally more expensive than alternative systems initially but the operation cost of gas systems is relatively cheaper than that of alternative ones. Consequently, in order to achieve projected gas market development, it is necessary to make the maximum effort to educate customers to recognize the advantages of gas systems, e.g., higher economy, ease of handling, safety, environmental friendliness, etc. Organized public relation activities are important and active presentation of gas use systems to planners and users of newly constructed buildings in the early stage is also necessary.

(2) Power Generation Market

Installation of self powered generators in buildings was common a few years ago when there was a shortage of electricity. But now it may be difficult to get permission for self generation from relevant agencies due to improved electrical facilities in the Jakarta area. Still a change of energy circumstances and the consequent revival of self generators is not

implausible. For the time being, diesel engines are slightly cheaper than gas engines, but an increase in fuel price will reverse the situation. The sensitivity of the pay back years of co-generation systems are analyzed in Chapter 11. PGN should not miss the timing that co-generation systems become feasible.

(3) Training of Sales Engineers & Cooperation with Manufacturers

In order to expand gas use in boilers, air conditioners and power generators, training of sales engineers is urgent. At the same time in cultivating the gas market, it is efficient to conduct marketing activities in conjunction with manufacturers. It is important to keep good relationships with manufacturers and to exchange marketing and technical information constantly.

(4) Piping Strategy

Expansion of gas sales depends on the density of gas pipelines, so strategic gas pipeline extension must be worked out. There are many big regional developments in the Jatabek area as shown in the Appendices. It is necessary to lay additional pipelines to catch up with the speed of development near existing pipelines. At the same time most big buildings constructed lately are concentrated in the "Golden Triangle Area" (as shown in the Appendix); so the main streets in that area and their extension must be focused as target areas for the installation of new pipelines or for reinforcing existing pipelines. In this sense, the planned subway construction is a good chance to lay pipelines in order to reduce costs.