Chapter 10

Industrial Gas Market

10. Industrial Gas Market

10.1 Overview of Energy Consumption in the Industrial Sector

10.1.1 Historical Trends of Energy Demand

(1) Energy supply and demand of the Study area

The industrial areas in five prefectures in West Java are specially selected for this study. They are DKI Jakarta and Kabupatens Tangerang, Bekasi, Karawang and Purwakarta. These regions are under the jurisdiction of the PGN Jakarta Branch Office. Besides those regions, Kabupatens Serang and Bogor have already developed large industrial areas. Those two prefectures are additionally described in this chapter.

The situation of fuels consumption for factory use in the industrial sector in the five regions are illustrated in Fig. 10-1-1, Fig. 10-1-2, and Table 10-1-1. Fig. 10-1-1 shows by type the annual consumption of factory use fuels in industry for each county from 1985 to 1994. Fig. 10-1-2 shows the trends of composition in this breakdown.

The statistics of the total industrial fuels include fuels for factory transportation, i.e., for truck diesel oil fuel and automotive gasoline, and net fuels used for production in factories, i.e., for process heating, boiler, and power generation. Fig. 10.1-1, Fig. 10.1-2, and Table 10.1-1 show the data of net fuels used for production in factories excluding transport use. Whole fuel data including both use of transport and production in factories are compiled in the Appendices.

The statistical data of industrial gas consumption in each county include LPG. The majority of gas referred to in these tables is natural gas from offshore West Java that is brought ashore via pipelines. Analyses in this chapter use the total industrial consumption of gas including LPG.

The statistics distinguish between consumption of fuel for utility power generation and for industrial purposes. This chapter's analyses of industrial gas consumption in each county, therefore, do not include gas consumption for utility power generation.

(2) Present situation of fuel demand for the industrial sector

First, general trend of fuels consumption in industrial sector of the regions, is presented and then the trend in each region are reviewed as follows.

Table 10-1-1 Consumption of Factory Use Fuel of Industrial Sector in PGN Jakarta Branch Office Area

(103kcal)

Tangerang	1985	%	1990	%	1993	%	1994	%
Gas	35,024,080	7.1%	571,727,000	41.1%	1,011,508,160	41.0%	1,330,048,720	47.9%
Diesel oil	387,388,872	78.2%	652,889,457	46.9%	1,245,745,602	50.5%	1,338,179,710	48.2%
Kerosene	72,231,640	14.6%	164,715,720	11.8%	199,350,840	8.1%	23,965,240	0.9%
Bunker C Fuel	0	0.0%	0	0.0%	8,642,910	0.4%	38,683,126	1.4%
Coal	931,000	0.2%	1,533,000	0.1%	1,064,000	0.0%	18,613,000	0.7%
Coke	7,200	0.0%	792,000	0.1%	676,800	0.0%	27,973,600	1.0%
Total of Tangerang	495,582,792	100.0%	1,391,657,177	100.0%	2,466,988,312	100.0%	2,777,463,396	100.0%

DKI Jakarta	1985	%	1990	%	1993	%	1994	%
Gas	292,329,960	17.7%	777,460,320	39.4%	803,184,720	28.9%	1,360,758,880	38.4%
Diesel oil	1,113,443,928	67.3%	836,696,160	42.4%	846,420,759	30.4%	1,048,788,486	29.6%
Kerosene	234,808,080	14.2%	347,279,400	17.6%	191,368,320	6.9%	225,349,280	6.4%
Bunker C Fuel	0	0.0%	0	0.0%	794,874,272	28.6%	840,569,386	23.7%
Coal	1,449,000	0.1%	28,000	0.0%	50,848,000	1.8%	50,883,000	1.4%
Coke	13,636,800	0.8%	11,901,600	0.6%	94,514,400	3.4%	21,146,400	0.6%
Total of DKI Jakarta	1,655,667,768	100.0%	1,973,365,480	100.0%	2,781,210,471	100.0%	3,547,495,432	100.0%

Bekasi	1985	%	1990	%	1993	%	1994	%
Gas	397,800	0.3%	47,789,040	20.8%	157,891,240	19.6%	476,369,920	41.1%
Diesel oil	126,546,669	96.0%	143,177,274	62.2%	317,558,457	39.4%	232,991,604	20.1%
Kerosene	4,711,720	3.6%	35,227,400	15.3%	128,188,840	15.9%	114,080,200	9.8%
Bunker C Fuel	0	0.0%	0	0.0%	202,273,392	25.1%	298,077,852	25.7%
Coal	0	0.0%	133,000	0.1%	7,000	0.0%	16,940,000	1.5%
Coke	136,800	0.1%	3,830,400	1.7%	108,000	0.0%	19,821,600	1.7%
Total of Bekasi	131,792,989	100.0%	230,157,114	100.0%	806,026,929	100.0%	1,158,281,176	100.0%

Karawang	1985	%	1990	%	1993	%	1994	%
Gas	0	0.0%	150,280	0.2%	574,600	0.1%	105,399,320	20.0%
Diesel oil	83,053,332	98.2%	72,984,339	98.3%	490,797,702	99.3%	368,184,375	70.0%
Kerosene	1,555,840	1.8%	1,149,200	1.5%	2,979,080	0.6%	3,827,720	0.7%
Bunker C Fuel	0	0.0%	0	0.0%	68,362	0.0%	48,331,934	9.2%
Coal	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Coke	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Total of Karawang	84,609,172	100.0%	74,283,819	100.0%	494,419,744	100.0%	525,743,349	100.0%

Purwakarta	1985	%	1990	%	1993	%	1994	%
Gas	17,680	0.0%	0	0.0%	8,840	0.0%	8,406,840	1.8%
Diesel oil	14,111,091	36.5%	22,621,248	76.2%	19,992,978	3.2%	57,912,570	12.5%
Kerosene	24,274,640	62.7%	7,063,160	23.8%	11,774,880	1.9%	9,529,520	2.1%
Bunker C Fuel	0	0.0%	0	0.0%	590,911,362	94.9%	388,344,990	83.7%
Coal	189,000	0.5%	21,000	0.1%	0	0.0%	0	0.0%
Coke	100,800	0.3%	0	0.0%	0	0.0%	0	0.0%
Purwakarta total	38,693,211	100.0%	29,705,408	100.0%	622,688,060	100.0%	464,193,920	100.0%

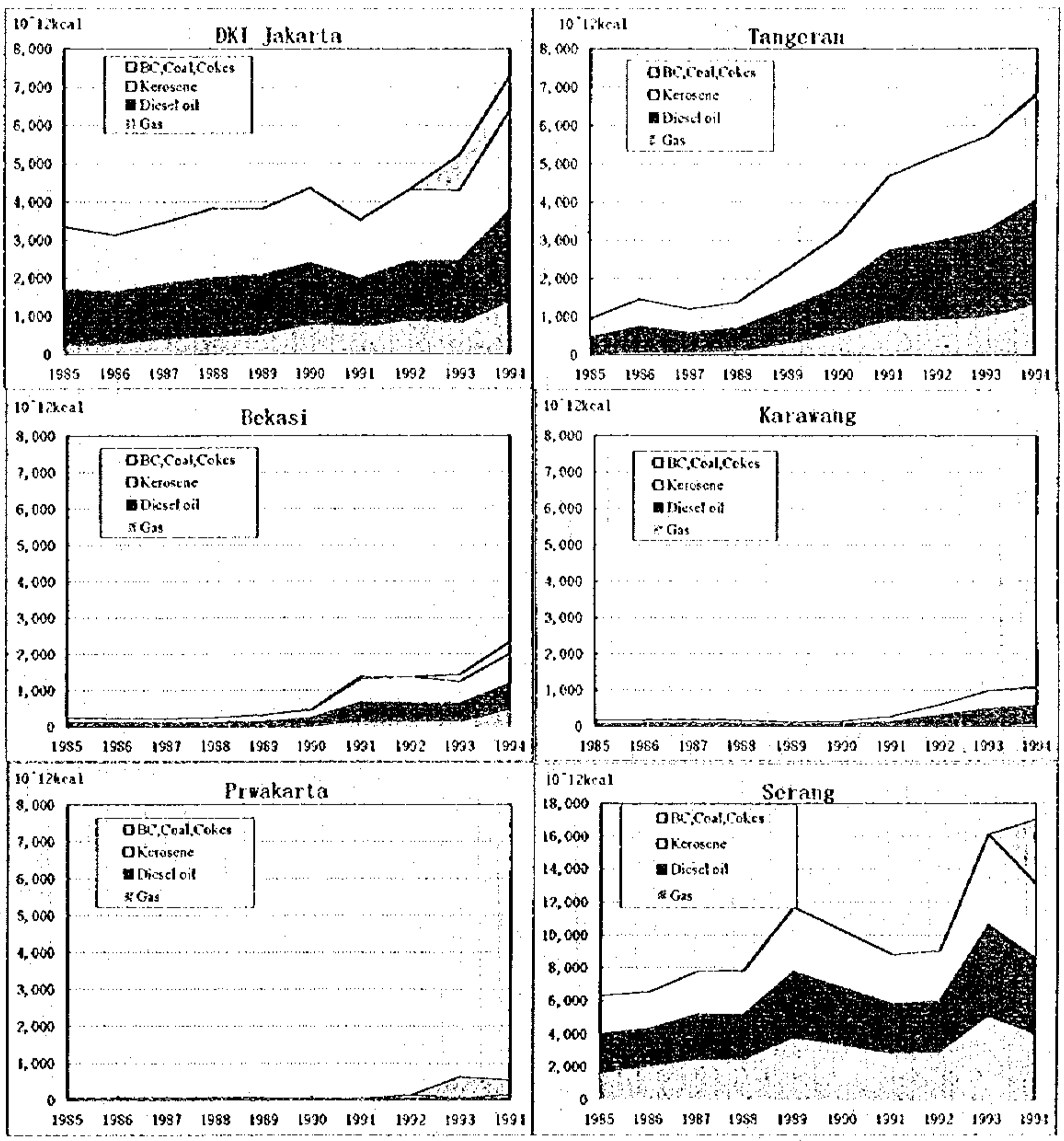
Total of 5 regions	1985	%	1990	%	1993	%	1994	%
Gas	327,769,520	13.6%	1,397,126,640	37.8%	1,973,167,560	27.5%	3,280,983,680	38.7%
Diesel oil	1,724,543,892	71.7%	1,728,368,478	46.7%	2,920,515,498	40.7%	3,046,056,745	35.9%
Kerosene	337,581,920	14.0%	555,434,880	15.0%	533,661,960	7.4%	376,751,960	4.4%
Bunker C Fuel	0	0.0%	0	0.0%	1,596,770,298	22.3%	1,614,007,288	19.0%
Coal	2,569,000	0.1%	1,715,000	0.0%	51,919,000	0.7%	86,436,000	1.0%
Coke	13,881,600	0.6%	16,524,000	0.4%	95,299,200	1.3%	68,941,600	0.8%
Total of 5 regions	2,406,345,932	100.0%	3,699,168,998	100.0%	7,171,333,516	100.0%	8,473,177,273	100.0%

Remarks: BC, C, C, mean C grade Heavy Oil, Coke, Coal

Diesel oil means fuel for net Factory use (Process heating, Boiler, Power generation), not include fuel for transportation

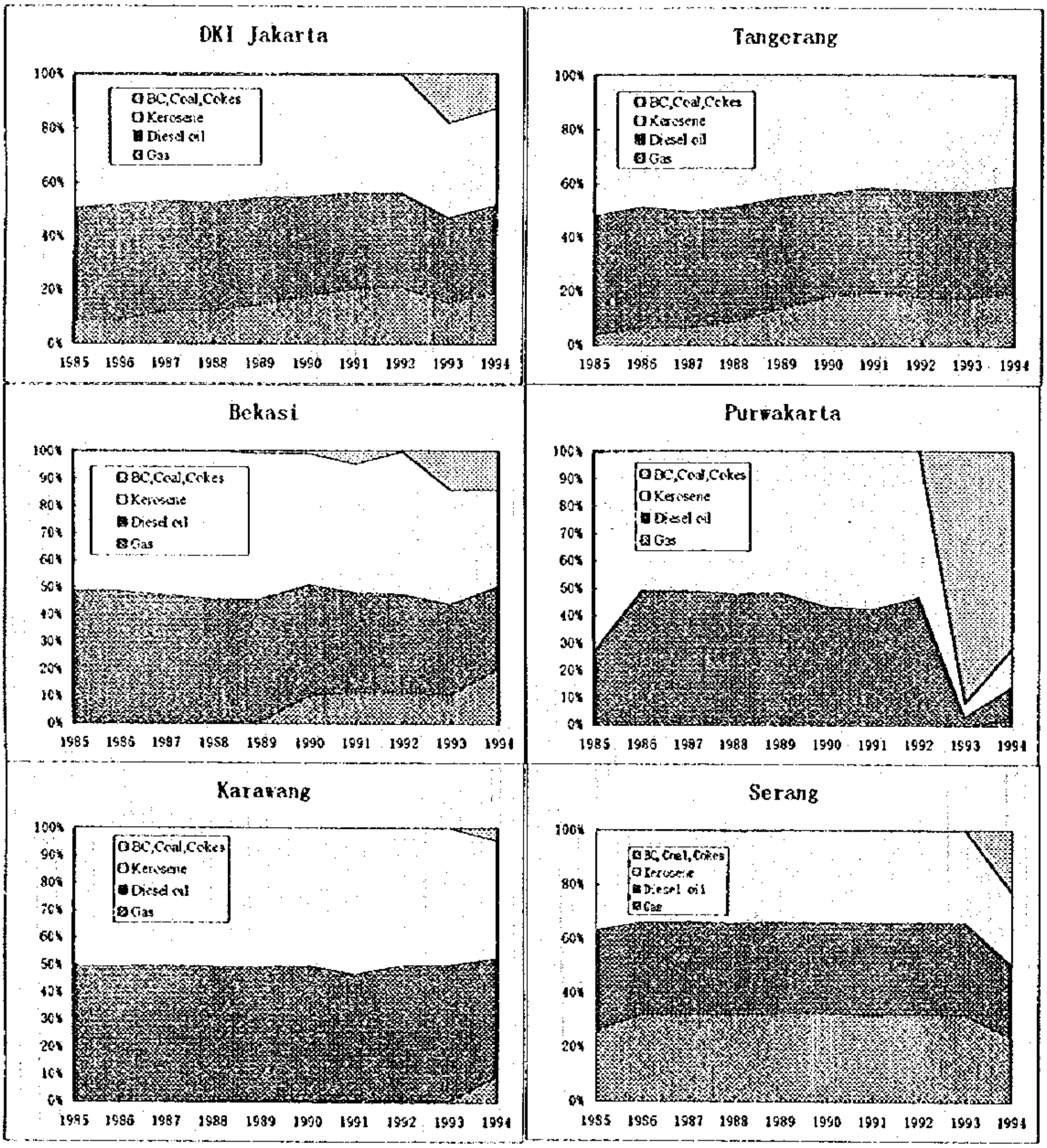
Source: BPS, Quantity of fuel and lubricant used by industrial code, 1985-1994

Fig. 10-1-1 Fuel Consumption of the Industrial Sector in West Java



Remarks: BC, C, C, mean C grade Heavy Oil, Coke, Coal
Diesel oil means fuel for net Factory use (Process heating, Boiler, Power generation), not include fuel for transportation
Source: BPS, Quantity of fuel and lubricant used by industrial code, 1985-1994

Fig. 10-1-2 Share of Fuel Consumption of the Industrial Sector in West Java



Remarks: BC, C, C, mean C grade Heavy Oil, Coke, Coal

Diesel oil means fuel for net Factory use (Process heating, Boiler, Power generation), not include fuel for transportation

Source: BPS, Quantity of fuel and lubricant used by industrial code, 1985-1994

(a) General view in the regions

Types of fuels used in the industry in these regions are currently in transition from diesel oil/ kerosene to urban gas and C grade heavy oil. Diesel oil/kerosene have traditionally been the primary industrial fuels in these regions, gradual change to urban gas began in the latter half of the 1980s.

Then the rapid and large-scale change to C grade heavy oil began approximately three years ago, and this fuel is now used as a factory fuel in a quantity almost equal to the quantity of urban gas in factories. Serang County is the sole site where urban gas has traditionally been consumed as a factory fuel for basic material industries such as steel manufacturing and petrochemical industries, however, even there, consumption of C grade heavy oil is increasing.

(b) DKI Jakarta

DKI Jakarta led West Java Province in industrial development. Urban gas has been used as a factory fuel from around 1985, and by 1990 it comprised approximately 40% of all factory fuels. Over the past three years, while the consumption of urban gas has been increasing, its proportion in the total has been static or slightly reduced because of the rapid increase in consumption of C grade heavy oil. While consumption of C grade heavy oil was almost nil in 1992, and had increased to 30% of the total by 1994. Consumption of diesel oil/kerosene was reduced beginning in 1994, currently diesel oil/kerosene are 36% of the total. Industries in DKI Jakarta currently using C grade heavy oil are widely varied, ranging from the glass industry to the food processing, textile, chemical, and metalworking industries. C grade heavy oil is used in a variety of applications, such as furnaces, boilers, and in-house power generating plants. Data by industry type and county obtained from the Statistics Department (BPS, Quantity of fuel and lubricant used by industrial code, 1985-1994) have revealed that the use of C grade heavy oil is not limited to any specific industrial sectors or application.

(c) Tangerang

Tangerang began using urban gas in 1989. Industrial consumption of urban gas had reached 40% of the total by 1991. This proportion has subsequently remained static because consumption of diesel oil/kerosene has been greater than that of urban gas. C grade heavy oil had just begun to be used in 1994 in the chemical, textile, and paper industries.

(d) Bekasi

Bekasi is a new industrial area immediately east of DKI Jakarta. Urban gas has been used since the first-stage industrialization of this area in 1990, By 1994, industrial consumption of this fuel amounted to 40% of the total. C grade heavy oil was first used in 1991, and by 1994 it comprised approximately 30% of all factory fuel used in the area. It is widely used in such industries as paper, textile, and auto parts. The introduction of C grade heavy oil led first to the static, and then a declining, consumption of diesel oil/ kerosene. The proportional consumption of diesel oil/kerosene dropped from 96% in 1989 to 30% in 1994.

(e) Karawang

Karawang is immediately east of Bekasi, and followed Bekasi in establishment of industry around 1991. Both urban gas and C grade heavy oil have been used since 1994. C grade heavy oil is used primarily in the textile industry, and it comprises only a small proportion of industrial fuel used in the food processing industry. The pattern of fuel consumption in Karawang appears to be similar to that of Bekasi. However, because consumption is still in its initial stage, it is too early to draw conclusions about industrial fuel patterns.

(f) Purwakarta

Purwakarta is immediately east of Karawang. It is a new industrial area developed after Karawang. The use of C grade heavy oil began a year prior to the use of urban gas in this area, C grade heavy oil being introduced in 1993 in the brick making, textile, and chemical industries. As the total fuel consumption in Purwakarta is low, the proportion of C grade heavy oil is extremely high. However, a balanced consumption of C grade heavy oil and urban gas is likely in the future.

Bekasi, Karawang and Purwakarta are in the very early stages of development. Many factories are yet to be built there, so prior investment for distribution pipelines of urban gas is difficult, then urban gas and C grade heavy oil were introduced simultaneously.

(3) Other industrial regions outside of the Study area

Serang and Bogor are not included in the Study area. However, as they have been major industrial regions in West Java for many years, their fuel consumption are reviewed.

(a) Serang

Serang is the westernmost area in West Java, immediately west of Tangerang. Industry in Serang consists mostly of the production of basic materials such as steel and petrochemicals. Industrialization in Serang began around 1980. Natural gas from offshore fields was introduced as a factory fuel at the very beginning, so that the proportion of urban gas was as high as 96% in 1993. In 1994, however, C grade heavy oil began to be used in large amounts by the steel industry, and in smaller amounts by the petrochemical industry, and the share of gas consumption in the total has decreased to 48% of the factory fuel total.

(b) Bogor

As this area is located inland to the south of DKI Jakarta, it suffers from considerable inconvenience in terms of transport and supply of diesel oil/kerosene, coal, coke, and C grade heavy oil compared with regions on the north coast, although it does have a branch distribution pipeline from the transmission pipeline of urban gas. Consumption of urban gas in the area increased gradually from 1989, but stays at a low percentage of 14% of the total in 1994. Recently, it has been used in the machinery, electrical goods, steel fabrication, chemical, rubber, food processing, and lumber industries.

A number of large cement plants are in Bogor, in which coal has been used in large quantities for the past 10 years. Glass and machinery industries in the area already consume coke in large amounts. Coal and coke amount to 47% of the total in 1994. C grade heavy oil has been used since 1991, and the share is 1% of the total in 1994.

It is interesting to note that the large-scale conversion to a new type of fuel is progressing in a well-established inland industrial area such as Bogor, which suffers from difficulties in fuel supply.

10.1.2 Changes of Energy Supply and Demand Structure in the Industrial Sector

In the West Java industrial regions, fuel-switching to new factory fuels is rapidly progressing, particularly over the past 3-4 years. The fuel-switching is from diesel oil/kerosene to urban gas and C grade heavy oil.

In DKI Jakarta and Bekasi, the proportion of diesel oil/kerosene of factory use had already dropped to 30% in 1994. Diesel oil/kerosene consumption in these prefectures has now been reduced to the point at which they are no longer the primary fuels.

C grade heavy oil is now more than able to compete with urban gas as a fuel of preference. Now that a base has been established, it is inconceivable that the consumption of bunker C grade heavy oil will decrease in the short term. Fuel conversion from diesel oil/kerosene in the West Java industrial regions was once promoted solely by urban gas. It is now going to be accelerated jointly by C grade heavy oil and urban gas as well.

Urban gas could not stop an increase of quantity in diesel oil/kerosene consumption. With the introduction of C grade heavy oil, however, the combination of the two has finally resulted in a reduction of quantity in diesel oil/kerosene consumption.

10.1.3 Fuel Selection in Factories

Basic reason of fuel shift from diesel oil/kerosene to urban gas or C grade heavy oil is presumably the price difference among them. As seen in Table 3-2-4 and Table 3-3-1, diesel oil has two grades, HSD(for high speed diesel engine) and IDO(for industrial use). Price is 4.59 US＄/mmBTU(as of 1993) for HSD and 4.25 US＄/mmBTU for IDO. The price of kerosene is 3.47 US＄/mmBTU(as of 1993).

On the other hand, the selling price of gas of PGN is in a range of from 2.45to2.85 US＄/mmBTU(as of 1994) and that of heavy oil is 2.69 US＄/mmBTU(as of 1993). Accordingly, the shift of fuel from diesel oil/kerosene to urban gas or C grade heavy oil has significance to fuel-consuming plants.

Comparison of unit calorific price between urban gas and C grade heavy oil according to the data given above suggests that the price of C grade heavy oil is positioned at middle of the selling price band of gas by PGN, and the price of C grade heavy oil cannot be lower than that of urban gas. Some customers, however, say that C grade heavy oil is cheaper than urban gas.

In fact, C grade heavy oil has several disadvantages compared with urban gas in terms of fuel handling conditions such as troublesome handling, necessity of storage tank, burden of countermeasures to future environmental issues. On the other hand, urban gas secures advantageous position owing to the cleanness as well as superiority in these handling issues.

The urban gas supplier who expects further demand growth can enter further advantageous development in the sales by conducting construction of gas supply network to consumers at an adequate timing and by successfully removing the concern of consumers about the limitation of supply amount and the pressure drop at use point.

Present Indonesia is an importing country of light oils such as gasoline and diesel oil, accounting for import of 3.3 million kl of diesel oil during 1994. Regarding the heavy oil, Indonesia exported 7.5 million kl of domestic high quality, low sulfur, high wax heavy oil during 1994, and imported 700 thousand kl of C grade heavy oil during the year. The consumption of C grade heavy oil at the five regions for this survey was about 600 thousand kl during 1994.

Even if the industrial consumption of C grade heavy oil increases in the future and if the import of C grade heavy oil increases, the volume of diesel oil import should decrease by the correspond amount, which is in line with government policy.

Nevertheless, C grade heavy oil is expected to be cracked to make transportation fuels, so the supply of C grade heavy oil may enter a tight state in Indonesia in the future. Consequently, coal will be promoted as a source of alternative fuel for coming large energy demand.

Many new cement plants at Bogor have used coal, and about half of the total fuel source in Bogor is occupied by coal. In the future, a government policy will be settled to construct coal-fired power plants of PLN in West Java, a coal distribution network in West Java will be prepared, and the switch to coal fuel is expected to be enhanced also in general industries.

10.2 Results of the Site Survey

10.2.1 Method of the Site Survey

The examination of factory fuel use in the study areas was carried out through two methods-the questionnaire survey and interview survey. The number of factories examined were as follows:

Number of factories which received questionnaires	300
Number of factories which responded to questionnaires	139
Number of factories interviewed	54
Number of industrial estate offices interviewed	8

10.2.2 Characteristics of the Study Area

(1) Development in the industrial regions

According to the interview survey of operating factories, firms constructing factories and industrial estate offices, prospects for future industrial development in West Java can be summarized as follows:

Construction of factories on new ground is not easy to get permission in Tangerang. Factories on existing sites may only be constructed and expanded. Because the initial industrial development plan for Tangerang was insufficient, factories and agricultural villages were mixed together, causing considerable traffic congestion and fears of a further worsening of the environment.. In the future, Tangerang will be developed for residential and commercial purposes to serve DKI Jakarta.

Basically factories can use 60% of total area for production facilities by the regulation. It is said that in Tangerang only 20% of the land for production facilities is available for future expansion. As factories in this region tend to be new, an increase in production of 200-300% is possible by expansion and modification of the primary manufacturing equipment. However, investment will slow down in approximately 2020, when equipment begins to deteriorate, and demand for factory fuels will stabilize by approximately 2020.

Industry in DKI Jakarta is even more mature than in Tangerang, and it is anticipated that equipment will deteriorate considerably by 2010-2020. The government desires that factories be moved to other areas in order to maintain the functions of the capital. Therefore, by 2010-2020, investment in this area will slow down and demand for fuel use will stabilize.

Table 10-2-1 Industrial Estates in West Java

Name of industrial		Area (ha)		Number of factory	State of land
		Total	Industry		
1. PT JIEP		570	390	369	Operation
DKI Jakarta					
2. KIEC (Kurakatau Ind. Est.	Steel	3300	1500		Operation
"	Ind.Es		550	44	Operation
3. Modern Cikande (MCIE)	phase 1	250	175	80	Operation
"	phase 2	650	455		Land working
"	phase 3	650	455		Planning
4. Langgeng Sahabat		500	350		Land working
Serang		5350	3485		
Tangerang		0	0		
5. EJIP (East Jakarta Industrial		310	220	66	Operation
6. Hyundai (Bekasi International		200	200	35	Operation
7. Delta Silicon		158	158	96	
8. MM 2100 Industrial Town	phase1,2	1300	360	93	Operation
"	phase 3		400	137	Land sale
9. Newton		51	51	42	
10.Diamond		13	13	21	
11.Boston		12	12	18	
12.Jababeka (Cikarang Ind. Est.)	phase1,2	800	553	560	Operation
"	phase3,4	600	315		Land working
13.National Gobel Industrial		100	100		Operation
Bekasi		3544	2282		
14.KIIC (Karawan Int'l Ind.City)	phase 1	350	245	42	Land sale
"	phase 2	700	490		Land working
15.Surya Cipta Industrial City,	phase 1	486	259		Operation
"	phase 2	500	285		Land working
"	phase 3	1000	550		Still land
16.Mitra Industrial Park	phase 1	500	200	7	Operation
	phase 2		300		Construct.
17.Peruri					Land working
Karawang		3536	2329		
18.Bukit Indah City	phase 1	2000	1200		Operation
"	phase 2	7100	3500		Still land
19.Indotaisei(Bukit Indah I.P.)	phase 1	300	200		Operation
"	phase 3	300	200		Still land
20.Hutama Industrial					
21.Pupuk Kujang Industrial					
22.Timor		300	210		
23.Bimantara(Hyundai		500	350		
Purwakarta		10500	5100		
24.Cirebon Industrial Estate					
Cirebon					
Grand total		23500	14146		

Source: by JICA Team

In the future, construction of new factories in West Java will be approved, with construction in existing industrial estates being given priority.
The new demand for factory fuels in West Java clearly originated from industrial estates and industrial zones. The majority of industrial development in West Java over the next 30 years will be in the industrial estates and industrial zones of Bekasi, Karawang, Purwakarta, and Serang, and it will involve factory relocation from Tangerang and DKI Jakarta. It is therefore important to improve the accuracy of estimates for consumption of factory fuels in the industrial estates and zones where factories have not yet been constructed.

Factory relocation from West Java, and construction of new factories in industrial regions outside West Java are promoted strongly. Also in this case, construction in existing industrial estates and industrial zones is given priority.

It is recognized that consistent industrial development in West Java is advancing under the administrative guidance of central and local governments.

(2) List of industrial estates

Table 10-2-1 shows the latest list of industrial estates prepared by the site survey. The total area of the industrial estates is 23,500 ha, area for selling as the industrial site to 14,100 ha. The industrial site is limited to 60% of the total area, securing the remainder as estate management and residential sites.

There is still room for constructing factories, however, in suitable land in the eastern part of Serang close to Tangerang, and in industrial zones in the western part of Serang, and Purwakarta. But the government plans to limit industrial development in West Java to a specific level and to develop industry in other provinces. It is uncertain if the area of industrial estates in West Java will be further increased.

10.2.3 Result of the Site Survey

(1) Allotment of fuel types in individual applications

1) Following is examples of the site survey results.
A glass plant uses C grade heavy oil to the main melting furnace, and urban gas to the succeeding annealing furnace. The large scale main melting furnace prefers long and bright flame created by C grade heavy oil, and the annealing furnace which needs accurate temperature control prefers urban gas.

2) A fabric dyeing plant uses far-infrared radiation emitted from a high temperature red-heat wire mesh to perform rapid drying of dyed cloth immediately before the coiling step. The fuel is LPG because the red-heat wire mesh needs an intense fire. They say

that the possibility of urban gas as the heat source is not yet studied.

3) In the coiling step of cloth at a fabric manufacturing plant, precise air conditioning is requested for the whole area of the plant building to uniformize the product quality. Since the electric air conditioning is unfavorable because of possibility of power failure, they use urban gas as the fuel. Nevertheless, they are anxious about the pressure drop of urban gas at the supply point.

Table 10-2-2 Unit Energy Consumption of Factories (by questionnaire survey)

No.	Name of Company	Kind of Industry	Location	Area (ha)	Production	Fuel Consumption, kl/y, solar eq.					Unit energy consumption solar eq.	
						Gas	LPG	Oil	Elect.	Total		
						kl/y, solar eq.		kl/y, solar eq.			kl/y.t	kl/y.ha
102	Unted Can	Fab. metal	Jakarta		40.2 t/y	4	35	1600	2	1641	41.0	
103	Serinco Djaya marmer	Ceramic			36750 t/y (700000 m^2/y)	28000		8400	1140	37540	1.02 (0.054 kl/m^2)	
104	Multisida Agrolindo	Chemical			10 t/y			240000	12.5			
105	Cigading Habeam Center	Fab. metal			60000 t/y		228000		0.3	228000	3.8	
106	Sunimagne Utama	Chemical			20400 t/y			7200		7200	0.35	
107	Dystar Cilegon	Chemical	Cilegon		1702 t/y			1256		1256	0.74	
108	Sulfindo Adhi Husada	Basic metal			20000 t/y			50000	29		2.5	
109	KHI Pipe Industries	paper	Cilegon		125000 t/y		2232	240000	418	242650	1.94	
110	Vevevorn	Chemical			1500 t/y			420000	5700	425700	284	
111	Unilever	paper			80000 t/y			11400000	2850	11402850	142	
112	Kati Kartika Bumi	Food	Karawaci		24000 t/y			2400000	11400	2411400	100.5	
113	ABC central Food	Chemical			150000 t/y			1320000	81	1320081	8.8	
114	Teyo Lamo	Chemical	Serang		700 t/y			700	26	726	1.0	
201	Mahkota Indonesia	Glass			18000 t/y	0	0	4700	265	4965	0.28	
202	Bumi Kaya Steel	Fab. Steel	Pulogading	1.4	6300 t/y	816 (850 × 10^3 m^3/y)	496 (400 t/y)	0	712	1209	0.19	864
203	Union Ceramics Utama	Ceramic			1020000 m^2/y (53550 t/y)	6240 (6500 × 10^3 m^3/y)		1900	665	8805	0.16	
204	Alcarindo Prima	Basic metal			17500 t/y	2201 (2293 × 10^3 m^3/y)			203	2404	0.14	
206	Galic Arta Bahari	Chemical	Bekasi Cibinung		240 t/y	0	2450 (1976 t/y)	240	1140	3830	16.0	
207	Glas Fibindo Indah	Glass			4200 t/y	2304 (2400 × 10^3 m^3/y)			86	2390	0.57	
209	Wahyumusa Wahan	Ceramic	Bekasi		120000 t/y	3456 (3600 × 10^3 m^3/y)			1140	4596	0.04	
211	Monokem surya	Chemical			1500 t/y			2000		2000	1.33	
212	YKK Zipper	Textile	Bekasi		4080000 t/y	1152 (1200 × 10^3 m^3/y)		6000000		6001152	1.47	
213	Gunung Garuda	Basic metal	Bekasi		360000 t/y	27648 (28800 × 10^3 m^3/y)			4940	32588	0.09	
214	Indo Porlen	Ceramic			9600 t/y			1560	475	2035	0.2	
216	Bridgestone Tire	Chemical (Rubber)			35258 t/y			21282	690	21972	0.62	
217	Khong Guan Biscuit	Food			8000 t/y	1440 (1500 × 10^3 m^3/y)	5 (3.7 t/y)		513	1958	0.24	
218	Priscalin	Food	Bekasi		48000 t/y			5000	353	5353	0.11	
221	Glas Fibindo Indah	Glass			4200 t/y	3840			86	3926	0.93	
222	Fajar Surya wisesa	paper			36000 t/y	39168				39168	1.08	
122	Sinar Rapi Asri			6.7	10000 t/y	1106		63		1169	0.12	174

Source : Questionnaire survey, 1996

4) A food processing plant has shifted the fuel for biscuit oven (indirect heating system) from diesel oil to urban gas, thus fully utilizing the advantages of urban gas with clean and easy for controlling properties.

Table 10-2-3 Unit Energy Consumption of Factories

No	Name of company	Kind of industry	Region	Area ha	Production	consumption, kl/y solar eq				Unit of consumption solar eq		kl/ha
						gas	oil	elect	total			
121	Asahimas	float grass safety glass	DKI Jkt	44	379,500 t/y	1,152	70,576	1,710	73,438	0.19	kl/t	1,669
120	Angsadaya	ceramic	Tangerang	42	264,000 t/y	32,250	9,600	3,420	45,270	0.17	kl/t	1,078
119	Synar Dunia Kristal	glass	Tangerang	6.1	900 t/y	2,995	-	542	3,539	3.93	kl/t	580
118	YKK Alumico	fabric metal	Tangerang	16.4	12,000 t/y	6,768	-	2,339	9,107	0.76	kl/t	555
215	Essar Dhanan Jaya	cold steel roll	Bekasi	14.4	20,000 t/y	13,939	-	4,750	18,689	0.093	kl/t	1,298
115	Sinar Antjol	chemical (soap)	DKI Jkt	0.4	48,000 t/y	4,147	75	760	4,982	0.10	kl/t	12,455
117	Pacinesia Chemical	chemical	Tangerang	1.1	1,710 t/y	576	4	73	654	0.38	kl/t	599
208	Argo Pantes	textile	Bekasi	20	20,000 t/y	-	-	8,550	8,550	0.43	kl/t	428
101	Jabatex	textile	Tangerang	20	12,000 t/y	6,912	9,600	2,633	19,145	1.60	kl/t	957
205	Takai Texprint	textile printing	Bekasi	6.4	36×10^6 yard	13,461	480	1,197	15,138	0.42	kl/10^6 yard	2,365
116	Hawaii Confectionery	food	DKI Jkt	0.77	5,400 t/y	864	-	300	1.164	0.22	kl/t	1,512

(2) Specific Energy Consumption in Factories

Details obtained from the questionnaire survey are shown in Table 10-2-2. Details obtained from the interview survey are shown in Table 10-2-3. The data of unit energy consumption per product in the same industry type differ and disperse widely in the range of double digit(for example, 1~100kl/t).

Fig.10-3-1 was created from the data, based on Industrial Statistics of Indonesia, on unit energy consumption of many factories in various industries. The data on unit energy consumption in Table 10-2-2 and Table 10-2-3 correspond to the dispersion by industry type in Fig. 10-2-1. However, Fig. 10-2-1 already had wide dispersion of double digit in each industry.

We tried to estimate the energy consumption for each factory by multiplying the standard unit energy consumption for each product(ton) by the production quantity. The results of the above work were intended to be applied to factories that have yet to be constructed. We are subject to the limitation, however, of knowing only the area of land(ha) for factory and the first-digit of the Indonesian Industrial Code of industry type(for example, 31, 32, 33, ---39). It is difficult to get information from companies who have yet to construct their factories. Data of the second-digit of the Indonesian Industrial Code(for example, 311, 322, 333---) and data of unit energy consumption corresponding to the second-digit of the Code are unavailable. Moreover, a quantity of land still remains unsold. Because of this, the exercise was abandoned.

Fig. 10-2-1 Fuel Consumption of Industrial Sector in Kabpatens

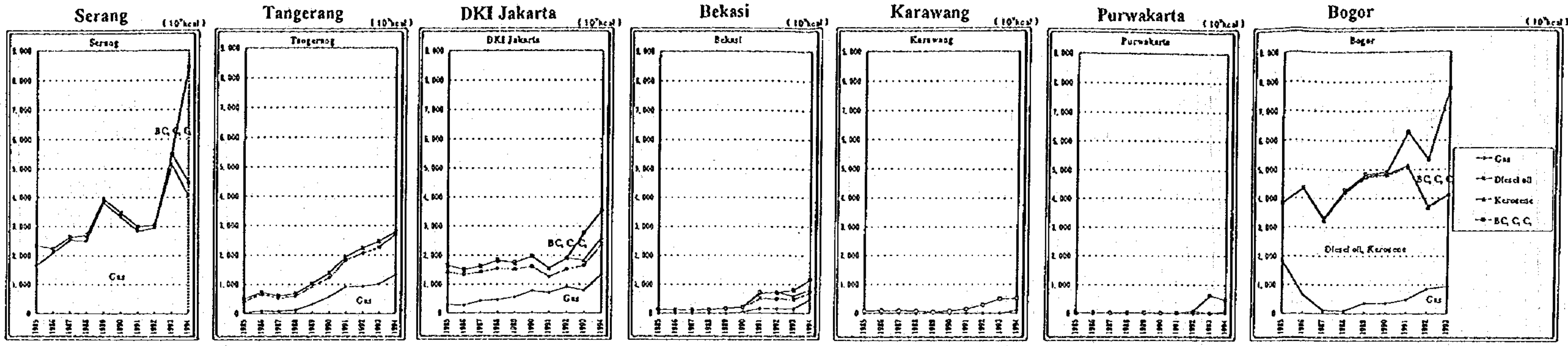


Fig. 10-2-1 (a) Fig. 10-2-1 (b) Fig. 10-2-1 (c) Fig. 10-2-1 (d) Fig. 10-2-1 (e) Fig. 10-2-1 (f) Fig. 10-2-1 (g)

Fig. 10-2-2 Share of Fuel Consumption of Industrial Sector in Kabpatens

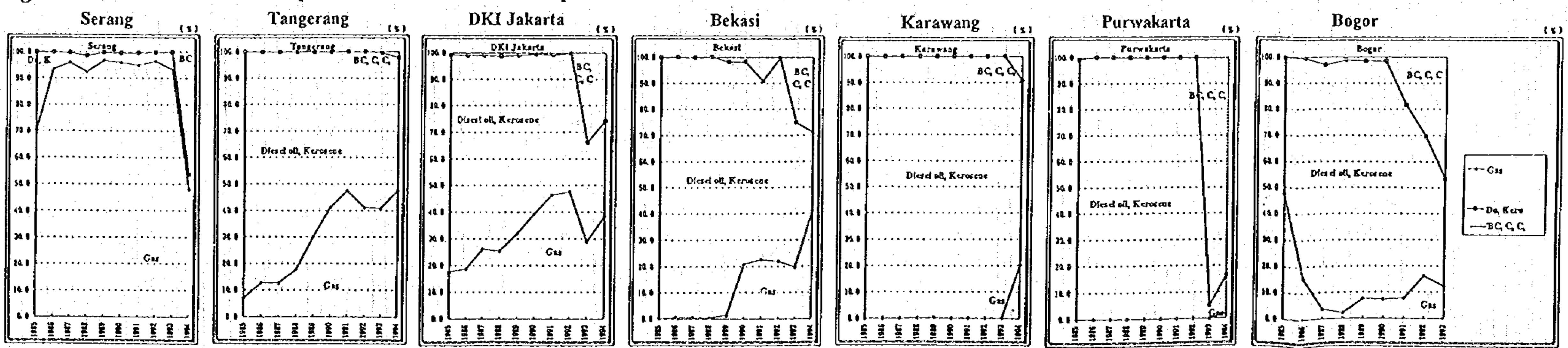


Fig. 10-2-2 (a) Fig. 10-2-2 (b) Fig. 10-2-2 (c) Fig. 10-2-2 (d) Fig. 10-2-2 (e) Fig. 10-2-2 (f) Fig. 10-2-2 (g)

Souce: BPS

10.3 Forecasting Energy Demand in the Industrial Sector

10.3.1 Methodology of Forecasting Demand

The survey area consists of Tangerang, DKI Jakarta, Bekasi, Karawang, and Purwakarta. Those regions are under the jurisdiction of the PGN Jakarta Branch Office.

Two methods for predicting demand were combined. For the near future (1997-2004), a micro-method was employed, using an end-use model (cumulative method). For the long-term (2005-2020), a macro-method was employed, using an econometric model (top-down method).

The econometric model used in long-term (2005-2020) forecasting employed the BPS statistical data(1985-1994) for the total industrial production (industrial GRDP) of all of West Java including DKI Jakarta, and the "industrial GRDP" data of each area under the jurisdiction of the PGN Jakarta Branch Office. Since the available data is insufficient for forecasting demand in regions which are only in the initial stages of industrial development, the data for 1997-2004, estimated by cumulative method, are applied in the long-term macro-analysis.

10.3.2 Model of Forecasting Energy Demand

Outlines of procedure of the short-term estimation and the long -term forecasting are shown as follows:

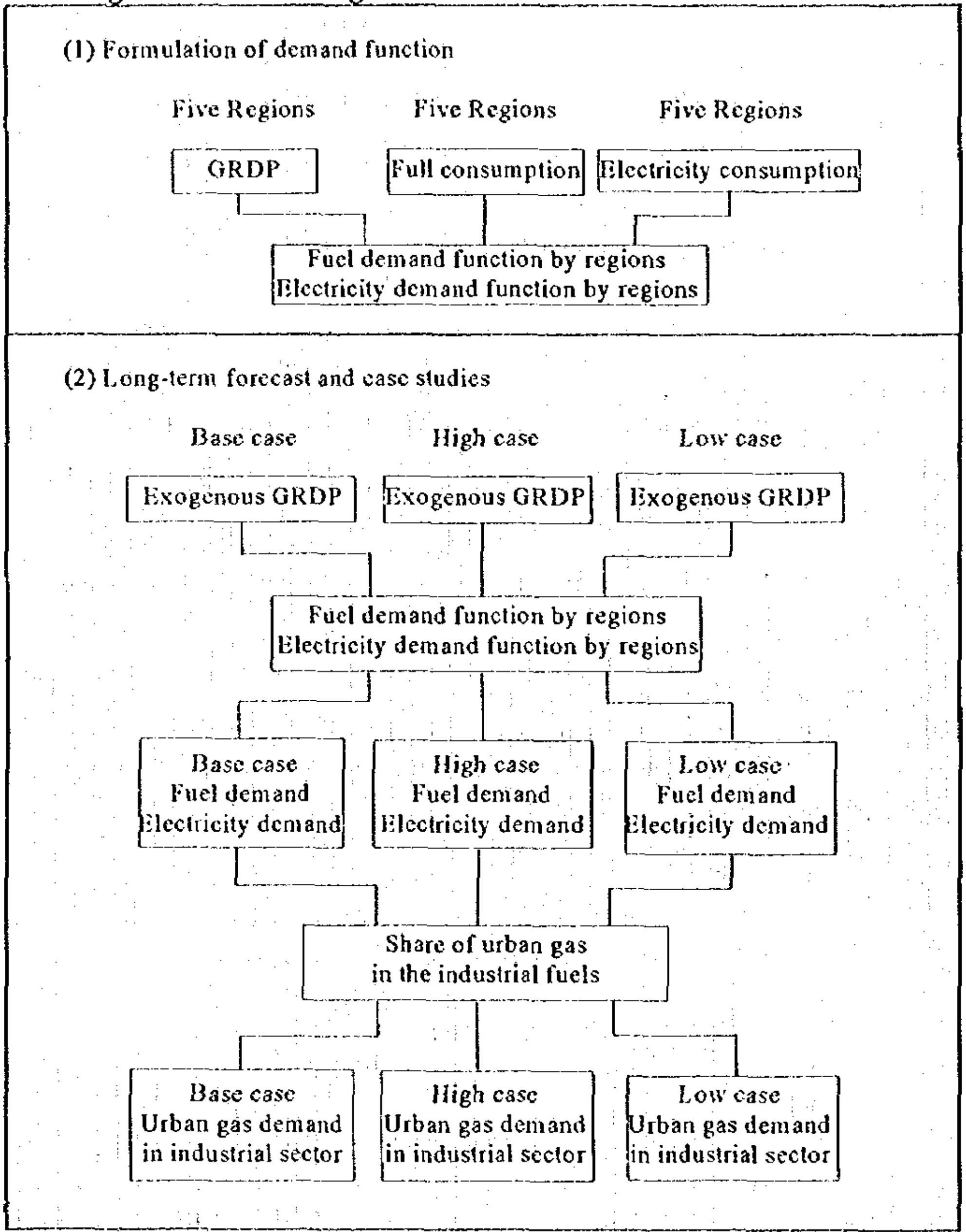
A. For the term of 1997-2004
1) Cumulating gas demand of customers in each region
2) The result during 1997-2004 is added to the extnded expierienced period for the econometric model

B. For the term of 2005-2020
1) Demand of electricity for industrial use of a year is calculated by the function of industrial GRDP of the year and the electricity demand of the previous year.
2) Demand of fuel for industrial use of a year is calculated by the function of industrial GRDP of the year and the fuel demand of the pervious year.
3) Total demand of energy for the industrial use is sum of the demand of electricity and fuel
4) The demand of fuels are calculated from the share of fuels. The share of fuels are set from the trend and balance among them.
5) Urban gas demand is calculated by the function of industrial GRDP of the year and the gas demand of the previous year, under the constraint condition within which other fuel demand was computed.

(1) Procedure of short-term demand estimation

Short-term demand estimation in a period of from 1997 to 2004 was carried out for the two groups of industrial area. One is the factory group area where the construction of plants are completed and operating, the other is the areas having no plant yet.

Fig. 10-3-1 Block Diagram of Demand Forecast in the Industrial Sector



PGN already markets urban gas to some factories. And for the rest of the existing factories, PGN has produced a list of potential customers by investigating factors such as facilities they operate and their fuel consumption, locations, and distances from gas distribution pipelines. Selling amount of the urban gas to these potential consumers is assumed to be actualized within several years, and addition of gas sales is allotted to every fiscal year. The list of potential consumers of PGN is given in Appendices.

Currently, many industrial estates and industrial zones have been constructed in Bekasi, Karawang, Purwakarta and Serang, and some of them have already entered the commercial operation. To the existing factories in these industrial estates, PGN has already supplied urban gas, and currently excavating potential consumers. The survey assumed that the urban gas sales to these potential consumers in the existing factories of industrial estates would be actualized within several years, and allotted the additional sales to each fiscal years.

1)The following relation is applied to existing factories.

$$G_{i.total} = \Sigma G_i = G_{i.T} + G_{i.J} + G_{i.B} + G_{i.K} + G_{i.P}$$

where,

G_i : urban gas demand for industrial use in each region in year i (m^3/y)

$G_{i.T}$, $G_{i.J}$, $G_{i.B}$, $G_{i.K}$, $G_{i.P}$: urban gas demand for industrial use in Tangerang, DKI Jakarta, Bekasi, Karawang, Purwakarta in year i, respectively (m_3/y)

$G_{i.total}$: Total urban gas demand for industrial use in 5 regions in year i (m^3/y)

i : year, i = 1, 2, 3, - - 8

1 denotes year 1997,

2 denotes year 1998,

-

-

8 denotes year 2004,

In each region, G_i is expressed as follows:

$$G_i = G_0 + \Sigma g_i \quad (i = 1, 2, 3,\text{- -} i) \quad = G_0 + g_1 + g_2 + \text{- - - -} + g_i$$

where

G_0 : regional urban gas demand for industrial use in 1996 (m^3/y)

g_i : regional total urban gas demand for industrial use in year i (m^3/y)

At year i, g_i is expressed as follows:

$$g_i = \Sigma f_{i.m} \quad (m = 1, 2, 3, \text{- -} m, i = 1, 2, 3 \text{- -} i)$$

where,

f_{im} : urban gas demand in m-th factory in year i (m^3/y)

m : numbered factory in the region, m = 1, 2, 3, - - m

2) To make the plan to install distribution pipelines, it is necessary to get gas demand in industrial estates where factories are not yet constructed. The method of unit gas demand per area is derived for this purpose.

EJIP surveyed all the factories on its estate to determine the desire to use urban gas. As a result of the survey, EJIP's own funds were used to lay the distribution pipeline branching from the main transmission pipeline. As shown in Table 10-3-7, and 10-3-8, of the 61 factories on the EJIP estate, 13 (21%) were using urban gas. These 13 factories occupied 46% of the land available for factories on the estate. Dividing the demand for urban gas on the estate by the area of factories using it produced a figure of 456,000 $m^3/y.ha$: and dividing the demand by the total area of land available for factory use in the estate produced a figure of 209,000 $m^3/y.ha$.

The results were approximately the same for the MM2100 and Jababeka estates, which are in the same area of Bekasi. The figures for total demand for urban gas in the estate divided by the area of land available for factory use, are shown below for each of the three industrial estates currently being developed in Bekasi.

Industrial estate	EJIP	209,000 $m^3/y.ha$
	MM2100	216,000 $m^3/y.ha$
	Jababeka	237,000 $m^3/y.ha$
	(arithmetic average)	220,000 $m^3/y.ha$
	(weighted average)	225,000 $m^3/y.ha$

The arithmetic average for unit consumption for the three industrial estates is 220,000$m^3/y.ha$.

The demand for urban gas noted here includes that of factories already using the gas and factories planning to use it.

Estimates of anticipated demand for urban gas in the MM2100 and Jababeka estates were obtained by PGN during sales negotiations and not the results of full survey. The areas of factories using urban gas are therefore as low as 33% and 22%, respectively. In Jababeka remains unprepared land in a part of Jababeka 2. It seems to be the reasons for the low percentage in Jababeka. A simple proportionate calculation by area suggests an additional 60% potential demand for MM2100, and 120% for Jababeka.

The EJIP estate contains a considerable number of electronics factories. It has no factories consuming large amounts of fuel, such as glass factories. For this reason, other estates will likely have higher unit demand than that of EJIP.

Glass and ceramics factories require large amounts of heat. However, the factories themselves occupy considerable area. The unit fuel consumption per area, therefore, is not necessarily as high as other factories. Jababeka has two glass factories. The unit gas demand per area is only twice as much as the unit of EJIP, including additional potential demand for each estate.

Based on the above, it is considered that the realistic range for unit consumption per area is between 220,000 m^3/y.ha and 440,000 m^3/y.ha. There is a case of another glass factory using both urban gas and C grade heavy oil (see **10.2.3 (1)**). The use of the high end of the range should be viewed with caution.

(2) Procedure of long-term demand forecasting

The block diagram of the long-term demand forecast is shown in Fig. 10-3-1.

As for the long -term demand forecast ranging from 1995 to 2020, the total energy demand over the whole survey areas was determined by preparing a demand function using two groups of factors as follows

- -Five regions (Tangerang, DKI Jakarta, Bekasi, Karawang, Purwakarta)
- -Energy sources (fuel, electricity)

Thereby, total ten demand functions were formulated. The following are the expression of the structural equations.

Log(regional fuel demand) = a*Log(regional GDP)
+b*Log(regional fuel demand of the last year)+c
Log(regional electricity demand) = a*Log(regional GDP)
+b*Log(regional electricity demand of the last year)+c

Sum of the industrial demand of fuel and electricity in the region accounts for the total industrial demand of energy in the regions. A product of the total industrial demand of fuel to the share of urban gas in the total fuel demand for industrial use gives the demand of urban gas for industrial use.

-Demand of industrial energy = Fuel demand + Electricity demand
-Demand of urban gas for industrial use = Fuel Demand*Share of urban gas for industrial use in total demand of fuel.

Future forecast was computed for each of 3 cases of GRDP, High case, Base case, Low case). The following is the result of regression analysis on 10 energy demand estimation equations

(a) Equation for estimating fuel and electricity for industrial use at DKI Jakarta

LN(FUEL.DKI)= -0.08+0.342*LN(VALUE.DKI)+0.677*LN(LAG1.FUEL.DKI) -o.44*DUM. 1991

(3.5) (3,0) (-5.2)

where,

R Square : 0.930

DW ratio : 2.38 (Durbin-Watson ratio)[1]

FUEL.DKI : fuel demand at DKI Jakarta

VALUE.DKI : GRDP at DKI Jakarta

t value in ( )

LN(ELEC.DKI)= -11.4+1.10*LN(VALUE.DKI)+0.26*LN(LAG1.ELEC.DKI)

(9.3) (3.1)

where,

R Square : 0.990

DW ratio : 1.66

ELEC.DKI : Electricity demand at DKI Jakarta

VALUE.DKI : GRDP at DKI Jakarta

t value in ( )

(b) Equation for estimating fuel and electricity for industrial use at Tangerang

LN(FUEL.TAN)=3.6+0.94*LN(VALUE.TAN) -0.06*LN(LAG1.FUEL.TAN) -5.53*DUM.1990

(10.2) (-3.3) (-58.9)

where,

RS : 0.998

DW : 2.34

FUEL.TAN : Fuel demand at Tangerang

VALUE.TAN : GRDP at Tangerang

t value in ( )

LN(ELEC.TAN)= -10.1+1.1*LN(VALUE.TAN)+0.312*LN(LAG1.ELEC.TAN)+0.522*DUM.1991

(1.6) (1.0) (2.0)

where,

RS : 0.920

DW : 2.36

ELEC.TAN : Electricity demand atTangerang

VALUE.TAN : GRDP at Tangerang

t value in ( )

---

[1] NOTE: DW ratio explained in Acronyms and Abbreviations as well as RS(R^2) and t-values

(c) Equation for estimating fuel and electricity for industrial use at Bekasi

LN(FUEL.BEK)= -6.15+1.13*LN(VALUE.BEK) +0.28*LN(LAG1.FUEL.BEK) +1.47*DUM.1990

(12.8) (5.4) (20.6)

where,

RS : 0.996

DW : 2.90

FUEL.BEK : Fuel demand at Bekasi

VALUE.BEK : GRDP at Bekasi

t value in ( )

LN(ELEC.BEK)= -2.83+0.328*LN(VALUE.BEK)+0.684*LN(LAG1.ELEC.BEK)+0.30*DUM.1992

(0.3) (1.2) (0.8)

where,

RS : 0.898

DW : 1.46

ELEC.BEK : Electricity demand at Bekasi

VALUE.BEK : GRDP at Bekasi

t value in ( )

(d) Equation for estimating fuel and electricity for industrial use at Karawang

LN(FUEL.KAW)= -9.64+1.46*LN(VALUE.KAW) +0.29*LN(LAG1.FUEL.KAW) -0.67*DUM.1989.1990

(5.8) (2.1) (-5.7)

where,

RS : 0.980

DW : 3.28

FUEL.KAW : Fuel demand at Karawang

VALUE.KAW : GRDP at Karawang

t value in ( )

LN(ELEC.KAW)= -8.06+1.0*LN(VALUE.KAW)

where,

ELEC.KAW : Electricity demand at Karawang

VALUE.KAW : GRDP at Karawang

t value in ( )

Since no equation of regression was available, the same growth rate of GRDP as in Karawang was applied

(e) Equation for estimating fuel and electricity for industrial use at Purwakarta

LN(FUEL.PUR)= -7.95+1.28*LN(VALUE.PUR) +0.46*LN(LAG1.FUEL.PUR)

(2.7) (1.7)

where,

RS : 0.907

DW : 2.35

FUEL.PUR : Fuel demand at Purwakarta

VALUE.PUR : GRDP at Purwakarta

t value in ( )

LN(ELEC.PUR)= -3.82+0.64*LN(VALUE.PUR)+0.27*LN(LAG1.ELEC.PUR)+0.87*DUM.1992

(0.8) (0.7) (2.4)

where,

RS : 0.798

DW : 1.4

ELEC.PUR : Electricity demand at Purwakarta

VALUE.PUR : GRDP at Purwakarta

t value in ( )

10.3.3 Energy Demand Forecast

(1) Short-term demand estimation

Table 10.3.1 and Fig. 10.3.2 show the demand forecast of urban gas of PGN sales within the area covered by PGN Jakarta Branch Office in West Java. The figures in 1995 and 1996 are the experienced sales quantity, and those in a period of from 1997 to 2004 are an estimated demand derived by cumulative method in a short term (Table 10.3.2). The demand forecast during a period of from 2005 to 2020 is the estimation in accordance with the long-term demand estimation method. The difference in demand coming from the difference of estimation methods of short-term and long-term was adjusted by the demand in 2005.

Table10-3-1 Projection of Urban Gas Use in the Industrial Sector

(Unit : $10^6 m^3/y$)

年	Base Case	High Case	Low Case
1995	751	751	751
1996	878	878	878
1997	960	960	960
1998	1,033	1,051	1,015
1999	1,135	1,178	1,091
2000	1,300	1,384	1,215
2001	1,461	1,586	1,336
2002	1,622	1,786	1,456
2003	1,748	1,944	1,550
2004	1,882	2,113	1,652
2005	1,982	2,217	1,802
2006	2,185	2,392	1,960
2007	2,341	2,588	2,074
2008	2,548	2,847	2,228
2009	2,833	3,201	2,443
2010	3,149	3,657	2,635
2011	3,365	4,019	2,701
2012	3,797	4,702	2,931
2013	4,265	5,488	3,160
2014	4,829	6,465	3,430
2015	5,477	7,639	3,726
2016	5,770	8,379	3,759
2017	6,562	9,949	4,086
2018	7,474	11,845	4,445
2019	8,404	13,896	4,782
2020	9,376	16,157	5,111
2000/1995	11.6% (1.5)	13.0% (1.6)	10.1% (1.4)
2010/2000	9.3 (1.2)	10.2 (1.2)	8.0 (1.2)
2020/2010	11.5 (1.5)	16.0 (1.6)	6.8 (1.3)
2020/1995	10.6 (1.4)	13.1 (1.5)	8.0 (1.3)

( ): GRDP Elasticity

(2) Long-term demand forecast .

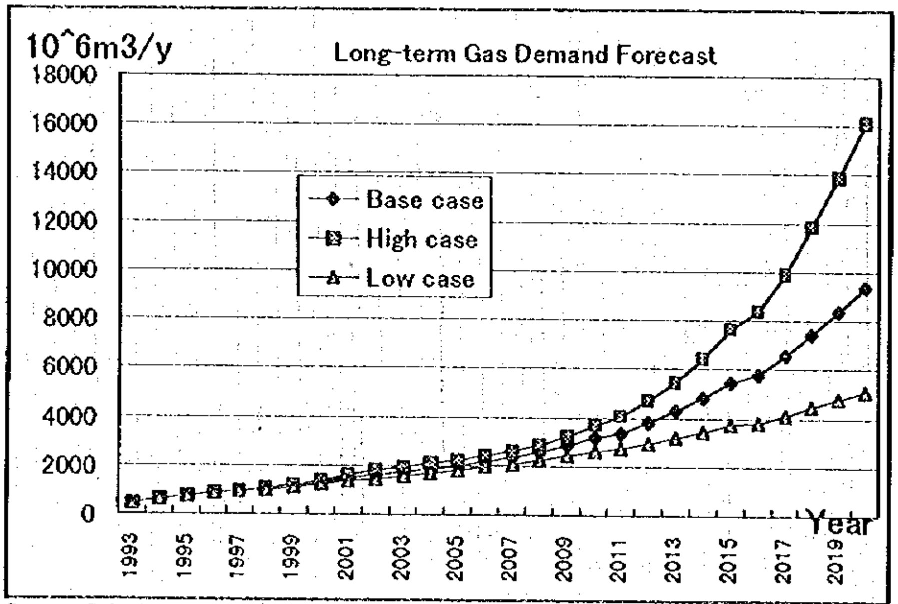
Table 10-3-1 shows the forecast result of the total demand of urban gas in five prefectures. Table 10-3-3 shows the forecast result in each prefecture, those are GRDPs of the prefecture, fuel demand including production use and transportation use in the industrial sector, electricity demand which industrial sector purchased from PLN, and urban gas demand in the industrial sector.

Table 10-3-2 Annual Raise up and Cumulative of Urban Gas Sales of the Industrial Sector in PGN Jakarta Branch Office Area

($10^3 m^3/y$)

		1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Tangerang	existing factories				20,000	20,000	20,000	20,000	20,000	20,000	17,000
	new industrial estates				0	0	0	0	0	0	0
DKI Jakarta	existing factories				10,000	10,000	10,000	10,000	10,000	10,000	10,000
	new industrial estates				0	0	0	0	0	0	0
Bekasi	existing factories				0	20,000	20,000	20,000	20,000	20,000	20,000
	new industrial estates				61,000	62,000	62,000	47,000	34,000	20,700	23,500
Karawang	existing factories				0	0	0	0	0	0	0
	new industrial estates				0	15,000	33,000	33,000	43,900	15,000	27,000
Purwakarta	existing factories				0	0	0	0	0	0	0
	new industrial estates				0	0	61,000	72,000	72,000	72,000	71,000
Total	existing factories				30,000	50,000	50,000	50,000	50,000	50,000	47,000
	new industrial estates				61,000	77,000	156,000	152,000	150,500	107,700	121,500
	grand total		126,900	82,800	91,000	127,000	206,000	202,000	200,500	157,700	168,500
Base case	annual raise up of sales		126,900	82,800	73,000	102,000	165,000	161,000	161,000	126,000	134,000
	cumulative	750,700	877,600	960,400	1,033,000	1,135,000	1,300,000	1,461,000	1,622,000	1,748,000	1,882,000
High case	annual raise up of sales		126,900	82,800	91,000	127,000	206,000	202,000	201,000	158,000	168,000
	cumulative	750,700	877,600	960,400	1,051,000	1,178,000	1,384,000	1,586,000	1,787,000	1,945,000	2,113,000
Low case	annual raise up of sales		126,900	82,800	54,000	76,000	124,000	121,000	120,000	95,000	191,000
	cumulative	750,700	877,600	960,400	1,015,000	1,091,000	1,215,000	1,336,000	1,456,000	1,55,1,000	1,652,000
		Historical		Short-term estimation							

Fig. 10-3-2 Long Term Urban Gas Demand Projection



Source: Calculated by the Study Team

Fig. 10.3-2 and Fig. 10.3-3 illustrate the trends of those results. In the Base Case of forecast, 0.75 billion m^3/y in 1995 of industrial urban gas sales in PGN Jakarta Branch Office will be 1.98 billion m^3/y in 2005, which is 2.6 times to 1995, 3.1 billion m^3/y in 2010, which is 4.2 times to 1995, 5.5 billion m^3/y in 2015, which is 7.3 times, and 9.4 billion m^3/y, which is 12.5 times to 1995.

Table 10-3-3 Energy Demand Projection of the Industrial Sector by Each District in the Study Area

Area	Item	Unit	1995	2000	2005	2010	2015	2020
	DKI Jakarta							
Base Case	GRDP	10^12 Rp	5,220	7,557	10,900	15,765	23,056	33,721
	Fuel	10^12kcal	8	12	18	27	40	60
	Electricity	10^12kcal	5	8	14	24	41	73
	Gas	10^12kcal		3	3	4	6	8
High Case	GRDP	10^12 Rp	5,259	7,777	11,587	17,582	28,704	46,861
	Fuel	10^12kcal	8	12	19	29	47	79
	Electricity	10^12kcal	5	8	15	27	56	116
	Gas	10^12kcal		3	3	5	7	11
Low Case	GRDP	10^12 Rp	5,181	7,328	10,135	13,833	17,908	23,185
	Fuel	10^12kcal	8	12	17	24	33	43
	Electricity	10^12kcal	5	8	12	20	29	43
	Gas	10^12kcal		2	3	4	5	6
	Tangerang							
Base Case	GRDP	10^12 Rp	768	1,111	1,603	2,318	3,390	4,958
	Fuel	10^12kcal	5	7	10	14	19	27
	Electricity	10^12kcal	2	5	8	15	27	50
	Gas	10^12kcal		3	4	5	7	10
High Case	GRDP	10^12 Rp	770	1,139	1,697	2,575	4,205	6,865
	Fuel	10^12kcal	5	7	10	15	23	36
	Electricity	10^12kcal	2	5	9	17	38	83
	Gas	10^12kcal		3	4	6	9	13
Low Case	GRDP	10^12 Rp	765	1,082	1,496	2,041	2,643	3,422
	Fuel	10^12kcal	5	7	9	12	15	19
	Electricity	10^12kcal	2	4	7	12	19	28
	Gas	10^12kcal		3	4	5	6	7
	Bekasi							
Base Case	GRDP	10^12 Rp	2,981	4,316	6,225	9,003	13,168	19,258
	Fuel	10^12kcal	3	5	9	16	30	54
	Electricity	10^12kcal	1	2	3	5	7	10
	Gas	10^12kcal		4	6	10	16	27
High Case	GRDP	10^12 Rp	2,992	4,425	6,593	10,004	16,332	26,664
	Fuel	10^12kcal	3	5	10	19	41	90
	Electricity	10^12kcal	1	2	3	5	8	13
	Gas	10^12kcal		5	7	11	23	45
Low Case	GRDP	10^12 Rp	2,970	4,201	5,810	7,930	10,266	13,290
	Fuel	10^12kcal	3	5	8	14	20	31
	Electricity	10^12kcal	1	2	3	4	6	7
	Gas	10^12kcal		4	5	8	11	15

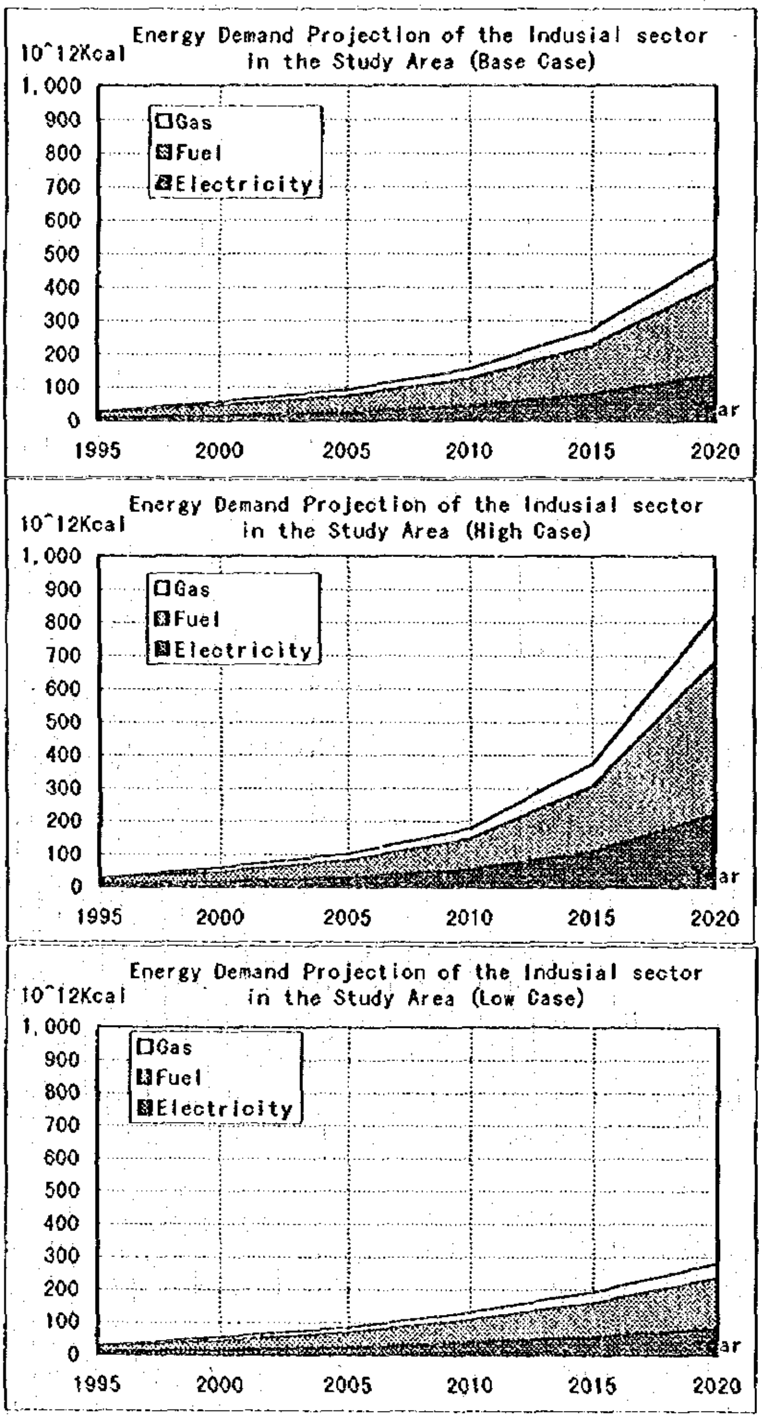
Source: Calculated by the Study Team

In the Low Case, it will be 5.1 billion m3/y and 6.8 times in 2020, and in the High Case, 16.2 billion m3/y and 21.5 times in 2020.

Annual average growth rate of gas sales in the survey area during a period of from 1995 to 2020 is 10.6% for the Base Case, 8.0% for the Low Case, and 13.1% for the High Case.
The GDP elasticity of the urban gas demand for industrial use during a period of from 1995 to 2020 is 1.4 for the Base Case, 1.3 for the Low Case, and 1.5 for the High Case. The following is the description of characteristics of individual regions.

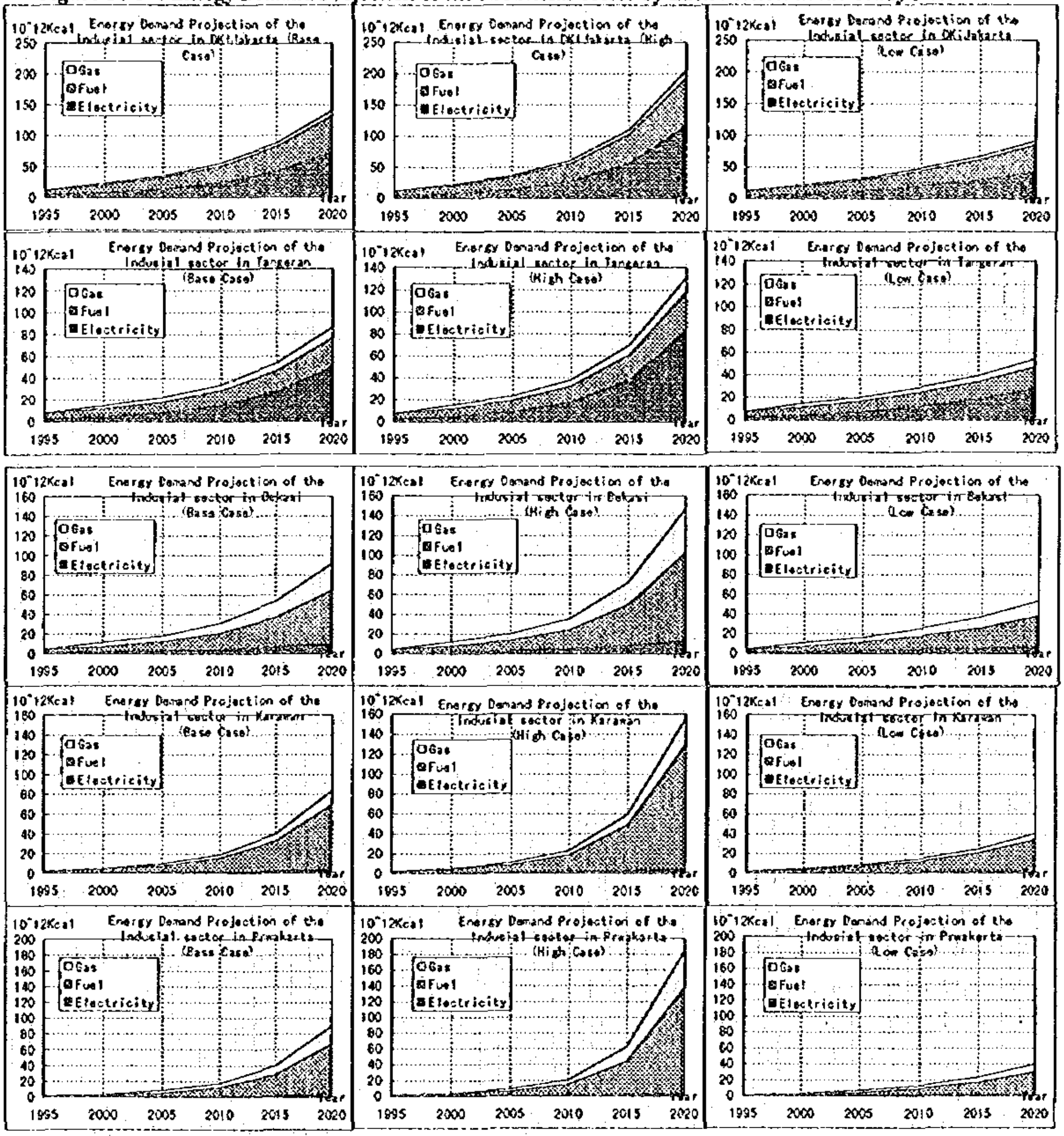
(a) The demand increase of urban gas for industrial use at DKI Jakarta and Tangerang should begin to slow down at around 2020. After then, the demand in these regions would draw a last half profile of S-shape saturation curve. Consequently, the value in 2020 in these districts can be accepted as the upper limit also in a period of after 2020.

Fig. 10-3-3 Energy Demand Projection of the Industrial Sector in the Study Area



Source: Calculated by the Study Team

Figure 10-3-4 Energy Demand Projection of the Industrial Sector by Each District in the Study Area



Source: Calculated by the Study Team

(b) The demand of urban gas for industrial use at Bekasi, Karawang, and Purwakarta should continue the growth at around 2010 to 2020. Most of the industrial estates currently approved should be filled up at around 2020 to 2025. Accordingly, the urban gas demand for industrial use in the whole area of the survey should continue its increase even in 2020, though the area includes DKI Jakarta and Tangerang.

(c) However, there is a governmental policy to promote industrialization in other Provinces and other islands, so it is not reasonable to assume the increase of area of industrial estates to two fold and further to three fold of the currently approved area in West Java. During and after 2020, therefore, the total gas demand increase in the survey area should follow the last half of the S-shape curve.

Table10-3-4 Ratio of Urban Gas Use by the Industrial Sector in Each Area (%)

	2005	2010	2015	2020
DKI Jakarta	16	16	15	14
Tangerang	40	39	38	37
Bekasi	68	60	55	50
Karawang	31	25	24	22
Purwakarta	65	45	43	35

Source: Calculated by the Study Team

(d) At Bekasi and Tangerang which are the forerunners of fuel shift among the five regions of the Study area, there has been established a condition that equal share of three kinds of industrial fuels: namely, diesel oil/kerosene, urban gas, and C grade heavy oil, in 1994. The share of diesel oil/kerosene continues to decrease. The decreasing tendency of the share of diesel oil/kerosene suggests to reduce their share to 10 to 15% at around 2005. Table 10.3.4 shows the share of urban gas in the total industrial fuels for each regions.

10.4 Comments on the Survey

(1) Given the current situation, where C grade heavy oil has already been introduced as a fuel alternative to diesel oil/kerosene, it is important for the provider of urban gas to not lose sight of the original purpose of gas market development by trying to outsell bunker C grade heavy oil in the market. Rather, a parallel promotion of the two fuels respective to reasonable use is more in line aligned with government policy.

Electric power generation in Indonesia in the future will employ coal. Therefore, sales promotion of urban gas as a replacement for electricity would be acceptable only in the case of the local electricity supply being insufficient.

(2) In the long term, one scenario presents the prospect the domestic supply of natural gas peaking between 2020 and 2030, even though the domestic gas supply will continue to be given priority. C grade heavy oil will eventually be upgraded to a transport fuel, after which coal will be introduced as an industrial fuel. It is important to set a pricing policy in accordance with the trends of the long-term supply capability of these three fuels. Close coordination with the relevant government offices is important in this regard.

(3) The parts of the industrial sector which find the performance of urban gas desirable

cover a wide range such as ovens in the food processing industry, the machining industry, and the glass industry, annealing furnaces for CRT manufacturing, annealing furnaces for high-quality ceramics, small and medium-size boilers, and precise air-conditioning and rapid drying after dyeing in the textile industry. The number of sectors demanding urban gas will increase with upgrading in the level of industrial technology, quality requirements, and increased labor saving demands. Presentation to factory management of new trends in technology, and new examples of the use of gas will be helpful for promoting fuel conversion by customers. Selling gas to factories requires prior marketing and the introduction of new technology.

It is important to explain the need to select urban gas to potential customers during the stage of design and planning of a factories. Planning personnel normally work at an office remote from the new factory sites: It is important to make efforts to visit these personnel at their places of work. This provides customers with a chance to select the optimum fuel before making an investment.

Installing a pipeline for a single factory is a very unattractive prospect for PGN. Neither is it beneficial for PGN to install a pipeline at the same cost to a group of factories several years after they are operational, as a considerable number of customers have already chosen other fuels. The most effective operation, as mentioned above, is to persuade the customers of the advantage of gas while their factories are in the planning stage, followed by early installation of the pipeline. This is the way to improve PGN's profit. The company's profit and vitality will be diminished otherwise. Training to improve the skills of sales personnel, and closer cooperation between accounting, marketing, and gas procurement divisions, will be linked to the same operation.

(4) What is the reason for the rapid, and large-scale fuel-switching from diesel oil/kerosene to C grade heavy oil? Were the introduction of C grade heavy oil required for the reduction in consumption of diesel oil/kerosene? These changes have been beneficial, rather than detrimental, to Indonesia. It is important that PGN correctly analyze these situations.

Chapter 11

New Technologies to Promote Gas Utilization

11. New Technologies to Promote Gas Utilization

11.1 Outline of the Work of New Technology Gas Use

The Team has examined the applicability of new technologies to promote efficient use of urban gas. Evaluation from an economic view point is emphasized. Gas cooling systems, co-generation systems and natural gas vehicles (NGV) have been selected as new technologies for the Indonesian gas market.

Throughout the field survey, energy consuming patterns in hotels, hospitals shopping malls, factories, restaurants and others were studied. The Team also surveyed the costs of equipment, installation work, maintenance, transportation and so on in Indonesia. Using the data obtained, the economy of the technology in Indonesia was evaluated as a model case for each facility.

Many facilities such as hotels, hospitals, office buildings, factories and others provide self power generators without heat utilization because of frequent failures of PLN power supply. Some owners want to operate their generators continuously to recover their capital investment. Because of this reason, the continuous operation of gas-driven, self-powered generators was studied as a gas utilization promotion technology, though the technology is not new. Also the economy of boilers and cooking appliances using gas instead of conventional fuels was studied.

In 1987 compressed natural gas (CNG) was introduced in Indonesia. Since then it has been marketed as a fuel for motor vehicles as part of the Government's policy to reduce dependence on oil fuels and air pollution caused by motor vehicles. But so far the growth of natural gas vehicles (NGV) has been sluggish and the government target to introduce 30,000 NGVs by 2000 might be difficult to achieve. To get information on NGVs in Indonesia, the Team interviewed conversion kit workshops, gas filling stations, experts of NGV and others. Based upon the information obtained through the survey, the Team proposes measures to promote NGV reliance.

11.2 Gas Cooling Systems

Gas absorption chiller and Gas Heat Pump (GHP) systems were studied as new technologies for gas cooling.

11.2.1 Absorption Chiller

Absorption chillers use lithium bromide solution (LiBr solution) as the working fluid as opposed to the chlorofluorocarbons (CFCs) used in turbo chillers. CFCs are said to deplete the stratospheric ozone layer and cause global warming. Because of this, in advanced countries, the production of CFCs has been phased out by 1996. Greater world attention is being drawn to absorption chillers in this regard. In Indonesia CFCs are scheduled to phase out by the end of 1997.

Absorption chillers are more economical than turbo chillers and are considered the most promising new technology to promote urban gas utilization. The operation is easy and a maintenance service system of suppliers will be established if the penetration of the system in Indonesia reaches a certain level. The simplified investment pay-back years for model cases for each application are in Table 11-2-1.

Table 11-2-1 Pay-back Years for Model Cases

Facility	Pay-back years for model cases
Hotel	2.7
Office Building	3.6
Shopping Center	2.1
Hospital	3.9
Factory (case of IPP customer)	5.0

Source: JICA Team

The installation costs vary according to the situation and the pay-back years are influenced by them to a large extent. As air conditioning systems for hotels, office buildings and other commercial applications, absorption chillers are economical, even included the high installation costs. The application of absorption chillers to factories instead of turbo chillers cannot be expected to be popular, because of low PLN power prices for industries. For factories receiving IPP power, the calculated pay-back time is 5 years. The 5 years of pay-back might be a critical point in judging whether or not it would be economical and a detailed study to estimate the construction cost for each condition should be done. Table 11-2-2 shows the result of the model case of office building application. Other results are included in the Appendices.

The result of the sensitivity analysis for energy prices is shown in Figure 11-2-1. If the power price is raised to 1.35 times of the current value (275Rp/kWh, current price 204Rp/kWh) and the gas price, to 1.52 times (500Rp/m3, current price 330Rp/m3), the pay-back year would not be changed. This means absorption chillers can compete against turbo chillers.

Table 11-2-2 Economic Evaluation (Air conditioning)
Absorption-chiller vs. Turbo-chiller

(1) Conditions/Assumptions

Facility	Type	Office	
	Floor area	9,000	m2
	Operation	10	Hr/Day
	from	8	o'clock
	to	18	o'clock
		300	Day/Year
	Ave. Load	68.5	kcal/m2/Hr
		204	RT
	Avg./Max.	0.67	-
Chiller	Load Design	102.2	kcal/m2/Hr
	Capacity/unit	304	RT
	No. of Operation	1	unit
	No. of Stand-by	0	unit
	Capacity/total	304	RT

	Absorption chiller	Turbo-chiller	
Power cost			
Source(PLN or IPP)	PLN	PLN	
Type	U-3/MV	U-3/MV	
Demand charge	5,180.0	5,180.0	Rp/kVA
Energy charge (off-P)	178.5	178.5	Rp/kWh
Energy charge (on-P)	240.5	240.5	Rp/kWh
Ave. energy charge	178.5	178.5	Rp/kWh
Fuel cost Gas	330		Rp/m3
Equipment cost	1,926	1,809	Mill.Rp
Motor capacity	45	216	kW/operation
Gas consumption	17,465		m3/M

* off-P:off peak hour
* on-P :peak hour

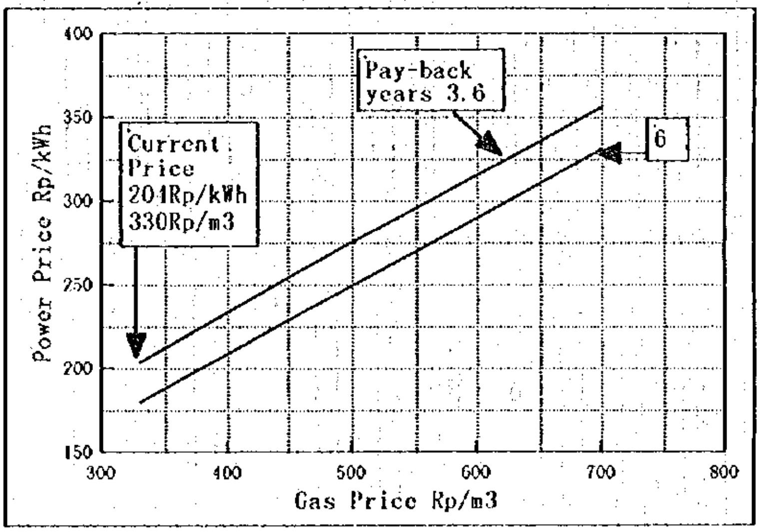
(2) Economic Analysis

	Absorption chiller	Turbo-chiller	
Annual running cost			
Variable cost			
Fuel cost	69.2	-	
Power cost	27.5	132.3	
Sub-total	96.7	132.3	Mill.Rp/Year
Fixed cost			
Depreciation	115.6	108.5	
Maintenance cost	57.8	54.3	
Tax & Insurance	19.3	18.1	
Interest	31.8	29.8	
Sub-total	224.4	210.7	Mill.Rp/Year
Total	321.0	343.1	Mill.Rp/Year

Pay-back year: 3.6 Year

Source: JICA Team

Fig. 11-2-1 Sensitivity Analysis - - Office Building
Effect of Power and Gas Price

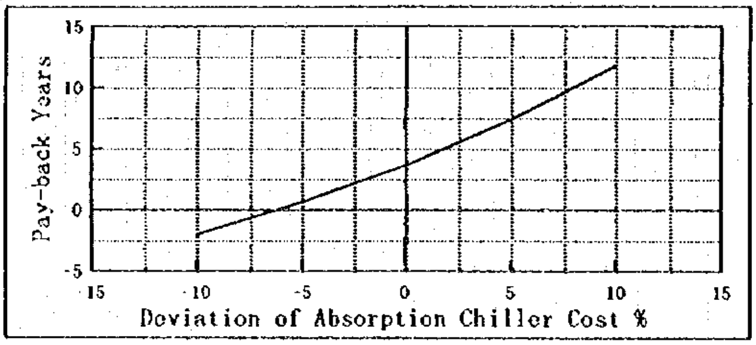


Source: JICA Team

The installation cost, and economics, of the system is influenced by many factors. Figure 11-2-2 shows the influence of the changing installation cost of the absorption chiller against the constant cost of a turbo chiller. The pay-back time of the system becomes 7.3 years from 3.6 years, if the deviation in the construction cost of the absorption chiller is 5% higher. Thus the influence of the installation cost on the economics is great.

Fig. 11-2-2 Sensitivity Analysis - - Office Building

Effect of Cost



Source: JICA Team

It is easy to replace a turbo chiller with an absorption chiller in a building is already equipped with chilled water pipings (so-called central cooling). In the case of an air source package chiller is already being installed, installing an absorption chiller is very difficult. This is because installing chilled water piping in a building being already constructed is very expensive.

In the case of small buildings, the air source package chiller is said to be more economical than the absorption chiller. 100RT is thought to be the border line capacity, and for capacity larger than 100RT, absorption chillers are generally more economical than air source package chillers. This capacity corresponds to a building of floor area of 2,000m2, if there is no special heat load.

11.2.2 GHPs (Gas Heat Pumps)

GHP is a system to using gas as a fuel to drive compressors for refrigerant vapor compression. This technology was developed as an alternative conditioner for the air source package chiller. This system is used in small buildings and its capacity might be less than 100RT.

We evaluated the economics of GHP in comparison with air source package chillers. The running costs of GHP are lower than those of the air source package chiller for office buildings, hotels, hospitals and shopping centers. But total operating costs become higher than those of air source package chillers because the capital cost of GHP is higher and so the depreciation cost is high. GHP is competitive with the air source package chiller only in the case of shopping centers, because power prices for commercial facilities for the class (PLN class U-2/LV) is relatively high and the operating hours of shopping center are long. Table 11-2-3 shows the model economic evaluation of GHP for a shopping center application.

Table 11-2-3 Economic Evaluation (Air conditioning)

GHP vs. Air Source Package

(1) Conditions/Assumptions

Facility	Type	Shopping	
	Floor area	1,500	m2
	Operation	13	Hr/Day
	from	8	o'clock
	to	21	o'clock
		360	Day/Year
	Ave. Load	71.6	kcal/m2/Hr
		36	RT
	Avg./Max.	0.67	-
Chiller	Load Design	106.9	kcal/m2/Hr
	Capacity/unit	53	RT
	No. of Operation	1	unit
	No. of Stand-by	0	unit

	GHP	Air source Package	
Power cost			
Source (PLN or IPP)	PLN	PLN	
Type	U-2/LV	U-2/LV	
Demand charge	7,320	7,320	Rp/kVA
Energy charge (off-P)	239.5	239.5	Rp/kWh
Energy charge (on-P)	239.5	239.5	Rp/kWh
Ave. energy charge	239.5	239.5	Rp/kWh
Fuel cost Gas	330		Rp/m3
Equipment cost	360	228	Mill. Rp
Motor capacity	8	50	kW/operation
Gas consumption	5,457		m3/M

* off-P: off peak hour
* on-P : peak hour

(2) Economic Analysis

	GHP	Air source Package	
Annual running cost			
Variable cost			
Fuel cost	21.6	-	
Power cost	9.9	61.2	
Sub-total	31.5	61.2	Mill. Rp/Year
Fixed cost			
Depreciation	21.6	13.7	
Maintenance cost	10.8	6.9	
Tax & Insurance	7.2	4.6	
Interest	39.6	25.1	
Sub-total	79.3	50.3	Mill. Rp/Year
Total	110.8	111.4	Mill. Rp/Year

Pay-back year: 5.1 Year

Source: JICA Team

11.3 Decentralized Power Systems

We discuss both co-generation and self power generation in this section, though a simple generator is not classified as co-generation.

11.3.1 Co-generation System

The most economical operation of a co-generation system is to run the system at full capacity constantly for a base load and to receive the rest of the fluctuating power from a commercial power supply such as PLN (grid-connected operation). But it became clear that grid-connected operation with PLN power was impossible. The PLN power supply is unstable in frequency and voltage. The deviation from standard condition is large and occurs frequently. A grid connection requires the operation of a co-generation system synchronously with PLN power. To operate a co-generation system synchronously with PLN power, it is necessary to control the regulator (a valve to control gas flow rate) of the co-generation system closely to the set point. The control range of the regulator is usually set to 100 % against 1 % deviation of the frequency and the voltage of grid-connected commercial power. If the deviation in the frequency or the voltage of PLN power exceed 1 % of the set point, the regulator becomes fully open or closed, and the co-generation system cannot be controlled and has to be stopped. This means that power supply failure of a co-generation system occurs repeatedly though the PLN power supply continues. Because of this, grid-connected operation with PLN power is thought to be impossible. On the other hand, the power supply from an IPP is said to be stable and grid-connection might be possible, though careful attention is necessary.

The installation cost of a co-generation system and its economy has been reviewed. The results of the economic evaluation for these facilities are shown in Table 11-3-1. It might be difficult to judge whether or not the installation for these facilities is economical. The application of the co-generation system for a factory receiving IPP power was evaluated. The calculated pay-back time is 4.7 years, if the system is operated at full capacity and all the heat from the system is utilized. Such a high utilization rate is hard to realize. For a factory receiving PLN power, installation of the system might not be economical. This is because PLN power prices for industry are lower.

Table 11-3-1 Pay-back Years for Model Case

Facility	Pay-back years for model case
Hotel	5.4
Factory (case of IPP customer)	4.7

Source: JICA Team

The result of a model case for a hotel is shown in Table 11-3-2.

The sensitivity analysis for power and gas price of a model case for a hotel is in Figure 11-3-1. The present prices of power and gas are 174Rp/kWh and 330Rp/m3 respectively, and the pay-back time is 5.4 years. If the power prices were to be raised to 223Rp/kWh(1.28 times of the present power price) and the gas price, to 500Rp/m3(1.52 times of the present gas price), the pay-back time of the system becomes 5 years.

Table 11-3-2 Economic Evaluation (Gas Engine Co-generation)

(1)Conditions/Assumptions

Facility : Hotel 44,000 m2

<Capacity>		<Efficiency %>	
Output	1	Power	31.0
No. of equipment	1	Steam	19.0
<Cost of Equipment>		Hot water	32.0
Unit cost mil.Rp	3.35	Total	82.0
Eq. cost mil.Rp	3355	<Price of power>	
<Fuel price>		Type	H-3MV
Gas	330	Demand charge	5400
<Heat>		Energy charge	166
Heat of combustion	7.94	<Accounting condition>	
Boiler eff. %	85.0	Depreciation yr.	15
		Salvage value %	10
		Interest %	20
		Maintenance Rp/kWh	19.6

<Unit> Power:MW;Time:hr;Fuel:kl or 1,000m3;Heat:Gcal;Money:1000Rp

(2)Result

<Amount> (-/Year)

	CG system	Conv.	CG benefit
Power demand MW	8640	8640	-
CG power generated MW	8640	-	8640
Purchased power MW	0	8640	-8640
Contract demand MW	0.00	1.00	-1.00
Heat demanded Gcal	7204	7204	-
CG high temp. Gcal	4236	-	4236
CG low temp. Gcal	2407	-	2407
Boiler Gcal	562	7204	-6643
CG fuel l	3019	-	3019
Boiler fuel l	83	1067	-984

<Economic calc.> (mil.Rp/year)

	CG system	Conv.	CG benefit
Demand charge	0.0	64.8	64.8
Energy charge	0.0	1436.0	1436.0
CG fuel	996.2	0.0	-996.2
Boiler fuel	27.5	299.4	272.0
Sub-total	1023.7	1800.2	776.5
Interest payment	301.9	0.0	-301.9
Maintenance	156.8	0.0	-156.8
Sub-total	458.7	0.0	-458.7
Total	1482.4	1800.2	317.8
Depreciation	201.3	0.0	-201.3

<CG operation> (%)

Power generated	100.0
Heat supplied	92.2
Heat utilized	54.3
Operation time	98.6
Load factor	98.6
Overall eff.	58.7

<Pow. unit cost> (Rp/kWh)

Variable cost	83.82
Fixed cost	76.39
Sub-total	160.22
Purchased pow.	ERR
Average	ERR
Conventional	173.70

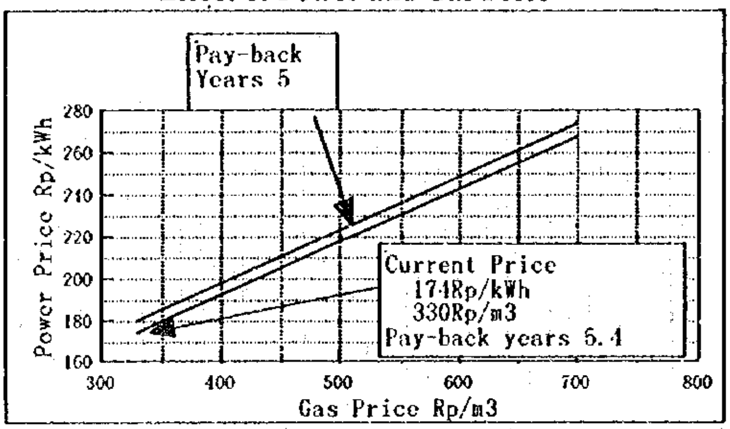
Economic evaluation>

Payback years 5.4

CG : Cogeneration system
Conv. : Conventional system

Source: JICA Team

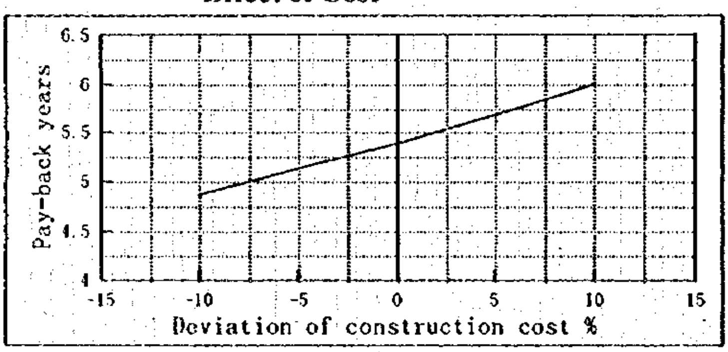
Fig. 11-3-1 Sensitivity Analysis - - Hotel
Effect of Power and Gas Price



Source: JICA Team

The result of the sensitivity analysis of the change in the construction costs is in Figure 11-3-2. The pay-back time of the system decreases to 4.9 years from 5.4 years, if the deviation in the construction cost of the system is -10 %(-10% = minus ten percent).

Fig. 11-3-2 Sensitivity Analysis - - Hotel
Effect of Cost



Source: JICA Team

The economics of a diesel engine co-generation system for a model case of a hotel was evaluated. The pay-back time of the diesel engine co-generation system for a hotel receiving PLN power is 3.7 years. On the other hand, the pay-back time of a gas engine co-generation system is 5.4 years and longer than that of a diesel engine co-generation system. The sale of a gas engine co-generation system might be difficult from the economic viewpoint. In Japan, diesel engine installation is limited in certain areas because of environmental restrictions. When the environmental restrictions of Jakarta become more strict in the future, the gas engine system may be adopted.

11.3.2 Self Power Generators

Many facilities such as hotels, hospitals, office buildings, factories and others run self power generators without heat utilization. Instead of only being used in emergencies, it might be more economical to use generators continuously. Gas and diesel engine generators without heat utilization were evaluated. The pay-back time of the gas engine system for a hotel model case is 6.1 years and the diesel engine system, 2.5 years. This means that the possibility of the adoption of gas engine generators is small, unless there are constraints such as environmental restrictions, lack of space of diesel oil storage tank and others.

11.4 Natural Gas Vehicle (NGV)

11.4.1 Background

The objectives of promoting NGV popularization in Indonesia are ① to save petroleum consumption in the transportation sector and ② to reduce air pollution caused by exhaust gas from automobiles. The Indonesian government is paying serious attention to environmental issues and is planning to introduce 30,000 NGVs by 2000. The ratio of petroleum fuel consumption in the transportation sector compared to other sectors such as houschold, industry and power plants, was about 47 % and the growth rate was 12.3 % (1994/95, Table 11-4-1).

Table 11-4-1 Ratio of Petroleum Fuel Consumption

(UNIT: MILLION KL)

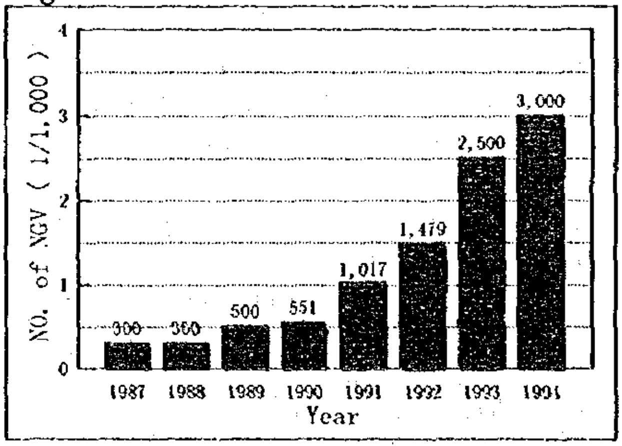
	1990		1991		1992		1993		1994	
	consumption	(%)	consumption	(%)	consumption	(%)	consumption	(%)	consumption	(%)
Households	7,878	23.2	8,099	22.5	8,455	21.7	8,626	20.8	8,844	21.5
Industry	7,153	21.0	7,568	21.0	8,512	21.9	9,196	22.2	9,702	23.6
Transportation	14,230	41.8	15,028	41.7	15,851	40.7	17,060	41.2	19,158	46.6
Powerplants	4,753	14.0	5,342	14.8	6,101	15.7	6,521	15.8	3,407	8.3
Total	31,014	100.0	36,037	100.0	38,919	100.0	41,403	100.0	41,111	100.0

Source: Pertamina

11.4.2 NGV Penetration

The NGV was introduced in Indonesia in 1987 and the number of NGVs were 3,000 in 1994 (Figure 11-4-1). All of the NGVs were converted from gasoline engine cars and they are all dual fuel. 2,500 out of 3,000 cars are taxis. The growth rate of NGV sales was about 42 % per year from 1987 to 1994. It might be hard to achieve the target of 30,000 cars by 2000, even if the growth rate of NGV continues at 40 % per year.

Fig. 11-4-1 NGV Numbers

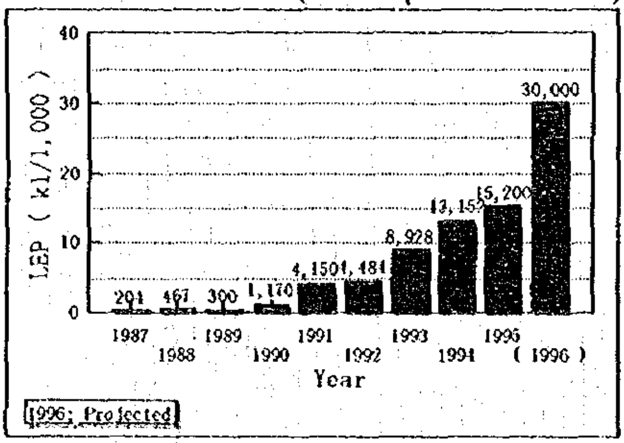


Source: PETROMINER Jan. 15, 1997

Figure 11-4-2 shows the CNG sales trend.

Fig. 11-4-2 CNG Sales Trend

LEP (Litter Equivalent Premium)



Source: PGN data

11.4.3 Influence on the Environment

Table 11-4-2 shows the influence of exhaust gas from automobiles on the environment as studied by Bapedal (Board of Environment Effect Control) in 1992. From this study, it is clear that the environmental influence by NGVs is large.

Table 11-4-2 Influence of Exhaust Gas from Automobiles

Item	Influence(%)
Total Suspended Solid	44
Hydrocarbon	89
Lead	100
NOx	73

Source: PETROMIER Jan. 15, 1997

Table 11-4-3 and Table 11-4-4 show the results of an emission test.

Table 11-4-3 Results of an Emission Test

Transmission	RPM	Premium (gasoline)		CNG (natural gas)	
		CO(%)	HC(ppm)	CO(%)	HC(ppm)
Neutral	Idling	8	150	1.6	80
III	3,500	6	60	2.7	40
	3,000	7	60	2.7	40
	2,500	7.3	50	0.5	40
	2,000	7.8	50	0.6	40
	1,500	8	80	0.3	25
IV	3,500	5	60	2	40
	3,000	6	60	1.2	30
	2,500	6.3	50	1.5	30
	2,000	8	60	1.0	20
	1,500	8	60	0.4	20
V	3,000	5	50	3	50
	2,500	5.5	50	2.7	40
	2,000	8	60	2	40
	1,500	8	60	2	40

Source: PETROMINER Jan. 15, 1997 Note) CO: carbon monoxide HC: hydrocarbon

RPM: revolutions per minute

Table 11-4-4 Results of an Emission Test

Unit: Gram/Mile(1 Mile = 1.61 km)

Pollutant	Gasoline	Diesel	CNG
Hydrocarbon	0.68	1.15	0.25
Carbon Monoxide	3.63	2.55	0.10
Nitrogen Oxide	1.37	1.95	0.50
Sulfur Oxide	0.45	0.80	-
Particle	0.06	0.70	-
Total	6.19	7.15	0.85

Source: World Bank Lemigas, GATRA. 15 Feb. 1997

11.4.4 Economic Evaluation of Conversion Kits

The fuel conversion from gasoline to CNG is relatively easy. It is done by applying a conversion kit which consists of a CNG vessel, regulators and others. The price of the kit is about Rp 2 million for a 2,000 cc class engine. The pay-back time of the conversion kit is in Figure 11-4-3. A taxi is said to drive more than 400 km/day and the pay-back time is very short, about 5 months. It is judged to be very economical. To penetrate NGV, the pay-back time is said to be less than 1 year and a good target might be those cars that drive more than 50,000 km per year.

Fig. 11-4-3 Pay-back Time of Conversion Kit for a Gasoline Engine

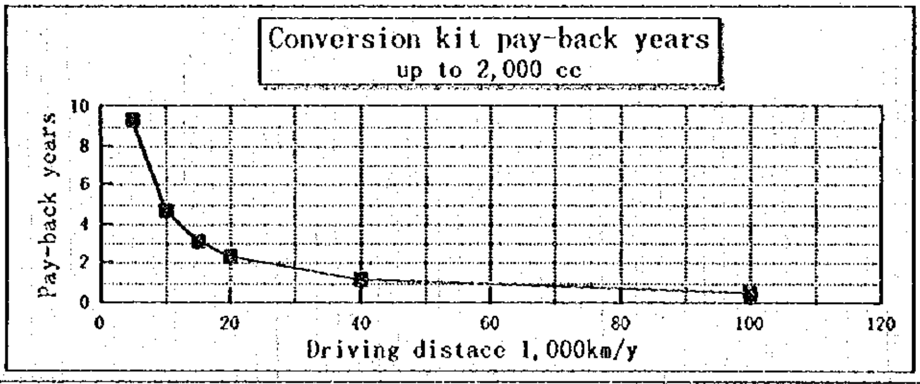
Gasoline Engine

Fuel Price

Fuel	Price Rp/LPE
Premix	875
Premium	700
Diesel-Oi	380
CNG	275

Pay-back year of conversion kit

Price of conversion kit	2,000,000	Rp
Gasoline cosumption	10	km/lit.
Driving distance	400	km/day
Operating days	312	days/y
Annual fuel cost:gasoline	8,736,000	Rp/year
Annual fuel cost:CNG	3,432,000	Rp/year
Pay-back years	0.38	years



Source: JICA Team

The price of the conversion kit for a diesel engine is Rp 10 million. The pay-back time of the conversion kit is more than 7 years for cars that drive long distances such as taxis. This is because the price of the conversion kit is high and the price of diesel fuel is low. From an environmental viewpoint it is more effective to convert diesel fuel to CNG. But it is hard from an economical view point.

Fig. 11-4-4 Pay-back Year of the Conversion Kit for a Diesel Engine

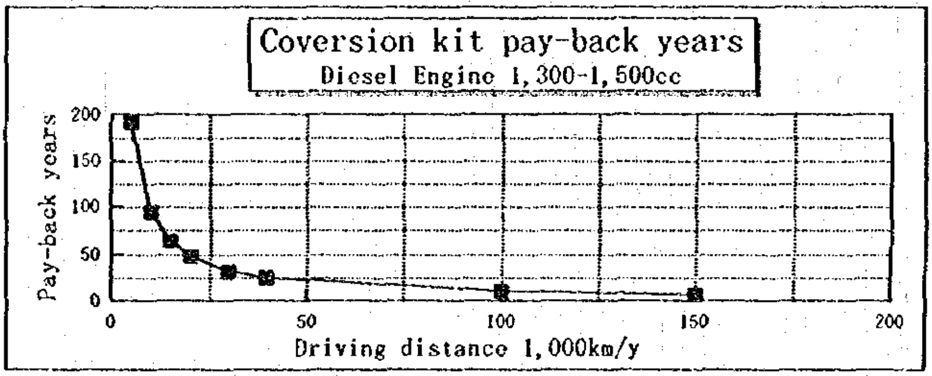
Diesel Engine

Fuel Price

Fuel	Price Rp/LPE
Premix	875
Premium	700
Diesel-Oi	380
CNG	275

Pay-back year of conversion kit

Price of conversion kit	10,000,000	Rp
Gasoline cosumption	10	km/lit.
Driving distance	400	km/day
Operating days	312	days/y
Annual fuel cost:Diese	4,742,400	Rp/year
Annual fuel cost:CNG	3,432,000	Rp/year
Pay-back years	7.63	years



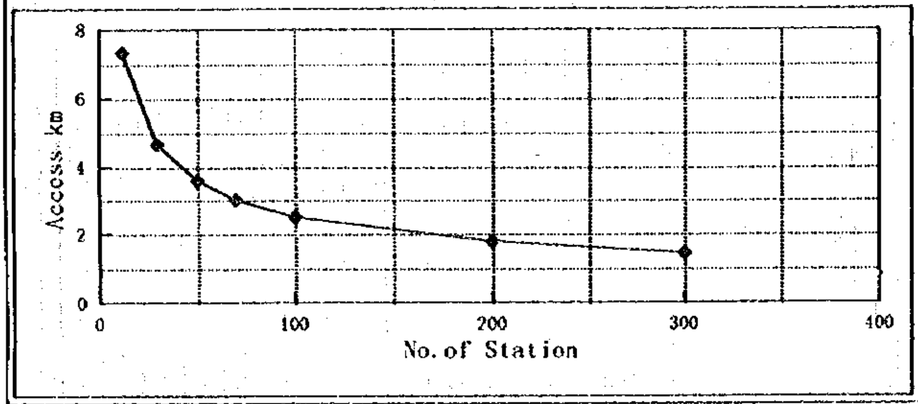
Source: JICA Team

11.4.5 Numbers of Filling Stations

At present there are 14 filling stations in Indonesia, of which 12 are in DKI Jakarta. Three stations are under construction. On the other hand, the number of gas station is about 300. The area of DKI Jakarta is some 650 square km and the distribution of gas station is one station per 2.2 square km. Therefore the average access distance to a gas station is less than 1.5 km, if stations are distributed uniformly in Jakarta. According to the research which was performed by the Institute of Technology of Bandung, about 100 CNG filling stations are necessary in Jakarta. In this case, the access distance is less than 2.5 km. From the point of users convenience for CNG penetration, the access distance is required to be short enough. Figure 11-4-5 shows the relationship between the number of filling stations and access distance.

Fig. 11-4-5 Relationship between Number of Filling Stations and Access Distance

No. of Station	Access km	
12	7.4	
30	4.7	
50	3.6	
70	3.0	
100	2.5	
200	1.8	
300	1.5	Approximate numbers of gasoline stations in Jakarta



Source: JICA Team

11.4.6 Proposed Policy to Market NGVs

The present incentives to promote NGV penetration in Indonesia are as follows:

① Setting low price for CNG
② Exempting from import duty gas filling station equipment and conversion kits
③ A lower power tariff for industry, for gas filling stations using compressors
④
⑤ Obligation of 20 % of mass transportation companies to use CNG for operating their vehicles

The current incentives are thought not sufficient to achieve the target to introduce 30,000 NGVs by 2000. Additional policy to promote NGV penetration might be necessary.

The following policy is considered to be effective to promote NGV penetration:
"to set regulations for CNG use by taxi companies, MIKROLET and central and local government to be at least 50 %."

The following conditions should be satisfied for the regulation to be effective.

① To guarantee to build about 100 filling stations in DKI Jakarta
② To prepare low interest long term loans for investors of filling station to secure land

③ To prepare low interest loans for conversion kit of MIKROLET
④ To assure urban gas supply to filling stations by pipeline network

11.4.7 Others

According to the research which was performed by the Institute of Technology of Bandung, one of the conditions for filling stations to keep the operation profitably is about 400 cars/ day・filling station. After the enforcement of the above policy, average numbers of NGVs per one filling station will be 390 cars/ day・filling station. This number is thought to be enough to operate a filling station.

The number of taxis in Jakarta	16,000
The number of MIKROLET in Jakarta	10,000
The rate of conversion to CNG	50 %
The utilization frequency	3 times/ day・car
The number of filling stations	100

The number of cars per one filling station
(16,000+10,000)×0.5×3÷100 = 390 cars/ day・filling station

The rate of reduction of exhaust gas pollutant and the saving rate of petroleum fuel for cars are estimated at around 3 %. The rate of reduction is not large. But this might have a large influence on CNG penetration for cars other than taxis and MIKROLET, if the number of filling stations is increased.

11.5 Projections

11.5.1 Highly Promising Technologies

The gas air-conditioning by absorption chillers will be one of the best technologies to promote gas utilization from the viewpoint of economics, environment, easy operation and convenience. For a small office building and others, the air source package type is economical. For medium and large buildings, the absorption chiller is suitable. The number of chillers operating in Indonesia is limited at present. The low penetration would be due to lack of knowledge about the technology. In Japan, about 75 % of medium to large office buildings adopt absorption chillers. Indonesia is phasing out CFCs and it can be expected that the absorption chiller will penetrate rapidly. PGN should definitely take a promoting role for the penetration as soon as possible.

The gas engine co-generation system may be hard to penetrate rapidly at present power and gas prices. And the diesel engine co-generation system is a strong competitor for the gas engine co-generation system. This technology may penetrate in the future because of the reliability of a stable power supply, the cleanliness and high efficiency.

If the number of filling stations is increased, NGVs will penetrate for taxis, MILROLET and others. The pay-back time of the conversion kit for a taxi is short, about 5 months. A condition of penetration is to provide a certain number of filling stations and some public action to assist in the construction of the stations is needed.

11.5.2 Less Promising Technologies

The GHP may penetrate to some extent. The tariff of PLN is determined for each facility and changed according to the amount of power consumption. For the case of long operation time and high PLN power tariff class, the GHP may penetrate. But the rate of the penetration will not be high.

Gas engine self power generator will have very few chance to compete with diesel engine generators.

Chapter 12

Master Plan of Demand and Distribution

12. Master Plan of Demand and Distribution

12.1 Integrated Gas Demand Scenarios

While we looked at demand estimation principles and detail potential demand forecast for each sector in the former chapters, we need to integrate and review them all. Since all gas flows in the same network, further constraints are taken into consideration to produce the revised estimate "possible gas demands".

Before going into the projection of urban gas demand specially in this master plan, we recall following items were referred to as the factors influencing the entire demand projection.

- Population growth
- GRP

12.1.1 Outline of Gas Demand Projection

Three cases of Base, High, and Low in the Master Plan are based on GRP, and three scenarios accordingly. The characteristic of each scenario is shown in Table 12-1-1.

Table 12-1-1 Demand Projection Scenario

Alternative	Scenario image	GRP
Scenario 1 Base Case	Standard economic development will be achieved. To cope with the responding growth in urban gas demand, PGN will need systematic and strategic activities.	Middle
Scenario 2 High Case	High economic development exceeding the standard will be achieved. To respond to the high growth in urban gas demand, PGN's strategic activities will be near the maximum limit.	High
Alternative 3 Low Case	Standard economic development will be achieved, but the systematic strategic activities will be below standard.	Low

Gas producers and transmitters cannot provide a limitless supply to meet all demands. On the assumption that all of the projects now being planned to supply natural gas to Java Island go on smoothly, the degree of progress and the planned completion period are used as the constraints to the growth in natural gas supply. Residential gas demand is projected on the assumption that PGN can construct all distribution pipelines and all indoor pipes necessary to realize such amount. Considering that the current number of households to which urban gas is supplied from the PGN Jakarta Branch is approximately 10,000, PGN will be subjected to broad innovation of its organization and business systems in the future in order to flexibly correspond to the number of customers increasing at the rate of dozens of thousands per year. The current sales of urban gas to residential customers will greatly depend on two factors; 1) Capacity of PGN's business management organization and 2) its capability of installing additional pipelines. Due to this reason, we defined the "possible demand" which has taken the above-mentioned restrictive conditions in addition to the projected potential demand in the residential market, and applied this newly defined value to the Master Plan stated below.

12.1.2 Estimation of Possible Sales to the Residential Market

(1) Constraints of business and organizational capacity

The projected demand for urban gas by residential customers in 2020 is 197,473 thousand m3/year, equivalent to a volume for 452,000 households in the Base Case. Simply this means that 24,000 households will be new customers each year. If PGN is going to double the number of the household customers, perhaps it will be unable to respond to the demand increase with the current business structure and, hence, it will have to drastically improve its organization and business systems. Therefore, the possible demand has been set rather conservatively.

The current meter reading and collection capacities in PGN are 1200/month/person and 740/month/person respectively. Assuming the number of residential customers increase by 10,000 every year, 8 persons for meter reading and 14 persons for collecting, thus 22 persons in total will additionally be needed. Including managerial persons, 25 persons in total will be needed.

Furthermore, PGN will have to carry out, by startup of urban gas supply into new customers, "quoting and contracting for gas work", "drafting gas supply plan", "gas work design", "Contracting with gas pipeline contractor and control of work performance", "work information control after completion of the pipeline work", etc. And personnel having the knowledge necessary for respective jobs must be arranged. Of these jobs, particularly "quoting and contracting for gas work" and "contracting with gas pipeline contractor and control of work performance" will be subjected to arrangement of additional personnel because it is difficult to fulfill them only by the existing personnel even if the work efficiency is improved.

The actual number of work items for market development, including those two, in past three years was 100 items /year/person and, hence, 100 persons may be needed for 10,000 new customers. But it is estimated that the market development activity could be implemented by 50 persons, considering demand concentration and job efficiency improvement. The number of personnel required for meter reading and collecting proportionates to customer stock, while the number of market development personnel proportionates to annual addition of customers. Viewed from the side of personnel, the development of residential demand depends on how the personnel are secured and educated. The development activity requires the personnel with the knowledge of specific job itself though not necessarily high expertise. For that, they will have to be trained respectively.

PGN uses a computer system to manage the meter reading and rate collecting. Upon hearing survey, PGN says it has a sufficient allowance in the capacity so it can respond to the number of customers approximately ten times as many as the current number. Therefore, current demand expansion may not be constrained by this factor.

(2) Capability of work performance

There are 9 work contractors specializing in steel pipeline work currently registered in PGN Jakarta Branch and 17 companies specializing in polyethylene pipeline work. It is forecast that the development of gas demand for the residential market will be bottle-necked by PGN's capability of polyethylene pipeline work performance. Why ? It is because, unlike steel pipeline work, the polyethylene pipeline work needs special tools and special skill and knowledge and is not a general method. The total work capability of 17 polyethylene pipeline constructors is estimated to be 40 km/year maximum from the past actual work data in PGN.

Currently these polyethylene work contractors are mainly engaged in rehabilitation work, but the amount of such work will decrease rapidly. In this view, it will be possible to shift the current capability of these companies to the new pipeline work incurred by market development.

From the result of field survey, approximately 10 m of pipeline must be installed to supply urban gas into one house and this means that 100 km pipeline of work is needed for gas supply into 10,000 houses. This value is much more than PGN's current capability of work performance. To eliminate this problem, the polyethylene pipeline work system will have to be improved. However, several years will be needed to establish such an improved work system because work personnel must be educated and trained, qualified and certified, and have the experience in work in order to maintain work quality. In addition, expensive fusion equipment is needed to perform polyethylene piping work and, therefore, it becomes necessary to continuously assure work companies of constant quantity of work, even from the viewpoint of breeding them. Considering these factors and the possible demand in the residential sector, we set up the maximum capability of polyethylene pipeline work performance to 200 km, approximately 5 times as many as the present capability. We assumed 3 years are necessary from the start of the project until the maximum work system is ready. Table 12-1-2 shows the projected result of "possible gas demand"

Table 12-1-3 shows the revised and integrated urban gas demand by scenario. We adopted the gas demand in Table 8-4-1 when it is smaller than the possible gas demand.

Table 12-1-2 Possible Gas Demand in Residential Sector

Year		Unit	1995	1996	1997	1998	1999	2000	2005	2010	2015	2020
Capacity of Construction	1st half	(km/year)			40	80	140	200	200	200	200	200
	2nd half	(km/year)			60	110	170	200	200	200	200	200
Number of New Customers						7,000	12,500	18,500	20,000	20,000	20,000	20,000
Number of Household			9,057	9,670	11,135	18,135	30,635	49,135	149,135	249,135	349,135	449,135
Base Case	Gas Consumption per House	m3/year				375	379	386	396	411	424	436
	Possible Gas Demand	thousand m3	2,490	2,274	2,766	5,391	10,157	17,434	57,414	100,584	146,078	193,734
High Case	Gas Consumption per House	m3/year				378	382	387	403	422	439	457
	Possible Gas Demand	thousand m3	2,490	2,274	2,766	5,412	10,215	17,472	58,380	103,202	151,148	202,932
Low Case	Gas Consumption per House	m3/year				317	321	385	390	400	408	416
	Possible Gas Demand	thousand m3	2,490	2,274	2,766	4985	9025.5	17396	56586	97966	140670	184974

Source: JICA Team, 1997

Unit Thousand m3/Year

Table 12-1-3 Gas Demand for Master Plan by Scenario

			1996	1997	1998	1999	2000	2005	2010	2015	2020
Base Case			890,107	976,389	1,054,611	1,165,387	1,344,738	2,159,716	3,519,074	6,091,692	10,304,243
	Residential		2,274	2,766	4,989	9,181	16,963	57,188	100,584	146,078	192,043
	Commercial		10,234	13,212	16,411	21,395	28,163	120,361	269,791	468,958	736,605
		Cooking	4,564	4,706	5,512	6,319	7,125	16,808	32,838	54,382	83,518
		Bo+Air	5,670	8,506	10,899	15,076	21,038	103,553	236,953	414,576	653,087
	Industrial		877,599	960,411	1,033,211	1,134,811	1,299,611	1,982,167	3,148,699	5,476,656	9,375,594
High Case			890,107	976,389	1,072,856	1,209,038	1,429,616	2,397,056	4,037,051	8,281,981	17,160,436
	Residential		2,274	2,766	5,034	9,232	17,042	58,380	103,202	151,148	202,932
	Commercial		10,234	13,212	16,411	21,395	28,163	122,106	276,688	492,126	800,871
		Cooking	4,564	4,706	5,512	6,319	7,125	17,002	33,603	56,951	90,643
		Bo+Air	5,670	8,506	10,899	15,076	21,038	105,105	243,085	435,175	710,229
	Industrial		877,599	960,411	1,051,411	1,178,411	1,384,411	2,216,570	3,657,161	7,638,707	16,156,633
Low Case			890,107	976,389	1,036,076	1,120,794	1,258,828	1,975,247	2,994,431	4,301,304	5,946,306
	Residential		2,274	2,766	4,654	8,189	15,854	54,965	97,966	131,594	163,020
	Commercial		10,234	13,212	16,411	21,395	28,163	118,360	261,827	443,891	672,260
		Cooking	4,564	4,706	5,512	6,319	7,125	16,586	31,955	51,603	76,385
		Bo+Air	5,670	8,506	10,899	15,076	21,038	101,773	229,872	392,288	595,875
	Industrial		877,599	960,411	1,015,011	1,091,211	1,214,811	1,801,922	2,634,638	3,725,819	5,111,025

Source: JICA Team, 1997

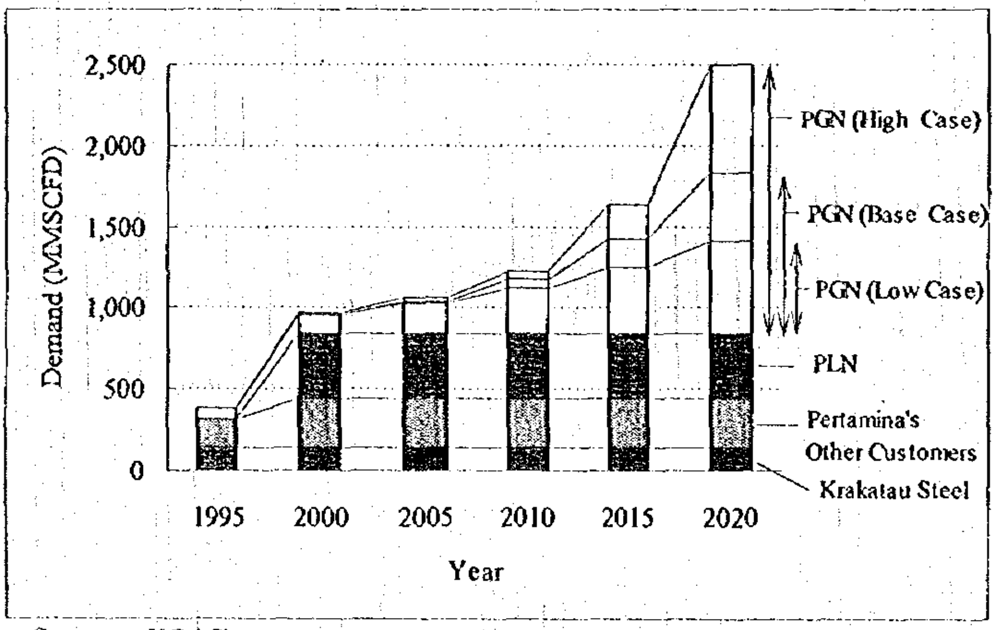
12.2 Projected Supply and Demand for Urban Gas

For the projection of supply and demand, we assumed the following conditions ;

(1) Gas Production in West Java follows the Pertamina's production plan. (cf. Fig. 5-1-1)
(2) The South Sumatra Pipeline to transmit 250 MMSCFD gas to Java will start in year 2000 and continue until year 2020.
(3) Direct customers of Pertamina use gas according to Pertamina's gas production plan until year 2000, and after that, they will keep using the same amount of gas as in year 2000.
(4) As for the gas demand in Serang, we use 94 MMSCFD, which is shown in Table 5-3-1, as the target demand in year 2020 though Serang is not included in our master plan region.

Fig. 12-1-1 shows the demand projection for natural gas in West Java according to the above conditions.

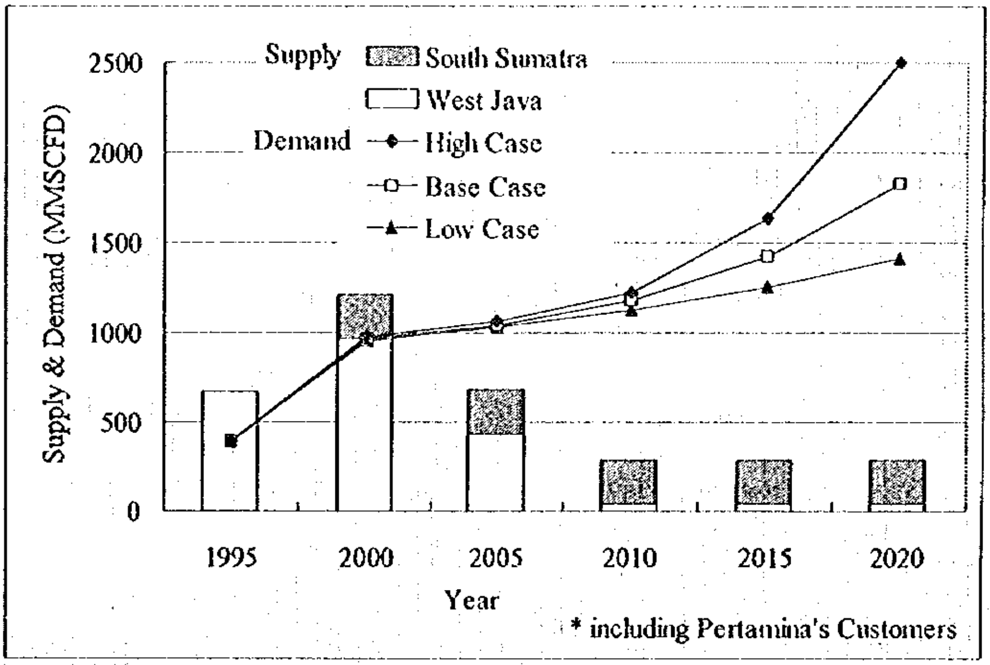
Fig. 12-1-1 Demand Projection for Natural Gas in West Java



Source : JICA Team

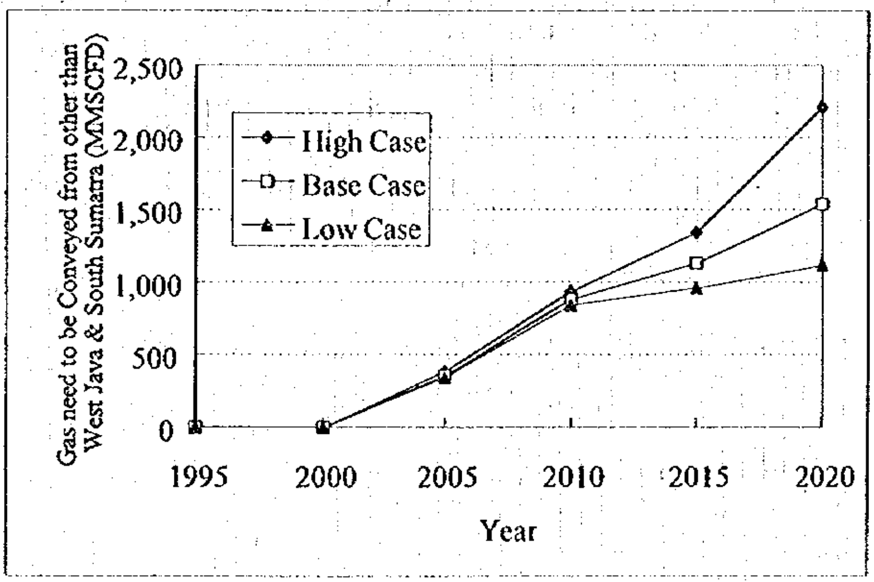
From the graph, gas demand for Krakatau Steel and PLN is greater than that for PGN at the year of 2000. However, PGN's demand begins to increase after 2005 and is forecasted to be almost same as the total demand of other consumers. Fig. 12-2-2 shows our supply and demand projection. Gas production in West Java is predicted to decrease after year 2000 and the gas sources outside West Java and South Sumatra have to be exploited for the area after year 2005 even in the low case demand. The amount of gas expected from other sources is shown in Fig. 12-2-3.

Fig. 12-2-2 Projected Supply and Demand for Natural Gas



Source : JICA Team

Fig. 12-2-3 Amount of Gas Expected from Other Sources



Source : JICA Team

According to Fig. 12-2-3, the amount of gas to be supplied from other than West Java and South Sumatra is 1,100 to 2,300 MMSCFD in 2020 and this amount is converted to 8 to 17 TSCF by reserve. Natuna, Sumatra and Irian Jaya are good candidates for gas supply. Natuna has more than 20 TSCF receive (Pertamina's data, 1996) and is one of the most suitable gas supply source. In order to transmit gas from these sources to West Java, construction of "Trans-Indonesia Pipeline" or LNG chain is necessary.

12.3 Design of Distribution Pipelines

12.3.1 Design Conditions

Before making pipeline expansion plans, we would like to make our design conditions clear so that the backgrounds of design can be easily understood.

(1) Pipe Material
3 pressure levels of networks will be utilized for the expansion plan; the high pressure network, the medium pressure network and the low pressure network. When we consider operation and maintenance after the pipeline installed, it is recommended to use the same pipe material as the existing ones for the newly expanded pipeline. Pipe materials to be used in our design are shown in Table 12-3-1.

As for the high pressure system, only the welded steel pipe can be used as the pipe material since gas pressure is so high that other material such as polyethylene will not be suitable. Also since PGN's high pressure network consists of two specifications, ANSI150 and ANSI300, we will pay special attention to the connection of both pipelines and consider the way that both networks will be utilized efficiently in the Master Plan. As for the medium and low pressure networks, we will choose polyethylene as the pipe material which is approved to be the most suitable pipe material world wide from the points of construction and maintenance.

Table 12-3-1 Pipe Materials for Distribution Network

Network	Pipe Material	Design Pressure	
		Minimum	Maximum
High Pressure	Steel (Welding)	4 bar	40 bar *
Medium Pressure	Polyethylene, Steel	0.3 bar	4 bar
Low Pressure	Polyethylene	100 mmH_2O	250 mmH_2O

* : In case of ANSI150 specification pipeline, the maximum pressure is 16 bar.
Source : JICA Team

(2) Distribution Pressure
It is necessary to choose the suitable distribution pressure for each demand sector because the characteristics of the sectors are different. Table 12-3-2 shows the basic

distribution pressure we will adopt for developing the new markets.

The medium pressure system with house regulators or the low pressure system is recommended for the residential sector because the gas consumption of each customer is small and the gas pressure should be reduced down to a low pressure at the entrance of a gas meter due to safety reasons.

Table 12-3-2 Basic Distribution Pressure to Each Demand Sector

Demand Sector	Characteristics of Sector	Basic Distribution System
Residential	• Demand of each customer is small. • High input pressure is not necessary. • Gas pressure should be reduced down to a low pressure level before a gas meter from safety reasons.	• Medium pressure with house regulator(HR) system • Low pressure system
Commercial	• Demand for boilers, air conditioners and power generators sometimes requires medium pressures for appliances. • High pressure input is not recommended because of safety reasons.	• Medium pressure for boilers, air conditioners & power generators. • Low pressure for cooking.
Industrial	• Usually demand is large. • If gas leaks at customers site, operators can close valves.	• High pressure

Source : JICA Team

As for the commercial sector, the medium pressure is recommended for boilers, air conditioners and power generators since the appliances often require a medium pressure for their input. A high pressure is not recommended for the commercial sector because a lot of unspecified persons use commercial buildings and distribution pressure should be kept as low as possible considering gas leakage or other accidents.

The industrial sector can directly use a high pressure system since it consumes large amount of gas. It is also expected that operators of the factory usually works while gas is used. We can assume that the risk of gas accident is much lower than those in the residential and commercial sectors and therefore, the high pressure distribution system can be adopted.

(3) Flow Equation

When we design a gas network, flow calculation is necessary in order to determine suitable pipe diameters. We will use the following "General Flow Equation" which is usually used for gas network design world wide.

$$Q = (0.2394 \cdot \frac{To}{Po} \cdot \sqrt{\frac{1}{z \cdot T}} \cdot \sqrt{1/f}) \cdot \sqrt{\frac{(P_1^2 - P_2^2) \cdot D^5}{S \cdot L}} \quad \text{------ (eq.12-1)}$$

where Q : flow rate [m^3/h]
P_1: upstream pressure [Kg/cm^2]
P_2: downstream pressure [Kg/cm^2]
D : pipe diameter [cm]
S : specific gravity [air = 1.0]
L : length [m]
T : gas temperature [°K]
Po : base pressure [Kg/cm^2]
To : base temperature [°K]
z : compressibility factor
$\sqrt{1/f}$: transmission factor of the line

We must set several parameters such as specific gravity S, gas temperature T and so on. The values or formulas for the parameters we use are shown in Table 12-3-3 and the theoretical backgrounds from which we select the values or formulas are discussed in the Appendix.

Table 12-3-3 Values or Formula for General Flow Equation

Parameter	Value or Formula
Specific Gravity S	0.595 (air = 1.0)
Gas Temperature T	27℃
Compressibility Factor z	(High Pressure) AGA (Medium & Low Pressure) z = 1.00 (constant)
Transmission Factor $\sqrt{1/f}$	(High Pressure) Panhandle A (Medium Pressure) IGT (Low Pressure) Mueller

Source : JICA Team

12.3.2 Estimation of Pipeline Load

In order to design a gas pipeline, it is necessary to estimate peak time a pipeline load. We usually use the unit of cubic meter per *hour* (m^3/h) for the pipeline load because the unit of day or month is too long to estimate the peak time load. When a customer uses gas constantly all day long, the peak load can be calculated directly from the customer's consumption volume. For example, if the consumption by a large industrial customer is given by the unit of m^3/day, the peak load can be calculated by dividing the volume by 24 hours. However, residential or commercial customers seldom use gas constantly for 24 hours. They use gas only for several hours a day.

Table 12-3-4 shows the way we will use to estimate pipeline load in the Study.

As shown in the table, the load survey provides us the information necessary for determining the peak load of one customer and the simultaneous consumption ratio in the residential sector. The actual data in the load survey have been analyzed to determine the simultaneous consumption ratio.

Table 12-3-4 Peak Load Estimation

Demand Sector	Way of Peak Load Estimation
Residential	(1) Estimate a peak load of one customer q [m^3/h] using the results of the load survey conducted during the Second Field Work. In the Study, we use $q = 0.60$ [m^3/h] (2) Peak load of pipeline Q [m^3/h] is calculated by $Q = q \times n \times Y$ where n denotes the number of customers and Y the simultaneous consumption ratio.
Commercial	Individual survey of capacity and usage time of gas appliances are basically necessary. However, in case that only macro data (annual demand) is available, we calculate the peak load from the demand assuming that 1000 hours and 3000 hours of working time for cooking use and air conditioning use respectively.
Industrial	Basically individual survey is necessary. However, in case that only macro data (annual demand) is available, we calculate the peak load from the demand assuming that 8760 hours of working time.

Source : JICA Team

As for the commercial and industrial customers, the individual survey of the capacity and usage hour of gas appliances are recommended since their demands are usually large and they give a heavy load to pipelines. However, in case that only macro data is available, we have to calculate peak load from daily or yearly demand considering the customer's average working hours as shown in Table 12-3-4.

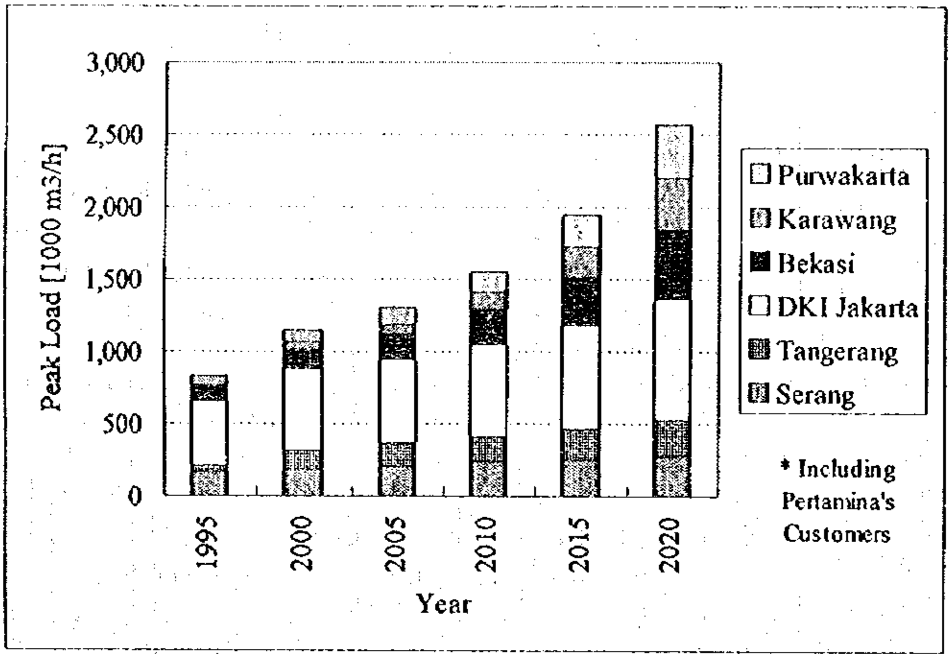
12.4 Proposed Urban Gas Network

12.4.1 Transmission Line Proposed for West Java

Using the base case demand projection, we simulated the transmission status in West Java until year 2020. Fig. 12-4-1 shows the peak load in each district which was calculated from the base case demand projection. Also Fig. 12-4-2 shows the peak load increase indices based on our projection.

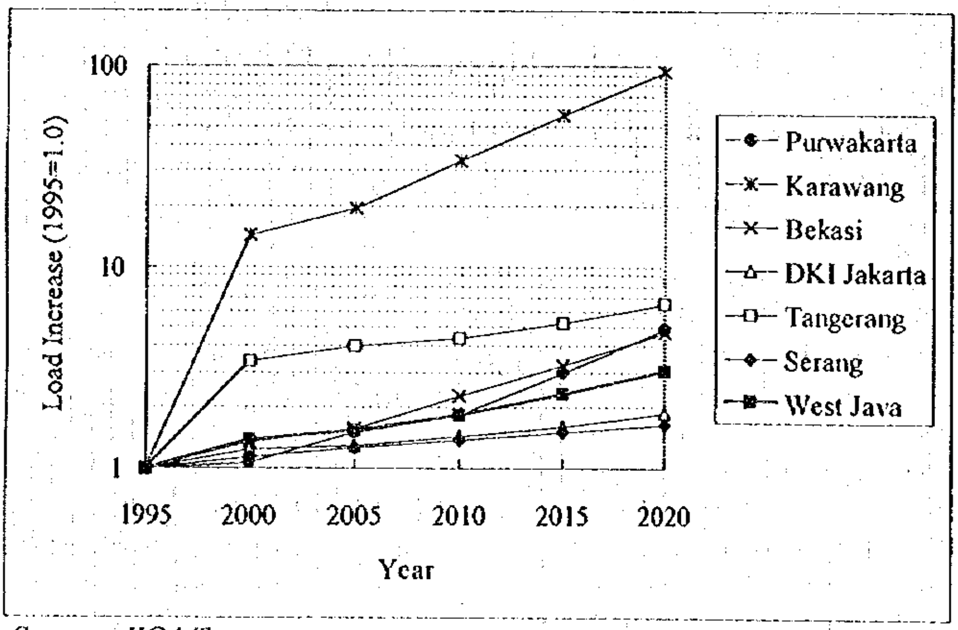
From the both graphs, peak load in West Java is expected to reach more than 2.5 million m^3/h in year 2020 which is 3 times larger than the current one, and especially load in Kab. Karawang is expected to increase rapidly. Since Kab. Purwakarta, Kab. Karawang and Kab. Bekasi have large industrial estates, the demands in these districts are expected to increase sharply. Peak load in Tangerang includes the load for an IPP in BSD after year 2000.

Fig. 12-4-1 Peak Load Projection in Each District (Base Case)



Source : JICA Team

Fig. 12-4-2 Peak Load Increase in Each District (Base Case)



Source : JICA Team

Using these base case peak time load, we conducted network analysis in order to confirm the capacity of transmission system. According to the results of network simulation conducted, the pipelines which increase the transmission capacity from Subang and Pasir Jadi gas fields to Pertamina's existing pipeline is necessary until year 1999. (Fig. 12-4-3) After the South Sumatra Line is connected to Pertamina's existing transmission line at Cilegon in year 2000, the status of West Java transmission system will change dramatically. Boosters at Tegal Gede and Bitung are no longer necessary to work to transmit gas to Cilegon since gas comes from Cilegon. (Fig. 12-4-4) This condition is predicted to continue until year 2015. (Fig. 12-4-5) After year 2015, another transmission lines are necessary to respond to the demand. One of the options to increase the capacity is to install pipelines from Cilegon to Bitung and from Muara Tower to Tegal Gede. (Fig. 12-4-6)

Since there exist several uncertainties, there may be some alternative plans for transmitting gas to West Java after 2015. The alternatives plan should be evaluated from the points of cost, supply security and influence to the surroundings considering the item shown in Table 12-4-1.

Table 12-4-1 Items to Be Considered for the Measures after 2015

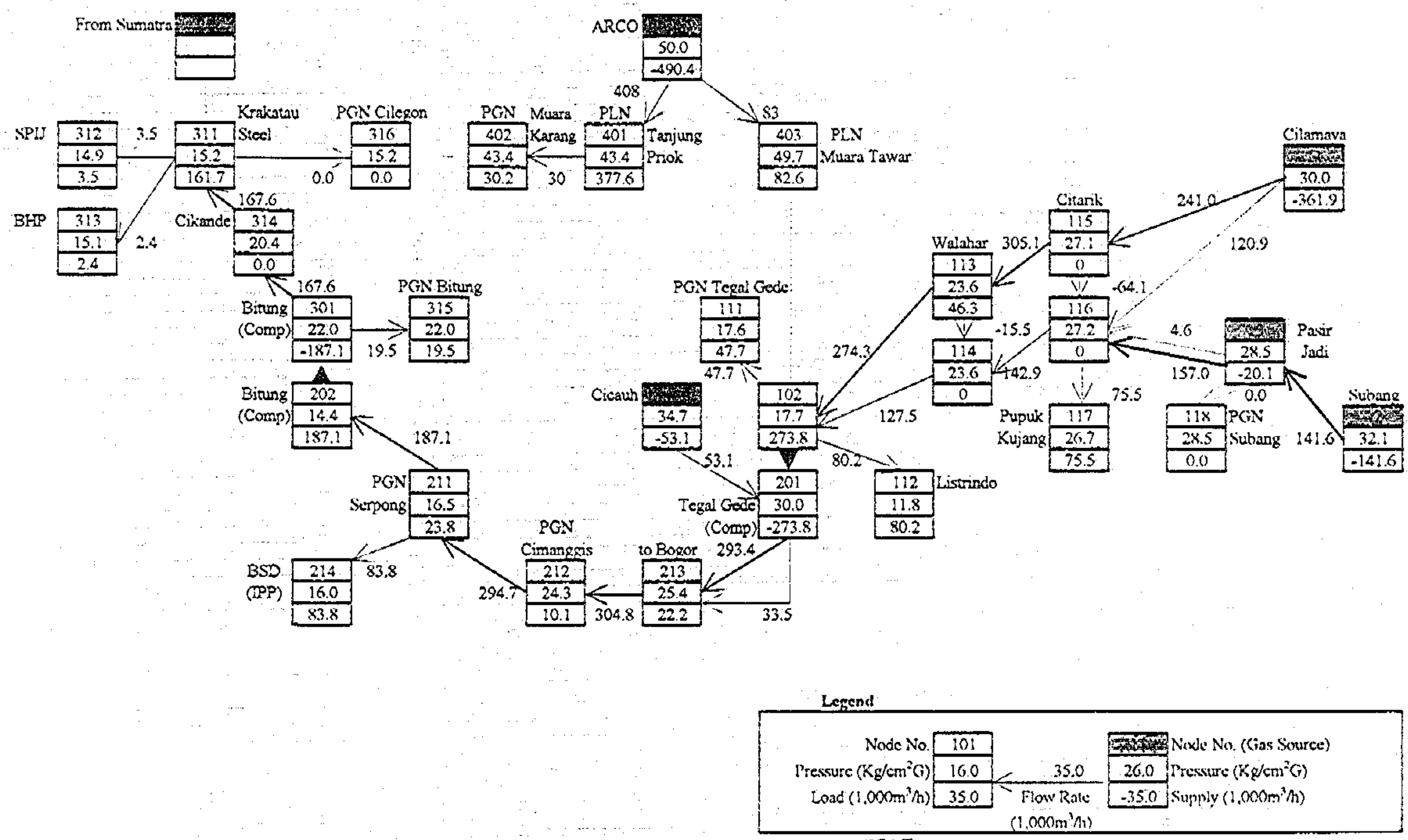
Item	Cost	Security	Influence to Surrounding
Production	- Production capacity - Production cost	- Production years	- Quality of gas produced and compatibility to old gas
Transmission	- Cost comparison between pipeline and LNG transmission	- Amount of stock gas when transmission is suspended	- Degree of urbanization along pipeline - Noise and vibration from compressor station

Source : JICA Team

From the point of gas production, the capacity, cost and duration of production on the gas fields should be evaluated and it is necessary to confirm the compatibility of gas produced to the gas distributed in West Java.

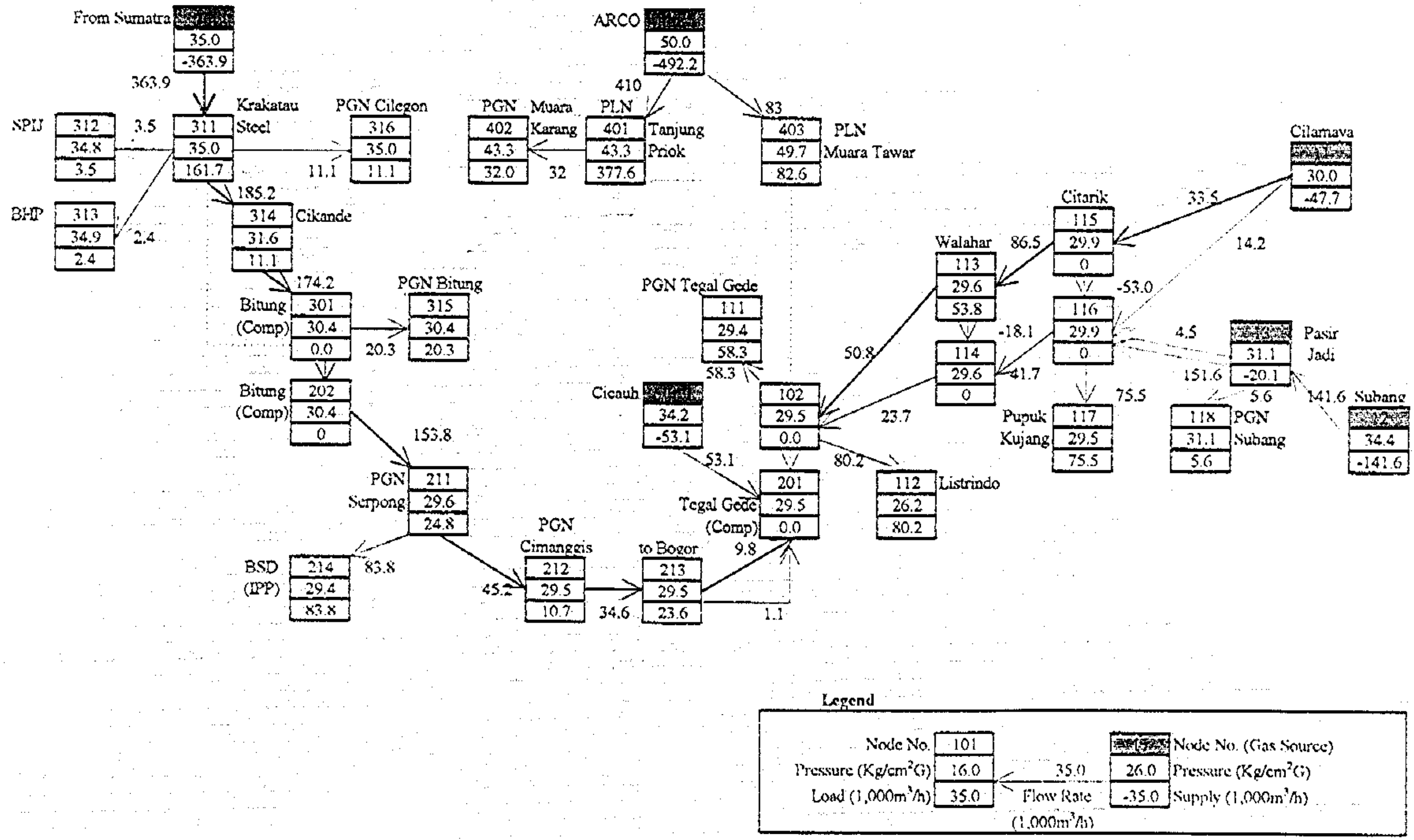
From the point of gas transmission, the initial and running cost on pipeline transmission and LNG transmission should be compared. Also it is necessary to confirm the influence in the case that the transmission is suspended. The width of ROW (Right Of Way) should be determined considering the degree of the urbanization along the pipeline.

Fig. 12-4-3 Transmission Situation before Sumatra Line Connected (year 1999, Base Case)



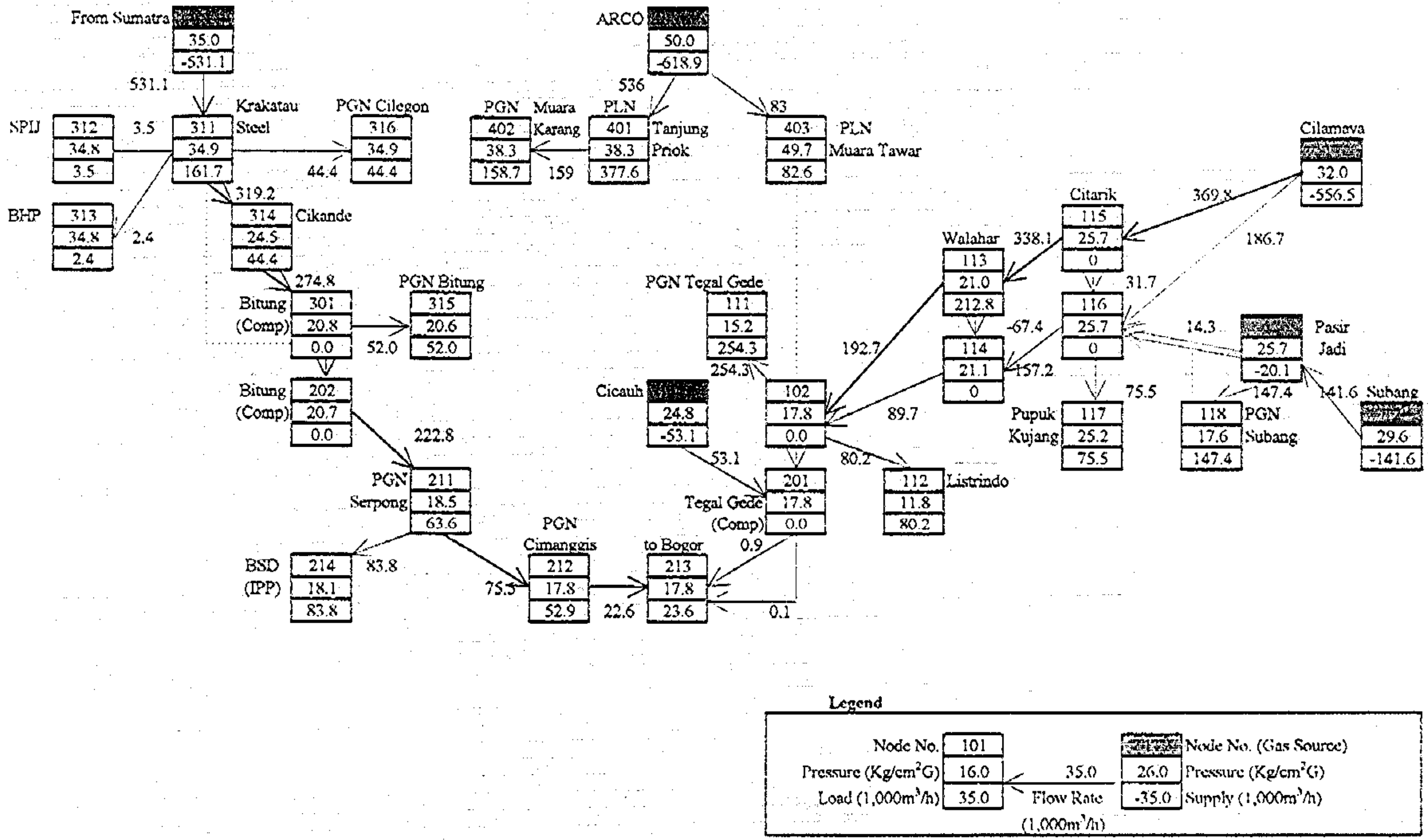
Source : JICA Team

Fig. 12-4-4 Transmission Situation (year 2000, Base Case)



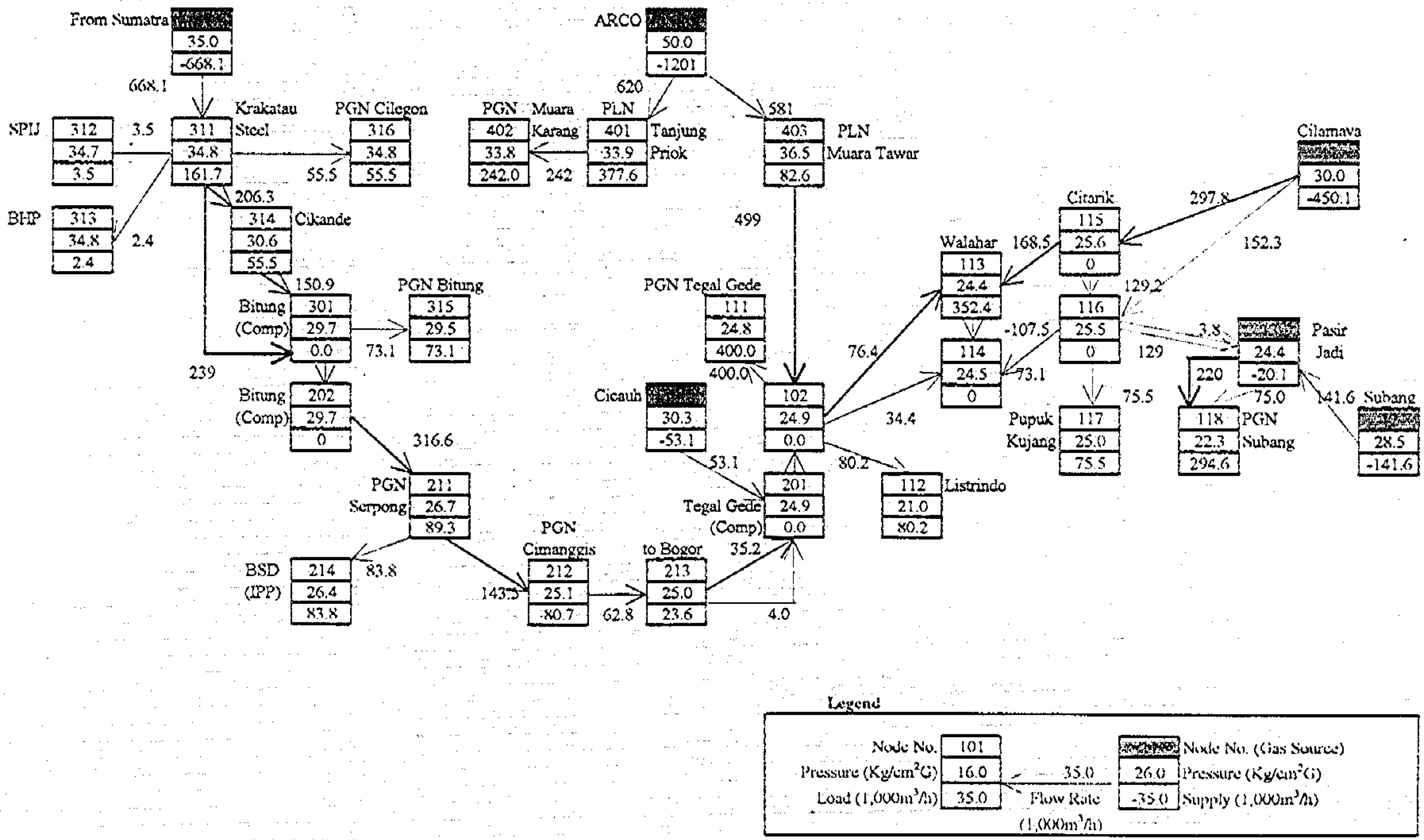
Source : JICA Team

Fig. 12-4-5 Transmission Situation (year 2015, Base Case)



Source : JICA Team

Fig. 12-4-6 Transmission Situation (year 2020, Base Case)



Source : JICA Team

12.4.2 Distribution Pipeline Proposed

In order to make the Master Plan more realistic, the Team listed up the target area or customer in the residential, commercial and industrial sectors. As shown in Table 12-4-2, we listed up 44 residential estates, 49 commercial and residential development plans and 16 industrial estates. Table 12-4-3, Table 12-4-4 and Table 12-4-5 show the names of the targets, their gas demand and the pipelines necessary from the existing pipeline to the entrance of the target.

Table 12-4-2 Number of Gas Development Targets

		Residential Estate	Commercial & Residential Development	Industrial Estate	Total
Distance from Existing Pipeline	- 5 km	33	42	13	88
	5 - 10 km	2	6	3	11
	10 km -	9	1	0	10
	Total	44	49	16	109

Source : JICA Team

The location of the targets and the pipelines and regulators necessary for the targets are shown on the attached map entitled "Gas Market Development Plan". We recommend to develop these targets from those which are located near the existing pipeline to those which are far from the existing pipelines.

The total load of these targets is about 400 thousand m^3/h. In order to confirm the existing pipeline capacity, we conducted network analysis. Since 200 thousand m^3/h of the total load is for the industrial estates in Kab. Karawang and Kab. Purwakarta, the load added to the existing network from the Tegal Gede Offtake Station to Balaraja is about 200 thousand m^3/h. Fig. 12-4-7 shows the results of the simulation. As shown in the figure, the distribution capacity in the western part of the network is not sufficient for the total load in case that a new pipeline from Cikande Offtake Station does not connect to the existing pipeline at Balaraja. Therefore, it is recommended to install the pipeline between Cikande and Balaraja at an early stage of the demand development.

Table 12-4-3 List of Residential Estates Developed by Government

No.	Project Name	No. of Houses	Gas Demand		Pipeline Necessary		
			1000m3/y	m3/h	P	D	L
1	Bumi Cengkareng Indah	2,944	74	360	4 bar	125mm	1 km
2	Bumi Sanggraha	2,001	50	250	4 bar	90mm	2 km
3	Bumi Malaka Asri	11,419	285	1,380	4 bar	8"	1 km
4	Kebon Kacang	536	13	70	4 bar	63mm	1 km
5	Tanah Abang	960	24	120	4 bar	63mm	1 km
6	Pulo Gadung	154	4	20	4 bar	63mm	1 km
7	Bandar Kemayoran	5,346	134	650	4 bar	180mm	1 km
8	Bumi Rawa Tembaga	7,784	195	940	4 bar	180mm	1 km
9	Depok I	6,336	158	770	4 bar	180mm	20 km
10	Bumi Karawachi Baru	20,486	512	2,460	4 bar	6"	1 km
11	Depok II	14,666	367	1,760	4 bar	8"	16 km
12	Bumi Setia Mekar	6,416	160	770	4 bar	180mm	1 km
13	Tangerang Kelapa Dua	2,399	60	290	4 bar	125mm	2 km
14	Bumi Bekasi Baru	8,247	206	990	4 bar	180mm	1 km
15	Bumi Gunung Putri	85	2	20	4 bar	63mm	5 km
16	Bumi Cimanggis	220	6	30	4 bar	63mm	12 km
17	Bumi Margahayu	120	3	20	4 bar	63mm	1 km
18	Parung Hijau	370	9	50	4 bar	63mm	25 km
19	Sapta Taruna III	260	7	40	4 bar	63mm	5 km
20	Sapta Taruna IV	1,358	34	170	4 bar	90mm	12 km
21	Bumi Suradita	1,699	42	210	4 bar	90mm	12 km
22	Bumi Parung Panjang	13,500	338	1,620	4 bar	8"	20 km
23	Deptan Citayam	1,866	47	230	4 bar	90mm	25 km
24	Aneka Gas Citayam	286	7	40	4 bar	63mm	25 km
25	Rusun Pondok Kelapa DKI	1,092	27	140	4 bar	63mm	6 km
26	Tebet Park	790	20	100	4 bar	63mm	1 km
27	Menteng Park	240	6	30	4 bar	63mm	1 km
28	Oasis Square	454	11	60	4 bar	63mm	1 km
29	Rusun Karang Anyar	360	9	50	4 bar	63mm	2 km
30	Rusun Tambora	490	12	60	4 bar	63mm	1 km
31	Rusun Bidaracina	696	17	90	4 bar	63mm	1 km
32	Rusun Pejompongan Indah	600	15	80	4 bar	63mm	3 km
33	Rusun Benhil	296	7	40	4 bar	63mm	1 km
34	Rusun Penjaringan	1,566	39	190	4 bar	90mm	1 km
35	Rumah sewa Pondok Bambu	125	3	20	4 bar	63mm	4 km
36	Rumah sewa Cipinang	152	4	20	4 bar	63mm	2 km
37	Rumah sewa Rawasari	152	4	20	4 bar	63mm	2 km
38	Rumah sewa Cengkareng	124	3	20	4 bar	63mm	3 km
39	Rumah sewa Pondok Kelapa	150	4	20	4 bar	63mm	3 km
40	Palm Estate	207	5	30	4 bar	63mm	4 km
41	Sunter Mas DKI	354	9	50	4 bar	63mm	1 km
42	Perumahan Pemda DKI (P)	572	14	70	4 bar	63mm	6 km
43	Perumahan Pemda DKI (C)	1,500	38	180	4 bar	90mm	5 km
44	Harapan Baru Regency	1,500	38	180	4 bar	90mm	2 km
	Total	120,878	3,022	14,710			242 km

Source : JICA Team

Table 12-4-4 List of Commercial & Residential Estate Development Plans

No.	Name of development	Area	Gas Demand		Pipeline Necessary		
		(ha)	$1000m^3/y$	m^3/h	P	D	L
1	Lippo Virage	1,000	5,300	4,200	10 bar	6"	2 Km
2	Modern Land	1,000	5,300	4,200	10 bar	6"	1 Km
3	Gading Surpong	1,000	5,300	4,200	10 bar	6"	1 Km
4	Bintaro Jaya	1,000	5,300	4,200	10 bar	6"	5 Km
5	Bumi Serpong Damai	6,000	72,000	42,600	10 bar	12"	1 Km
6	Villa Permata	750	4,000	3,200	10 bar	6"	1 Km
7	Alam Sutera	750	4,000	3,200	10 bar	6"	1 Km
8	Banjar Wijaya	750	4,000	3,200	10 bar	6"	1 Km
9	Citra Garden	375	2,000	1,600	10 bar	4"	2 Km
10	Kebayoran Regency	375	2,000	1,600	10 bar	4"	10 Km
11	Kedaton	175	900	700	10 bar	4"	2 Km
12	Palm Spring Village	175	900	700	10 bar	4"	1 Km
13	Royyal Green Garden	175	900	700	10 bar	4"	1 Km
14	Villa Melati Mas	175	900	700	10 bar	4"	1 Km
15	Cipondoh Makmur	75	400	300	10 bar	4"	5 Km
16	Duta Taman Bandara	75	400	300	10 bar	4"	2 Km
17	Duta Garden	75	400	300	10 bar	4"	1 Km
18	Metro Permata	75	400	300	10 bar	4"	7 Km
19	Pantai Indah Kapuk	1,000	5,300	4,200	10 bar	6"	5 Km
20	Vila Taman Bandara	175	900	700	10 bar	4"	10 Km
21	Taman Surya	175	900	700	10 bar	4"	6 Km
22	Permata Hijau Regency	175	900	700	10 bar	4"	7 Km
23	Puri Indah	175	900	700	10 bar	4"	5 Km
24	Green Garden	175	900	700	10 bar	4"	2 Km
25	Pantai Mutiara	175	900	700	10 bar	4"	2 Km
26	Kosambi Baru	75	400	300	10 bar	4"	2 Km
27	Taman Semanan Indah	75	400	300	10 bar	4"	2 Km
28	Palm View Garden	75	400	300	10 bar	4"	1 Km
29	Taman Kencana	75	400	300	10 bar	4"	5 Km
30	Green Ville	75	400	300	10 bar	4"	2 Km
31	Sunter Agung Podomoro	750	4,000	3,200	10 bar	6"	4 Km
32	Gading Kirana	750	4,000	3,200	10 bar	6"	3 Km
33	Kelapa Gading	750	4,000	3,200	10 bar	6"	2 Km
34	Pantai Modern	750	4,000	3,200	10 bar	6"	13 Km
35	Harapan Indah	750	4,000	3,200	10 bar	6"	1 Km
36	Taman Impian Estate	375	2,000	1,600	10 bar	4"	1 Km
37	Sunter Paradise	75	400	300	10 bar	4"	2 Km
38	Kota Legenda	1,000	5,300	4,200	10 bar	6"	1 Km
39	Lippo City	1,000	5,300	4,200	10 bar	6"	1 Km

Table 12-4-4 List of Commercial & Residential Estate Development Plans (Continued)

No.	Name of development	Area	Gas Demand		Pipeline Necessary		
		(ha)	$1000m^3/y$	m^3/h	P	D	L
40	Cikarang baru	750	4,000	3,200	10 bar	6"	1 Km
41	Jakamulya	175	900	700	10 bar	4"	4 Km
42	Kumang Pratama	175	900	700	10 bar	4"	2 Km
43	Taman Galaxy Indahi	75	400	300	10 bar	4"	3 Km
44	Pondok Pekayon Indah	75	400	300	10 bar	4"	2 Km
45	Taman Naragong Indah	75	400	300	10 bar	4"	6 Km
46	Jatimulya Jaya	75	400	300	10 bar	4"	2 Km
47	Sentosa Garden	75	400	300	10 bar	4"	3 Km
48	Citra Raya	2,000	10,600	8,400	10 bar	8"	1 Km
49	Kota Tigaraksa	3,000	15,900	12,600	10 bar	10"	3 Km
	Total	29,100	194,400	139,500			149 Km

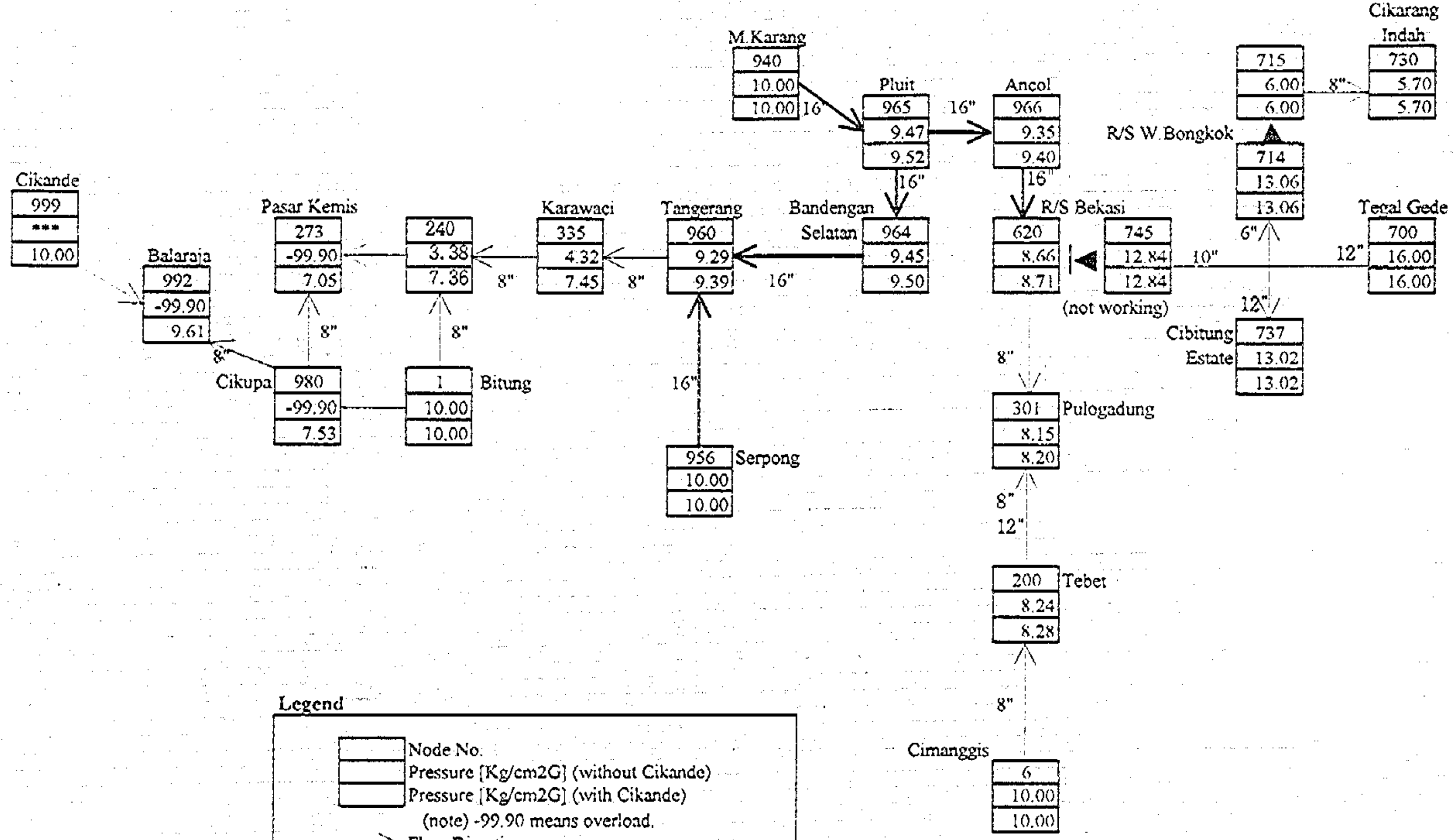
Source : JICA Team

Table 12-4-5 List of Industrial Estate Development Plans

No.	Name of Industrial Estate	Area	Gas Demand		Pipeline Necessary		
		(ha)	$1000m^3/y$	m^3/h	P	D	L
1	EJIP (East Jakarta Industrial Park)	220	48,400	5,500	10 bar	6"	1 km
2	Hyundai (Bekasi International Industry)	200	44,000	5,000	10 bar	6"	1 km
3	Delta Silicon	158	34,800	4,000	10 bar	6"	1 km
4	Newton Techno Park	51	11,200	1,300	10 bar	4"	1 km
5	Diamond Techno Park	13	2,900	300	10 bar	4"	1 km
6	Boston Techno Park	12	2,600	300	10 bar	4"	1 km
7	MM 2100 Industrial Town	760	167,200	19,100	10 bar	12"	1 km
8	Jababeka (Cikarang Industrial Estate)	868	191,000	21,800	10 bar	12"	1 km
9	National Gobel Industrial Park	100	22,000	2,500	10 bar	4"	1 km
10	KIIC (Karawang International Industrial City)	735	161,700	18,500	10 bar	12"	3 km
11	Surya Cipta Industrial City	1094	240,700	27,500	10 bar	16"	1 km
12	Mitra Industrial Park	500	110,000	12,600	10 bar	10"	1 km
13	Peruri	500	110,000	12,600	10 bar	10"	1 km
14	Bukit Indah City	4700	1,034,000	118,000	10 bar	ew Offtak	8 km
15	Indotaisei	400	88,000	10,000	10 bar	8"	8 km
16	Timor	210	46,200	5,300	10 bar	6"	8 km
	Total		2,314,700	264,300			39 km

Source : JICA Team

Fig. 12-4-7 Distribution Status after Developing Target Customers



Legend
- Node No.
- Pressure [Kg/cm2G] (without Cikande)
- Pressure [Kg/cm2G] (with Cikande)
- (note) -99.90 means overload.
- → Flow Direction
- 12" Pipe Diameter

Source : JICA Team