

CHAPTER 2

DEVELOPMENT OF NATURAL GAS RESOURCES

2.1 Introduction

This chapter discusses the Malaysian energy policies, energy resources and energy demand/requirement, which had led to the development of natural gas resources and subsequently the gas infrastructure construction undertaken by PETRONAS. Further, this chapter also outlines the energy sectors that use natural gas has an alternative fuel to meet their growing demand for energy.

2.2 Energy Sector Policies

The exploration and exploitation of petroleum reserves as a whole, were initially subject to the Concession System. Through this system, the Government collects revenue from the payment made by exploration companies in the form of a 25 percent royalty as well as through the petroleum income

tax, while the companies concerned retain the balance as cost recovery and profits.

With the enactment of the **Petroleum Development Act in 1974**, PETRONAS, the national oil company, was established and the Production Sharing Contract (PSC) system was implemented to replace the Concession System. The Act vests all petroleum resources to PETRONAS which exercises full control in the exploration and exploitation of petroleum and to manage all downstream operations of the petroleum industry.

The PSC, on the other hand, is aimed at ensuring that the development of Malaysia's petroleum resources would yield maximum benefit to the country, apart from assuring the oil exploration company of a fair return on its investment. The PSCs normally have a duration of 25 years (5 years exploration and 20 years production). Under the PSC, the foreign firms will have to provide 20% of the recovery cost for oil and 25% for gas while the profit will be split to a 70:30 ratio in favour of PETRONAS.

During the early days of the PSC system in the 1970s, the emphasis was essentially on exploiting the nation's oil reserves, as the benefits of utilizing gas were not apparent then. About 20 per cent of the gas reserves at that time was associated gas¹, but much of it was flared, therefore, wasted. Over time, however, it became increasingly clear that this was a waste of potential resources and revenue to the nation. To prevent further loss and taking into consideration the nation's vulnerability by over depending on oil in the face of the oil shocks during the 1970s and 1980s, the Government enacted the energy policy.

The National Energy Policy (1979) was incorporated in the Third Malaysian Plan (1976-1980). The policy's three key objectives constitute the framework for present and future programs in the energy sector. Its primary objectives are as follows :-

- a) Supply Objective - to provide the nation with adequate and secure energy supply by reducing the nation's dependence on oil and by developing and utilizing alternative sources of energy.

- b) Utilization Objective - to promote and encourage the efficient utilization of energy consumption within the given socio-cultural and economic parameters.
- c) Environmental Objective - to ensure an efficient, environment friendly and sustainable energy sector.

In 1980, the National Depletion Policy (NDP) was introduced by the government with the objective of prolonging the life of national resources i.e. oil and gas by maintaining a reasonable production level. The main features of the NDP are as follows:-

- a) Production Control will be applied to major fields (i.e. those with more than 400 million barrels of oil-initially-in-place (OIIP)).
- b) Production from major fields will be limited to a ceiling of 3% of OIIP in any one year.
- c) PETRONAS is given the power to postpone the development and production of major fields for a period of three to five years.

In the case of gas, its production from the fields offshore Peninsular Malaysia is at present limited to a

maximum of 2,000 mmscfd. However this limit is subject to review, as and when new gas reserves are discovered.

The government also formulated and implemented the Four-Fuel Policy (1981), which enunciates the objective to reduce the country's total dependence on any one energy source. This objective was the result of the aftermath of the first oil shock, as oil was the main fuel for electricity generation during that time.

The Four-Fuel or Diversification Policy aims at ensuring reliability and security of supply by diversifying and expanding the utilization of indigenous energy resources comprising hydro, gas and coal as alternative energy options to oil. Not only did this increase the nation's self-reliance with regard to energy supply, it also ensured national savings in foreign exchange. Furthermore, the usage of a cleaner fuel such as gas is the best avenue towards a less polluted environment.

2.3 Malaysia's Energy Sector

The energy sector plays a key role in the development and growth of the economy as the availability of adequate supply of energy is a prerequisite to generate economic activities. Malaysia, which has embarked on a heavy industrialization programme, is relying on the use of its energy resources to stimulate greater industrial activity, seen as the key to continued growth and economic well-being.

Malaysia is fortunate to be blessed with generous energy resources ranging from non-renewable resources such as oil, gas and coal to renewable resources such as hydropower, fuel wood and solar energy. As at December 31, 1995 Malaysia had about 4.1 billion barrels of under oil reserves, 85 trillion cubic feet (tcf) of natural gas reserves, 982 million tonnes of coal reserves and 29,000 megawatt (MW) of gross hydropower potential. In terms of thermal equivalence, Malaysia's gas reserves are about four times as large as oil reserves. The oil and gas

reserves are located in three main areas i.e. offshore Terengganu, Sarawak and Sabah (Table 2.1).

Table 2.1 CRUDE OIL & NATURAL GAS RESERVES IN 1990 AND 1995

Exploration Area	Crude Oil (billion barrels)		Natural Gas ¹ (tcf)	
	1990	1995	1990	1995
Off Sabah	0.493	0.615	2.276	6.8
Off Sarawak	0.957	0.984	27.312	37.40
Off Terengganu	1.450	2.501	27.312	40.80
Malaysia	2.90	4.10	56.9	85.0

Source : 7th Malaysia Plan

Note : ¹ Total gas produced at well head

2.3.1 Energy Supply

Oil which accounted for more than 90 per cent of energy supply of Malaysia in the early 1970s has been progressively replaced by other fuels such as gas and electricity. The reduction in the dependence of oil has not only contributed to the achievement of the four fuel diversification policy, but also enabled the nation to increase its oil export to earn additional foreign exchange as well as reduce oil imports.

In Malaysia, gas began to make significant contribution to the energy supply mix only after 1983. The share of crude oil and petroleum products in total primary energy supply continued to decline from 86 per cent in 1978 to 71.4 per cent in 1990, to 55.3 per cent in 1995, while that of natural gas increased from 15.7 per cent in 1990 to 33.8 per cent in 1995 (Table 2.2). The increase in gas supply was mainly attributed to accelerated production activities by PETRONAS and its PSC to meet the increasing demand for gas in the electricity and non-electricity sectors. It is expected that by 2000, the natural gas supply will increase to 41.6 percent of the total primary energy supply in Malaysia.

Table 2.2 Primary Commercial Energy Supply¹ by Source 1985-2000 (Petagoule, PJ)

Source	1985		1990		1995		2000		Average Annual Growth Rate (%)		
	PJ	%	PJ	%	PJ	%	PJ	%	5MP	6MP	7MP
Crude Oil & Petroleum Product	406.3	70.9	520.2	71.4	746.1	55.3	943.2	49.4	3.5	7.5	4.8
Natural Gas ²	109.0	19.0	114.4	15.7	456.4	33.8	793.9	41.6	15.2	32.0	11.7
Hydro	42.6	7.4	38.3	5.3	52.8	3.9	53.5	2.8	1.8	6.6	0.3
Coal & Coke	15.1	2.7	55.5	7.6	93.2	7.0	117.9	6.2	33.2	10.9	4.8
Total	573.0	100	728.9	100	1,348.5	100	1,908.5	100	7.3	13.1	7.2

Source : Sixth Malaysian Plan & Seventh Malaysian Plan

- Note : 1. Refers to the supply of commercial energy that has not undergone a transformation process to produce energy. Non commercial energy such as biomass and solar have been excluded.
2. Excludes flared gas, reinjected gas and exports of liquefied natural gas.

2.3.2 Energy Demand

Energy demand is expected to grow at 8.9 per cent per annum in the Seventh Plan compared to 7.7 per cent per annum during the Fifth Plan period and 8.6 per cent per annum in the Sixth Plan (Table 2.3).

Table 2.3 Final Commercial Energy¹ Demand by Source 1985-2000 (Petajoule, PJ)

Source	1985		1990		1993		1995		2000		Average Annual Growth Rate (%)		
	PJ	%	PJ	%	PJ	%	PJ	%	PJ	%	5MP	6MP	7MP
Petroleum Product	282.7	76.8	414.1	74.9	494.6	68.4	561.7	67.1	777.5	60.8	5.9	6.3	6.7
Natural Gas ²	25.0	6.8	45.7	8.3	98.7	13.7	103.5	12.4	188.1	14.7	15.4	17.8	12.7
Electricity	45.1	12.3	71.8	13.0	105.5	14.6	131.4	15.7	221.8	17.3	11.8	12.8	11.0
Coal & Coke	15.1	4.2	21.5	3.9	24.1	3.3	40.1	4.8	92.0	7.2	12.0	13.3	18.1
Total	367.9	100	553.1	100	722.9	100	836.7	100	1,279.4	100	7.7	8.6	8.9

Source : Sixth Malaysian Plan & Seventh Malaysian Plan

- Note :
1. Refers to the quantity of commercial energy delivered to final consumers but excludes gas, coal and fuel oil used in electricity generation.
 2. Includes natural gas used as fuel and feedstock consumed by the non-electricity sector.

In terms of energy mix, the share of oil-based petroleum products declined and the share of natural gas, electricity and coal & coke increased (Table 2.3). The move from crude oil and petroleum products to alternative sources of energy is the result of the successful implementation of the four-fuel diversification policy. This is especially seen in the utilization of the natural gas resources in the electricity generation, feedstock requirement in petrochemical industry and the direct usage in the industrial, commercial and residential sectors. The demand for gas grew at 15.4 per cent in the Fifth Malaysian Plan, 17.8 per cent in the Sixth Malaysian Plan and expected to grow at 12.7 per cent in the Seventh Malaysian Plan (Table 2.3).

In reference to Table 2.4, the manufacturing and transport sectors are the major energy consumers. Together their energy demand account for about 70 per cent of total final energy consumed in 1990. The transport sector is the largest energy consuming sector; 43 per cent in 1985, 39.1 per cent in 1995 and expected to be at 38.3 per cent in 2000. This is followed by the manufacturing sector where the energy demand has increased from 20.1 per cent in

1995 to 35.7 per cent in 1995 and to 38.2 per cent in 2000. The commercial and residential sectors account for slightly more than one-tenth of the total energy demand.

Table 2.4 Final Commercial Energy Demand by Sector 1990-2000 (Petajoule, PJ)

Sector	1990		1995		2000		Avg. Annual Growth Rate (%)	
	PJ	%	PJ	%	PJ	%	6MP	7MP
Agriculture & Forestry	32.8	5.9	52.7	6.3	63.4	5.0	9.9	3.7
Mining & Quarrying	25.7	4.6	34.4	4.1	50.0	3.9	6.0	7.8
Manufacturing	187.8	34.0	298.7	35.7	488.7	38.2	9.7	10.3
Transport	220.9	39.9	326.7	39.1	490.1	38.3	8.1	8.4
Commercial	23.9	4.3	34.7	4.1	53.3	4.2	7.7	9.0
Residential	43.4	7.8	51.5	6.2	64.4	5.0	3.5	4.6
Non-Energy	18.5	3.3	38.0	4.5	69.5	5.4	15.5	12.8
Total	553.0	100.0	836.7	100.0	1,279.4	100.0	8.6	8.9

Source : Seventh Malaysian Plan

2.4 The Market for Natural Gas Utilization

With the growing demand for energy, natural gas was made available as an alternative fuel in the domestic market. The availability of natural gas not only helps to meet the growing demand for energy but also helps to lower the operation cost for the users. This is because gas

combustion is free from ash, smoke, sulfur and soot, keeping the process clean, resulting in higher energy efficiency and lesser equipment maintenance. Besides that, the development of gas distribution network contributes to the industrial growth by creating numerous spin-offs in the ancillary industries involved in the manufacturing of plastic pipes, gas meters, regulators, pipeline contractors, etc. Also, natural gas consists of less polluted hydrocarbons i.e. sulfur oxides, nitrogen oxides, carbon dioxides and is lead free, making it environmentally cleaner and safer to use. If used in vehicles, natural gas will reduce exhaust emissions by 90%. The market for natural gas utilization is power, petrochemical, industrial, commercial, residential and transportation sectors.

2.4.1 *Gas in the Power Sector*

As part of the government's strategy to diversify its energy use pattern and substitute the use of oil, the Malaysian government implemented the PGU project. In order to ensure the financial viability of the project, gas was targeted to be used in the power sector. This is because

the power sector provides the major base load demand for gas in Peninsular Malaysia so that the government can protect the huge investments in bringing the gas ashore.

In accordance, the PGU project was launched in 1981, to be undertaken in three stages i.e. PGU I, II and III. Currently, PGU I and PGU II has been completed where the PGU transmission pipeline runs from Kerteh to Segamat through Pasir Gudang to Singapore and from Segamat westwards to the Klang Valley. The PGU III is currently being constructed and is expected to be completed in 1988. The PGU pipeline was designed to pass through all the main power stations.

In line with the government's four-fuel diversification policy, TNB pursued the four-fuel option by commissioning major gas, hydro and coal based power plant in mid to late 1980s. With these developments, there was overall decline in the share of oil from 41.5 per cent in 1990 to 9.2 per cent in 1995 and a corresponding increase in the share of gas.

The share of gas in the generation mix in the Peninsula increased significantly from 27.1 per cent in 1990 to 70.3 per cent in 1995, largely displacing oil, whose share fell from 41.5 per cent to 9.2 per cent during the same period (Table 2.5). The big increase in gas utilization was accounted for by the commissioning of TNB's gas-based power plants in Connaught Bridge, Pasir Gudang, Port Klang, Serdang and Tanjung Kling as well as IPP plants in Paka, Pasir Gudang, Port Dickson, Sepang and Telok Gong. The percentage of gas in the generation mix is expected to increase slightly to 71 per cent in the year 2000. This marginal increase is due to the ceiling placed on the production and utilization of gas for power generation, which is in accordance to the depletion policy.

Table 2.5, shows the role of the power sector in creating a huge demand for gas. During the first six months of 1995, approximately 90 percent of the natural gas transmitted by Petronas Gas was distributed to the power industry including to Singapore with the remaining approximately 10 percent distributed to industrial and non-industrial end-users².

Table 2-5**Fuel Mix In TNB Electricity Generation, 1990-2000**

Year	Oil		Coal		Gas		Hydro		Others		Total	
	Gwh	%	Gwh	%	Gwh	%	Gwh	%	Gwh	%	Gwh	%
1990	8580	41.5	3146	15.2	5602	27.1	3288	15.9	62	0.3	20679	100
1995	3510	9.2	4068	10.7	26786	70.3	3651	9.6	76	0.2	38091	100
2000	2500	4.0	10797	17.3	44637	71.5	4425	7.1	89	0.1	62448	100

Source: Seventh Malaysian Plan

2.4.2 *Gas as Fuel in the Industrial, Commercial and Residential Sectors.*

The utilization of gas in the industrial sector in the Peninsular Malaysia increased significantly from 43 mmscfd in 1993 to 70 mmscfd in 1995, replacing other fuels i.e. Liquefied Natural Gas (LPG), Diesel and a small portion of fuel oil (Table 2.6). Gas utilization is expected to double in 1996 to 122 mmscfd and by the year 2000, to 478 mmscfd. As for the commercial & residential sectors, the utilization of gas is minimal compared to the other sectors. In 1994, natural gas utilization was 11 mmscfd and increased to 34 mmscfd in 1996. It is expected to increase significantly by the year 2000, to about 72 mmscfd.

Table 2-6 Gas Utilization In Peninsular Malaysia 1990- 2000 in mmscfd

Sector	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Elect. Gen.	121	150	293	360	488	680	773	799	847	1050	1300
Industry	8	12	15	43	51	70	122	167	240	464	478
Residential & Commercial	0	0	0	0	11	24	34	45	53	56	72
Export	0	0	43	127	151	150	150	150	150	150	150
LNG Feedstock											
TOTAL	129	162	351	530	701	924	1079	1161	1290	1720	2000

Source: 7th Malaysian Plan

2.4.3 Gas as Feedstock in Petrochemical Sector

The development of the gas industry plays a significant part in the development of the petrochemical business which uses natural gas components of ethane, propane and butane as readily available feedstock. Apart from enhancing the value added to natural gas, the petrochemical sector will contribute significantly towards the widening of the industrial base.

The petrochemical projects are implemented by the private sector with PETRONAS having equity participation in the joint-venture companies. The plants are Methyl Tertiary Butyl Ether (MTBE)/propylene and Polypropylene Malaysia Sdn

Bhd in Gebeng, Kuantan; Ethylene Malaysia Sdn Bhd and Polyethylene plant in Kertih, Terengganu and Petronas Fertilizer (Kedah) Sdn Bhd in Gurun, Kedah (1998). These plants have the capacity of producing above 100,000 metric tonnes of petrochemicals products.

The completion of these projects will generate spin-off projects and support activities that will both deepen and widen the manufacturing sector to fulfill the Government's objective in promoting higher value-added output. For example, basic polymers will be made available locally for end use applications such as the production of plastics, automotive and electrical components and synthetic fibers for textiles. All four plants above are expected to provide a boost to the plastic industry. The chemical and petrochemical sector had recorded growth of 33.9 per cent (Business Times, 18 March 1997) during a five-year period between 1991 and 1995.

2.4.4 *Gas in Transportation Sector*

To further diversify gas utilization in the country and encourage greater use of cleaner transportation fuels, gas

was promoted as a fuel for vehicles. As the transport sector accounts for about 40 per cent of total fuel energy consumption (Seventh Malaysian Plan), this sector provides substantial demand for natural gas to be used by vehicles.

In the Sixth Malaysian Plan period, six natural gas for vehicles (NGV) stations were constructed in the Klang Valley and one in Miri, while 923 petrol-driven vehicles, mainly taxis, were converted to run on dual-fuel engines i.e. using petrol and natural gas by PETRONAS. In Peninsular Malaysia, these stations are supplied through the natural gas distribution grid. More NGV stations have been planned by PETRONAS, which is aggressively promoting the use of natural gas in transportation companies, particularly those with fleets of buses and taxis.

2.5 Future Market for Natural Gas Utilization

A future use of natural gas as fuel will be in the air-conditioning system of commercial complexes and residential units. As gas is a more cost effective fuel,

using natural gas powered air-conditioning will result in savings compared to electricity-powered air-conditioning. The government, through PETRONAS has initiated the District Cooling System (DCS) which will use natural gas as the primary energy source to generate chilled water for the air-conditioning requirement in buildings.

Another potential use of natural gas is in co-generation whereby gas turbines are used to run electrical generators to supplement overall electrical load. The waste heat from the gas turbine driver exhaust is then further utilized to run hot water systems or steam boilers, which will enhance the overall efficiency of the gas-fired equipment, resulting in savings to end-users. Large commercial buildings like hotels and hospitals and large industrial customers would have substantial savings in their utility bills by installing co-generation.