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Energy Profiles of Selected Latin American and Caribbean Countries

KANG WU

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FOREWORD

The Program on Resources: Energy and Minerals of the East-West Center has been engaged in research on energy and resource issues in Latin America since 1989. The program's Latin American Energy Project is a natural outgrowth of ongoing research on energy developments in the Pacific basin. The project studies the development of the Latin American hydrocarbons sector in order to assess its interactions with the Western Hemisphere energy market and its linkages to other markets; to facilitate dialogue between public- and private-sector executives in the United States and in other countries of the region, as a means of furthering market stability, energy security, and investment opportunities; and to promote policies that provide for sustainable development of the hydrocarbons industry in the region.

The Regional Overview of Latin American and Caribbean Energy Production, Consumption, and Future Growth (Series Report No.1) and *Energy Profiles of Selected Latin American and Caribbean Countries* (Series Report No.2) are the first of the report series on petroleum and gas resources, policies, and development opportunities required under the U.S. Department of Energy grant (DE-FG-01-93EP10050) entitled "Emerging Energy Security Issues and Opportunities for the U.S. Private Sector during the 1990s." The two reports are interrelated, in that Report No. 1 provides a regional overview of energy production, consumption, and future growth that is based on the detailed, country-by-country studies presented in Report No. 2. While focusing on the oil and gas sector for each country, the reports also cover the coal, hydroelectricity, and nuclear power sectors. Forecasts of the primary energy consumption and oil product consumption for individual countries (Report No. 2) and for the region as a whole (Report No. 1) are based on a comprehensive assessment of overall economic development, projections of population and real GDP growth, recent energy consumption trends, and changes in energy prices and energy intensity. Stressing the importance of Latin American and Caribbean oil to the United States, the reports also indicate that the net export capacity of Latin America and the

Caribbean has a significant impact on rest of the world including the Asia-Pacific region, which itself is a huge oil importer.

It is hoped that these reports will provide valuable information and critical analysis on recent trends and the future outlook in the Latin American energy sector with particular reference to oil and gas. They should be read by energy economists, energy policy makers, government regulatory officials, oil company executives, and others who are interested in getting in-depth insight into the Latin American energy sector.

The East-West Center in Honolulu provides a forum for the exchange of views between industry, government, and academia among the nations of the Pacific rim. As such, its role as a catalyst is exemplified by the efforts of the Program on Resources to encourage and enhance U.S.-Latin American and Caribbean cooperation, as well as the linkage between the Asia-Pacific region and Latin America and the Caribbean.

Fereidun Fesharaki

Director

Program on Resources: Energy and Minerals

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ABBREVIATIONS, ACRONYMS, AND MEASUREMENTS

(for Reports No. 1 and 2)

ARPEL	Asistencia Recíproca Petrolera Empresarial Latinoamericana
b/cd	barrels per calendar day
b/d	barrels per day
bcf	billion cubic feet
bcf/d	billion cubic feet per day
boe	barrels of oil equivalent
boe/d	barrels of oil equivalent per day
CDU	crude distillation unit
Ecopetrol	Empresa Colombiana de Petróleos (Colombia)
ECU	European currency unit
EIA	Energy Information Administration
EIU	Economist Intelligence Unit
ENAP	Empresa Nacional de Petróleo (Chile)
FCC	fluid catalytic cracker
gal	gallon
GDP	gross domestic product
GNP	gross national product
GW	gigawatts
IDB	The Inter-American Development Bank
kcal	kilocalorie, 1 boe = 1.385×10^6 kcal
kero/jet	kerosene and jet fuel
km	kilometers
km ²	square kilometers
LNG	liquefied natural gas

LPG	liquefied petroleum gas
m	meters
Mcf	thousand cubic feet
MMcf/d	million cubic feet per day
MW	megawatts
MTBE	methyl tertiary butyl ether
NAFTA	North-American Free Trade Agreement
NGL	natural gas liquids
OLADE	Organización Latinoamericana de Energía
OPEC	Organization of Petroleum Exporting Countries
Pemex	Petróleos Mexicanos (Mexico)
Petrobrás	Petróleo Brasileiro (Brazil)
Petroecuador	Empresa Estatal Petróleos del Ecuador
Petroperú	Petróleos del Peru
Petrotrin	The Petroleum Company of Trinidad and Tobago
PDVSA	Petróleos de Venezuela, S.A.
PREM	Program on Resources: Energy and Minerals (East-West Center, Honolulu)
tcf	trillion cubic feet
tonne	metric ton
Trintoc	Trinidad and Tobago Oil Company
Trintomar	Trinidad and Tobago Marine Petroleum Company
Trintopec	Trinidad and Tobago Petroleum Company
t/y	tonnes per year
UAE	United Arab Emirates
US\$	U.S. dollars
VDU	vacuum distillation unit
YPF	Yacimientos Petrolíferos Fiscales (Argentina)
YPFB	Yacimientos Petrolíferos Fiscales Bolivianos (Bolivia)

I. INTRODUCTION

Countries in this report include Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Mexico, Peru, Trinidad and Tobago, and Venezuela. These ten countries are the most important oil and gas producers in the Latin American and the Caribbean region.¹ In the following sections, the primary energy supply (oil, gas, coal, hydroelectricity, and nuclear power whenever they are applicable), primary energy consumption, downstream oil sector development, gas utilization are discussed for each of the ten countries. The report also presents our latest forecasts of petroleum product consumption in each country toward 2000, which form the basis of the outlook for regional energy production and consumption outlined in Report No 1. Since the bulk of primary energy supply and demand is hydrocarbons for many countries, brief descriptions of the important hydrocarbons policy issues are provided at the end of the each country sections.

¹ Unless otherwise specified, all of Central and South Americas, Mexico, the Caribbean nations and territories, except Puerto Rico, the U.S. Virgin Islands, and the Netherlands Antilles, are included in the definition of Latin America and the Caribbean in this report, as well as in its sister Report No. 1, entitled *Regional Overview Review of Latin American and Caribbean Energy Production, Consumption, and Future Growth*.

II. MEXICO

Mexico, Latin America's third largest country with a land area of nearly 2 million km², is the region's leading oil and gas producer and is well endowed with minerals, metals, and other natural resources. Most Mexicans are mestizos of mixed European and Indian heritage; however, there are also Mexicans of pure European or Indian ancestry.¹

Mexico's president, Carlos Salinas de Gortari, has emphasized a free-market approach that has opened up the economy to foreign and private participation. Numerous state-run industries, including banking and telecommunications, have been privatized. The GDP growth was estimated to be 0.4 percent in 1993, down from 2.6 percent in 1992 and 3.7 percent in 1991. However, the inflation rate has decreased from 15.5 percent in 1992 and 22.7 percent in 1991, to 10.0 percent in 1993.² Mexico's economy is dependent on the United States for trade and investment. Over 70 percent of Mexico's exports goes to its northern neighbor, and Mexico is now the United States' third most important trading partner, after Canada and Japan. The trade and investment relationship between Mexico and the United States will be enhanced following the ratification and subsequent implementation of NAFTA.

Mexico has had substantial success in restructuring its economy to reduce dependence on exports of primary resources, including oil, which accounted for only 18 percent of export value in 1992, down from 33 percent in 1990. In recent years, sales of textiles, cement, beer, and auto parts to the United States have risen dramatically.

2.1. PRIMARY ENERGY SUPPLY

Mexico is the region's largest primary energy producer, though both its oil and gas reserves are second to those of Venezuela. In 1991, Mexico produced 4.1 million boe/d of primary energy.

1. See Culver-Hopper et al. (1992), p. 49.

2. See EIU (1993f and 1994f) for details.

The increase from 3.6 million boe/d in 1980 represents an average annual growth rate of 1.2 percent (Figure 2.1). Petroleum provided 75.3 percent of primary energy production in 1991, followed by gas (15.1%), other energy (4.7%), and coal (3.4%). Hydroelectricity and nuclear power accounted for only 0.9 and 0.5 percent, respectively, of total primary energy production. Between 1980 and 1991, production of coal increased at an average annual rate of 9 percent, hydroelectricity at 3.1 percent a year, oil at 1.7 percent a year, and other energy at 0.5 percent a year. During this period, natural gas production declined at an average annual rate of 1.9 percent, from 756,000 boe/d, or 4,464 MMcf/d, in 1980 to 731,000 boe/d, or 4,314 MMcf/d, in 1991. Mexico is a huge net energy exporter, mainly because of its large volume of crude exports. Mexico's exports of 1.9 million boe/d of energy in 1992 represented approximately 40 percent of the country's total energy production. However, it recently began to import gasoline and fuel oil as well as natural gas from the United States in order to satisfy domestic demand.

Oil

Mexico has Latin America's second largest crude oil reserves after Venezuela and accounted for 41 percent of total proven reserves in the region at the end of 1992. On average, oil reserves have declined since 1983. In 1992, proven oil reserves were 51.3 billion barrels, over half of which are located offshore.

Mexico is the region's largest crude producer. In 1992, the country produced 3.14 million b/d of crude oil (including condensate and NGL),³ about the same as it produced in 1991, and accounted for 41 percent of all the crude oil produced in Latin America (Table 2.1). Approximately half of the crude oil produced is exported each year. Annual crude exports increased to 1.62 million b/d in 1992,⁴ up from 1.616 million b/d in 1991 and 1.503 million b/d in 1990. About 48 percent of Mexico's crude exports, or 779,500 b/d, went to North America

3. NGL and condensate production is relatively large in Mexico. In 1992, this production was estimated to be 370,000 b/d.

4. The number also includes NGL and condensate. In 1992, Mexico's crude exports without NGL and condensate were 1.367 million b/d. See ARPEL (1993).

Figure 2.1
Mexico's Primary Energy Production
by Source, 1980 and 1991

Source: East-West Center PREM Data File. 4

Table 2.1
Petroleum Data for Mexico, 1988-1992
(^{'000 b/d})

Year	Reserves/a	Crude Production/b	Crude Exports	Crude Imports	Product Consumption
1988	54,110	3,004.0	1,566.4	0.0	1,429.1
1989	56,365	3,005.3	1,526.0	0.0	1,532.1
1990	51,983	2,993.8	1,503.5	0.0	1,591.0
1991	51,298	3,145.2	1,616.3	0.0	1,662.2
1992	51,298	3,144.3	1,619.8	0.0	1,701.6

a. Million barrels. b. Includes gas liquids and condensate.

Source: East-West Center PREM Data File.

Table 2.2
Natural Gas Data for Mexico, 1988-1992
(MMcf/d)

Year	Reserves/a	Production	Exports	Imports	Utilization/b
1988	74,831	4,340	0	0	4,146
1989	73,380	4,439	0	0	4,273
1990	72,744	4,482	0	43	4,318
1991	71,508	4,314	0	164	4,162
1992	70,900	4,389	0	250	4,234

a. Billion cubic feet (bcf). b. Defined as transformation plus final consumption, with appropriate adjustment of stock change.

Sources: East-West Center PREM Data File; Arpel (1993).

(mainly the United States) in 1991, a year in which Mexico was the United States' second largest crude supplier after Saudi Arabia. Other than North America, 22 percent of Mexico's crude exports went to Western Europe, 9 percent to the Asia-Pacific region, and about 3 percent to other Latin American countries such as Brazil, Costa Rica, El Salvador, and Honduras.

All upstream oil activities are controlled by Petr6leos Mexicanos, or Pemex, Mexico's national oil company. Pemex has exclusive control over all aspects of the Mexican hydrocarbon industries, except secondary petrochemicals, which are open to private and foreign investment. The fully integrated state firm has developed into one of the world's five largest oil companies since its founding in 1938 and plays a major role in world energy markets. Like some of the other state oil companies in the region, Pemex is undergoing a painful process of restructuring and streamlining in order to make itself more efficient and competitive in dealing with the country's declining oil reserves, growing energy demand, and stiff competition in oil markets around the world. Although the Mexican Constitution gives Pemex exclusive rights over the country's hydrocarbons resources and forbids the sale of the monopoly to the private sector, many observers believe that restructuring, downsizing, or even partial privatization of Pemex may be critical to this giant state oil company's future.⁵

Concurrent with its internal reforms and restructuring efforts, Pemex hopes to increase crude production (excluding NGL and condensate) to 3.1 million b/d by 1995 and maintain or modestly increase exports. However, without substantial investment in the petroleum industry or the discovery of significant new reserves, Mexico's oil production may not keep up with growing domestic demand, and the country could cease to be a giant crude exporter by the early twenty-first century, an outcome that Pemex is working hard to avoid.

Natural Gas

In 1992, Mexico produced 4,389 MMcf/d of natural gas, slightly up from 4,314 MMcf/d in 1991 (Table 2.2), which accounted for 33 percent of the gas produced in Latin America. As in

5. See Halkias (1992).

the case of crude oil, Mexico is the region's largest gas producer but its proven gas reserves are second to Venezuela's. Proven gas reserves were 70.9 trillion cubic feet (tcf) in 1991, accounting for about 28 percent of the region's total gas reserves. The majority of the natural gas produced in Mexico currently is extracted in association with oil. All of Mexico's natural gas is produced by the state oil company Pemex. Two subsidiaries of Pemex, Distribuidora de Gas de Queretaro S.A. (Digaqro) and Distribuidora de Gas Natural del Estado de Mexico S.A. (Diganamex), are responsible for distribution of the natural gas produced by Pemex.

Mexico started importing gas from the United States at a volume of 43 MMcf/d in 1990. The gas imports increased to 164 MMcf/d in 1991 and 250 MMcf/d in 1992. Given its growing demand for natural gas due to environmental concerns, the country has to continue to rely on imported natural gas to satisfy its demand, which may give U.S. companies opportunities to expand their exports.⁶

Coal

Mexico is the second largest coal producer in Latin America, after Colombia, and has the third largest coal reserves in the region, after Colombia and Brazil. Its coal reserves were estimated at 1.88 billion tonnes in 1991. The coal production amounted to 9.4 million tonnes in 1991, up from 10 million tonnes in 1990. The estimated coal production in 1992 was around 11 million tonnes (Table 2.3).⁷ All the coal produced in Mexico is consumed domestically. Over the past decade, coal production recorded the highest growth rate among all primary energy sources in Mexico, increasing at an average annual rate of 9 percent between 1980 and 1991. During this period, coal imports plummeted from 1.2 million tonnes in 1980 to 31 thousand tonnes in 1989, but increased again to 276 thousand tonnes in 1990. The coal imports in 1991 and 1992 were

6. While Mexico has adequate gas reserves, they are not all near the consuming centers. It is much cheaper for Mexico to import gas from the United States than it is to develop reserves in order to meet all of its domestic demand.

7. This estimation is based on British Petroleum (1993) and EIA (1992).

Table 2.3
Coal Data for Mexico, 1988-1992
('000 tonnes)

Year	Reserves/a	Production	Exports	Imports	Apparent Consumption/b
1988	1,898	6,554	92	116	6,578
1989	1,866	7,041	47	31	7,025
1990	1,886	10,014	8	276	10,282
1991	1,877	9,401	1	36	9,436
1992	1,877	11,000	1	42	11,041

a. Million tonnes. b. Defined as production plus net imports.

Source: East-West Center PREM Data File.

minimal.⁸ Mexico has been a net coal importer in every year since 1980, with the exceptions of 1987 and 1989. Of the 9.6 million tonnes of coal consumed in Mexico in 1991, 42 percent was used by the power sector and 58 percent went to the production of coke. None of the coal was consumed directly in the industrial sector. Given the rapid increase in coal production in recent years and the existence of large untapped coal deposits, Mexico may become self-sufficient in coal by the turn of the century.

Hydroelectricity

Mexico's hydroenergy potential is 53,530 MW, which is lower than that of Brazil, Colombia, Venezuela, and Peru. Total installed hydropower capacity in 1991 was 7,932 MW, reflecting a utilization rate of 14.8 percent, which is higher than that of Colombia and Peru. In 1991, hydropower capacity accounted for 30 percent of total installed power generation capacity (26,900 MW) in Mexico. The country has 52 hydropower stations, the largest with a capacity of 1,500 MW. Hydroelectricity production in Mexico increased at an average annual rate of 3.1 percent between 1980 and 1991. According to the Federal Electricity Commission (CFE) of Mexico, the country plans to install an additional 1,098 MW of capacity in the short term (to 1995), 2,729 MW in the medium term (to 2000), and 9,753 MW over the long term (to 2010).⁹

Nuclear Power

Nuclear power plays a minor role in Mexico's energy balance, accounting for only 0.5 percent of its primary energy production and 0.8 percent of its primary energy consumption in 1991. The country is a latecomer in nuclear power development in the region and brought its first nuclear power plant, Laguna Verde 1, on line in 1988. The installed capacity of 675 MW in 1991 accounted for 2.5 percent of total power generation capacity in Mexico. Several additional nuclear plants have been planned, but only one, Laguna Verde 2, is currently under construction. Although the Energy Modernization Program indicates that, by the year 2010,

8. Estimates are based on OLADE (1993).

9. See Rodríguez-Elizarrarás (1992).

Mexico will require 5,000 to 6,000 MW of nuclear power generating capacity, current budget allocations provide only for the completion of Laguna Verde 2. The completion of Laguna Verde 2 will add another 675 MW to the nuclear power generating capacity in Mexico.¹⁰ Thus, it is expected that nuclear power consumption will continue to grow through 2000 and beyond. As in many other countries, the ambitious nuclear power development program in Mexico has already been replaced by cautious planning that focuses on issues of safety, construction costs, and actual performance of nuclear power plants.

2.2. PRIMARY ENERGY CONSUMPTION

Current Situation

In 1991, primary energy consumption in Mexico was 2.82 million boe/d. The increase from 2.36 million boe/d in 1980 represents an average annual growth rate of 1.6 percent (Figure 2.2). Nearly 59 percent of primary energy consumption was provided by petroleum, while natural gas provided 25.2 percent of the country's needs. Mexico's remaining energy needs were satisfied by coal (5.1%), hydroelectricity (1.1%), nuclear power (0.8%), and other energy sources (9.3%). Between 1980 and 1991, coal consumption exhibited the fastest growth rate, increasing at an average annual rate of 6.3 percent, followed by other energy consumption at an average annual rate of 3.4 percent a year and oil consumption at 1.4 percent a year. Gas consumption was only up by 0.6 percent a year, other energy consumption increased by 1.4 percent a year during this period, and the shares of both of these energy sources in total primary energy consumption decreased (Table 2.4).

Outlook for 2000

The forecast for Mexico's primary energy consumption is based on various factors, including projections of population and real GDP growth, and an assessment of historical changes in per capita primary energy consumption and energy intensity. Fuel price changes will be discussed in the forecast of oil product consumption. The Mexican population increased at an average annual rate of 2.46 percent from 1980 to 1992, and real GDP rose by an average of 0.9 percent

10. See Escofet (1992).

Figure 2.2
Mexico's Actual and Projected Primary
Energy Consumption, 1980, 1991, and 2000

Source: East-West Center PREM Data File and Forecasts.

Table 2.4
Percentage Distribution of Primary Energy
Consumption: Mexico, 1980, 1991, and 2000
 (%)

	1980	1991	2000
Oil	60.2	58.6	58.0
Natural Gas	28.0	25.1	27.4
Coal	3.1	5.1	5.0
Hydroelectricity	1.1	1.1	1.0
Nuclear Power	0.0	0.8	0.8
Other	7.6	9.3	7.8
Total	100.0	100.0	100.0

Source: East-West Center PREM Data File and Forecasts.

a year between 1980 and 1991. Based on the forecast of the Inter-American Development Bank, it is expected that the population will increase by an average of 1.89 percent a year from 1992 to 2000 and real GDP will rise at an average of 4.7 percent a year between 1991 and 2000. The expected rapid economic growth rate will boost energy consumption. During the period of 1980-91, because of sluggish economic growth (0.9% a year), a moderate rise in primary energy consumption (1.9% a year), and a high rate of population increase (2.5% a year), per capita primary energy consumption dropped, from 12.2 boe/person in 1980 to 11.4 boe/person in 1991, and energy intensity rose from 6,243 kcal/US\$(1980) in 1980 to 6,763 kcal/US\$(1980) in 1991. All of these data and assumptions are summarized in Table 2.5.

Given Mexico's rich energy resources, the country is expected to remain a net energy exporter for the rest of the century. However, faced with rapidly growing domestic demand, Mexico is heading toward a supply imbalance, unless it can increase its proven hydrocarbons reserves and production as well as upgrade refining capacity at a faster rate. Some structural changes will also be required. In addition, natural gas and gasoline imports are likely to increase quickly. Based on the data and assumptions outlined in Table 2.5 and the above assessments, our forecast indicates that primary energy consumption will rise at an average annual rate of 3 percent between 1991 and 2000, reaching 3.7 million boe/d. Oil and gas will continue to dominate energy consumption through the end of the decade, accounting for over 85 percent of primary energy consumption in 2000. While coal consumption is expected to grow at an average rate of 3 percent a year, hydroelectricity and nuclear power consumption will both increase by 2.5 percent over this period (see Figure 2.2).

2.3. DOWNSTREAM OIL SECTOR AND PRODUCT CONSUMPTION

Refining Sector

Mexico's six refineries, all owned by Pemex, had a total capacity of 1.515 million b/d in early 1993, after three refineries with a combined capacity of 164,000 b/d at Azcapotzalco, Poza Rica, and Reynosa were shut down in 1991 for environmental reasons (Table 2.6). Despite the

Table 2.5
Key Data and Assumptions for Forecast of
Mexico's Primary Energy Consumption, 1980-2000

Key Item	Unit	Data/Assumptions
Population		
AAGR 1980-1992	percent	2.46
AAGR 1992-2000	percent	1.89
GDP		
AAGR 1980-1991	percent	0.9
AAGR 1991-2000	percent	4.7
Per Capita GDP		
AAGR 1980-1991	percent	-1.4
AAGR 1991-2000	percent	2.8
Per Capita Primary Energy Consumption		
1980	boe/person	12.2
1991	boe/person	11.4
AAGR 1980-1991	percent	-0.7
Energy Intensity		
1980	kcal/US\$(1980)	6,243
1991	kcal/US\$(1980)	6,763
AAGR 1980-1991	percent	0.7

AAGR = average annual growth rate.

Sources: East-West Center PREM Data File and IDB (1993).

Table 2.6
Mexico's 1993 Refining Capacity and Configuration
('000 b/cd)

Company	Location	CDU	VDU	Thermal Operations	Cat. Cracking	Cat. Reforming	Hydro Cracking	Hydro Refining	Hydro Treating
Pemex	Cadereyta	235.0	137.0		40.0	20.0		50.0	36.0
Pemex	Ciudad Madero	195.0	81.5	18.0	43.0	15.0		40.0	18.0
Pemex	Minatitlan	200.0	83.0		40.0	31.0		25.0	75.0
Pemex	Salamanca	235.0	101.2	4.0	40.0	24.8	18.5	10.0	61.0
Pemex	Salina Cruz	330.0	155.0		40.0	50.0		100.0	61.0
Pemex	Tula, Hidalgo	320.0	155.0	41.0	40.0	30.0		50.0	36.0
Total		1,515.0	712.7	63.0	243.0	170.8	18.5	275.0	287.0

Sources: Oil & Gas Journal; Pemex Data; East-West Center PREM Data File.

shutdowns, the country still has the largest refining capacity in Latin America.¹¹ The Mexican refineries are not very sophisticated and the overall cracking-to-distillation ratio is only 21 percent, resulting in a shortfall of gasoline production.

In order to compensate for the lost capacity of the three closed refineries, Pemex has decided to build a new grassroots refinery with a capacity of 150,000 b/d in Salina Cruz. Construction of the facility was scheduled to begin in 1993 but was delayed. The construction alone would take about forty months, costing a total of \$1.4 billion according to plans. A second refinery of the same size has been planned and will probably be located on the Gulf Coast. Expansion of crude distillate capacity also includes 60,000 b/d in Salamanca and 35,000 b/d in Cadereyta. Pemex has recently awarded a contract to the Mexican firm Bufete Industria Construcción—in which the U.S. company M.W. Kellogg has a 25 percent stake—to build a 40,000 b/d catalytic cracker in Salina Cruz in order to increase output of gasoline. In addition, five refinery upgrading projects are currently under construction: two hydrotreaters with a combined capacity of 61,000 b/d in Tula, a vacuum distillation unit with a capacity of 48,000 b/d in Salamanca, a 50,000 b/d visbreaker in Cadereyta, and another 50,000 b/d visbreaker in Salina Cruz. Several other projects in Tula are in the engineering stage: a catalytic reformer with 30,000 b/d capacity, a 50,000 b/d hydrocracker, and a 90,000 t/y MTBE project.¹² During 1991 and 1992, visbreakers with capacities totalling 100,000 b/d were also being built in Cadereyta and Salina Cruz. In the gas processing industry, Pemex is building a 150 MMcf/d cryogenic expander unit.

Petroleum Product Balance

Mexico's 1991 total product consumption was nearly 1.66 million b/d—the largest demand in Latin America—while the production of refined products was 1.62 million b/d (Table 2.7). Gasoline and fuel oil accounted for 34 and 28 percent, respectively, of Mexico's petroleum product consumption in 1991, while nearly equal shares of diesel and LPG accounted for a

11. PDVSA of Venezuela controls more refining capacity than Pemex does, but about 35 percent of PDVSA's refineries are located abroad.

12. See *Oil & Gas Journal*, October 26, 1992.

Table 2.7
Mexico's Petroleum Product Balance, 1991
('000 b/d)

Product	Production	Imports	Exports	Consumption	Stock Change
LPG	244.6	20.9	36.1	229.6	-0.1
Gasoline	511.4	74.9	15.6	566.3	4.4
Kero/Jet	70.6	0.0	16.4	52.4	1.8
Diesel	275.2	0.0	19.8	254.7	0.6
Fuel Oil	416.7	46.9	7.8	454.7	1.1
Others	105.6	1.1	0.6	104.5	1.6
Total	1,624.2	143.8	96.3	1,662.2	9.4

Note: Individual units do not necessarily add up to the total because of independent rounding.

Source: East-West Center PREM Data File.

combined 29 percent. The remainder was kero/jet (3%) and other products (6%). Product exports in 1991 totalled 96,300 b/d, while product imports amounted to 143,800 b/d, mainly consisting of gasoline (52%), fuel oil (33%), and LPG (15%). In 1991, 61 percent of Mexico's oil product imports were from the United States; during the same year about 50 percent of its product exports went to the United States and 33 percent to other Latin American (including the Caribbean) countries.¹³

Outlook for Petroleum Product Consumption

During the period between January 1990 and October 1992, LPG, diesel, and fuel oil prices remained flat in Mexico's domestic market, but gasoline prices increased rapidly. From November 1992 to September 1993, LPG and diesel prices also went up. In January 1990, the average gasoline price was 87¢/gal; by September 1993 it had increased by 70 percent to US\$1.48/gal (Figure 2.3). Like many other Latin American currencies, the Mexican peso has depreciated almost continuously against the U.S. dollar in recent years, with the exchange rate dropping from 2,675 Mexican pesos/US\$ in January 1990 to 3,110 Mexican pesos/US\$ in December 1992 (Figure 2.4). In January 1993, the Mexican government introduced the new Mexican peso to replace the old one. Between January and September 1993, the new Mexican peso depreciated slightly from 3.09 pesos per US dollar to 3.3 pesos per US dollar. As a result of the 1994 implementation of NAFTA, it is expected that fuel prices in Mexico will increase further, even though energy has not been directly negotiated under NAFTA. Higher fuel prices may help curb Mexico's oil product consumption and somewhat counteract the demand effects of the strong economic growth projected for the country through 2000.

The forecast for Mexico's oil product consumption is based on the assessment of economic performance and changes in fuel prices as mentioned earlier. It is expected that demand for oil products in Mexico will increase at an average annual rate of between 1.5 and 4.9 percent, with the base case scenario projecting an average annual growth rate of 2.9 percent (Table 2.8). Product consumption is forecast to increase to 1.86 million b/d (1.76 million b/d and 2 million

13. See *World Oil Trade* (1993).

Figure 2.3
Domestic Prices of Selected Refinery
Products in Mexico, Jan. 1990 - Sep. 1993

Source: East-West Center PREM Data File.

Figure 2.4
Mexico's Monthly Exchange Rate,
Jan. 1990 - Sep. 1993

Source: East-West Center PREM Data File.

Table 2.8
Forecast of Mexico's Petroleum Product Consumption, 1991, 1995, and 2000
('000 b/d)

Year	LPG	Gasoline	Kero/Jet	Diesel	Fuel Oil	Others	Total
1991 (actual)	229.6	566.3	52.4	254.7	454.7	104.5	1,662.2
1995 (forecast)							
High Case	289.9	714.9	63.6	333.8	493.1	113.4	2,008.8
Base Case	260.9	643.6	58.9	315.5	476.0	109.4	1,864.4
Low Case	243.7	601.1	55.6	292.2	462.0	106.2	1,760.8
2000 (forecast)							
High Case	383.4	945.5	81.2	468.2	544.4	125.2	2,547.9
Base Case	304.7	753.7	68.3	407.5	502.8	115.6	2,152.6
Low Case	262.5	647.5	59.9	342.9	471.4	108.4	1,892.5

Note: Individual units do not necessarily add up to the total because of independent rounding.

Source: East-West Center PREM Data File and Forecasts.

b/d for low and high case forecasts, respectively) in 1995 and 2.15 million b/d (1.89 million b/d and 2.55 million b/d for low and high case forecasts) in 2000 for the base case scenario. While fuel oil and other products consumption is expected to increase at a rate below the average growth rate for all major fuels, the growth rates for LPG, gasoline, and diesel are all expected to rise faster than the average.

2.4. NATURAL GAS UTILIZATION AND TRADE LINKS

Current Situation

In 1991, Mexican imports of natural gas from the United States totalled 164 MMcf/d, up from 43 MMcf/d in 1990, and the imports in 1992 were 250 MMcf/d. In 1991, of the 4,234 MMcf/d of utilized natural gas, 59 percent went to gas treatment plants, 24 percent was consumed in the industrial sector, 12 percent was used by power plants, and the rest was utilized by the residential sector. The petrochemical industry is by far the largest user of natural gas in Mexico as 80 percent of the industry uses gas as a feedstock (see Appendix I).

The natural gas price structure has become more market-oriented as the government has started reforming the price policy. In early 1991, Pemex instituted a price policy for natural gas under which domestic gas prices are determined by adding an allowance for transportation costs to the import prices at the Texas border. Although the Mexican government consistently rejected the idea of setting up a natural gas common market with the United States and Canada during the negotiation of NAFTA,¹⁴ its practice of linking domestic gas prices with border prices will certainly work in the direction of bringing domestic prices in line with international market prices.

Existing natural gas pipelines between Mexico and the United States include two lines from McAllen to Reynosa with a combined capacity of 750 MMcf/d and two smaller lines with

14. Mexico's rejection of a gas common market is broadly based in the government's refusal to discuss any issues related to the oil and gas sector in the NAFTA agreement. See Baker (1993).

capacities of 9 MMcf/d and 25 MMcf/d. Given the increasing demand for natural gas in Mexico, more pipelines from the United States to Mexico are expected to be built (Table 2.9).

Prospects for Future Gas Use and Trade Links

It is expected that natural gas utilization will grow at an average annual rate of 4 percent through 2000. The gas share in total primary energy consumption is expected to rise from 23.4 percent in 1991 to 25.5 percent in 2000, due to the significant increase in consumption. Natural gas will be used increasingly to substitute for some oil in the power and industrial sectors as a result of environmental concerns as well as to free up more crude and products for export.

Four more pipelines running from the United States to Mexico have been proposed for the next several years to supply the increasing gas demand in Mexico. The combined capacity of these four lines ranges from 1,074 MMcf/d to 1,844 MMcf/d (see Table 2.9). If completed, the estimated 5,250 MMcf/d of Mexican demand for gas in the year 2000 can be largely satisfied.

2.5. IMPORTANT HYDROCARBONS POLICY ISSUES

The most important policy issue in Mexico's hydrocarbons sector is the country's ability to make the required investments in order to maintain its role as a net exporter, while supplying its growing domestic energy consumption needs. The main challenge to achieving this objective will be to raise the required investment funds of US\$20 billion that are essential to boost declining oil reserves and build upgrades to domestic refineries. While Pemex can provide US\$12 billion, US\$8 billion will have to come from private sources. In order to raise the needed funds from the external sources, Pemex has employed a variety of options. In 1989, Pemex was the first of the Latin American national oil companies to issue bonds, and it is continuing to use bonds as an important means of funding its oil development plans. In 1992, Pemex borrowed from commercial banks for the first time in a decade. However, the funding of upstream activities in the hydrocarbons sector through direct foreign investment has not been permitted in the country for decades under the Mexican Constitution. Private participation in risk contracts is prohibited by the Mexican Constitution, and a highly nationalistic attitude toward the ownership of hydrocarbons prevents political action to modify such a law. In fact, this was one of three

Table 2.9
Natural Gas Trade Links Between the U.S. and Mexico

	Capacity (MMcf/d)	Main Route
Existing		
Texas Eastern (TETCO)	350	McAllen-Reynosa
Western Gas Interstate	170	El Paso-Ciudad Juarez
Valero	9	Eagle Pass-Piedras Negras
Valero	400	McAllen-Reynosa
El Paso Natural Gas	25	Naco, AZ-Naco, Mexico
Proposed		
Enron/Houston Pipeline	600	McAllen-Reynosa
SoCal Gas/SDG&E(opt.1)	24-144	San Diego-Rosarita
SoCal Gas/SDG&E(opt.2)	50-500	San Diego-Rosarita
El Paso Natural Gas	300-500	Yuma-San Luis
El Paso Natural Gas	100	El Paso-Ciudad Juarez

Source: East-West Center PREM Data File.

areas of great controversy during the negotiations of the NAFTA with the United States and Canada. Pemex is expected to continue to offer foreign and private investors only marginal opportunities for participation in its hydrocarbons sector—a policy which could threaten the energy supply needed for continued strong economic growth.

Another major policy issue that may influence Mexico's future oil and gas supply is the direction and impact of Pemex's restructuring efforts. The state oil company needs to be streamlined and reorganized in order to cope with the increasing need for production efficiency and investment flexibility. Efficiency has been a problem for Pemex. For example, the company has not met its exploration and production goals for years. The reforms introduced by the Salinas administration four years ago, aimed at converting the relatively inefficient and overstaffed Pemex into an internationally competitive oil company, have progressed at a rather slow pace. However, the government has vowed to speed up the reforms. In addition to cutting staff and reducing payrolls, there are plans to establish independent oil companies as Pemex subsidiaries. The government also has tentative plans to lease some of the producing fields to foreign oil companies on a contract basis and reduce Pemex's taxes to the level of private companies. Furthermore, the government has announced that instead of taking away all profits from Pemex and allocating its funds later as it does today, the government will let the state oil company manage its own funds and regularly pay taxes. In spite of all these changes, there is still a long way to go to fully realize the government's targets for improving Pemex's management, which will have a profound impact on Mexico's oil and gas industry in the future.

Finally, an important policy issue that is directly related to the downstream oil sector and product consumption in Mexico is the environment. Air pollution caused by automobiles in metropolitan Mexico City and in major cities in northeastern Mexico is very severe, and air quality has deteriorated significantly in recent years. Three refineries were shut down in 1991 because of the severe pollution they caused. The Mexican government has made efforts to upgrade its gasoline quality and has started to import MTBE and other oxygenate additives in order to reduce lead levels. The country needs to build more MTBE facilities and gradually phase out leaded gasoline in order to preserve the environment.

III. VENEZUELA

Venezuela has a land area of only 912,000 km², but it has the largest hydrocarbon resources in the region. The country is a founding member of OPEC. Like most of Latin America, Venezuela is a country of social and economic contrasts. Venezuelans are a diverse people with a mixture of European, African, and Indian ancestry.¹⁵ Culturally, it has much in common with its Caribbean neighbors. The country has one of the highest population growth rates among Western Hemisphere countries and, in terms of socio-economic indicators (such as urbanization and life expectancy), it ranks among the region's more developed economies.

The Venezuelan economy has exhibited substantial growth over the past several years, although there was a sharp recession in 1989. In 1990, GDP grew 5.3 percent and in 1991 reached the highest rate (9.7%) achieved thus far in Latin America. However, after 1992, the economy has sharply worsened. The GDP growth was down to 6.8 percent a year in 1992; the real GDP even fell by 1 percent during 1993. The inflation rate rose from over 31 percent in 1992 to 38 percent in 1993 and is expected to remain at the level of 40 percent for the the next few years.¹⁶ Meanwhile, Interim President Velásquez's government is trying to implement a series of reforms by decrees. The long-delayed value added tax law went into effect on Oct. 1, 1993. The government has ordered big increases in stamp taxes and is expected to permit foreign investors to buy shares in existing banks and to establish local operations.¹⁷ The monetary policy has been tightened again. The government is attempting to diversify the economy away from oil by emphasizing growth and exports in other industries such as aluminum, steel, iron ore, and coal; in addition, Venezuela is trying to increase value added by promoting exports of petroleum products rather than crude. The petroleum industry remains the most important contributor to GDP (28%) and to exports (80%). Crude and product exports were valued at nearly US\$11.2

¹⁵ See Culver-Hopper et al. (1992), p. 65.

¹⁶ EIU (1994h), pp.3-5.

¹⁷ See EIU (1993i).

billion in 1992. The United States is Venezuela's most important trade partner, followed by Germany and Japan.

3.1. PRIMARY ENERGY SUPPLY

Venezuela is a large net energy exporter, mainly because of its oil exports. In 1991, the country was the leading exporter of crude oil and petroleum products in Latin America, exporting 1.38 million b/d and 737,100 b/d, respectively. Venezuela also exports most of the coal it produces. Primary energy production in 1991 was 3.34 million boe/d, up from 2.89 million boe/d in 1980. Petroleum provided 77.3 percent of total primary energy production in 1991, followed by gas at 19.5 percent; together, oil and gas accounted for nearly 97 percent of all primary energy produced (Figure 3.1). Coal production has exhibited the most dramatic upsurge in recent years as it increased nearly 45 times from 1980 to 1991. Yet gas and hydroelectricity production also increased substantially. In 1991 gas production was nearly double and hydroelectricity production more than double the respective production levels in 1980. However, oil production increased by only 4.4 percent from 1980 to 1991, reflecting an average annual growth rate of 0.4 percent. Given the dominance of oil in energy production, total energy production increased by only 15.9 percent, the result of an average annual growth rate of 1.35 percent, during the period 1980-1991.

Oil

Venezuela has the largest oil and gas reserves in Latin America. These extensive reserves coupled with relatively low domestic demand will ensure that the country will continue to be a major exporter into the next century. In late 1992, proven oil reserves were 62.7 billion barrels, the sixth largest in the world. While only 27 percent of total current reserves are made up of condensates and light and medium gravity crudes (higher than 22° API), some international oil companies such as BP believe that Venezuela has large amounts of high value crude still to be found. The undiscovered light and medium crude reserves were estimated at around 15 billion barrels, according to a report commissioned by Petróleos de Venezuela (PDVSA, the Venezuelan

Figure 3.1
Venezuela's Primary Energy
Production by Source, 1980 and 1991

Source: East-West Center PREM Data File.

national oil company) and prepared by BP.¹⁸ The remaining 73 percent of the proven reserves are composed of heavy and extra-heavy crudes with a gravity lower than 14° API, which will require the use of high conversion refineries in order to obtain the desired proportion of light products such as gasoline.

After Mexico, Venezuela is Latin America's second largest oil producer. While Venezuela's crude production capacity is 2.8 million b/d, actual production averaged 2.33 million b/d in 1992, about the same as in 1991 (Table 3.1). Approximately 41 percent of the crude was refined in Venezuela and 59 percent was exported (28% was processed in overseas refineries in which PDVSA has shares, and 31% was sold to third parties).

For the first time in 1991, Venezuela's exports exceeded Mexico's, and the country became the region's largest exporter of crude oil when NGLs were excluded, exporting 1.38 million b/d, up 31 percent from its 1990 crude exports of 1.05 million b/d. In 1992, Venezuela's crude exports were 1.37 million b/d, about the same as in 1991. Crude exports, which have been increasing steadily over the last decade, amounted to nearly 60 percent of production. While Venezuela is the second most important supplier of crude and products to the U.S. market after Saudi Arabia, its 1991 crude exports to the United States were slightly lower than U.S. crude imports from Mexico. In 1991, 48 percent of Venezuelan crude exports went to the United States and Canada, 17 percent to Western Europe, 10.3 percent to Latin America (Brazil, Chile, and most Central American countries), 23.9 percent to the Caribbean region, and less than 1 percent to Asia and Africa.¹⁹

In Venezuela, the oil business is conducted exclusively by the national oil company, *Petróleos de Venezuela S.A.* PDVSA was founded in 1976 upon the nationalization of the country's hydrocarbon industries and is one of the world's five largest oil companies. The company is

¹⁸ See *Platt's Oilgram News*, January 28, 1993.

¹⁹ See OLADE (1993).

Table 3.1
Petroleum Data for Venezuela, 1988-1992
('000 b/d)

Year	Reserves/a	Crude Production	Crude Exports	Crude Imports	Product Consumption
1988	58,084	1,953.4	1,013.6	7.4	436.4
1989	58,504	1,914.3	923.7	0.0	370.2
1990	59,040	2,195.3	1,054.6	0.0	447.6
1991	62,000	2,332.0	1,381.3	0.0	447.4
1992	62,650	2,334.7	1,374.5	0.0	457.4

a. Million barrels.

Source: East-West Center PREM Data File.

Table 3.2
Natural Gas Data for Venezuela, 1988-1992
(MMcf/d)

Year	Reserves/a	Production	Exports	Imports	Utilization/b
1988	102,243	2,469	0	0	1,981
1989	100,846	2,369	0	0	1,908
1990	105,688	2,759	0	0	2,071
1991	110,000	3,049	0	0	2,289
1992	126,492	3,137	0	0	2,363

a. Billion cubic feet (bcf). b. Defined as transformation plus final consumption, with appropriate adjustment of stock change.

Source: East-West Center PREM Data File.

fully integrated, and through its international subsidiaries, it is involved in major refining and marketing efforts in the United States and Europe. PDVSA has three fully integrated principal operating companies: Lagoven, Corpoven, and Maraven.²⁰

PDVSA plans to increase its production capacity to 3.6 million b/d by 1996. Over the 10 years beginning 1994, PDVSA plans to invest a total of US\$48.5 billion and aims to increase production potential to 4 million b/d.²¹ The implementation of these plans by PDVSA alone might turn out to be difficult in view of the reductions currently taking place in the company's budget. As a result, PDVSA has begun to seek foreign participation in the form of operations contracts in its upstream sector and strategic associations. In June 1992, after the first tender, two operations contracts for the reactivation of marginal oil fields were signed, one with Benton Oil & Gas, a California independent, in partnership with a private Venezuelan firm, Vincler CA, and the other with Teikoku Oil of Japan. There are 250 such marginal fields in the country that could collectively boost production 60,000 b/d by 1996 and 90,000 b/d by 2000. During November 1992, there was a second round of bidding for the operation of additional fields. The 74 fields being offered have been consolidated into 13 production units. These development contracts are "operational," with preagreed payments for barrels produced, and do not violate Article 5 of the Venezuelan Constitution which prohibits foreign ownership of oil. By late 1993, the second round drew 44 bids from 20 individual firms including the United States's Occidental, Coastal, and Pennzoil, France's Elf and Total, Canada's Norcen, and 16 consortia of international and local companies. By mid-1994, the 13 areas that are awarded have estimated reserves of 2 billion barrels of oil with gravities ranging from 10°API to 42°API.

PDVSA also seeks to form "strategic associations" with foreign oil companies whereby a long-term relationship that is beneficial to all parties is established. Three such associations have

²⁰ See Culver-Hopper et al. (1992), p. 67.

²¹ See *PDVSA Contact Newsletter*, November-December 1993.

already been approved by the Venezuelan Congress by late 1993.²² This is another way in which PDVSA hopes to acquire private funding for its development plans. The associations are not restricted to any one activity, but they must help Venezuela meet crucial energy goals such as:

1. production, upgrading, and conversion of heavy and extra-heavy crudes, particularly those of the Orinoco Belt;
2. construction of export refineries in Venezuela to process heavy crudes;
3. participation of PDVSA in foreign refineries able to process growing quantities of Venezuelan heavy crudes.

Incentives for these associations are being proposed in the form of tax reductions whereby the "government take" for heavy oil development would be reduced from US\$11 to US\$6 per barrel. This will boost the return from the current 2 percent to 12 percent.

Natural Gas

Venezuela has Latin America's largest natural gas reserves, estimated at 126.5 bcf in late 1992 and accounting for about 49 percent of the region's total. The country is also the second largest gas producer after Mexico, with a 1992 production level of 3,137 MMcf/d (Table 3.2). Its commercial dry gas production accounted for 24 percent of Latin America's total in 1992.

Gas production increased at an average annual rate of 4.8 percent between 1980 and 1991. Further increases in gas production are expected in the future. Natural gas production is expected to receive a boost if the US\$3 billion "Cristobal Colon" project is developed. This project, aimed at exporting liquefied natural gas (LNG) processed from the gas reserves located on the eastern coast of Venezuela, was planned as a joint venture with Shell, Exxon, and Mitsubishi. Although congressional approval was given in late 1993, the project has been controversial because it would allow foreign interests to acquire equity in hydrocarbons reserves for the first time since the nationalization of the oil industry in 1976.

²² See *Platt's Oilgram News*, August 17, 1993.

While all three of PDVSA's operating companies produce gas, only Corpoven S.A. is responsible for domestic distribution. Corpoven owns all of the gas infrastructure in the country and distributes natural gas to the residential and industrial sectors. In addition, there are some small private companies involved in the retailing of gas.

Coal

Venezuela is the second largest coal exporter in Latin America and the volume of exports is growing. While Venezuela's shares in the region's coal reserves and production in 1991 were both 6 percent, its coal exports accounted for 11 percent of the regional total. With reserves of 576 million tonnes in 1992, Venezuela produced 3 million tonnes and exported 2.6 million tonnes, or 85 percent of the coal produced in the country (Table 3.3). Both production and exports were higher than the 1991 level of 2.5 and 2.1 million tonnes, respectively.

Between 1988 and 1992, coal production and exports increased at average rates of 30 and 26 percent a year, respectively. In 1989 alone, coal production increased by 95 percent over the 1988 level. In 1991, all of the 402 thousand tonnes of coal used in the country went to the industrial sector. Coal production is expected to increase to 15 million tonnes by 1997.

Hydroelectricity

Hydroelectricity accounted for only 1.9 percent of total primary energy production in Venezuela in 1991 after increasing at an average rate of 8.8 percent a year between 1980 and 1991. The country has seven hydropower stations; the largest plant, Guri, located in Bolivar, has a capacity of 9,025 MW and is one of the largest hydropower stations in the world. Installed hydropower capacity nearly tripled from 2,728 MW in 1980 to 10,425 MW in 1991, raising the country's hydroelectricity utilization ratio from 3.9 percent to 14.9 percent. Hydropower capacity accounted for approximately 55 percent of total installed power generating capacity in 1991. The Venezuelan government is planning to increase its hydropower capacity. It is expected that in the short term (to 1995), 2,548 MW will be added to the existing hydropower capacity; in the medium term (to 2000), two additional hydropower stations with a combined capacity of 4,848

Table 3.3
Coal Data for Venezuela, 1988-1992
('000 tonnes)

Year	Reserves/a	Production	Exports	Imports	Apparent Consumption/b
1988	514	1,091	1,026	19	84
1989	558	2,125	1,689	0	436
1990	697	2,189	1,834	0	355
1991	697	2,521	2,119	0	402
1992	576	3,072	2,622	0	450

a. Million tonnes. b. Defined as production plus net imports.

Source: East-West Center PREM Data File.

MW will be constructed; and over the long term (to 2010), four more projects with a combined capacity of 9,100 MW are planned.²³

3.2. PRIMARY ENERGY CONSUMPTION

Current Situation

Venezuela's primary energy consumption consists of only four sources: oil, gas, coal, and hydroelectricity. Total primary energy consumption in 1991 was about 1 million boe/d, up from 821,000 boe/d in 1980 (Figure 3.2). Oil consumption decreased by an average of 0.5 percent a year between 1980 and 1991; in comparison, gas consumption increased at an average annual rate of 3.3 percent during this period. Oil and gas accounted for 42.4 and 49.5 percent, respectively, of the 1991 primary energy consumption (Table 3.4). Hydroelectricity accounted for 7.5 percent of the consumption, but its use has been increasing by an average of 10.7 percent a year since 1980. Minimal quantities of coal were consumed; however, the average annual growth rate for coal consumption was a hefty 22.8 percent between 1980 and 1991. On average, primary energy consumption in Venezuela went up 1.8 percent per year between 1980 and 1991 (see Figure 3.2)

Outlook for 2000

The forecast for Venezuela's primary energy consumption is based on projections of its population and real GDP growth as well as changes in consumption in the past. Between 1980 and 1992, Venezuela's population grew at an average annual rate of 2.92 percent, the highest growth rate among the nine Latin American countries, while its real GDP declined by an average of 0.1 percent a year between 1980 and 1991. According to the IDB (1993), the average annual population growth rate between 1992 and 2000 is expected to drop to 2.23 percent per year, and as a result of the economic recovery of recent years, real GDP is expected to increase by an average 4.7 percent a year between 1991 and 2000. While primary energy consumption increased by an average annual rate of 2.6 percent between 1980 and 1991, per capita primary energy consumption went down slightly from 20 boe/person in 1980 to 18 boe/person in 1991

²³ See Rodríguez-Elizarrarás (1992).

Figure 3.2
Venezuela's Actual and Projected Primary
Energy Consumption, 1980, 1991, and 2000

('000 boe/d)

Source: East-West Center PREM Data File and Forecasts.

Table 3.4
Percentage Distribution of Primary Energy
Consumption: Venezuela, 1980, 1991, and 2000
 (%)

	1980	1991	2000
Oil	54.7	42.4	43.4
Natural Gas	42.1	49.5	49.6
Coal	0.2	0.6	0.5
Hydroelectricity	3.0	7.5	6.5
Total	100.0	100.0	100.0

Source: East-West Center PREM Data File and Forecasts.

and energy intensity went up from 6,875 kcal/US\$(1980) in 1980 to 8,458 kcal/US\$(1980) in 1991. All of these data and assumptions are summarized in Table 3.5.

Based on these assumptions and an assessment of the overall economy, it is expected that total primary energy consumption in Venezuela will increase at an average annual rate of 4.3 percent through the year 2000, led largely by oil consumption growth. Refinery fuel prices are still very low in Venezuela. Plans calling for reductions in the oil product price subsidies that are expected to be implemented within the next few years may have only a minor effect on containing the expansion of petroleum consumption given the strong growth of the economy. Oil consumption is thus expected to increase at an average annual rate of 4.6 percent. Growth rates for gas, coal, and hydroelectricity consumption are expected to be 4.4, 3.5, and 2.5 percent, respectively, during the period 1991-2000. Total primary energy consumption is expected to reach 1.46 million boe/d in 2000.

3.3. DOWNSTREAM OIL SECTOR AND PRODUCT CONSUMPTION

Refining Sector

PDVSA's six domestic refineries have a combined crude distillation capacity of 1.171 million b/d (Table 3.6) and processed an average of 1 million b/d of crude in 1991, bringing utilization to a high rate of 86 percent. With an overall cracking-to-distillation ratio of 31.5 percent, Venezuela's refineries are complicated enough to handle heavy, medium, and light crudes, although heavy crude constitutes the majority of inputs. Secondary processing capacity mainly consists of 134,100 b/d of thermal operations and 233,900 b/d of catalytic cracking capacity. In addition to its domestic refineries, PDVSA has joint or full ownership in nine refineries in the United States, Europe, and Curaçao that have the capacity to process approximately 1.3 million b/d of crude, of which PDVSA's share is 1 million b/d (see Table 3.6). Joint ventures with foreign companies are also contributing to the rapid expansion of the petrochemical industry in Venezuela.

PDVSA plans to increase its refining capacity at home and abroad. The company is currently negotiating for a 50 percent stake in Lyondell's sophisticated 265,000 b/d refinery in Houston,

Table 3.5
Key Data and Assumptions for Forecast of Venezuela's
Primary Energy Consumption, 1980-2000

Key Item	Unit	Data/Assumptions
Population		
AAGR 1980-1992	percent	2.92
AAGR 1992-2000	percent	2.23
GDP		
AAGR 1980-1991	percent	-0.1
AAGR 1991-2000	percent	4.7
Per Capita GDP		
AAGR 1980-1991	percent	-2.8
AAGR 1991-2000	percent	2.4
Per Capita Primary Energy Consumption		
1980	boe/person	20.0
1991	boe/person	18.0
AAGR 1980-1991	percent	-0.2
Energy Intensity		
1980	kcal/US\$(1980)	6,875
1991	kcal/US\$(1980)	8,458
AAGR 1980-1991	percent	2.67

AAGR = average annual growth rate.

Sources: East-West Center PREM Data File and IDB (1993).

Table 3.6
Venezuela's 1993 Refining Capacity and Configuration
('000 b/cd)

Company	Location	Crude Distillation	VDU	Thermal Operations	Cat. Cracking	Cat. Reforming	Hydro Cracking	Hydro Refining	Hydro Treating
DOMESTIC CAPACITY									
PDVSA-Corpoven	El Palito, Carabobo	105.0	63.2		50.4	8.9			8.9
PDVSA-Corpoven	El Toreno, Barinas	4.8							
PDVSA-Corpoven	Puerto La Cruz, Anzoategui	195.0			13.6				
PDVSA-Corpoven	San Roque, Anzoategui	5.2	1.8						
PDVSA-Lagoven	Amuay, Falcon	571.0	336.0	52.1	97.2				212.0
PDVSA- Maraven	Punta Cardon, Falcon	286.0	147.6	82.0	72.7				63.3
Domestic Capacity Total		1,167.0	548.6	134.1	233.9	8.9			284.2
INTERNATIONAL PARTICIPATION AND OWNERSHIP									
Nynas Petroleum/a	Antwerp, Belgium	15.0	12.5						
Ruhr Oel/a	Gelsenkirchen, Germany	215.4	48.2	44.0		27.2	30.0	63.0	53.0
Refineria Isla /b	Curacao, Netherlands Antilles	320.0	158.0	67.0	42.0	15.0			40.0
AB Nynas Petroleum/a	Gothenburg, Sweden	12.5	9.0						
AB Nynas Petroleum/a	Nynashamn, Sweden	28.0	31.0						2.5
PDVSA/c	Georgia, U.S.	28.0							
Uno-Ven/a	Illinois, U.S.	147.0	58.0	27.9	58.0	29.8			103.8
Citgo Petroleum/c	Louisiana, U.S.	320.0	75.0	88.0	150.0	106.0	45.0	40.0	173.0
Seaview Petroleum/d	New Jersey, U.S.	80.0	35.0						
Citgo Petroleum/c	Texas, U.S.	132.5	80.0	33.5	76.5	54.0		106.7	60.0
International Participation and Ownership Total		1,298.4	506.7	260.4	326.5	232.0	75.0	209.7	432.3
PDVSA's Share of the International Total		1,049.5							
TOTAL PDVSA CAPACITY		2,216.5							

a. 50% PDVSA. b. Leased by PDVSA. c. 100% PDVSA. d. 50% CITGO.

Sources: Oil & Gas Journal; PDVSA Data; East-West Center PREM Data File.

Texas. In Venezuela, Corpoven S.A. is planning the construction of a 340,000 b/d refinery in Puerto La Cruz and another 277,000 b/d crude distillation unit (CDU) facility at Jose, to be completed by 1997. Total domestic refining capacity is thus expected to increase by 617,000 b/d by the end of the century. All three subsidiaries of PDVSA—Corpoven S.A., Lagoven S.A., and Maraven S.A.—also have plans to upgrade their refineries in order to meet the rising fuel quality requirements in export markets. In addition, Corpoven S.A. will construct an MTBE facility in El Palito at a cost of US\$11 million, and Maraven S.A. will build another MTBE plant with a capacity of 66,300 t/y in Cardon; both plants are currently in the engineering stage.²⁴ The construction of MTBE plants reflects PDVSA's desire to upgrade gasoline quality for export and for domestic use, in order to reduce the air pollution caused by automobiles in the country.

Petroleum Product Balance

Production of refined products totalled 1.18 million b/d, more than 700,000 b/d in excess of domestic demand (Table 3.7). In 1991, refined product consumption totalled 447,000 b/d. Gasoline accounted for nearly half (47%) of the products consumed, and smaller shares of demand were recorded by diesel (19%), LPG (16%), and fuel oil (9%) (see Table 3.7). In 1991, Venezuela exported 62 percent of its refined products, or 737,100 b/d, which consisted mainly of fuel oil, diesel, and gasoline. About 64 percent of the product exports went to the United States, 7 percent to Latin American countries, 7 percent to Western Europe, and 5 percent to the Asia-Pacific region.²⁵

Outlook for Petroleum Product Consumption

Refined products are heavily subsidized by the Venezuelan government. In terms of U.S. dollars, product prices have been consistently kept low in recent years. For instance, the prices of LPG, premium gasoline, and kerosene were 18¢/gal, 24¢/gal, and 9¢/gal, respectively, in January 1990, and these prices have since then "increased" to 24¢/gal, 23¢/gal, and 13¢/gal (as

²⁴ See *Oil & Gas Journal*, October 26, 1992.

²⁵ See *World Oil Trade* (1993).

Table 3.7
Venezuela's Petroleum Product Balance, 1991
('000 b/d)

Product	Production	Imports	Exports	Consumption	Stock Change
LPG	100.5	0.0	29.0	71.5	0.0
Gasoline	356.1	0.0	147.9	211.6	-3.4
Kero/Jet	88.3	0.0	77.5	14.1	-3.3
Diesel	303.1	0.0	218.5	84.1	0.6
Fuel Oil	264.8	0.0	223.6	41.3	0.0
Others	67.0	0.0	40.7	24.9	1.4
Total	1,179.8	0.0	737.1	447.4	-4.7

Note: Individual units do not necessarily add up to the total because of independent rounding.

Source: East-West Center PREM Data File.

of September 1993) (Figure 3.3). During the same period, the bolivar depreciated from 43.3 bolivars/US\$ in January 1990 to 98 bolivars/US\$ in September 1993 (Figure 3.4).

Based on our assessment of the economy and fuel price changes, petroleum product consumption in Venezuela is expected to increase at an average rate of 4.6 percent annually in the base case, driven by increases in LPG, gasoline, and diesel consumption. Using the 1991 base year consumption level of 447,000 b/d of major products, which excludes refineries' own consumption and losses, the product consumption level could rise to 669,600 b/d by 2000 (Table 3.8). The base case scenario also assumes a partial liberalization of product prices. Petroleum product consumption could be significantly constrained by the elimination of domestic subsidies, one of the goals of the present administration, which has met with violent opposition from consumers. If subsidies are eliminated and price hikes occur, consumption is expected to grow at an average rate of only 2 percent annually (low case). The forecast for the high case indicates that petroleum product consumption could grow by as much as 7 percent per year through 2000 if economic performance is particularly strong and fuel prices are controlled tightly by the government.

3.4. NATURAL GAS UTILIZATION

A fairly large portion of the gas produced in Venezuela is flared, and in 1991 the total amount of gas wasted in this way amounted to 368 MMcf/d. Also, about 378 MMcf/d of natural gas were lost during transformation and transportation, and another 448 MMcf/d were consumed by the gas sector itself in 1991. As a result, about 2,332 MMcf/d, or 73 percent of total produced gas, were consumed by various sectors of the economy in Venezuela in 1991. The main uses for natural gas are in the industrial sector (868 MMcf/d), the power sector (460 MMcf/d), and gas treatment plants (340 MMcf/d) that convert it to LPG (see Appendix II). Natural gas utilization has been increasing at an average of about 5.2 percent per year between 1980 and 1991. It is expected that gas consumption will increase at an average annual rate of 4.4 percent between 1991 and 2000. The country's relatively high gas consumption growth forecast for the 1990s is partly a result of the rapidly increasing demand for LPG, which uses a substantial volume of natural gas as a feedstock.

Figure 3.3
Domestic Prices of Selected Refinery
Products in Venezuela, Jan. 1990 - Sep. 1993

Source: East-West Center PREM Data File.

Figure 3.4
Venezuela's Monthly Exchange Rate,
Jan. 1990 - Sep. 1993

Source: East-West Center PREM Data File.

Table 3.8
Forecast of Venezuela's Petroleum Product Consumption, 1991, 1995, and 2000
('000 b/d)

Year	LPG	Gasoline	Kero/Jet	Diesel	Fuel Oil	Others	Total
1991 (actual)	71.5	211.6	14.1	84.1	41.3	24.9	447.4
1995 (forecast)							
High Case	112.5	293.3	19.9	114.4	51.0	31.4	622.5
Base Case	101.0	267.2	18.1	98.3	45.0	29.1	558.7
Low Case	90.3	233.6	15.6	94.6	41.0	27.5	502.5
2000 (forecast)							
High Case	165.3	383.3	25.4	153.0	56.0	40.1	823.2
Base Case	126.1	318.9	21.3	119.6	50.0	33.7	669.6
Low Case	99.7	248.0	16.0	99.4	44.0	29.6	536.6

Note: Individual units do not necessarily add up to the total because of independent rounding.

Source: East-West Center PREM Data File and Forecasts.

3.5. IMPORTANT HYDROCARBONS POLICY ISSUES

The Venezuelan government has tightened controls over foreign exchanges and credits since the mid-1994. In the meantime, PDVSA has continued to move in the direction of further opening up the oil industry to private-sector participation. The state oil company is even planning to have another round of international bidding for the "marginal oil fields". For these reasons, foreign companies are still confident with their investment in Venezuela despite the government's current foreign exchange policy.

Developing policies that address the extent and form of foreign participation to be permitted in the oil and gas sectors is one of the most debated topics in Venezuela today. This is to be expected, as any policy changes involving the oil industry are considered very important by all Venezuelans. Oil is the largest industry in the country, providing 25 percent of GNP, 86 percent of foreign exchange earnings, and 83 percent of tax revenues. While the need for private and foreign capital is recognized, and there is pressure from multilateral lending agencies to allow private participation in traditionally government-owned industries, private and foreign ownership of national hydrocarbons resources is prohibited by the Venezuelan Constitution. However, foreign companies may enter into associations with PDVSA for the development of oil and gas, subject to approval by Congress. Congressional approval for such projects has met with great resistance due to the climate of political controversy in Venezuela during the past several years. For example, the "Cristobal Colon" project and other association projects have been approved only after debating the subject for years. Political influence, nationalistic attitudes, and likely government intervention in PDVSA's investment plans thus complicate the company's strategic goals for the hydrocarbons sector.

IV. BRAZIL

Brazil is Latin America's largest, most populous country with a land area of over 8.5 million km² and 156 million inhabitants (1992). This vast country is full of contrasts. While Brazil is rich in minerals, metals, and natural resources and is the region's major industrial power and exporter, it is also the world's largest debtor nation, is Latin America's largest oil importer, and has areas of severe poverty and underdevelopment. Furthermore, the country's wealth is unevenly distributed, leading to major differences in the socioeconomic development between the poor northern part of the country and the prosperous south. The Brazilian population includes individuals of European, African, and mixed heritage, in addition to a sizeable ethnic Japanese community.²⁶

Brazil's GDP experienced a 0.8 percent decline in 1992 but grew at an estimated rate of 4.9 percent in 1993. The country's inflation is still in four digits, and the external debt is over US\$120 billion.²⁷ Under the government's economic reform program, many state industries are being privatized, including petrochemicals, and trade has been liberalized significantly. In the meantime, the government has managed to raise tax revenues and to reduce the rate of inflation. In 1992, Brazil's principal exports were metallurgical products and transport equipment, agricultural products, metallic ores, and chemical products. The country's main trading partners are the United States, the European Community, other Latin American nations, and Asia. The country's current account has become positive since 1992, after two years of deficits during 1990-1991.

4.1. PRIMARY ENERGY SUPPLY

As the largest and most populous country in Latin America, Brazil has the highest consumption of energy in the region and consumes more energy than it produces. The country is heavily

26. See Culver-Hopper et al. (1992), p. 21.

27. See EIU (1993b and 1994b) for details.

dependent on imports of oil and coal for its energy requirements. It is also a net importer of refined products, especially LPG and diesel. In 1991, total primary energy production in Brazil amounted to 2.1 million boe/d, of which 29.4 percent was provided by oil, 17.6 percent by hydroelectricity, and as much as 45.6 percent by other energy such as firewood, cane products, and other biomass sources. Gas accounted for only 5.2 percent, coal for 1.8 percent, and nuclear power for 0.4 percent of the primary energy production (Figure 4.1). In comparison, in 1980 oil provided only 13.4 percent and gas 3 percent of Brazil's primary energy production of 1.3 million boe/d. Other energy accounted for 63.8 percent of primary energy output in 1980.

As a result of the government's efforts to increase indigenous energy output, primary energy production increased at an average annual rate of 4.1 percent between 1980 and 1991. Oil production increased annually at an average of 11.8 percent, followed by gas at 9.7 percent, and hydroelectricity at 4.9 percent during this period. Coal is the only energy source for which production decreased by an average of 0.2 percent a year during the period 1980-1991. Other energy production increased slightly by approximately 1 percent a year (see Figure 4.1).

Oil

With the discovery and development of several major offshore hydrocarbon basins in the late 1980s, Brazil became Latin America's third largest producer of crude oil. Brazil's crude oil production averaged 627,400 b/d in 1992, higher than the 1991 output of 622,800 b/d (Table 4.1), and is expected to reach over 700,000 b/d in 1993.²⁸ Nearly 70 percent of this petroleum was produced offshore. Proven oil reserves were estimated to be 3.6 billion barrels at the end of 1992, 800 million barrels higher than the 1991 reserves of 2.8 billion barrels. With the new reserves in offshore areas, total reserves (proven and probable) could be as high as 8.8 billion barrels.

The Brazilian state oil company, *Petróleo Brasileiro*, or Petrobrás, founded in 1953, is one of the world's 10 largest oil companies in terms of operations and assets. The fully integrated

28. See *Petroleum Intelligence Weekly*, March 18, 1993.

Figure 4.1
Brazil's Primary Energy
Production by Source, 1980 and 1991

Source: East-West Center PREM Data File.

Table 4.1
Petroleum Data for Brazil, 1988-1992
(^{'000 b/d})

Year	Reserves/a	Crude Production	Crude Exports	Crude Imports	Product Consumption
1988	2,550	555.5	3.7	640.4	1,224.6
1989	2,816	595.2	0.0	591.6	1,268.6
1990	2,840	630.5	0.0	570.7	1,281.0
1991	2,800	622.8	0.0	525.7	1,268.9
1992	3,600	627.4	0.0	529.8	1,314.8

a. Million barrels, excluding deep-water reserves, which since 1988 have raised total reserves to 8.8 billion barrels.

Source: East-West Center PREM Data File.

Table 4.2
Natural Gas Data for Brazil, 1988-1992
(MMcf/d)

Year	Reserves/a	Production	Exports	Imports	Utilization/b
1988	3,700	545	0	0	436
1989	3,849	563	0	0	466
1990	4,045	591	0	0	475
1991	4,046	588	0	0	477
1992	4,400	608	0	0	519

a. Billion cubic feet (bcf). b. Defined as transformation plus final consumption, with appropriate adjustment of stock change.

Source: East-West Center PREM Data File.

company has made pioneering advances in deep-water drilling, setting world records in the Campos Basin.²⁹ Petrobrás's original plans call for increasing crude production to 1 million b/d by 1995 and 1.5 million b/d by the year 2000. These ambitious production targets were to help the country reduce its oil imports and to achieve petroleum self-sufficiency by the year 2000. However, these production goals may be too high to achieve, even though the new reserves in the offshore Campos Basin as well as pioneering advances in deep-water drilling will assist Petrobrás in steadily increasing crude production. In addition, due to increasing demand and planned expansion of the country's refineries, it now appears that the country will continue to import crude at levels of approximately 500,000-600,000 b/d through the year 2000 rather than significantly lower its dependence on imported oil.

In 1991, total Brazilian crude imports were 525,800 b/d; however, only a small portion of these imports (17% of the total) was from Latin America (mainly Venezuela and Mexico). The largest source of crude supply is the Middle Eastern countries, accounting for 69 percent of Brazil's imports in 1991.³⁰ The crude imports increased slightly to 529,800 b/d in 1992 (see Table 4.1). Beginning in 1993, Brazil increased crude imports from Argentina in order to reduce its imports from the Middle East in general and from Iran in particular.³¹ In late 1993, Argentina surpassed Kuwait to become the second largest oil supplier to Brazil, next only to Saudi Arabia.

Natural Gas

In recent years, Brazilian gas reserves have increased steadily from 3.7 tcf in 1988 to 4.4 tcf in 1992 (Table 4.2). During the same period, however, gas production increased from 545 MMcf/d in 1988, to 588 MMcf/d in 1991, and 608 MMcf/d in 1992. The share of unused gas (flared or reinjected) in total gas production decreased from 37 percent in 1988 to 18 percent in 1991, and the total gas utilization increased by an average of 4.4 percent a year during this

29. See Culver-Hopper et al. (1992), p. 23.

30. See *World Oil Trade* (1993).

31. See *Petroleum Intelligence Weekly*, March 8, 1993.

period, higher than the average annual production growth rate of 2.8 percent. As the country is preparing to significantly expand its consumption of natural gas, more of the fuel will be needed as the country's production will not be able to satisfy this growing gas demand. Brazil will eventually import substantial volumes of gas from Bolivia, Argentina, and probably Peru.

In addition to Petrobrás, which is responsible for the development of natural gas resources and utilization in Brazil, Infraestrutura de Gas a Regiao Sul S.A. (Infragas), a project involving 107 companies in Parana and Santa Catarina states, was established to take charge of importing natural gas from Argentina. The company targeted the start up of the construction of infrastructure for a 140 MMcf/d gas pipeline for late 1994.

Coal

Brazil has the second largest coal reserves in Latin America, after Colombia. In 1991, coal reserves were estimated to be 4.3 billion tonnes. However, more than three-quarters of the coal consumed in the country is imported. From 1988 to 1992, as Brazil's annual coal production decreased from 6.69 million tonnes to only 2.83 million tonnes, whereas coal imports remained within the range of 14-16 million tonnes (Table 4.3). The United States provided approximately 64 percent of Brazil's coal imports in 1991; the rest were provided by Australia (18%), Poland (14%), and other countries. Direct coal consumption accounted for only 12 percent of the 1991 total coal utilization in the country, while 88 percent of the coal was used in power generation plants and the coking industry. Brazil is likely to remain a coal importer through the end of the decade. The country may further increase its use of coal for power generation in the future.

Hydroelectricity

Brazil has the greatest hydroenergy potential (213,000 MW) and the largest installed hydropower capacity in Latin America (27,649 MW in 1991), accounting for 31 and 57 percent, respectively, of the regional hydroenergy potential and installed capacity. The country's utilization rate of

Table 4.3
Coal Data for Brazil, 1988-1992
(^{'000 tonnes})

Year	Reserves/a	Production	Exports	Imports	Apparent Consumption/b
1988	5,337	6,688	0	14,146	20,834
1989	5,325	5,909	0	14,557	20,466
1990	5,314	3,904	0	15,462	19,366
1991	5,309	4,291	0	16,395	20,686
1992	5,309	2,827	0	15,846	18,673

a. Million tonnes. b. Defined as production plus net imports.

Source: East-West Center PREM Data File.

hydroenergy potential (22%) is also one of the highest among large Latin American countries.³² In 1991, the installed hydropower capacity accounted for 86 percent of the total installed capacity in the country.

Brazil has a total of 56 hydropower stations, and the average capacity per station is 493 MW. Four of these are huge hydropower stations, each with a capacity of over 5,000 MW. The world's largest hydropower station, Itaipú, is located on the border of Brazil and Paraguay. It has a capacity of 10,500 MW and is shared by the two countries. The world's second largest hydropower station, Itatuba, is also located in Brazil and has a capacity of 9,100 MW. The country has another 11 hydropower stations each with a capacity of between 1,000 and 5,000 MW. About 10 stations have a capacity of less than 100 MW, mostly owned by self-producers.³³

Brazil's hydroelectricity production increased at an average annual rate of nearly 5 percent between 1980 and 1991. It is expected that hydroelectricity production will continue to increase to the end of the decade, but at a lower annual rate.

Nuclear Power

As in the other Latin American countries with nuclear programs, nuclear power plays a relatively small role in Brazil's primary energy supply. In 1991, nuclear power accounted for 0.4 percent of total primary energy production in Brazil. The country brought its first nuclear power plant, Angra I, on line in 1985. The plant's current capacity is 626 MW, accounting for 1.2 percent of total installed power generation capacity in the country. Angra II is currently under construction, but all plans for Angra III, originally slated for construction in the 1990s, have been stopped. It is estimated that by 1994-95, approximately 1,245 MW of new nuclear power capacity will be added to Brazil's power sector. It is unclear when Angra II will become

32. Only three Latin American countries have a higher hydroenergy utilization ratio than Brazil: Uruguay (74%), Paraguay (28%), and El Salvador (25%). The hydroenergy potential of both Uruguay and El Salvador is under 2,000 MW, and that of Paraguay is 23,000 MW.

33. See OLADE (1993).

fully operational. The general expectation is that the pace of nuclear power plant construction will be significantly slowed throughout Latin America.³⁴

4.2. PRIMARY ENERGY CONSUMPTION

Current Situation

In 1991, Brazil consumed 2.77 million boe/d of primary energy, 28 percent of the region's total. However, the country's consumption pattern has been greatly affected by its recent economic and political troubles. Brazil's primary energy consumption growth averaged 3.2 percent annually during the 1980s. As a result of recession as well as economic austerity programs, however, this growth was suddenly interrupted in 1990, when it dropped 12.6 percent from the 1989 level. Primary energy consumption growth resumed in 1991 with an increase of 3.2 percent over the 1990 level. Overall, from 1980 to 1991, primary energy consumption rose from 2.29 million boe/d to 2.77 million boe/d at an average annual growth rate of 1.7 percent (Figure 4.2).

Petroleum accounted for 41.9 percent of total primary energy consumption in 1991. Natural gas provided only about 3.2 percent, despite the rapid increase in use in recent years. Firewood and cane products (mainly for fuel alcohol) provided 34.5 percent of the total, while hydroelectricity accounted for 13.3 percent and coal 6.7 percent. In 1991, nuclear power satisfied 0.3 percent of total demand (Table 4.4). During the past decade, natural gas consumption exhibited the highest growth rate, increasing an average of 13.9 percent a year between 1980 and 1991; hydroelectricity consumption increased by 4.9 percent a year and oil consumption³⁵ by only 0.5 percent a year. Biomass energy—the second largest source of primary energy in Brazil—increased by only 1 percent a year during this period.

34. See Escofet (1992).

35. Unless otherwise specified, alcohol fuels for automobiles, which averaged 200,000 b/d in 1991 and 1992, are not included in Brazil's petroleum product or oil consumption in this study.

Figure 4.2
Brazil's Actual and Projected Primary
Energy Consumption, 1980, 1991, and 2000

Source: East-West Center PREM Data File and Forecasts.

Table 4.4
Percentage Distribution of Primary Energy
Consumption: Brazil, 1980, 1991, and 2000
 (%)

	1980	1991	2000
Oil	47.9	41.9	40.6
Natural Gas	1.0	3.2	8.2
Coal	4.2	6.7	6.8
Hydroelectricity	9.5	13.4	13.8
Nuclear Power	0.0	0.3	0.3
Other	37.4	34.5	30.3
TOTAL	100.0	100.0	100.0

Source: East-West Center PREM Data File and Forecasts.

As mentioned earlier, Brazil's natural resources are not able to supply all of its energy needs and the country, therefore, remains a net energy importer. Energy imports consist mainly of petroleum and, to a lesser extent, coal. While Brazil is the largest petroleum importer in Latin America, import levels have been decreasing at an average annual rate of about 5 percent since 1988. In 1991, Brazil imported 529,800 b/d of crude oil, approximately 40 percent of its total consumption. However, it is not anticipated that imports will drop far below 500,000 b/d in the near future because of rising consumption.

Outlook for 2000

The forecast for Brazil's primary energy consumption is based on projections of its population and economic growth as well as past trends in per capita primary energy consumption, energy intensity, and recent changes in major fuel prices. Between 1980 and 1991, Brazil's average annual real GDP growth rate was 2 percent. During the period 1980-1992, the population grew at an average annual rate of 2.13 percent. It is expected that the country's average real GDP growth rate will increase to 3.3 percent a year between 1991 and 2000 and that population growth will slow to 1.75 percent a year between 1992 and 2000.³⁶ Between 1980 and 1991, per capita energy consumption decreased from 6.9 boe/person to 6.6 boe/person. During the same period, energy intensity also decreased slightly from 4,978 kcal/US\$(1980) to 4,850 kcal/US\$(1980). All of the above data and assumptions are summarized in Table 4.5.

Based on these assumptions, Brazil's primary energy consumption is expected to increase an average of 2.7 percent annually between 1991 and 2000, reaching 3.5 million boe/d (see Figure 4.2). As the Brazilian government is making a concerted effort to increase natural gas consumption, the average annual growth rate for consumption of this fuel is expected to reach 13.9 percent, and the share of natural gas in primary energy consumption is expected to more than double from the 1991 level, supplying 8.2 percent of total primary energy demanded by the year 2000. Hydroelectricity consumption is expected to increase at an average annual rate of 3 percent between 1991 and 2000; demand for coal is projected to grow by 2.8 percent a year and

36. See IDB (1993).

Table 4.5
Key Data and Assumptions for Forecast of Brazil's
Primary Energy Consumption, 1980-2000

Key Item	Unit	Data/Assumptions
Population		
AAGR 1980-1992	percent	2.13
AAGR 1992-2000	percent	1.75
GDP		
AAGR 1980-1991	percent	2.0
AAGR 1991-2000	percent	3.3
Per Capita GDP		
AAGR 1980-1991	percent	-0.2
AAGR 1991-2000	percent	1.6
Per Capita Primary Energy Consumption		
1980	boe/person	6.9
1991	boe/person	6.6
AAGR 1980-1991	percent	-0.4
Energy Intensity		
1980	kcal/US\$(1980)	4,978
1991	kcal/US\$(1980)	4,850
AAGR 1980-1991	percent	-0.2

AAGR = average annual growth rate.

Sources: East-West Center PREM Data File and IDB (1993).

for nuclear power by 2.5 percent a year during this period. The share of other energy (i.e., firewood and cane products) in total primary energy consumption will decline from 34.5 percent in 1991 to 30.4 percent in 2000 as demand growth slows to 1.2 percent annually. The growth rate of oil consumption is assumed to be slightly lower than the average growth rate of primary energy consumption between 1991 and 2000; therefore, oil's share of total consumption will exhibit only a minute decrease from 41.9 percent in 1991 to 40.6 percent in 2000.

4.3. DOWNSTREAM OIL SECTOR AND PRODUCT CONSUMPTION

Refining Sector

Brazil has Latin America's second largest crude refining capacity, totalling 1.4 million b/d, with Petrobrás accounting for nearly 99 percent of this capacity (Table 4.6). In 1991, refinery throughput was 1.15 million b/d for the country's thirteen refineries, about 82 percent of current capacity. In spite of its large capacity, the cracking-to-distillation ratio in Brazil's refinery complex is only about 25 percent, lower than the regional average of nearly 30 percent. Secondary processing capacity in the country includes 39,765 b/d of thermal operations, 316,585 b/d of catalytic cracking, 23,610 b/d of catalytic reforming, and 155,860 b/d of catalytic hydrotreating.

Petrobrás plans to raise its crude distillation capacity from the current 1.4 million b/d to 1.8 million b/d by 1995. By the late 1990s, this capacity is to be increased to nearly 2 million b/d, aimed at producing less fuel oil and more diesel in order to adapt to changing consumption patterns as well as meeting the more stringent environmental standards for fuels. Emphasis will be on upgrading seven of the existing refineries to handle an increasingly heavier crude slate to be supplied by the Campos Basin. In addition to crude distillation capacity expansion, Petrobrás plans to increase the hydrotreating capacity by 160,000 b/d, FCC capacity by 170,000 b/d, delayed coking capacity by 52,000 b/d, catalytic reforming capacity by 1,500 b/d, and hydrogen producing capacity by 124 MMcf/d through 2000.³⁷ Like Venezuela and Mexico, Brazil began in early 1993 to invite foreign companies to participate in the construction of three MTBE units

37. See *Oil & Gas Journal*, October 26, 1992.

Table 4.6
Brazil's 1993 Refining Capacity and Configuration
('000 b/cd)

Company	Location	CDU	VDU	Thermal Operations	Cat. Cracking	Cat. Reforming	Hydro Treating
Petrobras	Araucaria, Parana	144.8	66.3		42.3		
Petrobras	Betim, Minas Gerais	144.7	72.3		32.1		35.2
Petrobras	Canoas, Rio Grande do Sul	72.4	35.0		13.7		
Petrobras	Capuava, Sao Paulo	30.2	10.2		17.3		
Petrobras	Cubatao, Sao Paulo	155.3	71.7	31.1	50.6	10.5	
Petrobras	Duque de Caxias, RJ	209.2	114.8		35.8	13.1	32.9
Petrobras	Fortaleza, Ceara		4.5				
Petrobras	Manaus, Amazonas	8.5	5.4		1.9		3.4
Petrobras	Mataripe, Bahia	113.5	74.4		25.0		2.5
Petrobras	Paulinia, Sao Paulo	289.5	144.8		41.6		
Petrobras	Sao Jose dos Campos, SP	215.1	122.5		53.8		81.9
RPI/a	Rio Grande do Sul	9.3	4.1		2.5		
RPM/b	Rio de Janeiro	10.0		8.7			
Total	Total	1,402.5	725.9	39.8	316.6	23.6	155.9

Note: Individual units do not necessarily add up to the total because of independent rounding.

a. Refinaria de Petroleo Iparanga SA. b. Refinaria de Petroleos de Manquinhos.

Sources: Oil & Gas Journal; East-West Center PREM Data File.

with a combined capacity of 220,000 t/y in three of the Petrobrás refineries.³⁸ The building of domestic MTBE capacity is clearly targeted toward improving the quality of gasoline produced in the country and reducing air pollution caused by automobiles in large cities.

Petroleum Product Balance

While in 1991 the petroleum product output level of 1.24 million b/d was only 24,000 b/d lower than total products consumed (1.27 million b/d), Brazil imported 111,600 b/d and exported 85,800 b/d of refined products that year (Table 4.7). Diesel accounted for 34.7 percent of total oil product consumption, followed by gasoline (27.5%), fuel oil (13.4%), LPG (12.4%), and kero/jet (3.7%).

There has long been a distortion in Brazil's oil product consumption pattern, caused by the government policy aimed at curtailing domestic consumption of gasoline by substituting sugar-based alcohol for use in motor vehicles. The surplus gasoline production is exported to the United States, providing revenues to Petrobrás. To encourage the use of fuel alcohol in motor vehicles and discourage the use of gasoline, the government inflates the price of gasoline and keeps the price of alcohol between 65 and 75 percent of gasoline prices. By 1985, the sixth year of the Proalcohol program, 96 percent of the automobiles produced were alcohol fueled. However, alcohol consumption by motor vehicles has decreased substantially in recent years, and since 1990 the percentage of cars produced that use alcohol has not been greater than 30 percent. This decrease in use was due to an increase in the price of fuel alcohol and a severe shortage of the fuel in 1990 and 1991. As a result, since 1985 net gasoline exports have decreased substantially (Figure 4.3). The huge losses of the alcohol program have prompted the Brazilian government to offer part of the alcohol producing facilities for sale. Petrobrás also subsidizes the sale of other petroleum products.

Outlook for Petroleum Product Consumption

The forecast for petroleum product consumption is based on the same factors outlined for

38. See *Platt's Oilgram News*, March 23, 1993.

Table 4.7
Brazil's Petroleum Product Balance, 1991
('000 b/d)

Product	Production	Imports	Exports	Consumption	Stock Change
LPG	113.9	47.5	0.0	157.9	3.5
Gasoline	351.2	24.6	26.8	348.5	0.0
Kero/Jet	56.0	2.5	11.7	47.1	-0.3
Diesel	410.9	31.4	3.2	440.8	-1.8
Fuel Oil	206.5	4.1	41.7	169.5	-0.6
Others	105.6	1.5	2.4	104.9	-0.2
Total	1,244.1	111.6	85.8	1,268.8	0.6

Note: Individual units do not necessarily add up to the total because of independent rounding.

Source: East-West Center PREM Data File.

Figure 4.3
The Effect of the Alcohol Program on Gasoline
Consumption and Net Exports in Brazil, 1980-1992

Source: East-West Center PREM Data File.

primary energy consumption. It also takes into consideration the structure and change of refinery fuel prices in domestic markets. Major fuel prices in terms of U.S. dollars have been decreasing since January 1990 (Figure 4.4). Depreciation of the nuevo cruz (changed to the cruzeiro in March 1990) against the U.S. dollar during the same period may be one of the major factors causing the price drop (Figure 4.5). However, if one keeps in mind that the fluctuating exchange rate reflects changes in the domestic price index, then it could be concluded that the real prices of major fuels in Brazil have become cheaper since 1990. Lower fuel prices, all other things being equal, will boost energy consumption.

Based on the above assessment, petroleum product consumption in Brazil is expected to grow at average annual rates of 1.4 percent through 1995 and 3.1 percent to the year 2000, assuming present economic and political problems are solved within the next few years. On average, petroleum product consumption is expected to grow by 2.3 percent annually between 1991 and 2000 in the base case, reaching 1.56 million b/d by the turn of the century (Table 4.8). The low case, which estimates an average annual growth of only 0.7 percent, reflects a pessimistic forecast of economic growth throughout the decade. The high case consumption growth scenario of 4.3 percent is driven by high gasoline demand (with an average annual increase of 6%) as it is increasingly substituted for a decreasing supply of alcohol as a fuel for motor vehicles.

4.4. NATURAL GAS UTILIZATION AND TRADE LINKS

Current Situation

While natural gas consumption in Brazil is currently among the lowest in the region (477 MMcf/d which provided only about 3 percent of primary energy consumption in 1991), it will play a larger role in the country's energy balance in the future. In 1991, gas utilization in Brazil accounted for 81 percent of the total gas produced, while the other 19 percent was flared, reinjected, or consumed by the gas sector itself. Of the 477 MMcf/d of gas utilized, 24 percent was used to produce LPG, 16 percent was consumed by the gas sector itself, and 55 percent was consumed directly by the industrial and petrochemical sectors (Appendix III). At present, Brazil does not engage in international gas trade. However, several major pipelines have been proposed, and Brazil will soon import gas from Bolivia, Argentina, and probably Peru.

Figure 4.4

—■— Diesel

Figure 4.5
Brazil's Monthly Exchange Rate,
Jan. 1990 - Sep. 1993

Source: East-West Center PREM Data File.

Table 4.8
Forecast of Brazil's Petroleum Product Consumption, 1991, 1995, and 2000
('000 b/d)

Year	LPG	Gasoline/a	Kero/Jet	Diesel	Fuel Oil	Others	Total
1991 (actual)	157.9	348.5	47.1	440.8	169.5	104.9	1,268.9
1995 (forecast)							
High Case	177.7	435.9	51.0	480.0	179.9	113.6	1,438.1
Base Case	170.9	376.5	49.0	462.4	171.7	109.2	1,339.8
Low Case	164.3	348.5	45.3	440.8	169.5	107.0	1,275.5
2000 (forecast)							
High Case	237.9	583.3	66.7	612.6	185.7	115.9	1,802.1
Base Case	208.0	436.5	58.2	557.2	182.7	114.8	1,557.4
Low Case	177.0	366.3	48.2	486.7	165.5	109.7	1,353.5

Note: Individual units do not necessarily add up to the total because of independent rounding.

a. Excludes alcohol used in automobiles.

Source: East-West Center PREM Data File and Forecasts.

Prospects for Future Gas Use and Trade Links

The Brazilian government plans to increase the country's natural gas consumption fivefold by the year 2000. However, in our forecast, we expect that natural gas consumption will increase an average of 14 percent annually until 2000, reaching approximately 1,500 MMcf/d, or somewhat more than three times the 1991 level. Unless domestic gas production increases substantially in the near future, a significant portion of the gas requirements will need to be satisfied by imported natural gas.

Currently, the government and private industry are working together to establish an extensive natural gas network in the southern part of the country in order to provide gas to industry, power plants, and residential consumers in the large cities. Also, compressed natural gas (CNG) is to be heavily promoted as an alternative motor fuel to gasoline or diesel. Besides the economic advantages of switching to a cheaper fuel, the use of natural gas is being encouraged in Brazil in order to ameliorate the air pollution in large cities such as Sao Paulo.

As mentioned earlier, Brazil has reached an agreement with YPFB to take 280 MMcf/d of natural gas from Bolivia beginning in 1995. The volume of gas imported could increase to 560 MMcf/d by the year 2000. The main section of the 2,115-mile-long pipeline from the Santa Cruz gas fields to Sao Paulo is scheduled to be completed by early 1995. From Sao Paulo, the pipeline will run east to Rio de Janeiro and south to the cities of Curitiba and Pôrto Alegre. The governments of Brazil and Bolivia are expected to fund two-thirds of the project's cost, estimated to be US\$3.5-US\$4 billion, with the World Bank expected to finance the remaining one-third. In a separate deal, Petrobrás is negotiating with YPF to build another pipeline to southern Brazil from Argentina. This pipeline is to have a capacity of 140 MMcf/d. In the long run, Petrobrás may also import natural gas from Peru's Camisea gas field through a pipeline to Pôrto Velho in northwest Brazil.

4.5. IMPORTANT HYDROCARBONS POLICY ISSUES

The political crisis in Brazil, which resulted in the impeachment of President Collor and a reassessment of his economic programs by the new government, could have a major impact on the hydrocarbons policy of the country. Changes in the government may set back the

comprehensive economic reforms launched by Mr. Collor and his government. A referendum on the country's system of government was held in April 1993.³⁹ It is expected that little progress can be made in reforming the hydrocarbons sector in the near term until the political implications of the referendum are translated into policy.

One of the most important issues affecting the hydrocarbons industry in Brazil is its precarious financial situation, which led to severe cuts in the 1992 investment budget. The 1991-1995 investment plan, aimed at increasing oil production to 1 million b/d by 1995, was estimated to cost up to US\$19 billion, with required investments of US\$2.9 billion during 1992. However, the 1992 budget was cut in half to US\$1.4 billion as a result of cash flow problems that stemmed mainly from subsidies for petroleum products, one-third of which are produced from imported oil and alcohol.

One solution to Petrobrás's difficult financial situation would be to allow private participation in areas of the industry besides the petrochemical sector. Any moves in this direction, however, have met with serious opposition from nationalists, labor unions, and the managers and engineers of Petrobrás. However, the Brazilian Constitution, which prohibits any new private equity in the national petroleum sector, with the exception of petrochemicals and distribution and marketing, is being revised. While the new administration of President Itamar Franco does not favor the privatization of Petrobrás, it is expected that changes will be made that will allow some private and foreign company participation in the upstream and downstream hydrocarbons sector, given the large amounts of investment needed to increase the country's hydrocarbon production and refining capacity. For the time being, the majority of the Petrobrás's budget (60-70%) is being provided by the government, and the rest is being raised on the international financial markets.

39. The results of the referendum showed that the Brazilian people still prefer the presidential type of government to a parliamentary type of government or monarchy.

V. ARGENTINA

Argentina is Latin America's second largest country, after Brazil, with a land area of over 2.7 million km² and a varied geography that stretches over 2,000 miles from the tropics to Tierra del Fuego. It is also the fourth most populous nation in the region, after Brazil, Mexico, and Colombia. In many respects, Argentina is one of Latin America's most-developed countries: it has a well-educated and qualified labor force, and one of the region's lowest birth rates and highest literacy rates. However, since the 1930s, social and political instability has challenged the country's ability to utilize its natural and human resources to the fullest potential. Most of Argentina's 33 million people are of European origin, and there are also sizeable Middle Eastern and Jewish communities in Buenos Aires.⁴⁰

Argentina's economy in the 1980s was characterized by hyperinflation, large public and foreign debts, capital flight, and recession. Under the direction of President Menem's administration, the economy is being restructured through deregulation, privatization of most public sector enterprises, encouragement of foreign investment, and trade liberalization. In 1991, the government cut a number of taxes to help reduce business costs. Deregulation has continued; companies have laid off staff. Private pension funds have been introduced. Labor reform is crucial but difficult.

It was estimated that in 1993 Argentina's GDP grew at a rate of 5.7 percent, which was slower than the average real GNP growth of 8.8 percent per year achieved in 1991-92. Inflation dropped from 24.9 percent in 1992 to about 12.6 percent in 1993.⁴¹ Argentina's principal exports are agricultural products and meats, followed by metals and chemicals. Petrochemicals is one area where substantial export growth is expected. The United States is Argentina's principal trade partner, followed by Brazil, the European Union, and Japan. Once the Mercosur

40. See Culver-Hopper et al. (1992), p. 9.

41. See EIU (1993a and 1994a) for details.

free-trade pact is established in the mid 1990s, Argentina's trade with its neighbors should increase significantly.

5.1. PRIMARY ENERGY SUPPLY

Argentina is a net energy exporter, exporting mainly oil (crude oil, LPG, gasoline, and diesel), while importing natural gas, coal, and some refined products (kerosene, diesel, and fuel oil). Oil (49.9%) and natural gas (40.3%) accounted for over 90 percent of Argentina's primary energy production in 1991 (Figure 5.1), while the remaining shares were provided by nuclear power (3%), hydroelectricity (2.6%), coal (0.3%), and other energy (3.9%). The country is basically energy self-sufficient.

Total primary energy production in Argentina increased from 823,000 boe/d to 1 million boe/d between 1980 and 1991 at an average annual growth rate of 1.8 percent (see Figure 5.1). Natural gas played the largest role in this increase, while nuclear power production showed the highest average annual growth rate of 9.8 percent between 1980 and 1991. During this period, gas production grew at an average annual rate of 5 percent, and its share in total primary energy production expanded from 28.7 percent in 1980 to 40.3 percent in 1991. In comparison, oil production remained essentially flat during the same period, and its share in primary energy production decreased from nearly 61 percent in 1980 to 50 percent in 1991. Coal and hydroelectricity production decreased at average annual rates of 2.6 percent and 1.2 percent, respectively, from 1980 to 1991.

Oil

Argentina is Latin America's fourth largest oil producer. The country achieved petroleum self-sufficiency in the early 1980s and is now striving to export a significant share of its output, mainly to the Southern Cone area in Latin America. Argentine oil production initially peaked at 497,000 b/d in 1981, then decreased to 428,000 b/d in 1987, but has risen steadily since then. Production reached 493,200 b/d in 1991, followed by a sharp increase in 1992 to 555,300 b/d and over 600,000 b/d in 1993, the highest annual output in the country's history of oil production.

Figure 5.1
Argentina's Primary Energy
Production by Source, 1980 and 1991

Source: East-West Center PREM Data File.

The 1992 production was thus 12.6 percent higher than the 1991 output. From 1988 to 1992, the country's oil production rose at an average annual rate of 5.4 percent (Table 5.1). The greater participation of the private sector following Argentina's privatization of state oil interests is considered one of the major factors in the increased output in 1992. In 1992, private and foreign interests were responsible for more than 60 percent of Argentina's production; this share is expected to grow to approximately 75 percent in the near future.⁴² The government's production target for 1993 was 600,000 b/d. The Menem administration hopes to further raise Argentina's oil production to 689,000 b/d in the mid 1990s and 750,000 b/d by the end of the decade.⁴³

Oil reserves were 1.57 billion barrels at the end of 1992, the same as in 1991 but much lower than the reserves of 2.28 billion barrels in late 1990 (Table 5.1). Although much of the country's territory remains underexplored for hydrocarbons, making possible an increase of reserves in the 1990s, the lowering of current proven oil and gas reserves has put additional pressure on the government to promote the acceleration of exploration and development activities.

Argentina exported 126,000 b/d and imported 22,600 b/d of oil (crude and products) in 1991.⁴⁴ In 1992, crude exports totalled 59,100 b/d, up from 24,800 b/d in 1991 and 16,100 b/d in 1990. About 31 percent of the 1991 crude went to the United States, 58 percent to Latin America (Chile, Paraguay, and Uruguay), and 3 percent to Japan.⁴⁵ Beginning in March 1993, Brazil was expected to import approximately 9-11 million barrels of light crude annually (25,000-30,000 b/d) from Argentina. As the country's hydrocarbons policy has been reoriented to increase oil exports, Argentina is expected to export crude oil not only to the traditional customers, such as

42. See Culver-Hopper and Totto (1992), p. 28.

43. Ibid., p. 33.

44. Refinery products accounted for 80 percent of both oil exports and imports in 1991. Details of the country's petroleum product trade will be discussed in the section on the downstream oil sector and product consumption.

45. See *World Oil Trade* (1993).

Table 5.1
Petroleum Data for Argentina, 1988-1992
('000 b/d)

Year	Reserves/a	Crude Production	Crude Exports	Crude Imports	Product Consumption
1988	2,268	450.2	8.0	0.0	472.8
1989	2,279	460.3	11.9	0.0	433.1
1990	2,280	481.8	16.1	0.0	427.4
1991	1,570	493.2	24.8	4.3	430.1
1992	1,570	555.3	59.1	0.0	448.1

a. Million barrels.

Source: East-West Center PREM Data File.

Table 5.2
Natural Gas Data for Argentina, 1988-1992
(MMcf/d)

Year	Reserves/a	Production	Exports	Imports	Utilization/b
1988	26,700	2,304	0	232	2,160
1989	27,299	2,403	0	232	2,226
1990	27,000	2,286	0	212	2,109
1991	20,449	2,384	0	211	2,259
1992	22,700	2,398	0	231	2,295

a. Billion cubic feet (bcf). b. Defined as transformation plus final consumption, with appropriate adjustment of stock change.

Source: East-West Center PREM Data File.

Chile, Uruguay, and Paraguay, but also to East Asia. If domestic petroleum demand growth remains stable and the government achieves its production targets, Argentina could be exporting over 200,000 b/d of crude and refined products by the end of the decade. This would nearly double the 1991 exports of 126,000 b/d. Exports will consist mainly of products as Argentina has a significant surplus refining capacity.

Until 1992, the largest single player in Argentina's oil industry was the national oil company, Yacimientos Petrolíferos Fiscales (YPF); however, this is changing as the company's restructuring continues and the government finalizes the transfer of various state assets to private hands in the ongoing divestment of YPF. YPF was founded in 1922 and is the world's oldest national oil company. Until deregulation and the move toward privatization, the fully integrated company controlled a wide variety of oil and non-oil assets and monopolized all exploration activities in Argentina.⁴⁶ YPF's current reorganization will lead to privatization of all upstream oil and gas exploration and a reorganization of its production operations and its downstream refining and distribution system. Restructuring involves the offering of YPF shares on the stock market, a reduction of the work force, the sale of oil and gas operating rights, tankers, refineries, pipelines, and distribution facilities, and the transfer of YPF's drilling teams and geophysical equipment to the private sector.⁴⁷ By mid 1993, 160 million YPF shares, about 44 percent of the company's assets, had been sold to international and private shareholders. The sale allowed YPF to gain US\$3.04 billion in cash.⁴⁸ In 1993, YPF also sold one of its important oil pipelines (the 560-mile, 14-inch diameter line from Neuquén to the port of Rosales in Bahía Blanca) and its San Lorenzo refinery to a consortium of Argentine companies—Perez Companc, CGC, and Pasa Petroquímica—and most of its remaining drilling equipment was sold to a host of companies. Once reorganized, YPF will operate like a private company in many areas of the hydrocarbons sector alongside other domestic private and foreign companies.

46. See Culver-Hopper et al. (1992), p. 11.

47. See Culver-Hopper and Tutto (1992).

48. See Culver-Hopper (1993).

Natural Gas

Argentina is primarily a gas-rich country, with the third largest gas reserves in Latin America, after Venezuela and Mexico. The country has the region's longest history of gas exploration as gas development was initiated more than three decades ago. Argentina's gas reserves rose sharply between 1977 and 1989, registering more than a threefold increase from less than 7,000 bcf to a peak of 27,299 bcf. At the end of 1992, proven natural gas reserves were 22,700 bcf, up from 20,449 bcf in 1991 but lower than 27,299 bcf in late 1989 (Table 5.2). In 1992, natural gas production averaged 2,398 MMcf/d, up from 2,384 MMcf/d in 1991 and 2,286 MMcf/d in 1990. Argentina's commercial gas production ranks third in Latin America after Venezuela and Mexico.

Gas del Estado, the state gas transmission and distribution company, was originally established in 1946 to transmit and distribute manufactured natural gas. In December 1992, Gas del Estado was completely transferred to ten private consortia. In addition to Argentine private firms, some foreign companies will be among the new operators (Enron and Nova Corp.) and distributors (British Gas) of natural gas in Argentina. Before its sell-off, Gas del Estado served about 4.1 million customers in the industrial, commercial, and residential sectors of the economy. In early 1991, the company had 14 gas processing plants with a capacity of 1,488 MMcf/d. The company also had about 8,000 miles of trunk lines and 6,000 miles of branch and feeder lines, including lines to industrial and residential consumers.⁴⁹

Argentina has been the only South American country to import gas for over two decades, and the country has recently extended its contract with Bolivia. However, Argentina has the potential to export natural gas to its neighbors in the future. Argentina and Chile are already close to reaching a trade agreement for the export of Argentine gas to northern Chile. Other potential importers of Argentine natural gas are Brazil, Uruguay, and Paraguay. In order to realize its ambitious export plans for gas, Argentina must substantially increase production from current

49. See Culver-Hopper and Tutto (1992), pp. 54-55.

levels. This could be achieved only by increasing the participation of private companies in upstream activities.

Coal

Coal plays a relatively small role in Argentina's energy balance. The country's coal reserves were only 151 million tonnes in 1992 and production was 207 thousand tonnes, down from 292 thousand tonnes in 1991 and 512 thousand tons in 1988 (Table 5.3). Argentina imported 1.18 million tonnes of coal in 1991—more than the 883 thousand tonnes imported in 1991 but less than the imports of 1.23 million tonnes in 1990 and 1.52 million tonnes in 1989. In 1991, about 75 percent of the coal used in Argentina went to coke plants, and the remaining share went to other secondary energy transforming units such as power plants.

From 1980 to 1991, Argentine coal production decreased by an average of 2.6 percent a year. Given the sparse coal reserves in Argentina, a significant increase of indigenous coal production is unlikely by the end of the decade. The majority of the country's coal consumption, which is expected to increase at an average annual rate of 1.5 percent between 1991 and 2000, will continue to be satisfied by imports.

Hydroelectricity

Argentina's current hydropower capacity is 6,610 MW, 14.9 percent of the country's hydroenergy potential of 44,500 MW. The country has 39 hydropower stations at the present time, three of which have a capacity of over 1,000 MW and 25 of which have a capacity under 50 MW. The largest hydropower station, Salto Grande, is located in Entre Rios and has a capacity of 1,418 MW.

In 1991, hydropower stations generated less electricity than nuclear power plants in Argentina. From 1980 to 1991, hydroelectricity production in the country decreased by an average of 1.2 percent a year. As a result, the share of hydroelectricity in total primary energy production declined from 3.6 percent in 1980 to 2.6 percent in 1991. It is expected that Argentine

Table 5.3
Coal Data for Argentina, 1988-1992
('000 tonnes)

Year	Reserves/a	Production	Exports	Imports	Apparent Consumption/b
1988	478	512	0	1,402	1,914
1989	478	515	0	1,524	2,039
1990	103	277	33	1,233	1,477
1991	151	292	15	883	1,160
1992	151	207	0	1,178	1,385

a. Million tonnes. b. Defined as production plus net imports.

Source: East-West Center PREM Data File.

hydroelectricity production as well as consumption will exhibit only a moderate increase by the year 2000, rising at an average annual rate of about 1.25 percent.

Nuclear Power

Argentina's first nuclear power plant went on stream in 1974. The country currently has two plants in operation with a total capacity of 1,018 MW. The 648 MW Embalse nuclear power plant is located in Córbona, and the smaller Atucha nuclear power plant is located near the capital, Buenos Aires.

Over the past decade, nuclear power production increased at an average annual rate of 9.8 percent in Argentina and its share in total primary energy production expanded from 1.3 percent in 1980 to 3 percent in 1991. However, nuclear power plant construction in recent years has been slowed, due to budget constraints and public concerns over safety. Plans for additional nuclear power plants have been put on hold. While it was decided that the second unit of Atucha would be completed by 1995, adding 745 MW of new capacity, the programs for nuclear power plants III and IV were stopped.⁵⁰

5.2. PRIMARY ENERGY CONSUMPTION

Current Situation

In 1991, primary energy consumption in Argentina amounted to 903,400 boe/d, only slightly higher than the 825,000 boe/d recorded in 1980. The average annual growth rate of primary energy consumption was only 0.8 percent from 1980 to 1991 (Figure 5.2). The country relies on oil and natural gas for over 87 percent of its primary energy consumption. Oil provided 45 percent of primary energy in 1991, while gas accounted for 42.6 percent, with hydroelectricity (2.9%), nuclear power (3.3%), coal (1.9%), and other energy (4.3%) comprising the remaining shares (Table 5.4). From 1980 to 1991, all fuels except gas and nuclear power experienced decreases in consumption to varying extents, the annual averages ranging from 2.2 percent for

50. See Escofet (1992).

Figure 5.2
Argentina's Actual and Projected Primary
Energy Consumption, 1980, 1991, and 2000

Source: East-West Center PREM Data File and Forecasts.

Table 5.4
Percentage Distribution of Primary Energy
Consumption: Argentina, 1980, 1991, and 2000
 (%)

	1980	1991	2000
Oil	63.0	45.0	43.2
Natural Gas	24.3	42.6	45.6
Coal	2.7	1.9	1.8
Hydroelectricity	3.6	2.9	2.6
Nuclear Power	1.3	3.3	3.2
Other	5.1	4.3	3.6
Total	100.0	100.0	100.0

Source: East-West Center PREM Data File and Forecasts.

oil to 0.9 percent for other energy. Natural gas and nuclear power consumption increased at annual rates of 6.1 and 9.8 percent, respectively, during this period.

Outlook for 2000

The forecast for Argentina's primary energy consumption in the year 2000 is based on projections of its future population and economic growth as well as changes in per capita primary energy consumption and changes in energy intensity during the past decade. From 1980 to 1992, the Argentine population growth averaged 1.33 percent per year. It is estimated that from 1992 to 2000, the country's population will grow at an average annual rate of 1.14 percent, the lowest rate among the ten Latin American countries under study.⁵¹ While there are different forecasts for the country's real GDP growth,⁵² based on the Inter-American Development Bank's forecasts, we project that Argentina's real GDP will grow at an average annual rate of 3.2 percent between 1991 and 2000. During the past decade, the country's per capita primary energy consumption decreased from 10.7 boe/person in 1980 to 10.1 boe/person in 1991, and its energy intensity increased from 5,272 kcal/US\$(1980) in 1980 to 5,934 kcal/US\$(1980) in 1991, indicating that the country had negative GDP growth, low primary energy consumption, and relatively higher population growth over the period. All of the above data and assumptions are summarized in Table 5.5.

Based on the above assumptions (Table 5.5) as well as the performance of the energy sector during the past decade and its latest developments, it is projected that primary energy consumption in Argentina will grow at an average annual rate of approximately 2.5 percent between 1991 and 2000, reaching 1.12 million boe/d in 2000. Since the government is vigorously promoting natural gas production and utilization, gas consumption is expected to increase at an average rate of 3.3 percent per year between 1991 and 2000, faster than oil consumption, which is expected to rise at an average annual rate of approximately 2 percent.

51. See IDB (1993).

52. For instance, the EIU (1993a) forecasts that the real GDP growth rate of Argentina will be 5 percent for 1991-1994.

Table 5.5
Key Data and Assumptions for Forecast of Argentina's
Primary Energy Consumption, 1980-2000

Key Item	Unit	Data/Assumptions
Population		
AAGR 1980-1992	percent	1.33
AAGR 1992-2000	percent	1.14
GDP		
AAGR 1980-1991	percent	-0.2
AAGR 1991-2000	percent	3.2
Per Capita GDP		
AAGR 1980-1991	percent	-1.6
AAGR 1991-2000	percent	2.0
Per Capita Primary Energy Consumption		
1980	boe/person	10.7
1991	boe/person	10.1
AAGR 1980-1991	percent	-0.5
Energy Intensity		
1980	kcal/US\$(1980)	5,272
1991	kcal/US\$(1980)	5,934
AAGR 1980-1991	percent	1.4

AAGR = average annual growth rate.

Sources: East-West Center PREM Data File and IDB (1993).

The share of natural gas in total energy consumption is expected to increase from 43 percent in 1991 to 46 percent in the year 2000. In comparison, the share of oil is projected to decline from 45 percent to 43 percent of total primary energy consumption. Together, oil and gas will account for over 88 percent of total primary energy by 2000, the same proportion as in 1991. As a result of the expected high GDP and primary energy consumption growth (3.2% and 2.5% per annum, respectively) and low population growth (1.14% per annum) during the period 1991-2000, per capita primary energy consumption will be higher and energy intensity will be lower in 2000 than in 1991, reaching 11.3 boe/person and 5,572 kcal/US\$(1980), respectively.

5.3. DOWNSTREAM OIL SECTOR AND PRODUCT CONSUMPTION

Refining Sector

Argentina's 12 refinery installations have a combined crude distillation capacity of 709,485 b/d (Table 5.6), well exceeding the country's 1992 domestic crude production (555,300 b/d) and the demand for petroleum products (448,100 b/d). With approximately 510,000 b/d of refinery throughput in 1991, the utilization rate of Argentina's refining capacity is about 72 percent. The secondary refining capacity includes 303,400 b/d of vacuum distillation capacity, 180,100 b/d of catalytic cracking capacity, 164,100 b/d of thermal cracking capacity, and 23,900 b/d of hydrocracking capacity. Argentina's refining sector has a high cracking-to-distillation ratio of 53 percent, indicating that the refineries are relatively sophisticated. In comparison, the average cracking-to-distillation ratio for the region is 30 percent and for the United States, 60 percent. As a result, light and middle distillates accounted for the bulk (75%) of total refined output in 1991.

Ongoing refinery construction in Argentina includes the building of a new hydrotreater with 2,000 b/d capacity by Shell Argentina near Buenos Aires and the expansion of an existing hydrotreater at La Plata, YPF's largest and most capable refinery, by Astra Evangelista to increase the production of jet fuel. Since the country already has surplus refining capacity, construction in the near future is expected to focus on refinery upgrading. For instance, YPF plans to build two catalytic reforming units with a combined capacity of 21,700 b/d, another hydrotreater of 5,600 b/d, three isomers of 14,100 b/d, and an MTBE unit of 40,000 t/y in the

Table 5.6
Argentina's 1993 Refining Capacity and Configuration
('000 b/cd)

Company	Location	CDU	VDU	Thermal Operations	Cat. Cracking	Cat. Reforming	Hydro Cracking	Hydro Refining	Hydro Treating
Destileria Argentina de Petroleo	Lomas de Zamora	3.6	1.1						
Esso SAPA	Campana	93.0	51.3	24.2	29.6	8.3			15.8
Esso SAPA	Galvan	18.4		7.7					
Isaura SA	Bahia Blanca	25.2	14.5		8.8				
Shell Cia Argentina de Petroleo	Buenos Aires	121.7	54.0	27.0	29.2	12.0			22.4
Sol Petroleo SA	San Francisco Solana	6.0							
YPF/a	Campo Duran	32.0							
YPF/a	Dock Sud	4.0	1.0						
YPF	La Plata	216.0	99.4	39.9	71.9	9.0		15.0	17.9
YPF	Lujan de Cuyo	129.0	66.0	49.3	40.6	9.0	23.9	19.5	4.4
YPF	Plaza Huincul	23.0				3.0			3.0
Consortium/b	San Lorenzo	37.6	16.1	16.0					
Total		709.5	303.4	164.1	180.1	41.3	23.9	34.5	63.5

a. Offered by YPF for sale in 1993. b. Including Perez Companc, CGC, and Pasa Petroquimica.

Sources: Oil & Gas Journal; East-West Center PREM Data File.

next few years.⁵³ In addition to the sale of the San Lorenzo refinery in early 1993, YPF also sold two other smaller refineries at Campo Duran and Duck Sud to investors, reducing YPF's share in the country's total refineries from 62.2 percent in early 1993 to 52 percent in 1994.

Petroleum Product Balance

In 1991, Argentina's domestic demand for refined products was 430,100 b/d, down from approximately 473,000 b/d in 1988. But in 1992, petroleum product demand in Argentina, boosted by economic recovery started in 1991, went up 4.2 percent to 448,100 b/d. The 1991 demand structure is characterized by a large transportation fuels component and a smaller content of fuel oil and kerosene. The fuel-oil share of Argentina's petroleum product consumption was approximately 16 percent. Diesel and gasoline accounted for 31 and 26 percent, respectively, of the consumption. The share of LPG was 9 percent and that of kerosene and jet fuels was 5 percent (Table 5.7).

Presently, the Argentine refineries are meeting internal market demand and have additional production to market abroad as well. In 1991, the output slate showed a close resemblance to the structure of the domestic demand barrel. The yields for the main liquid fuels were: 32 percent for diesel, 29 percent for gasoline, 14 percent for fuel oil, 9 percent for LPG, and 4 percent for kerosene and jet fuels (see Table 5.7). The volume of exported refined products was about 19 percent of total refinery output and consisted mostly of gasoline, diesel, and fuel oil. The main market destinations for excess production, which reached 101,200 b/d in 1991, have been the United States (49%) and other Western Hemisphere nations (31%), with some volume moving to Western Europe and the Asia-Pacific region.⁵⁴

Outlook for Petroleum Product Consumption

Over the past decade, Argentina experienced a steady decrease in oil consumption, dropping at

53. See *Oil & Gas Journal*, October 18, 1993, p. 61.

54. See *World Oil Trade* (1993).

Table 5.7
Argentina's Petroleum Product Balance, 1991
('000 b/d)

Product	Production	Imports	Exports	Consumption	Stock Change
LPG	48.1	0.0	6.4	39.1	2.6
Gasoline	150.4	0.0	39.1	113.2	-2.0
Kero/Jet	22.6	0.9	0.3	22.2	1.0
Diesel	168.8	5.1	34.7	134.0	5.2
Fuel Oil	72.1	11.5	12.0	70.4	1.3
Others	59.5	0.6	8.7	51.3	0.1
Total	521.4	18.2	101.2	430.1	8.2

Note: Individual units do not necessarily add up to the total because of independent rounding.

Source: East-West Center PREM Data File.

an average annual rate of 2 percent between 1980 and 1991, arising in part from a sluggish economy for most of the 1980s, but also because of the successful program of inter-fuel substitution (based mainly on natural gas) in power generation. Inter-fuel substitution has served to drastically cut down fuel oil consumption and in fact has lowered the demand for all other oil products as well. Our forecast of future oil product consumption is based on the assumption of moderate GDP growth (3.2% per year between 1991 and 2000), low population increase (1.14% a year from 1992 to 2000), and the current structure of oil product prices in the country.

Among the ten Latin American countries, Argentina has one of the most competitive markets for refined products and, thus, prices are high. For instance, in September 1993, average prices for LPG and premium gasoline reached US\$1.33/gal and US\$2.70/gal, respectively (Figure 5.3). Refinery prices, in terms of U.S. dollars, experienced three sharp drops in April 1989, February 1990, and January 1991, all corresponding to the depreciation of the austral, the Argentine currency (Figure 5.4). The country introduced a new currency, the Argentine peso, in January 1992, and the currency has become relatively stable since then. High refinery prices may dampen oil consumption growth, and this factor will be taken into consideration in our forecast.

In our base case scenario, Argentina's petroleum product consumption (totalling 430,100 b/d in 1991) is expected to grow at an average annual rate of approximately 2.1 percent between 1991 and 2000, reaching 513,200 b/d in the year 2000. The demand growth rates for LPG, gasoline, and diesel are expected to be higher than the average, while those for fuel oil and kero/jet will be lower than the average (Table 5.8). The high case scenario assumes the successful privatization of the country's oil sector, effective market-oriented economic reform, and no significant oil price hikes, with major oil product consumption expected to grow at an average annual rate of 4.7 percent, reaching 648,500 b/d in the year 2000. In the low case, where expected poor economic performance is coupled with fuel price hikes, overall oil product consumption is projected to grow at an average annual rate of only 1 percent, with demand for LPG, gasoline, kero/jet, and diesel growing respectively at 2, 1.3, 1, and 1 percent a year and fuel oil remaining at its 1991 level throughout the 1990s (See Table 5.8).

Figure 5.3
Domestic Prices of Selected Refinery
Products in Argentina, Jan. 1990 - Sep. 1993

Source: East-West Center PREM Data File.

Figure 5.4
Argentina's Monthly Exchange Rate,
Jan. 1990 - Sep. 1993

Source: East-West Center PREM Data File.

Table 5.8
Forecast of Argentina's Petroleum Product Consumption , 1991, 1995, and 2000
('000 b/d)

Year	LPG	Gasoline	Kero/Jet	Diesel	Fuel Oil	Others	Total
1991 (actual)	39.1	113.2	22.2	134.0	70.4	51.3	430.1
1995 (forecast)							
High Case	48.4	139.4	26.0	166.0	79.2	58.9	517.9
Base Case	44.0	123.7	23.3	146.5	73.2	54.6	465.3
Low Case	42.3	118.9	23.1	139.4	70.4	52.4	446.5
2000 (forecast)							
High Case	63.3	180.9	31.6	216.9	87.4	68.3	648.5
Base Case	51.0	138.3	24.5	163.7	77.0	58.8	513.2
Low Case	46.7	126.6	24.3	146.5	70.4	53.7	468.1

Note: Individual units do not necessarily add up to the total because of independent rounding.

Source: East-West Center PREM Data File and Forecasts.

5.4. NATURAL GAS UTILIZATION AND TRADE LINKS

Current Situation

Argentina has imported natural gas from Bolivia for more than 20 years. Although Argentina's proven natural gas reserves are estimated to be adequate to meet domestic demand, in early 1992 a 20-month contract to purchase Bolivian gas supplies through the end of 1993 was signed. Currently, Argentina is the second largest gas consumer in the region (after Mexico), consuming approximately 2,259 MMcf/d of gas in 1991—24 percent went to the power sector, 11 percent went to gas treatment plants and other secondary processing units, 50 percent was directly consumed by final demand sectors, and 15 percent was the gas sector's own consumption. In 1991, the residential sector accounted for 51 percent of the direct natural gas consumption of 1,133 MMcf/d, followed by the industrial sector (42%). Transportation and nonenergy uses accounted for the remaining 7 percent of direct gas consumption (see Appendix III).

Prospects for Future Gas Use and Trade Links

Natural gas is expected to play a more important role in Argentina's future energy balance—both as a substitute for oil in various sectors of the economy and as an export to regional customers. Three international pipeline projects are currently under consideration for Argentine gas exports to Chile, Brazil, and Uruguay. Transandean pipelines are expected to be built for both gas and oil exports from Argentina to Chile. It is expected that Argentine imports of Bolivian gas will stop following the implementation of the gas trade agreement between Bolivia and Brazil.

Argentina's ambitious plans for gas exports pose a significant challenge for the country's gas sector. While overall energy consumption is expected to grow by an average rate of 2.4 percent a year until 2000, natural gas use could increase at a higher average annual rate of 3.3 percent. Thus total gas utilization is expected to reach 3,000-3,200 MMcf/d in the year 2000. For gas export plans to be realized, therefore, gas production needs to rise to at least 3,400-3,600 MMcf/d by 2000.

5.5. IMPORTANT HYDROCARBONS POLICY ISSUES

The most important hydrocarbons policy issue in Argentina is the current restructuring and

privatization of the state oil and gas sectors. Among the successes of these privatization efforts are the sharply increased oil output in both 1992 (the year in which the Argentine congress approved YPF's privatization plan) and 1993 (with further increases expected in the mid 1990s and beyond), and the improvement in YPF's profit margins after the partial sell-off. Argentina's reputation as an increasingly attractive market for foreign investment has also been boosted internationally. However, the process has not been without problems. Some of the privatization efforts have been delayed, while other sales attempts failed because of unrealistic bidding terms. Perhaps the most serious problem has been the allegations of corruption of government officials that has complicated the smooth transfer of state energy assets to private hands, and the privatization program therefore has been challenged by opposition parties. In a broader sense, the success of current reforms in the country's hydrocarbons sector depends on the speed and extent to which the current government will be able to continue to privatize the oil and gas industries, and thereby realize its ambitious production and export plans, and also depends on whether future governments will continue to be committed to a dominant private role in the state oil and gas sectors.⁵⁵

Although the current trend toward a free market seems to be well under way, given the highly nationalistic sentiments of Argentines in the past and possible changes in the government and its policies in the future, some private and foreign investors have been cautious. Among the things that the government needs to do to guarantee an effective reform in the hydrocarbons area are to make wise use of the proceeds from the sales of the state assets (especially important in view of continued high foreign debt) and to undertake legal reforms to protect private interests.

55. According to the existing Argentine Constitution, President Menem is ineligible to run in the next presidential election, which will be held in 1995. Fernando de La Rúa, the leading candidate of the major opposition Radical Party, has voiced some objections to the privatization of YPF and Gas del Estado and has vowed to reverse some of the measures taken in early 1993. However, the constitution is being revised, and the results will open the way to the reelection of President Menem. For further information, see EIU (1994a), p.5.

The declining oil reserves probably constitute one of the greatest challenges to the government's effort to firmly boost the country's oil production over the long term. Although the Menem government has opened wide areas of the country to exploration by foreign and domestic private companies, no big finds of oil and gas have been made so far. The country also needs to use its natural gas more efficiently, as the volume of unused gas (230 MMcf/d) was larger than the country's gas imports (211 MMcf/d) in 1991, and did not include the additional 95 MMcf/d lost during transportation and processing. As the country's nuclear power program has been slowed down and coal production continues to be short of demand, Argentina will have to rely on oil and gas for most of its energy needs. Higher demand for oil and gas, a possibility reflected in our high case scenario, is likely to reduce the oil and gas exports from the country by the year 2000.

In short, the future of Argentina's hydrocarbons sector depends on how successful its current energy reforms will be and whether the continuing oil exploration efforts in the country can produce favorable results. More efficient use of natural gas is also very important. Despite all kinds of present problems and great challenges ahead, it is nevertheless widely believed that the Menem government's bold push for the privatization of its inefficient state oil and gas sector will pay off in the future.

VI. COLOMBIA

Colombia is richly endowed with metallic ores, emeralds, hydrocarbon resources, and the region's largest coal deposits. The country has a land area of 1.14 million km² and ports on both the Pacific and Caribbean coasts. The people have inherited the cultural characteristics of Andean as well as Caribbean countries. More than 50 percent of Colombia's 33 million people are mestizo, while 18 percent have European ancestry and 24 percent are mulatto. A smaller proportion has either pure African or Indian heritage.⁵⁶

The political situation in Colombia has been uneasy, due to continuing activities of guerrilla groups and drug cartels. Economically, the country has done well—much better than the political situation would suggest—with inflation among the lowest in the region and GDP growing at an average of 3.5 percent annually during the 1980s. Economic growth accelerated from the 3.5 percent registered in 1992 to 5.2 percent in 1993.⁵⁷ Colombia's two most important exports are oil and coffee, accounting for 19 and 17 percent of trade revenue, respectively, in 1992. Other major exports are coal and metals. Colombia's main trading partner is the United States, which in 1992 accounted for 39 percent of both Colombia's exports and its imports. Other key trading partners are Venezuela, Germany, and Japan.

6.1. PRIMARY ENERGY SUPPLY

Colombia is a net energy exporter, with exports consisting mainly of high quality crude oil (169,800 b/d in 1991 and 181,800 b/d in 1992), oil products (71,100 b/d in 1992), and coal (16.3 million tonnes in 1991). It is the region's largest coal producer and exporter. Although its coal exports in 1992 were lower than the 1991 level, the increase was more than 50 percent over 1988. Primary energy production in 1991 amounted to 1 million boe/d, significantly up from 370,000 boe/d in 1980, reflecting an average annual rate of increase of 9.5 percent (Figure 6.1).

56. See Culver-Hopper et al. (1992), p. 33.

57. See EIU (1993d and 1994d) for details.

Figure 6.1
Colombia's Primary Energy
Production by Source, 1980 and 1991

Source: East-West Center PREM Data File.

Coal exhibited the highest production growth rate during this period, rising from 50,000 boe/d in 1980 to 302,800 boe/d in 1991 at an average annual growth rate of 17.8 percent. Oil production also increased by an impressive rate, averaging 11.9 percent a year. Hydroelectricity production was up by 7 percent a year during this period. Natural gas and other energy (mainly firewood and cane products) output grew at average annual rates of only 2.1 and 1.7 percent, respectively. While the shares of oil and coal in total primary energy production increased significantly from 36 and 13.5 percent, respectively, in 1980 to 45 and 30 percent in 1991, the share of other energy production dropped from 25.2 percent in 1980 to 11.1 percent in 1991. In 1991, gas and hydroelectricity accounted for 8.4 and 5.5 percent, respectively, of primary energy production in Colombia, significantly lower than their shares of 18.1 and 7.2 percent, respectively, in the 1980 primary product level (see Figure 6.1).

Oil

Colombia's petroleum reserves and production have been increasing significantly since Caño Limón crude came on stream in 1985, and they are expected to increase further with the new Cusiana discovery. In 1992, petroleum reserves were estimated to be 1.94 billion barrels, the fourth largest in Latin America after Venezuela, Mexico, and Brazil. Crude production in 1992 was around 440,000 b/d, up 3.4 percent from 425,600 b/d in 1991 (Table 6.1). Colombia's oil production fell short of the planned targets because of numerous guerrilla attacks on the Caño Limón export pipeline. Crude production in 1993 is estimated to be around 455,000 b/d, 3.4 percent higher than the 1992 production level. In 1992, crude exports from Colombia were 181,800 b/d, up from 169,800 b/d in 1991, but lower than the 192,100 b/d exported in 1990. It is estimated that total crude exports of Colombia averaged around 200,000 b/d in 1993.⁵⁸ In 1991, about 64 percent of Colombia's crude exports went to the United States, and all the remaining exports were shipped to other countries in the Western Hemisphere.

Exploration and development activities in Colombia are open to foreign participation. Colombia's national oil company, Empresa Colombiana de Petróleos (Ecopetrol), engages in upstream and

58. See Wu (1993b), p. 3.

Table 6.1
Petroleum Data for Colombia, 1988-1992

('000 b/d)

Year	Reserves/a	Crude Production	Crude Exports	Crude Imports	Product Consumption
1988	2,028	376.9	145.1	0.0	188.8
1989	2,060	402.8	164.2	0.0	186.3
1990	2,000	438.3	192.1	0.0	197.6
1991	1,935	425.6	169.8	0.0	200.8
1992	1,935	439.8	181.8	2.9	227.0

a. Million barrels.

Source: East-West Center PREM Data File.

Table 6.2
Natural Gas Data for Colombia, 1988-1992

(MMcf/d)

Year	Reserves/a	Production	Exports	Imports	Utilization/b
1988	3,943	484	0	0	443
1989	4,020	442	0	0	414
1990	4,500	494	0	0	445
1991	3,889	500	0	0	451
1992	7,200	494	0	0	439

a. Billion cubic feet (bcf). b. Defined as transformation plus final consumption, with appropriate adjustment of stock change.

Source: East-West Center PREM Data File.

downstream hydrocarbon activities and the production of petrochemicals. It is also involved in association contracts with foreign and domestic firms and controls all refining in the country. In 1992, 68 percent of the country's oil was produced under association contracts (joint-venture operations) between Ecopetrol and foreign oil companies. Ecopetrol directly produced 21 percent of the crude output and the remaining 11 percent was produced under concessions in which Ecopetrol did not participate.⁵⁹

The Cusiana field is being explored under an association contract between Ecopetrol and BP, Total, and Triton Colombia. Unofficial estimates of reserves for the field range from a minimum of 1.5 billion barrels up to a massive 10 billion barrels of oil. Initial production from the Cusiana oil fields has been estimated at 150,000 b/d by the end of 1995. Some believe that the proven reserves are no more than 1.5 billion barrels, should the neighboring Cupiagua oil field not be counted.⁶⁰ With the new reserves, Colombia hopes to increase oil production to over 800,000 b/d by 1996, allowing the country to more than double its exports to 500,000 b/d or more. If the Cusiana reserves are not as substantial as expected, production from the field may not lead to a rapid expansion of exports, but will simply extend the ability of the country to supply domestic consumption and maintain the current level of exports into the next century. Our estimation is that, with Cusiana oil, Colombia's oil production could reach 910,000 b/d to 1.1 million b/d by the year 2000. Depending on the domestic consumption level, Colombia's oil (crude and products) exports can be anywhere in the range between 580,000 and 870,000 b/d by the end of the decade.

Natural Gas

At the end of 1992, Colombia's natural gas reserves were estimated to be 7,200 bcf, up 85

59. See *ibid.*

60. The estimate of 1.5 billion barrels of crude reserves in the Cusiana oil field was released by BP in October 1992. Other analysts put the Cusiana reserves on the order of 2 to 5 billion barrels. An estimation of 10 billion barrels has also surfaced. For more details, see Brogan (1993); and Wu (1993b).

percent from the 1991 reserves of 3,889 bcf (Table 6.2). About 15 percent of the total reserves are directly owned by Ecopetrol, 80 percent are contracted in association with private companies, and 5 percent are in concessions. In 1992, the country produced 494 MMcf/d of natural gas, almost the same as in 1990 and 1991. Additional gas production is expected to reach the market in association with Cusiana oil.

The main players in the gas industry in Colombia are Ecopetrol, which is engaged in gas production and development, and Promigas, a national company mainly involved in the distribution of gas. Foreign companies that have entered association contracts with Ecopetrol for natural gas development are Elf Aquitaine, Exxon, Occidental, and Texpet. Other companies, such as Exxon and Shell, have natural gas concessions. During the decade between 1980 and 1991, gas production increased at an average annual rate of 2.1 percent. The growth rate of production is expected to increase through the year 2000.

Coal

Colombia ranks first in coal reserves, production, and exports in Latin America. The 1991 coal reserves of 6,503 million tonnes accounted for 47 percent of total coal reserves in the region. The country's coal production increased rapidly in the past decade, reaching 23.6 million tonnes in 1991, 55 percent of the region's total output. Coal exports from the country amounted to 16.3 million tonnes in 1991, 88 percent of the total coal exports of Latin American countries. From 1988 to 1991, coal production in Colombia grew at an average annual rate of 16 percent and exports increased at exactly the same rate during this period (Table 6.3).

Colombia uses its coal mainly in the industrial sector (64% of total coal consumption). Coal use in power generation accounted for only 15 percent of total coal consumption. It is expected that coal production will continue to increase rapidly in Colombia for the rest of the decade. It is very likely that coal exports could reach between 20 and 30 million tonnes by the year 2000, which places Colombia in the rank of top coal exporters in the world.

Table 6.3
Coal Data for Colombia, 1988-1992
('000 tonnes)

Year	Reserves/a	Production	Exports	Imports	Apparent Consumption/b
1988	5,339	15,101	10,429	0	4,672
1989	4,579	18,902	13,462	0	5,440
1990	6,443	20,468	14,592	0	5,876
1991	6,503	23,600	16,297	0	7,303
1992	6,488	23,776	15,968	0	7,808

a. Million tonnes. b. Defined as production plus net imports.

Source: East-West Center PREM Data File.

Hydroelectricity

Colombia's utilization of its hydroenergy potential is only 7.2 percent. While the country's hydroenergy potential accounts for 13.6 percent of the total potential in Latin America, its installed hydropower capacity of 3,078 MW is only 3.2 percent of the installed hydropower capacity in the region. However, Colombia's hydroelectricity production has increased rapidly over the past decade, more than doubling the utilization ratio of its hydroenergy potential from 3.2 percent in 1980 to 7.2 percent in 1991. The 39 hydropower stations currently in operation have an average capacity of 79 MW. Seven of the 39 stations have a capacity above 500 MW, with the largest twin hydropower plants, San Carlos-1 and San Carlos-2, each having a capacity of 620 MW.

In the 1970s, the Colombian government undertook a large-scale survey of its rivers in order to identify possible hydropower projects for the 1980s and 1990s. The current hydroelectricity development plans are largely based on this survey. Given that the country has significant underexploited hydroenergy resources, it is expected that the installed hydroelectricity capacity in Colombia will increase by 30 to 50 percent by the turn of the century as new stations are commissioned.⁶¹ Hydroelectricity production and consumption are expected to continue to increase at an average annual rate of approximately 3 percent for the rest of the decade.

6.2. PRIMARY ENERGY CONSUMPTION

Current Situation

Colombia is the fifth largest primary energy consumer in Latin America. In 1991, Colombia's primary energy consumption totaled 505,700 boe/d, up 28 percent from 395,000 boe/d in 1980, reflecting an annual average growth rate of 2.3 percent (Figure 6.2). Petroleum provided 36 percent of Colombia's primary energy consumption, while natural gas supplied 15.1 percent of the country's needs (Table 6.4), higher than its share in total primary energy production (8.4%). Coal accounted for 15.7 percent of primary energy consumption in Colombia, the second highest share in Latin America after Chile; the remaining shares were provided by hydroelectricity

61. See Rodríguez-Elizarrarás (1992).

Figure 6.2
Colombia's Actual and Projected Primary
Energy Consumption, 1980, 1991, and 2000

('000 boe/d)

Source: East-West Center PREM Data File and

Table 6.4
Percentage Distribution of Primary Energy
Consumption: Colombia, 1980, 1991, and 2000
 (%)

	1980	1991	2000
Oil	45.3	36.0	37.4
Natural Gas	13.9	15.1	16.5
Coal	11.9	15.7	16.4
Hydroelectricity	5.3	11.0	11.1
Other	23.6	22.2	18.6
Total	100.0	100.0	100.0

Source: East-West Center PREM Data File and Forecasts.

(11%)—the fastest growing source of energy in the last decade—and by traditional sources such as firewood and cane products (22.2%). Between 1980 and 1991, hydroelectricity consumption grew at an average annual rate of 9.3 percent, coal consumption grew by 4.9 percent a year, gas consumption by 3.1 percent a year, and oil consumption by only 0.2 percent a year.

Outlook for 2000

The forecast for Colombia's primary energy consumption by source in the year 2000 is based on projections of population and real GDP growth between 1991 and 2000, as well as changes in per capita primary energy consumption and energy intensity in the past. The price structure of refined products and price movement are also important and will be discussed in the section on oil product consumption. From 1980 to 1992, the Colombian population grew from 26.91 million to 34.87 million at an average annual growth rate of 2.18 percent. Real GDP growth averaged 3.2 percent a year between 1980 and 1991. It is expected that the population will increase at a rate of 1.77 percent a year between 1992 and 2000, and that the annual GDP growth rate will increase to 4 percent between 1991 and 2000.⁶² Since in the past decade the growth rate of primary energy consumption (2.4% per year) was lower than that of real GDP (3.2% a year) and both were higher than the annual growth rate of the population (2.18%), per capita primary energy consumption in Colombia increased from 5.4 boe/person in 1980 to 5.5 boe/person in 1991; energy intensity decreased from 6,008 kcal/US\$(1980) in 1980 to 5,429 kcal/US\$(1980) in 1991. All of these data and assumptions are summarized in Table 6.5.

Based on these assumptions, it is expected that primary energy consumption in Colombia will grow at an average annual rate of 3 percent to the year 2000, reaching 658,700 boe/d. Oil consumption is expected to grow by 3.4 percent per year between 1991 and 2000. The present government policy seeks to increase gas utilization efficiency by using it directly for residential consumption as well as substituting it with coal, a cheaper fuel, for power generation. As a result, natural gas and coal consumption are expected to grow faster than total primary energy consumption at average rates of 4 and 3.5 percent, respectively. Other energy consumption,

62. See IDB (1993).

Table 6.5
Key Data and Assumptions for Forecast of Colombia's
Primary Energy Consumption, 1980-2000

Key Item	Unit	Data/Assumptions
Population		
AAGR 1980-1992	percent	2.18
AAGR 1992-2000	percent	1.77
GDP		
AAGR 1980-1991	percent	3.2
AAGR 1991-2000	percent	4.0
Per Capita GDP		
AAGR 1980-1991	percent	1.2
AAGR 1991-2000	percent	2.2
Per Capita Primary Energy Consumption		
1980	boe/person	5.3
1991	boe/person	5.5
AAGR 1980-1991	percent	0.4
Energy Intensity		
1980	kcal/US\$(1980)	5,927
1991	kcal/US\$(1980)	5,429
AAGR 1980-1991	percent	-0.8

AAGR = average annual growth rate.

Sources: East-West Center PREM Data File and IDB (1993).

which accounted for 22.2 percent of total primary energy use in Colombia in 1991, is expected to continue to grow at a low rate of 1 percent between 1991 and 2000, reducing its share in primary energy consumption to 18.6 percent in 2000.

6.3. DOWNSTREAM OIL SECTOR AND PRODUCT CONSUMPTION

Refining

Colombia's 1993 refining capacity was 264,400 b/d at four facilities, all owned by Ecopetrol (Table 6.6). With a throughput of 244,640 b/d in 1991, the country's refining sector is running close to its capacity (93%). Colombia's refining sector is fairly sophisticated compared to other countries in the region. While the average cracking-to-distillation ratio for the region is only 30 percent, Colombia's 58 percent ratio is the highest among Latin American countries, reflecting efforts to improve the output slate to meet high gasoline demand. However, the country still has a deficit in its gasoline supply. Ecopetrol's original plan was to budget US\$1.4 billion for the period 1991-1996 for refinery upgrades and the construction of a new refinery with a capacity of 75,000 b/d to be located in the middle of the Magdalena valley. While the upgrading is still ongoing, Ecopetrol has shelved the plan to build the new refinery because of the high capital expenditure cost.⁶³ Ecopetrol will instead expand its largest refinery at Barrancabermeja by approximately 17,000 barrels per calendar day (b/cd), and the expanded unit is scheduled to be functioning by 1995. The company hopes to increase gasoline production to 130,000 b/d in order to supply all domestic gasoline demand.⁶⁴ Ecopetrol has also called for foreign oil companies to invest in, operate, and jointly own a new refinery—the first foreign ownership in the refining sector if successfully achieved.

Petroleum Product Balance

While production of petroleum products totalled 246,400 b/d in 1991, ostensibly higher than the 200,800 b/d of refined products required in Colombia, it failed to satisfy about 26,000 b/d of

63. See EIU (1993d), p. 21.

64. See Arenas (1993), p. 9.

Table 6.6
Colombia's 1993 Refining Capacity and Configuration
('000 b/cd)

Company	Location	CDU	VDU	Thermal Operations	Cat. Cracking	Cat. Reforming	Hydro Treating
Ecopetrol	Barrancabermeja-Santander	185.0	96.0	39.0	66.0	6.0	6.0
Ecopetrol	Cartegena-Bolivar	72.0	42.0	20.0	28.0		
Ecopetrol	Orito, Putumayo	2.4					
Ecopetrol	Tibu, N. de Santander	5.0					
Total		264.4	138.0	59.0	94.0	6.0	6.0

Sources: Oil & Gas Journal; East-West Center PREM Data File.

domestic gasoline demand. However, it provided a surplus of diesel and fuel oil—lower value products than gasoline. Petroleum product consumption in 1991 was 200,800 b/d, consisting mainly of gasoline (57%) and diesel (19%). Colombia exported 71,000 b/d of oil products, about 29 percent of its total production (Table 6.7). Over 80 percent of the product exports went to the United States and 90 percent of total exports consisted of fuel oil. Because of a deficit in domestic production, the country imported 26,000 b/d of gasoline, accounting for 23 percent of total gasoline consumption. While LPG consumption was 15,200 b/d in 1991, Ecopetrol estimates that there is an unsatisfied demand for LPG of about 4,000 b/d. As a result, there are plans to increase refinery output of the fuel by upgrading catalytic cracking capacity. The government heavily subsidizes domestic gasoline prices, making them the third lowest in Latin America after those in Venezuela and Ecuador.

Outlook for Petroleum Product Consumption

In addition to population and economic growth trends during the 1990s, an analysis of fuel prices is also important in projecting future oil consumption in Colombia. As Figure 6.3 shows, the prices of major refined products in terms of U.S. dollars are very low in the domestic market, and they underwent virtually no changes during the period from January 1990 to September 1992, except for seasonal fluctuations. For instance, on average, LPG and premium gasoline were priced at 32¢/gal and 74¢/gal, respectively, in January 1989. The prices of these two products increased to 55¢/gal and 82¢/gal in September 1993. Since Colombia's currency depreciated in relation to the U.S. dollar from 445.69 pesos/US\$ in January 1990 to 871.76 pesos/US\$ in September 1993 (Figure 6.4), the nominal prices of the refined products in terms of the Colombia peso were rising more rapidly than prices denoted in U.S. dollars although the real prices were not. The implication of the above analysis is twofold. On the one hand, low product prices in Colombia resulted in an unexpectedly high demand for oil products, especially gasoline and diesel; on the other hand, oil product consumption in Colombia may become constrained once the free market operates for refined products and subsidies come to an end.

Based on an assessment of Colombia's economic performance and population growth and the above analysis of its refined product price structure, it is estimated that total domestic product

Table 6.7
Colombia's Petroleum Product Balance, 1991
('000 b/d)

Product	Production	Imports	Exports	Consumption	Stock Change
LPG	15.1	0.0	0.0	15.2	0.0
Gasoline	88.2	26.0	0.0	113.7	0.5
Kero/Jet	16.0	0.0	0.0	15.9	0.0
Diesel	44.6	0.0	6.8	37.3	0.6
Fuel Oil	74.7	0.0	64.3	10.9	-0.4
Others	7.8	0.0	0.0	7.8	0.0
Total	246.4	26.0	71.0	200.8	0.7

Note: Individual units do not necessarily add up to the total because of independent rounding.

Source: East-West Center PREM Data File.

Figure 6.3
Domestic Prices of Selected Refinery
Products in Colombia, Jan. 1990 - Sep. 1993

Source: East-West Center PREM Data File.

Figure 6.4
Colombia's Monthly Exchange Rate,
Jan. 1990 - Sep. 1993

Source: East-West Center PREM Data File.

consumption will rise at an average annual rate of 3.4 percent in the base case, where a partial liberalization of prices is possible (Table 6.8). In this case, by the year 2000 oil product consumption could reach 271,600 b/d, up from the 1991 level of 200,800 b/d. LPG, diesel, and kero/jet are expected to lead this increase. However, in the low case scenario, oil product consumption could also be constrained and increase at an annual rate of only 1.6 percent a year between 1991 and 2000 if price subsidies are eliminated. On the other hand, oil consumption could also increase significantly as rapid economic growth generates more demand and the fuel prices are not high enough to curb consumption. Our high case scenario assumes that the structure and level of current refined product prices prevail and that major petroleum product consumption will grow at 5.6 percent per year, reaching 327,000 b/d in 2000 (see Table 6.8).

6.4. NATURAL GAS UTILIZATION

The power sector is the largest consumer of gas in Colombia, accounting for 31 percent of total use of 451 MMcf/d in 1991. Ecopetrol consumed 20 percent of the gas, or 125 MMcf/d, in its refineries, gas treatment plants, and by itself. Industrial sectors consumed 17 percent, or 101 MMcf/d, of the gas. The rest of the gas went to the petrochemical, residential, transportation, and commercial and public service sectors as well as self-producers (see Appendix V).

The Colombian government hopes to change the consumption pattern of natural gas by encouraging an increase in residential consumption and substituting coal for natural gas in the power sector. In 1991, the government launched an ambitious gas distribution system aimed at reaching 3.7 million families by the year 2005. The project involves building a new gas infrastructure on the scale of the present electricity grid. Some of the gas is expected to be imported from Venezuela. As a result, it is estimated that gas consumption will increase at an average annual rate of 4 percent through the year 2000, reaching 108,800 boe/d, or 642 MMcf/d.

6.5. IMPORTANT HYDROCARBONS POLICY ISSUES

One of the most important issues facing the Colombian hydrocarbons industry is the development of the Cusiana field. Despite decreasing production of the Caño Limón field, if Cusiana reserve

Table 6.8
Forecast of Colombia's Petroleum Product Consumption, 1991, 1995, and 2000
('000 b/d)

Year	LPG	Gasoline	Kero/jet	Diesel	Fuel Oil	Others	Total
1991 (actual)	15.1	113.7	15.9	37.3	10.9	7.8	200.8
1995 (forecast)							
High Case	23.4	140.9	22.5	53.6	14.3	9.3	263.9
Base Case	19.9	130.5	20.1	48.0	12.7	8.6	239.8
Low Case	17.7	120.7	17.9	42.0	12.3	8.3	218.8
2000 (forecast)							
High Case	28.5	174.7	28.7	68.4	15.8	10.8	326.9
Base Case	21.9	147.6	23.3	55.9	13.4	9.5	271.6
Low Case	18.6	126.9	19.3	45.2	12.6	8.7	231.3

Note: Individual units do not necessarily add up to the total because of independent rounding.

Source: East-West Center PREM Data File and Forecasts.

estimates of at least 1.5 billion barrels of medium to light crude oil and condensate are confirmed, Colombia could significantly increase production above the present level of 440,000 b/d. Furthermore, the associated gas produced with the Cusiana crude could supply the projected increase in energy consumption.

Another important policy issue facing the Colombian hydrocarbons industry is the systematic sabotage of transportation and production facilities and the kidnapping of oil executives carried out by guerrilla groups. These attacks have cost the government a 21 percent decline in oil export revenues and may have a long-term impact on foreign investment in the country. Originally, the reason for such violent activity was the intention of the guerrillas to nationalize the country's oil industry. However, most recently, their nationalistic political ideology has been replaced with an espousal of their "business terrorism," a lucrative activity which earned them US\$250 million in 1991. In order to pay for the anti-insurgency activities, the government has raised taxes on the operations of foreign oil companies from 30 percent to 37.5 percent and instituted a "war tax" of US\$1.00 per barrel of oil produced. While a series of negotiation rounds has taken place, attacks continue. These guerrilla attacks, which have already caused occasional electricity blackouts in the country, will pose a threat for Ecopetrol's development plans as additional installations and transportation facilities will increase the targets available for guerrilla attack.

Finally, the issues at stake are Colombia's tax and fiscal reforms. As the Colombian government strives to open its oil industry to foreign investment, better incentives in domestic financial and tax policies are needed in order to entice foreign oil companies to invest in the promising oil sector.

VII. ECUADOR

Wedged between Colombia and Peru on South America's northern Pacific coast, Ecuador is geographically divided into three areas by two Andean cordilleras that run from north to south: the coastal lowlands; the highlands between the two mountain ranges; and the Amazon Basin to the east.

Ecuador's 1992 population stood at 11.1 million and is fairly evenly distributed between the coastal and mountain highland regions, with only about 2 percent living in the Amazon Basin. Over the past five years, the population grew at an average annual rate of 2.8 percent. The increasing urbanization is concentrated in the two major cities of Quito and Guayaquil, which together are home to about 26 percent of the total population.⁶⁵ Indians account for about 37 percent of the population, and Ecuador is considered to have the strongest Indian movement in South America. An example of the strength of the movement is the US\$100,000 environmental tax that has been imposed by the government on oil companies that signed contracts during the recent seventh round of international bidding in the Oriente region.⁶⁶

In 1993, Ecuador's GDP grew by 2.3 percent. This is down sharply from the 3.5 percent growth seen in 1992. Inflation, however, fell to 42 percent in 1993 from 54.6 percent in 1992. The government has managed to lower inflation by normalizing relations with the country's external commercial bank creditor and implementing a tight monetary policy.⁶⁷

External debt totalled US\$12.3 billion in 1992, down from US\$12.5 billion in 1991. Ecuador's merchandise trade account remained in surplus at US\$730 million in 1993, continuing the trend

65. See Culver-Hopper et al. (1992), p. 39.

66. For the same round of bidding, the Ecuadorean Ministry of Agriculture placed a 15-year ban on all crude activities in the Cuyabeno natural reserve area. See *Platt's Oilgram News*, August 13, 1992.

67. See EIU (1993e and 1994e) for details.

over the past several years. Over 89 percent of 1992 export earnings came from sales of oil and foodstuffs, including bananas, shrimp, cocoa, fish products, and coffee. The country has, however, experienced current account deficits each year since the late 1980s.

7.1. PRIMARY ENERGY SUPPLY

Ecuador is a net energy exporter with petroleum dominating its primary energy supply and demand. In 1991, as the fourth largest petroleum exporter in Latin America, Ecuador exported an average of 170,600 b/d of crude oil and 28,000 b/d of petroleum products. Energy imports consisted mainly of LPG and gasoline. The 1991 primary energy production in Ecuador was 355,360 boe/d, up from 240,470 boe/d in 1980 at an average annual growth rate of 3.6 percent (Figure 7.1). Petroleum accounted for 86.9 percent of Ecuador's primary energy production in 1991, and the remaining share was provided by natural gas, hydroelectricity, and other energy (firewood and cane products). Over the past decade, hydroelectricity production increased at an average annual rate of 17.5 percent, raising its share in total primary energy production from less than 1 percent in 1980 to 2.7 percent in 1991. During the same period, oil production went up by an average of 3.5 percent a year, gas production by 3.6 percent a year, and other energy production by 2.1 percent a year. The share of other energy production decreased from 7.9 percent in 1980 to 6.7 percent in 1991 (see Figure 7.1). Ecuador is expected to remain a net energy exporter through the end of the century, but both the value and quality of its export crude and products will be lower than they are today as domestic production of crude becomes heavier and the demand for high-quality oil products increases.

Oil

Ecuador ranks sixth in both petroleum reserves and production in Latin America. Its crude oil reserves at the end of 1992 were estimated at 1.6 billion barrels, up 3.2 percent from 1.55 billion barrels in 1991. In recent years, Ecuador's crude production has remained close to 300,000 b/d. However, in 1992 crude output rose 7.1 percent to 321,000 b/d from 299,700 b/d the previous year (Table 7.1). Crude production in 1993 was estimated at 345,000 b/d, 7.5 percent higher than the 1992 production level. Crude exports averaged around 170,000 b/d during the period 1989-1991, but went up to 200,300 b/d in 1992. In 1991, about 41 percent

Figure 7.1
Ecuador's Primary Energy
Production by Source, 1980 and 1991

Source: East-West Center PREM Data File.

Table 7.1
Petroleum Data for Ecuador, 1988-1992
('000 b/d)

Year	Reserves/a	Crude Production	Crude Exports	Crude Imports	Product Consumption
1988	1,350	302.8	189.0	0.0	91.4
1989	1,514	278.9	174.6	0.0	87.5
1990	1,420	286.1	170.6	0.0	93.4
1991	1,550	299.7	170.6	0.0	99.9
1992	1,600	321.0	200.3	0.0	101.9

a. Million barrels.

Source: East-West Center PREM Data File.

Table 7.2
Natural Gas Data for Ecuador, 1988-1992
(MMcf/d)

Year	Reserves/a	Production	Exports	Imports	Utilization/b
1988	4,020	80	0	0	12
1989	3,990	126	0	0	18
1990	3,950	130	0	0	18
1991	3,885	81	0	0	23
1992	3,899	84	0	0	19

a. Billion cubic feet (bcf). b. Defined as transformation plus final consumption, with appropriate adjustment of stock change.

Source: East-West Center PREM Data File.

of Ecuador's crude exports went to other Latin American countries, 33 percent to North America (Mainly the United States), and 26 percent to the Asia-Pacific region. In other words, nearly three-fourths of the country's 1991 crude exports were directed toward the Western Hemisphere.

All aspects of oil and gas development in Ecuador are managed by the national oil company, Empresa Estatal Petróleos del Ecuador (Petroecuador). Three subsidiaries have been created to carry on day-to-day operations: Petroproduccion for exploration and production; Petrocomercial for domestic and foreign sales; and Petroindustrial for refining operations. Current production and exploration activity is concentrated in the Oriente region in the Amazon rain forest of eastern Ecuador. Oil is also produced in the Santa Elena fields, both onshore and offshore, along the southwestern coastal area.⁶⁸

Generally, Ecuador's crude oil reserves, especially those containing medium Oriente crude with a 29° API gravity and 1.01 percent sulfur content, have not increased in recent years. The new oil finds have been much heavier and more sour than Oriente crude. Crudes from the new fields have a gravity of around 10-20° API with a sulfur content often in excess of 2 percent. Medium Oriente crude production from Ecuador is expected to decline and production of heavy oil will increase significantly by 1995. In order to maximize the value of crude production and exports, the heavy oil will be blended with the Oriente crude to produce a crude mixture with a gravity of 21° API. In 1995, the country is expected to produce 340,000-350,000 b/d of Oriente crude and crude mixture. After 1995, Oriente crude production is expected to further decline, severely limiting the availability of light crude for blending. As a result, Ecuador's production of Oriente crude and crude mixture is expected to decline to 270,000-280,000 b/d around the year 2000.⁶⁹ However, Ecuador's upstream oil sector is open to foreign investment. By the end of 1993, a total of six rounds of international bidding had been held. Petroecuador announced the seventh round of international tenders on January 10, 1994, and the bidding started on January 24,

68. See Culver-Hopper et al. (1992), p. 41.

69. See Wu (1992b).

1994.⁷⁰ Twenty-eight companies submitted bids for thirteen blocks offered in this round, which closed May 31, 1994.⁷¹ Since June 1992, Petroecuador has accelerated its exploration and production activities, and the new government of President Sixto Duran has approved a number of new development projects operated by international oil companies. As foreign oil companies intensify their production activities, oil output from these sources could possibly rise to 125,000 b/d in 2000 and thus raise overall production levels in Ecuador.

Natural Gas

Exploration for natural gas in Ecuador has been limited because the present Hydrocarbons Law was developed primarily for oil. Legal guidelines for natural gas development are not well established in the country. Thus, reform of the Hydrocarbon Law is necessary for the development of Ecuador's gas reserves.

Proven gas reserves were estimated to be 3,899 bcf at the end of 1992 (Table 7.2). The country produced 84 MMcf/d of natural gas in 1992, which was at about the same level as in 1991 but significantly lower than the 1990 production of 130 MMcf/d. A large proportion of the natural gas produced in Ecuador is flared, reinjected, or wasted. In fact, 1992 gas utilization was only 19 MMcf/d, a mere 23 percent of the total gas produced. Given the country's substantial underexploited gas reserves, natural gas production is expected to increase in the 1990s. Consumption of gas is expected to grow even faster as Petroecuador plans to feed more gas into its gas treatment plants for the production of LPG.

Hydroelectricity

Hydroelectricity provided 2.7 percent of Ecuador's 1991 primary energy production and 7.1 percent of its primary energy consumption. While Ecuador still has one of the lowest hydroenergy utilization ratios in Latin America, its installed capacity increased five and a half

70. See EIU (1994e), p. 19.

71. See *Platt's Oilgram News*, June 13, 1994.

times from 226 MW in 1980 to 1,471 MW in 1991, raising its utilization ratio from less than 1 percent to 5.9 percent during this period. At present, hydropower capacity accounts for 64 percent of total installed power generation capacity of 2,301 MW in Ecuador. Of the 10 hydropower stations, the largest one, Paute A-B-C, located in Azuay, has an installed capacity of 1,075 MW, with the other nine stations having an average capacity of 44 MW. It is expected that the construction of hydropower stations will continue and the production of hydropower will increase in the future.

7.2. PRIMARY ENERGY CONSUMPTION

Current Situation

In 1991, total primary energy consumption in Ecuador was 130,000 boe/d, increasing at an annual rate of 2.1 percent since 1980 (Figure 7.2). Petroleum accounted for 71.3 percent of primary energy consumption (Table 7.3). Firewood and cane products provided the next largest share of energy (18.4%), followed by hydroelectricity (7.4%), and natural gas (2.9%). Oil consumption increased at an average annual rate of only 1.5 percent between 1980 and 1991. In comparison, natural gas consumption increased by 20.5 percent a year and hydroelectricity demand rose by 17.5 percent a year during this period.

Outlook for 2000

The forecast for Ecuador's primary energy consumption in the year 2000 is based on projections of population and real GDP growth between 1991 and 2000, as well as the changes in per capita primary energy consumption and energy intensity in the past. Table 7.4 summarizes the key data and assumptions for the forecast of primary energy consumption in Ecuador. Ecuador's population increased from 8.12 million in 1980 to 11.09 million in 1992 at an average annual growth rate of 2.63 percent. Real GDP grew an average of 2 percent a year between 1980 and 1991. It is expected that the population will grow an average of 2.28 percent a year between 1992 to 2000, and that GDP will increase at an average rate of 3.5 percent a year between 1991 and 2000.⁷² Over the past decade, per capita primary energy consumption in Ecuador went down

72. See IDB (1993).

Figure 7.2
Ecuador's Actual and Projected Primary
Energy Consumption, 1980, 1991, and 2000

('000 boe/d)

Source: East-West Center PREM Data File and Forecasts.

Table 7.3
Percentage Distribution of Primary Energy
Consumption: Ecuador, 1980, 1991, and 2000
 (%)

	1980	1991	2000
Oil	79.6	71.3	70.5
Natural Gas	0.5	2.9	5.2
Hydroelectricity	1.6	7.4	7.6
Other	18.3	18.4	16.7
Total	100.0	100.0	100.0

Source: East-West Center PREM Data File and Forecasts.

Table 7.4
Key Data and Assumptions for Forecast of Ecuador's
Primary Energy Consumption, 1980-2000

Key Item	Unit	Data/Assumptions
Population		
AAGR 1980-1992	percent	2.63
AAGR 1992-2000	percent	2.28
GDP		
AAGR 1980-1991	percent	2.0
AAGR 1991-2000	percent	3.5
Per Capita GDP		
AAGR 1980-1991	percent	-0.6
AAGR 1991-2000	percent	1.1
Per Capital Primary Energy Consumption		
1980	boe/person	4.7
1991	boe/person	4.4
AAGR 1980-1991	percent	-0.5
Energy Intensity		
1980	kcal/US\$(1980)	4,401
1991	kcal/US\$(1980)	4,451
AAGR 1980-1991	percent	0.1

AAGR = average annual growth rate.

Sources: East-West Center PREM Data File and IDB (1993).

slightly from 4.7 boe/person in 1980 to 4.4 boe/person in 1991, and energy intensity went up from 4,401 kcal/US\$(1980) in 1980 to 4,451 kcal/US\$(1980) in 1991. This indicates that the growth rate of real GDP was lower than the growth rate of primary energy consumption, and the latter was lower than the population increase.

Based on these assumptions, it is expected that overall primary energy consumption in Ecuador will increase at an average annual rate of 3.1 percent between 1991 and 2000. Natural gas consumption is forecast to grow at a hefty 10 percent per year during this period. As a result, the share of natural gas in primary energy consumption is expected to nearly double from its 1991 level of 2.9 percent to 5.2 percent in 2000. Oil consumption is expected to grow by an average of 3 percent a year (see Figure 7.2).

7.3. DOWNSTREAM OIL SECTOR AND PRODUCT CONSUMPTION

Refining Sector

Ecuador's 1993 installed refining capacity stood at 147,000 b/d (Table 7.5). Refinery throughput in 1991 was 124,150 b/d, giving its refining capacity a utilization rate of 84 percent. Ecuador's refining complex has a cracking-to-distillation ratio of 28 percent, close to the regional average ratio of 30 percent. Secondary processing units include 25,200 b/d of thermal operations, 16,000 b/d of catalytic cracking, and 2,780 b/d of catalytic reforming (see Table 7.5). Petroecuador owns all the refineries in the country.

While mainly focusing on upgrading the existing installations, Petroecuador has recently drawn up plans to expand its crude distillation capacity at the Esmeraldas and Amazonas refineries. The state oil company believes its current refining capacity is sufficient for the next few years and expansion plans are principally long-term projects, including 20,000 b/d and 10,000 b/d CDU expansion, respectively, at the Esmeraldas and Amazonas refineries.⁷³ By upgrading the existing refineries and eliminating bottlenecks in the production process, Petroecuador intends to increase LPG production in order to meet the growing demand for LPG. The company also intends to

73. See *Oil & Gas Journal*, October 18, 1993.

Table 7.5
Ecuador's 1993 Refining Capacity and Configuration
('000 b/cd)

Company	Location	CDU	VDU	Thermal Operations	Cat. Cracking	Cat. Reforming
Petroecuador	Esmeraldas	90.0	43.0	25.2	16.0	2.8
Petroecuador	Sta. Elena Peninsula	46.0				
Petroecuador	Refineria Amazonas	10.0				
Petroecuador/a	Lago-Agrio	1.0				
Total		147.0	43.0	25.2	16.0	2.8

a. Managed until June 1992 by Texaco, which then turned over the ownership and management of the refinery to Petroecuador.

Sources: *Oil & Gas Journal*; *East-West Center PREM Data File*.

increase the production of unleaded gasoline as only about 10 percent of Petroecuador's gasoline production is unleaded.⁷⁴ The state oil company is also planning to further upgrade its refineries after 1996 in order to process the rising share of heavy crude in Ecuador's oil production.

Petroleum Product Balance

Ecuador produced 120,500 b/d of refined products in 1991, with fuel oil production accounting for 41 percent, gasoline 26 percent, diesel 21 percent, and LPG only 5 percent. However, Ecuador's product consumption pattern shows LPG demand to be 13 percent of total consumption, gasoline 32 percent, diesel 23 percent, and fuel oil 25 percent of about 100,000 b/d total (Table 7.6). Thus, Ecuador's refining balance has a significant fuel oil surplus and an LPG deficit. In 1991, refined product exports were around 28,000 b/d, 89 percent of which were fuel oil. This does not include the "black market" oil product trade between Ecuador and neighboring countries, Colombia and Peru. It is estimated that approximately 10 percent of refined products is illegally exported because of Ecuador's low domestic prices. About 70 percent of Ecuador's 1991 product exports went to the United States.⁷⁵ The country imported 7,300 b/d of products, 88 percent of which was LPG (see Table 7.6).

Outlook for Petroleum Product Consumption

Population growth and economic performance are important factors that affect a country's energy consumption. In addition to those factors, fuel price patterns and changes also have an enormous impact on oil consumption. Oil product prices in Ecuador are among the lowest in Latin America, and the prices experienced little change over the past several years through late 1992. For instance, the average prices of LPG and premium gasoline were only 15¢/gal and 55¢/gal, respectively, in January 1990, and remained as low as 11¢/gal and 62¢/gal in August 1992 (Figure 7.3). The prices of these two fuels increased sharply in September 1992, after Andres Barreiro assumed the position as the new energy minister. His action in raising domestic fuel

74. See Wu (1992b).

75. See *World Oil Trade* (1993).

Table 7.6
Ecuador's Petroleum Product Balance, 1991
('000 b/d)

Product	Production	Imports	Exports	Consumption	Stock Change
LPG	6.0	6.4	0.0	12.5	-0.1
Gasoline	30.8	0.8	0.0	31.6	0.0
Kero/Jet	6.7	0.1	0.9	6.1	-0.1
Diesel	25.6	0.0	2.3	23.2	0.1
Fuel Oil	49.6	0.0	24.8	24.8	0.1
Others	1.7	0.0	0.0	1.7	0.0
Total	120.5	7.3	28.0	99.9	0.0

Note: Individual units do not necessarily add up to the total because of independent rounding.

Source: East-West Center PREM Data File.

Figure 7.3
Domestic Prices of Selected Refinery
Products in Ecuador, Jan. 1990 - Sep. 1993

Source: East-West Center PREM Data File.

prices was so controversial, however, that he was forced to resign in February 1993, becoming the fourth energy minister in Ecuador to step down since 1991 over the issue of fuel prices. In September 1993, average prices of LPG and premium gasoline were 21¢/gal and US\$1.24/gal, significantly higher than the prices two years earlier but still among the lowest in Latin America. As mentioned earlier, low fuel prices caused the smuggling of Ecuadorian refined products to neighboring countries and boosted domestic oil consumption. The Ecuadorian sucre has been depreciating against the U.S. dollar, and its value dropped from 663 sucres/US\$ in January 1990 to 1,940 sucres/US\$ in September 1993 (Figure 7.4). The depreciation partially reflects high domestic inflation in Ecuador.

Based on an assessment of the above factors, the average annual growth rate of oil product consumption in Ecuador is expected to be 3 percent between 1991 and 2000. Oil product consumption in the year 2000 will reach 129,900 b/d, up from approximately 99,000 b/d in 1991 (Table 7.7). However, the high case scenario shows that major oil product consumption could increase at an average annual rate of 4.2 percent, while under the low case scenario it might grow by only 1 percent a year. In terms of the base case scenario, consumption of LPG and diesel is expected to rise more rapidly than the average at rates of 5 and 4 percent, respectively, while fuel oil consumption will expand by only 1 percent per annum.

7.4. NATURAL GAS UTILIZATION

With a high reserves-to-annual-production ratio and a low gas utilization rate (the rest of the gas is flared or reinjected), Ecuador has significant potential to increase gas production and make better use of its produced gas. In 1991, all of the 23 MMcf/d of utilized natural gas went to gas treatment plants for the production of LPG (see Appendix VI). As part of the government's new hydrocarbons policy, more gas will be used to produce LPG, given its high demand. Furthermore, the government is planning to encourage direct consumption of natural gas in the residential and light industrial markets. Gas utilization is expected to increase at an average annual rate of 10 percent between 1991 and 2000, due to increasing LPG demand and new direct consumption of natural gas in the future.

Figure 7.4
Ecuador's Monthly Exchange Rate,
Jan. 1990 - Sep. 1993

Source: East-West Center PREM Data File.

Table 7.7
Forecast of Ecuador's Petroleum Product Consumption, 1991, 1995, and 2000
('000 b/d)

Year	LPG	Gasoline	Kero/Jet	Diesel	Fuel Oil	Others	Total
1991 (actual)	12.5	31.6	6.1	23.2	24.8	1.7	99.9
1995 (forecast)							
High Case	16.4	37.0	6.8	28.7	26.8	1.9	117.7
Base Case	15.2	35.6	6.6	27.1	25.8	1.8	112.1
Low Case	13.5	32.9	6.3	25.1	25.0	1.8	104.7
2000 (forecast)							
High Case	23.0	45.0	7.9	36.7	29.6	2.1	144.3
Base Case	19.4	41.2	7.3	33.0	27.1	1.9	129.9
Low Case	15.0	34.6	6.6	26.4	25.3	1.8	109.6

Note: Individual units do not necessarily add up to the total because of independent rounding.

Source: East-West Center PREM Data File and Forecasts.

7.5. IMPORTANT HYDROCARBONS POLICY ISSUES

The major policy issue facing Ecuador's oil and gas sector is acquiring adequate funding—either internally or through foreign investment—to sustain the country's oil production and maintain exports. The country also needs a well-formulated policy for its gas sector. At present, the government still maintains its focus on oil and it intends to:

1. continue to diversify its crude export markets;
2. continue to pursue new marketing strategies for its blended crude;
3. upgrade its refineries to increase production of light fuels;
4. sustain the production of Oriente crude by using enhanced oil recovery (EOR) measures; and
5. enhance Petroecuador's overall exploration and production activities for oil.

While all these measures will contribute to the well-being of the oil sector, the funding for these projects is in question. It is estimated that as much as US\$3 billion will be needed to develop heavy oil reserves in Ecuador, and even more outside investment will be required to ensure that Ecuador remains an oil exporter into the twenty-first century. Among the conditions needed to attract such investments, the most crucial is creating a stable investment climate.

The importance of a stable regulatory environment for foreign participation in future petroleum development has been highlighted by the October 1991 decision by Conoco to withdraw from Ecuador, abandoning a US\$600 million heavy crude development project. Although Conoco cited financial considerations as the basis for its move, it is believed that changes in pricing and environmental regulations were important factors in the company's decision to withdraw after completing two and a half years of negotiations over the commercial development of Block 16 in the Amazon region. Conoco's partner, Maxus, has continued with the project's development. However, the new government is making efforts to encourage foreign investment in oil exploration and production, and has been quick to approve new projects. It has gone even further by proposing to privatize the state owned Petroecuador. But the privatization plan is still pending as the Congress debates the pros and cons of the plan. The Ecuadorean government has also become more independent in pursuing its oil production and export policies after withdrawing from full membership in OPEC in late 1992. These developments may signal a change in

government policy toward foreign investment in the country and may have a long-term impact on the future of the country's hydrocarbons sector.

VIII. TRINIDAD AND TOBAGO

Trinidad and Tobago is a small, English-speaking Caribbean island country located just seven miles off the northeastern coast of Venezuela. Trinidad and Tobago has a high education level and a literacy rate of 97 percent. Its per capita GNP (US\$3,670 in 1991)⁷⁶ is the highest in Latin America and the Caribbean. However, the economy is experiencing difficulties as the country is burdened with a large foreign debt (US\$2.1 billion in early 1992) and a high unemployment rate (about 23% in 1991), although the GDP growth rate has taken a positive turn since 1990 following years of negative growth.

The abundant oil and natural gas resources, in addition to a well-developed heavy industry infrastructure, enabled the island state to become one of the most prosperous countries in the Latin American and Caribbean region, especially in the 1970s. The Trinidad and Tobago economy has been based on oil and gas for two decades. Oil revenues allowed the country to embark on a rapid industrial and infrastructural development program that generated a dramatic increase in domestic consumption of oil in the 1970s.⁷⁷ However, Trinidad and Tobago has been in a recession since the end of 1982, owing to its slow adjustment to declining world oil prices. The country experienced an urban unemployment rate of over 20 percent during the late 1980s. During 1990-1991, real GDP grew by an average of 2.4 percent a year. However, real GDP declined again by 0.1 percent in 1992 and by 1 percent in 1993.⁷⁸

8.1. PRIMARY ENERGY SUPPLY

The most important primary energy sources in Trinidad and Tobago are natural gas and oil. In 1991, the country produced 279,500 boe/d of primary energy, down from 292,500 boe/d in 1980 (Figure 8.1). In 1992, the primary energy production went down further to 278,500 boe/d.

76. See World Bank (1993).

77. See Culver-Hopper et al. (1992), p. 59.

78. See EIU (1993h and 1994g) for details.

Figure 8.1
Trinidad and Tobago's Primary Energy
Production by Source, 1980 and 1991

Source: East-West Center PREM Data File.

Trinidad and Tobago is the only country among the ten examined in this report that experienced a drop in primary energy production during the 1980s, mainly because of the decline in oil production. Oil accounted for 52.9 percent of the country's 1991 primary energy production, followed by natural gas (46.5%). During the period from 1980 to 1991, natural gas production increased at an average annual rate of 4.8 percent while oil production declined by an average of 3.3 percent each year.

Trinidad and Tobago is a net energy exporter, with all exports being oil and products. In 1991, the country exported 72,500 b/d of crude oil and 75,000 b/d of refined products. In the same year, the country imported 41,700 b/d of crude and 2,000 b/d of products. The country has rapidly expanded its gas industry in recent years as oil production continues to drop. By 1990 the earnings from the gas-based industries provided almost one-quarter of the petroleum sector's contribution.⁷⁹ Gas will play an even larger role in Trinidad and Tobago's economy in the future.

Oil

The oil industry—both upstream and downstream—has been important to Trinidad and Tobago. Oil alone accounted for 23 percent of the country's 1992 GDP.⁸⁰ It provided 72 percent of trade revenues in 1992; when petrochemical exports are included, hydrocarbon-based exports accounted for nearly 90 percent of the country's export earnings.

Proven reserves of crude oil were estimated to be 494 million barrels at the end of 1992, about the same as in 1991 but down from 536 million barrels in 1989. Crude production in 1992 was 145,900 b/d, down from 147,600 b/d in 1991 and 151,200 b/d in 1990 (Table 8.1). The country's oil reserve base is small compared with reserves of the big players in the region, such

79. See Boopsingh (1993a).

80. See EIU (1993h).

Table 8.1
Petroleum Data for Trinidad and Tobago, 1988-1992
('000 b/d)

Year	Reserves/a	Crude Production	Crude Exports	Crude Imports	Product Consumption
1988	524	151.3	74.5	7.0	17.0
1989	536	149.3	73.2	2.8	15.6
1990	522	151.2	75.3	17.6	19.0
1991	494	147.6	72.5	41.7	20.3
1992	494	145.9	79.1	55.5	24.7

a. Million barrels.

Source: East-West Center PREM Data File.

Table 8.2
Natural Gas Data for Trinidad and Tobago, 1988-1992
(MMcf/d)

Year	Reserves/a	Production	Exports	Imports	Utilization/b
1988	9,905	720	0	0	483
1989	9,431	700	0	0	481
1990	9,154	643	0	0	506
1991	8,666	716	0	0	568
1992	8,718	720	0	0	561

a. Billion cubic feet (bcf). b. Defined as transformation plus final consumption, with appropriate adjustment of stock change.

Source: East-West Center PREM Data File.

as Venezuela and Mexico. At the 1992 production level of 145,900 b/d, the life of the reserves is estimated to be less than 10 years.

About three-quarters of Trinidad and Tobago's oil production is from offshore oil fields. Amoco Trinidad Oil Company, the only major foreign oil company currently producing a significant volume of oil in the country, provided approximately half of the crude oil output in 1990. British-owned Premier Consolidated Oilfields produced only minor amounts (less than 1,000 b/d).⁸¹

While exporting 72,500 b/d and 79,100 b/d of crude oil in 1991 and 1992, respectively, Trinidad and Tobago also imported as much as 41,700 b/d and 55,500 b/d of crude oil for its refineries in these two years—a sharp increase over the imports of only about 18,000 b/d in 1990. (These data do not include the estimated 70,000 b/d of Venezuelan crude that was processed for PDVSA.) The country also exported 75,000 b/d (78%) of the oil products it produced in 1991. All of the country's 1991 crude exports (72,500 b/d) went to the United States. The country's oil product exports are much more diversified. For instance in 1990, Trinidad and Tobago exported refined products not only to the United States (which accounted for 20 percent of total product exports), but also to Barbados (LPG, kerosene, diesel, and fuel oil), Brazil (diesel oil), the Dominican Republic (diesel), Costa Rica (diesel), Guyana (gasoline, kerosene, diesel, and fuel oil), Jamaica (fuel oil), Panama (LPG), Suriname (gasoline, kerosene, and fuel oil), and other countries.

Since 1988, the government has held several bidding rounds calling for joint ventures between foreign oil companies and the state-owned enterprises, now consolidated as the Petroleum Company of Trinidad and Tobago (Petrotrin).⁸² However, results of the oil exploration have been disappointing so far. Government officials acknowledge that all large and economically

81. See Quijano et al. (1990); and Wu (1992a).

82. Petrotrin was founded in late 1992 by the merger of the Trinidad and Tobago Petroleum Company (Trintopec) and the Trinidad and Tobago Oil Company (Trintoc).

feasible crude fields have already been found. More advanced technology and greater expenditures will be necessary for further exploration. Moreover, the newly found oil tends to be heavier and more sour than high-quality crude that has traditionally been produced, which makes it more difficult to export or feed into domestic refineries.

Natural Gas

Natural gas reserves in Trinidad and Tobago are relatively abundant. With its proven reserves of 8.7 trillion cubic feet (tcf), Trinidad and Tobago ranks fourth in the region in reserves, after Venezuela, Mexico, and Argentina. It produced 720 MMcf/d of natural gas in 1992, ranking fifth in the region, slightly up from the 716 MMcf/d produced in 1990 (Table 8.2).

Figure 8.2 shows proven reserves of natural gas and production from 1972 to 1992. Gas production increased steadily from 230 MMcf/d in 1972 to 720 MMcf/d in 1992, growing at an average annual rate of 5.9 percent. In recent years, gas reserves have been declining. However, it is believed that the estimated reserves shown in Figure 8.2 are too conservative. If the new discoveries of offshore natural gas are confirmed, the reserves will certainly increase. Even with a conservative estimate of 8.7 tcf of proven gas reserves, the country could continue for at least another 30 years at its 1992 level of production.

8.2. PRIMARY ENERGY CONSUMPTION

Current Situation

Trinidad and Tobago's domestic energy consumption is gas-based rather than oil-based. In 1991, primary energy consumption was 123,000 boe/d, up from 58,000 boe/d in 1980, growing at an average annual rate of 7.1 percent (Figure 8.3). The primary consumption consists almost entirely of gas and oil. Of the 123,000 boe/d of primary energy consumption in 1991, gas accounted for 84 percent. Oil (15%) and cane products (less than 1%) made up the remaining shares (Table 8.3). During the period from 1980 to 1991, while oil consumption experienced a decline, gas consumption increased at an average annual rate of 9.4 percent, further emphasizing the predominance of gas in the hydrocarbons sector.

Figure 8.2
Natural Gas Production and Proven
Reserves In Trinidad and Tobago, 1972-1992

Source: East-West Center PREM Data File.

Figure 8.3
Trinidad and Tobago's Actual and Projected
Primary Energy Consumption, 1980, 1991, and 2000

Source: East-West Center PREM Data File and Forecasts.

Table 8.3
Percentage Distribution of Primary Energy
Consumption: Trinidad and Tobago, 1980, 1991, and 2000
 (%)

	1980	1991	2000
Oil	33.0	15.2	13.1
Natural Gas	66.5	84.1	86.3
Others	0.5	0.7	0.6
Total	100.0	100.0	100.0

Source: East-West Center PREM Data File and Forecasts.

Outlook for 2000

As in the cases of other countries in this report, the forecast for Trinidad and Tobago's primary energy consumption is based on several factors, including population and GDP growth, and an assessment of historical changes in per capita energy consumption and energy intensity. Fuel price changes are also taken into consideration in forecasting oil product consumption.

Among the ten countries in this study, Trinidad and Tobago has the smallest population (1.34 million in 1993).⁸³ Trinidad and Tobago's population increased at an average annual rate of 1.7 percent from 1980 to 1991, and real GDP decreased by an average of 1.8 percent from 1980 to 1991. Based on IDB (1993), EIU (1993h), and OLADE (1993) estimates, it is expected that the population will increase by an average of 1.5 percent from 1991 to 2000, and that real GDP will rise an average of 1 percent a year between 1991 and 2000 following the recovery of the economy in the early 1990s. The key data and assumptions, including changes in per capita primary energy consumption and energy intensity in the past decade, are summarized in Table 8.4.

Given the relatively small size and large gas and oil reserve base of the country, Trinidad and Tobago will remain a net energy exporter. However, gas consumption will continue to grow faster than oil consumption in the future. It is estimated that gas consumption will rise from 104,000 boe/d in 1991 to 141,300 boe/d in 2000, thereby increasing its share in total primary energy consumption from 84.1 percent to 86.3 percent, while the share of oil decreases from 15.3 percent to 13.1 percent (see Table 8.3).

8.3. DOWNSTREAM OIL SECTOR AND PRODUCT CONSUMPTION

Refinery Dilemma in Trinidad and Tobago

Trinidad and Tobago's current nameplate refining capacity is 246,000 b/d. Two refineries operated by the state-owned Trinidad and Tobago Oil Company (Trintoc) produced approximately 100,000 b/d of oil products in 1991, at a low utilization rate of only 41 percent

83. See OLADE (1993).

Table 8.4
Key Data and Assumptions for Forecast of Trinidad and Tobago's
Primary Energy Consumption, 1980-2000

Key Item	Unit	Data/Assumptions
Population		
AAGR 1980-1991	percent	1.70
AAGR 1991-2000	percent	1.50
GDP		
AAGR 1980-1991	percent	-1.8
AAGR 1991-2000	percent	1.0
Per Capita GDP		
AAGR 1980-1991	percent	-3.5
AAGR 1991-2000	percent	-0.5
Per Capita Primary Energy Consumption		
1980	boe/person	19.6
1991	boe/person	34.7
AAGR 1980-1991	percent	5.3
Energy Intensity		
1980	kcal/US\$(1980)	5,047
1991	kcal/US\$(1980)	13,146
AAGR 1980-1991	percent	9.1

AAGR = average annual growth rate.

Sources: East-West Center PREM Data File and IDB (1993).

of the plants' capacity. In order to make better use of this spare capacity, Trintoc leased part of its refinery capacity to Venezuela's PDVSA. In 1990, PDVSA processed 30,000 b/d of oil in Trinidad, all of which was shipped back to Venezuela. The volume of oil processed for PDVSA increased to 70,000 b/d in 1991 and 1992.

Both of Trinidad and Tobago's refineries are now owned by the newly consolidated state oil company, Petrotrin. One of the refineries is located at Pointe-à-Pierre in western Trinidad. It has a crude distillation capacity of 166,000 b/d. The other refinery with a capacity of 80,000 b/d is located at Point Fortin (Table 8.5).

A major dilemma for Trinidad and Tobago's oil sector is caused by two incompatible policy options. On the one hand, the government wants to retain the existing refining complex (which is huge compared to domestic consumption). On the other hand, the government also intends to maintain a high volume of crude exports. However, it is difficult for the government to effectively pursue both options. As a result of poor management, low profits, reduced demand for fuel oil in the U.S. market, and high oil prices in the early 1980s, the country's refining capacity was reduced from 456,000 b/d in 1980 to 260,000 b/d in 1985 and 246,000 b/d in 1992. However, even with these reductions, 31-59 percent of current capacity may remain idle at any point, depending on how much capacity is being leased by foreign companies.

In addition to the low utilization rate and reduced capacity, there are other problems in Trinidad and Tobago's refining industry. The industry is based on aging facilities and infrastructure that is in need of rehabilitation. Its refining capacity remains simple, with a cracking-to-distillation ratio of only 9 percent, a rather low level that is unable to meet increasing demand for lighter products in international markets. Thus it must upgrade its facilities in order to be able to meet the more stringent fuel specifications in the United States and to increase flexibility to cater to other product export markets.

These problems have caught the attention of the new government, which is now planning to improve the downstream infrastructure and upgrade the country's refineries. The Inter-American

Table 8.5
Trinidad and Tobago's 1993 Refining Capacity and Configuration
('000 b/cd)

Company	Location	CDU	VDU	Thermal Operations	Cat. Cracking	Cat. Reforming	Hydro Treating
Petrotrin	Pointe-a-Pierre	166.0	130.0	8.0	26.0	22.2	39.6
Petrotrin	Point Fortin	80.0				5.7	20.0
Total		246.0	130.0	8.0	26.0	27.9	59.6

Sources: Oil & Gas Journal; East-West Center PREM Data File.

Development Bank (IDB) will become the main financier of Petrotrin's refinery modernization and the Petrotrin/Trintomar⁸⁴ secondary oil recovery programs. Given the dilemma facing Trinidad and Tobago's oil industry, there are several options that the government can pursue in order to raise the utilization rates of its refineries:

1. reduce total capacity by closing down one of the refineries;
2. reduce crude exports and feed more domestic crude oil into its refineries;
3. increase crude imports to provide additional feedstocks for its refineries;
4. seek more processing contracts with countries such as Venezuela and Nigeria⁸⁵ to utilize the excess capacity.

The first option was highly unlikely because the government intended to maintain or even expand its refining capacity—until 1993, when Petrotrin offered to either sell off or shut down the small refinery at Point Fortin. There are also some problems with the second option, since the quality of some of the recently produced domestic oil is not very suitable for the country's refineries. However, there is sufficient excess capacity available for increasing domestic inputs to the refineries if the government intends to do so. Besides increasing domestic crude throughputs, Trinidad and Tobago's government can seriously consider the last two options as it seeks to turn the country into an important oil refiner and trader in the Western Hemisphere.

Due to its geographical location between North and South America, Trinidad and Tobago has the potential to become a very important crude refining center in the Western Hemisphere. The country's refining capacity is nearly sixteen times larger than its domestic oil consumption.

84. Trintomar (Trinidad & Tobago Marine Petroleum Company) was established in 1988 as a consortium of three state energy companies existing at that time: Trintoc, Trintopec, and the National Gas Company (NGC).

85. Nigeria may be refining some of its crude in Trinidad and Tobago under a technical agreement.

There are a number of things that the country can do to revive its refining sector. First, the island commonwealth can take advantage of its strategic location and sufficient refining capacity to develop into an important regional oil trading and refining center for the Americas.

Second, the country can steadily increase third-party processing deals to raise the utilization rate of its refining capacity. This way, the country can turn itself into an important regional trading center for crude and refined products. Since Trinidad and Tobago is near Venezuela—one of the two largest crude oil producers and exporters in the region—it will not be difficult for the country to obtain crude oil to supplement its own production.

Finally, the least the country can do over the short term is to provide good maintenance for its refining facilities and make them available for leasing. African and Middle Eastern oil can be refined in Trinidad and exported. We expect that more countries will be interested in leasing the country's extra capacity to refine crude oil.

The conclusion drawn from this short discussion is that the government of Trinidad and Tobago is facing tough choices in order to solve the dilemma as described above. Given the country's limited oil reserves, coupled with relatively abundant gas resources and large underutilized refining capacity as well as unstable oil prices in world markets, maintaining a sizable volume of crude oil exports is neither sustainable nor economically feasible. Under these circumstances, natural gas becomes one of the important resources that the country can employ to revive its hydrocarbons sector, which will be discussed in the following section. On an overall basis, the government would better utilize the country's resources by shifting the emphasis of its hydrocarbons policy from crude exports to developing natural gas, revamping the refineries, enhancing petrochemical production, and exporting more gas (in the form of LNG) and gas products (petrochemicals and fertilizers) as well as petroleum products after refinery upgrading.

Petroleum Product Balance

In 1991, oil product consumption in Trinidad and Tobago in 1991 was 20,300 b/d, up from 19,000 b/d in 1990. The consumption increased further to 24,700 b/d in 1992. Gasoline

accounted for 40 percent; diesel, 18 percent; LPG, 8 percent; and kerosene, 7 percent. Fuel oil consumption was only 500 b/d, or 2 percent of total consumption. Other products, such as gasses and non-energy products, accounted for 25 percent of the total volume of product consumption. Since most of Trinidad and Tobago's power plants are fueled by natural gas, 97 percent of the produced fuel oil was exported in 1991 (Table 8.6).

Outlook for Petroleum Product Consumption

Trinidad and Tobago has a fairly competitive petroleum product market. The domestic prices of the main refined products are by and large in line with the international market or North American markets. The dollar-equivalent fuel prices were relatively stable before November 1992 and since then have increased and fluctuated. In January 1990, the price of premium gasoline was US\$1.33/gal, increasing to US\$1.75/gal in January 1992. In September 1993, the price was US\$1.50/gal (Figure 8.4). The Trinidad and Tobago dollar was also stable before April 1993, registering at 4.25 TT\$ per US dollar, but was devalued to 5.63 TT\$ per US dollar in September 1993 (Figure 8.5).

The forecast of Trinidad and Tobago's oil product consumption is based on the historical trend of the consumption and fuel price changes as mentioned above. It is expected that demand for oil products in Trinidad and Tobago will increase at an average annual rate between 0.7 and 3.5 percent. Product consumption is forecast to increase to 23,200 b/d in the year 2000 for the base case, 28,500 b/d for the high case, and 21,600 b/d for the low case (Table 8.7). The highest growth rate is expected for LPG consumption, at an annual average rate of 6.1 percent between 1991 and 2000, followed by diesel at 1.3 percent a year and kero/jet at 1.2 percent a year. Consumption of other products, including gasoline and fuel oil, is expected to increase less than 1 percent a year.

8.4. NATURAL GAS UTILIZATION

One estimate has put Trinidad and Tobago's natural gas reserves, probable and possible, as high as 22.5 tcf, which is more than double the current proven reserves. In a separate estimate, it was

Table 8.6
Trinidad and Tobago's Petroleum Product Balance, 1991
('000 b/d)

Product	Production	Imports	Exports	Consumption	Stock Change
LPG	4.0	0.5	2.9	1.6	0.0
Gasoline	19.5	0.0	10.3	8.0	1.2
Kero/Jet	8.6	0.0	7.1	1.5	-0.1
Diesel	14.5	1.3	11.7	3.6	0.4
Fuel Oil	43.0	0.0	41.7	0.5	0.8
Others	6.9	0.3	1.3	5.0	0.8
Total	96.4	2.0	75.0	20.3	3.2

Note: Individual units do not necessarily add up to the total because of independent rounding.

Source: East-West Center PREM Data File.

Source: East-West Center PREM Data File.

Figure 8.5
Trinidad and Tobago's Monthly
Exchange Rate, Jan. 1990 - Sep. 1993

Source: East-West Center PREM Data File.

Table 8.7
Forecast of Trinidad and Tobago's Petroleum Product Consumption, 1991, 1995, and 2000
('000 b/d)

Year	LPG	Gasoline	Kero/Jet	Diesel	Fuel Oil	Others	Total
1991 (actual)	1.6	8.0	1.5	3.6	0.5	5.0	20.3
1995 (forecast)							
High Case	2.5	9.2	1.8	4.4	0.6	5.7	24.2
Base Case	2.3	8.4	1.6	3.9	0.5	5.2	22.0
Low Case	2.2	8.2	1.6	3.8	0.5	5.1	21.5
2000 (forecast)							
High Case	3.1	10.7	2.1	5.4	0.7	6.6	28.5
Base Case	2.7	8.8	1.7	4.1	0.6	5.4	23.2
Low Case	2.4	8.2	1.6	3.8	0.5	5.1	21.6

Note: Individual units do not necessarily add up to the total because of independent rounding.

Source: East-West Center PREM Data File and Forecasts.

reported that the state-owned National Gas Company (NGC) has at its disposal 16.5 tcf of gas reserves. Recent exploration in Trinidad and Tobago focused on finding crude oil has resulted in substantial offshore discoveries of natural gas. By any account, the future of this country's gas sector is promising as a result of increasing demand for gas in the domestic market and for LNG in overseas markets.

About 78 percent of the 720 MMcf/d of natural gas produced in 1992 was consumed, all domestically, and the rest of the gas was flared, lost, or simply unused (see Appendix VII). Approximately one-quarter of current industrial sector consumption is accounted for by electricity generation, and 56 percent goes to the manufacture of petrochemicals (fertilizers and methanol).

Amoco Trinidad Oil Company is one of the major foreign companies that have gas holdings in this country. The other companies are Occidental, Germany's Deminex, and British Gas. Amoco Trinidad has planned to invest US\$300 million to develop offshore gas fields under a contract signed with the NGC in November 1991. The two fields that Amoco is to develop off Trinidad's eastern coast have a combined capacity of 480 MMcf/d in which production will peak in the mid-1990s. The company will increase its delivery of gas to the NGC from the current level of 200 MMcf/d to 350 MMcf/d by 1996.

Trinidad and Tobago's natural gas resources were largely underdeveloped until the late 1970s when the government initiated efforts to diversify its fuel consumption. Development of natural gas became even more important in the late 1980s when oil production started to decline. In its efforts to encourage gas consumption and expand gas exports, there are four options available to the Trinidad and Tobago government:

1. greater domestic use of natural gas;
2. indirect exports, through the production and marketing abroad of gas-intensive commodities, such as methanol, fertilizers, and probably MTBE and other such chemicals;

3. higher utilization rate of produced gas; and
4. direct exports of gas through a pipeline or in the form of LNG.

While it has pursued the first two options throughout the 1980s, the government is now focusing its attention on the third option and, most importantly, the fourth option. The government is actively negotiating with international gas companies to encourage more investment in the gas sector. The government is also searching for potential gas export markets.

The government's efforts to attract foreign investment have paid off. In addition to the proposed LNG plants of Amoco Trinidad Oil Company, British Gas is studying the possibility of setting up large LNG plants in Trinidad to supply LNG to Europe, where the prices are higher than in the U.S. market. The two-phase project could be completed within six to seven years with a total investment of up to US\$2 billion. Each phase of the project will be capable of producing 250 MMcf/d of LNG.

8.5. IMPORTANT HYDROCARBONS POLICY ISSUES

Although the nationalist sentiments were not as strong in Trinidad and Tobago as in other major Latin American oil producers in the 1970s, the government did buy out the entire assets of Shell and partial interests of Texaco and Tesoro in order to form its first national oil company, Trintoc, in the face of rising oil prices. Texaco and Tesoro finally withdrew from the country in 1985 when the government bought out Texaco's 225,000 b/d Pointe-à-Pierre refinery and its onshore production properties, as well as Tesoro's 49.9 percent share of the Trinidad-Tesoro Company. The withdrawal of these companies had a negative impact on government efforts to attract foreign investment in oil exploration, which were further hampered by the country's complicated tax regime and lengthy bidding process. Operations of the oil industry in Trinidad and Tobago are governed by the 1969 Petroleum Act and the 1970 Petroleum Regulations. These two laws were further amended in 1974 by the Petroleum Taxes Act, and again in 1981, 1984, and 1988. In addition to the Petroleum Profits Tax (PPT) that foreign oil companies have to pay, the Supplemental Profit Tax (SPT) has particularly drawn criticism from foreign investors as heavy and uncertain.

In recent years, both the former government (from 1986 to 1991) and the present government (since December 1991) have made great efforts to attract foreign investors by holding international biddings, and to intensify exploration activities by encouraging offshore exploration and enhanced recovery of onshore oil. Under Prime Minister Patrick Manning, the present government's tax reform began in July 1992. New and reduced tax rates, including the SPT, became effective in late 1992.⁸⁶ The government also encourages the participation of private/foreign sector in oil and gas development, both upstream and downstream, by reducing the state involvement in certain projects.

Despite all of the dilemmas and problems discussed above, there is much hope for Trinidad and Tobago's hydrocarbons sector. First of all, the country's natural gas resources have a bright future. The planned LNG plants to be established by British Gas and Amoco Trinidad are worldscale. Potential markets for LNG include the United States, Europe, Puerto Rico, Panama, Brazil, and other Caribbean countries. The government could earn substantial amounts of foreign exchange through exports of natural gas through pipelines or as LNG.

Secondly, the role of Trinidad and Tobago in the regional petroleum product market can be greatly enhanced if the refining sector can indeed be revived under the new policies. To achieve this goal, the government needs to pay more attention to the refining sector. Increasing the utilization rate of current refining capacity and upgrading the refineries are among the many things that the government can do. If not all of the indigenous crude can be used in the refineries because of unsuitable qualities, Trintoc could import substantial amounts of crude to feed its refineries and to make the expensive program of refinery upgrading economically justifiable and feasible. The government recently began focusing its attention on the issues of refinery upgrading and natural gas development. It expects to double its secondary refining capacity by the mid 1990s and is now actively seeking a partner with adequate crude oil supplies to cooperate in the program.

86. See Boopsingh (1993b).

We believe that Trinidad and Tobago will continue to benefit from its oil and gas resource endowments and its established hydrocarbons sector. Should it take advantage of its geographical location and substantial natural gas reserves, as well as underutilized refining potential, Trinidad and Tobago could become a very important link for the refined oil, petrochemicals, and LNG trade between North and South America.

IX. PERU

With a land area of 1.3 million km² and 22.5 million people (1992), Peru ranks fourth in land area and fifth in terms of population in Latin America. Peru's population growth (2.3% per annum in the 1980s and a forecast of 2% in the 1990s) and urbanization rates (70% in 1989) are higher than the world average.⁸⁷ Most Peruvians are mestizo or Indian; a small percentage of the population is of pure European or East Asian heritage.⁸⁸

The performance of the Peruvian economy in the 1980s varied significantly from year to year. Calculated on an average annual basis, real GDP grew at a rate of 2.1% from 1980 to 1988 but declined at a rate of 8.7 percent from 1988 to 1990. While GDP growth was positive in 1991, the Peruvian economy continue to experience negative overall GDP growth during 1990-1992. The economy rebounded in 1993 and the GDP growth was estimated to be 6 percent during the year. Inflation reached 7,482 percent in 1990, but sharply declined to 410 percent in 1991, 74 percent in 1992 and 40 percent by the end of 1993.⁸⁹ Currently, the government is focusing on curbing inflation. However, this effort is complicated by exchange rate fluctuations. The devaluation of the inti and the introduction of a new currency (the new sol), while helping to bolster Peru's exports, could lead to either a new jump in inflation or forced price control. The government appears to be trying to solve the problems of inflation and the inti's overvaluation simultaneously. Peru's exports have increased slightly since 1989. The United States accounts for about one-fourth of both exports and imports. With a sizeable debt of US\$21 billion in 1992 and a lack of outside funding, the growth of Peru's economy, including the hydrocarbons sectors, will be sharply constrained.

87. See IDB (1993).

88. See Culver-Hopper et al. (1992), p. 53.

89. See EIU (1993g) for details.

9.1. PRIMARY ENERGY SUPPLY

Peru has long been a net energy exporter, exporting mainly fuel oil and smaller amounts of gasoline. However, in recent years the country has gradually increased its imports of crude oil. As a result, the country has become merely self-sufficient in its overall energy balance. In 1991, oil provided 48.6 percent of Peru's primary energy production, while other energy (mostly firewood) accounted for 34.7 percent (Figure 9.1). The rest of the primary energy production was provided by hydroelectricity (10.4%), natural gas (5.9%), and coal (0.3%). Among the ten Latin American countries included in this study, Peru is one of only two countries in which primary energy production declined over the past decade. Primary energy in Peru declined from 305,360 boe/d in 1980 to 235,680 boe/d in 1991 at an average annual rate of 2.4 percent. Oil production exhibited the largest decrease, dropping from 194,810 boe/d in 1980 to 114,160 boe/d in 1991 at an average annual rate of 4.7 percent, while gas production declined at an average annual rate of 3.8 percent during this period. On the other hand, coal production increased by an average rate of 3.1 percent a year, and hydroelectricity production rose by 4.6 percent a year between 1980 and 1991. Meanwhile, other energy increased at an average annual rate of less than 1 percent during this period.

Oil

Peru's oil reserves and production have been declining since 1988. At the end of 1992, proven reserves were estimated at 381 million barrels, down from 457 million barrels in 1988 (Table 9.1). Peru's 1992 crude production was 115,900 b/d, which is slightly higher than the 114,800 b/d produced in 1991, but 9 percent lower than the 128,900 b/d produced in 1990. The crude production increased by another 10,000 b/d to 126,000 b/d in 1993.⁹⁰ Of the total oil production in 1991, approximately half was produced by the state oil company, *Petróleos del Peru* (*Petroperú*), and its subsidiary, *Petromar*. *Occidental Petroleum* (*Oxy*) and *Oxy/Bridas* (a joint venture between *Oxy* and Argentina's *Bridas*) produced the other half of Peru's crude oil. Peru's 1991 crude oil imports reached 34,000 b/d, nearly double the 1990 imports of 17,600 b/d. Ecuador provided 67 percent of Peru's crude oil imports in 1991, and Colombia provided 34

90. See *Oil & Gas Journal*, March 14, 1994, p.87.

Figure 9.1
Peru's Primary Energy
Production by Source, 1980 and 1991

Source: East-West Center PREM Data File.

Table 9.1
Petroleum Data for Peru, 1988-1992
('000 b/d)

Year	Reserves/a	Crude Production	Crude Exports	Crude Imports	Product Consumption
1988	457	141.7	5.1	24.1	140.5
1989	412	130.4	1.0	18.8	121.4
1990	406	128.9	3.0	17.6	124.1
1991	383	114.8	1.0	34.0	116.6
1992	381	115.9	0.9	31.8	116.1

a. Million barrels.

Source: East-West Center PREM Data File.

Table 9.2
Natural Gas Data for Peru, 1988-1992
(MMcf/d)

Year	Reserves/a	Production	Exports	Imports	Utilization/b
1988	623	103	0	0	78
1989	650	94	0	0	68
1990	7,018/c	89	0	0	67
1991	7,075	83	0	0	63
1992	7,054	73	0	0	56

a. Billion cubic feet (bcf). b. Defined as transformation plus final consumption, with appropriate adjustment of stock change. c. Increases in reserves come from the unexploited Camisea deposit.

Source: East-West Center PREM Data File.

percent. The country also exports a small amount of crude oil (about 1,000 b/d in 1991) to Chile.⁹¹

The continuing decline in the production of oil, the most important source of energy in Peru, is a critical issue in the evaluation of the country's future energy supply. The Fujimori government has made efforts to accelerate oil exploration and development activities so as to arrest the decline of hydrocarbons production and reduce the country's dependence on costly foreign oil imports. Petroperú is forecasting that crude production will increase to 127,200 b/d in 1993 and 132,900 b/d in 1994. However, Peru's efforts to attract foreign investment to help increase its oil production may be hampered by the unstable domestic political situation.

All hydrocarbons activities in Peru fall under the purview of the Ministry of Energy and Mines. Contracts are administered by Petroperú, but must be approved by the Council of Ministers. During the last two decades, Petroperú has controlled most of the upstream operations and all downstream activities as well as imports and exports of oil. Private oil companies were permitted to operate in the upstream sector under contract with Petroperú. The oil industry has been substantially deregulated since late 1991 and privatized since 1993. (Petromar was sold to local and foreign investors in 1993.) A new hydrocarbons law has been approved by the Constituent Assembly. Under the new law, Petroperú will be completely demonopolized—90 percent of its fields will be handed over for exploration by foreign companies and its assets will be sold.⁹² Over 20 foreign oil companies have shown strong interests in conducting oil exploration and production activities in Peru under the country's relaxed hydrocarbons regime.

Natural Gas

Proven natural gas reserves at the end of 1992 were estimated at 7,054 bcf (Table 9.2). Gas reserves have increased exponentially since 1988, when reserves were only 623 bcf. Over 90

91. See *World Oil Trade* (1993).

92. See EIU (1993g), pp. 19-20.

percent of the significantly higher 1990 gas reserves correspond to the yet-unexploited Camisea deposit in the southern jungle region of the country. Peru now has the fifth largest gas reserves in Latin America. There are two main gas and condensate fields, first discovered by Shell, in the Camisea deposit. Recoverable natural gas and NGL deposits in this area have been estimated to be as high as 10,800 bcf and 725 million barrels, respectively. The Camisea fields are part of a larger geological basin known as the Ucayali Basin in Peru. Development of the Camisea deposit represents the most significant investment opportunity in the country's hydrocarbons sector.⁹³

While the country has significant gas resources, production does not reflect the potential of its reserves. In 1991, the country produced 83 MMcf/d of natural gas, down from 89 MMcf/d in 1990. The gas production sunk further to 73 MMcf/d in 1992. Most of the gas production was in northwestern Peru. Gas utilization in 1991 was 63 MMcf/d, with the rest flared and reinjected. No gas trade with other countries has yet taken place in Peru.

Before privatization, Petroperú controlled not only most of the oil-related activities in the country but also gas exploration, production, and processing. The gas fields, like the oil fields, will be opened for exploration by foreign investors. Some foreign oil companies, including Royal Dutch/Shell and Brazil's Braspetro and Odebrecht Construction, have already demonstrated an interest in Peru's gas resources.

Coal

Coal plays a minor role in Peru's primary energy production. Its coal reserves were estimated at 66 million tonnes in 1991, a year in which it produced only 60 thousand tonnes of coal, down from 130 thousand tonnes in 1989 and 102 thousand tonnes in 1990. The production increased to 90 thousand tonnes in 1992 (Table 9.3). However, despite this recent decline in production, on average coal production increased at an annual rate of 6.3 percent during the period 1980-1992. Coal imports amounted to 199 thousand tonnes in 1991 and 190 thousand tonnes in 1992,

93. See Obadía et al. (1992), p. 43.

Table 9.3
Coal Data for Peru, 1988-1992
('000 tonnes)

Year	Reserves/a	Production	Exports	Imports	Apparent Consumption/b
1988	66.0	126	0	62	188
1989	66.0	130	0	60	190
1990	66.0	102	0	45	147
1991	66.0	60	0	199	259
1992	66.0	90	0	190	280

a. Million tonnes. b. Defined as production plus net imports.

Source: East-West Center PREM Data File.

sharply increasing from 45 thousand tonnes in 1990. Of the 259 thousand tonnes of apparent coal consumption in 1991, about one-fourth was used to produce coke and the rest was consumed by the industrial, residential, agricultural, fishing, and mining sectors.

Hydroelectricity

Peru's installed hydropower capacity is 2,457 MW, constituting 59 percent of total power generating capacity in the country; but this is only 3.9 percent of the country's total hydroenergy potential of 62,530 MW. The capacity increments over the past decade were very limited, adding only 589 MW between 1980 and 1991. The country has seventeen hydropower stations and six of them have capacities of under 50 MW each. The Montaro-Restit plant, located in Huancavelica, is the largest hydropower station in Peru with an installed capacity of 1,010 MW. Hydroelectricity production increased by an average of 4.6 percent a year between 1980 and 1991, and its share in total primary energy production rose from 4.9 percent to 10.4 percent during this period. Given the country's low hydroenergy utilization rate, it is expected that new capacity will be added in the coming years. Therefore, both hydroelectricity production and consumption are expected to continue to increase for the rest of the decade.

9.2. PRIMARY ENERGY CONSUMPTION

Current Situation

Total primary energy consumption in 1991 was 232,200 boe/d, down from 238,000 boe/d in 1980 (Figure 9.2). Petroleum accounted for 48 percent of Peru's primary energy consumption in 1991, while firewood and cane bagasse provided 35 percent. Hydroelectricity, coal, and gas satisfied the remaining energy needs (Table 9.4). While gas and oil consumption declined by 2.4 percent and 1.6 percent a year, respectively, during the period between 1980 and 1991, coal consumption exhibited a sharp increase of 12.9 percent a year and consumption of hydroelectricity increased by an average of 4.6 percent a year. Together, oil and gas accounted for 62 percent of total primary energy consumption in Peru in 1980, but their combined share dropped to 53 percent by 1991.

Figure 9.2
Peru's Actual and Projected Primary
Energy Consumption, 1980, 1991, and 2000

Source: East-West Center PREM Data File and Forecasts.

Table 9.4
Percentage Distribution of Primary Energy
Consumption: Peru, 1980, 1991, and 2000
 (%)

	1980	1991	2000
Oil	56.4	48.2	48.4
Natural Gas	5.9	4.6	5.6
Coal	0.4	1.6	1.9
Hydroelectricity	6.2	10.5	11.2
Other	31.1	35.1	32.9
Total	100.0	100.0	100.0

Source: East-West Center PREM Data File and Forecasts.

Outlook for 2000

The forecast for Peru's primary energy consumption is based on projections of its population and real GDP growth as well as changes in per capita primary energy consumption and energy intensity. The Peruvian population grew at an average annual rate of about 2.37 percent between 1980 to 1992, but real GDP decreased by an average of 1.1 percent a year from 1980 and 1991. It is projected that the population growth rate will drop to an average of 2 percent a year between 1992 and 2000 and that the real GDP growth rate will increase to an average of 3.3 percent between 1991 and 2000.⁹⁴ Per capita primary energy consumption in Peru decreased from 5.0 boe/person in 1980 to 3.9 boe/person in 1991, and energy intensity increased from 5,593 kcal/US\$(1980) to 6,203 kcal/US\$(1980) during the same period. All of these data and assumptions are summarized in Table 9.5.

Based on these assumptions, primary energy consumption growth in Peru during the period 1991-2000 is expected to be the lowest of the ten countries in this study—and probably among the lowest in the entire region. This is mainly due to the difficult situation of the Peruvian economy and the political instability that has prevented economic growth and prosperity since the mid-1980s. The growth of the Peruvian economy is expected to be modest—averaging about 2.4 percent a year—during the next few years. During the second half of the 1990s economic growth could pick up, increasing to 3.5 percent a year between 1995 and 2000, if the government's efforts to solve the present economic problems are successful. Thus, between 1991 and 1995, primary energy consumption is expected to increase at a low average rate of 0.6 percent per year; this average rate could jump to 2.4 percent per year after 1995, with consumption reaching 271,000 boe/d in the year 2000. On average, primary energy consumption in Peru is expected to grow at an annual rate of 1.7 percent between 1991 and 2000. During this period, natural gas consumption is expected to increase at a higher average rate of 4 percent a year, followed by coal at 3.5 percent a year. Oil consumption is expected to expand at an average annual rate of 1.8 percent. Other energy consumption will continue to grow at a low rate of about 1 percent a year during the same period.

94. See IDB (1993).

Table 9.5
Key Data and Assumptions for Forecast of Peru's
Primary Energy Consumption, 1980-2000

Key Item	Unit	Data/Assumptions
Population		
AAGR 1980-1992	percent	2.37
AAGR 1992-2000	percent	1.99
GDP		
AAGR 1980-1991	percent	-1.1
AAGR 1991-2000	percent	3.3
Per Capita GDP		
AAGR 1980-1991	percent	-3.3
AAGR 1991-2000	percent	1.2
Per Capita Primary Energy Consumption		
1980	boe/person	5.0
1991	boe/person	3.9
AAGR 1980-1991	percent	-2.4
Energy Intensity		
1980	kcal/US\$(1980)	5,593
1991	kcal/US\$(1980)	6,203
AAGR 1980-1991	percent	0.9

AAGR = average annual growth rate.

Sources: East-West Center PREM Data File and IDB (1993).

9.3. DOWNSTREAM OIL SECTOR AND PRODUCT CONSUMPTION

Refining Sector

Petroperú owns and operates the country's six refineries, with the largest located in Lima, the country's capital. Total refining capacity was 188,820 b/d in early 1993 (Table 9.6). The cracking-to-distillation ratio of Peru's refineries is 13 percent, less than half of the region's average ratio. Secondary processing facilities include two catalytic crackers with a combined capacity of 24,600 b/d and one reformer with a capacity of 1,760 b/d. Refinery throughput in 1991 was 147,700 b/d, giving the Peruvian refining sector a utilization rate of 78 percent.

Petroperú has begun realizing its plans to expand and upgrade its refining complex. The Talara refinery is currently being expanded and upgraded to increase crude distillation capacity from 62,000 b/d to 75,000 b/d, vacuum distillation capacity from 22,800 b/d to 43,800 b/d, and fluid catalytic cracking (FCC) capacity from 16,600 b/d to 23,000 b/d. These expansions are scheduled for completion by 1996. A 1,620 b/d VDU and a 1,620 b/d cat reformer at Petroperú's Iquitos refinery are also in the planning stage. In addition, the La Pampilla refinery at Lima is to be substantially upgraded to handle Peru's heavier crude slate at a cost of US\$280 million. According to the plans, the vacuum distillation capacity will increase to 5,970 b/d from the current 4,350 b/d by 1994. A visbreaker with a capacity of 33,000 b/d and an FCC unit with a capacity of 15,000 b/d are also expected to be constructed at La Pampilla. In the planning stage for Petroperú's Iquitos refinery are a catalytic reformer with a capacity of 1,620 b/d and a vacuum distillation unit with a capacity of 1,620 b/d. In order to finance the much-needed investments in its processing, marketing, and distribution facilities, Petroperú originally planned to privatize some of its refineries, over 80 state-owned service stations, and a transport unit. However, the initial effort to sell one of Petroperú's small refineries was not successful.⁹⁵ Petroperú will soon embark on a full-scale privatization, and the results remain to be seen.

95. Petroperú failed to sell its 6,300 b/d Conchan refinery as no bidders applied for the sell-off in late 1992.

Table 9.6
Peru's 1993 Refining Capacity and Configuration
('000 b/cd)

Company	Location	CDU	VDU	Cat. Cracking	Cat. Reforming
Petroperu	Conchan	6.3	4.4	0.0	0.0
Petroperu	Iquitos, Loreto	10.5	0.0	0.0	0.0
Petroperu	La Pampilla, Lima	105.0	18.0	8.0	1.8
Petroperu	Marsella, Loreto	2.2	0.0	0.0	0.0
Petroperu	Pucallpa	2.9	0.0	0.0	0.0
Petroperu	Talara	62.0	22.8	16.6	0.0
Total		188.8	45.2	24.6	1.8

Sources: Oil & Gas Journal; East-West Center PREM Data File.

Petroleum Product Balance

Consumption of oil products totalled 116,600 b/d in 1991, with consumption distributed fairly evenly among gasoline (23%), kerosene/jet fuel (18%), diesel (28%), and fuel oil (23%). LPG consumption accounted for 5 percent of the total (Table 9.7). Exports of oil products from Peru increased to 43,800 b/d in 1991 from 39,700 b/d in 1990. However, 97 percent of total product exports consisted of fuel oil. The recipients of Peru's 1991 oil products were the United States, Mexico, Argentina, and Japan. Peru imported a small number of products (10,400 b/d), mainly diesel (64%) and LPG (20%), from countries such as the United States, Mexico, the Netherlands Antilles, Brazil, Chile, and France.⁹⁶

Outlook for Petroleum Product Consumption

In terms of U.S. dollars, refined fuel prices in Peru are very competitive. For instance, in March 1992, the average price of premium gasoline reached US\$2.85/gal, higher than the price in most Latin American countries (Figure 9.3). The fuel prices have since then declined. For instance, the average gasoline price was US\$1.85 in September 1993. On the other hand, the Peruvian exchange rate in recent years has been very volatile and the currency has depreciated rapidly, indicating that domestic refinery prices in terms of intis or new sols are also volatile. Peru introduced its new currency, the *nuevo sol* (new sol), in July 1991; one new sol is equivalent to one million intis. Prior to introduction of the new sol, the inti had already sharply depreciated from 6,393 intis/US\$ in January 1990 to 840,000 intis/US\$ in June 1991 (Figure 9.4).

The above changes in refined product prices in recent years, along with our projections of Peruvian population and economic growth, will be taken into consideration in the forecast of the country's petroleum product consumption. Based on the 1991 consumption level of 116,600 b/d of petroleum products, our base case scenario shows that product consumption is expected to increase slightly to 120,400 b/d in 1995 at an average annual growth rate of 0.8 percent between 1991 and 1995 and will rise to 136,500 b/d in 2000 at an average annual growth rate of 2.5

96. See *World Oil Trade* (1993).

Table 9.7
Peru's Petroleum Product Balance, 1991
('000 b/d)

Product	Production	Imports	Exports	Consumption	Stock Change
LPG	4.3	2.1	0.0	6.3	0.0
Gasoline	28.2	0.7	1.1	26.9	1.0
Kero/Jet	20.9	0.6	0.0	21.4	0.1
Diesel	26.3	6.7	0.5	32.2	0.3
Fuel Oil	69.0	0.0	42.3	26.3	0.4
Others	3.2	0.3	0.0	3.5	0.0
Total	151.8	10.4	43.8	116.6	1.8

Note: Individual units do not necessarily add up to the total because of independent rounding.

Source: East-West Center PREM Data File.

Figure 9.3
Domestic Prices of Selected Refinery
Products in Peru, Jan. 1990 - Sep. 1993

Source: East-West Center PREM Data File.

Figure 9.4
Peru's Monthly Exchange Rate,
Jan. 1990 - Sep. 1993

Source: East-West Center PREM Data File.

percent between 1995 and 2000 (Table 9.8). On an overall basis, oil product consumption between 1991 and 2000 is expected to increase at an average annual rate of 1.8 percent in the base case and 3.1 percent in the high case but to decrease an average of 0.3 percent a year in the low case. While the growth rates for gasoline, LPG, and diesel consumption are expected to be above the average rate for total major product consumption in our base case scenario, fuel oil consumption is expected to grow only by 1.5 percent each year. Until the planned refinery upgrades are completed, Peru will need to continue finding export markets for the large surplus of fuel oil it produces.

9.4. NATURAL GAS UTILIZATION

Of the 83 MMcf/d of natural gas produced in Peru in 1991, 10 MMcf/d were flared (see Appendix VIII). The majority of the gas utilized went to gas treatment plants. In order to increase utilization of its natural gas resources, Peru is currently constructing four new pipelines, with a total length of 780 miles, to transport gas from fields such as Camisea-Cuzco and Aquaytia to Lima and other cities. Based on the 1991 level of gas consumption (63 MMcf/d), Peru's natural gas demand is expected to increase at an average annual rate of 4 percent and reach nearly 90 MMcf/d in the year 2000. As it has substantial reserves, the country will have an adequate supply to meet its domestic demand for natural gas; however, its gas production will continue to lag behind its reserve potential. Although development of the Camisea gas/condensate deposit represents the most significant investment opportunity in Peru's hydrocarbons sector, political instability and the requirement for substantial amounts of money continue to keep many foreign and private companies from committing large investments to the deposit. Petroperú estimates that the development of the Camisea fields, including pipelines, processing, and marketing facilities, will require an initial investment of US\$1.5 billion through 1996; ultimately, US\$2.2 billion will be needed for the project.

9.5. IMPORTANT HYDROCARBONS POLICY ISSUES

The recent deregulation of the oil industry and privatization of the state oil company are seen as positive signs as Peru moves toward international cooperation in its hydrocarbons sector. One of the current administration's energy objectives is to promote foreign and domestic private

Table 9.8
Forecast of Peru's Petroleum Product Consumption, 1991, 1995, and 2000
('000 b/d)

Year	LPG	Gasoline	Kero/Jet	Diesel	Fuel Oil	Others	Total
1991 (actual)	6.3	26.9	21.4	32.2	26.3	3.5	116.6
1995 (forecast)							
High Case	6.8	28.8	22.7	34.1	30.0	3.7	126.2
Base Case	6.6	28.0	21.8	33.3	27.0	3.6	120.4
Low Case	6.3	27.5	20.2	30.3	25.0	3.5	112.7
2000 (forecast)							
High Case	8.9	36.4	27.6	41.5	35.0	4.6	154.0
Base Case	7.6	32.5	24.7	37.7	30.0	4.0	136.5
Low Case	6.5	28.0	20.2	30.3	25.0	3.8	113.7

Note: Individual units do not necessarily add up to the total because of independent rounding.

Source: East-West Center PREM Data File and Forecasts.

investment in exploration, refining, and marketing operations. The government is especially eager to encourage exploration of the gas-rich Camisea fields. While the opportunities for participation in Peru's oil and gas sectors by foreign companies are potentially great, a number of issues must be satisfactorily addressed in order to realize the investment targets.

The most important policy issue is the ability of the Peruvian government to ensure the safety of private and foreign investments that are threatened by radical groups' attacks and nationalistic sentiments. Another important issue is the solution of the 1985 expropriation of the offshore properties belonging to Belco (a subsidiary of the Houston-based Enron Corporation) and various other financial disputes between Petroperú and foreign oil companies. Furthermore, the growing influence of environmental groups in the country may complicate the government's efforts to increase oil production and attract foreign investment. On the political front, the dispute between the current administration and the congress, and the subsequent move of President Fujimori to dissolve the congress has posed some problems for the government's new policy initiatives. In light of these difficulties, the prospects for a smooth and successful privatization of Peru's state oil and gas sectors are questionable.

X. BOLIVIA

Bolivia is located in the central western section of the South American continent and has no direct access to the ocean. The country is bordered by Brazil to the east and north, Paraguay and Argentina to the south, and Chile and Peru to the west. Bolivia's small population of 7.8 million (1992) inhabits a 1.1 million km² land area about the size of Texas and California combined. Approximately half of the population lives in urban areas. Average annual population growth from 1989-2000 is projected to be 2.8 percent—higher than the rest of Latin America.⁹⁷

Since the election in June 1993, the new government has attempted to cut fiscal expenditure and increase revenue in order to reduce fiscal deficits. Privatization is a high priority, including all nationalized industries. Meanwhile, the government is looking for more support from external sources such as the International Monetary Fund. The estimated GDP growth in 1993 was 3.6 percent, slightly higher than the growth in 1992. The 1993 inflation is estimated at 9.5 percent, lower than the 10.5 percent registered in 1992 and 14.5 percent in 1991.⁹⁸

Bolivian trade policy has become more liberal in recent years as the country moves toward free trade. Tariffs on imports have been cut repeatedly; as a result, Bolivia has the lowest tariffs in the Andean region. Natural gas is the country's largest single export; of the US\$760 million in total 1991 Bolivian export revenue, natural gas accounted for 29.4 percent. In 1991, neighboring Argentina was Bolivia's largest market for exports, followed by the United States. The United States is the largest merchandise exporter to Bolivia.

10.1. PRIMARY ENERGY SUPPLY

Bolivia is a net energy exporter. While total primary energy production reached 147,300 boe/d in 1991, primary energy consumption was only 63,000 boe/d, indicating that the country

97. See Culver-Hopper et al. (1992), p. 15.

98. See EIU (1993g) for details.

produced more than twice the energy it consumed. Bolivia exports significant quantities of natural gas to its neighbor, Argentina, and will export gas to Brazil in the future. Except for a small quantity of electricity from Argentina, the country did not import any energy products in 1991.

Of the 147,300 boe/d of primary energy produced in 1991, 67.7 percent was gas and 15.9 percent was oil (Figure 10.1). Other energy (mainly firewood and cane products) accounted for 10.4 percent of primary energy production, and the remaining share (5.9%) was provided by hydroelectricity. The country has no proven coal reserves and no production or consumption of coal. Between 1980 and 1991, hydroelectricity production increased by an average of 3.5 percent a year and gas production rose by 1.2 percent a year. Both oil and other energy production decreased during this period, by average rates of 1.1 and 0.5 percent per year, respectively. Total primary energy production increased at an average annual rate of less than 1 percent a year during the period 1980-1991.

Oil

Bolivia produced approximately 22,100 b/d of crude in 1992, down from 23,500 b/d in 1991. Output had risen 6 percent from 1990 to 1991 (Table 10.1), however, and thus 1992 production was the same as in 1990. At the end of 1992, the country's proven oil reserves were estimated at 112 million barrels, down 5.9 percent from 119 million barrels in 1991. From 1989 to 1992, the country's oil reserves decreased by an average of 15 percent a year. However, oil reserves could be adjusted upward if the recently discovered San Alberto oil field proves to contain the 28 million barrels of oil estimated in a preliminary assessment. The country does not engage in any international trade of crude oil, although it does export a small amount of LPG. All the crude oil produced in Bolivia is consumed domestically.

Yacimientos Petrolíferos Fiscales Bolivianos (YPFB) is Bolivia's state oil and gas company. It is in charge of exploration, production, transportation, refining, and commercialization of hydrocarbons. YPFB has been performing the role of an integrated oil company since its

Figure 10.1
Bolivia's Primary Energy
Production by Source, 1980 and 1991

Source: East-West Center PREM Data File.

Table 10.1
Petroleum Data for Bolivia, 1988-1992
('000 b/d)

Year	Reserves/a	Crude Production	Crude Exports	Crude Imports	Product Consumption
1988	176	20.3	0.0	0.0	24.3
1989	182	20.9	0.0	0.0	25.4
1990	119	22.1	0.0	0.0	26.2
1991	119	23.5	0.0	0.0	27.5
1992	112	22.1	0.0	0.0	28.1

a. Million barrels.

Source: East-West Center PREM Data File.

Table 10.2
Natural Gas Data for Bolivia, 1988-1992
(MMcf/d)

Year	Reserves/a	Production	Exports	Imports	Utilization/b
1988	5,354	512	237	0	96
1989	5,475	573	240	0	77
1990	4,149	572	239	0	85
1991	4,500	589	236	0	85
1992	4,108	599	231	0	100

a. Billion cubic feet (bcf). b. Defined as transformation plus final consumption, with appropriate adjustment of stock change.

Source: East-West Center PREM Data File.

founding in 1936 after taking over the assets of Standard Oil of New Jersey (now Exxon).⁹⁹ However, since 1993, YPFB has embarked on a series of new reforms. Under the government's *Plan de Todos*, "a Plan for Everybody," 50 percent of YPFB assets will be transferred to its strategic partners, and the other 50 percent will be owned by all Bolivian citizens.¹⁰⁰

Faced with declining reserves and limited national financial resources available to expand upstream activities in the oil sector, the Bolivian government is actively seeking foreign investment in order to increase output and reserves. More than a dozen foreign oil companies now have contracts with YPFB to conduct exploration and production (E&P) activities, including Chevron, Santa Fe Resources, Pluspetrol, Petrolex, Phillips, Texaco, Sun Oil, Mobil, and Eurocan Ventures. YPFB predicts that stepped-up exploration over the next 10 years will add approximately 335 million barrels of oil and condensate to its reserves. Crude production is to be increased to 60,000 b/d by the year 2000. Much of the increase in output is expected to be the result of accelerated foreign participation in the upstream oil sector.

Natural Gas

Bolivia is more generously endowed with natural gas than crude oil. While it is believed that 53 percent of Bolivia's territory has hydrocarbons potential, about 80 percent of the hydrocarbons production comes from gas-condensate fields.¹⁰¹ By the end of 1992, natural gas reserves were estimated at 4,108 bcf, down from 4,500 bcf in 1991 but about the same as the 1990 reserves (Table 10.2). According to Bolivian officials, the reason that Bolivia cannot increase proven gas reserves at present is the lack of markets to justify necessary investment. But gas is there.¹⁰² Overall 1992 gas production was 599 MMcf/d, up from 589 MMcf/d in 1991 and 572 MMcf/d

99. See Culver-Hopper et al. (1992), p. 17.

100. See Miranda Pacheco (1993).

101. See *ibid.*

102. See *ibid.*

in 1990. In 1991, about 45 percent of the gas produced was flared or reinjected in order to obtain more natural gas liquids (NGL), and another 40 percent was exported.

YPFB accounts for approximately two-thirds of Bolivian natural gas output. The remaining share of gas was produced by private domestic companies or by foreign companies that are contracted by YPFB. To substantially increase saleable natural gas production in order to meet export targets in the future, foreign and private domestic capital and technical expertise are being actively sought by YPFB. The foreign oil companies that are being contracted by YPFB for oil exploration are also conducting gas E&P activities. So far, their continuing exploration activities in the country are showing some favorable results in natural gas and condensate deposits, as evidenced by increased gas reserves in 1991. However, both oil and gas reserves and production decreased in 1992. Given the important role that Bolivia is set to play in the regional gas market in the future, greater efforts need to be made to increase its reserves and production. The government's recent efforts to privatize YPFB and to offer more incentives to foreign investors will pay off.

Hydroelectricity

Of the ten Latin American countries under study, Bolivia has the lowest utilization rate of its hydroenergy potential. While its hydroenergy potential is estimated to be 18,000 MW, Bolivia's 1991 installed capacity was only 333 MW, about 1.9 percent of its potential. The country features small hydropower plants with an average size of only 17.5 MW, and 15 of the total 19 plants have capacities under 10 MW each. However, Bolivia has perhaps the longest history of using hydroelectricity in Latin America. Three of its small hydropower plants, with a total capacity of 11 MW, started operations as early as the beginning of this century.

In the past decade, hydroelectricity was the fastest growing source of energy in Bolivia. Between 1980 and 1991, production and consumption of hydroelectricity increased by average rates of 3.5 and 3.4 percent a year, respectively. It is expected that hydroelectricity production will continue to expand at an average annual rate of approximately 2.5 percent between 1991 and 2000, as the country has vast unused hydroenergy potential. However, limited available

investment funds and higher priorities assigned to other energy sectors may prevent the hydroenergy potential from being developed faster.

10.2. PRIMARY ENERGY CONSUMPTION

Current Situation

Bolivia's primary energy consumption in 1991 was about 63,000 boe/d (Figure 10.2). Although gas dominates production in Bolivia's energy sector, petroleum still provides the largest share of primary energy consumption in the country, accounting for 39 percent in 1991, followed by natural gas (23%), and hydroelectricity (14%). Other energy—firewood, cane products, and other sources—provided the remaining 24 percent (Table 10.3). Bolivian gas consumption increased at a high average rate of 5.6 percent a year between 1980 and 1991, and its share in primary energy consumption rose from 14 to 23 percent. Hydroelectricity consumption also increased by an average of 3.5 percent a year, while oil consumption decreased by 1.3 percent annually during this period. On average, primary energy consumption in Bolivia increased by 0.7 percent a year between 1980 and 1991.

Outlook for 2000

The forecast for Bolivia's energy consumption in the year 2000 is based on several factors. Although Bolivia's economy and energy consumption remained stagnant during most of the 1980s, both have been growing steadily since the late 1980s. According to an Inter-American Development Bank forecast, Bolivia's real GDP growth rate is expected to increase at an average of 6.9 percent a year between 1991 and 2000. Bolivia has the third highest population growth rate among the ten Latin American countries included in this study. From 1980 to 1992, the Bolivian population grew at an average annual rate of 2.51 percent; this average rate is expected to increase to 2.89 percent between 1992 and 2000. During the past decade, Bolivia's per capita primary energy consumption declined from 3.8 boe/person to 3.1 boe/person, and its energy intensity rose from 6,683 kcal/US\$(1980) to 7,133 kcal/US\$(1980). These changes indicate that real GDP growth was lower than the increase in primary energy consumption, and the latter was lower than the country's population growth. All of these data and assumptions are summarized in Table 10.4.

Figure 10.2
Bolivia's Actual and Projected Primary
Energy Consumption, 1980, 1991, and 2000

Source: East-West Center PREM Data File and Forecasts.

Table 10.3
Percentage Distribution of Primary Energy
Consumption: Bolivia, 1980, 1991, and 2000
 (%)

	1980	1991	2000
Oil	48.5	38.8	38.8
Natural Gas	13.6	23.1	28.7
Hydroelectricity	10.2	13.8	13.0
Other	27.7	24.3	19.5
Total	100.0	100.0	100.0

Source: East-West Center PREM Data File and Forecasts.

Table 10.4
Key Data and Assumptions for Forecast of Bolivia's
Primary Energy Consumption, 1980-2000

Key Item	Unit	Data/Assumptions
Population		
AAGR 1980-1992	percent	2.51
AAGR 1992-2000	percent	2.89
GDP		
AAGR 1980-1991	percent	0.1
AAGR 1991-2000	percent	6.9
Per Capita GDP		
AAGR 1980-1991	percent	-2.4
AAGR 1991-2000	percent	3.6
Per Capita Primary Energy Consumption		
1980	boe/person	3.8
1991	boe/person	3.1
AAGR 1980-1991	percent	-1.8
Energy Intensity		
1980	kcal/US\$(1980)	6,683
1991	kcal/US\$(1980)	7,133
AAGR 1980-1991	percent	0.6

AAGR = average annual growth rate.

Sources: East-West Center PREM Data File and IDB (1993).

Based on the above assumptions (see Table 10.4), it is expected that primary energy consumption will grow at an average annual rate of 3.5 percent between 1991 and 2000, reaching 86,000 boe/d. Gas consumption is expected to grow at an average annual rate of 6 percent, faster than the rates for all other energy sources during 1991-2000, but at about the same growth rate as recorded for gas between 1980 and 1991. As a result, the share of natural gas in primary energy consumption should rise to 29 percent in 2000 from 23 percent in 1991 (see Table 10.3). Oil consumption is projected to grow at an average annual rate of 3.5 percent, and its share in total primary energy consumption will remain the same. The average annual growth rate of hydroelectricity consumption during 1991-2000 is expected to be 2.7 percent. As a result of its low growth, the share of firewood and cane products in total energy consumption is expected to decline from 24 percent in 1991 to 20 percent in 2000.

10.3. DOWNSTREAM OIL SECTOR AND OIL PRODUCT CONSUMPTION

Refining Sector and Petroleum Product Balance

Bolivia has three refineries which are all owned and operated by YPFB. The refining system has basically a hydroskimming configuration. The combined crude distillation capacity is 45,250 b/d (Table 10.5), substantially exceeding the 1992 product consumption level of about 28,100 b/d. Since the country only exports a small amount of LPG, its refined product output slate closely resembles the composition of product consumption. In 1991, Bolivia consumed 27,500 b/d of major petroleum products, of which gasoline accounted for 34 percent, diesel 29 percent, and LPG 23 percent (Table 10.6). Kerosene, jet fuel, fuel oil, and other products provided the remainder. In 1991, refinery output was 28,100 b/d, of which 33 percent was provided by gasoline, 27 percent by diesel, 23 percent by LPG, and 17 percent by kero/jet, fuel oil, and other products. The country exported a small amount of LPG (300 b/d) in 1991.

Outlook for Petroleum Product Consumption

As shown in Figure 10.3, fuel prices in Bolivia are high, especially when compared to prices in other Latin American countries. For instance, in September 1993, the premium gasoline price in Bolivia was US\$2.36/gal, among the highest in Latin America. Between January 1990 and September 1993, major refined product prices in Bolivia rose periodically (Figure 10.3). During

Table 10.5
Bolivia's 1993 Refining Capacity and Configuration
('000 b/cd)

Company	Location	CDU	VDU	Cat. Reforming	Hydro Treating
YPFB	Cochabamba	27.3	2.2	8.2	8.2
YPFB	Santa Cruz	15.0	0.0	6.4	6.4
YPFB	Sucre	3.0	0.0	0.0	0.0
Total		45.3	2.2	14.6	14.6

Sources: Oil & Gas Journal; East-West Center PREM Data File.

Table 10.6
Bolivia's Petroleum Product Balance, 1991
('000 b/d)

Product	Production	Imports	Exports	Consumption	Stock Change
LPG	6.6	0.0	0.3	6.2	0.0
Gasoline	9.2	0.0	0.0	9.3	-0.1
Kero/Jet	2.5	0.0	0.0	2.5	-0.1
Diesel	7.7	0.0	0.0	7.9	-0.1
Fuel Oil	0.3	0.0	0.0	0.3	0.1
Others	1.8	0.0	0.0	1.3	0.5
Total	28.1	0.0	0.3	27.5	0.3

Note: Individual units do not necessarily add up to the total because of independent rounding.

Source: East-West Center PREM Data File.

Figure 10.3
Domestic Prices of Selected Refinery
Products in Bolivia, Jan. 1990 - Sep. 1993

Source: East-West Center PREM Data File.

the same period, the boliviano was depreciated steadily against the U.S. dollar (Figure 10.4). If the exchange rate fluctuations reflect the changes in the domestic consumer price index, then fuel prices in Bolivia have become more and more expensive in recent years.

Based on the 1991 demand level of 27,500 b/d, Bolivia's major refined fuel consumption is expected to grow at an average annual rate of 3.5 percent between 1991 and 2000, reaching approximately 37,400 b/d in 2000 in the base case scenario (Table 10.7). A greater rate of increase in oil product consumption is possible if economic growth is higher than expected. This is reflected in our high case scenario where the growth rate of main oil product consumption is expected to average 6.4 percent per annum, reaching 48,200 b/d in the year 2000. In contrast, if Bolivian economic growth slows down significantly, oil consumption could rise by only 1.9 percent per year, totalling 32,600 b/d in the year 2000. The country is expected to increase its consumption of LPG, kero/jet, and diesel more than its demand for gasoline and fuel oil (see Table 10.7).

10.4. NATURAL GAS UTILIZATION AND TRADE LINKS

Current Situation

As about 45 percent of the 1991 gas output was either flared or reinjected, Bolivia produced 322 MMcf/d of saleable gas. Of the 322 MMcf/d of saleable gas, 236 MMcf/d were exported, 25 MMcf/d were consumed by the gas sector itself, and 63 MMcf/d were utilized domestically (see Appendix IX). About 67 percent of the 63 MMcf/d domestic utilization of gas went to power plants and gas treatment plants. Direct consumption of natural gas accounted for 33 percent of total use, almost all (99.5%) of which was accounted for by the industrial sector, with a tiny amount (0.5%) consumed by the residential sector. The country has great potential to increase its gas use by raising the utilization rate of its existing gas processing capacity. In 1991, all of Bolivia's 236 MMcf/d of gas exports went to Argentina. The country's 20-year agreement to supply natural gas to Argentina ended in April 1992. A new contract was signed in March 1992 for the export of 240 MMcf/d of gas to Argentina for another 20 months. The revised gas price was US\$1.00 per thousand cubic feet (Mcf) at the time the contract was signed. Although it increased to US\$1.50 in early 1994, it is still much lower than the US\$2.50/Mcf price under the

Figure 10.4
Bolivia's Monthly Exchange Rate,
Jan. 1990 - Sep. 1993

Source: East-West Center PREM Data File.

Table 10.7
Forecast of Bolivia's Petroleum Product Consumption, 1991, 1995, and 2000
('000 b/d)

Year	LPG	Gasoline	Kero/Jet	Diesel	Fuel Oil	Others	Total
1991 (actual)	6.2	9.3	2.5	7.9	0.3	1.3	27.5
1995 (forecast)							
High Case	8.2	11.3	3.3	10.7	0.3	1.6	35.3
Base Case	7.3	10.0	3.0	9.6	0.3	1.4	31.6
Low Case	6.8	9.8	2.7	8.7	0.3	1.4	29.7
2000 (forecast)							
High Case	11.5	14.4	4.7	15.3	0.4	2.0	48.2
Base Case	8.9	11.3	3.6	11.7	0.3	1.6	37.4
Low Case	7.7	10.6	3.0	9.6	0.3	1.4	32.6

Note: Individual units do not necessarily add up to the total because of independent rounding.

Source: East-West Center PREM Data File and Forecasts.

previous contract. In 1991, gas sales by Bolivia to Argentina were valued at US\$224 million, about 29 percent of the country's total export earnings. As the 20-month gas agreement ended in early 1994, Bolivia continued to supply gas to Argentina, which terms were gradually determined by market conditions in Argentina as the latter deregulated its domestic market in 1994.

Prospects for Future Gas Use and Trade Links

While domestic demand is limited given the country's small population, the Bolivian government continues to make efforts to increase gas consumption domestically. In addition to those efforts, a top priority of the Bolivian government is to secure sufficient markets for its natural gas in the Latin American region, especially markets other than Argentina.

In February 1993, the governments of Bolivia and Brazil signed an agreement to build a 2,115 mile natural gas pipeline with a capacity of 280 MMcf/d from Santa Cruz, Bolivia, to Sao Paulo and other cities in Brazil by 1995-1996. Accompanying this agreement was a 20-year supply contract to deliver Bolivian gas to Brazil. According to the contract, an initial volume of 280 MMcf/d of Bolivian gas will be delivered around 1995-1996 and increase to 560 MMcf/d by the year 2000. Some of the gas will fuel a power plant in Corumba, Brazil. While Argentine imports of Bolivian gas are expected to be reduced and eventually terminated in the near future, the new agreement between the governments of Bolivia and Brazil will likely assist in increasing Bolivia's gas production by producing needed revenues for the Bolivian national oil company. The infrastructure required for developing the natural gas deposits for exports to Brazil is in the planning stage. The gas link between Bolivia and Brazil will become part of an international gas network that is to be developed in South America.

The Bolivia-Brazil gas integrated project will be aided by the World Bank. The Bank expects to lend US\$49 million to Bolivia for its gas exports plan and US\$150 million to Brazil for the Rio natural gas distribution system.¹⁰³ In addition to exporting to Brazil, the Bolivians are also

103. See Razavi (1993).

exploring the possibility of exports to Chile via the existing Argentine pipeline network and a possible new branch from Salta, Argentina, to Tocopilla, Chile. The project is structured as a cooperative venture with private Chilean interests, perhaps backed by US\$500 million of European capital.

10.5. IMPORTANT HYDROCARBONS POLICY ISSUES

Bolivia's hydrocarbons sector is currently undergoing an important restructuring. The new hydrocarbons law, adopted in 1990, opened additional areas to foreign investment. The privatization of the state oil company and expansion of private participation in contracts for exploration and production will soon be implemented. In addition, the Bolivian government is promoting the development of the infrastructure needed for direct consumption of natural gas in the residential and light industrial sectors. In order to foster efficiency through competition, the government is offering incentives to private investors who want to establish gas distribution companies. The most important policy issue is to guarantee a smooth transfer from the state dominated hydrocarbons sector to a system combining state management with more private participation.

XI. CHILE

Chile's 13.4 million (1992) people are concentrated along a 757,000 km² narrow strip on the southwestern coast of South America. While Chile has one of the highest urbanization rates in the region, its population density and population growth are the lowest in Latin America.

In the late 1980s and early 1990s, Chile had the highest economic growth in Latin America. Real GDP growth reached 10.3 percent in 1992 but is expected to drop to 6 percent in 1993.

Chile's external debt management remains a model for the rest of Latin America. Although its current external debt is US\$19 billion, the government has met all of its financial obligations in a timely manner. Its successful debt/equity swap program coupled with increased export earnings have slowed down the increasing rate of the country's foreign debt.

A decreasing demand for imports and growing export earnings have helped to maintain a surplus balance in Chile's trade, which reached \$749 million for the year 1992. While its traditional exports include primary minerals (mainly copper), fruit, fish, and forestry products, the government is trying to promote the export of items with a greater value added, such as alloys, printing papers, canned goods, and wine, as well as industrial chemicals and machinery. Its principal trading partners are the United States, Japan, Brazil, and Germany. Chile's trade legislation is among the most liberal in Latin America, and the current free-trade negotiations with the United States aim at lowering all trade barriers. In 1993, real GDP grew by 6 percent, down from the 10.3 percent recorded in 1992; the 1993 inflation rate was 12.7 percent, lower than the 15.4 percent recorded in 1992. During the period 1989-1993, the annual growth rate of real GDP in Chile averaged over 7 percent a year, the highest among Latin American countries.¹⁰⁴

104. See EIU (1993c and 1994c) for details.

11.1. PRIMARY ENERGY SUPPLY

Chile is not well endowed with resources to meet its energy demand, and most of its resources are located in the remote far southern region, away from principal consumption centers. As a result, imports are playing an ever larger role in the energy sector, especially oil and coal and probably natural gas in the future. In 1991, Chile produced a total of 158,300 boe/d of primary energy, up only 16 percent from the production level of 136,300 boe/d in 1980. While coal, hydroelectricity, and firewood production exhibited increases that averaged 6.3 percent, 5.7 percent, and 4 percent a year, respectively, between 1980 and 1991, oil production in Chile decreased at an average annual rate of 6 percent, and gas output declined by 3 percent a year during the same period. In 1991, firewood provided 37.2 percent of primary energy production, followed by coal (19.3%), natural gas (18.3%), and hydroelectricity (14.7%). Crude oil provided the remaining 10.5 percent of primary energy production (Figure 11.1)

Oil

Since 1989, proven oil reserves in Chile have remained at 300 million barrels (Table 11.1). Oil production has been experiencing a steady decline over the past decade since it peaked at 40,150 b/d in 1982. Over the period 1988-1992, production decreased at an average annual rate of 9.3 percent, and imports increased at an average annual rate of 7.3. In 1992, crude output was only 14,900 b/d, down from 17,800 b/d in 1991. With 109,200 b/d of crude imports in 1992, the volume of crude imports is thus more than six times higher than the volume of production, and constitutes 71 percent of the country's oil consumption. About 46 percent of Chile's 1991 oil imports were from Latin American oil producers (Venezuela, Colombia, Ecuador, Argentina, and Peru). The other 54 percent came from Africa (Nigeria, Gabon, and Angola), the Middle East (UAE and Oman), and Asia (Malaysia).¹⁰⁵ The production and import of oil and gas are the responsibility of the national oil company, Empresa Nacional de Petróleo (ENAP). In 1989, the government had plans to privatize ENAP. However, the present administration has postponed these plans. The Chilean government has made efforts in recent years to increase indigenous crude production by inviting participation from the private sector.

105. See *World Oil Trade* (1993).

Figure 11.1
Chile's Primary Energy
Production by Source, 1980 and 1991

Source: East-West Center PREM Data File.

Table 11.1
Petroleum Data for Chile, 1988-1992
('000 b/d)

Year	Reserves/a	Crude Production	Crude Exports	Crude Imports	Product Consumption
1988	287	22.0	0.0	82.3	118.4
1989	300	19.7	0.0	90.9	131.8
1990	300	17.5	0.0	106.0	139.0
1991	300	17.8	0.0	109.0	149.6
1992	300	14.9	0.0	109.2	152.8

a. Million barrels.

Source: East-West Center PREM Data File.

Table 11.2
Natural Gas Data for Chile, 1988-1992
(MMcf/d)

Year	Reserves/a	Production	Exports	Imports	Utilization/b
1988	4,200	134	0	0	110
1989	4,200	243	0	0	212
1990	4,100	257	0	0	217
1991	4,100	171	0	0	151
1992	3,900	193	0	0	180

a. Billion cubic feet (bcf). b. Defined as transformation plus final consumption, with appropriate adjustment of stock change.

Source: East-West Center PREM Data File.

ENAP has entered into a number of contracts with foreign oil companies for exploration and production in Chile, including a contract for joint exploration of a 3,000 km² area in Lago Blanco, Tierra del Fuego, by Anderman-Smith (a U.S. company) and ENAP. In addition to its domestic activities, Sipetrol, one of the four affiliate companies of ENAP, has expanded its crude exploration activities abroad.

The private sector controls about 85 percent of wholesale distribution of petroleum products and 100 percent of retail distribution in Chile. Shell and Exxon are the largest companies operating in these areas. Fletcher Challenge of New Zealand owns the largest methanol plant in the world, located in Punta Arenas in the southern tip of Chile.

Natural Gas

Natural gas reserves were estimated at 3,900 bcf at the end of 1992, slightly down from 4,100 bcf in 1991. Gas production in 1992 was 193 MMcf/d, up from the 1991 level of 171 MMcf/d but down from the 1990 level of 257 MMcf/d. However, 1992 gas output was 44 percent higher than in 1988. Gas utilization increased from 110 MMcf/d in 1988 to 217 MMcf/d in 1990. In 1991 utilization decreased to 150 MMcf/d, and it was 180 MMcf/d in 1992 (Table 11.2). As Chile's gas reserves are sizeable, development and production of natural gas is expected to rise in the future, once investment in infrastructure in the remote southern region is undertaken. Gas provided 23 percent of primary energy production in 1991, which was a greater share than oil.

Coal

Proven reserves of coal in Chile were estimated at only 156 million tonnes in 1992, down from 194 million tonnes in 1991. Despite limited coal reserves, the country is the fifth largest coal producer in Latin America after Colombia, Mexico, Brazil, and Venezuela. In 1992, the country produced 2.4 million tonnes of coal, up from 2.2 million tonnes in 1991, and imported about 847 thousand tonnes, down from 1.5 million tonnes in 1991 (Table 11.3). About three-fourths of the coal used in 1991 went to the secondary processing sector, which includes power plants, the coking industry, and self-producers; the other fourth was directly consumed by final users. The industrial sector accounted for 97 percent of total direct coal consumption in 1991, while

Table 11.3
Coal Data for Chile, 1988-1992
('000 tonnes)

Year	Reserves/a	Production	Exports	Imports	Apparent Consumption/b
1988	194	1,926	0	359	2,285
1989	194	1,949	0	1,483	3,432
1990	194	2,184	0	1,660	3,844
1991	194	2,208	0	1,490	3,698
1992	156	2,367	0	879	3,246

a. Million tonnes. b. Defined as production plus net imports.

Source: East-West Center PREM Data File.

the residential sector consumed the remaining 3 percent. It is expected that Chile will continue to import coal through the end of the decade.

Hydroelectricity

Hydroenergy potential in Chile amounts to approximately 26,000 MW. Its 1991 installed hydropower capacity was 3,078 MW, with a utilization ratio of 11.8 percent that accounted for 61 percent of total installed power generation capacity in the country. Chile has a total of 24 hydropower plants with an average size of 128 MW. Fifteen of the stations have capacities of less than 100 MW each. The largest hydropower station, Pehuenche, located in Talca, has a capacity of 500 MW. In the past decade, hydroelectricity production and power plant construction increased rapidly. Between 1980 and 1991, the utilization ratio of the hydroenergy potential increased from 5.6 percent to 11.8 percent, and hydroelectricity production increased by an average of 5.3 percent a year. The increase of hydroelectricity production is expected to continue at a lower annual rate through the year 2000.

11.2. PRIMARY ENERGY CONSUMPTION

Current Situation

As a result of the country's rapid economic expansion, Chile had one of the highest energy consumption growth rates in the region over the past decade, with demand increasing at an average annual rate of 3.7 percent between 1980 and 1991 (Figure 11.2). In 1991, the country's primary energy consumption totalled 298,000 boe/d, of which 49.9 percent was provided by petroleum (Table 11.4). Other energy sources are coal (14.2%), firewood (19.8%), natural gas (8.6%), and hydroelectricity (7.5%). Between 1980 and 1991, gas consumption rose an average of 5.5 percent a year, coal consumption 5.6 percent a year, and hydroelectricity consumption 5.4 percent a year, while firewood consumption also went up 4.9 percent a year. Oil consumption exhibited the lowest growth rate during this period, increasing at an average annual rate of 2.4 percent. Owing to decreasing crude reserves and production, Chile is a growing importer of petroleum. The country is Latin America's second largest importer of oil after Brazil.

Figure 11.2
Chile's Actual and Projected Primary
Energy Consumption, 1980, 1991, and 2000

Source: East-West Center PREM Data File and Forecasts.

Table 11.4
Percentage Distribution of Primary Energy
Consumption: Chile, 1980, 1991, and 2000
 (%)

	1980	1991	2000
Oil	57.5	49.9	48.7
Natural Gas	7.1	8.6	11.2
Coal	11.6	14.2	15.0
Hydroelectricity	6.3	7.5	7.2
Other	17.5	19.8	17.9
Total	100.0	100.0	100.0

Source: East-West Center PREM Data File and Forecasts.

Outlook for 2000

The forecast for Chile's primary energy consumption in the year 2000 is based on a number of factors such as projections of population and economic growth and changes in per capita primary energy consumption and energy intensity. The Chilean population grew at an average annual rate of 1.8 percent between 1980 and 1992, and the average annual growth rate of real GDP was 2.3 percent between 1980 and 1991—a fairly high growth rate among the Latin American countries for that period. It is estimated that the population growth rate will decrease to 1.46 percent a year between 1992 and 2000, and that the real GDP growth rate will increase to an average of 5.1 percent between 1991 and 2000.¹⁰⁶ Given the high growth of primary energy consumption accompanied by low population expansion over the past decade, per capita primary energy consumption increased from 6.5 boe/person in 1980 to 8.1 boe/person in 1991. During the same period, energy intensity also increased from 3,688 kcal/US\$(1980) to 4,293 kcal/US\$(1980). These data and assumptions are summarized in Table 11.5.

Based on these assumptions and the fact that primary energy consumption has increased at an average annual rate of nearly 4.5 percent during the period 1986-1991, energy demand is expected to grow at an average annual rate of 3.9 percent through the year 2000, totalling 420,000 boe/d. This average annual consumption growth rate of 3.9 percent breaks down to 3.6 percent for oil, 7 percent for gas, 4.5 percent for coal, 3.5 percent for hydroelectricity, and 2.8 percent for firewood during this period. While the share of oil consumption is expected to decrease slightly (from 49.9% of total primary energy consumption in 1991 to 48.7% in 2000), the shares of natural gas and coal are expected to increase.

11.3. DOWNSTREAM OIL SECTOR AND PRODUCT CONSUMPTION

Refining Sector

Chile's three refineries have 143,700 b/d of crude distillation capacity (Table 11.6). The two main refineries are the Petrox refinery at Talcahuano (72,000 b/d) and the Refineria de Concón at Concón (62,700 b/d). Both refineries have reforming and catalytic cracking capacities and

106. See IDB (1993).

Table 11.5.
Key Data and Assumptions for Forecast of Chile's
Primary Energy Consumption, 1980-2000

Key Item	Unit	Data/Assumptions
Population		
AAGR 1980-1992	percent	1.80
AAGR 1992-2000	percent	1.46
GDP		
AAGR 1980-1991	percent	2.1
AAGR 1991-2000	percent	5.1
Per Capita GDP		
AAGR 1980-1991	percent	0.6
AAGR 1991-2000	percent	3.6
Per Capita Primary Energy Consumption		
1980		
1991	boe/person	6.5
AAGR 1980-1991	boe/person	8.1
	percent	2.0
Energy Intensity		
1980	kcal/US\$(1980)	3,688
1991	kcal/US\$(1980)	4,293
AAGR 1980-1991	percent	1.4

AAGR = average annual growth rate.

Sources: East-West Center PREM Data File and IDB (1993).

Table 11.6
Chile's 1993 Refining Capacity and Configuration
('000 b/cd)

Company	Location	CDU	VDU	Thermal Operations	Cat. Cracking	Cat. Reforming	Hydro Treating
ENAP	Gregorio Magallanes	9.0					
Petrox	Talcahuano	72.0	35.8	10.0	20.7	4.5	6.5
Refinera de Concon	Concon	62.7	37.4	9.2	17.5	5.0	5.0
Total		143.7	73.2	19.2	38.2	9.5	11.5

Sources: *Oil & Gas Journal*; *East-West Center PREM Data File*.

have a combined cracking-to-distillation ratio of 40 percent, the third highest in Latin America (after Colombia and Argentina). With Chilean refinery throughput at 137,160 b/d in 1991, the refineries were running at about 95 percent of their capacity.

An 8,500 b/d hydrocracker is being constructed at the Concón refinery, at a cost of US\$20.8 million. The unit is designed to produce 28,000 b/d of desulfurized diesel oil and was scheduled to be completed in December 1993. An increase in diesel production will displace Chile's growing diesel imports, which reached 4,900 b/d in 1991. The refinery's 17,500 b/d catalytic cracking unit at Concón is also being expanded by an additional 8,000 b/d, at a cost of US\$15 million, to raise the yields of LPG and gasoline. The construction of a 9,000 b/d delayed coker and a 12,000 b/d hydrotreater is planned for the refinery at Talcahuano. Also at Concón, the construction of an 8,500 b/d hydrocracker has been completed.¹⁰⁷

Petroleum Products Balance

Chile's petroleum product consumption, which totalled 152,800 b/d in 1992, has been increasing at an average annual rate of 6.6 percent since 1988. Diesel accounted for 33 percent of Chile's 1991 petroleum product consumption, followed by gasoline (23%), fuel oil (18%), LPG (13%), and other products (Table 11.7). While Chile's refineries supply most of the country's petroleum products, 15,900 b/d were imported in 1991, principally from Latin American countries and the United States. LPG and diesel constituted 84 percent of total imports. Gasoline imports were reduced to only 1,700 b/d and the country actually exported 300 b/d of gasoline in 1991, owing to upgrades completed at the Petrox refinery during that year. In 1991, Chile also exported a nominal amount of fuel oil.

Outlook for Petroleum Product Consumption

In addition to population and real GDP growth, changes in the prices of major refined products

107. See *Oil & Gas Journal*, October 18, 1993, and December 20, 1993. The 8,500 b/d hydrocracker is not shown in Table 11.6, as the table lists the refineries as of January 1, 1993.

Table 11.7
Chile's Petroleum Product Balance, 1991
('000 b/d)

Product	Production	Imports	Exports	Consumption	Stock Change
LPG	12.8	7.0	0.0	19.3	0.5
Gasoline	35.6	1.7	0.3	34.7	2.2
Kero/Jet	10.9	0.6	0.0	10.5	0.9
Diesel	41.9	6.4	0.0	49.2	-0.9
Fuel Oil	26.3	0.2	1.4	26.7	-1.5
Others	17.5	0.0	7.5	9.2	0.8
Total	145.0	15.9	9.2	149.6	2.0

Note: Individual units do not necessarily add up to the total because of independent rounding.

Source: East-West Center PREM Data File.

are also important in forecasting petroleum product consumption in the future. The major fuel prices in U.S. dollars in the Chilean market are relatively competitive and have remained stable in recent years (Figure 11.3). For instance, in June 1991, average prices of LPG and premium gasoline were US\$1.14/gal and US\$1.48/gal, respectively; these prices changed slightly to US\$1.15/gal and US\$1.58/gal in June 1993. This trend has been accompanied by a depreciating Chilean peso (Figure 11.4), which depreciated from 295.6 Chilean pesos per U.S. dollar in January 1990, to 408 Chilean pesos per U.S. dollar in September 1993. If all other things remain equal, rising oil product prices will serve to slow down oil consumption.

Based on these assumptions, petroleum product consumption in Chile is expected to increase at an average annual rate of 3.6 percent in the base case; however, the possibility of exploding consumption due to high economic growth is recognized in the high case scenario, where growth occurs at a rate of 7.9 percent per annum. Petroleum product consumption will rise from 149,600 b/d in 1991 to 205,100 b/d in the base case and to 296,200 b/d in the high case by the year 2000. If economic growth slows down considerably, product consumption might rise at an average annual rate of only 2.1 percent (Table 11.8).

11.4. NATURAL GAS UTILIZATION AND TRADE LINKS

Current Situation

Of Chile's 1991 total gas production of 171 MMcf/d, 12 percent was flared and 6 percent was consumed by the gas sector itself (see Appendix X). Domestic gas utilization (excluding the gas sector's consumption) was 141 MMcf/d, of which 43 percent was consumed by Fletcher Challenge's methanol plant and other gas treatment plants, 38 percent by the refining sector, and 13 percent by residential users in Puerto Natales, Punta Arenas, and Porvenir. The rest of the gas went to self-producers and the industrial sector. Although its use is expanding rapidly in Chile, the country has not yet imported any natural gas.

Prospects for Future Gas Use and Trade Links

In accordance with the government's policy to diversify the country's energy sources, Chile is expected to increase its consumption of natural gas. The average annual consumption rate is

Figure 11.3
Domestic Prices of Selected Refinery
Products in Chile, Jan. 1990 - Sep. 1993

Source: East-West Center PREM Data File.

Figure 11.4
Chile's Monthly Exchange Rate,
Jan. 1990 - Sep. 1993

Source: East-West Center PREM Data File.

Table 11.8
Forecast of Chile's Petroleum Product Consumption, 1991, 1995, and 2000
('000 b/d)

Year	LPG	Gasoline	Kero/Jet	Diesel	Fuel Oil	Others	Total
1991 (actual)	19.3	34.7	10.5	49.2	26.7	9.2	149.6
1995 (forecast)							
High Case	26.3	47.3	14.3	72.2	30.6	13.9	204.6
Base Case	22.2	39.1	12.1	59.2	28.7	12.7	174.1
Low Case	20.9	37.6	11.4	55.4	27.6	12.0	164.9
2000 (forecast)							
High Case	38.7	69.4	21.0	114.6	35.5	16.9	296.2
Base Case	26.4	45.3	14.3	73.8	31.6	13.7	205.1
Low Case	23.1	41.5	12.6	61.7	28.8	12.6	180.4

Note: Individual units do not necessarily add up to the total because of independent rounding.

Source: East-West Center PREM Data File and Forecasts.

expected to be 7 percent through the year 2000. While Chile possesses sizeable natural gas reserves that could satisfy such demand, most of the gas is located in the southern tip of the country, making it economically inaccessible for the principal prospective markets in the north and central areas of the country. As a result, the government is actively seeking to develop the infrastructure to import natural gas from Argentina and Bolivia. The transandean oil pipeline from Neuquen, Argentina, to Concepción, Chile (the site of Chile's largest refinery, Talcuhano), was completed in early 1994. In addition, negotiations are under way for a gas pipeline from Argentina to Chile, with a capacity of 175 MMcf/d. The gas project would be built with private, foreign, and national oil company participation at an estimated cost of US\$1 billion. In addition, the possibility of building a gas pipeline from southern Bolivia to northern Chile has been discussed.

11.5. IMPORTANT HYDROCARBONS POLICY ISSUES

One of the greatest challenges facing Chile today is to reconcile its growing energy needs with the rising dependence on energy resources imported from volatile markets. While imported crude oil accounts for a significant portion of its needs, the country may soon start importing natural gas. In order to reduce its overall dependence on imported energy, Chile's energy policy focuses on actively promoting diversification and more efficient use of energy resources (oil, gas, coal, and firewood).

In terms of diversification of energy sources, the government is placing emphasis on two principal areas. The first is the introduction of gas into new markets. The government is promoting the use of natural gas in the central and northern regions, which have the largest concentrations of potential consumers. The second is the development of nonconventional energy sources such as geothermal and other renewable energy. Chile is well positioned to become the leading Latin American country in the use of nonconventional sources as its investment climate and economic growth are very attractive to foreign investors. The Chilean legislative branch is now in the process of developing a legal framework for investment in this area.

Chile is also well situated to increase its efficiency in the use of energy resources. The government is providing incentives to promote the transfer of efficient energy use technologies to small and medium users in the country. Special emphasis has been placed on improving the efficiency of coal and wood utilization.

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Appendix I
Energy Balance of Mexico, 1991
('000 boe/d)

	Crude Oil	Gas	Coal	Hydro- electricity	Geothermal Power	Nuclear Power	Fire- wood	Cane Products	Others	Total Primary
Production	3,473	731	140	31	7	23	139	44	129	4,716
Importation			5							5
Exportation	1,785		1							1,786
Inventory Variation	3	1								4
Unused	0	23						0	56	79
Total Supply	1,691	709	143	31	7	23	139	43	73	2,859
Refinery	-1,666								-3	-1,669
Power Plants			-61	-31	-7	-23				-122
Gas Treatment Plant		-672							-69	-741
Coke/Blast Furnace			-82							-82
Total Transformation	-1,666	-672	-143	-31	-7	-23			-73	-2,614
Own Consumption	0	18							0	18
Losses	15	0								15
Adjustment	10		0							10
Industrial		18						40		58
Residential		2					139			141
Energy Consumption		20					139	40		198
Non-energy Consum								4		4
Final Consumption		20					139	43		202

(to be continued)

Appendix I (continued)
Energy Balance of Mexico, 1991
('000 boe/d)

	Electricity	LPG	Gasoline	Kero/jet	Diesel Oil	Fuel Oil	Other Energy	Non-Energy	Total Secondary
Production	201	190	475	72	295	475	534	108	2,350
Importation	1	16	70			53	1	1	143
Exportation	3	28	14	17	21	9	0	1	94
Inventory Variation		0	-4	-2		-1		-2	-9
Unused									
Total Supply	199	178	526	54	273	519	536	106	2,389
Refinery		37	410	72	295	475	28	49	1,365
Power Plants	201				-8	-312	-80		201
Gas Treatment Plant		153	65				479	59	756
Coke/Blast Furnace							28		28
Total Transformation					-8	-312	455		-400
Own Consumption	10	15	46	9	35	50	138	4	306
Losses	28								28
Adjustment			0	0	0	0	-29		-29
Transportation	1	8	447	37	173	9			675
Industrial	89	8		1	24	134	275		531
Residential	60	146		4	1	15	17		242
Agric, Fishing, Mining	11	1		3	32				46
Energy Consumption	161	163	447	45	230	157	292		1,495
Non-Energy Consump.			33	0			54	102	190
Final Consumption	161	163	480	45	230	157	346	102	1,685

Note: Individual units do not necessarily add up to the total because of independent rounding.

Sources: East-West Center PREM Data File and OLADE (1993).

Appendix II
Energy Balance of Venezuela, 1991
('000 boe/d)

	Crude Oil	Gas	Coal	Hydro- electricity	Geothermal Power	Nuclear Power	Fire- wood	Cane Products	Others	Total Primary
Production	2,581	655	36	75					4	3,351
Importation										
Exportation	1,529		31						3	1,562
Inventory Variation	56								-1	54
Unused		79								79
Total Supply	1,108	576	6	75						1,765
Refinery	-1,105									-1,105
Power Plants		-99		-75						-174
Self-Producers		-22								-22
Gas Treatment Plant		-73								-73
Other Centers	-3									-3
Total Transformation	-1,108	-194		-75						-1,377
Own Consumption		96								96
Losses		81								81
Adjustment			0							0
Industrial		187	6							192
Residential		18								18
Energy Consumption		204	6							210
Final Consumption		204	6							210

(to be continued)

Appendix II (continued)
Energy Balance of Venezuela, 1991
('000 boe/d)

	Electricity	LPG	Gasoline	Kero/jet	Diesel Oil	Fuel Oil	Other Energy	Non-Energy	Total Secondary
Production	102	73	329	90	323	300	4	63	1,285
Importation									
Exportation	0	21	137	79	234	253		41	764
Inventory Variation			3	3				-1	5
Unused									
Total Supply	102	52	196	14	90	47	4	21	525
Refinery		5	310	90	323	297	4	63	1,092
Power Plants	98				-7	-31			98
Self-Producers	4					-3	-3		4
Gas Treatment Plant		67	20						87
Other Centers						3			3
Total Transformation					-7	-33	1		-44
Own Consumption	4	23	41	0	22	5	0	2	97
Losses	17				0	0	1		19
Adjustment	0	0			0				0
Transportation	1		154	7	37	0			199
Industrial	43	4	0	2	22	8			81
Residential	17	25		5					47
Commercial, Pub. Serv.	18		0	0	1				19
Agric, Fishing, Mining					0	0			0
Construction/Others	1		0		0				1
Energy Consumption	80	29	155	14	60	9			347
Non-Energy Consump.								18	18
Final Consumption	80	29	155	14	60	9		18	366

Note: Individual units do not necessarily add up to the total because of independent rounding.

Sources: East-West Center PREM Data File and OLADE (1993).

Appendix III
Energy Balance of Brazil, 1991
('000 boe/d)

	Crude Oil	Gas	Coal	Hydro- electricity	Geothermal Power	Nuclear Power	Fire- wood	Cane Products	Others	Total Primary
Production	616	109	38	370		8	521	389	46	2,098
Importation	520		146							666
Exportation										
Inventory Variation	1	0	5							7
Unused		20								20
Total Supply	1,138	89	189	370		8	521	389	46	2,750
Refinery	-1,127									-1,127
Power Plants			-20	-364		-8				-393
Self-Producers		-2		-5			-2	-8	-13	-31
Gas Treatment Plant		-21								-21
Charcoal Plant							-218			-218
Coke/Blast Furnace			-142							-142
Distillery								-144	-1	-145
Other Centers		-3								-3
Total Transformation	-1,127	-25	-162	-370		-8	-221	-153	-14	-2,080
Own Consumption		14						147		162
Losses			3							3
Adjustment	11	0		0			0			11
Industrial		28	23				102	89	32	274
Residential		0					155			155
Commercial, Pub. Serv.		0					2			2
Agric, Fishing, Mining		2	0				41			43
Energy Consumption		30	23				300	89	32	474
Non-energy Consump.		19								19
Final Consumption		49	23				300	89	32	494

(to be continued)

Appendix III (continued)
Energy Balance of Brazil, 1991
('000 boe/d)

	Electricity	LPG	Gasoline and Alcohol	Kero/jet	Diesel Oil	Fuel Oil	Other Energy	Non- Energy	Total Secondary
Production	398	78	397	51	399	223	207	59	1,814
Importation	46	33	21	2	30	4	14	2	152
Exportation	0		23	11	3	45		2	84
Inventory Variation		-2	-15	0	2	1	-2	0	-16
Unused							1		1
Total Supply	444	109	381	43	428	183	221	58	1,865
Refinery		65	272	51	398	223	46	59	1,115
Power Plants	377				-9	-7			377
Self-Producers	21				-2	-8	-3		21
Gas Treatment Plant		11	1				6	0	17
Charcoal Plant							109		109
Coke/Blast Furnace							27		34
Distillery			124						124
Other Centers		3	-16		1		12		16
Total Transformation			-16		-11	-15	197		-52
Own Consumption	13	0		0	9	21	40		84
Losses	61		1				7		69
Adjustment	0	0				-3			-3
Transportation	2		268	38	335	13			657
Industrial	186	3		1	4	121	135		450
Residential	87	99		2			15		202
Commercial, Pub. Serv.	73	6		0	2	6	2		90
Agric, Fishing, Mining	22	0		0	66	9	3		101
Energy Consumption	369	108	268	42	409	150	155		1,501
Non-Energy Consump.			97	2			7	58	163
Final Consumption	369	108	365	43	409	150	161	58	1,664

Note: Individual units do not necessarily add up to the total because of independent rounding.

Sources: East-West Center PREM Data File and OLADE (1993).

Appendix IV
Energy Balance of Argentina, 1991
('000 boe/d)

	Crude Oil	Gas	Coal	Hydro- electricity	Geothermal Power	Nuclear Power	Fire- wood	Cane Products	Others	Total Primary
Production	500	404	3	26		30	14	9	16	1,002
Importation	4	36	13							53
Exportation	25		0							25
Inventory Variation	-2		2							0
Unused		39								39
Total Supply	477	401	18	26		30	14	9	16	990
Refinery	-462									-462
Power Plants		-94	-4	-26		-30				-154
Self-Producers		-15	-1					-1		-17
Gas Treatment Plant		-27								-27
Charcoal Plant							-8			-8
Coke/Blast Furnace			-12							-12
Total Transformation	-462	-136	-16	-26		-30	-8	-1		-680
Own Consumption	0	57	0							57
Losses		16								16
Adjustment	15		1				0			15
Transportation		6								6
Industrial		80	0					8	15	104
Residential		99					6			105
Energy Consumption		185	0				6	8	15	215
Non-energy Consump.		7								7
Final Consumption		192	0				6	8	15	222

(to be continued)

Appendix IV (continued)
Energy Balance of Argentina, 1991
('000 boe/d)

	Electricity	LPG	Gasoline	Kero/jet	Diesel Oil	Fuel Oil	Other Energy	Non-Energy	Total Secondary
Production	89	32	131	22	170	75	47	23	590
Importation	3			1	5	12		1	22
Exportation	0	4	34	0	35	13	6	5	97
Inventory Variation		-2	2	-1	-5	-1	-1	1	-8
Unused							1		1
Total Supply	92	26	99	21	135	74	52	20	506
Refinery		15	127	22	170	75	31	12	452
Power Plants	83				-7	-31			83
Self-Producers	6				-1		-5		6
Gas Treatment Plant		17	4					6	27
Charcoal Plant							5		5
Coke/Blast Furnace							1	5	17
Total Transformation					-8	-31	32		-54
Own Consumption	6	0	0	0	3	25	11	0	45
Losses	14								14
Adjustment	1	2	1	0	-9	2	1	-2	-5
Transportation	0		88	12	92	0			193
Industrial	39	0			2	15	9		65
Residential	31	20		8	7	1	2		71
Agric, Fishing, Mining	1				32				33
Energy Consumption	72	21	88	21	134	16	11		362
Non-Energy Consump.		4	10				1	23	37
Final Consumption	72	25	97	21	134	16	12	23	398

Note: Individual units do not necessarily add up to the total because of independent rounding.

Sources: East-West Center PREM Data File and OLADE (1993).

Appendix V
Energy Balance of Colombia, 1991

('000 boe/d)

	Crude Oil	Gas	Coal	Hydro- electricity	Geothermal Power	Nuclear Power	Fire- wood	Cane Products	Others	Total Primary
Production	454	84	303	56			81	27	3	1,009
Importation										
Exportation	181		209							390
Inventory Variation	1		-10							-9
Unused		8	2							10
Total Supply	274	76	82	56			81	27	3	600
Refinery	-261	-13								-274
Power Plants		-32	-11	-56						-99
Self-Producers		-6	-2					-1		-10
Gas Treatment Plant		-2								-2
Charcoal Plant							-3			-3
Coke/Blast Furnace			-9							-9
Total Transformation	-261	-52	-23	-56			-3	-1		-397
Own Consumption		6								6
Losses	0		3							3
Adjustment	-1	-3	5							0
Transportation		0								0
Industrial	13	17	47				0	19	2	99
Residential		2	4				67			73
Commercial, Pub. Serv.	0	1								1
Agric, Fishing, Mining	0						11	8	1	19
Construction/Others	0									0
Energy Consumption	14	21	51				78	26	3	194
Final Consumption	14	21	51				78	26	3	194

(to be continued)

Appendix V (continued)
Energy Balance of Colombia, 1991
('000 boe/d)

	Electricity	LPG	Gasoline	Kero/jet	Diesel Oil	Fuel Oil	Other Energy	Non-Energy	Total Secondary
Production	62	10	77	15	44	80	10	7	306
Importation			23	0	0				23
Exportation					7	69	1		76
Inventory Variation		0			-1	0			-1
Unused									
Total Supply	62	10	100	15	37	12	10	7	252
Refinery		10	75	15	44	80	1	7	232
Power Plants	60				-1				60
Self-Producers	2						-1		2
Gas Treatment Plant		1	2						3
Charcoal Plant							1		1
Coke/Blast Furnace							6		6
Other Centers									2
Total Transformation					-1		6		-5
Own Consumption	2	1	1	0	1	8	2	0	16
Losses	13						0		13
Adjustment		0	1		0	0	0		2
Transportation			87	10	19	0			117
Industrial	14	0		2	5	2	2		25
Residential	22	9	4	3			1		39
Commercial, Pub. Serv.	9	1		0	4	0			14
Agric, Fishing, Mining	1		0		5	0			6
Construction/Others	1		7	0	1	0			9
Energy Consumption	47	10	98	15	35	3	3		210
Non-Energy Consump.								7	7
Final Consumption	47	10	98	15	35	3	3	7	217

Note: Individual units do not necessarily add up to the total because of independent rounding.

Sources: East-West Center PREM Data File and OLADE (1993).

Appendix VI
Energy Balance of Ecuador, 1991
('000 boe/d)

	Crude Oil	Gas	Coal	Hydro- electricity	Geothermal Power	Nuclear Power	Fire- wood	Cane Products	Others	Total Primary
Production	309	13		10			20	4		355
Importation										
Exportation	176									176
Inventory Variation	0									0
Unused		9								9
Total Supply	133	4		10			20	4		171
Refinery	-128									-128
Power Plants				-10						-10
Gas Treatment Plant		-4								-4
Total Transformation	-128	-4		-10						-141
Own Consumption	1									1
Losses	1									1
Adjustment	4	0								4
Industrial							1	4		6
Residential							18			18
Energy Consumption							20	4		24
Final Consumption							20	4		24

(to be continued)

Appendix VI (continued)
Energy Balance of Ecuador, 1991
('000 boe/d)

	Electricity	LPG	Gasoline	Kero/jet	Diesel Oil	Fuel Oil	Other Energy	Non-Energy	Total Secondary
Production	12	4	27	6	26	51		2	128
Importation		4	1	0					5
Exportation				1	2	26			29
Inventory Variation		0	0	0				0	0
Unused									
Total Supply	12	9	28	6	23	26		2	105
Refinery		2	27	6	26	51		2	114
Power Plants	12				-1	-9			12
Self-Producers	0								0
Gas Treatment Plant		2							2
Total Transformation					-1	-9			-10
Own Consumption	0		0	0	1	1			2
Losses	3								3
Adjustment		0		1	0	0		0	1
Transportation			22	3	13	8			46
Industrial	3	0	0	0	3	7			14
Residential	3	8	1	1					12
Commercial, Pub. Serv.	2	0	1	0	3	0			6
Agric, Fishing, Mining			1	0	4				5
Construction/Others		0	4	1					5
Energy Consumption	9	9	28	5	22	16			88
Non-Energy Consump.								2	2
Final Consumption	9	9	28	5	22	16		2	90

Note: Individual units do not necessarily add up to the total because of independent rounding.

Sources: East-West Center PREM Data File and OLADE (1993).

Appendix VII
Energy Balance of Trinidad and Tobago, 1991
('000 boe/d)

	Crude Oil	Gas	Coal	Hydro- electricity	Geothermal Power	Nuclear Power	Fire- wood	Cane Products	Others	Total Primary
Production	148	130						2		280
Importation	42									42
Exportation	73									73
Inventory Variation	-3									-3
Unused		25						1		26
Total Supply	114	105						1		220
Refinery	-114									-114
Power Plants		-24								-24
Self-Producers		-1						-1		-2
Total Transformation	-114	-25						-1		-139
Own Consumption		14								14
Losses		2								2
Adjustment	0	0								0
Industrial		40								40
Energy Consumption		40								40
Non-energy Consump.		25								25
Final Consumption		65								65

(to be continued)

Appendix VII (continued)
Energy Balance of Trinidad and Tobago, 1991
('000 boe/d)

	Electricity	LPG	Gasoline	Kero/jet	Diesel Oil	Fuel Oil	Other Energy	Non-Energy	Total Secondary
Production	6	3	17	8	14	44	5	0	98
Importation		0	0		1			0	2
Exportation		2	9	7	12	43	1	0	74
Inventory Variation			-1	0		-1	-1	0	-3
Unused									
Total Supply	6	1	7	1	4	1	5	0	23
Refinery		3	17	8	14	44	5	0	92
Power Plants	6								6
Self-Producers	0								0
Total Transformation							5		98
Own Consumption	0	0	0	0	0	0	3		3
Losses	1								1
Adjustment	0	0				0	0		
Transportation			7	1	2	0			10
Industrial	3	0	0	0	2	0			5
Residential	1	0		0					2
Commercial, Pub. Serv.	1	0	0		0				1
Agric, Fishing, Mining			0		0				0
Construction/Others					0				0
Energy Consumption	5	1	7	1	4	1			19
Non-Energy Consump.							0	0	1
Final Consumption	5	1	7	1	4	1	0	0	19

Note: Individual units do not necessarily add up to the total because of independent rounding.

Source: East-West Center PREM Data File and OLADE (1993).

Appendix VIII
Energy Balance of Peru, 1991
('000 boe/d)

	Crude Oil	Gas	Coal	Hydro- electricity	Geothermal Power	Nuclear Power	Fire- wood	Cane Products	Others	Total Primary
Production	114	14	1	24			70	6	5	235
Importation	34		3							37
Exportation	1									1
Inventory Variation			0							0
Unused		3								3
Total Supply	146	11	4	24			70	6	5	267
Refinery	-150									-150
Power Plants				-21						-21
Self-Producers				-3				-1		-4
Gas Treatment Plant		-10								-10
Charcoal Plant							-6			-6
Coke/Blast Furnace			-1							-1
Total Transformation	-150	-10	-1	-24			-6	-1		-192
Own Consumption	0									0
Adjustment	-4	1	1				0			-2
Industrial			2				9			11
Residential			0				55		5	61
Agric, Fishing, Mining			0					2		2
Energy Consumption			3				64	2	5	74
Non-energy Consump.								3		3
Final Consumption			3				64	5	5	77

(to be continued)

Appendix VIII (continued)
Energy Balance of Peru, 1991
('000 boe/d)

	Electricity	LPG	Gasoline	Kero/jet	Diesel Oil	Fuel Oil	Other Energy	Non-Energy	Total Secondary
Production	25	3	25	20	26	73	11	2	185
Importation		1	1	1	7		2	0	12
Exportation			1		0	45		0	46
Inventory Variation									-1
Unused									
Total Supply	25	4	25	20	32	28	13	2	149
Refinery		3	24	20	26	73	1	1	149
Power Plants	18				-3	-1			18
Self-Producers	7				-4	-4	-1		7
Gas Treatment Plant		0	0				8	1	10
Charcoal Plant							1		1
Coke/Blast Furnace									1
Total Transformation					-7	-5	9		-14
Own Consumption	0	0	0	0	1	2	7		10
Losses	3								3
Adjustment		0	0	1	-2		1	0	-1
Transportation			23	4	19	1			46
Industrial	7	1	0	0	3	8	1		19
Residential	8	3		14			2		27
Commercial, Pub. Serv.			2	1	2	0			5
Agric, Fishing, Mining	6	0	0	0	3	13	0		23
Energy Consumption	22	4	24	20	26	22	3		120
Non-Energy Consump.								2	2
Final Consumption	22	4	24	20	26	22	3	2	122

Note: Individual units do not necessarily add up to the total because of independent rounding.

Sources: East-West Center PREM Data File and OLADE (1993).

Appendix IX
Energy Balance of Bolivia, 1991
('000 boe/d)

	Crude Oil	Gas	Coal	Hydro- electricity	Geothermal Power	Nuclear Power	Fire- wood	Cane Products	Others	Total Primary
Production	23	100		9			9	4	2	147
Importation										
Exportation		40								40
Inventory Variation	0									0
Unused		45								45
Total Supply	24	15		9			9	4	2	62
Refinery	-24									-24
Power Plants		-5		-8						-13
Self-Producers				-1						-1
Gas Treatment Plant		-2								-2
Total Transformation	-24	-7		-9						-41
Own Consumption	0	4								4
Adjustment							0			-1
Industrial		3						3		7
Residential		0					9		2	11
Energy Consumption		3					9	3	2	18
Final Consumption		3					9	3	2	18

(to be continued)

Appendix IX (continued)
Energy Balance of Bolivia, 1991
('000 boe/d)

	Electricity	LPG	Gasoline	Kero/jet	Diesel Oil	Fuel Oil	Other Energy	Non-Energy	Total Secondary
Production	4	4	8	2	8	0	2	0	29
Importation	0								0
Exportation	0	0							0
Inventory Variation			0	0	0		0		
Unused									
Total Supply	4	4	8	2	8	0	2		28
Refinery		1	8	2	8	0	2	0	21
Power Plants	3								3
Self-Producers	0								0
Gas Treatment Plant		3							3
Charcoal Plant							0		0
Total Transformation					-1		2		-1
Own Consumption	0	0	0	0	0		1	0	2
Losses	1	0	0	0		0	0		1
Transportation			8	2	6				15
Industrial	1	0		0	0	0	0		2
Residential	2	4		0	0		0		6
Agric, Fishing, Mining				0	0				0
Construction/Others	0	0		0	0				1
Energy Consumption	3	4	8	2	7	0	0		25
Non-Energy Consump.							0	0	0
Final Consumption	3	4	8	2	7	0	0	0	25

Note: Individual units do not necessarily add up to the total because of independent rounding.

Sources: East-West Center PREM Data File and OLADE (1993).

Appendix X
Energy Balance of Chile, 1991
('000 boe/d)

	Crude Oil	Gas	Coal	Hydro- electricity	Geothermal Power	Nuclear Power	Fire- wood	Cane Products	Others	Total Primary
Production	17	29	31	23			59		0	158
Importation	115		21							135
Exportation										
Inventory Variation			-9	-1						-10
Unused		3								3
Total Supply	131	26	42	22			59		0	280
Refinery	-131	-9								-140
Power Plants			-16	-20						-36
Self-Producers		-1	-7	-2			-2			-12
Gas Treatment Plant		-11								-11
Coke/Blast Furnace			-8							-8
Total Transformation	-131	-21	-31	-22			-2			-207
Own Consumption		2								2
Adjustment	0	0	0				0			0
Transportation		0								0
Industrial		0	11				18			28
Residential		3	0				39			43
Energy Consumption		3	11				57			71
Final Consumption		3	11				57			71

(to be continued)

Appendix X (continued)
Energy Balance of Chile, 1991
('000 boe/d)

	Electricity	LPG	Gasoline	Kero/jet	Diesel Oil	Fuel Oil	Other Energy	Non-Energy	Total Secondary
Production	34	10	33	11	44	29	22	2	185
Importation		5	2	1	7	0			14
Exportation			0			2	7		9
Inventory Variation			-2	-1	1	2	-1		-2
Unused									
Total Supply	34	15	33	11	52	30	28	2	189
Refinery		10	33	11	44	29	7	2	137
Power Plants	30				-3	-2			30
Self-Producers	4				-1	-3			4
Gas Treatment Plant		0	0				8		8
Coke/Blast Furnace							7		7
Total Transformation					-4	-6	22		-10
Own Consumption	1	0			0	3	3		8
Losses	4						2		5
Adjustment	0		1				1		2
Transportation	0		32	6	32	4			74
Industrial	19	1	0	1	12	17	7		58
Residential	9	13		4	3	0	1		30
Energy Consumption	29	15	32	11	47	21	8		162
Non-Energy Consump.								2	2
Final Consumption	29	15	32	11	47	21	8	2	164

Note: Individual units do not necessarily add up to the total because of independent rounding.

Sources: East-West Center PREM Data File and OLADE (1993).

EAST-WEST CENTER

The U.S. Congress established the East-West Center in 1960 to promote cultural and technological exchanges among the governments and peoples of the Asia-Pacific region, including the United States. The Center promotes responsible development, long-term stability and the human dignity of all people in the region and prepares the United States for constructive involvement in Asia and the Pacific through research, education and dialogue. It provides a neutral meeting ground at which people with a wide range of perspectives exchange views on topics of contemporary significance.

The Center is a public, non-profit institution with an international board of governors. Some 2,000 scholars, government and business leaders, educators, journalists, and other professionals annually work with the Center's staff on major Asia-Pacific issues. Since 1960 about 30,000 men and women from the region have participated in the Center's cooperative programs.

Academic, government, civic, business, and media leaders are invited to join with the East-West Center's international staff in exploring major issues of international and regional concern, within the Center's programs on Resources, Environment, International Economics and Politics, Population, Cultural Studies and the Pacific Islands Development Program.

PROGRAM ON RESOURCES: ENERGY AND MINERALS

The Program on Resources conducts research on energy and mineral resources in Asia, the Pacific region, and the Americas. The research addresses critical issues such as supply security, strategies for efficient development and utilization of domestic energy and minerals, and the mitigation at local and global levels of negative social and environmental impacts. The main goal is to assist planners in government and the private sector in the formulation of effective programs that coordinate national policies, e.g., economic development and growth, security of energy (oil, gas, coal, electricity) and mineral supplies, maintenance of the environment, and protection of public health.

The aims of the research projects are the identification of critical issues and problem solving, employing the most sophisticated modeling and analytical techniques in economics, geology, engineering, and finance. The Program on Resources devotes a major part of its time to analysis and assessment of resource policy issues in Asia-Pacific nations and the United States and plays an active role in interacting with lawmakers and government agencies at local and national levels. The Program on Resources accordingly collaborates closely with the energy and mining departments of governments in the region and with private and state-owned energy and mining companies.

A major objective the Program on Resources is to foster the academic and practical education of students from Asia-Pacific nations and the United States through participation in research projects at the Center. Senior staff hold affiliate appointments at the University of Hawaii and participate in guiding thesis or dissertation research.

For further information about the Program on Resources or a list of publications, contact

Dr. Fereidun Fesharaki
Director
Program on Resources: Energy and Minerals
East-West Center
1777 East-West Road
Honolulu, Hawaii 96848, USA

Telephone (808) 944-7560
Fax (808) 944-7559