EMERGING ENERGY SECURITY ISSUES

Report Series No. 1

Regional Overview of Latin American and Caribbean Energy Production, Consumption, and Future Growth

KANG WU

Program on Resources: Energy and Minerals
East-West Center
Honolulu, Hawaii

July 1994

Prepared for the
United States Department of Energy,
Office of International Energy Assessments
under Grant No. DE-FG01-93EP10050

MASTER

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

870

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, make any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

TABLE OF CONTENTS

List of Tables	iii
List of Figures	iv
Foreword	v
Abbreviations, Acronyms, and Measurements	vii
I. Introduction	1
II. Primary Energy Production and Consumption: Current Situation	2
2.1. Primary Energy Supply	2
Oil	4
Natural Gas	6
Coal	11
Hydroelectricity	14
Nuclear Power	16
2.2. Primary Energy Consumption	17
2.3. Downstream Oil Sector and Product Consumption	20
Refining Sector	20
Petroleum Product Balance and Product Consumption	22
2.4. Natural Gas Utilization and Trade Links	23
III. The Future Energy Growth	26
3.1. Future Growth Primary Energy Supply	26
Oil	27
Natural Gas	28
Coal	28
Hydroelectricity	29
Nuclear Power	29
3.2. The Outlook for Primary Energy Consumption	30

Determinants of Future Energy Consumption Growth	30
Primary Energy Consumption Forecast	36
Future Change of Energy Intensity and Per Capita Energy Consumption	41
3.3. Outlook for the Downstream Oil Sector Development and Oil Product Consumption	44
3.4. The Impact of Latin America and the Caribbean's Oil Export Potential on the Rest of the World	46
3.5. Prospects for Gas Utilization and Trade Links	47
IV. Important Hydrocarbons Policy Issues	50
4.1. Privatization and Demonopolization	50
4.2. Investment Requirements and Investment Climate	51
4.3. Regional Cooperation	52
4.4. Environmental Concerns	54
V. Summary and Concluding Remarks	55
Selected Bibliography	58
Appendix. Energy Balance of Latin America and the Caribbean, 1991	60

LIST OF TABLES

1.	Oil Reserves and Production in Selected Latin American and Caribbean Countries, 1992	5
2.	Latin America and the Caribbean's Oil Balance, 1992	7
3.	Natural Gas Reserves and Commercial Dry Gas Production in Selected Latin American and Caribbean Countries, 1992	10
4.	Coal Supply in Latin America and the Caribbean, 1989 and 1991	13
5.	Development of Hydroenergy Potential in Selected Latin American Countries, 1980 and 1991	15
6.	Percentage Distribution of Primary Energy Consumption: Latin America and the Caribbean, 1980 and 1991	19
7.	Refining Capacity in Selected Latin American and Caribbean Countries, 1993 ...	21
8.	Latin America and the Caribbean's Oil Product Balance, 1991	24
9.	Actual and Projected Population in Selected Latin American and Caribbean Countries, 1990-2000	31
10.	Actual and Projected Real GDP in Selected Latin American and Caribbean Countries, 1990-2000	32
11.	Income Elasticities of Energy Demand in Selected Latin American Countries	37
12.	Percentage Distribution of Actual and Projected Primary Energy Consumption in Latin America and the Caribbean, 1991 and 2000	40
13.	Forecast of Latin America and the Caribbean's Petroleum Product Consumption, 1991, 1995, and 2000	45
14.	Natural Gas Trade Links in Latin America: Pipelines	49

LIST OF FIGURES

1.	Primary Energy Production in Latin America and the Caribbean, 1980 and 1991 . . .	3
2.	Structure of Latin America and the Caribbean's Oil Exports, 1992	8
3.	Structure of Latin America and the Caribbean's Oil Imports, 1992	8
4.	Destinations of Latin America and the Caribbean's Extraregional Oil Exports, 1992	9
5.	Origins of Latin America and the Caribbean's Extraregional Oil Imports, 1992	9
6.	Latin America and the Caribbean's Primary Energy Consumption, 1980 and 1991	18
7.	Per Capita Primary Energy Consumption in Selected Latin American and Caribbean Countries, 1980 and 1991	34
8.	Energy Intensity in Selected Latin American and Caribbean Countries, 1980 and 1991	35
9.	Actual and Projected Primary Energy Consumption in Latin America and the Caribbean, 1991 and 2000	38
10.	Actual and Projected Per Capita Primary Energy Consumption in Selected Latin American and Caribbean Countries, 1991 and 2000	42
11.	Actual and Projected Energy Intensity in Selected Latin American and Caribbean Countries, 1991 and 2000	43

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
East-West Center
July 1994

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

The Latin American and Caribbean region¹—comprising Mexico, Central and South America, and the Caribbean—is relatively well endowed with energy resources, although the distribution of these resources is uneven across countries. The region produces more energy than it consumes, and the surplus energy, which amounts to 3.6 million barrels of oil equivalent per day (boe/d), is mostly oil. While the region's total oil (crude and products) exports decreased from 4.4 million barrels per day (b/d) in 1981 to 3.8 million b/d in 1992, its net oil exports increased from about 1.6 million b/d in 1981 to 2.8 million b/d in 1992. In 1993, the surplus oil in Latin America and the Caribbean remained at 2.8 million b/d.

This report analyzes the key issues of the Latin American and Caribbean energy industry and presents the future outlook for oil, gas, coal, hydroelectricity, and nuclear power developments in the region. In addition, the status of biomass energy, geothermal, and other noncommercial energy in the region will be briefly discussed in the context of overall energy development.

The rest of the report is organized as follows: Section II assesses the current situation of Latin American and Caribbean energy production and consumption, covering primary energy supply, primary energy consumption, downstream petroleum sector development, and natural gas utilization. Section III presents the results of our study of future energy growth in Latin America. Important hydrocarbons policy issues in the region are discussed in Section IV, and a summary and concluding remarks are provided in Section V.

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.

II. Production and Consumption: Current Situation

In this section, the current situation of primary energy supply and demand for the entire region, the downstream refining sector, oil product consumption, and natural gas use will be discussed in detail.

2.1. PRIMARY ENERGY SUPPLY

Total Latin American and Caribbean primary energy production in 1991 was 13.9 million boe/d, up 3.5 percent from 13.4 million boe/d in 1990. It increased another 1.3 percent to 14 million in 1992. In 1991, most of the primary energy produced in the region was petroleum (59.4%), while natural gas (16.3%), and other energy (14.4%)—firewood, cane products, geothermal power,² and others—accounted for the next largest shares. Hydroelectricity (5.5%), coal (4%), and nuclear power (0.4%) comprised the remaining production shares. By comparison, in 1980 oil accounted for 62.6 percent; gas, 16.6 percent; coal, 1.6 percent; hydroelectricity, 3.7 percent; nuclear power, 0.1 percent; and other energy, 15.4 percent of the region's primary energy production (Figure 1). Between 1980 and 1991, production of oil and gas increased at annual rates of 2.2 and 2.5 percent, respectively, and their shares in primary energy consumption decreased. During the same period, coal production increased by 11.3 percent per year; hydroelectricity, 6.4 percent; nuclear power, 15.6 percent; and other energy, 2.1 percent. Total primary energy production in Latin America and the Caribbean rose at an average annual growth rate of 2.7 percent between 1980 and 1991, up from 10.4 million boe/d to 13.9 million boe/d.

Latin America and the Caribbean is a net exporter of crude oil, refinery products, and coal. In 1991, net energy exports amounted to 3.6 million boe/d, or 26 percent of all energy produced in the region, up from 3.1 million boe/d in 1990. The bulk of the region's net primary energy

2. Geothermal power is installed only in three Latin American countries (Mexico, Nicaragua, and El Salvador). It accounted for 0.12 percent of the region's total primary energy production in 1991 and is included in the category of other energy.

Figure 1
Primary Energy Production in Latin America
and the Caribbean, 1980 and 1991

Source: East-West Center PREM Data File.

exports is oil (of which about 80 percent was crude and 20 percent products), while coal accounts for a tiny share (about 1.6% of total net exports).³ Coal plays a relatively minor role in Latin American and Caribbean energy production and consumption. Before 1987, Latin America and the Caribbean was a net importer of coal. In 1991, the region exported a total of 18.6 million tonnes of coal (including exports within the region). With total imports of 14.2 million tonnes, the region's net coal exports amounted to 4.4 million tonnes, or 57,000 boe/d. Current coal producers include Colombia, Brazil, Mexico, Venezuela, Chile, Argentina, Peru, and Panama, but only Colombia and Venezuela are significant as coal exporters. Natural gas accounted for over 16 percent of primary energy production in 1991, and all of it was consumed within the region. Bolivia, the only country that exports natural gas as yet, pipes the fuel to neighboring Argentina. Mexico, the only other country in the region that currently imports natural gas, was a gas exporter in the past, but began importing gas from the United States in 1990. Mexican gas imports were 43 MMcf/d in 1990, increased to 164 MMcf/d in 1991, and 250 MMcf/d in 1992. Each of the five commercialized energy forms—oil, gas, coal, hydroelectricity, and nuclear power—is examined in detail below.

Oil

Latin America and the Caribbean currently accounts for 12.3 percent of the world's oil reserves and 12 percent of crude production (Table 1). At the end of 1992, proven crude oil reserves in Latin America and the Caribbean stood at 124 billion barrels; 1992 total regional oil production, including condensate and natural gas liquids (NGL), was estimated at 7.7 million b/d. Oil resources in Latin America and the Caribbean are very unevenly distributed. Together, Mexico and Venezuela account for nearly 92 percent of the region's 124 billion barrels of oil reserves and more than 70 percent of crude production, while countries such as Paraguay and Uruguay have no proven reserves or production. In addition, Venezuela has approximately 270

3. Latin America is a net coal exporter only based on the heat content (in terms of boe). In terms of absolute quantity of tonnage, Latin America imports more coal than it exports. The difference is due to the heat content of Colombian coal (1 tonne is equivalent to roughly 4.7 boe) and Brazil's imported coal (1 tonne is equivalent to approximately 3.9 boe). See the section on coal in this chapter for details.

Table 1
Oil Reserves and Production in Selected
Latin American and Caribbean Countries, 1992

Country	Reserves/a		Production/b		RP Ratio (Years)
	Billion barrels	Share in the region (%)	000 b/d	Share in the region (%)	
Mexico	51.3	41.3	3,144	40.7	45
Venezuela	62.7	50.4	2,335	30.2	74
Brazil	3.6	2.9	627	8.1	16
Argentina	1.6	1.3	555	7.2	8
Colombia	1.9	1.6	440	5.7	12
Ecuador	1.6	1.3	321	4.2	14
Trinidad and Tobago	0.5	0.4	146	1.9	9
Peru	0.4	0.3	116	1.5	9
Bolivia	0.1	0.1	22	0.3	14
Chile	0.3	0.2	15	0.2	55
Others	0.3	0.2	10	0.1	70
Latin America & Caribbean	124.2	1.0	7,731	100.0	44
World Total	1,006.8		64,666		43
Share of L.America & Caribbean in World		12.3%		12.0%	

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

a. End of the year. b. Production of NGLs (natural gas liquids) is included.

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

billion barrels of recoverable heavy and extra-heavy oil in the Orinoco Tar Belt that could eventually be exported as synthetic crude or as Orimulsion, a boiler fuel made of a mixture of bitumen and water. Mexico and Venezuela are the region's largest exporters of crude and products. At its 1992 level, Latin American and Caribbean crude production could continue for about 44 years, which is slightly higher than the world average reserves/production ratio of 43 years (see Table 1).

Latin America and the Caribbean has been a net oil-exporting region throughout the past two decades. In 1992, Latin America and the Caribbean exported a total of 3.8 million b/d of petroleum—2.96 million b/d of crude and 875,000 b/d of oil products (Table 2). Including intraregional trade, the 1992 exports of crude oil and products for Latin America and the Caribbean stood at 4.47 million b/d, of which 86 percent was extraregional exports and 14 percent was intraregional exports (Figure 2). By the same token, Latin America and the Caribbean's 1992 total oil imports were 1.65 million b/d, of which 61 percent originated from extraregional sources and 39 percent from intraregional sources (Figure 3). At present, 73 percent of Latin American and Caribbean crude and product exports are sent to the United States, the region's principal trading partner, 19 percent to Western Europe, and only 5 percent to the Asia-Pacific region (Figure 4). Latin American and Caribbean oil exports provide about one-third of the United States's total petroleum imports, but only 2 percent of total Asia-Pacific extraregional crude oil imports, which averaged 8.77 million b/d in 1992. The Middle East is by far the largest source of Latin America and the Caribbean's extraregional oil imports, accounting for 52 percent of the total in 1992, followed by the United States at 15 percent (Figure 5). At present, Venezuela, Mexico, Colombia, and Ecuador are Latin America and the Caribbean's major oil exporters. Argentina, Trinidad and Tobago, and Peru are minor oil exporters. Brazil and Chile are the region's principal crude and product importers.

Natural Gas

At the end of 1992, Latin America and the Caribbean's 259 trillion cubic feet (tcf) of gas accounted for approximately 5.3 percent of the world's natural gas reserves (Table 3).

Table 2
Latin America and the Caribbean's Oil Balance, 1992

Item	('000 b/d)
Crude Production	7,731
Exports	
Crude	2,957
Products	875
Total	3,832
Imports	
Crude	630
Products	383
Total	1,014
Product Consumption	4,993

Notes: Individual units do not necessarily add up to the total because of independent rounding. Exports and imports are extraregional trade only

Source: ARPEL; East-West Center PREM Data File.

Figure 2
Structure of Latin America and the Caribbean's
Oil Exports, 1992

Sources: ARPEL; East-West Center PREM Data File.

Figure 3
Structure of Latin America and the Caribbean's
Oil Imports, 1992

Sources: ARPEL; East-West Center PREM Data File.

Figure 4
Destinations of Latin America and the Caribbean's
Extraregional Oil Exports, 1992

Note: Total oil (crude and products) exports: 3.8 million b/d; extraregional trade only.

Sources: ARPEL; East-West Center PREM Data File.

Figure 5
Origins of Latin America and the Caribbean's
Extraregional Oil Imports, 1992

Note: Total oil (crude and products) imports: 1.0 million b/d; extraregional trade only.

Sources: ARPEL; East-West Center PREM Data File.

Table 3
Natural Gas Reserves and Commercial Dry Gas
Production in Selected Latin American Countries, 1992

Country	Reserves/a		Production/b		RP Ratio (Years)
	Bcf	Share in the Region (%)	MMcf/d	Share in the Region (%)	
Mexico	70,900	27.3	3,593	39.1	54
Venezuela	126,492	48.7	2,221	24.2	156
Argentina	22,700	8.7	1,661	18.1	37
Trinidad and Tobago	8,718	3.4	526	5.7	45
Colombia	7,200	2.8	395	4.3	50
Brazil	4,400	1.7	302	3.3	40
Bolivia	4,108	1.6	295	3.2	38
Chile	3,900	1.5	103	1.1	103
Peru	7,054	2.7	73	0.8	265
Ecuador	3,899	1.5	21	0.2	509
Others	101	0.0	3	0.0	102
Latin America & the Caribbean	259,472	100.0	9,193	100.0	77
World Total	4,885,362		208,811		64
Share of L.America & Caribbean in World		5.3%		4.4%	

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

a. End of the year. b. Commercialized dry gas production only.

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

Commercialized dry gas production⁴ averaged 9,193 million cubic feet per day (MMcf/d) in 1992, representing 4.4 percent of the world's total gas output. Venezuela, Mexico, and Argentina accounted for nearly 85 percent of the region's natural gas reserves and approximately 81 percent of production in 1992. Venezuela, Mexico, and Argentina will continue to be major producers in the 1990s, while the shares of Bolivia, Peru, and Trinidad and Tobago in the regional gas production are likely to increase. In addition, Venezuela and Argentina have the potential to increase their output levels.

As mentioned earlier, all natural gas produced in Latin America and the Caribbean is now consumed within the region. In addition, Mexico imports some gas from the United States. The intraregional gas trade is currently limited to Bolivia (exporter) and Argentina (importer). For the rest of the 1990s, the gas trade should increase as a number of countries in the region are developing their gas reserves for export. Bolivia has just reached an agreement with Brazil to supply natural gas to the latter for 20 years, beginning in 1995. In the meantime, negotiations on an agreement for Chile to import natural gas from Argentina are under way. In addition, several countries plan to increase gas consumption to conserve oil for export as well as reduce pollution. The expected increase in gas use will change the energy consumption picture. Venezuela and Peru both have large untapped natural gas reserves, but both countries are facing political, legal, and financial difficulties in developing such resources. Several LNG (liquefied natural gas) projects are planned or under construction in Venezuela and Trinidad and Tobago. The latter expects to ship out its first cargo of LNG in 1997. Chile could also export LNG made of Argentine gas. In Colombia, the government has adopted a market-oriented gas policy that could result in accelerated development of gas reserves.

Coal

Coal plays a relatively minor role in the Latin American and Caribbean energy balance, accounting for 4 and 4.9 percent, respectively, of the region's total primary energy supply and

4. Commercialized dry gas production is only part of total gas output. In the chapters for each country that follow, the gas output refers to total production.

consumption in 1991. At the end of 1992, the region's total proven coal reserves (including anthracite, bituminous, subbituminous, and lignite) were estimated to be 11.4 billion metric tons (tonnes), representing about 1.1 percent of the world's total reserves. Coal production in Latin America and the Caribbean in 1991 totalled some 42 million tonnes, accounting for 1 percent of the world's output.⁵ Until the early 1980s, coal was used mainly by the iron and steel industry in Latin America, but its thermal use for power generation has assumed some importance in several countries, particularly Colombia and Mexico.⁶ Coal exports from Latin America and the Caribbean were virtually nonexistent until the mid 1980s, when Colombia's El Cerrejón mining project started mass production. By 1991, Colombia, the largest coal producer and exporter in the region, was producing 23.6 million tonnes and exporting 16.3 million tonnes of coal. It accounted for 56 percent of regional coal production, followed by Mexico (22%), Brazil (10%), Venezuela (6%), and Chile (5%), with Argentina and Peru producing the remaining shares (Table 4).

In terms of coal trade, Colombia dominated the regional export market, accounting for 88 percent of all coal exports in 1991, followed by Venezuela (11%) and Mexico (less than 1%). Brazil is the largest coal importer in the region, importing 16.4 million tonnes of coal in 1991. Other coal importers include Chile, Argentina, Mexico, Peru, and Uruguay.

Latin America and the Caribbean is a net coal importer if tonnage is used as the measure. However, if heat content in terms of oil equivalent is used as the measure, then the region registers a surplus in coal trade, since Colombia exports thermal bituminous coal with high heat content whereas Brazil imports coking coal with relatively low heat content. Whether the region is a net coal importer or exporter has little implication at the present. The greater implication

5. Of the 4.4 billion tonnes of coal produced worldwide in 1991, 69 percent or 3 billion tonnes was hard coal and 21 percent or 1.4 billion tonnes was lignite and brown coal. All of the coal produced in Latin America was hard coal. See British Petroleum (1992) and OLADE (1993).

6. See Rodríguez-Elizarrarás (1992).

Table 4
Coal Supply in Latin America, 1989 and 1991
('000 tonnes)

Country	Production		Exports		Imports	
	1989	1991	1989	1991	1989	1991
Colombia	18,902	23,600	13,462	16,297	0	0
Mexico	7,041	9,401	47	99	31	321
Brazil	5,909	4,291	0	0	14,557	16,395
Venezuela	2,125	2,521	1,689	2,119	0	0
Chile	1,949	2,208	0	0	1,483	1,490
Argentina	515	292	0	0	1,524	883
Peru	130	102	0	0	60	45
Others	0	0	0	0	498	345
Total Latin America and the Caribbean	36,571	42,415	15,198	18,515	18,153	19,479

Source: East-West Center PREM Data File.

of Latin America's coal trade pattern is its unique characteristic of extraregional trade, illustrated as follows.

While Colombia is the source of almost all coal shipped from the region, Brazil imports a similar amount of coal from outside of Latin America. Due to the large amount of trade, both countries have significant impacts on the international coal market. From 1989 to 1991, Mexico, Brazil, and Chile increased their coal imports while Peru, Argentina, and other countries reduced them. The total regional imports increased from 18.5 million tonnes in 1989 to 19.5 million tonnes in 1991. During the same time, total coal exports increased at an annual rate of 10.4 percent from 15.2 million tonnes to 18.5 million tonnes. Thus, net coal imports of Latin America and the Caribbean decreased from 3 million tonnes in 1989 to 949 thousand tonnes in 1991.

Hydroelectricity

Latin America and the Caribbean has tremendous hydroenergy potential, estimated at 682,373 MW, due to its favorable climate and geographical conditions. The development of this potential, however, has been very low, although on average the utilization rate of the region's hydroenergy potential doubled between 1980 and 1991 from 7.1 percent to 14.1 percent (Table 5). On the other hand, even at low utilization rates, it is estimated that 72 percent of the total electricity production in Latin America and the Caribbean is generated by means of hydroenergy.⁷ Latin America and the Caribbean has the largest hydropower stations in the world—Itaipú in Brazil and Paraguay (capacity: 10,500 MW, shared by the two countries), Itatuba (capacity: 9,100 MW) in Brazil, and El Guri in Venezuela (capacity: 9,025 MW). Together, these three hydropower stations account for nearly 30 percent of the total hydropower generation capacity of 96,000 MW in the region.

Among the ten countries studied, Brazil has the highest installed capacity—accounting for 48 percent of total capacity in the region—and the highest utilization rate of its hydroenergy

7. Ibid.

Table 5
Development of Hydroenergy Potential in Selected
Latin American Countries, 1980 and 1991

Country	Potential (MW)	1980		1991	
		Installed Capacity (MW)	Utilization Rate (%)	Installed Capacity (MW)	Utilization Rate (%)
Argentina	44,500	3,625	8.1	6,610	14.9
Bolivia	18,000	265	1.5	333	1.9
Brazil	213,000	27,649	13.0	46,076	21.6
Chile	26,046	1,470	5.6	3,078	11.8
Colombia	93,000	3,017	3.2	6,707	7.2
Ecuador	25,605	226	0.9	1,471	5.9
Mexico	53,530	6,063	11.3	7,932	14.8
Peru	62,530	1,868	3.0	2,457	3.9
Venezuela	70,000	2,728	3.9	10,425	14.9
Others	76,662	1,886	2.5	10,912	13.8
Total Latin America & the Caribbean	682,873	48,797	7.1	96,001	14.1

Source: East-West Center PREM Data File.

potential (21.6%). Hydroenergy potentials are least developed in Bolivia, Peru, and Ecuador. Generally speaking, the Andean subregion has a high hydroenergy potential (289,680 MW) but a very low utilization rate (about 7% in 1991).

The hydropower sector has been developed very rapidly in Latin America and the Caribbean in the past decade. From 1980 to 1991, installed hydropower capacity in the region increased from 48,797 MW to 96,000 MW, at an average annual growth rate of 6.3 percent. During the same period, the actual hydroelectricity production and consumption increased at average annual rates of 6.4 and 5.8 percent, respectively. Nevertheless, hydroelectricity infrastructure expansion has also been an important cause of many countries' indebtedness in Latin America.⁸ Under these circumstances, the future development of hydropower in the region depends crucially on the funding for power projects and on international cooperation.

Nuclear Power

Only three countries—Argentina, Brazil, and Mexico—in Latin America and the Caribbean have installed nuclear capacity. Prior to 1991, Cuba, with help of the then Soviet Union and other Eastern European countries, had planned to build four commercial nuclear reactors at the Juragua site. There were two Russian-designed 440 MW reactors under construction at this site, Juragua 1 and 2, until late 1992 when the Cuban government decided to halt the construction because of payment disputes with Russia.⁹ The construction of these two nuclear plants will be postponed indefinitely unless there is a breakthrough between Russia and Cuba, probably with help of a third party such as France.

Argentina completed its first nuclear power plant in 1974, Brazil in 1985, and Mexico in 1989. The combined nuclear power generating capacity in the three countries amounted to 2,350 MW in 1991. Because of public concern over safety following the accidents of Three Mile Island in

8. Ibid.

9. See EIA (1993), p. 57.

the United States and Chernobyl in the Ukraine and the high costs associated with the construction of nuclear power plants, Latin American and Caribbean governments no longer view nuclear power as a realistic alternative in future energy expansion plans.¹⁰ However, the topic is still open to debate. It is very likely that the slow development of nuclear programs in Latin America and the Caribbean is mainly caused by insufficient funding.

All three countries—Argentina, Brazil, and Mexico—had major plans to further develop nuclear power in the 1990s. The budget and financing situation in these countries has changed, however, since the time when the new nuclear plants were planned, and delays of some projects are possible. In Argentina, which has two nuclear power plants (Atucha I and Embalse Nuclear Power Station), it was decided that the second unit of the Atucha facility (the country's third nuclear plant) would be completed, but all plans for another two nuclear plants have been stopped. In Brazil, plans call for only Angra 2 to be finished, whereas Angra 3 has been cancelled. Mexico's once-ambitious nuclear power program, which envisaged the installation of 5,000 to 6,000 MW of new capacity by 2010, suffers from budget constraints. It is now estimated that during the period between 1995 and 2000 additional nuclear power capacity of 2,660 MW will be installed in the three countries—670 MW in Mexico, 745 MW in Argentina, and 1,245 MW in Brazil. As a result, nuclear power consumption is expected to continue to expand in these countries up to the year 2000.

2.2. PRIMARY ENERGY CONSUMPTION

In 1991, primary energy consumption totaled 9.8 million boe/d in Latin America, having grown at an average annual rate of 2.2 percent since 1980 (Figure 6). During the same period, oil consumption in the region grew at an annual rate of only 1.2 percent, and its share in total primary energy consumption declined. Gas consumption in the region grew at an average rate of 3.2 percent per year; coal, 5.6 percent per year; hydroelectricity, 5.8 percent per year; and nuclear power, 17.1 percent per year (Table 6). As a result, the shares of gas, coal, hydro, and nuclear power in the region's primary energy consumption all rose during the period.

10. See Escofet (1992).

Figure 6
Latin America and the Caribbean's Primary
Energy Consumption, 1980 and 1991

Table 6
Percentage Distribution of Primary Energy Consumption:
Latin America and the Caribbean, 1980 and 1991
 (%)

	1980	1991
Oil	53.1	47.8
Natural Gas	17.7	19.5
Coal	3.4	4.9
Hydroelectricity	5.0	7.4
Nuclear Power	0.1	0.6
Other	20.7	19.8
Total	100.0	100.0

Source: East-West Center PREM Data File.

Consumption of other energy (including firewood, cane products, and others) increased at an average annual rate of only 1.8 percent during the period 1980–1991, lowering its share in total primary energy consumption.

In 1991, petroleum accounted for 47.8 percent of Latin America and the Caribbean's total primary energy consumption, down from 53.1 percent in 1980 (see Table 6). Together, geothermal power, firewood, cane products, and other noncommercial energy sources comprised the next largest share (19.8%) in Latin American and Caribbean primary energy consumption. The highest country shares were found in Peru (35%), Brazil (35%), Bolivia (24%), Colombia (22%), and Chile (20%). On the other hand, Venezuela's primary energy consumption is largely satisfied by oil and gas, and it has no biomass or other noncommercial energy consumption. The remainder of the region's primary energy consumption in 1991 was provided by natural gas (19.5%), hydroelectricity (7.3%), coal (4.9%), and nuclear power (0.6%).

2.3. DOWNSTREAM OIL SECTOR AND PRODUCT CONSUMPTION

Refining Sector

Total refining capacity for the region stood at 6.4 million b/d as of January 1, 1993.¹¹ This is less than the 6.6 million b/d of two years earlier and reflects the shutdown of 164,000 b/d of capacity in Mexico in 1991 (Table 7). In comparison, the refining capacity in the United States is 15.2 million b/d. The ratio of cracking-to-distillation capacity, which is a very rough indication of refinery flexibility, is about 28 percent on a regional basis. Colombia and Argentina have high ratios (58 and 53 percent, respectively) that are close to the ratio for the United States (about 60 percent). As a result of pressure from a heavier indigenous crude slate coupled with the need to meet domestic demand for higher quality products, most countries in the region are planning extensive expansion and upgrades of refining capacity. Plans for crude distillation capacity expansion within the region call for another 1 million b/d during

11. As defined earlier, the refining capacity in Puerto Rico, the U.S. Virgin Islands, and the Netherlands Antilles, which totalled 1.1 million b/d in 1993, is not included here.

Table 7
Refining Capacity in Selected Latin American and Caribbean Countries, 1993
('000 b/cd)

Country	Number of Refineries	Crude Distillation	Thermal Operations/a	Cat. Reforming	Cat. Cracking	Cat. Hydro-cracking	Cracking/Distillation Ratio/b
Argentina	12	709.5	168.5	41.3	180.1	23.9	52.5%
Bolivia	3	45.3	...	14.6	...	...	0.0%
Brazil	13	1,402.5	39.8	23.6	316.6	...	25.4%
Chile	3	143.7	19.2	9.5	38.2	...	40.0%
Colombia	4	264.4	59.0	6.0	94.0	...	57.9%
Ecuador	5	147.0	25.2	2.8	16.0	...	28.0%
Mexico/c	6	1,515.0	63.0	170.8	243.0	18.5	21.4%
Peru	6	188.8	...	1.8	24.6	...	13.0%
Trinidad & Tobago	2	246.0	8.0	27.9	26.0	...	13.8%
Venezuela	6	1,167.0	134.1	8.9	233.9	...	31.5%
Other	16	575.1	26.5	35.4	4.8	...	5.4%
Latin America & the Caribbean	76	6,404.3	543.3	342.4	1,177.2	42.4	27.5%
United States	184	15,209.9	1,794.3	3,597.1	5,200.2	2,132.4	60.0%
World Total	712	73,186.3	6,211.4	9,171.6	10,921.1	2,702.5	27.1%

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

a. Include thermal cracking, visbreaking, fluid coking, delayed coking, and others. b. Cracking/distillation ratio = (thermal operation + catalytic cracking + catalytic hydrocracking)/crude distillation. c. Excludes Pemex's three refineries that were shut down in 1991.

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

1992–1996.¹² Upgrading capacity, especially desulfurization and cracking units, is also being planned. A number of countries, notably Venezuela, Mexico, Brazil, and Colombia, have announced extensive plans to build secondary facilities, subject to their success in securing capital.

Given the growing demand for refinery products, especially gasoline and diesel, in Latin America, the region's refining capacity is expected to be expanded continuously throughout the decade. Of the ten countries examined individually in this study, only Bolivia has no major plans to expand refinery capacity. Details of these expansion plans in each country will be discussed in Report No. 2¹³. For most of the oil companies in the region, financing is one of the major factors that will determine the extent of refinery expansion. Although plans for crude distillation capacity expansion within the region include another million barrels per day of capacity in the coming years, financing remains a difficult issue because of restrictions on private domestic and foreign participation. As refining projects compete with capital requirements for upstream development and electricity generation, delays may be unavoidable.¹⁴

Petroleum Product Balance and Product Consumption

Economic development in Latin America and the Caribbean is creating a change in the regional consumption pattern away from fuel oil and toward increased demand for transport fuels, especially gasoline. Between 1980 and 1990, demand for gasoline grew by 3.7 percent per year, while total product demand increased at an annual rate of only 1.2 percent. The demand for fuel oil, however, declined by 0.6 percent per annum over the period, reflecting the progress in fuel-substitution programs in power generation.

12. See Tutto et al. (1992).

13. See Report Series No. 2, *Energy Profiles of Selected Latin American and Caribbean Countries*, July 1994, prepared for the U.S. Department of Energy, by East-West Center, Program on Resources: Energy and Minerals, Honolulu, Hawaii.

14. See Tutto et al. (1992).

Regional consumption of refinery products totaled 4.91 million b/d in 1991, of which 31.6 percent was provided by gasoline, followed by diesel (24.4%), fuel oil (20.7%), and LPG (11.8%). Kerosene and jet fuel (kero/jet) only accounted for less than 5 percent of total product consumption (Table 8). The principal petroleum product exported by Latin American and Caribbean countries (intraregional trade included) was fuel oil, which accounted for 37.2 percent of the total, while diesel (23.7%) and gasoline (19.0%) were the next largest exported products by volume.¹⁵ Conversely, gasoline is the main product imported (27.9 percent of total imports), followed by fuel oil (27.5%), diesel (22.5%), and LPG (17.3%). Kero/jet imports accounted for less than 3 percent of total product imports.

2.4. NATURAL GAS UTILIZATION AND TRADE LINKS

In all but a few countries in the region, natural gas is an underutilized resource. Natural gas constituted about 30 percent of the region's hydrocarbons reserves (oil and gas) in 1991, but it accounted for only about 20 percent of total commercial hydrocarbons production, compared to 80 percent for petroleum. The current ratio of proven reserves to production for natural gas (1992 gas reserves/1992 commercialized gas production) ranged from 509 years for Ecuador, 156 years for Venezuela, and 152 years for Peru, to 38 years for Bolivia and 37 years for Argentina, with an average of 77 years for the region. In comparison, the reserves/production ratio for crude oil is, on average, about 44 years for the region. While oil provided 48 percent of primary energy consumption, natural gas contributed 20 percent of the total. Per capita consumption of natural gas in the region as a whole is less than the world average and far lower than the level in most industrialized countries. The region thus has great potential to increase gas production as well as consumption.

In 1991, the Latin American and Caribbean domestic gas supply amounted to 2.27 million boe/d. Gas utilization was about 2 million boe/d, of which about 57 percent was fed into refineries, power plants, and gas treatment plants, 28 percent was directly used by final users,

15. Due to the difference in study scope and sources of data collection, the imports for Latin America shown in Table 1.8 are not exactly the same as discussed earlier in this chapter.

Table 8
Latin America and the Caribbean's Oil Product Balance, 1991
('000 b/d)

Product	Production	Imports	Exports	Consumption	Stock Change
LPG	563.9	98.3	74.7	581.0	6.4
Gasoline	1,657.9	159.2	241.6	1,552.7	22.8
Kero/Jet	328.8	19.3	119.4	227.2	1.5
Diesel	1,378.0	128.2	302.0	1,201.0	3.2
Fuel Oil	1,332.9	156.7	473.8	1,014.9	1.0
Others	395.3	7.6	61.7	337.1	4.1
Total	5,656.9	569.3	1,273.3	4,913.9	39.0

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

Source: OLADE; East-West Center PREM Data File.

and 10 percent was consumed by the gas sector itself. Losses account for the remaining percentage. Industry comprised the bulk of direct gas consumption in the region, accounting for 67 percent of the total, followed by the residential (22%) and other sectors. About 9 percent of the direct gas consumption in 1991 was non-energy (see the Appendix).

International trade of natural gas in Latin America and the Caribbean is still limited to a few countries; Argentina and Mexico are the only importers and Bolivia is the only exporter. The existing international pipelines include the U.S.-Mexico pipelines with a combined capacity of 954 MMcf/d and the Bolivia-Argentina pipeline with a capacity of 390 MMcf/d. While the Bolivia-Argentina pipeline has been operational for more than two decades, a new 400 MMcf/d international gas pipeline from McAllen, Texas, to Reynosa, Mexico, became operational in August 1992.

III. The Future Energy Growth

This section focuses on the region's future energy growth, and builds upon the review of the current situation of Latin American and Caribbean energy presented in the previous section and the detailed examination of the energy sector in ten countries in Report No. 2. The forecast of the regional energy growth is primarily based on the growth projections for individual countries detailed in Report No. 2, combined with the overall pattern of the region's development in the past and at the present time.

The rest of this section is organized as follows: The first subsection illustrates the prospects for Latin America and the Caribbean's primary energy supply with each of the major energy fuels being examined. The second subsection begins with a short discussion of the determinants for energy consumption growth and then forecasts the primary energy consumption by the year 2000. The changes in energy intensity and per capita primary energy consumption for selected Latin American and Caribbean countries are examined in the third subsection. Given the importance of the region's future oil product consumption and natural gas use in Latin America and the Caribbean's energy balance, the fourth and fifth subsections further discuss the international trade implications of the future consumption patterns. Finally, concluding remarks on Latin America and the Caribbean's future energy growth and a summary of major issues in this report are given in the last subsection.

3.1. FUTURE GROWTH OF LATIN AMERICA'S PRIMARY ENERGY SUPPLY

While Latin America and the Caribbean has substantial potential to increase its energy consumption during the rest of the 1990s, there are many uncertainties associated with the region's energy development that will greatly influence the outcome. Differences in approach and methodology when evaluating these uncertainties will contribute to the wide range of forecasts of the region's oil, gas, coal, and nuclear power production capacity. Such uncertainties include the abilities of Latin American and Caribbean governments to continue their various degrees of open door policy; the political reaction to increased foreign investment in the

region's energy sector; the development of democracy; environmental concerns; the effects of nationalist sentiment; and many other major issues. Based on each country's individual energy development plans, the following perspectives of the region's future energy production will take into account both (1) successful policy implementation, a large foreign investment influx, and largely harmonious energy-environmental interaction for the high case scenario; and (2) frequent policy interruptions, violent political conflicts, social disorder, return of military rule, and ultimately disinvestment by private domestic and foreign investors in the energy sector for the low case scenario. Unlike primary energy consumption, which is more stable and more directly associated with population and economic growth, the forecasts of primary energy supply (in terms of indigenous production) will vary substantially depending on the amounts and allocations of investment in the energy sector.

Oil

All major oil producers studied in this report, except Ecuador, Peru, and Trinidad and Tobago, have the potential to significantly increase production levels in the 1990s. Peru's 1992 oil production (115,700 b/d) was only slightly higher than its 1991 output level (114,900 b/d), and its efforts to attract foreign investment and increase oil production may be hampered by the unstable domestic political situation. But the government is striving to widen its cooperation with foreign investors in the hydrocarbons area. Ecuador is faced with an increasingly heavier gravity in its oil deposits, and its ability to boost the oil production level by the year 2000 is largely limited as its production is expected to peak in the mid 1990s. However, the enhanced exploration activities by foreign oil companies in recent years could considerably boost the country's oil production and prolong its peak production years. For the entire Latin American and Caribbean region, it is estimated that production capacity could reach 8.5 to 11 million b/d by the end of the decade, depending on how successful individual hydrocarbons producers are in mobilizing the funds needed to ensure production capacity increases.¹⁶

16. See Wu (1993), p. 681.

Natural Gas

Many countries in Latin America and the Caribbean produce natural gas. This fuel has been championed as the "fuel of the future" because it is superior to other fossil fuels in its environmental effects. The majority of the gas produced in Latin America and the Caribbean is associated gas, and for various reasons, gas utilization is lower than actual production. Many countries reinject the produced gas; some gas is used only by the gas sector itself; and some gas is simply wasted by flaring.

The countries that have potential to increase gas production are Venezuela, Trinidad and Tobago, Bolivia, Brazil, Argentina, and Peru. A number of LNG projects have been initiated in Venezuela and Trinidad and Tobago. While a large portion of the projected production increase is driven by the booming domestic gas market, the incentives for higher production in Argentina, Bolivia, Venezuela, and Trinidad and Tobago derive partially from the growing export markets. The gas trade of Latin America, both intraregional (through pipelines) and extraregional (via LNG tankers), should increase during the rest of the decade. As many countries continue to reduce the share of unused gas, part of the new demand will be satisfied by raising the utilization rate of the gas that is already being produced. The growth of gas production in the region would therefore be lower than the consumption growth, if exports outside the region were not considered. The region is expected, however, to produce not only enough gas for its own consumption but also a possible surplus for export as LNG to Europe and the Asia-Pacific region. The materialization of such extraregional exports hinges largely on whether the plans for LNG projects are successfully developed in Venezuela, Trinidad and Tobago, and Chile.

Coal

Owing to the concentration of the region's coal deposits and production in only a few countries (Colombia, Venezuela, Mexico, and Brazil), and given the region's traditional reliance on oil and gas for its energy needs, coal will continue to play a minor role in Latin America and the Caribbean's energy production and consumption. The growth rate of coal production was high during the past decade and it will continue to grow rapidly.

By the year 2000, the coal exports of Colombia are expected to reach the level of 20-30 million tonnes, most of which will be thermal bituminous coal and will be exported to countries outside Latin America. Venezuela will rapidly increase its coal production and exports will reach approximately 15 to 20 million tonnes by the year 2000. Coal production in Mexico will continue to increase and the country may become self-sufficient in coal use by the end of the decade. Latin America and the Caribbean will continue to play an important role in international coal markets due to the unique pattern of trade. As Brazil continues to expand its domestic coal production, thereby slowing the growth of its imports, the region will soon become a net coal exporter both in heat content and in absolute tonnage.

Hydroelectricity

Latin America and the Caribbean features both the world's largest hydropower stations and many small ones. Hydropower plants were built very rapidly during the 1980s, and installed capacity expanded from 49 gigawatts (GW) in 1980 to 95 GW in 1991, reflecting an average annual growth rate of 6.3 percent. During the same period, hydroelectricity production rose by an annual average of 6.4 percent. Since the early 1990s, however, hydropower construction has slowed significantly. Lack of investment is one of the major reasons for the slowdown. At present, the utilization of Latin America and the Caribbean's hydroenergy potential is still a low 14 percent. The rate is even lower in countries such as Bolivia, Ecuador, and Peru. During the 1990s, the addition of new hydropower capacity is expected to be less than in the 1980s. As suggested by projected hydroelectricity consumption in the region, hydroelectricity production is expected to grow at an average annual rate of 2 to 3 percent during the period 1991-2000.

Nuclear Power

Despite a decade of fast growth in the 1980s, nuclear power still accounts for less than 1 percent of Latin America and the Caribbean's total electricity generation. The future growth of nuclear power in the region is full of uncertainties. Mexico, Brazil, and Argentina have already ruled out nuclear power as a major energy form that their economies could rely upon in the future. The completion of Cuba's two unfinished nuclear power units, on the other hand, will be

postponed for a long period of time, if not forever, as a result of the 1991 break-up of the Soviet Union and the ensuing withdrawal of Soviet financial and technical assistance.

The likely prospects of the nuclear power stations that are operational or under construction in three Latin American and Caribbean countries are discussed earlier in this report as well as in the individual country studies for Mexico, Brazil, and Argentina (see Report No. 2). It is estimated that by the year 2000 additional nuclear power capacity of 2,660 MW will be installed in these three countries.

3.2. THE OUTLOOK FOR PRIMARY ENERGY CONSUMPTION

The forecast of primary energy consumption for Latin America and the Caribbean is based primarily on detailed country-by-country study in Report No. 2. The determinants of economic consumption in the future have been used in the forecasts of each country. Before the regional primary energy consumption forecast is made, these determining factors will be reviewed and summarized as follows.

Determinants of Future Energy Consumption Growth

Population Growth

Table 9 shows the populations of ten selected Latin American and Caribbean countries from 1990 to 1992 and projections from 1993 to 2000. Among these ten countries, the population growth rate between 1992 and 2000 is expected to be highest in Bolivia (2.89% per year) and lowest in Argentina (1.14%).

GDP Growth

After years of economic recession, hyper-inflation, and disinvestment of foreign capital from the 1970s through the mid-1980s, many Latin American and Caribbean countries began to exhibit healthy economic growth and controlled inflation in the early 1990s. The GDP growth forecast by the Inter-American Development Bank for the ten countries included in this study indicates that all will exhibit positive real GDP growth between 1992 and 1997, with the possibility of continued growth through the year 2000 (Table 10). Bolivia is expected to have the highest GDP

Table 9
Actual and Projected Population in Selected
Latin American and Caribbean Countries, 1990-2000 /a
(millions)

Country	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Argentina	32.3	32.7	33.1	33.5	33.9	34.3	34.7	35.1	35.4	35.8	36.2
Bolivia	7.3	7.5	7.7	8.0	8.2	8.4	8.7	8.9	9.2	9.5	9.7
Brazil	150.4	153.3	156.3	159.2	162.2	165.1	168.0	170.9	173.8	176.6	179.5
Chile	13.2	14.0	13.6	13.8	14.0	14.2	14.5	14.7	14.9	15.1	15.3
Colombia	33.0	33.6	34.3	34.9	35.5	36.2	36.8	37.5	38.1	38.8	39.4
Ecuador	10.6	10.9	11.1	11.4	11.7	11.9	12.2	12.5	12.8	13.0	13.3
Mexico	88.6	90.5	92.3	94.2	96.1	98.0	99.8	101.7	103.6	105.4	107.2
Peru	21.6	22.0	22.5	22.9	23.4	23.9	24.3	24.8	25.3	25.8	26.3
Trinidad & Tobago	1.3	1.3	1.3	1.3	1.4	1.4	1.4	1.4	1.4	1.5	1.5
Venezuela	19.7	20.2	20.7	21.2	21.7	22.2	22.7	23.2	23.7	24.2	24.7

a. 1990-1992 are actual numbers.

Source: IDB.

Table 10
Actual and Projected Real GDP in Selected
Latin American and Caribbean Countries, 1990-2000/a
(billions of 1985 dollars)

Country	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Argentina	66	70	74	77	78	78	81	84	87	90	93
Bolivia	6	6	7	7	8	9	10	10	10	11	11
Brazil	245	248	252	260	266	278	290	304	314	323	333
Chile	22	23	24	26	28	29	30	31	33	34	36
Colombia	43	44	45	47	49	51	54	56	58	60	63
Ecuador	17	18	18	19	19	20	21	22	23	24	25
Mexico	197	204	210	216	227	238	254	270	282	295	309
Peru	16	16	16	17	17	18	19	20	20	21	21
Trinidad & Tobago	6	7	7	7	7	7	7	7	7	7	7
Venezuela	70	77	82	86	90	94	99	103	107	112	116

a. 1990-1991 are actual numbers; 1992-1996 are IDB forecasts; 1997-2000 are author's forecasts based on IDB information.

Sources: IDB; OLADE; East-West Center PREM Data File.

growth rate (6.9% per year) between 1991 and 2000, followed by Chile (5.1%), Mexico (4.7%), and Venezuela (4.7%). Trinidad and Tobago is expected to have the lowest real GDP growth (1%) among the ten countries. The GDP growth generally raises energy consumption in each country for the rest of the decade.

Energy Price Changes

Energy price changes, if they are significant, may influence the growth of primary energy consumption. In Latin America, fuel prices differ from country to country; sometimes the differences are very large. For instance, in September 1993, the representative regular gasoline prices in domestic markets ranged from US\$2.16/gal in Argentina to 24¢/gal in Venezuela; representative gasoil prices ranged from US\$1.41/gal in Bolivia to 21¢/g in Venezuela; representative kerosene prices ranged from US\$1.03/gal in Argentina and US\$1.02/gal in Chile to 3¢/g in Ecuador; and representative fuel oil prices ranged from US\$1.27/gal in Bolivia to 29¢/gal in Colombia and 14¢/gal in Venezuela. The likely relaxation of energy price regulations in Argentina, Peru, and Venezuela and resulting price surges may curb the growth of energy consumption in these countries. Ecuador and Brazil are experimenting with the same measures in relaxing price controls but are experiencing some difficulties because of domestic politics. Details of the possible price changes are discussed in each country studies (see Report No. 2).

Energy Intensity and Per Capita Consumption

Energy intensity and per capita energy consumption (in this case, primary energy consumption) are relatively stable over time. However, changes in these two measures often reflect changes in energy use in the economy. Figure 7 compares the per capita primary energy consumption (boe per person) in ten Latin American and Caribbean countries in 1980 and 1991. From 1980 to 1991, per capita primary energy consumption declined in all countries except Colombia, Chile, and Trinidad and Tobago. In 1991, the highest per capita energy consumption was found in Trinidad and Tobago (19.5 boe/person) and the lowest was found in Bolivia (3.8 boe/person). Figure 8 compares the energy intensity (kcal per 1980 US\$) in ten countries in 1980 and 1991. During this interval, energy intensity increased in all countries except Brazil and Colombia. The

Figure 7
Per Capita Primary Energy Consumption in Selected
Latin American and Caribbean Countries, 1980 and 1991

Source: East-West Center PREM

Figure 8
Energy Intensity in Selected Latin American
and Caribbean Countries, 1980 and 1991

(kcal/1980 US\$)

Source: East-West Center PREM
 Data File.

highest energy intensity in 1991 was found in Trinidad and Tobago (13,145 kcal/US\$1980) and the lowest in Chile (4,293 kcal/US\$1980).

Elasticity of Energy Demand

Another useful measurement to relate primary energy consumption to economic growth is the income elasticity of energy demand. Compared to energy intensity (energy consumption per unit of GDP at constant prices), the income elasticity of energy demand emphasizes the relationship between changes in real GDP and changes in energy consumption. Based on the projected GDP growth for each country, the output elasticity of energy demand could be used, given that other factors are also considered, to forecast future primary energy consumption. Table 11 shows the real growth rates of GDP and primary energy consumption in the ten countries from 1973 to 1991. The direct output elasticity of primary energy demand is calculated based on the above growth rates. Other income elasticities, such as those derived by Zuazagoitia et al. (1991)¹⁷ using a regression model, are also reported in the table. Both results are a bit unusual in the sense that elasticities are either too high for some countries or too low for others. One of the reasons that such results as shown in Table 11 are problematic is that there is a lack of consideration of energy prices in the calculation and, even if prices are included in the model, they are often distorted as a consequence of government intervention in many Latin American and Caribbean countries. While recognizing the usefulness of this measurement, the income elasticities shown in Table 11 were not used for our primary energy consumption forecast.

Primary Energy Consumption Forecast

Based on the assessment of the energy sector of each individual country, primary energy consumption in Latin America and the Caribbean is forecast to grow at an average annual rate of nearly 3 percent between 1991 and 2000, reaching 12.8 million boe/d in 2000 (Figure 9). Overall oil consumption in Latin America and the Caribbean is expected to grow at an average

17. The regression model used in Zuazagoitia et al. (1991) is $\ln \text{FEC} = a_0 + a_1 \ln \text{POP} + (\ln \text{POP})^2 + \ln \text{GDPPC} + (\ln \text{GDPPC})^2 + \epsilon$ where FEC = final energy consumption; POP = population; GDPPC = per capita GDP (1980US\$); and ϵ = error term.

Table 11

Income Elasticities of Energy Demand in Selected Latin American Countries

	Argentina	Bolivia	Brazil	Colombia	Chile	Ecuador	Mexico	Peru	Venezuela
AAGR of Real GDP, 1973-1991/a	0.4%	1.2%	3.6%	4.0%	3.0%	3.6%	3.5%	1.0%	0.9%
AAGR of Primary Energy Consumption, 1973-1991/a	1.3%	5.5%	3.0%	2.8%	2.7%	5.1%	4.4%	0.7%	3.9%
Direct Income Elasticity of Primary Energy Demand, 1973-1991	3.41	4.44	0.82	0.72	0.90	1.41	1.27	0.70	4.21
Long-Term Income Elasticity of Final Energy Demand, 1970- 1986/b	0.17	-0.07	0.27	0.81	0.49	0.72	1.14	0.74	-0.76

a. AAGR=annual average growth rate. b. Derived by Zuazagoitia et al. (1991) using regression models.

Sources: East-West Center PREM Data File; Zuazagoitia et al. (1991).

Figure 9
Actual and Projected Primary Energy Consumption
in Latin America and the Caribbean, 1991 and 2000

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

annual rate of 2.9 percent—slightly lower than the rate for total primary energy consumption—during the same period. In 2000, the share of oil consumption in primary energy consumption (47.4%) will be slightly lower than its 1991 share of 47.8 percent (Table 12).

Rising environmental concerns, coupled with the desire to conserve oil supplies for exports or to reduce oil imports, are giving a boost to the development of natural gas in Latin America. The share of gas in total primary energy consumption is expected to increase from 19.5 percent in 1991 to 22.6 percent in 2000, growing at an average annual rate of 4.7 percent (see Figure 9 and Table 12). While production is expected to rise at a lower rate until the year 2000, demand will be met by increasing utilization efficiency.

Coal consumption is also expected to grow slightly faster than total primary energy consumption. As the demand for electricity grows, coal-fired power stations will be installed in more countries. But the rate at which this use of coal will grow by 2000 and beyond depends on both technical and environmental factors. If adequate environmental controls are implemented in coal-fired power plants, the coal option could be attractive for Latin American and Caribbean countries. Between 1980 and 1991, coal consumption in Latin American and Caribbean grew at an average annual rate of 5.6 percent. It is expected that during 1991-2000, the annual coal demand growth rate will average 3.1 percent. The share of coal in Latin America and the Caribbean's primary energy consumption is expected to be 5 percent in 2000, about the same as the 4.9 percent registered in 1991.

As the region continues to develop economically and Brazil continues to phase down its fuel alcohol program, consumption of organic fuels will decline. Biomass and other noncommercial energy consumption is expected to increase at an average annual rate of only 1.4 percent through the year 2000. As a result, its share in the region's primary energy consumption is expected to decline from 19.8 percent in 1991 to 17.2 percent in 2000.

Nuclear power, which provides a small percentage of energy consumption in Argentina, Brazil, and Mexico, is expected to continue playing only a nominal role in the supply of energy to the

Table 12
Percentage Distribution of Actual and Projected Primary Energy
Consumption in Latin America and the Caribbean, 1991 and 2000
 (%)

	1991	2000
Oil	47.8	47.4
Natural Gas	19.5	22.6
Coal	4.9	5.0
Hydroelectricity	7.4	7.2
Nuclear Power	0.6	0.6
Other	19.8	17.2
Total	100.0	100.0

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

region. Its share in total regional primary energy consumption is expected to remain at 0.6 percent in 2000, which will be the same as in 1991. The expected average annual growth rate of 2.3 percent for nuclear power consumption is lower than the rate for total primary energy consumption, because of the uncertainties associated with the current nuclear projects under construction in these three countries.

Given the huge hydroenergy potential in the region and its low utilization, construction of new hydroenergy projects is expected in Latin America. Among others, the governments of Mexico, Colombia, and Venezuela have completed studies and surveys of the major rivers in their countries and have pledged to make greater use of their hydroenergy potential in the future. Addition of new hydropower capacity in these three countries by 2000 and beyond has been planned. Our forecast indicates that hydroelectricity consumption will grow at an average annual rate of 2.7 percent between 1991 and 2000, although its share of total energy consumption will remain almost unchanged (see Table 12).

In short, Latin America and the Caribbean is expected to continue to play a key role in the international petroleum market and an increasingly important role in the coal market (Colombia and Venezuela as exporters, and Brazil and Chile as importers) throughout the 1990s. The region will also continue to be a net energy exporter through the year 2000. Given the region's rich endowment of natural resources and the projected energy development plans for the 1990s, energy production is expected to be able to satisfy the forecast primary energy consumption growth of 3 percent per year.

Future Change of Energy Intensity and Per Capita Energy Consumption

Per capita primary energy consumption and energy intensity exhibit dramatic changes based on the forecast of primary energy consumption in the ten Latin American and Caribbean countries. Due to the expected high growth of primary energy consumption for 1990s for most Latin American and Caribbean countries, the consumption on a per capita basis will increase in all countries in the study with the exception of Peru, which has the lowest projected primary energy consumption during the period (Figure 10). By the same token, Figure 11 illustrates the

Figure 10
Actual and Projected Per Capita Primary Energy Consumption in
Selected Latin American and Caribbean Countries, 1991 and 2000

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

Figure 11
Actual and Projected Energy Intensity in Selected
Latin American and Caribbean Countries, 1991 and 2000

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

projected change of energy intensity in the ten Latin American and Caribbean countries. Since projected GDP growth is higher than primary energy consumption growth in most countries, energy intensity is expected to decline during the period 1991-2000 in every country except Trinidad and Tobago, which has the lowest projected GDP growth rate.

3.3. OUTLOOK FOR THE DOWNSTREAM OIL SECTOR DEVELOPMENT AND PRODUCT CONSUMPTION

Given the growing demand in Latin America and the Caribbean for refinery products, especially gasoline and diesel, the region's refining capacity is expected to be expanded continuously throughout the decade. Bolivia alone, among the ten countries studied in this report, has no major plans to expand its refinery capacity. Details of the expansion plans are discussed in the respective country studies. For most of the oil companies in the region, financing is one of the major factors that will determine the extent of refinery expansion. Although plans for crude distillation capacity expansion within the region include another million b/d of capacity in the coming years, financing remains a difficult issue because of restrictions on private domestic and foreign participation. As refining projects compete with capital requirements for upstream development and electricity generation, delays may be unavoidable.¹⁸

Our forecast of the region's major petroleum product demand for the year 2000 is based on the region's 1991 level of consumption of major oil products, which was 4.9 million b/d. The base case scenario shows that between 1991 and 1995, consumption of major petroleum products is expected to grow by an average of 2.7 percent per year, increasing to 3 percent per annum between 1995 and 2000 (Table 13). On an overall basis, the consumption of major oil products is expected to increase by 2.9 percent a year between 1991 and 2000. The prospect of higher economic growth is reflected in the high case scenario, where oil consumption could expand by an average of 4.8 percent per year between 1991 and 2000. However, should the economies in the region deteriorate and political instability increase, then the growth rate of oil product

18. See Totto et al. (1992).

Table 13
Forecast of Latin America and the Caribbean's Petroleum
Product Consumption, 1991, 1995 and 2000
('000 b/d)

Year	LPG	Gasoline	Kero/Jet	Diesel	Fuel Oil	Others	Total
1991 (actual)	581.0	1,552.7	227.2	1,201.0	1,014.9	337.1	4,913.9
1995 (forecast)							
High Case	740.0	1,971.6	272.0	1,462.1	1,114.4	379.3	5,939.4
Base Case	675.7	1,763.9	251.7	1,355.8	1,059.1	360.2	5,466.3
Low Case	631.8	1,632.3	234.1	1,274.9	1,025.1	349.0	5,147.2
2000 (forecast)							
High Case	998.9	2,578.2	344.3	1,937.6	1,207.6	419.7	7,486.3
Base Case	807.9	2,056.7	290.0	1,656.4	1,132.3	385.8	6,329.0
Low Case	687.5	1,746.2	250.7	1,421.4	1,044.2	360.1	5,510.2

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

Source: Based on individual country forecasts in Report No. 2.

consumption could drop to 1.3 percent per year. In the base case scenario, product consumption is expected to reach 5.5 million b/d in 1995 and 6.3 million b/d in 2000.

3.4. THE IMPACT OF LATIN AMERICA'S OIL EXPORT POTENTIAL ON THE REST OF THE WORLD

Latin America and the Caribbean is currently the largest oil exporter to the United States, and it accounted for 33 percent of total U.S. oil imports (crude and products). U.S. imports from Latin America and the Caribbean exceeded those from the entire Middle East.¹⁹ Many Latin American and Caribbean oil producers have traditionally targeted the United States for their hydrocarbons exports. While Latin America and the Caribbean will continue to play a very important role in the U.S. oil market, newer and tougher quality-control regulations in the United States may disqualify some of the Latin American and Caribbean crudes and products, effectively barring them from U.S. markets.

In contrast, Latin America and the Caribbean provided only 2.2 percent of the extraregional oil imports of the Asia-Pacific region—another giant oil consumer. Although current oil consumption in the Asia-Pacific region is lower than consumption in the United States, the former will surpass the latter during the second half of the decade. The Asia-Pacific region already relies heavily on Persian Gulf oil for its import requirements. As Asia-Pacific oil consumption is expected to reach unprecedented levels, the region may have to turn to Latin America and the Caribbean for a larger share of its future oil supply.

The problem confronting an expansion of the Latin American and Caribbean and Asia-Pacific oil connection lies in the lack of upgrading capacity among Asia-Pacific refiners to process heavy Latin American and Caribbean oil. Sulfur content may be another concern. Given the current refining configuration in many Latin American and Caribbean countries, only low-sulfur oil may be suitable for these refineries, whereas low-sulfur, light crude resources are rather limited in Latin America. However, Asian-Pacific countries are currently investing heavily in

19. See British Petroleum (1993).

refinery upgrading.²⁰ Once the upgraded capacity is installed, more Latin American and Caribbean oil will be able to enter the Asia-Pacific oil market. According to Wu (1993), Latin America and the Caribbean will become the best alternative to the Middle East as energy supplier to the Asia-Pacific region. Production capacity in Latin America and the Caribbean by the end of this decade will be in the range of 8.5 to 11 million b/d, and investment is the key to raising the capacity in the region. The Asian-Pacific nations can increase their investment in Latin America and the Caribbean's hydrocarbons in order to secure a larger oil base and share of the extra oil. The future is still uncertain, but the Asia-Pacific countries have no choice but to help boost Latin America and the Caribbean's oil production if energy import diversification is a goal to pursue. While Latin America and the Caribbean cannot provide "energy security" to the Asia-Pacific region, it may well serve the purpose of "energy diversification."

3.5. PROSPECTS FOR GAS UTILIZATION AND TRADE LINKS

Natural gas is expected to be the fastest growing source of energy in Latin America, and demand will outstrip supply in several countries, leading to a significant increase in intraregional gas trade. Our forecasts indicate that natural gas consumption could grow at a rate as high as 4.7 percent per year, increasing its share of primary energy demand from 19.5 percent in 1991 to almost 23 percent in 2000. Natural gas consumption is expected to reach 2.5 million boe/d by the year 2000. Nearly a third of the rise in natural gas consumption is expected to take place in Mexico (31%) alone, which is followed by Venezuela (24%) and Brazil (21%). By using gas more efficiently, Mexico and Venezuela—the largest gas producers in Latin America—can easily increase their already large amounts of gas use. Mexico is by far the largest gas consumer. Despite its position as the largest gas producer in the region, about 4 percent of the gas that Mexico consumes has to be imported from the United States. The country is expected to consume gas in even larger amounts, especially as environmental standards are enforced, necessitating an increasing flow of gas imports from the United States. Brazil is expected to exhibit the largest percentage increase in gas consumption among all Latin American and Caribbean countries, averaging 13.9 percent a year during the period 1991-2000. The Brazilian

20. See Wu (1993) for a detailed study of Asia-Pacific refinery upgrading.

government is making a concerted effort to increase gas consumption and is planning to invest heavily in developing its gas transmission and distribution infrastructure throughout the major cities in the southern part of the country. Most of the additional gas consumed in Brazil will be imported from Argentina and Bolivia. Other countries planning significant

increases in their natural gas consumption are Colombia, Ecuador, and Chile. Colombia is planning to utilize its natural gas resources more efficiently and increase consumption by shifting gas use from the power sector to the residential and industrial sectors. Ecuador is planning to utilize a larger share of its gas in order to meet its high LPG demand. Chile, in its efforts to reduce its dependency on foreign oil, is planning to import gas from Argentina and Bolivia in order to develop markets in the central and northern part of the country.

As for future trade links, the level of international gas trade in Latin America and the Caribbean is expected to increase several times to nearly 1,300 MMcf/d by the year 2000. About a dozen new international pipelines have been proposed by Latin American and Caribbean countries for completion by the end of the decade. The Brazilian and Bolivian governments signed an agreement in February 1993 to build a 2,115-mile, 280-MMcf/d gas pipeline from Santa Cruz, Bolivia, to Sao Paulo, and other cities in southern Brazil by 1995-1996 (Table 14). This 20-year agreement for Bolivia to supply 280 MMcf/d of natural gas to Brazil starting in 1995-1996 may boost the gas output in Bolivia. The pipeline capacity may double to 560 MMcf/d as the agreement calls for an increase in gas export by the year 2000. Chile may also receive gas deliveries from Bolivia through a proposed pipeline. Argentina, the traditional customer of Bolivia, may stop importing from that country once the Bolivia-Brazil deal becomes effective in 1996, and Argentina could itself start exporting gas to southern Brazil, Chile, and Uruguay. The 750-mile transandean pipeline from southern Argentine gas fields to Santiago, Chile, may be completed by 1996.

Table 14
Natural Gas Trade Links in Latin America: Pipelines

Gas Pipeline	Capacity (MMcf/d)	Main Route
Existing		
U.S./Mexico		
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
Bolivia/Argentina	390	Santa Cruz-Campo Duran and points south
YPFB/Gas del Estado		
Planned/Proposed		
U.S./Mexico		
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
Argentina/Chile		
Transandean Gas Pipeline	175	Neuquén-Concepcion-Santiago
Argentina/Brazil		
	140	Uruguania-Rio Grande do Sul, Parana, Santa Catarina States
Argentina/Uruguay		
	n.a.	probably to Montevideo
Bolivia/Brazil		
	280-560	Santa Cruz-Corumba-Sao Paulo and points south
Bolivia/Chile		
	150	Tarija-N.Chile-Tocopilla
Peru/Brazil		
	n.a.	Camisea-Porto Velho
Venezuela/Colombia		
	200	Guajira-Huila (branches to major cities)

n.a. = not available to date.

Source: Culver-Hopper (1992).

IV. IMPORTANT HYDROCARBONS POLICY ISSUES

As economic recovery continues in the region, all Latin American and Caribbean countries face growing demand for energy sources. The governments in the region have to use the limited capital available to them efficiently in order to achieve their targets of energy and economic development, and they must effectively attract foreign and private investment to provide the additional funding required to achieve these goals. The important policy issues in the Latin American and Caribbean hydrocarbons sector can be categorized as follows.

4.1. PRIVATIZATION AND DEMONOPOLIZATION

Until recently, the hydrocarbons sector in many Latin American and Caribbean countries was largely closed to private domestic and foreign investment under hydrocarbon laws or in countries such as in Mexico and Brazil by national constitutions. Over the past few years, in their efforts to reduce costs and increase efficiency, national oil companies in the region have been undergoing substantial reorganizations, which include downsizing, demonopolization, and privatization.²¹ Pemex, the giant Mexican state oil company, which ranked first among the world's national oil companies in the number of employees and third in oil production in 1990, began its painful but necessary restructuring in 1991 in order to downsize its staff and become more efficient. Also in 1991, Peru eliminated the monopoly of its national oil company, Petroperú, by instituting policies that include offering small refineries for sale and granting more concessions to foreign and domestic private oil companies, especially for upstream oil development. In 1994, the pace of privatizing Petroperú was accelerated. PDVSA, Venezuela's national oil company, is in the process of demonopolizing its upstream activities by opening up the development of marginal fields to private participation. Petrotrin, the newly consolidated Trinidad and Tobago national oil company, has also begun gradual privatization. Even YPF of Bolivia has offered to transfer half of its assets to international and private domestic investors.

21. See Obadía et al. (1992), p. 3.

An important complement to the reorganizations of national oil companies in various countries is the reduction of domestic subsidies for oil products. Both Venezuela and Ecuador have been implementing measures to reduce their subsidies, which are the region's heaviest, even though these initiatives have met with great public resistance. Other countries, such as Chile and Bolivia, have been able to reduce or totally eliminate petroleum product subsidies.

Argentina has so far been the strongest advocate for privatization of the state oil and gas sector in Latin America. It is matched only by Petroperú in its efforts to "destate" the oil company. In 1991, Argentina began to privatize the assets of its national oil company, YPF, and its national gas company, Gas del Estado. Nearly half of YPF's assets were sold to private and foreign companies in 1993, and YPF's share of domestic oil production has been reduced from 70 percent to about 40 percent since 1991. In late 1992, Gas del Estado was sold to private domestic and foreign investors. The success or failure of Argentina's bold push for privatization may offer important lessons for other Latin American and Caribbean countries' national oil and gas companies.

4.2. INVESTMENT REQUIREMENTS AND INVESTMENT CLIMATE

Substantial investment in all areas of the Latin American and Caribbean hydrocarbons industry is needed. Large producers such as Mexico and Venezuela need tremendous amounts of investment to maintain or increase their production levels. Brazil has the potential to substantially increase its oil reserves and thus needs sufficient funds for upstream exploration. Medium-size oil producers such as Argentina, Ecuador, Peru, and Trinidad and Tobago are striving to reverse the declining crude oil reserves in their countries and require various levels of investment in the search for new oil. Altogether, capital requirements for the modernization and expansion of the hydrocarbons sector in Latin America and the Caribbean are estimated to be close to US\$120 billion between 1992 and 1996.²²

22. See Obadía et al. (1992), p. 12.

The three largest hydrocarbon producers—Mexico, Venezuela, and Brazil—account for approximately 68 percent of the total investment needed. The largest portion of the capital required, at least US\$50 billion, is earmarked for upstream activities to increase oil and gas production capacity. Private investment is estimated to account for about 40 percent of the total for the region, and most of this share is expected to be provided by multinational oil companies, international banks, and foreign and domestic independent oil companies. Most of the private investment is expected to flow to the upstream sector and the petrochemical industry in the form of direct investment by multinational and foreign and domestic independent oil companies.

Given the importance of attracting private/foreign investment to meet the demand for funding, a favorable investment climate needs to be established in the region to realize this goal. While the governments of many Latin American and Caribbean countries have revised their hydrocarbons policies in order to introduce more foreign capital into their hydrocarbons sectors, a number of pending issues are linked with broader political and economic developments in the region. The highly nationalistic constitutions of Mexico and Venezuela, the guerrilla activities in Colombia and Peru, the uncertainty of the reforms under the new administration in Brazil, the fuel price policy dispute in Ecuador, and the future development of Argentina's privatization program are some of the many unresolved issues that may complicate the climate for foreign investment.

4.3. REGIONAL COOPERATION

While the 1990s appear to be a promising decade for the hydrocarbons sector in Latin America, many countries in the region are experiencing difficulties in reforming the energy sector and their economies in general. Under these circumstances, regional cooperation has become more attractive as common interests and mutually beneficial trade and investment opportunities are developing throughout the region. In the hydrocarbons sector, organizations such as OLADE and ARPEL are positioned to play significant roles in promoting energy security and efficiency

as centers of technical assistance and information.²³ In addition, associations such as the Andean Pact, the San José Accord, and Mercosur are encouraging greater integration of Latin American and Caribbean energy markets. The Andean Pact, which includes Venezuela, Colombia, Ecuador, Peru, and Bolivia, provides funding for oil and gas development projects in some of its member countries through the Andean Development Bank. Through the San José Accord, Venezuela and Mexico have secured crude markets in nine Central American and Caribbean countries, including Costa Rica, El Salvador, Guatemala, Nicaragua, Panama, the Dominican Republic, Barbados, Belize, and Jamaica. Mercosur, an organization established to build a common market between Brazil, Argentina, Uruguay, and Paraguay, has also addressed energy integration, and it is strongly promoting the development of intraregional gas trade.²⁴

In addition to the multinational organizations, bilateral energy links among Latin American and Caribbean countries are developing rapidly. Venezuela and Colombia have strengthened their ties through the trade of electricity. Bolivia, Brazil, Argentina, Chile, Peru, and Paraguay may soon set up a network of gas trade links to transport natural gas from gas fields in Argentina, Bolivia, and Peru to consuming areas in the other countries. A number of countries in the region are jointly developing hydroenergy resources along their borders. While regional integration has been a great challenge to Latin American and Caribbean countries in the past, there is tremendous potential for multilateral efforts in the future.

23. The Organización Latinoamericana de Energía (OLADE), also known as the Latin American Energy Organization, is the association of the energy ministers of Latin American governments. The Asistencia Recíproca Petrolera Empresarial Latinoamericana (ARPEL), also known as the Association of Petroleum Enterprises of Latin America, was founded as an association of state oil companies. In May 1993, ARPEL's original name was modified by changing the word *estatal* (which implied state assistance) to *empresarial* (which implies a broader-based business orientation), thereby opening the way to future membership for private-sector companies and reflecting the rapid change in the region's hydrocarbons sector. See Brussoni (1993) for details of ARPEL's roles and activities.

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

4.4. ENVIRONMENTAL CONCERNS

An issue of growing importance in Latin America and the Caribbean is protection of the environment. Concerns are mounting over the impact of upstream activities on the natural environment in sensitive jungle ecosystems and offshore areas, as well as the effects of pollution from sources ranging from motor vehicles to power plants, refineries, and petrochemical plants.²⁵

Of all the Latin American and Caribbean countries, Mexico, which has suffered some of the region's most serious deterioration of environmental quality, has perhaps been the most aggressive in addressing the problems caused by pollution. In 1991, the country shut down three highly polluting refineries with capacity totalling 164,000 b/d. It also imports MTBE to reduce the lead content and increase the quality of gasoline. Brazil and Venezuela are planning to build their own MTBE capacity as part of their overall refinery expansion programs. In August 1990, the state oil companies of these two countries signed a mutual cooperation agreement to combat oil spills in Venezuelan and Brazilian territorial waters. Another indication that the Latin American and Caribbean governments are making efforts to protect the environment is the projected increase of gas use in a number of countries. As regional trade expands, gas will become the fastest-growing traded energy product in Latin America and the Caribbean by 2000.

In short, hydrocarbons policy has a tremendous impact on the development of energy production and consumption. While the issues discussed above are shared by many Latin American and Caribbean countries, each individual country in the region faces a unique set of concerns in its energy sector development, because of the dissimilarity in size, energy resource endowments, and history of energy use. Depending on their policy choices, Latin American and Caribbean countries will face different advantages or constraints in achieving their individual development goals during the 1990s.

25. See Culver-Hopper et al. (1992), p. 5.

V. SUMMARY AND CONCLUDING REMARKS

The major points of the future growth of Latin America and the Caribbean's energy can be summarized as follows.

1. Following some revolutionary changes since the late 1980s, the energy supply and demand outlook in the 1990s not only appears bright, but it will be far different from the situation of the 1980s and earlier. Imported new technologies and an influx of direct foreign investment may boost oil and gas production in the region. Energy demand, which stagnated during the early 1980s, will grow faster in the 1990s as a result of positive GDP growth in most countries.
2. The remainder of the 1990s promises many opportunities for foreign companies from all over the world, and from the United States in particular, to invest in Latin America—to develop the region's energy potential. Asian-Pacific countries should also take advantage of the open policies in many Latin American and Caribbean countries today to invest in the region's energy development.
3. Depending on the availability of private and foreign capital, future crude oil production capacity in the Latin American and Caribbean region may range from 8.5 to 11 million b/d. In addition to exporting to its traditional markets in North America, the region could eventually serve as an alternative source of energy supply to the countries of Asia and the Pacific, if sufficient investment in the energy sector is forthcoming.
4. Trade and consumption of natural gas will be confined mostly to domestic markets and neighboring countries within the region over the next few years. However, once the LNG plants in Trinidad and Tobago and in Venezuela (possibly also in Chile) are completed, natural gas may be exported to other parts of the world, including the Far East. On the other hand, U.S. natural gas exports to Mexico are expected to increase steadily.

5. The importance of Colombia and Venezuela as leading coal exporters in the region will increase. While Venezuela's coal production is expected to increase rapidly, Colombia will remain among the world's top ranking coal exporters in the year 2000.
6. Hydroelectric plant construction is likely to continue in Latin America, given the region's potential hydroenergy resources. Yet the actual pace of construction may be hampered by limited funding.
7. Even though nuclear energy has lost its former claim to be the ultimate power-generating source of the future, several nuclear plants that are currently under construction are expected to double today's installed capacity within a few years.

This report has discussed production, consumption, and future growth of each of the major primary energy forms. The ten most important energy producing and consuming countries in the region have been studied in further detail. Several major conclusions emerge from this study. First, while energy resources are relatively abundant in Latin America, new investment, together with improvements in energy efficiency and enhanced regional cooperation, have become crucial for the future development of the energy sector.

Second, privatization and demonopolization of national oil and gas companies have appeared as one of the major trends in Latin America and the Caribbean's energy sector. In their efforts to reduce costs and increase efficiency, national oil companies in the region have been undergoing substantial reorganization, including downsizing, demonopolization, and privatization. Although privatization is not the sole nor best answer to every nation's problems, it is being vigorously pursued by some important energy producers in the region. Following the drastic reforms carried out by YPF of Argentina, other state oil and gas companies—such as Petroecuador, Petroperú, Ecopetrol, Petrotrin, and to a lesser extent Pemex and PDVSA—have begun to reduce the scope of the state monopolies in their oil and gas industries or to decentralize the decision-making power within their organizations. The process of market-oriented reforms has proved to be painful and tortuous for many governments. Yet it is believed that reforms are the only way to

revamp the inefficient and money-losing national energy entities in the face of stiff international competition.

Third, following the adoption by many governments of new policies to attract foreign investment, the investment climate has been improved in most if not all countries. Substantial investment is needed in all areas of the region's energy sector, and many countries are welcoming private domestic and foreign capital. Gone are the days when the governments of the region's major oil and gas producers shunned foreign investment in the exploration and production of national resources.

Fourth, regional cooperation has gained new momentum as the market has rapidly changed and developed in Latin America. During the 1990s regional cooperation has become more attractive than ever, with the development throughout the region of common interests and mutually beneficial trade and investment opportunities. Multilateral agreements to promote Western Hemisphere regional cooperation—such as Mercosur, the San José Accord, and the North American Free Trade Agreement (NAFTA)—involve not only the Latin American and Caribbean countries but also the United States and Canada. In addition, bilateral cooperation is essential for the successful development of the hydroenergy resources in the region.

SELECTED BIBLIOGRAPHY

- ARPEL (Asistencia Recíproca Petrolera Empresarial Latinoamericana, the Association of Petroleum Enterprises of Latin America). 1993. *Data Estadísticos ano 1992*. Montevideo, Uruguay: Asistencia Recíproca Petrolera Empresarial Latinoamericana.
- British Petroleum. 1993. *BP Statistical Review of World Energy*, June 1993.
- British Petroleum. 1992. *BP Statistical Review of World Energy*, June 1992.
- Culver-Hopper, Julia. 1992. Natural Gas: Outlook for Latin American/Caribbean Energy Markets in the 1990s. *Energy Advisory No. 99*. Honolulu, Hawaii: East-West Center, Program on Resources: Energy and Minerals.
- Culver-Hopper, Julia, Kang Wu, Cynthia Obadía, Suhesigh Rahmasari, and Cary Bloyd. 1992. *Selected Latin American/Caribbean Country Profiles*. Latin American/ Caribbean Oil and Gas Report Series No. 1. Honolulu, Hawaii: East-West Center, Program on Resources: Energy and Minerals.
- EIA (Energy Information Administration). 1993. *World Nuclear Capacity and Fuel Cycle Requirements 1993*. Washington, D.C.: U.S. Department of Energy.
- Escofet, Alberto. 1992. Evolution of Energy Markets: Nuclear Energy. *Revista Energética* 16(3):111-15.
- Inter-American Development Bank (IDB). 1993. Unpublished forecasts of population and GDP growth in Latin America.
- Obadía, Cynthia; Julia Culver-Hopper; Kang Wu; and Lisa Totto. 1992. *Investment Opportunities and Financing Issues in the Latin American/Caribbean Hydrocarbons Sector*. Latin American/Caribbean Oil and Gas Report Series No. 2. Honolulu, Hawaii: East-West Center, Program on Resources: Energy and Minerals.
- Oil & Gas Journal. Tulsa, Okla.: PennWell Publishing Company.
- OLADE (Organización Latinoamericana de Energía, the Latin American Energy Organization). 1993. *Energy-Economic Information System for Latin American and the Caribbean*. Computer disk database (September 1993 version), developed with cooperation from the Commission of the European Communities.

- Rodríguez-Elizarrarás, Gustavo. 1992. Evolution and Outlook of Coal, Natural Gas, Geothermal Energy, and Hydroenergy in Latin America and the Caribbean. *Revista Energética* 16(3):95-104.
- Totto, Lisa, Cynthia Obadía, and Kang Wu. 1992. Structural Changes in Store for Latin America-US Oil Trade. *Oil & Gas News*, March 23-29, 1992.
- Wu, Kang. 1993. Prospects for the Future Oil Link between Latin America and the Asia-Pacific Region. In *Energy and the Environment: Proceedings of the Fifteenth Annual North American Conference of the International Association for Energy Economics*, ed. S. A. Van Vactor and William Kemp, 675-86. Washington, D.C.: International Association for Energy Economics.
- Zuazagoitia, J., F. Perelló-Aracena, H. D. Haasis, and O. Rentz. 1991. An Energy-GDP-Population Analysis for Latin American Countries. *Energy* 16(6):923-31.

Appendix (continued)
Energy Balance of Latin America, 1991
('000 boe/d)

	Electricity	LPG	Gasoline	Kero/jet	Diesel Oil	Fuel Oil	Other Energy	Non-Energy	Total Secondary
Production	1,057	413	1,572	323	1,409	1,464	841	273	7,353
Importation	51	71	143	18	125	167	19	7	602
Exportation	53	56	218	120	318	518	16	49	1,348
Inventory Variation		-4	-19	-2	-3	-1	-5	-3	-36
Unused		0					2		2
Total Supply	1,055	425	1,479	220	1,213	1,112	873	228	6,568
Refinery		155	1,354	323	1,408	1,461	126	202	5,030
Power Plants	1,004				-51	-484	-80		1,004
Self-Producers	53				-13	-29	-13		53
Gas Treatment Plant		255	92				501	65	913
Charcoal Plant							127		127
Coke/Blast Furnace							68	5	78
Distillery			126						126
Other Centers		3	-16		1	3	13		22
Total Transformation			-16		-63	-513	742		-692

(to be continued)

Appendix (continued)
Energy Balance of Latin America, 1991
('000 boe/d)

	Electricity	LPG	Gasoline	Kero/jet	Diesel Oil	Fuel Oil	Other Energy	Non-Energy	Total Secondary
Own Consumption	41	39	88	9	72	120	208	7	584
Losses	156	0	1	0	0	0	11	0	168
Adjustment		2	3	1	-11	-2	-26	-3	-35
Transportation	5	9	1,204	134	802	41			2,194
Industrial	426	21	2	9	97	372	429		1,354
Residential	268	339	6	59	12	16	48		748
Commercial, Pub. Serv.	115	8	3	3	15	8	4		156
Agric, Fishing, Mining	42	1	2	3	160	43	4		253
Construction/Others	3	0	11	1	4	1	0		20
Energy Consumption	858	379	1,227	208	1,089	481	484		4,726
Non-Energy Consump.		4	143	2		0	62	223	434
Final Consumption	858	383	1,371	209	1,089	481	546	223	5,160

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
Energy Balance of Latin America, 1991

('000 boe/d)

	Crude Oil	Gas	Coal	Hydro- electricity	Geothermal Power	Nuclear Power	Firewood	Cane Products	Others	Total Primary
Production	8,260	2,270	551	766	17	53	1,152	620	220	13,908
Importation	984	36	184							1,203
Exportation	3,773	40	241						3	4,057
Inventory Variation	54	1	-3			8			-1	60
Unused	0	255	2	45	3			1	57	362
Total Supply	5,525	2,013	489	721	15	61	1,152	618	159	10,752
Refinery	-5,445	-22							-3	-5,471
Power Plants	-3	-254	-118	-707	-15	-61				-1,157
Self-Producers		-47	-13	-14			-6	-35	-14	-130
Gas Treatment Plant		-821							-70	-891
Charcoal Plant							-261			-261
Coke/Blast Furnace			-252							-252
Distillery								-147	-1	-148
Other Centers	-3	-3								-6
Total Transformation	-5,452	-1,146	-383	-721	-15	-61	-267	-182	-88	-8,314

(to be continued)

Appendix (continued)
Energy Balance of Latin America, 1991
('000 boe/d)

	Crude Oil	Gas	Coal	Hydro- electricity	Geothermal Power	Nuclear Power	Firewood	Cane Products	Others	Total Primary
Own Consumption	2	211	0					147	0	361
Losses	16	99	6				0	0		122
Adjustment	34	-2	6				0		0	38
Transportation		7	0				0			7
Industrial	20	374	88				156	267	63	969
Residential		124	4				673		8	809
Commercial, Pub. Serv.	0	1					2			4
Agric, Fishing, Mining	0	2	0				52	10	1	65
Construction/Others	0						0			1
Energy Consumption	21	508	92				885	277	71	1,855
Non-energy Consump.		51						11		62
Final Consumption	21	559	92				885	289	71	1,917

(to be continued)

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