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**ENERGY IN LATIN AMERICA:  
THE HISTORICAL RECORD**

*Joseph W. Mullen*



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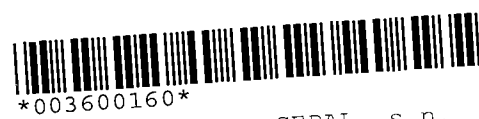


C E P A L

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## ENERGY IN LATIN AMERICA: THE HISTORICAL RECORD

*Joseph W. Mullen\**



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Joseph W. Mullen



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## ENERGY IN LATIN AMERICA: THE HISTORICAL RECORD

### Editor's Note: Purpose and Scope of the Study

The purpose of this study is to provide a brief description of the pattern of growth and change in Latin America's energy industries over the past quarter of a century. The study opens with a discussion of Latin America in the world energy economy. It goes on to document the region's wealth in energy resources; and then to examine the pattern of growth and change in the post-war era in each of Latin America's major energy industries: oil and natural gas, coal, and electric power.

This is the first of two studies on energy in Latin America in the Cuaderno series. The second study, *The Price of World Oil: Prospects and Implications for Energy Policy-Makers in Latin America's Oil-Deficit Countries*, focuses on the price of international crude oil over the remainder of this century and on the ramifications of expected crude oil prices for energy policy-makers in Latin America.

### Chapter I

#### LATIN AMERICA AND THE WORLD ENERGY PROFILE

##### (a) *General Comparisons*

The level of Latin America's consumption of the modern fuels<sup>1</sup> increased by 6.7 per cent per annum during 1950-1975 and on a per capita basis by 3.8 per cent per annum during this 25-year period.

As shown in table 1, the rate of growth of Latin America's modern energy consumption during 1950-1975, in both absolute and per capita terms, exceeded the corresponding rates for the developed countries and the world as a whole. On the other hand, the average rate of growth of Latin America's modern energy consumption during this period, in both absolute and per capita terms, was less than the average rates recorded in the non-Latin American group of developing countries.

In absolute terms, modern energy consumption in Latin America in 1975 ( $219 \times 10^6$  t.p.e.) was less than one-third the level recorded in that year in all the other developing countries taken collectively ( $751 \times 10^6$  t.p.e.). This fact reflects the far larger population of the latter group of countries (2.5 billion) than the former (0.3 billion), however. Thus, when population is taken into account, Latin America's modern energy consumption (682 k.p.e. per capita) in 1975 was more than double the comparable figure for the other developing countries (300 k.p.e. per capita), although still far below the level recorded in the developed countries (4,076 k.p.e. per capita).

The relationship between per capita modern energy consumption and per capita total real output in many Latin American economies, in both 1950 and 1975, fell between the average levels recorded in the developed countries, on the one hand, and in the impoverished group of developing countries, on the other. This relationship is shown diagrammatically in Diagram 1 and table 2 for selected countries in 1972.

With regard to changes in the level of energy-intensiveness of production, Latin America consumed about 2.1 kgs of coal equivalent energy per unit of total real output produced in 1965, thus standing mid-way between the comparable ratios recorded, in that year, in the developed group of non-centrally-planned economies (2.4 kgs) and in the underdeveloped group of

<sup>1</sup> The term "modern fuels" includes coal, oil, natural gas and liquified natural gas, hydroelectricity, and nuclear fuels. It excludes a wide variety of traditional energy sources, such as human and animal power, direct solar energy, winds, tides, geothermal energy, vegetable fuels and animal wastes. All growth rates presented in this study are compound annual growth rates.

Table 1

**WORLD AND SELECTED COUNTRY GROUPINGS: GROWTH IN THE CONSUMPTION OF TOTAL ENERGY AND  
TOTAL ENERGY PER CAPITA, 1950 AND 1975**

	1950				1975				Growth rate 1950-1975		
	Consumption		Population		Consumption		Population		Consump- tion	Popula- tion	Per capita consump- tion
	Millions of tons P.E.	Percent- age	Millions	Percent- age	Millions of tons P.E.	Percent- age	Millions	Percent- age			
Developed countries <sup>a</sup>	1 568	92.8	848	34.2	1 849	82.5	1 125	28.5	4.4	1.2	3.2
Developing countries	121	7.2	1 632	65.8	970	17.5	2 821	71.5	8.7	2.2	6.3
Latin America <sup>b</sup>	43	2.6	158	6.4	272	4.0	321	8.1	6.7	2.9	3.8
Other	78	4.6	1 474	59.4	53	13.5	2 500	63.4	9.5	2.1	7.2
<b>World</b>	<b>1 689</b>	<b>100.0</b>	<b>2 480</b>	<b>100.0</b>	<b>5 555</b>	<b>100.0</b>	<b>3 946</b>	<b>100.0</b>	<b>4.9</b>	<b>1.9</b>	<b>3.7</b>

Source: Latin America: CEPAL, on the basis of official data; other countries: CEPAL, on the basis of data from United Nations, *World Energy Supplies*, Series J, N° 19 and 20.

Note: P.E.: Petroleum equivalent

<sup>a</sup> United States, Canada, Japan, Australia, New Zealand, Israel, South Africa, Soviet Union and European countries

<sup>b</sup> Argentina, Bahamas, Barbados, Bolivia, Brazil, Colombia, Costa Rica, Cuba, Chile, Ecuador, El Salvador, Grenada, Guatemala, Guyana, Haiti, Honduras, Jamaica, Mexico, Nicaragua, Panama, Paraguay, Peru, Dominican Republic, Surinam, Trinidad and Tobago, Uruguay and Venezuela.



Diagram 1

SELECTED COUNTRIES: PER CAPITA COMMERCIAL ENERGY CONSUMPTION  
AND GROSS DOMESTIC PRODUCT, 1950-1974

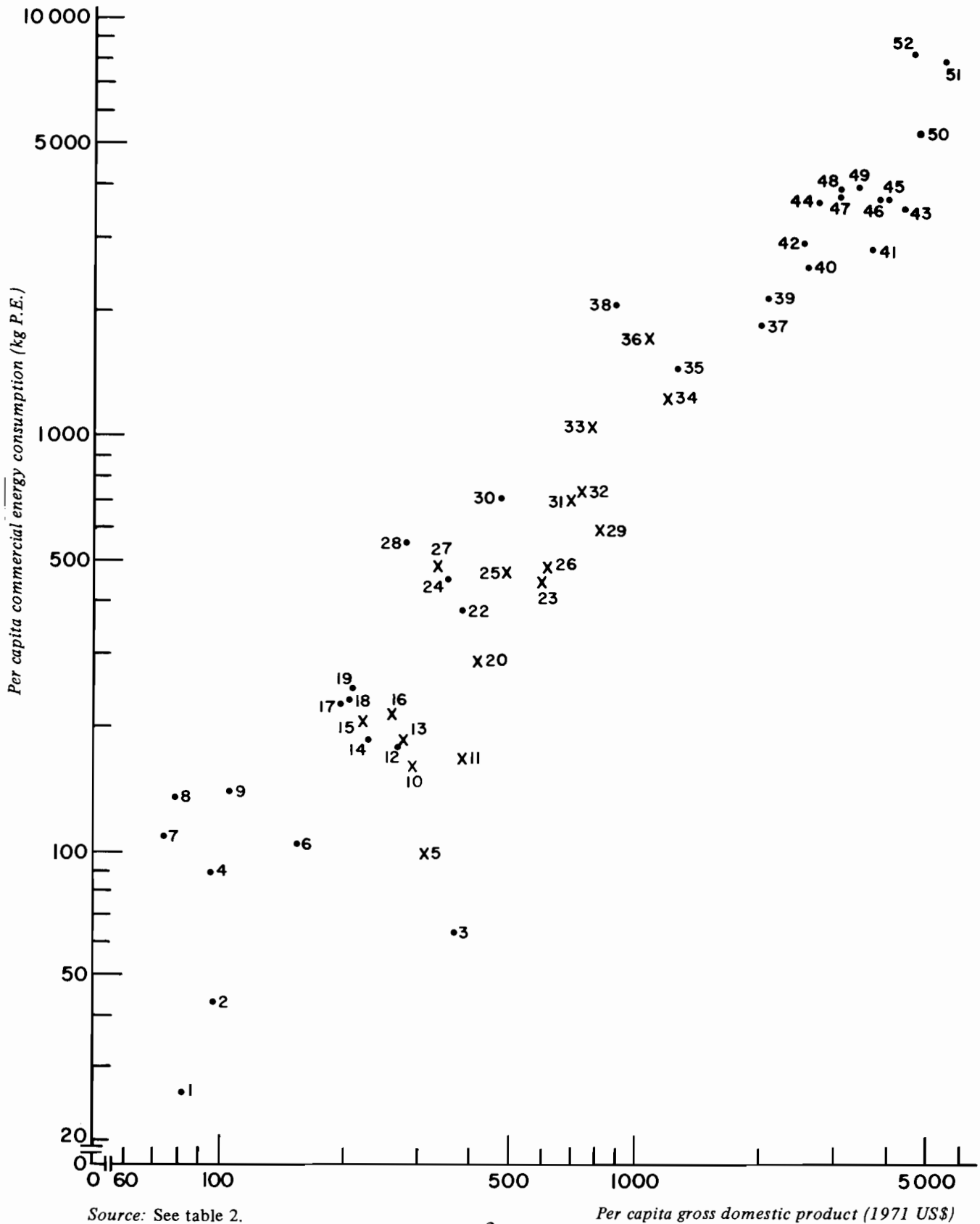


Table 2  
**SELECTED COUNTRIES: POPULATION, ENERGY CONSUMPTION PER CAPITA  
 AND REAL OUTPUT PER CAPITA**

	<i>Population (millions)</i>	<i>Per capita com- mercial energy consumption (kg P.E.)</i>	<i>Per capita GDP, (\$ 1971)</i>
Ethiopia	25.66	26	82
Malawi	4.67	43	98
Uganda	10.46	64	137
Zaire	22.91	87	95
Paraguay	2.58	97	267
Kenya	12.07	104	152
Indonesia	121.63	106	74
Pakistan	64.42	131	79
India	562.47	136	105
El Salvador	3.76	160	295
Guatemala	5.39	169	384
Morocco	15.85	174	266
Honduras	2.69	182	284
Ghana	9.09	184	230
Bolivia	5.19	204	220
Ecuador	6.51	215	260
Thailand	36.29	225	200
Philippines	39.04	228	204
Egypt	34.84	242	210
Dominican Republic	4.30	284	405
Nicaragua	1.99	296	...
Turkey	37.01	380	380
Costa Rica	1.84	451	583
Zambia	4.42	457	350
Peru	14.46	463	492
Brazil	98.85	467	460
Colombia	22.49	476	327
Korea	32.36	553	280
Panama	1.52	586	808
Iran	30.55	692	470
Uruguay	2.96	716	684
Mexico	52.44	829	730
Chile	10.04	1 049	766
Argentina	23.92	1 220	1 179
Spain	34.49	1 440	1 220
Venezuela	10.97	1 704	1 059
Israel	3.08	1 850	1 970
South Africa	22.99	2 040	790
Italy	54.35	2 120	2 050
Japan	106.96	2 510	2 610
France	51.70	2 770	3 600
Austria	7.49	2 930	2 510
Switzerland	6.39	3 480	4 300
United Kingdom	55.80	3 620	2 720
West Germany	61.67	3 700	3 930
Denmark	4.99	3 720	3 810
Netherlands	13.33	3 830	3 060
Australia	12.96	3 930	3 130
Belgium	9.71	3 940	3 400
Sweden	8.12	5 370	4 780
United States	208.84	7 920	5 350
Canada	21.85	8 080	4 490

Source: United Nations, *World Energy Supplies, 1950-1974*. (1976), World Bank, *World Bank Atlas: Population, per capita product and growth rates*.

non-centrally-planned economies (1.8 kgs).<sup>2</sup> A preliminary estimate suggests that the level of Latin America's modern energy input per unit of real total output still lies between the levels recorded in the developed and developing economies.

Table 3 presents data on the changing composition of modern energy consumption at the international level. With the exception of the Persian Gulf countries, Latin America has depended on liquid fuels (oil and liquefied gas) to a greater extent, and for a longer period, than any other major world region, and indeed longer than most individual countries or economic country groupings. The substitution of oil and gas for coal was virtually complete in Latin America before this substitution process gained world-wide momentum in the fifties. In short, Latin America's industrial development—a largely post-war phenomenon—has been based on oil and, since 1950, increasingly on natural gas as well. In 1975, these two fuels supplied about four-fifths of Latin America's modern energy requirements. Latin America's economic apparatus is thus outstanding in the degree of its dependence on oil and gas.

The data in table 3 show that Latin America accounts for relatively minor fractions of world-wide modern energy consumption (both total and component). This reflects the corresponding lack of dominance of Latin America in world production and, to a lesser extent, in world population. Latin America has consistently accounted for relatively minor fractions of world modern energy production, about 7 per cent in 1950 and 6 per cent in 1975.

As shown in table 3, Latin America is an important source of energy in world markets. The region has constantly been an importer of solid fuels, and its export role is based squarely on oil. In 1975, the region consumed only three-fifths of the volume of modern energy that it produced, largely because about one-half of its crude oil production was exported in that year.

#### (b) *Latin America's trade in modern energy sources*

Oil has been Latin America's leading export earner in the post-war era, generally accounting for between one-fifth (1950) and about three-tenths (1975) of total regional export earnings (see table 4). Venezuela has consistently accounted for about nine-tenths of the region's annual oil exports, and oil has provided, in turn, more than nine-tenths of that nation's annual export earnings. Oil exports from Ecuador, Bolivia, and Mexico have increased sharply in value in recent years, but they are still minor in regional and world terms.

The scale and global pattern of Latin America's imports and exports of energy sources has changed substantially during the past three decades. Until the early fifties, Venezuela was the world's second largest crude oil producing region, surpassed only by the United States. Since then, the region's historically dominant position in the world crude oil market has been lost to the Middle East and Africa. This displacement has occurred not only in the booming markets for crude oil in North America and Western Europe, but also in the South American and Caribbean crude oil markets (see table 5). Latin American suppliers never gained a foothold in the rapidly expanding crude oil markets of the Far East, largely because of the geographic advantage of Middle Eastern suppliers there.

Latin America's petroleum exports are dominated by crude oil, but the share of refined oil products in total petroleum exports has been increasing over the past quarter of a century. In 1975 North America accounted for 86 per cent of Latin America's extra-regional exports of crude oil (see table 6), while intra-regional crude oil exports accounted for almost one-half of the total Latin American crude oil exports in that year. A major market for South American crude oil is the Caribbean, where a number of large refineries transform it into refined oil products, mainly for export to the North American market. Latin America's exports of refined oil products consist basically of fuel oil (see table 7). This product is exported principally to the United States, where refineries are heavily geared to the production of motor gasoline, using compara-

<sup>2</sup> J. Darmstadter *et.al.*, *Energy in the World Economy*. (Baltimore, The Johns Hopkins Press, 1971), p. 63. A kilogramme of coal equivalent energy is the amount of energy contained in a kilogramme of coal, which, in the present case, is defined as 6,992 kcals.

Table 3a

**WORLD AND SELECTED COUNTRY GROUPS: ENERGY PRODUCTION AND CONSUMPTION, 1950**

*(Millions of tons of petroleum equivalent of 10 700 kcal/kg)*

	Production						Consumption							
	Fossil fuels			Electricity			Fossil fuels							
	Coal	Crude oil	Natural gas	Hydro	Nuclear	Total	By source:						By use:	
							Coal	Petroleum derivatives	Natural gas	Heat	Electricity	Electricity		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	Total (10+12)	
Market economy countries:	+ 34	481	170	106	—	1 491	728	402	152	1 121	161	267	1 388	
Developing	35	198	20	6	—	259	35	50	4	80	9	15	95	
Latin America	4	102	18	5	—	129	6	29	3	33	5	10	43	
Venezuela	—	78	14	—	—	92	—	3	1	4	—	—	4	
Others	4	24	4	5	—	37	6	26	2	29	5	10	39	
Others	31	96	2	1	—	130	29	21	1	47	4	5	52	
India	21	—	—	1	—	22	20	3	—	21	2	3	24	
Indonesia	1	5	1	—	—	7	—	2	1	3	—	—	3	
Korea	1	—	—	—	—	1	1	—	—	1	—	—	1	
Arab countries <sup>a</sup>	—	79	—	—	—	79	1	1	—	2	—	—	2	
Others	8	12	1	—	—	21	7	15	—	20	2	2	22	
Developed	699	283	150	100	—	1 232	693	352	148	1 041	152	252	1 293	
United States	323	275	147	—	—	778	292	283	145	626	94	127	753	
Western Europe	311	4	1	36	—	352	321	45	1	319	48	84	403	
Japan	25	—	—	12	—	37	26	1	—	25	2	14	39	
Canada	10	4	2	17	—	33	26	16	2	43	1	18	61	
Australia	12	—	—	1	—	13	12	4	—	13	3	4	17	
South Africa	17	—	—	—	—	17	15	2	—	13	4	4	17	
Others <sup>b</sup>	1	—	—	1	—	2	1	1	—	2	—	1	3	
Centrally-planned economies:	298	42	8	6	—	354	274	37	8	278	41	47	325	
Developing	24	—	—	1	—	25	28	—	—	26	2	3	29	
China	21	—	—	1	—	22	28	—	—	26	2	3	29	
Others <sup>c</sup>	3	—	—	—	—	3	—	—	—	—	—	—	—	
Developed	274	42	8	5	—	329	246	37	8	252	39	44	296	
Soviet Union	167	36	5	4	—	210	149	33	5	161	26	30	191	
Eastern European countries	107	6	2	1	—	115	97	4	3	91	13	14	105	
World Regions:	1 032	523	178	112	—	1 845	1 002	439	160	1 399	202	314	1 713	
Regions														
Latin America	4	102	18	5	—	129	6	29	3	33	5	10	43	
North America	333	279	150	50	—	812	318	299	147	669	95	145	814	
Rest of America	—	—	—	—	—	—	—	2	—	2	—	—	2	
Western Europe	311	4	1	36	—	352	321	45	1	319	48	84	403	
Eastern Europe	274	42	8	5	—	329	246	37	8	252	39	44	296	
Africa	19	3	—	—	—	22	19	8	—	22	5	5	27	
Middle East	2	82	—	—	—	84	2	4	—	5	1	1	6	
Far East	76	11	1	14	—	102	76	10	1	81	6	20	101	
Oceania	13	—	—	2	—	15	14	5	—	16	3	5	21	
Total	1 032	523	178	112	—	1 845	1 002	439	160	1 399	202	314	1 713	

**Source:** See table 3b.

<sup>a</sup>Algeria, Libya, Iran, Iraq, Saudi Arabia, the Emirates and Kuwait.

<sup>b</sup>Israel, New Zealand.

<sup>c</sup>North Korea, Mongolia and Vietnam.

Table 3b  
WORLD AND SELECTED COUNTRY GROUPINGS: ENERGY PRODUCTION AND CONSUMPTION, 1975  
(Millions of tons of petroleum equivalent of 10 700 kcal/kg)

	Production						Consumption						
	Fossil fuels			Electricity		Total	Fossil fuels			By use:			
	Coal	Crude oil	Natural gas	Hydro	Nuclear		Coal	Petro-leum deriv-ates	Natural gas	Heat	Elec-tricity (4+5+11)	Total (10+12)	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	
Market economy countries:													
Developing	808	2 075	819	333	86	4 121	823	1 827	760	2 539	871	1 290	3 829
Latin America <sup>a</sup>	95	1 486	145	466	2	1 794	101	310	78	408	81	149	557
Venezuela	—	123	33	3	—	159	—	9	10	15	4	7	22
Others	9	105	47	36	1	198	11	126	24	136	25	62	198
Others	86	1 258	65	27	1	1 437	90	175	44	257	52	80	337
India	63	8	1	13	1	86	63	20	1	61	23	37	98
Indonesia	—	61	5	—	—	66	—	10	5	15	—	—	15
Korea	12	—	—	—	—	12	12	11	—	18	5	5	23
Arab countries <sup>b</sup>	1	1 005	41	2	—	1 049	1	33	26	53	7	9	62
Others	10	184	18	12	—	224	14	101	12	110	17	29	139
Developed	713	589	674	267	84	2 327	722	1 517	682	2 131	790	1 141	3 272
United States	375	455	462	80	45	1 417	342	680	475	1 098	399	524	1 622
Western Europe	217	28	140	102	29	516	241	525	153	676	243	374	1 050
Japan	13	1	3	23	7	47	52	193	8	158	95	125	283
Canada	15	79	65	53	3	215	16	73	41	115	15	71	186
Australia	46	21	4	4	—	75	26	26	4	41	15	19	60
South Africa	46	—	—	—	—	46	44	11	—	36	19	19	55
Others <sup>c</sup>	1	5	—	5	—	11	1	9	1	7	4	9	16
Centrally-planned economies:													
Developing	917	568	310	52	4	1 851	891	476	308	1 330	345	401	1 731
China	337	77	3	14	—	431	336	64	3	377	26	40	417
Others <sup>d</sup>	307	76	3	10	—	396	306	60	3	346	23	33	379
Others <sup>d</sup>	30	1	—	4	—	35	30	4	—	31	3	7	38
Developed	580	491	307	38	4	1 420	555	412	305	953	319	361	1 314
Soviet Union	331	472	264	33	3	1 103	319	339	254	676	236	272	948
Eastern European countries	249	19	43	5	1	317	236	73	51	277	83	89	366
World	1 725	2 643	1 129	385	90	5 972	1 714	2 303	1 068	3 869	1 216	1 691	5 560
Regions:													
Latin America	9	228	80	39	1	357	11	135	34	151	29	69	220
North America	390	534	527	133	48	1 632	358	753	516	1 213	414	595	1 808
Rest of America	—	—	—	—	—	—	—	11	—	8	3	3	11
Western Europe	217	28	140	102	29	516	241	525	153	676	243	374	1 050
Eastern Europe	580	491	307	38	4	1 420	555	412	305	953	319	361	1 314
Africa	49	234	12	9	—	304	49	46	6	76	25	34	110
Middle East	5	946	33	3	—	987	5	51	25	69	12	15	84
Far East	427	161	26	52	8	674	467	339	25	677	154	214	891
Oceania	48	21	4	9	—	82	28	31	4	46	17	26	72
Total	1 725	2 643	1 129	385	90	5 972	1 714	2 303	1 068	3 869	1 216	1 691	5 560

Source: Latin America: CEPAL, on the basis of official data; other regions and countries: CEPAL, on the basis of United Nations, *World Energy Supplies, 1950-1974 and World Energy Supplies, 1971-1975*.

<sup>a</sup>Countries included are indicated in Exhibit 1. <sup>b</sup>Algeria, Libya, Iran, Iraq, Saudi Arabia, the Emirates and Kuwait. <sup>c</sup>Israel, New Zealand. <sup>d</sup>North Korea, Mongolia, and Vietnam.

Table 4

## LATIN AMERICA AND SELECTED LATIN AMERICA COUNTRIES: OIL AND TOTAL EXPORTS, 1950-1975

(Millions of dollars and percentages)

	1950	1955	1960	1965	1970	1975 <sup>a</sup>
<i>Latin America</i>						
Total exports of crude oil and derivatives (millions of dollars)	1 327	2 092	2 526	2 702	2 642	11 748
Exports of crude oil and derivatives as a percentage of total exports	20	26	29	26	18	30
<i>Venezuela</i>						
Exports of crude oil and derivatives (millions of dollars)	1 217	1 952	2 411	2 552	2 496	10 530
Exports of crude oil and derivatives as a percentage of total national exports	97	96	92	93	95	94
Exports of crude oil and derivatives as a percentage of total Latin American exports of same products	92	93	95	94	94	90
<i>Ecuador</i>						
Exports of crude oil and derivatives (millions of dollars)	—	2	—	1	1 <sup>b</sup>	516 <sup>b</sup>
Exports of crude oil and derivatives as a percentage of total national exports	—	1	—	—	—	57
Exports of crude oil and derivatives as a percentage of total Latin American exports of same products	—	0.1	—	0	0	4.4
<i>Mexico</i>						
Exports of crude oil and derivatives (millions of dollars)	2.8	1.8	20	40	37	460
Exports of crude oil and derivatives as a percentage of total national exports	6	6	3	3	3	19
Exports of crude oil and derivatives as a percentage of total Latin American exports of same products	0.2	0.1	0.1	1.5	1.4	3.9
<i>Bolivia</i>						
Exports of crude oil and derivatives (millions of dollars)	—	2	4	—	13	115
Exports of crude oil and derivatives as a percentage of total national exports	—	3	7	—	6	26
Exports of crude oil and derivatives as a percentage of total Latin American exports of same products	—	0.1	0.2	—	0.5	0.2

Source: 1950, 1955 and 1960: J. Grundwald and P. Musgrove, *Natural Resources in Latin American Development*, (The Johns Hopkins Press: Baltimore, 1970), pp. 280-281. Data for 1965, 1970 and 1975: CEPAL, with total exports of countries taken from *International Financial Statistics* (various issues), except for Venezuela's exports in 1975 (CEPAL figures).

<sup>a</sup>Estimate.

<sup>b</sup>Does not include refined products.

Main importing countries and areas	Africa					North America
	Algeria	Libya	Nige- ria	Others	Total	
<i>Africa</i>	0.48	0.75	1.60	0.31	3.14	—
South Africa	—	—	—	—	—	—
Others	0.48	0.75	1.60	0.31	3.14	—
<i>North America</i>	12.49	15.99	27.01	7.95	63.44	30.94
Canada	0.15	0.55	0.85	2.12	3.67	—
United States	12.34	15.44	26.16	5.83	59.77	30.94
<i>Latin America</i>	0.98	6.96	3.06	0.64	11.64	0.29
Bahamas	—	3.48	2.80	0.40	6.68	0.29
Brazil	0.76	2.11	—	0.18	3.05	—
Others	0.22	1.37	0.26	0.06	1.91	—
<i>Caribbean</i>	1.26	2.00	6.72	3.45	13.43	—
Netherlands	—	—	—	—	—	—
Antilles	—	—	2.16	1.14	3.30	—
Virgin Islands	1.26	2.00	4.56	2.31	10.13	—
Puerto Rico	—	—	—	—	—	—
Others	—	—	—	—	—	—
<i>Middle East</i>	—	1.14	—	0.03	1.17	—
<i>Far East</i>	0.26	2.30	2.36	0.86	5.78	—
Korea	—	—	—	—	—	—
India	—	—	—	—	—	—
Japan	0.26	2.30	2.36	0.86	5.78	—
Singapore	—	—	—	—	—	—
Others	—	—	—	—	—	—
<i>Western Europe</i>	24.18	36.69	44.16	11.08	119.11	—
West Germany	8.21	14.80	10.11	1.85	34.97	—
Belgium	0.88	0.61	1.22	0.45	3.16	—
Spain	1.60	4.05	0.10	2.20	7.95	—
France	5.88	2.01	9.71	2.77	20.37	—
Greece	0.18	0.22	—	1.14	1.54	—
Netherlands	0.48	0.52	7.48	—	8.48	—
United Kingdom	1.64	2.43	10.59	0.30	14.96	—
Italy	4.64	12.97	0.98	2.28	20.87	—
Sweden	0.06	—	1.09	—	1.15	—
Others	0.61	2.08	2.88	0.09	5.66	—
<i>Eastern Europe</i>	1.34	0.35	—	0.49	2.18	—
East Germany	—	—	—	0.11	0.11	—
Bulgaria	0.15	0.11	—	0.19	0.45	—
Czechoslovakia	—	0.13	—	—	0.13	—
Poland	—	0.11	—	—	0.11	—
Others	1.19	—	—	0.19	1.38	—
<i>Oceania</i>	—	—	—	—	—	—
<i>Others</i>	—	—	—	—	—	—
<b>Total</b>	<b>40.99</b>	<b>69.18</b>	<b>84.91</b>	<b>24.81</b>	<b>219.89</b>	<b>31.23</b>

Source: CEPAL, on the basis of *World Energy Supplies*, Series J, Nº 2



Table 5

## WORLD AND SELECTED COUNTRIES: OIL IMPORTS AND EXPORTS, 1975

(Millions of metric tons)

Main importing countries and areas	Main exporting countries and areas																							
	Africa					North America	Latin America			Middle East								Far East			Soviet Union and China			
	Algeria	Libya	Nigeria	Others	Total		Venezuela	Others	Total	Saudi Arabia	Emirates	Iraq	Iran	Qatar	Kuwait	Oman	Others	Total	Indonesia	Others	Total	Others	Total	
Africa	0.48	0.75	1.60	0.31	3.14	-	-	-	-	4.88	0.44	4.35	17.16	2.37	-	-	-	29.20	-	0.39	0.39	0.57	-	33.30
South Africa	-	-	-	-	-	-	-	-	-	-	0.14	-	12.70	1.77	-	-	-	14.61	-	0.39	0.39	-	-	15.00
Others	0.48	0.75	1.60	0.31	3.14	-	-	-	-	4.88	0.30	4.35	4.46	0.60	-	-	-	14.59	-	-	-	0.57	-	18.30
North America	12.49	15.99	27.01	7.95	63.44	30.94	34.51	12.83	47.34	42.70	10.90	1.77	23.01	0.98	1.77	1.63	-	82.76	18.59	-	18.59	-	0.63	243.70
Canada	0.15	0.55	0.85	2.12	3.67	-	13.33	0.15	13.48	9.41	1.71	1.67	9.30	0.08	1.46	0.65	-	24.28	-	-	-	-	-	41.43
United States	12.34	15.44	26.16	5.83	59.77	30.94	21.18	12.68	33.86	33.29	9.19	0.10	13.71	0.90	0.31	0.98	-	58.48	18.59	-	18.59	-	0.63	202.27
Latin America	0.98	6.96	3.06	0.64	11.64	0.29	10.08	6.35	16.43	22.36	1.61	9.30	4.65	0.35	5.18	2.33	-	45.76	2.61	-	2.61	5.80	-	82.55
Bahamas	-	3.48	2.80	0.40	6.68	0.29	-	0.90	0.90	5.00	-	-	0.30	-	-	-	-	5.30	-	-	-	-	-	13.17
Brazil	0.76	2.11	-	0.18	3.05	-	0.92	0.15	1.07	11.15	0.75	8.29	1.80	0.35	5.18	2.33	-	29.85	-	-	-	0.25	-	34.22
Others	0.22	1.37	0.26	0.06	1.91	-	9.16	5.30	14.46	6.21	0.86	1.01	2.55	-	-	-	-	10.63	2.61	-	2.61	5.55	-	35.16
Caribbean	1.26	2.00	6.72	3.45	13.43	-	24.48	3.16	27.64	8.92	3.25	-	5.87	2.66	-	0.56	0.61	21.87	2.34	-	2.34	0.30	-	65.58
Netherlands	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Antilles	-	-	2.16	1.14	3.30	-	19.23	1.95	21.18	2.40	-	-	-	-	-	0.56	-	2.96	-	-	-	-	-	27.44
Virgin Islands	1.26	2.00	4.56	2.31	10.13	-	-	0.40	0.40	4.88	1.25	-	3.64	-	-	-	0.61	10.38	2.34	-	2.34	0.30	-	23.55
Puerto Rico	-	-	-	-	-	-	5.01	0.66	5.67	1.64	2.00	-	2.23	2.66	-	-	-	8.53	-	-	-	-	-	14.20
Others	-	-	-	-	-	-	0.24	0.15	0.39	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.39
Middle East	-	1.14	-	0.03	1.17	-	-	-	-	9.76	-	12.66	1.82	-	0.82	0.12	0.03	25.21	-	-	-	-	-	26.38
Far East	0.26	2.30	2.36	0.86	5.78	-	0.24	-	0.24	84.32	21.09	8.80	75.60	1.41	43.85	7.41	-	242.48	25.26	21.57	37.83	10.15	0.11	296.59
Korea	-	-	-	-	-	-	-	-	-	6.19	-	-	1.00	-	8.02	-	-	15.21	-	-	-	-	-	15.21
India	-	-	-	-	-	-	-	-	-	4.04	-	2.00	6.50	-	-	-	-	12.54	-	-	-	0.98	0.03	13.55
Japan	0.26	2.30	2.36	0.86	5.78	-	0.24	-	0.24	63.36	19.86	4.55	57.36	0.07	20.95	6.40	-	172.55	23.98	8.60	32.58	8.36	0.06	219.57
Singapore	-	-	-	-	-	-	-	-	-	2.12	0.93	1.25	3.45	-	7.29	1.01	-	16.05	0.04	0.71	0.75	-	0.02	16.82
Others	-	-	-	-	-	-	-	-	-	8.61	0.30	1.00	7.29	1.34	7.59	-	-	26.13	0.76	3.74	4.50	0.81	-	31.44
Western Europe	24.18	36.69	44.16	11.08	119.11	-	7.41	0.17	7.58	151.28	42.82	55.89	99.74	11.99	35.12	5.01	8.65	410.50	-	-	-	23.52	8.60	569.31
West Germany	8.21	14.80	10.11	1.85	34.97	-	1.21	-	1.21	17.86	7.88	1.40	14.19	1.26	2.69	-	0.81	46.09	-	-	-	3.35	0.63	86.25
Belgium	0.88	0.61	1.22	0.45	3.16	-	0.37	-	0.37	12.74	1.45	1.62	5.38	0.12	2.30	-	-	23.61	-	-	-	0.50	0.42	28.06
Spain	1.60	4.05	0.10	2.20	7.95	-	0.84	-	0.84	17.58	2.93	6.03	4.51	0.11	1.55	-	-	32.71	-	-	-	1.00	-	42.50
France	5.88	2.01	9.71	2.77	20.37	-	0.68	-	0.68	31.44	13.80	12.01	13.29	72.36	6.40	1.05	1.96	82.31	-	-	-	1.30	0.98	105.64
Greece	0.18	0.22	-	1.14	1.54	-	-	-	-	5.40	-	0.97	1.38	-	-	-	2.21	9.96	-	-	-	1.50	-	13.00
Netherlands	0.48	0.52	7.48	-	8.48	-	-	-	-	12.39	5.74	1.94	17.42	0.96	5.44	0.50	-	44.39	-	-	-	0.02	-	52.89
United Kingdom	1.64	2.43	10.59	0.30	14.96	-	3.15	0.17	3.32	22.19	3.82	2.61	17.55	3.87	10.91	2.81	0.12	63.88	-	-	-	4.02	-	92.15
Italy	4.64	12.97	0.98	2.28	20.87	-	0.64	-	0.64	23.65	2.35	18.69	12.86	2.09	3.35	0.08	3.55	66.62	-	-	-	0.24	0.92	10.77
Sweden	0.06	-	1.09	-	1.15	-	0.50	-	0.50	2.15	1.33	0.11	3.09	0.81	0.47	-	-	7.96	-	-	-	10.59	1.10	50.34
Others	0.61	2.08	2.88	0.09	5.66	-	0.02	-	0.02	5.88	3.52	10.51	10.07	0.41	2.01	0.57	-	32.97	-	-	-	59.71	0.36	76.62
Eastern Europe	1.34	0.35	-	0.49	2.18	-	-	0.36	0.36	-	-	9.87	3.80	-	0.10	-	0.24	14.01	-	-	-	15.10	-	17.00
East Germany	-	-	-	0.11	0.11	-	-	-	-	-	-	1.45	-	-	0.10	-	-	-	-	-	-	10.00	-	10.45
Bulgaria	0.15	0.11	-	0.19	0.45	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	15.51	-	15.84
Czechoslovakia	-	0.13	-	-	0.13	-	-	-	-	-	-	-	0.20	-	-	-	-	0.20	-	-	-	12.13	0.36	13.31
Poland	-	0.11	-	-	0.11	-	-	0.36	0.36	-	-	-	0.10	0.25	-	-	-	-	-	-	-	6.97	-	20.02
Others	1.19	-	-	0.19	1.38	-	-	-	-	-	-	-	8.12	3.55	-	-	-	11.67	-	-	-	-	0.11	12.23
Oceania	-	-	-	-	-	-	-	-	-	3.97	-	1.59	2.07	0.94	3.09	-	-	-	-	-	-	3.00	-	3.00
Others	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	40.99	69.18	84.91	24.81	219.89	31.23	76.72	22.87	99.59	328.19	80.38	103.22	233.72	20.70	90.94	17.06	9.53	883.74	48.83	13.12	61.95	103.05	9.81	1 409.26

Source: CEPAL, on the basis of World Energy Supplies, Series I, No 20.



Table 6

**WORLD AND SELECTED GROUPINGS: IMPORTS OF CRUDE OIL, REFINED OIL PRODUCTS, AND NATURAL GAS  
FROM LATIN AMERICA 1960 AND 1975<sup>a</sup>**

*(Millions of metric tons)*

	North America	Western Europe	Latin America	Other Caribbean	Middle East	Far East	Japan	Africa	Oceania	Total
1960	37.44	16.19	13.42	41.73	0.16	0.10	—	0.17	0.06	109.27
1975	43.73	7.05	16.43	26.65	—	—	0.24	—	—	94.10
1960	22.90	11.07	4.78	1.49	—	0.06	0.02	1.85	0.19	42.28
1975	23.15	3.09	5.28	2.99	—	—	0.05	1.07	0.01	35.64
1960	70.73	169.68	20.07	41.99	17.20	14.58	26.79	1.52	11.26	373.82
1975	243.70	569.31	77.00	71.13	26.38	77.02	219.57	33.30	12.23	1 329.64
1960 <sup>d</sup>	45.70	62.90	13.78	4.49	4.47	17.74	8.60	15.68	3.47	135.70
1975	93.24	121.57	10.86	7.15	4.02	19.29	13.88	10.66	7.05	287.72
1960	52.90	9.50	66.90	99.40	1.00	0.70	0.00	11.20	0.50	29.20
1975	17.90	1.20	21.30	37.50	—	—	—	—	—	7.10
1960 <sup>d</sup>	56.90	17.60	31.50	40.30	0.20	0.90	0.90	11.00	0.70	33.50
1975	24.80	2.50	48.60	41.80	—	—	0.40	10.00	0.10	12.40
1960	1 331	—	—	—	—	—	—	—	—	1 331
1975	—	—	1 438 <sup>e</sup>	—	—	—	—	—	—	1 438

Source: United Nations, *World Energy Supplies, 1958-1961 and World Energy Supplies, 1971-1975*; Trinidad and Tobago, *Overseas Trade, various issues*; Venezuela, *Petróleo y Otros*

*Datos, various issues.*

<sup>a</sup>Excluding centrally planned economies.

<sup>b</sup>Venezuela, Trinidad and Tobago, Ecuador and Bolivia.

<sup>c</sup>Venezuela and Trinidad and Tobago.

<sup>d</sup>1961.

<sup>e</sup>Bolivia.

Table 7  
**LATIN AMERICA: EXPORTS OF CRUDE OIL AND REFINED OIL PRODUCTS, 1950-1975**  
*(Thousands of metric tons)*

<i>Year</i>	<i>Liquefied gas</i>	<i>Gasoline</i>	<i>Kerosene</i>	<i>Gas oil/ diesel oil/ fuel oil</i>	<i>Subtotal</i>	<i>Crude oil</i>	<i>Total</i>
1950	—	6 744	1 754	43 494	51 992	72 181	124 173
1951	—	6 448	2 356	48 334	57 138	78 636	135 774
1952	—	6 175	3 185	50 116	59 476	83 444	142 920
1953	—	6 294	3 219	50 863	60 376	76 055	136 431
1954	66	6 489	3 683	47 561	57 799	83 745	141 544
1955	68	5 648	4 025	53 795	63 536	93 048	156 584
1956	65	5 419	4 439	59 124	69 047	105 433	174 480
1957	67	5 419	4 912	56 957	67 355	115 449	182 804
1958	115	7 423	5 690	58 161	71 389	107 382	178 771
1959	167	6 514	5 518	62 324	74 523	111 133	185 656
1960	228	6 575	4 629	66 867	78 299	111 834	190 133
1961	276	6 948	5 387	70 712	83 323	114 814	198 137
1962	393	7 024	5 370	77 771	90 558	123 445	214 003
1963	363	7 593	6 737	82 869	97 562	124 029	221 591
1964	437	8 160	7 452	85 967	102 016	130 218	232 234
1965	408	8 055	7 837	88 797	105 097	129 735	234 832
1966	568	8 414	8 845	87 752	105 579	125 280	230 859
1967	664	9 058	9 816	89 473	109 011	135 047	244 058
1968	669	9 473	10 252	90 572	110 966	136 179	247 145
1969	687	9 461	10 403	96 113	116 664	137 924	254 588
1970	905	9 800	9 278	109 612	129 595	137 271	266 866
1971	1 375	10 186	8 143	108 416	128 120	129 375	257 495
1972	1 880	10 044	7 540	111 567	131 031	123 644	254 675
1973	1 653	9 505	8 134	120 515	139 807	133 888	273 695
1974	1 194	9 744	6 551	121 222	138 711	108 966	247 677
1975	1 407	10 785	5 019	78 106	95 317	99 569	194 886

*Source:* United Nations, *World Energy Supplies*, Series J, Nos. 19 and 20.  
*Note:* This table covers both members and non-member of CEPAL.

tively light crude oils, so that that nation must import a significant part of its increasing demand for heavier refined oil products, such as fuel oil. Many of the region's oil-deficit countries export relatively small quantities of refined oil products in highly competitive intra-regional and extra-regional circuits, the aim of this trade being to close the gap between domestic market requirements and domestic refinery output in these countries.

Imports of energy sources into Latin America (see table 8) consist of oil, coal, coke and minor volumes of natural gas and electricity. Extra-regional imports of crude oil, largely from the Middle East and to a lesser extent from Africa, have considerably altered the almost complete reliance on intra-regional sources of crude oil which characterized Latin America's oil import pattern in the early post-war era. As indicated in table 8, in 1975 the Middle East and Africa accounted for roughly 55 per cent and 20 per cent, respectively, of total crude oil imports by Latin American oil-importing countries, while crude oil from regional sources accounted for only one-seventh of these imports. Additionally, the sharp increase in domestic crude oil refining in Latin America since the early fifties has triggered an actual decline in the volume of imported oil products. These imports are still secured largely through intra-regional trade, although some special products are secured in significant quantities from extra-regional sources.

Although some Latin American countries have ample resources of indigenous coal, it is comparatively costly to extract and transport and is of relatively low calorific value. Hence, many Latin American countries have turned to imports of higher quality coals and cokes to satisfy the growing demand for these products, mainly by their metallurgical industries. The bulk of the region's coal and coke imports have come from the United States and, to a lesser extent, from Eastern Europe. Latin America's net imports of natural gas and electricity are quantitatively minor and represent the comparatively small trade in these fuels between Mexico and the United States.

## Chapter II

### LATIN AMERICA'S MODERN ENERGY BASE

There is a variety of concepts regarding non-renewable and renewable energy resources. With regard to non-renewable energy resources, the concept most commonly used (and abused) is 'proven reserves'. This is a point estimate of the volume of a non-renewable energy resource contained within conservatively defined limits of known fields which is believed, with a high (and typically unspecified) degree of certainty, to be economically recoverable at prevailing prices and costs.

An estimate of proven reserves should be interpreted in the context of its (unknown) error density function. To say, for example, that on 1 January 1977 the stock of proven reserves of crude oil in a country was x billion barrels really means something like the following: on that date, the estimator of these reserves believed with a subjectively generated level of certitude of, say, 90 per cent that the true level of proven reserves of oil there was, most probably, x billion barrels, so that the actual level of proven reserves there on that date would probably be contained within a subjectively generated limit range of, say,  $(x \pm .25 x)$  billion barrels.<sup>3</sup>

Proven reserves of oil, or of any other non-renewable energy resource, constitute a working inventory of that resource, which is the result of the past creation of known reserves from

<sup>3</sup>This interpretation is given to put statements of proven reserves in their proper conceptual context. This does not imply that estimates of proven reserves are built up in such a mathematically rigorous manner. Actually, the estimation of proven reserves is partly an art, partly a science, and the published figures on proven oil reserves, although reflecting much knowledge, also contain much guesswork, outright bias, and more than a little ignorance.

Table 8

## LATIN AMERICA: INTRAREGIONAL AND INTERREGIONAL FUEL IMPORTS, 1960 AND 1975

(In units as indicated)

	Imports from						Intra-regional imports <sup>a</sup>	Total	Total world imports	
	North America	Western Europe	Africa	Middle East	Far East	Oceania				
Eastern Europe and Soviet Union										
A. Crude petroleum (Millions of metric tons)										
1960	—	—	—	4.17	0.07	—	1.65	13.42	19.31	381.95
1975	0.29	—	16.43	45.78	2.61	—	5.80	12.34	83.25	1 409.26
B. Petroleum derivatives (Millions of metric tons)										
1960								4.78	11.10	180.28
1975								5.28	10.86	302.67
C. Coal and coke (Millions of tons of coal equivalent)										
1960	2.12	0.17	0.03	—	—	—	0.65	—	2.97	132.10
1975	3.46	0.03	—	—	—	0.16	1.26	—	4.91	193.26
D. Natural gas (Millions of cubic metres)										
1960	499	—	—	—	—	—	—	—	499	5 550
1975	269	—	—	—	—	—	—	1 438	1 707	120 988

Source: United Nations, *World Energy Supplies, 1958-1961 and World Energy Supplies, 1971-1975*.<sup>a</sup>See list of component countries in table 1.

unknown resources, on the one hand, followed by any reductions in those reserves through production. Because it is costly to add to proven reserves, neither governments nor private oil companies add to them unrestrainedly. Some international oil companies, for example, might consider a ratio of proven reserves of oil to anticipated oil production which gave an expected life of, say, ten years to be an acceptable level of working inventory to carry against the commercial, political, and other risks that they expect to face. Proven reserves of oil, or any other non-renewable energy resource, increase as energy prices rise and as primary, secondary, and tertiary extraction technology improves. Obviously, proven reserves of oil, or any other non-renewable energy resource, are not a valid gauge of a nation's wealth in that energy resource.

Proven reserves of oil and natural gas in Latin America at the end of 1976 have been estimated at 30 billion barrels and at  $90 \times 10^{12}$  cubic feet respectively, or at 5 per cent and 4 per cent of the estimated volume of the world's proven reserves of these energy resources at that time. As shown in table 9, the distribution of Latin America's proven reserves of oil and gas is geographically disparate. In the case of oil, nine-tenths of these reserves are located in four Latin American countries: Venezuela (52 per cent), Mexico (24 per cent), Argentina (8 per cent), and Ecuador (6 per cent), while as regards natural gas, five countries accounted for 85 per cent of Latin America's proven reserves at that time: Venezuela (45 per cent), Ecuador (13 per cent), Mexico (13 per cent), Argentina (8 per cent) and Bolivia (6 per cent).

Table 9

**LATIN AMERICA: PROVEN RESERVES OF CRUDE OIL, PRODUCTION OF CRUDE OIL  
AND NATURAL GAS BY COUNTRY, 1976**

	<i>Crude oil</i> (Millions of barrels)		<i>Natural gas</i> (Billions of cubic feet)	
	<i>Reserves</i>	<i>Production</i>	<i>Reserves</i>	<i>Production</i>
Argentina	2 300.0	144.4	6 800	364
Barbados	3.7	—	300	—
Bolivia	240.0	14.9	5 000	154
Brazil	800.0	60.7	900	58
Colombia	825.0	52.8	5 000	124
Chile	182.0	8.4	2 000	248
Ecuador	1 700.0	68.4	12 000	12
Guatemala	21.3	—	—	—
Mexico	7 000.0	327.3	12 000	772
Peru	747.0	28.0	2 200	71
Trinidad and Tobago	520.0	77.7	3 425	131
Venezuela	15 270.0	839.8	40 700	1 311
<i>Total</i>	<i>29 609.0</i>	<i>1 622.4</i>	<i>90 325</i>	<i>3 245</i>
<i>World</i>	<i>598 990.3</i>	<i>20 881.8</i>	<i>2 303 777</i>	<i>...</i>

Source: Reserves: *Oil and Gas Journal*, 27 December 1976; production: CEPAL, on the basis of official data.

Note: The figures shown above for Mexico were increased to 14,000 million barrels of oil and 30,000 billion cubic feet of natural gas at end-1977. Sharp upward revisions were also recorded for Chile and Venezuela. See: *Oil and Gas Journal*, 26 December, 1977, p. 101.

Latin America's proven reserves of crude oil at the end of 1976 represented 18 times the level of crude oil production in the region in that year; the comparable ratio in the case of natural gas was 28.

"Expanded proven reserves" is another concept used with non-renewable energy resources. It refers to the sum of proven reserves at a given point in time, plus the expected addition to these reserves generated by conceptually expanding the conservatively defined limits of known fields employed in estimating the level of proven reserves. Thus, the concept of "expanded proven reserves" has meaning only in a probabilistic sense, insofar as it relates changing stocks of oil with changing levels of certainty associated with statements about the extent of those stocks. The error density function of expanded proven reserves is unknown, as in the case of proven reserves.

Grossling offers one estimate of the probable extent of expanded proven oil reserves:

"... For most of the non-OPEC developing countries, I can make the following generalization. An additional quantity [of oil] equal to proven reserves can be obtained with probability 0.8, and another equal additional quantity with probability 0.5. Hence the expected ... [volume] ... of the expanded proven reserves designated here as  $R_2$  would be  $(1 + 0.8 + 0.5) R_1 \dots = [\text{Proven Reserves}] \dots = 2.3. R_1$ ".<sup>4</sup>

Excluding Latin American OPEC members, proven reserves of crude oil at the end of 1976 were about 13 billion barrels. The application of Grossling's factor would yield an estimate, with a weighted average certitude of 77 per cent, that expanded proven reserves for this group of Latin American countries would fall in the range of 30 billion barrels plus or minus 8 billion barrels (using an estimated 25 per cent error factor). If Venezuela and Ecuador are included, the resulting level of expanded proven reserves for the region would be 68 billion barrels plus or minus 17 billion barrels (using the same 25 per cent error factor).<sup>5</sup> If secondary and tertiary recovery techniques are considered, these estimates would increase considerably.

'Undiscovered' resources is another resource concept. This is the unknown stock of an economically recoverable, non-renewable energy resource that is now lying beneath the surface in unknown places. It is from these stocks that, historically, proven reserves have been created. The sum of undiscovered energy resources plus expanded proven reserves constitutes a country's wealth in a particular non-renewable energy resource. This wealth in a given energy resource plus the volume of its cumulative production in the past defines the ultimate recoverable volume of that energy resource and the country's original endowment with economically exploitable volumes of that energy resource.

Grossling places Latin America's ultimate recoverable reserves of oil at 336-960 billion barrels and of natural gas at 1,920-4,800 trillion cubic feet.<sup>6</sup> Subtracting the end-1975 regional cumulative production of each of these energy sources (estimated at about 45 billion barrels and 30 trillion cubic feet, respectively), one arrives at the following estimate of Latin America's reserves of economically exploitable oil and gas still in the ground: between 291-915 billion barrels of oil and between 1,890-4,770 trillion cubic feet of natural gas. In the case of oil, this estimate is 208-654 times the level of regional oil production in 1975 and between 264-832 times the level of regional oil consumption in 1975. The estimated economically exploitable reserves of natural gas represent between 900-2,271 years of regional production and between 1,181-2,981 years of regional consumption at the 1975 rates of annual production and consumption, respectively (estimated at 2.1 and 1.6 trillion cubic feet).

<sup>4</sup> B.F. Grossling, *Latin America's Petroleum Prospects in the Energy Crisis*, Geological Survey Bulletin 1411 of the United States Department of Interior, 1975, p. 16. Bracketed insertions are not in the original text.

<sup>5</sup> This volume may be compared with Emery's estimate of South America's "other identified resources" of oil of 74 billion barrels as cited by Grossling, *op.cit.*, p. 35. See: K.O. Emery, *Resources of fossil fuels*, unpublished report to the U.S. National Research Council, 1973.

<sup>6</sup> B.F. Grossling, "A Critical Survey of World Petroleum Opportunities", January 1977, p. 19 (draft version).

Grossling's estimates of ultimate recoverable reserves in Latin America are based on the use of benchmark figures for oil and gas reserves per unit of prospective producing area in conterminous United States, Canada, and the USSR. His estimate of Latin America's ultimate recoverable reserves of oil and gas have a downward bias, which he underscored in an earlier study on the same subject using a comparable methodology; in that study, he said that the estimates "... do not include any allowance for the occurrence of giant-size accumulations like the Middle East. These cannot be excluded; moreover, I suspect that the Caribbean area and the Argentine continental shelf are two regions where they could occur".<sup>7</sup>

Identified reserves is a concept that is often used in discussions of energy resources other than oil. It is a measure of the stock of an energy resource known to exist and capable of being extracted profitably at given prices and costs. This term is usually employed in discussions of non-fuel mineral resources. It is comparable to the concept of expanded proven reserves used in discussion of oil and gas reserves. The concept of identified reserves excludes undiscovered recoverable reserves.

The potential yield from Latin America's identified reserves of oil shale, located largely in Brazil, has been estimated at 800 billion barrels, while the potential yield from undiscovered oil shale reserves in the region is thought to be of the order of 41,200 billion barrels.<sup>8</sup> Identified resources of oil in tar sands in the region, concentrated in Venezuela, are thought to be of the order of 1,200 billion barrels, no estimate being available for undiscovered stocks of this energy resource.<sup>9</sup> For purposes of comparison, in 1973 the Latin American economies consumed a total of about 882 million barrels of oil products.

Latin America's stock of identified coal resources has been reckoned at 20 billion-metric tons and undiscovered coal resources at 10 billion metric tons.<sup>10</sup> By way of comparison, coal consumption in Latin America in 1972 was about 16 million metric tons.

Table 10 presents an estimate of the extent of both "reasonably assured resources" and "estimated additional resources" of  $U_3O_8$  in Latin America in 1977. Reasonably assured resources of uranium are those believed to be contained in known deposits and thought to be recoverable within specified ranges of production cost with proven mining and processing technology. 'Estimated additional resources' of uranium refers to quantities of uranium, above and beyond those contained in reasonably assured resources, that geologic evidence suggests could occur and that are thought to be recoverable within specified ranges of cost.<sup>11</sup> In 1977, production of uranium in Latin America was nil. Map 1 shows the location of uranium resources in Latin America.

Estimates of thorium resources in Latin America are available only for Brazil, where reasonably assured resources of it are placed at 58,200 tons and where estimated additional resources are reckoned at 3,000 tons (see table 10).

An estimate of Latin America's hydroelectricity potential requires a different definitional approach from that used in discussing non-renewable energy resources because the energy resource involved in this case (i.e., falling water) is renewable. The measuring concept employed is the flow of hydroelectricity that could be generated in the region if all economically exploitable hydropower sites were developed and operated on the basis of average expected water run-off conditions. In 1966, CEPAL estimated that in Latin America this volume of hydroelectricity was of the order of  $2,835 \times 10^3$  GWh.<sup>12</sup> By way of comparison, the actual level of hydroelectricity generation in the region in 1975 was about  $121 \times 10^3$  GWh.

<sup>7</sup> Grossling, "Latin America's Petroleum Prospects in the Energy Crisis", *Geological Survey Bulletin* 1411, p.30.

<sup>8</sup> Both estimates are taken from Grossling, *op. cit.*, p. 35.

<sup>9</sup> Grossling, *op. cit.*, p. 16.

<sup>10</sup> Grossling, *op. cit.*, p. 35.

<sup>11</sup> *Uranium: Resources, Production and Demand*, December, 1977, a joint report by the OECD Nuclear Energy Agency and the International Atomic Energy Agency, p. 11.

<sup>12</sup> CEPAL, *Economic Bulletin for Latin America*, May 1967, pp. 56-63.

# URANIUM DEPOSITS AND OCCURRENCES IN LATIN AMERICA



*Source: Uranium Resources, Production and Demand, a joint report by the OECD Nuclear Energy Agency and the International Atomic Energy Agency, December 1977, p. 131.*

Note: The fact that this map shows specific boundaries does not mean that they are sanctioned or accepted by the United Nations.



Table 10  
**WORLD AND LATIN AMERICA, URANIUM AND THORIUM RESOURCES ON JANUARY 1, 1977**  
*(Thousand tons U and Th)*

<i>Cost range</i>	<i>Uranium resources</i>				<i>Thorium resources</i>	
	<i>Reasonably assured</i>		<i>Estimated additional</i>		<i>Reasonably assured</i>	<i>Estimated additional</i>
	<i>(A)</i>	<i>(B)</i>	<i>(C)</i>	<i>(D)</i>		
<i>Country</i>						
Argentina	17.8	2.4	0	0	—	—
Bolivia	0	0	0	0.5	—	—
Brazil	18.2	0	8.2	0	58.2	3.0
Chile	0	0	5.1	0	—	—
Mexico	4.7 <sup>a</sup>	0 <sup>a</sup>	2.4 <sup>a</sup>	0 <sup>a</sup>	—	—
<i>Total World (rounded)</i>	<i>1 650</i>	<i>540</i>	<i>1 510</i>	<i>590</i>	<i>490</i>	<i>833</i>

*Source:* Data on uranium: *Uranium Resources Production and Demand*, December 1977, a joint report by the OECD Nuclear Energy Agency and the International Atomic Energy Agency, pp. 20-21. Data for thorium: *Ibid*, p. 125. The data for Brazil are noted as being taken from *Uranium Resources, Production and Demand*, August, 1973. Cost ranges are not given for thorium resources.

Zeros are reported as in text of source. A dash indicates no country coverage in the source.

*Note:* (A) < \$ 80/kg. U, < \$ 30/lb. U<sub>3</sub>O<sub>8</sub>; this component is "reserves".

(B) \$ 80-130/kg. U, \$ 30-50/lb. U<sub>3</sub>O<sub>8</sub>.

(C) < \$ 80/kg. U, < \$ 30/lb. U<sub>3</sub>O<sub>8</sub>.

(D) \$ 80-130/kg. U, \$ 30-50/lb. U<sub>3</sub>O<sub>8</sub>.

<sup>a</sup>Data refer to in-situ rather than recoverable.

Since the CEPAL estimate of hydroelectricity potential was made in 1965, world energy prices have, of course, sharply increased, rendering the estimate clearly out-of-date. The level of potential hydroelectricity generation in the region today is probably much higher than the 1965 CEPAL estimate, but its true extent is simply not known today with anything even approaching acceptable precision.

The estimates presented above underscore the large scale and diversity of Latin America's wealth in modern energy resources. However, they obscure the widely disparate geographic distribution of these resources among the more than two dozen countries that constitute Latin America. Moreover, they provide no insight into the long-term economic competitiveness of these individual energy resources, either intra-regionally or internationally. Additionally, the estimates are so rough empirically that they have little operational usefulness, especially as they have not been corrected for the effect of the sharp increase in world energy prices since 1973. Finally, the various estimates of energy reserves and resources discussed above are regional aggregates, and while a regional focus is useful for some purpose, in questions of energy resources and policy the key unit is typically the nation, not the region, and so discussions of the region's wealth in energy resources are often beside the point.

## GROWTH AND CHANGE IN LATIN AMERICA'S ENERGY INDUSTRIES SINCE THE FIFTIES

### (a) *Total energy*

Latin America's consumption of modern fuels and vegetable fuels increased by 5.3 per cent per annum during 1950-1975. As shown in table 11, vegetable fuels were consumed in every Latin American country in both 1950 and 1975, although the region's overall dependence on this type of fuel declined sharply during the intervening period: from 40 per cent of total regional energy consumption in 1950 to 16 per cent in 1975.

Nevertheless, vegetable fuels still constitute a major source of energy supplies in most Latin American countries. In 1975, for example, they constituted more than one-fifth of total energy supplies in seven Latin American economies and more than two-fifths of those supplies in another eight countries.

The data in table 11 indicate that Latin America drew on all the modern fuels in satisfying its modern energy requirements in both 1950 and 1975.<sup>13</sup> Oil and natural gas increased their share in the region's modern energy consumption from 74 per cent (i.e., 67 per cent and 7 per cent, respectively), in 1950 to 77 per cent (62 per cent and 15 per cent, respectively) in 1975. The share of coal declined from 13 per cent to 5 per cent over this period, while that of hydropower was 14 per cent in 1950 and 18 per cent in 1975. Nuclear power was introduced into the region's energy base by Argentina in 1974, but the volume involved in that year was minuscule *vis-à-vis* the volume of regional energy consumption.

Latin America's overall pattern of reliance on a diversity of modern fuels is not typical of each Latin American country. In both 1950 and 1975, for example, only seven<sup>14</sup> of the twenty-six countries shown in table 11 produced and consumed the four basic modern energy sources (coal, oil, natural gas, and hydropower), and it would be misleading to suggest that even these countries' modern energy structures were broadly based. In 1975, for example, 75 per cent of modern energy consumption in these seven countries came from oil and gas alone.

Of the remaining nineteen countries listed in table 11, three (Bolivia, Ecuador and Trinidad and Tobago) produce oil and natural gas. Bolivia and Ecuador also produce hydropower, but vegetable fuels are important in both economies. In 1975, they supplied 43 per cent of Bolivia's total energy requirements and 38 per cent of Ecuador's. In both Bolivia and Ecuador, oil is clearly the backbone of the energy system. It constituted 73 per cent of Bolivia's modern energy consumption in 1975 and 89 per cent of Ecuador's. In meeting its modern energy requirements, the economy of Trinidad and Tobago is dependent on oil and gas in roughly equal proportions. Other modern fuels are not produced there, and vegetable fuels are comparatively minor in terms of total energy requirements (6 per cent in 1975).

Few of the remaining sixteen countries listed in table 11 produced any modern fuel on a significant scale in either 1950 or 1975, and all of them were critically reliant on imported oil throughout this extended period. In four countries—the Bahamas, Barbados, Grenada and Guyana—the supply of indigenous fuels in 1975 was limited exclusively to vegetable sources, with the result that their energy supplies in 1975 came entirely from vegetable fuels and from imported refined oil products.

<sup>13</sup> With the exception of nuclear fuels in 1950.

<sup>14</sup> Argentina, Brazil, Chile, Colombia, Mexico, Peru and Venezuela.

Table 11a

**LATIN AMERICA: PRODUCTION AND CONSUMPTION OF ENERGY SOURCES BY COUNTRY, 1950**  
(Thousands of tons of petroleum equivalent of 10 700 kcal/kg)

	Production					Consumption						
	Coal	Crude oil	Natural gas	Hydro-electricity	Vegetable fuels	Total	Coal	Petroleum derivatives	Natural gas	Hydro-electricity	Vegetable fuels	Total
Argentina	27	3 357	657	77	1 457	5 575	1 250	7 307	464	77	1 457	10 555
Bahamas	—	—	—	—	5	5	—	16	—	—	5	21
Barbados	—	—	2	—	126	128	—	21	—	—	126	147
Bolivia	—	80	—	110	536	726	7	122	—	110	536	775
Brazil	864	46	4	3 030	9 687	13 631	1 340	4 316	—	3 030	9 687	18 373
Chile	1 381	82	174	694	853	3 184	1 381	1 134	—	694	853	4 062
Colombia	720	4 699	1 044	362	2 299	9 124	710	931	180	362	2 299	4 492
Costa Rica	—	—	—	74	162	236	—	96	—	74	162	332
Cuba	—	22	—	6	3 241	3 269	36	1 720	20	6	3 241	5 023
Ecuador	—	347	115	30	657	1 149	—	230	—	30	657	917
El Salvador	—	—	—	17	325	342	—	91	—	17	325	433
Grenada	—	—	—	—	13	13	—	—	—	—	13	13
Guatemala	—	—	—	35	524	559	—	247	—	35	524	806
Guyana	—	—	—	—	194	194	—	85	—	—	194	279
Haiti	—	—	—	—	816	816	—	37	—	—	816	853
Honduras	—	—	—	3	256	259	—	145	—	3	256	404
Jamaica	—	—	—	21	345	366	—	82	—	21	345	448
Mexico	590	10 572	1 611	821	4 217	17 811	660	7 337	1 144	821	4 217	14 179
Nicaragua	—	—	—	15	217	232	—	67	—	15	217	299
Panama	—	—	—	2	114	116	—	182	—	2	114	298
Paraguay	—	—	—	—	263	263	—	11	—	—	263	274
Peru	74	2 006	712	299	1 424	4 515	40	1 097	4	299	1 424	2 864
Dominican Republic	—	—	—	—	662	662	—	130	—	—	662	792
Trinidad and Tobago	—	2 904	395	—	138	3 437	—	167	130	—	138	435
Uruguay	—	—	—	222	121	343	80	734	—	222	121	1 157
Venezuela	7	78 236	13 724	73	538	92 578	17	2 500	972	73	538	4 100
Latin America	3 663	102 351	18 438	5 891	29 190	159 533	5 521	28 805	2 924	5 891	29 190	72 331

Source: See table 10b.

Table 11b  
LATIN AMERICA: PRODUCTION AND CONSUMPTION OF ENERGY SOURCES BY COUNTRY, 1975a  
(Thousands of tons of petroleum equivalent of 10 700 kcal/kg)

	Production					Consumption						
	Coal	Crude oil	Natural gas	Hydro-electricity <sup>b,c</sup>	Vegetable fuels	Total	Coal	Petroleum derivatives	Natural gas	Hydro-electricity <sup>b,c</sup>	Vegetable fuels	Total
Argentina	291	20 667	8 931	2 307	1 669	33 865	950	19 846	6 640	2 307	1 669	31 412
Bahamas	—	—	—	—	6	6	—	842	—	—	6	848
Barbados	—	—	—	—	64	64	—	168	—	—	64	232
Bolivia	—	1 920	3 379	239	858	6 396	—	817	63	239	858	1 977
Brazil	1 752	8 582	1 412	22 081	15 475	49 302	2 850	35 827	435*	22 081	15 475	76 668
Chile	999	1 166	6 168	1 835	565	10 733	842	3 992	1 093*	1 835	565	8 327
Colombia	2 093	7 920	2 953	2 945	2 753	18 664	2 093	6 596	1 530*	2 945	2 753	15 917
Costa Rica	—	—	—	380	297	677	—	586	—	380	297	1 263
Cuba	—	226	—	19	3 809	4 054	100	6 995	—	19	3 809	10 923
Ecuador	—	7 754	260	193	1 396	9 603	—	1 989	52*	193	1 396	3 630
El Salvador	—	—	—	120	546	666	—	622	—	120	546	1 288
Grenada	—	—	—	—	15	15	—	20	—	—	15	35
Guatemala	—	—	—	84	1 059	1 143	—	906	—	84	1 059	2 049
Guyana	—	—	—	—	307	307	—	628	—	—	307	935
Haiti	—	—	—	43	1 146	1 189	—	79	—	43	1 146	1 268
Honduras	—	—	—	126	494	620	—	410	—	126	494	1 030
Jamaica	—	—	—	39	380	419	—	1 885	—	39	380	2 304
Mexico	3 380	42 115	19 361	4 509	5 655	75 020	3 720	30 968	12 807	4 509	5 655	57 659
Nicaragua	—	—	—	121	410	531	—	666	—	121	410	1 197
Panama	—	—	—	29	181	210	—	1 111	—	29	181	1 321
Paraguay	—	—	—	156	452	608	—	229	—	156	452	837
Peru	56	3 512	1 649	1 651	1 725	8 593	203	5 645	435*	1 651	1 725	9 659
Dominican Republic	—	—	—	27	1 101	1 128	—	1 385	—	27	1 101	2 513
Trinidad and Tobago	—	11 251	3 113	—	147	14 511	—	1 317	1 148	—	147	2 612
Uruguay	—	—	—	339	102	441	20	1 592	—	339	102	2 053
Venezuela	45	122 546	33 035	2 665	767	159 058	210	9 286	9 498	2 665	767	22 426
Latin America	8 616	227 659	80 261	39 908	41 379	397 823	10 988	134 407	33 701	39 908	41 379	260 383

Source: CEPAL, on the basis of official data.

a Preliminary figures. b 1 KWH = 3 200 kcal. c Including electric energy generated by nuclear and geothermic plants.

\* Estimate.

In twelve of these sixteen countries,<sup>15</sup> modern energy production in 1975 was limited to one fuel. In Cuba it was limited to minor volumes of crude oil and hydropower,<sup>16</sup> and in the other eleven countries to hydropower alone. Moreover, in all twelve countries hydropower only supplied an average of 5 per cent of total energy requirements in 1975, the remaining 95 per cent being supplied from imported oil (59 per cent), vegetable fuels (35 per cent) and coal (1 per cent). Taken together, these twelve Latin American countries relied on imported oil for roughly nine-tenths of their modern energy requirements in 1975.

(b) *The oil industry*

(i) *Introduction.* The oil industry consists of several segments: first, crude oil exploration, development and production; second, crude oil refining; and, third, oil marketing (including both the import and export of crude oil and refined products and the domestic marketing of refined oil products). These segments of the oil industry, and the transport links between them, make possible the ultimate application of refined oil products in production. The pattern of growth and change in these three basic segments of the region's oil industry in the post-war era is discussed below.

(ii) *Indigenous oil production and domestic oil consumption.* The eleven Latin American countries producing crude oil in 1975 were the same as those which produced it in 1950 (see table 12). Oil supplies in the remaining fifteen countries of the region were entirely imported in both 1950 and 1975.

Within this group of eleven crude oil producing countries, however, there have been substantial changes in the degree to which increasing requirements for refined oil products in the domestic economy have permitted the export of indigenously produced oil. (See table 13). Venezuela, of course, has been, and will continue to be, a major crude oil exporter. Ecuador, following recent oil discoveries, has moved quickly since 1972 to increase its oil exports. In 1950, Ecuador's crude oil production was roughly 50 per cent greater than the volume of its internal refined product requirements, but by 1975 such production was 3.9 times the volume of refined oil products consumed domestically (see table 13).

Mexico's crude oil surplus of the early fifties was erased by 1973, only to be reestablished in 1975. Recent developments in the Mexican oil industry promise a resumption of crude oil exports on a significant scale in the future.<sup>17</sup> Current plans are to develop an oil export capacity by 1982 of 1,188 thousand barrels per day, fifteen per cent of which will be in the form of refined products; present oil exports are about 200 thousand barrels per day, including about 20 thousand barrels per day of motor gasoline.<sup>18</sup> Mexico, together with the North Sea and Alaska, is now clearly among the leading marginal sources of world crude oil, and, for this reason, Mexican oil supplies will play an increasingly important role in the determination of future prices for world oil.

Argentina was heavily dependent on imported crude in the early fifties, but by 1975 it was producing a volume of crude oil more or less equal to its domestic consumption of refined oil products.<sup>19</sup> Here again, the recent discovery at Puerto Rojas, near Mendoza, is a promising sign

<sup>15</sup> Costa Rica, Cuba (which produces small volumes of oil and hydropower), El Salvador, Guatemala, Haiti, Honduras, Jamaica, Nicaragua, Panama, Paraguay, the Dominican Republic and Uruguay.

<sup>16</sup> Crude oil production in 1975 in Cuba was roughly 3 per cent of the volume of refined oil product consumption in that year. Oil constituted 98 per cent of Cuba's modern energy base in 1975, while vegetable wastes supplied 35 per cent of Cuba's total energy consumption in that year (see table 11).

<sup>17</sup> In 1974, a major United States oil company estimated that oil reserves located in Chiapas-Tabasco could amount to 10-20 billion barrels. See: *International Petroleum Encyclopedia*, 1976 issue, p. 190.

<sup>18</sup> See: "Mexico Plans Push on Exports of Gas as well as Oil", *Petroleum Intelligence Weekly*, June 6, 1977, p. 5.

<sup>19</sup> The comparison is misleading in that Argentina's indigenous crude oil production in 1950 was lower than might otherwise have been possible at that time since the private oil companies were reducing crude oil output, all new oil exploration and development activity having been reserved for Yacimientos Petrolíferos Fiscales (YPF)

Table 12

**LATIN AMERICA: CRUDE OIL PRODUCTION BY COUNTRY, 1950-1975 (SELECTED YEARS)***(Thousands of m<sup>3</sup>)*

	1950	1960	1970	1973	1974	1975
Argentina	3 730	10 178	22 797	24 441	24 024	22 968
Bolivia	98	569	1 402	2 745	2 640	2 342
Brazil	54	4 708	9 685	9 876	10 295	9 979
Colombia	5 401	8 867	12 728	10 667	9 760	9 104
Cuba	25	25	174	153	187	251
Chile	100	1 150	1 976	1 817	1 599	1 422
Ecuador	418	438	230	12 116	10 274	9 342
Mexico <sup>a</sup>	11 747	17 293	28 238	30 442	37 890	46 794
Peru	2 389	3 063	4 176	3 977	4 293	4 181
Trinidad and Tobago	3 227	6 735	8 116	9 646	10 830	12 501
Venezuela	86 929	165 613	215 177	195 331	172 713	136 162
<i>Total</i>	<i>114 118</i>	<i>218 639</i>	<i>304 699</i>	<i>301 211</i>	<i>284 505</i>	<i>255 046</i>
<i>Total (excluding Venezuela)</i>	<i>27 189</i>	<i>53 026</i>	<i>89 522</i>	<i>105 880</i>	<i>111 792</i>	<i>118 884</i>
<i>World</i>	<i>604 677</i>	<i>1 210 496</i>	<i>2 606 352</i>	<i>3 204 286</i>	<i>3 291 861</i>	<i>3 125 185</i>
<i>Latin America as a percentage of world total</i>	<i>18.9</i>	<i>18.1</i>	<i>11.7</i>	<i>9.4</i>	<i>8.6</i>	<i>8.2</i>

Source: Latin America: CEPAL, on the basis of official data; world: *Oil and Gas Journal*, several issues.

<sup>a</sup>Includes natural gas liquids.

for the future. Major efforts in oil exploration and development will be called for, however, if Argentina is to remain free of reliance on imported oil in the future.

Peru, a minor crude oil exporter in 1950, supplied roughly three-fifths of its internal refined product requirements from indigenous crude oil in 1975. Self-sufficiency in oil supplies could be

by law in 1935. See: Gertrude G. Edwards, "The Frondizzi Contracts and Petroleum Self-Sufficiency in Argentina", R.F.M. Miksell, *et.al.*, *Foreign Investments in the Petroleum and Minerals Industries*, (Baltimore, Md., 1971), p. 161.

achieved and export status recovered with the completion of the Concordia-Bayovar crude oil pipeline.<sup>20</sup>

In Trinidad and Tobago, a major crude oil exporter in the region in the fifties, the ratio of crude oil production to domestic oil consumption declined from 16.3 in 1950 to 8.5 in 1975. Crude oil production in Trinidad and Tobago increased only slowly during the sixties, averaging 1.9 per cent per annum, but since 1970 it has increased more rapidly with the development work centered in the eastern offshore areas.

Colombia was a major Latin American crude oil exporter in the fifties and sixties, but its crude oil export position deteriorated sharply in the seventies. This occurred largely as a result of the pressure of rising domestic requirements for refined oil products in the face of more slowly rising domestic crude oil production, a phenomenon in turn largely explained by the comparatively low prices for crude oil and refined oil products set by the State. Recent changes in this policy could bring about a resurgence of indigenous crude oil supplies in Colombia.<sup>21</sup>

The reverse took place during this period in Bolivia. In 1950, indigenous crude oil supplied about two-thirds of Bolivia's domestic market for refined products, but in 1975 crude oil production in Bolivia was 2.4 times the volume of refined oil products consumed domestically. The ambitious five-year oil development programme of Yacimientos Petrolíferos Fiscales Bolivianos (YPFB) promises to increase Bolivia's participation in the world oil market over the next decade.<sup>22</sup>

The remaining three of the region's eleven crude oil producing countries produced substantially less than their volume of internal refined product consumption in both 1950 and 1975. Cuba's crude oil production was negligible in both years, the major change during the period being the shift in import reliance from the United States (and, to a lesser extent, Venezuela) to the Soviet bloc.<sup>23</sup> Although crude oil production in Brazil and Chile, the two remaining crude oil producers in the region, has increased rapidly since 1950, both produce substantially less crude oil than the volume of their domestic demand for refined oil products.<sup>24</sup> In each country, however, local crude oil production has increased significantly since the early fifties, and Brazil and Chile, by 1975, were supplying volumes of indigenous crude oil that represented about one-quarter (Brazil) and three-tenths (Chile) of their internal consumption of refined products. Their strong emphasis on increasing indigenous oil supplies and the development of newly-found reserves<sup>25</sup> could reduce the degree of dependence of both countries on imported oil in the relatively near future.

The total consumption of refined oil products in the remaining group of fifteen Latin American countries which do not produce crude oil (see table 11) constituted less than 10 per cent of total regional consumption in both 1950 and 1975. Obviously, this reflects in part the relatively minor proportions of regional production and population in these countries. The absence of a crude oil producing industry in each of these fifteen countries constitutes a serious

<sup>20</sup>This pipeline is 557 miles in length. It has a 200,000 b/d initial capacity (with expansion capacity to 500,000 b/d). The pipeline crosses the Amazon jungle, the Andes, and Sechura desert, reaching Bayovar at the Pacific coast. It went operational in July, 1977.

<sup>21</sup>See: "Petroleum Intelligence Weekly", August 18, 1975, p. 10; and: *International Petroleum Encyclopedia*, (The Petroleum Publishing Company, Tulsa, 1975), p. 183.

<sup>22</sup>See: *International Petroleum Encyclopedia*, (The Petroleum Publishing Company, Tulsa, 1975), p. 178.

<sup>23</sup>The Soviet Union has assumed the role of Cuba's major crude oil supplier in recent years, but to save transport costs the crude oil being landed in Cuba is often the result of swaps of Soviet for non-Soviet oil, and is, therefore, not necessarily Soviet oil in a physical sense.

<sup>24</sup>This statement should not be construed as implying that self-sufficiency in crude oil supplies is *a priori* an economically defensible or desirable goal.

<sup>25</sup>In the case of Brazil, one estimate, based on preliminary data, is that the Garoupa field discovered in 1974 in the Campos Basin, contains about 600 million barrels of oil. This offshore field is located relatively close to the large concentration of refineries in the States of Minas Gerais, São Paulo, and Rio de Janeiro. Planned production from Garoupa is set at 200,000 b/d in comparison with Brazil's total crude oil production of about 172,000 b/d in 1975. One preliminary estimate places reserves of oil and natural gas in Chile's new discovery in the Magallanes Straits at more than 189 million barrels and 80 billion cubic meters, respectively.

constraint on the options open to their energy planners in designing policies to confront the currently high price of imported oil.

Although Latin America as a whole has consistently exported a greater volume of crude oil than its refined oil requirements, the picture changes substantially when the region's oil-surplus countries are excluded from the regional totals. Thus, in 1950, 3.9 tons of oil were produced in the region for each ton of refined products consumed, and by 1975 this ratio had declined to 1.8. If only the region's oil-deficit countries are considered, however, the figures in table 13 show that indigenous crude oil production in the region was only about one-quarter of the consumption of refined products in both 1950 and 1975.

(iii) *Exploration and development.*<sup>26</sup> Many more Latin American countries have explored for oil in their countries than those which have established a crude oil production capability. Table 14 presents data on two decades of petroleum exploration activity in Latin America. Roughly 13 per cent of all wells drilled in the region during this period were exploratory wells, and 35 per cent of these exploratory wells were successful.<sup>27</sup> Examination of the data shows that the success rate was particularly high in many South American countries and in Mexico, Trinidad and Tobago and Barbados. Exploration wells in the remaining countries of Central America and in the Caribbean were notably unsuccessful.

Historically, the ratio of wells drilled per unit of potentially oil-bearing land in Latin America has been relatively low. The number of wells drilled per square mile in Latin America (.02) is about 2 per cent of the comparable ratio for the United States (1.17), and is roughly 13 per cent of that for the Soviet Union.<sup>28</sup> Additionally, Latin America's drilling record has been relatively poor by international standards from the point of view of the volume of oil and gas found per unit of land area drilled. In short, much of Latin America's potential oil and gas-bearing areas remain unexplored, which suggests, in turn, that the bulk of Latin America's wealth in oil and gas reserves is still in the ground, waiting to be found. It is quite possible that, in a matter of decades, Latin America may take its place once again as a leading source of world oil.

Table 15 presents the pattern of expenditures on oil and gas exploration and development in Venezuela and the rest of Latin America since the late fifties. Exploration expenditures in Latin America excluding Venezuela peaked in 1959 and subsequently remained at relatively low levels during the sixties. The level of exploration expenditures (in current dollars) by this group of countries was the same in 1969 as it was in 1960, signifying a strong decline in the volume of real resources committed in support of oil and gas exploration activities during that period. Exploration expenditures by these countries continued to stagnate during 1970-1973, but doubled to 150 million dollars in 1974, remaining at that level in 1975.

A similar trend is evident in the pattern of expenditures by Latin America, excluding Venezuela, on oil and gas development and production. These expenditures increased steadily to a peak of 485 million dollars in 1960, but thereafter they declined, falling to 360 million dollars by 1970. Since then, development and production expenditures by this group of countries have been increasing, and particularly since 1973.

The basic explanation for these diverse trends lies in the changing structure (actual and expected) of world crude oil prices, on the one hand, and in the structure of the expected

<sup>26</sup> In Latin America, the bulk of exploration and development wells are drilled to find oil, not natural gas. Gas is found largely in association with oil in the region, and it is therefore a by-product of finding oil. Available statistics on exploration, development, and production expenditures in Latin America are not disaggregated for oil and gas, and therefore the subject will be discussed here jointly for both oil and gas.

<sup>27</sup> This is an extraordinarily high success ratio for exploratory wells, and it suggests that many outpost wells are being included in the total for exploratory wells (i.e., the total probably does not include only true wildcat wells).

<sup>28</sup> Actually, there is a strong upward bias in the United States ratio due to the stimulation of well drilling there as a result of the oil prorating system. The figures above were calculated from data presented in: B.F. Grossling, "Latin America's Petroleum Prospects in the Energy Crisis", Geological Survey Bulletin 1411, (United States Government Printing Office, Washington, 1975), p. 27.



Table 13

**LATIN AMERICA: CONSUMPTION OF REFINED OIL PRODUCTS AND PRODUCTION OF CRUDE OIL BY COUNTRY, 1950-1975 (SELECTED YEARS)**  
*(Thousands of tons of petroleum equivalent of 10 700 kcal/kg)*

	1950		1970		1973		1975	
	Consumption of petroleum derivatives	Production of crude oil	Consumption of petroleum derivatives	Production of crude oil	Consumption of petroleum derivatives	Production of crude oil	Consumption of petroleum derivatives	Production of crude oil
Argentina	7 307	3 357	20 136	20 519	21 708	21 997	19 846	20 667
Bolivia	122	80	508	1 150	617	2 251	817	1 920
Brazil	4 316	46	23 413	8 329	33 416	8 493	35 827	8 582
Colombia	931	4 699	4 997	11 073	6 165	9 280	6 596	7 920
Cuba	1 716	23	5 830	157	6 875	138	6 995	226
Chile	1 134	82	4 424	1 620	4 904	1 490	3 992	1 166
Ecuador	230	347	1 186	191	1 398	10 056	1 989	7 754
Mexico	7 337	10 572	21 702	25 414	27 290	27 398	30 968	42 115
Peru	1 097	2 007	4 584	3 508	5 070	3 341	5 645	3 512
Trinidad and Tobago	178	2 904	1 571	7 304	1 590	8 681	1 317	11 251
Venezuela	1 700	78 236	6 229	193 659	8 185	175 798	9 286	122 546
<i>Total</i>	<i>26 068</i>	<i>102 353</i>	<i>94 580</i>	<i>272 924</i>	<i>117 218</i>	<i>268 923</i>	<i>123 278</i>	<i>227 659</i>
<i>Total group A<sup>a</sup></i>	<i>11 473</i>	<i>98 765</i>	<i>55 143</i>	<i>259 119</i>	<i>66 953</i>	<i>255 461</i>	<i>70 819</i>	<i>214 173</i>
<i>Total group B<sup>b</sup></i>	<i>14 595</i>	<i>3 588</i>	<i>39 437</i>	<i>13 805</i>	<i>50 265</i>	<i>13 462</i>	<i>52 459</i>	<i>13 486</i>

Source: CEPAL, on the basis of official data.

<sup>a</sup>This group comprises those countries in which the production of petroleum is greater than the consumption of petroleum derivatives.

<sup>b</sup>This group comprises those countries in which the production of crude is less than the consumption of petroleum derivatives.

The figures presented above exclude energy sources used in non-energy applications such as petrochemical feedstocks.

Table 14  
LATIN AMERICA: REVIEW OF OIL DRILLING ACTIVITY IN THE POSTWAR (II) ERA BY COUNTRY

Country	Period	Wells			
		Exploratory wells	Productive exploratory wells	Total	Number of feet drilled
Brazil	1949-1972	1 441 <sup>a</sup>	303 <sup>a</sup>	3 680	≈16 130 000
Argentina	1951-1972	1 725	522 <sup>a</sup>	20 644	68 543 000 <sup>a</sup>
Mexico	1949-1972	2 662	801 <sup>a</sup>	16 554	71 805 000 <sup>a</sup>
Peru	1948-1972	734	292 <sup>a</sup>	9 700 <sup>a</sup>	20 200 000 <sup>ad</sup>
Colombia	≤1972	920 <sup>a</sup>	250 <sup>a</sup>	3 857	18 755 000 <sup>a</sup>
Venezuela	1949-1972	2 655	401 <sup>a</sup>	28 571	118 900 000 <sup>ad</sup>
Bolivia	1949-1972	231 <sup>a</sup>	72 <sup>a</sup>	765	4 847 000 <sup>ad</sup>
Paraguay	1949-1972	22	...	29	76 082
Ecuador	1949-1972	309	166	2 970	4 887 193 <sup>d</sup>
Chile	1945-1972	353	78	1 520	10 488 000 <sup>a</sup>
Nicaragua	1949-1972	20	...	20	>178 912 <sup>b</sup>
Honduras	1949-1972	6	...	6	56 277
Uruguay	≤1972	...	...	...	...
Guatemala	1949-1972	17	0	17	68 410 <sup>c</sup>
Panama	1949-1972	12	...	12	>65 484 <sup>b</sup>
Surinam	1949-1972	33	0	33	102 148 <sup>ab</sup>
Guyana	1949-1972	9	0	9	48 336
Cuba <sup>d</sup>	1949-1964	>201	>11	>524	>1 712 723
French Guiana	≤1972	...	...	...	...
Dominican Republic <sup>d</sup>	1949-1970	18 <sup>a</sup>	0	18 <sup>a</sup>	>44 419
Jamaica	1949-1972	8	...	8	29 581 <sup>c</sup>
Belize	1949-1972	28	...	28	>94 987 <sup>c</sup>
Trinidad and Tobago	1949-1972	515 <sup>ad</sup>	230 <sup>ad</sup>	8 450 <sup>a</sup>	25 266 001
El Salvador	≤1972	0	0	0	0
Haiti	1949-1972	3	0	3	>12 930 <sup>b</sup>
Costa Rica	≤1972	19	...	19	131 103
Barbados	1950-1951	17	6	19	149 760 <sup>c</sup>
<i>Cumulative total</i>		<i>11 958</i>	<i>4 132</i>	<i>91 962</i>	<i>362 592 346</i>

Source: B. F. Grossling, *Latin America's Petroleum Prospects*, Geological Survey Bulletin 1411, United States Government Printing Office, Washington, D.C., 1975, p. 28, table 12.

Note: The average depth of the wells is 4.263 feet. The exploratory wells represent 14 per cent of the total; 35 per cent of the exploratory wells were productive. The figures underlined indicate total cumulative values up to 1972.

<sup>a</sup>Estimate.

<sup>b</sup>One-year data gap.

<sup>c</sup>Two-year data gap.

<sup>d</sup>Several-years data gap.

Table 15  
**LATIN AMERICA: WELLS DRILLED AND INVESTMENTS IN OIL AND GAS EXPLORATION AND  
 PRODUCTION IN VENEZUELA AND OTHER LATIN AMERICAN COUNTRIES, 1958-1975**  
 (Millions of dollars and units)

	Venezuela						Rest of Latin America <sup>a</sup>	
	Investment		Number of wells drilled <sup>b</sup>				Investment	
	Explora- tion	Exploita- tion	Explora- tion wells	Develop- ment wells	Exploita- tion wells	Total	Explora- tion	Exploita- tion
1958	50	500	168	430	586	1 184	65	300
1959	40	375	103	238	351	692	85	436
1960	30	225	62	214	168	444	75	485
1961	20	165	77	202	198	477	65	480
1962	15	160	69	128	339	536	75	425
1963	10	170	54	116	328	498	75	330
1964	10	155	61	118	442	621	60	265
1965	10	175	64	117	513	694	60	245
1966	10	120	45	45	304	394	50	255
1967	15	120	30	45	243	318	60	250
1968	15	175	28	72	338	438	75	350
1969	20	200	34	68	387	489	75	325
1970	15	205	37	65	520	622	85	360
1971	30	210	44	121	436	601	75	525
1972	25	150	64	105	329	498	75	550
1973	25	200	58	88	275	421	75	575
1974	30	290	69	96	242	407	150	925
1975	30	240	36	94	151	281	150	950

Source: Chase Manhattan Bank, Energy Economics Division, *Capital Investment of the World Petroleum Industry*.

<sup>a</sup>Western Hemisphere, excluding the United States, Canada and Venezuela.

<sup>b</sup>These figures were taken from Ministerio de Minas e Hidrocarburos de Venezuela, *Petróleo y Otros Datos Estadísticos*, 1971 and 1975.

marginal costs of supplying indigenous crude oil in this group of countries, on the other. More specifically, world crude oil prices during 1950-1957 remained high relative to supply costs, not only in most of the leading oil-exporting countries at that time, but also in many Latin American oil-deficit/oil-producing countries. This fact provided a stimulus to develop more crude oil reserves and to produce from them and/or to explore for cheaper oil. This incentive was reinforced because the structure of world oil prices at that time was being taken as an indication

of future oil prices and because import substitution strategies were being pursued aggressively, as a matter of national policy, by oil-deficit countries in Latin America. On the other hand, this tendency was restrained by the fact that decreases in the unit cost of international oil transport were reducing the expected landed cost of imported crude oil during this period.

The price (in current dollars) of internationally traded crude oil peaked in 1958 and then declined until 1970. Since 1970, the trend in world oil prices has been sharply upwards, particularly since 1973. The decline in exploration expenditures during the sixties in Latin America (excluding Venezuela) reflects, *inter alia*, widespread decisions at that time against investment in oil and gas exploration programmes in the face of what was probably the prevailing expectation at that time that future landed prices of world oil would be significantly lower than current prices of the day. Furthermore, while continuing development and production expenditures did support an increasing level of crude oil output, the expectation of declining real prices for world oil evidently restrained many oil companies and governments in the region from undertaking not only exploration but also major oil development programmes.

An upward revision of the level of actual (and expected) world crude oil prices in the seventies is undoubtedly the major force behind the upswing in the level of oil exploration, development and production expenditures in Latin America (excluding Venezuela) during the present decade.

Changes in the pattern of expenditures in Venezuela on oil and gas exploration, development and production must be examined separately from those of other Latin American countries. In 1943, the Venezuelan Government agreed to the extension up to 1983 of the concessions of the foreign oil companies operating there, in return for increased taxes. In the early fifties, oil production increased sharply in Venezuela during a period of burgeoning world oil consumption, while Venezuela's proven reserves of crude oil increased only sluggishly (see table 16). Despite a sharp increase in the drilling of exploratory and development wells, Venezuela's reserve production ratio showed no appreciable change during 1950-1955.

Departing from previous policy, the Venezuelan Government extended new concessions to foreign oil companies in 1956 and 1957, and investments in oil and gas exploration and development increased through 1958. Since then, new concessions have not been extended to foreign oil companies, which have shifted their investment focus progressively to the Middle East and Africa. Crude oils from these regions have increasingly displaced Venezuelan crude oil, and this retarding effect was compounded by the United States crude oil import quota system that was imposed in 1959 on announced grounds of "national security".

The data in table 15 underscore the sharp decline since 1958 in the number of new wells commissioned in Venezuela, not only in exploration but also in development and production. Given the declining volume of real resources committed to developing crude oil reserves, the result, once again, was that Venezuela's reserve production ratio began to decline, falling to 11.2 in 1969 and 1970. Since then, however, the strong increase in real crude oil prices in the world market has been a windfall to Venezuela in terms of the extent of its proven crude oil reserves. Gains on this account, in conjunction with declining levels of crude oil production since 1970, have been the major forces behind the strong increase in recent years in Venezuela's reserve production ratio, which reached 21.5 in 1975. Nevertheless, the long-term need to build up crude oil reserves is being increasingly stressed in Venezuela, and the stage seems set for striking increases in investment for this purpose.

Since 1970, the increased price of world oil has been accompanied by reductions in the level of Venezuelan crude oil production (see table 16) and *de facto* increases in Venezuela's economically exploitable reserves of crude oil. Venezuela's exploration and development expenditures have increased since 1970, but exploration expenditures, although increasing, still remain at relatively low levels (see table 15). Crude oil reserve management in Venezuela in the recent past has focused basically on the task of drawing from proven and extended proven reserves, with little emphasis on the identification of new fields by wildcat drilling.

Table 16

## VENEZUELA: PROVEN OIL RESERVES AND PRODUCTION OF CRUDE OIL, 1950-1975

Year	Reserves (billions of barrels) <sup>a</sup>	Production (thousands of barrels/ day	Percentage (a)/(b)	Year	Reserves (billions of barrels)	Production (thousands of barrels/ day	Percentage (a)/(b)
	(a)	(b)	(a)/(b)		(a)	(b)	(a)/(b)
1950	8.7	1 498	15.8	1963	17.0	3 248	14.3
1951	9.1	1 705	14.7	1964	17.2	3 395	14.4
1952	9.2	1 804	14.0	1965	17.2	3 505	13.4
1953	10.2	1 765	15.9	1966	16.9	3 400	13.6
1954	10.9	1 895	15.8	1967	15.9	3 575	12.2
1955	12.4	2 157	15.7	1968	15.7	3 640	11.8
1956	14.0	2 457	15.6	1969	14.9	3 639	11.2
1957	15.6	2 779	15.4	1970	15.1	3 708	11.2
1958	16.8	2 615	17.7	1971	14.8	3 549	11.4
1959	17.0	2 771	16.8	1972	13.9	3 220	11.8
1960	17.4	2 846	16.7	1973	14.1	3 366	11.5
1961	16.9	2 920	15.8	1974	18.6	2 976	17.1
1962	16.8	3 200	14.4	1975	18.5	2 346	21.5

Source: Ministerio de Minas e Hidrocarburos de Venezuela, *Petróleo y Otros Datos Estadísticos*, 1971 and 1975.

<sup>a</sup>At the end of the year indicated.

(iv) *Oil refining.* Since the fifties, Latin America has substituted domestically refined for imported refined oil products on a major scale. In 1950, the region's oil-importing countries were heavily reliant on the international market for their supplies of refined oil products (see table 17). Since then, however, substitution has proceeded to such a point that, by 1975, imports of refined oil products were still only about the same (i.e., 12 million cubic metres) as had been recorded twenty-five years earlier. Refined oil products imported into the region today stem basically from the need to rectify relatively minor discrepancies between domestic market requirements for and refinery yields of individual refined oil products, together with the need for some specialized products which it is more economical to import than to produce locally.

The main factors promoting the expansion of local refining capacity in Latin America since the fifties have been the increasing scale and diversity of the requirements for refined oil products in those countries and the strong decline in the cost of transporting oil internationally. These pressures have been operating on a world scale, the result being a massive shift from resource-oriented to market-oriented refineries in the post-war era. In Latin America, as elsewhere, the pressure to secure reductions in the transport costs of oil imports through local refining was reinforced by central government support of import substitution and projects designed to save foreign exchange. Other perceived advantages were probably at work as well, such as increasing the diversity of energy suppliers and the pursuit of prestige projects. As will be discussed subsequently, this shift to the domestic refining of imported crude oil rather than

Table 17

**LATIN AMERICA: IMPORTS OF CRUDE OIL AND REFINED OIL PRODUCTS<sup>a</sup> BY COUNTRY, 1950-1975 (SELECTED YEARS)**  
(Thousands of m<sup>3</sup>)

	1950		1960		1970		1973		1974		1975	
	Crude	Derivates	Crude	Derivates	Crude	Derivates	Crude	Derivates	Crude	Derivates	Crude	Derivates
Argentina	3 559	2 703	3 685	1 929	1 684	1 490	3 395	1 268	3 427	1 023	2 495	1 484
Bolivia	—	75	—	42	—	16	—	17	—	18	—	19
Brazil	13	4 978	6 704	4 816	18 675	2 521	41 523	1 221	40 261	1 238	40 784	269
Colombia	—	244	—	98	—	36	—	—	—	92	—	314
Chile	—	1 348	588	989	2 386	1 044	3 641	406	4 769	96	3 146	—
Ecuador	—	8	252	96	1 132	30	1 052	25	1 499	87	1 314	80
Guyana	—	...	—	243	—	567	—	549	—	...	—	...
Paraguay	—	13	—	124	208	42	124	30	144	45	228	50
Peru	—	44	60	608	791	519	2 034	280	1 899	351	2 724	500
Uruguay	864	44	1 500	104	1 929	147	1 963	103	2 003	153	2 099	105
Venezuela	—	—	—	—	—	—	—	—	—	—	—	—
Mexico	—	347	—	471	—	2 251	3 751	4 605	983	3 597	—	3 698
Central America <sup>b</sup>	—	736	—	1 434	2 721	653	3 890	470	3 658	366	3 416	796
Panama	—	212	—	414	4 179	47	4 167	24	4 006	44	4 750	68
Barbados	6	24	12	52	90	262	176	269	167	318	172*	300*
Cuba	269	1 037 <sup>c</sup>	3 736	2 024 <sup>c</sup>	4 898	1 850	6 026	2 092	6 753	2 097	6 663	3 132
Jamaica	—	...	—	948	1 825	285	1 687	1 160	1 744	1 151	1 653	1 439
Haiti	—	44	—	102	—	115	—	98*	—	119*	—	110*
Dominican Republic	—	120	—	358	—	954	912	345	1 668	203	1 391*	244
Trinidad and Tobago	1 520	—	6 395	—	17 978	—	16 888	—	17 091	560	9 025	—
<b>Total</b>	<b>6 231</b>	<b>11 977</b>	<b>22 932</b>	<b>14 852</b>	<b>58 496</b>	<b>12 829</b>	<b>91 229</b>	<b>12 962</b>	<b>90 072</b>	<b>11 558</b>	<b>79 860</b>	<b>11 608</b>

Source: CEPAL, on the basis of official data.

<sup>a</sup>Includes only liquefied gas, kerosene, jet fuel, gas oil/diesel oil and fuel oil.

<sup>b</sup>Central America comprises Costa Rica, El Salvador, Guatemala, Honduras and Nicaragua.

<sup>c</sup>These figures represent only Venezuela's exports to Cuba.

\* Estimate.

The figures presented above exclude energy sources used in non-energy applications such as petrochemical feedstocks.

importing refined oil products was accompanied in Latin America by a tightening of control by central governments over the domestic refining industry and, more generally, over the domestic energy industries. Finally, as will also be discussed later, many of the quantitative increases in Latin America's crude oil refining capacity since the fifties have been export-oriented, built to satisfy the growing market for refined products in North and South America and, to a lesser extent, in Western Europe.

The substitution of domestically refined for imported oil products has been accompanied by an increased regional reliance on imported rather than indigenous crude oil (see table 18). In 1975, this dependence was total in many Central American and Caribbean economies as well as in Paraguay and Uruguay, and in the same year imported crude oil was the major source of crude oil used in the refinery systems of Cuba (97 per cent), Brazil (76 per cent), Chile (66 per cent) and, to a lesser extent, Trinidad and Tobago (57 per cent) and Peru (38 per cent). In Argentina, however, imported oil represented only 10 per cent of refinery runs in 1975. The remaining crude oil producing countries in the region<sup>29</sup> operated their refineries on indigenous crude oil in both 1950 and 1975.

The expansion in Latin America's refining capacity since the fifties (see table 19) has been accompanied by three other trends: first, an increase in the average size of crude oil refining units; second, the installation of more catalytic cracking and reforming capacity;<sup>30</sup> and, third, an increase in the number of large-scale export-oriented refineries in the region, these being located in Venezuela and in the Caribbean.

Between 1957 and 1976, installed refining capacity in Latin America increased from 2,644 to 7,690 thousand barrels per day (TBD), while the scale of the average oil refinery<sup>31</sup> increased from 37 to 85 TBD (see table 20). Much of the increase in regional refinery capacity recorded during this period was accounted for by the installation of large-scale (i.e., more than 100 TBD capacity) export-oriented refineries in the Caribbean and in Venezuela. A similar concentration of refinery capacity in units of over 100 TBD was observed in South America excluding Venezuela. This shift to larger-scale refineries was seen in Argentina, Brazil and Colombia, and it allowed each of these countries to increase their refining capacity between 1957 and 1976 while reducing the number of refineries. In the remaining countries of South America, during the same period, one refinery was built in the 31-50 TBD range (in Ecuador); three were built in the 51-100 TBD range (two in Chile and one in Peru); and there was an increase in both the number and capacity of small-scale (i.e., less than 30 TBD) refineries in the remaining small oil markets of South America. In Central America, the new refineries installed during 1957-1976 tended to be small in scale, reflecting the size of internal markets there. Mexico, in contrast reduced the number of its refineries during 1957-1976 while increasing national refining capacity by 316 TBD. This was achieved chiefly by the installation of three refineries, each with a capacity of more than 100 TBD.

This increase in average refinery size in the region has been accompanied by an increase in reforming capacity and, in the non-oil-exporting countries of the region, in catalytic cracking capacity as well (see table 19). Thus, the growth in distillate refining capacity and in catalytic and reforming capacity in the region has been sufficient to reduce imports of gasoline from about 68,000 barrels per day in 1950 to about 40,000 barrels per day by 1975, despite a five-fold expansion in the consumption of gasoline in these countries during the period.

<sup>29</sup> Namely, Venezuela, Bolivia, Colombia, Ecuador and Mexico.

<sup>30</sup> Catalytic cracking is the act of breaking down relatively large oil molecules into smaller and lower boiling molecules. The more stable of these molecules are then collected largely in the form of craked gasoline, the remaining reactive molecules polymerizing into tar and coke. Reforming refers to the cracking of naphtha to yield more volatile fractions of higher octanes. Reforming differs from catalytic cracking essentially in that a more volatile charge stock is used in reforming than in catalytic cracking, but each process has as its main purpose the production of more motor gasoline.

<sup>31</sup> Average refining capacity is total crude oil refining capacity divided by the number of refineries constituting that capacity.

Table 18

LATIN AMERICA: OIL REFINING AND NET CRUDE OIL IMPORTS BY COUNTRY, 1950-1975 (SELECTED YEARS)

*Source:* CEPAL, on the basis of official data.  
\* Estimate.



Table 19

## LATIN AMERICA AND WORLD: OIL REFINING CAPACITY BY TYPE AND BY COUNTRY, 1954, 1960, 1970 AND 1975

(Thousands of barrels per day)

	On 1 January 1954				On 1 January 1960				On 1 January 1970				On 1 January 1975			
	No of re-finer-ies	Crude oil	Crack-ing	Reform-ing	No of re-finer-ies	Crude oil	Crack-ing	Reform-ing	No of re-finer-ies	Crude oil	Crack-ing	Reform-ing	No of re-finer-ies	Crude oil	Crack-ing	Reform-ing
Antigua	—	—	—	—	—	—	—	—	—	—	—	—	—	16.0	—	2.0
Argentina	16	186.1	65.4	—	14	238.4	87.4	—	14	457.2	219.2	18.9	14	720.7	101.2	51.4
Bahamas	—	—	—	—	—	—	—	—	—	—	—	—	1	500.0	—	—
Barbados	—	—	—	—	—	—	—	—	1	3.0	—	—	1	3.0	—	—
Bolivia	4	12.3	—	—	4	12.2	—	—	5	11.6	—	—	5	25.5	—	—
Brazil	9	105.8	29.5	19.7	8	156.3	63.3	—	11	501.6	86.9	38.7	10	96.8	183.0	21.0
Chile	1	20.0	13.4	—	1	24.0	9.5	4.0	2	91.0	32.5	10.0	3	123.5	26.3	10.0
Colombia	3	39.5	16.5	15.1	5	51.2	60.8	—	5	137.4	76.0	—	6	172.1	48.5	2.0
Costa Rica	—	—	—	—	—	—	—	—	1	8.0	3.0	1.2	1	11.0	—	1.5
Cuba	3	7.7	2.4	—	6	86.9	24.5	10.9	3	93.0	24.0	15.6	13	122.0	14.6	11.7
Dominican Republic	—	—	—	—	—	—	—	—	—	—	—	—	2	45.5	—	7.0
Ecuador	2	5.4	—	—	2	7.4	—	—	2	33.0	6.0	1.0	4	44.3	—	—
El Salvador	—	—	—	—	—	—	—	—	1	14.0	—	—	1	14.0	—	2.6
Guatemala	—	—	—	—	—	—	—	—	2	20.5	—	—	2	24.8	—	5.5
Honduras	—	—	—	—	—	—	—	—	1	10.0	—	—	1	14.0	—	1.8
Jamaica	—	—	—	—	—	—	—	—	1	32.0	—	—	1	32.6	—	3.0
Martinique	—	—	—	—	—	—	—	—	—	—	—	—	1	10.4	—	2.5
Mexico	8	243.5	32.0	—	8	357.0	87.0	—	6	494.5	102.0	56.6	6	760.0	109.0	35.3
Aruba and Curaçao	2	640.0	393.0	44.0	2	680.0	478.0	20.0	2	840.0	510.0	23.0	2	900.0	35.0	15.0
Nicaragua	—	—	—	—	—	—	—	—	1	21.8	—	—	1	13.2	—	2.6
Panama	—	—	—	—	—	—	—	—	1	78.0	23.5	8.0	1	100.0	—	7.5
Paraguay	—	—	—	—	—	—	—	—	1	5.0	—	—	1	5.0	—	—
Peru	3	47.5	15.2	—	3	49.2	20.8	—	4	91.5	25.0	1.2	5	129.6	26.0	1.8
Puerto Rico	—	—	—	—	2	83.7	82.4	7.5	2	155.0	70.5	13.5	3	283.8	47.8	75.5
Trinidad and Tobago	3	115.0	35.0	15.0	3	182.0	53.0	8.5	3	430.0	26.5	32.0	2	461.0	26.5	27.0
Uruguay	1	28.0	2.0	7.0	1	28.0	2.0	—	1	40.0	5.0	3.0	1	43.0	4.0	3.0
Venezuela	14	528.3	85.5	—	14	826.0	118.5	19.8	12	1 313.4	215.9	22.3	12	1 531.7	46.6	20.6
Total	69	1 974.1	689.9	100.8	73	2 842.3	1 090.2	74.0	82	4 881.5	1 426.0	262.1	91	7 068.5	668.5	310.3
World <sup>a</sup>	597	15 186.6	4 030.4	3 513.4	595	20 915.7	9 329.1	3 264.0	704	41 842.0	10 242.0	6 144.6	720	56 232.0	6 933.2	7 127.9
Total Latin America <sup>b</sup>	50	1 087.3	176.4	41.8	52	1 010.6	358.3	18.2	63	2 143.1	603.1	171.3	71	3 392.0	512.6	172.2

Source: *Oil and Gas Journal*, December 1953, 1954, 1969 and 1974.<sup>a</sup>Excluding countries with centrally planned economies; <sup>b</sup>Excluding Aruba and Curaçao, Bahamas, Puerto Rico, Trinidad and Tobago and Venezuela.

Refining operations in Latin America are of two main types: first, the typical case of the refining system oriented to the domestic market; and second, the relatively large, export-oriented refinery systems which transform crude oil into fuel oil and other refined products for export, largely to the markets of North and South America and Western Europe.

In Venezuela the export-oriented refineries operate on indigenous crude oil, but in Trinidad and Tobago they are heavily dependent on imported crude oil. In 1975, indigenous crude oil constituted only about one-half of Trinidad and Tobago's total crude requirements, the remainder being supplied largely from the Middle East (65 per cent) and Indonesia (32 per cent).<sup>32</sup>

The other export-oriented refineries located in the Caribbean run exclusively on imported crude oil. In 1975, crude oil imports into Aruba and Curaçao, for example, came largely from Venezuela (70 per cent) and to a lesser extent from the Middle East (11 per cent) and North Africa (12 per cent). In Puerto Rico, the major suppliers of imported crude oil in 1975 were the Middle East (60 per cent) and Venezuela (35 per cent). Export refinery operations in the Bahamas in 1975 were heavily dependent on crude oil imported from Africa (51 per cent) and from the Middle East (40 per cent).<sup>33</sup>

Map 2 shows the location in Latin America of petroleum fields, refineries, tanker-receiving ports, pipelines, rivers with river- and ocean-going traffic, and major concentrations of population. The bulk of the refining capacity in Central and South America is located in or near large coastal cities. This spatial pattern of refinery location chiefly reflects two facts: first, the bulk of this capacity runs on imported crude oil; and second the large coastal cities, where these refineries are located, also constitute the major domestic markets for refined oil products.

Concentrations of population and industrial activity outside these major port cities are typically too small to merit the installation of crude oil pipelines from coastal crude oil receiving terminals to the inland refineries that would have to be built to service these small inland markets. Generally, they are supplied by moving refined oil products from seaboard refineries by truck, train, barge and product pipelines, while the other quantitatively minor coastal markets are supplied by some combination of moving refined products by sea from the large coastal refineries. Refined products pipelines do not abound in the region, and the relatively minor mileage of such pipelines is concentrated in Argentina, Bolivia, Chile, Colombia and Mexico.

There are, however, exceptions to the general spatial pattern of refinery concentration in/or near major coastal cities. The several thousand miles of crude oil trunk pipelines of this kind are located largely in Argentina, Bolivia, Brazil, Colombia, Mexico and Venezuela, where there are relatively large markets for a diversity of refined oil products (e.g., Mexico City). The bulk of the crude oil pipeline capacity in the region, however, has been installed to move crude oil from producing areas to the coast for direct export or local refining for the domestic and/or the export market.

(v) *Latin America's international oil trade.* This section briefly deals with two topics: first, the scale, country composition, and geographic destination of Latin America's exports of crude oil and refined oil products; and second, the scale and geographic source of crude oil imports into Latin America's oil-deficit countries.

The figures in table 21 underscore the continuing importance of Venezuela in regional exports of both crude and refined oil products. In 1950, Venezuela accounted for 90 per cent of crude oil exports and 20 per cent of refined oil exports from Latin America. The comparable shares in 1975 were 77 per cent and 43 per cent, respectively. The increasing percentage share of Venezuela in the export of refined products during this period was won largely at the expense of Aruba and Curaçao, whose share correspondingly declined from 76 per cent in 1950 to 34 per cent in 1975. Moreover, the share of refined oil products in the mix of Venezuela's total oil exports has increased from 13 per cent in 1950 to 29 per cent in 1975. In this regard, Venezuela, which is a relatively high-cost crude oil supplier (compared with many Middle Eastern and

<sup>32</sup> United Nations, *World Energy Supplies, 1971-1975, Series J. No 20, 1977, p. 76.*

<sup>33</sup> *Ibid*, pp. 74-77.

Table 20  
LATIN AMERICA: NUMBER AND CAPACITY OF REFINERIES BY COUNTRY, 1957 AND 1976  
(Thousands of barrels per day)

On 1 January 1976																							
On 1 January 1957																							
Num- ber a	Capac- ity ber a	0-15	Num- ber a	Capac- ity ber a	31-50	Num- ber a	51-100	Num- ber a	Capac- ity ber a	0-15	Num- ber a	Capac- ity ber a	16-30	Num- ber a	31-50	Capac- ity ber a	51-100	Num- ber a	Capac- ity ber a	101 and over	Total capac- ity		
11	38 300	3	64 000	-	-	1	95 000	-	-	15	197 300	6	33 401	2	45 304	1	33 335	1	92 000	3	479 803	13	683 843
4	11 710	-	-	-	-	-	-	-	-	4	11 710	4	12 575	1	21 100	-	-	-	-	-	5	33 675	
6	28 800	1	20 000	-	-	1	65 000	-	-	8	113 800	3	28 900	-	-	1	33 600	3	215 700	3	708 100	10	986 300
-	-	1	20 000	-	-	-	-	-	-	1	20 000	1	13 000	-	-	-	-	2	136 200	-	-	3	149 200
3	7 700	1	26 500	1	36 500	-	-	-	-	5	70 700	4	11 500	-	-	1	50 000	-	-	1	110 000	6	171 500
2	5 625	-	-	-	-	-	-	-	-	2	5 625	2	9 000	-	-	1	34 900	-	-	-	-	3	43 900
-	-	-	-	-	-	-	-	-	-	-	-	1	5 000	-	-	-	-	-	-	-	1	5 000	
2	2 200	-	-	1	47 000	-	-	-	-	3	49 200	3	12 700	-	-	1	37 000	1	80 000	-	-	5	129 700
-	-	1	28 000	-	-	-	-	-	-	1	28 000	-	-	-	-	1	45 900	-	-	-	-	1	45 900
5	14 800	1	20 000	2	80 000	2	126 000	2	515 000	12	755 800	3	20 600	1	30 000	2	72 000	2	131 500	4	1 196 715	12	1 450 815
33	109 135	6	178 500	4	163 500	4	286 000	2	515 000	51	1 252 135	27	146 676	4	96 404	8	306 735	9	655 400	11	2 494 618	59	3 699 833
-	-	-	-	-	-	-	-	-	-	-	-	1	8 000	-	-	-	-	-	-	-	-	1	8 000
-	-	-	-	-	-	-	-	-	-	-	-	2	25 000	-	-	-	-	-	-	-	-	1	15 700
-	-	-	-	-	-	-	-	-	-	-	-	2	25 000	-	-	-	-	-	-	-	-	2	25 000
-	-	-	-	-	-	-	-	-	-	-	-	1	14 000	-	-	-	-	-	-	-	-	1	14 000
-	-	-	-	-	-	-	-	-	-	-	-	1	13 200	-	-	-	-	-	-	-	-	1	13 200
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	100 000
2	24 000	-	-	2	80 000	3	240 000	1	100 000	8	444 000	-	-	2	47 500	-	-	1	100 000	-	-	7	760 000
Total Central America and Mexico																							
2	24 000	-	-	2	80 000	3	240 000	1	100 000	8	444 000	5	60 200	3	63 200	-	-	2	200 000	4	612 500	14	935 900
-	-	-	-	-	-	-	-	2	650 000	2	650 000	-	-	-	-	-	-	-	-	2	849 000	2	849 000
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	500 000	1	500 000
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	728 000	1	728 000
1	13 500	-	-	-	-	1	58 800	-	-	2	72 300	-	-	-	-	1	37 800	1	85 000	1	161 000	3	283 800
1	4 000	-	-	1	37 000	-	-	1	100 000	3	141 000	-	-	-	-	-	-	1	100 000	1	361 000	2	461 000
Total West Indies																							
2	17 500	-	-	1	37 000	1	58 800	3	750 000	7	863 300	-	-	-	-	1	37 800	2	185 000	6	2 599 000	9	2 821 800
-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	16 000	-	-	-	-	-	1	16 000	
-	-	-	-	-	-	-	-	-	-	-	-	1	3 000	-	-	-	-	-	-	-	1	3 000	
2	2 200	2	47 000	1	35 000	-	-	-	-	5	84 200	1	4 970	-	-	1	42 000	1	75 000	-	-	3	121 970
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	32 600	-	-	-	1	32 600	
-	-	-	-	-	-	-	-	-	-	-	-	1	10 400	-	-	-	-	-	-	-	1	10 400	
-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	48 000	-	-	-	-	-	2	48 000	
Total West Indies importers																							
2	2 200	2	47 000	1	35 000	-	-	-	-	5	84 200	3	18 370	3	64 000	2	74 600	1	75 000	-	-	9	231 970
39	152 835	10	225 500	8	315 500	8	584 800	6	1 365 000	71	2 643 635	35	225 246	10	223 604	11	419 135	14	1 114 400	21	5 706 118	91	7 689 503

Source: Oil and Gas Journal.  
aNumber of refineries.



Sources: International Petroleum Encyclopedia, 1976; CEPAL.

Note: The fact that this map shows specific boundaries does not mean that they are sanctioned or accepted by the United Nations.

African countries), has been concentrating increasingly on the export of refined products (largely fuel oil) to the North American and Latin American markets in contrast with its earlier and relatively more pronounced specialization in the world crude oil market.

The data in table 21 show the decline that took place in the fifties and sixties in crude oil exports from Aruba and Curaçao, Peru and Mexico, while at the same time they demonstrate the rapid growth in the volume of such exports from Bolivia, Ecuador, and Mexico in the seventies. In 1975 these latter three countries, together with Venezuela, accounted for 90 per cent of Latin America's crude oil exports.

A similar pattern of concentration in a few countries is evident in the case of exports of refined oil products. In 1975, three countries accounted for over nine-tenths of these exports: Aruba and Curaçao (34 per cent), Venezuela (43 per cent), and Trinidad and Tobago (14 per cent).<sup>34</sup>

Table 22 presents data on the destination of Venezuela's exports of crude oil and fuel oil. The figures on the volume of crude oil exports show Venezuela's heavy reliance on sales to the export refinery operations at Aruba and Curaçao and to the United States and Canada. In 1975 these three markets accounted for seven-tenths of Venezuela's crude oil exports, while in combination with sales to Latin America and Western Europe they accounted for all but 7 per cent of Venezuela's total volume of crude exports.

During the fifties and sixties, Venezuela's exports of crude oil to Aruba and Curaçao stagnated. This was largely the result of a corresponding stagnation in refined product exports from Aruba and Curaçao caused, in turn, by the worldwide shift at that time to domestic refining operations. Increased competition from other large-scale export-oriented refineries, including of course those in Venezuela itself, also contributed to this pattern (see table 21). These forces, together with the depressing influence of higher prices on refined product consumption throughout the world since 1973, largely account for the fact that Venezuela's exports of crude oil to Aruba and Curaçao in 1975 were only one-half the level recorded in 1950.

The steadily declining costs of moving oil internationally have made Middle Eastern and African oils increasingly competitive with Venezuelan oils in major world markets in the post-war era. Moreover, the imposition of mandatory oil import controls by the United States Government in 1959 was a major factor in limiting Venezuela's subsequent penetration of this market for crude oil and promoting its strategic concentration on the export of fuel oil to the United States.

Fuel oil accounted for seven-tenths of Venezuela's total exports of refined products in both 1950 and 1975. Exports of fuel oil from Venezuela are heavily concentrated in the United States market and, more specifically, in the market for boiler fuels in the eastern United States. In 1974, for example, about seven-tenths of Venezuela's fuel oil exports went to this market, but the strong decline in fuel oil imports by the United States from Venezuela reduced this share to 53 per cent in 1975.

Venezuela's Latin American and European fuel oil markets have been eroded since the fifties due to the expansion of domestic refining facilities in these markets (drawing largely on Middle Eastern and African crude oils) and the competition of other export refineries in/or oriented towards Europe. New markets for Venezuelan fuel oil have been created since the fifties in Aruba and Curaçao, in Puerto Rico, and in the expanding ships' bunker market in Panama. Up to 1974, however, growth in fuel oil sales to these three expanding markets had only roughly offset Venezuela's losses in its Latin American, European and other traditional fuel oil markets, with the result that net growth in its fuel oil exports from the fifties to 1974 was largely due to growth in the volume of such exports to the United States. With the strong decline in imports by all of Venezuela's key customers in 1975 (except Aruba and Curaçao), the volume of fuel oil exports in that year was reduced to what it had been about fifteen years earlier. For the most part, this decline was the result of the corresponding fall in United States fuel oil imports,

<sup>34</sup>The figures in table 21 exclude exports of refined oil products from the Bahamas and Puerto Rico and to this extent overstate the dominance of Venezuela, Aruba and Curaçao, and Trinidad and Tobago in this market.

Table 21  
LATIN AMERICA: EXPORTS OF CRUDE OIL AND REFINED OIL PRODUCTS BY COUNTRY, 1950-1975<sup>a</sup> (SELECTED YEARS)  
(Thousands of m<sup>3</sup>)

	1950		1960		1970		1973		1974		1975	
	Crude oil	Petroleum derivatives	Crude oil	Petroleum derivatives	Crude oil	Petroleum derivatives	Crude oil	Petroleum derivatives	Crude oil	Petroleum derivatives	Crude oil	Petroleum derivatives
Argentina	—	—	—	—	36	152	32	69	81	58	18	48
Aruba and Curaçao <sup>b</sup>	944	40 445	283	37 899	206	46 374	568	46 993	697	39 729	459	27 971
Bolivia	9	3	247	7	741	—	1 883	—	1 717	—	1 317	—
Brazil	—	—	733	66	80	—	998	2 826	773	2 411	1 257	2 089
Colombia	4 495	—	4 991	644	5 311	1 686	1 494	1 677	76	1 632	—	1 382
Ecuador	149	—	—	—	33	6	11 324	—	9 418	—	8 311	—
Mexico	1 864	1 034	1 66	1 192	—	171	—	839	922	916	5 466	408
Panama	—	—	—	—	—	1 048	—	670	—	2 675	—	2 964
Peru	445	706	446	536	350	2	196	504	200 <sup>d</sup>	428	236	358
Trinidad and Tobago	...	...	806	11 824	2 876	21 260	5 323	18 560	7 548	17 728	8 718	11 251
Venezuela <sup>c</sup>	71 931	10 688	116 214	40 028	141 292	60 065	123 240	59 580	102 623	57 085	85 438	35 632
<i>Total</i>	79 837	52 876	123 886	92 196	150 925	130 764	145 058	131 718	124 055	122 722	111 220	82 103

Source: CEPAL, on the basis of official data.

<sup>a</sup>Includes liquefied gas, gasoline, kerosene, jet fuel, gas oil/diesel oil and fuel oil.

<sup>b</sup>Aruba and Curaçao do not produce crude oil. Therefore, the figures for crude represent re-exports.

<sup>c</sup>Exports include both petroleum fuels and non-fuels and exclude fuel for ships.

<sup>d</sup>Estimate.

Table 22  
**VENEZUELA: EXPORTS OF CRUDE OIL AND FUEL OIL BY IMPORTING  
 COUNTRIES AND REGIONS, 1950-1975 (SELECTED YEARS)**  
*(Thousands of m<sup>3</sup>)*

	1950	1960	1970	1973	1974	1975
<b>A. Crude oil</b>						
United States	16 615	28 255	24 099	28 924	21 716	23 589
Canada	4 846	11 658	19 083	17 380	19 358	14 844
Puerto Rico	—	4 192	7 164	10 534	5 114	5 583
Latin America <sup>a</sup>	3 246	14 981	21 702	17 834	14 039	10 455
Aruba and Curaçao	43 560	40 886	44 975	34 007	31 048	21 416
Europe	3 538	15 785	23 508	13 889	10 898	9 288
Other countries	126	466	751	672	450	263
<i>Total</i>	<i>71 931</i>	<i>116 223</i>	<i>141 282</i>	<i>123 240</i>	<i>102 623</i>	<i>85 438</i>
<b>B. Fuel oil</b>						
United States	3 850	18 514	34 323	34 615	30 708	13 486
Canada	314	684	2 405	2 059	1 760	814
Puerto Rico	21	60	34	228	788	71
Panama Canal Zone	—	—	947	1 334	878	825
Latin America <sup>b</sup>	1 101	2 752	2 518	1 865	2 546	2 365
Aruba and Curaçao	1 812	1 467	1 262	5 214	4 889	6 212
Europe	312	4 046	1 440	2 023	1 968	1 387
Other countries	68	431	342	47	212	92
<i>Total</i>	<i>7 478</i>	<i>27 954</i>	<i>43 272</i>	<i>47 385</i>	<i>43 749</i>	<i>25 252</i>

*Source:* Ministerio de Minas e Hidrocarburos de Venezuela, *Petróleo y Otros Datos Estadísticos*, October 1966 and October 1976.

*Note:* The fuel oil figures for 1950, 1955 and 1960 were supplied directly by the Venezuelan Ministry of Mines and Hydrocarbons.

<sup>a</sup>Excluding Puerto Rico, and Aruba and Curaçao.

<sup>b</sup>Excluding Puerto Rico, the Panama Canal Zone, and Aruba and Curaçao.

compounded by the relative displacement of Venezuelan fuel oils by exports from refineries in the Caribbean islands, particularly the Netherlands Antilles and from the Amerada Hess refinery in the Virgin Islands.

The increased prices Venezuela has received for its exports of crude oil and refined oil products since 1973, however, have more than compensated for reduced sales volumes since that time. Thus, between 1973-1975 the volume of those exports declined by 31 per cent and 40 per cent, respectively, while their value increased from 4.5 billion dollars to 9.9 billion dollars (see tables 21 and 23).

Crude oil imports by Latin American countries increased by about 10 per cent per annum between 1955 and 1970 (see table 24). During this period, almost every oil-deficit Latin American country sharply reduced its dependence on crude oil supplied from within the region,

so that the share of regional supplies in Latin America's total crude oil imports declined from 69 per cent in 1955 to 42 per cent in 1970. Since 1970, the decline in dependence on crude imports from within the region has been particularly marked. By 1975, 85 per cent of the crude oil imported by Latin America's oil-deficit countries came from outside the region, mostly from the Middle East (51 per cent) and Africa (12 per cent). In 1975, reliance on regional crude oil supplies stood at a mere one per cent and 12 per cent in the case of Trinidad and Tobago and Uruguay, respectively, and at only 2 per cent in Brazil, Latin America's major crude oil importer. The ratios were still relatively high in 1975 in the case of Chile (39 per cent) and Argentina (34 per cent).

(vi) *Latin America's consumption of refined oil products.* The bulk of Latin America's consumption of refined oil products is accounted for by a few countries. Eight of the twenty-four countries listed in table 25 accounted for nine-tenths of regional consumption of these products in 1975: Brazil (27 per cent), Mexico (23 per cent), Argentina (15 per cent), Venezuela (7 per cent), Colombia and Cuba (5 per cent each), Peru (4 per cent), and Chile (3 per cent). Although the consumption of refined oil products in the remaining sixteen countries has grown rapidly since the fifties, they still constitute small oil markets. On average, consumption in this group was roughly 18 thousand barrels per day in 1975, and in many of them the level of average daily oil consumption was substantially below even this relatively low figure.

Table 23  
VENEZUELA: VALUE OF PETROLEUM EXPORTS, 1950-1975<sup>a</sup>  
(SELECTED YEARS)  
(Millions of dollars)

Year	Value		Year	Value	
	Not adjusted for freight costs	Adjusted for freight costs <sup>b</sup>		Not adjusted for freight cost	Adjusted for freight cost <sup>b</sup>
1950	...	—	1966	2 221	—
1955	1 791	—	1967	2 333	—
1960	2 175	—	1968	2 425	—
1961	2 276	—	1969	2 449	—
1962	2 370	—	1970	2 496	—
1963	2 300	—	1971	2 912	3 127
1964	2 341	—	1972	2 924	3 509
1965	2 305	—	1973	4 463	5 294
			1974	10 520	14 669
			1975	9 890	10 635

Source: Ministerio de Minas e Hidrocarburos de Venezuela, *Petróleo y Otros Datos Estadísticos*, October 1966 and October 1976.

<sup>a</sup>1955-1966: at actual prices.

1967-1970: at reference prices.

1971-1975: at export prices. The values not adjusted for freight costs in those years were taken from *International Financial Statistics*, April 1976, to which were applied the rates of exchange mentioned on page 146 of *Petróleo y Otros Datos Estadísticos*, 1975, of the Ministry of Mines and Hydrocarbons of Venezuela.

<sup>b</sup>From 1971 onwards, an amount additional to the value of exports of crude oil and petroleum derivative hydrocarbons was established according to geographical position, in terms of freight rates, and will be calculated quarterly at a rate of 0.01605 bolívars per cubic metre for every tenth of a percentage point in the Worldscale tariff.



The growth rate of Latin America's consumption of refined oil products declined from 7.7 per cent during 1950-1960 to 5.8 per cent during 1960-1970. This decline was observed in 18 of the 24 countries listed in table 26.<sup>35</sup> The reasons are diverse, but —generalizing for the region as a whole— the major forces at work were probably a deceleration in the pace of growth in the relatively energy-intensive industries and in the mechanization of work processes between the fifties and sixties, together with a speeding-up of the substitution of natural gas for fuel oil. At the regional level, the forces promoting the deceleration in refined product consumption seem to have offset the effects of the acceleration in the rate of growth of Latin America's total real output and the more-or-less steady rate of growth in regional population between 1950 and 1970.<sup>36</sup>

The average rate of growth of regional consumption of refined products during 1970-1973 was 7.4 per cent (see table 25), the increase in world oil prices in those years providing no significant brake on Latin America's oil consumption. During 1973-1974, the period of sharpest increase in world oil prices, however, a sharp fall occurred in the growth rate of refined product consumption in Latin America, and thus growth was limited to 4.1 per cent despite a 6.9 per cent increase in real regional output<sup>37</sup> (as against 6.8 per cent during 1970-1973).<sup>38</sup> During 1974-1975, the slowing-down of the growth rate for refined product consumption was further intensified: growth was limited to 0.9 per cent, despite an increase in real regional output of 2.6 per cent. Significantly, the absolute level of consumption in the group of 18 oil-deficit countries noted in table 25 declined during this period, with the growth rate falling from 1.9 per cent (1973-1974) to -1.1 per cent (1974-1975). Four of the eighteen countries in this group had lower levels of consumption of refined products in 1975 than in 1970.

To sum up, the figures in table 25 suggest that the sharply increased world oil prices in the seventies, and particularly since 1973, eventually acted as a brake on the growth rate of consumption of refined oil products in almost all Latin American countries, although country-by-country examination shows that the extent and timing of the braking effect varied widely among them. It was particularly pronounced during 1974-1975 in the region's oil-deficit countries. In many countries, of course, it was compounded by a slowing of the growth rate of total real output, particularly during 1974-1975: a phenomenon which in turn was casually linked, in part, to the increased price of world oil in the first place.

The changes recorded in the structure of consumption of refined oil products in Latin America during 1950-1974 are detailed in table 26. Basically, there were two major kinds of change:

First, since 1950 gasoline and diesel oil, the region's key transport (and stationary engine) fuels, have been displacing fuel oil, the region's prime boiler fuel. The combined share of gasoline and diesel oil in total refined product consumption increased from about two-fifths in 1950 to one-half in 1975. These two products accounted for 57 per cent (31 per cent and 26 per cent, respectively) of the total increase in consumption of refined oil products recorded in Latin America during 1950-1975.

By way of comparison, the share of fuel oil in the volume of refined product consumption in the region declined from 50 per cent in 1950 to 31 per cent by 1975. Taken as a whole, the increasing share of gasoline and diesel oil reflects the fact that the mechanization and growth of

<sup>35</sup> In Brazil and Chile, the rates of growth were approximately equal in the periods 1950-1960 and 1960-1970. In the remaining four countries, i.e., Costa Rica, El Salvador, Barbados and Trinidad and Tobago there was an acceleration in the growth rate of refined product consumption. These four countries are of only minor quantitative importance in defining trends in regional oil consumption, however, and together accounted for only about 2 per cent of the volume of regional oil product consumption in 1970.

<sup>36</sup> The growth rate of total real output accelerated from 5.1 per cent during 1950-1960 to 5.6 per cent per annum during 1960-1970. Population growth averaged 2.8 per cent in both periods.

<sup>37</sup> CEPAL, "La Economía Latinoamericana en 1976 (I)", *Notas sobre la economía y el desarrollo de América Latina*, N° 250, August, 1977, p. 1.

<sup>38</sup> CEPAL, Statistical Division (unpublished data).

Table 24  
LATIN AMERICA: IMPORTS OF CRUDE OIL BY EXPORTING COUNTRIES AND REGION, 1955-1975 (SELECTED YEARS)  
(Thousands of m<sup>3</sup>)

Area of origin		Latin America			Middle East	Africa	USSR	Indonesia	Others	Total	Latin America as a percentage of the total
		Venezuela	Other	Total							
Importing country											
Argentina		2 398	277	2 675	1 755	39	110	—	42	4 621	57.9
1955		2 398	277	2 675	1 755	39	110	—	42	4 621	57.9
1960		3 317	269	3 586	99	—	—	—	—	3 685	97.3
1970		386	616	1 002	628	22	—	—	32	1 684	59.5
1975		71	789	850	—	1 645	—	—	—	2 495	34.1
Brazil		2 158	—	2 158	1 965	—	—	—	—	4 123	62.3
1955		2 158	—	2 158	1 965	—	—	—	—	4 123	62.3
1960		3 513	72	3 585	3 084	—	35	—	—	6 704	53.6
1970		2 634	56	2 690	11 466	4 519	—	—	—	18 675	14.4
1975		671	263	934	32 100	3 719	154	—	14 897	51 804	1.8
Chile		380	—	380	—	—	—	—	—	380	100.0
1955		380	—	380	—	—	—	—	—	380	100.0
1960		585	3	588	—	—	—	—	—	588	100.0
1970		555	860	1 415	971	—	—	—	—	2 386	59.3
1975		418	821	1 239	1 668	239	—	—	—	3 146	39.4
Trinidad and Tobago		2 622	—	2 622	—	—	—	—	389	3 011	87.1
1955		2 622	—	2 622	—	—	—	—	389	3 011	87.1
1960		4 362	413	4 775	1 484	52	—	84	—	6 395	74.7
1970		8 255	190	8 445	3 483	4 690	—	831	529	17 978	46.9
1975		63	11	74	5 984	69	—	2 898	—	9 025	0.8
Uruguay		1 004	364	1 368	—	—	—	—	—	1 368	100.0
1955		1 004	364	1 368	—	—	—	—	—	1 368	100.0
1960		1 361	—	1 361	115	—	24	—	—	1 500	90.7
1970		105	—	105	1 177	647	—	—	—	1 929	5.4
1975		226	28	254	1 700	145	—	—	—	2 099	12.1
Other countries <sup>a</sup>		516	—	516	—	—	—	—	—	516	100.0
1955		516	—	516	—	—	—	—	—	516	100.0
1960		4 060	—	4 060	—	—	—	—	—	4 060	100.0
1970		10 775	—	10 775	—	—	4 898	—	—	15 673	68.7
1975		10 347	3 952	14 299	16 387	9 938	6 663	2 044	144	49 475	28.9
Total		9 078	641	9 719	3 720	39	110	—	431	14 019	69.3
1955		9 078	641	9 719	3 720	39	110	—	431	14 019	69.3
1960		17 198	757	17 955	4 782	52	59	84	—	22 932	78.3
1970		22 710	1 722	24 432	17 725	9 878	4 898	831	561	58 325	41.9
1975		11 796	5 864	17 660	59 839	14 110	6 817	4 942	15 041	116 409	15.2

Source: CEPAL, on the basis of official data. <sup>a</sup>Bahamas, Costa Rica, Cuba, Ecuador, El Salvador, Guatemala, Honduras, Jamaica, Nicaragua, Panama, Peru and Dominican Republic.

Table 25  
**LATIN AMERICA: CONSUMPTION OF REFINED OIL PRODUCTS BY COUNTRY, 1950-1975<sup>a</sup>**  
**(SELECTED YEARS)**

(Thousands of tons of petroleum equivalent of 10 700 kcal/kg)

	1950	1960	1970	1973	1974	1975 <sup>b</sup>
Argentina	7 307	12 628	20 136	21 708	21 057	19 846
Barbados	22	54	166	184	183	168
Bolivia	122	278	508	617	697	817
Brazil	4 316	12 376	23 413	33 416	35 592	35 827
Colombia	931	2 786	4 997	6 165	6 536	6 596
Costa Rica	97	188	441	565	524	586
Cuba	1 716	4 084	5 850	6 875	6 905	6 995
Chile	1 134	2 237	4 424	4 904	4 868	3 992
Ecuador	230	530	1 186	1 398	1 614	1 989
El Salvador	93	198	443	593	556	622
Guatemala	246	464	710	949	900	906
Guyana	85	215	515	577	476	628
Haiti	34	85	94	84	81	79
Honduras	34	186	390	447	407	410
Jamaica	75	444	1 608	1 842	1 875	1 885
Mexico	7 337	12 855	21 702	27 290	30 054	30 968
Nicaragua	68	213	447	592	567	666
Panama	153	349	669	1 030	1 099	1 111
Paraguay	11	103	192	277	261	229
Peru	1 097	2 300	4 584	5 070	5 354	5 645
Dominican Republic	101	311	839	1 182	1 272	1 385
Trinidad and Tobago <sup>c</sup>	178	291	1 571	1 590	1 464	1 317
Uruguay	734	1 210	1 548	1 646	1 550	1 592
Venezuela <sup>c</sup>	1 700	3 906	6 229	8 185	8 458	9 286
<i>Total</i>	<i>27 821</i>	<i>58 291</i>	<i>102 662</i>	<i>127 186</i>	<i>132 350</i>	<i>133 545</i>

Source: CEPAL, on the basis of official data; for Guyana, Barbados, Cuba, Jamaica, Haiti, Dominican Republic and Trinidad and Tobago: United Nations, *World Energy Supplies*.

<sup>a</sup>Including liquefied gas, gasoline, kerosene, jet fuel, gas oil/diesel oil and fuel oil.

<sup>b</sup>Preliminary figures.

<sup>c</sup>Does not include bunkering of ships.

The figures presented above exclude energy sources used in non-energy applications such as petrochemical feedstocks.

transportation activities were proceeding at higher rates during 1950-1975 than the growth of consumption of fuel oil, which was already widely in use as early as 1950 as a boiler fuel in industry and power plants. It should be noted, however, that this pattern of change has taken place within the context of rapidly increasing volumes of consumption of fuel oil, gasoline, and diesel oil since the fifties.

Second, the share of these three leading oil products in Latin America's total refined product consumption has declined since the fifties from 91 per cent in 1950 to 84 per cent in 1975. This broadening of the base of refined oil products consumed in the region is due to the growth in the use of liquified petroleum gas, principally as a household fuel, from 1 per cent of total oil products consumed in the region in 1950 to 8 per cent in 1975. In contrast, kerosene, although increasing rapidly in terms of volumes consumed during this period, recorded the same market share of consumption in 1975 as it did in 1950 (8 per cent).

(vii) *Ownership and control of Latin America's oil industries.* Table 27 presents data on the extent of public ownership of various segments of the oil and gas industries in eleven Latin American countries until 1977. In 1975, those eleven countries accounted for about 95 per cent of Latin America's oil production; 92 per cent of crude oil exports; about one-half of both refined products exports and regional crude oil refining capacity; and 93 per cent of the volume of refined oil products consumed in Latin America.

The figures in table 27 underscore the widespread, high, and generally increasing level of public ownership of Latin America's oil industry. When account is taken of the fact that throughout Latin America central governments also play critical roles in the pricing, transport, importing and exporting of oil and in the investment decisions of the oil industry, it is readily apparent that the Latin American oil and gas industries are tightly controlled by governments throughout the region, even though they may not be owned by the government in a specific country.

Table 28 presents more detailed data on the structure of refinery ownership in Latin America. The eight major integrated world oil companies accounted for about 64 per cent of Latin America's refining capacity in 1957, but only 21 per cent in 1976, this sharp decline being due largely to the nationalization of the Venezuelan oil industry on 1 January 1976.

In 1957, over nine-tenths of the ownership by the major oil companies was concentrated in refining facilities in Venezuela, Aruba, Curaçao and Trinidad and Tobago. In 1976, however, full foreign ownership by one or more of the eight major companies was restricted to the export refineries at Trinidad and Tobago and at Aruba and Curaçao, and to a few small, domestically-oriented refineries in Central America and the Caribbean. Partial ownership by one or more of the eight major companies in 1976 was restricted to Argentina (32 per cent), Colombia (5 per cent), Ecuador (21 per cent), El Salvador (82 per cent), and Puerto Rico (13 per cent).

The nationalization of the Venezuelan oil industry in 1976 calls for comment at this point. Nationalization extended to all assets of the foreign oil companies in Venezuela, and compensation was calculated on the basis of the net book value of each company's assets. Altogether, the foreign companies received 1.28 billion dollars for these assets.<sup>39</sup> A Venezuelan commission was set up, and arrangements were made between each foreign oil company and the counterpart Venezuelan company created to deal with such arrangements. Under official policy, direct participation by foreign oil companies in the Venezuelan oil industry was rejected in favour of operating contracts negotiated on a company-by-company basis. According to this approach, the foreign oil company is paid a fee in return for specified services such as producing and refining crude oil. Obviously, however, the resulting net acquisition cost of Venezuelan oil to the companies must be sufficiently competitive to induce them to continue purchasing Venezuelan oil, since these companies also have access to oil elsewhere.

### (c) *Natural gas*

In Latin America, indigenous production of natural gas is limited to ten countries (see table 29), most of the reserves being located in four countries which in 1975 accounted for 84

<sup>39</sup> *International Petroleum Encyclopedia*, 1976, (The Petroleum Publishing Co., 1976), p. 194.



Table 26

LATIN AMERICA: CONSUMPTION OF SPECIFIC REFINED OIL PRODUCTS BY COUNTRIES, 1950, 1970, 1974 AND 1975  
(Thousands of m<sup>3</sup>)

	1950						1970						1974						1975					
	Lique- fied gas	Gasoline	Kerosene	Diesel oil/ gas oil	Fuel oil	Total	Lique- fied gas	Gasoline	Kerosene	Diesel oil/ gas oil	Fuel oil	Total	Lique- fied gas	Gasoline	Kerosene	Diesel oil/ gas oil	Fuel oil	Total	Lique- fied gas	Gasoline	Kerosene	Diesel oil/ gas oil	Fuel oil	Total
Argentina	48	2 138	724	856	4 642	8 408	1 687	5 421	1 304	6 060	9 177	23 649	1 700*	6 161	1 462	6 522	9 064	24 909	1 692	5 249	1 535	7 786	8 106	24 368
Bolivia	—	67	11	28	40	146	9	287	135	95	101	627	51	382	217	173	144	967	56	412	255	191	154	1 068
Brazil	29	2 281	321	676	1 820	5 127	2 392	9 807	1 388	6 515	8 116	28 218	3 127	14 737	2 132	10 219	12 187	42 402	3 243	14 724	2 157	11 609	11 437	43 170
Colombia	6	520	69	102	410	1 107	360	2 739	737	844	1 444	6 124	464	3 658	862	1 121	1 861	7 966	475	3 662	917	1 129	1 857	8 040
Chile	—	344	54	116	782	1 296	549	1 697	580	862	1 663	5 351	788	1 507	648	1 040	1 912	5 895	738	1 134	522	987	1 476	4 857
Ecuador	—	101	20	32	121	274	11	535	171	278	416	1 411	33	764	98	451	525*	1 871	50	919	299	510	602	2 380
Guyana	—	12	6	a	75	93	9	58	33	a	466	566	9	55	16	a	442	522	9	66	41	193	381	690
Paraguay	—	10	1	—	2	13	5	75	27	90	34	231	3*	76	30	161	40	310	9	76	26	128	36	275
Peru	3	405	143	125	599	1 275	100	1 654	890	1 091	1 710	5 445	185	2 230	1 101	1 262	1 876	6 654	196	2 126	1 160	1 308	1 920	6 710
Uruguay	—	229	132	57	39	457	57	345	220	382	791	1 795	67	279	228	416	802	1 792	66	278	229	450	907	1 930
Venezuela	...	861	271	453	1 315	2 900	376	4 104	681	1 312	1 005	7 478	825*	5 494	673	2 260	1 263	10 515	998	6 152	689	2 409	1 336	11 584
Mexico	172	2 199	707	650	4 725	8 453	3 620	8 840	2 575	5 521	6 135	26 691	4 668	11 393	2 862	7 849	9 890	36 662	4 570	11 682	2 930	9 167	11 291	39 640
Central America	—	204	31	123	268	626	93	774	289	957	663	2 776	119	927	307	1 221	977	3 551	100	872	272	1 317	1 015	3 576
Panama	—	47	17	27	85	176	33	232	111	157	252	785	54	322	160	250	537	1 323	65	356	132	279	479	1 311
Barbados	—	11	7	a	8	26	5	64	55	a	75	189	9	84	26	a	101	220	14	77	23	a	89	203
Cuba	16	495	73	a	1 357	1 941	100	1 069	518	a	4 852	6 539	123	1 324	560	a	5 720	7 727	132	1 324	567	a	5 805	7 828
Jamaica	—	57	14	a	23	94	32	453	112	a	1 213	1 810	73	285	229	a	1 500	2 087	74	373	172	a	1 480	2 099
Haiti	2	23	4	a	14	43	2	38	4	a	66	110	2	38	5	a	50	95	2	38	5	a	49	94
Dominican Republic	—	49	7	a	63	119	51	277	94	a	560	982	70	354	64	a	951	1 439	64	438	63	a	1 007	1 572
Trinidad and Tobago	—	66	18	a	120	204	25	446	1 176	a	288	1 935	26	452	972	a	344	1 794	23	293	957	a	328	1 601
<b>Total</b>	<b>276</b>	<b>10 119</b>	<b>2 630</b>	<b>3 245</b>	<b>16 508</b>	<b>32 778</b>	<b>9 516</b>	<b>38 915</b>	<b>11 100</b>	<b>24 164</b>	<b>39 027</b>	<b>122 722</b>	<b>12 396</b>	<b>50 522</b>	<b>12 652</b>	<b>32 945</b>	<b>50 186</b>	<b>158 701</b>	<b>12 576</b>	<b>50 251</b>	<b>12 951</b>	<b>37 463</b>	<b>49 755</b>	<b>162 996</b>

Source: CEPAL, on the basis of official data, and United Nations, *World Energy Supplies*. (Various issues).

\*Included in fuel oil.

The figures presented above exclude energy sources used in non-energy applications such as petrochemical feedstocks.





Table 27

## LATIN AMERICA: STATE PARTICIPATION IN THE OIL INDUSTRY BY COUNTRY, 1955, 1960, 1970, AND 1977

(Percentages)

Country	State enterprise	Production								Refining			Marketing		
		Petroleum				Natural gas							Petro- Natural leum gas		
		1955	1960	1970	1977	1955	1960	1970	1977	1955	1960	1970	1977	1972	1972
Argentina	Yacimientos Petrolíferos Fiscales (YPF)	84	95	99	99	...	95	100	100	66	57	61	62	67	100
Bolivia	Yacimientos Petrolíferos Fiscales Bolivianos (YPFB)	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Brazil	Petróleo Brasileiro (PETROBRAS)	100	100	100	100	100	100	100	100	63	73	89	98	...	...
Colombia	Empresa Colombiana del Petróleo (ECOPETROL)	29	18	17	17	29	29	45	...	...	48	56	95	15	10
Cuba	Empresa Consolidada del Petróleo	0	100	100	100	--	--	--	--	0	100	100	100	--	--
Chile	Empresa Nacional del Petróleo (ENAP)	100	100	100	100	100	100	100	100	100	100	100	100	25	100
Ecuador	Corporación Ecuatoriana del Petróleo (CEPE)	0	0	0	63 <sup>d</sup>	0	0	0	0	0	0	0	66 <sup>d</sup>	--	--
Mexico	Petróleo Mexicanos (PEMEX)	100	100	100	100	100	100	100	100	100	100	100	100	98	87 8 <sup>a</sup>
Peru	Empresa Petrolera Fiscal (E.P.F.) <sup>b</sup>	3	5	40	56	0	0	0	54	...	0	2	91	100	30 70
Uruguay	Administración Nacional de Combustibles Alcohol y Portland (ANCAP)	--	--	--	--	--	--	--	--	100	100	100	100	62	--
Venezuela	Corporación Venezolana del Petróleo (C.U.P.) <sup>c</sup>	0	0	1	100	0	0	0	1	100	0	0	2	100	23 71

Source: CEPAL, on the basis of official data and of *Oil and Gas Journal*, several issues. For marketing: Asociación de Asistencia Recíproca Petrolera Estatal Latinoamericana (ARPEL), *Datos Estadísticos de las Empresas Petroleras Estatales Latinoamericanas*, November 1973.

<sup>a</sup>Semi-public enterprises; <sup>b</sup>Now called Petróleos del Perú (PETROPERU); <sup>c</sup>The oil industry was nationalized in January 1976; <sup>d</sup>1978.

Table 28

**LATIN AMERICA AND WORLD: PARTICIPATION OF THE EIGHT MAJOR INTERNATIONAL OIL COMPANIES  
IN THE OIL REFINING INDUSTRY, BY COUNTRY, 1957, 1966 AND 1977**

(Thousands of barrels per day and percentages)

	1957			1966			1977			Refining capacity by enterprise in 1976					
	Refining capacity	Eight companies	Per-cent-age	Refining capacity	Eight companies	Per-cent-age	Refining capacity	Eight companies	Per-cent-age	ESSO	MOBIL	SHELL	SOCAL	TEXACO	GULF
Antigua	—	—	—	—	—	—	16.0	—	—	—	—	—	—	—	—
Argentina	197.3	55.3	28.0	435.5	159.0	36.5	703.1	224.0	31.9	109.0	—	115.0	—	—	—
Aruba and Curaçao	650.0	650.0	100.0	795.0	795.0	100.0	810.0	810.0	100.0	440.0	—	370.0	—	—	—
Bahamas	—	—	—	—	—	—	500.0	...	...	—	—	—	—	—	—
Barbados	—	—	—	3.0	3.0	100.0	3.0	3.0	100.0	—	3.0	—	—	—	—
Bolivia	11.7	—	—	14.5	—	—	37.1	—	—	—	—	—	—	—	—
Brazil	113.8	—	—	370.4	—	—	1 117.6	—	—	—	—	—	—	—	—
Colombia	70.7	29.7	42.0	129.3	53.3	41.2	165.0	8.5	5.2	—	—	—	—	—	—
Costa Rica	—	—	—	8.0	—	—	8.0	...	...	—	5.0	—	—	3.5	—
Cuba	84.2	82.0	97.4	...	—	—	122.0	—	—	—	—	—	—	—	—
Chile	20.0	—	—	91.0	—	—	139.5	—	—	—	—	—	—	—	—
Ecuador	5.6	—	—	11.5	1.5	13.0	40.9	8.6	21.0	—	—	—	—	1.0	7.6
El Salvador	—	—	—	13.5	12.8	94.8	15.7	12.8	81.5	8.1	—	4.7	—	—	—
Guatemala	—	—	—	20.5	20.5	100.0	14.9	...	...	—	—	—	—	—	—
Honduras	—	—	—	—	—	—	14.0	14.0	100.0	—	—	—	—	14.0	—
Virgin Islands	—	—	—	50.0	—	—	728.0	...	...	—	—	—	—	—	—
Jamaica	—	—	—	28.0	28.0	100.0	32.6	32.6	100.0	32.6	—	—	—	—	—
Martinique	—	—	—	—	—	—	10.4	...	...	—	—	—	—	—	—
Mexico	444.0	—	—	394.0	—	—	935.0	—	—	—	—	—	—	—	—
Nicaragua	—	—	—	5.6	5.6	100.0	14.9	14.9	100.0	14.9	—	—	—	—	—
Panama	—	—	—	55.0	—	—	100.0	...	...	—	—	—	—	—	—
Paraguay	—	—	—	5.0	—	—	5.0	...	...	—	—	—	—	—	—
Peru	49.2	47.0	95.5	63.6	59.5	93.6	115.9	—	—	—	—	—	—	—	—
Puerto Rico	72.3	6.5	8.9	155.0	40.0	25.8	283.8	37.8	13.3	—	—	—	—	37.8	—
Dominican Republic	—	—	—	—	—	—	46.5	...	...	—	—	—	—	—	—
Trinidad and Tobago	141.0	133.0	94.3	390.0	390.0	100.0	461.0	461.0	100.0	—	—	100.0	—	361.0	—
Uruguay	28.0	—	—	40.0	—	—	45.9	—	—	—	—	—	—	—	—
Venezuela	755.8	696.0	92.1	1 194.2	1 150.0	96.3	1 446.3	—	—	—	—	—	—	—	—
Total	2 643.6	1 699.5	64.2	4 272.6	2 718.2	63.6	7 931.2	1 627.2	20.5	604.6	8.0	589.7	—	379.5	45.4
World <sup>c</sup>	7 993.6	5 466.9	—	20 426.0	11 866.8	—	61 706.9	11 605.8	—	2 311.7	1 170.5	3 756.5	440.0	739.5	335.2
World (percentage)	100.0	68.4	—	100.0	58.1	—	100.0	18.8	—	3.7	1.9	6.1	0.7	1.2	0.5
															2.2
															2.5

Source: December 1957 and December 1966: M.A. Adelman, *The World Petroleum Market*, published for Resources for the Future Inc., by Johns Hopkins Press, Baltimore and London, pp. 327 and 332; December 1976: *Oil and Gas Journal*.

Note: CFP: Compagnie française des pétroles.

BP: British Petroleum.

<sup>a</sup>Bahamas Oil Refining Company; <sup>b</sup>Hess Oil, Virgin Islands. <sup>c</sup>Excluding countries with centrally planned economies.



per cent of total regional gas supplies: Venezuela (41 per cent), Mexico (24 per cent), Argentina (11 per cent) and Chile (8 per cent).

In 1975, natural gas accounted for about two-fifths of the modern energy sources consumed in Venezuela and Trinidad and Tobago (see table 11), and for major shares of modern energy consumption in Mexico (25 per cent), Argentina (22 per cent), Colombia (12 per cent), and Chile (14 per cent). It supplies between 2 and 6 per cent of modern energy requirements in Bolivia, Ecuador, and Peru, and less than one per cent in Brasil.

The discovery of natural gas reserves in Latin America is a by-product of successful oil exploration, since the two are usually found together and the objective of wildcat drilling in the region is typically to find oil, not gas. Few wildcat projects have been undertaken in the region in search of natural gas simply because the stock of proven gas reserves has usually been far more than that required to satisfy final energy markets. In the past, governments have preferred to invest scarce capital in the search for and development of oil deposits (or in other sectors of the economy) rather than in the development of costly systems of gas transmission and distribution needed to release gas reserves for consumption.

Latin America's natural gas distribution pipeline systems are largely intra-national (see Map 2). These pipelines transport natural gas from the producing fields to the processing facilities at urban coastal sites, usually some distance away, for ultimate delivery to domestic consumers. Latin America's international trade in natural gas is limited to minor volumes of gas exports from

Table 29

**LATIN AMERICA: PRODUCTION OF NATURAL GAS BY COUNTRY, 1955-1975 (SELECTED YEARS)**

(Millions of m<sup>3</sup>)

	1950	1955	1960	1965	1970	1973	1974	1975
Argentina	755	1 065	3 550	6 236	7 665	8 914	9 428	10 275
Bolivia	—	—	168	212	866	4 281	4 081	3 888
Brazil	5	62	535	683	1 264	1 180	1 488	1 625
Colombia	1 200*	1 800	2 338	2 658	2 971	3 222	3 303	3 398*
Cuba	—	—	—	—	—	—	—	—
Chile	200	466	2 194	6 215	7 628	7 376	7 042	7 097
Ecuador	132	180	185	251	172	155	348	299
Mexico	1 852	3 412	9 665	13 965	18 839	19 169	21 087	22 275
Peru	818 <sup>a</sup>	1 011	1 954	1 847	2 119	1 792	1 956	1 897*
Trinidad and Tobago	...	...	2 765	3 263	3 053	3 214	3 616	3 582
Venezuela	15 775	24 308	31 561	40 846	48 427	49 433	46 426	38 008
<b>Total</b>	<b>20 737</b>	<b>32 304</b>	<b>54 915</b>	<b>76 176</b>	<b>93 004</b>	<b>98 736</b>	<b>98 775</b>	<b>92 344</b>

Source: CEPAL, on the basis of official data.

<sup>a</sup>Figure for 1951.

\*Estimate.

Bolivia and Chile to Argentina<sup>40</sup> and to small volumes of two-way exchanges of this fuel between Mexico and the United States.<sup>41</sup> The pipelines supporting this trade are shown on Map 2.

The major pipeline project now planned in Latin America is the Bolivian-Brazilian gas transmission line.<sup>42</sup> Mexico's planned gas pipeline project is shown in Map 2. In Chile, interest has been shown in the economic feasibility of shipping liquefied gas from the southern gas fields to central and northern centres of energy consumption in the country, as a substitute for the imported oil on which these centres are now heavily reliant. The high price of oil in world markets could also increase interest in transporting natural gas from Peru's large fields, located east of the Andes, to Lima. In general, the sharp increase in the price of imported oil promises a widespread review of the potential for exploiting Latin America's wealth in natural gas as well as in other energy sources such as coal and hydropower.

As in the case of refined oil products, data on the end-use applications of natural gas in Latin America are too fragmentary for substantive analysis. Table 30 presents data on the volumes of gas produced and marketed in selected countries since the mid-fifties. These figures underscore the low ratio of gas actually marketed to the volumes of gas produced. Much of the difference is explained by the use of gas to maintain reservoir pressures and thus stave off otherwise physically unavoidable increases in the unit cost of crude oil production due to declines in well pressure over time. Sizeable volumes of natural gas produced in Latin America have also been flared off, however, as shown in table 30. The increased cost of world oil has increased pressure to reduce these volumes of flared gas in the future.

Although supporting data are not available, the major uses of the natural gas marketed in the region appear to be as a boiler fuel in thermal power stations (particularly in Venezuela, Mexico and Argentina) and as a feedstock for industrial chemicals (e.g., methanol) and fertilizers. Relatively minor volumes are also marketed for household use in cooking and space heating.

Table 27 presents data on the extent of central government direct ownership of most of the domestic natural gas industries in Latin America. As in the case of the oil industries of these countries, ownership of Latin America's natural gas industries is concentrated heavily in the hands of central governments.

#### (d) *Coal*

The share of coal in Latin America's consumption of modern fuels declined from 13 per cent in 1950 to 5 per cent in 1975. In 1975, coal was produced in only seven Latin American countries, four of which accounted for more than nine-tenths of regional production: Mexico (39 per cent), Colombia (24 per cent), Brazil (20 per cent), and Chile (12 per cent). Argentina, Peru and Venezuela also produced coal in 1975, but on decidedly minor scales (see table 31).

Table 31 shows the volumes of coal produced, imported, exported, and consumed in various Latin American countries in selected years since 1950. During 1960-1975, three countries accounted for the bulk of increased coal production in the region: Brazil, Colombia, and Mexico. In Colombia and Mexico, local coals are suitable for producing coke for the steel and other metallurgical industries, and this, plus the stimulus to conserve oil in the seventies, is one of the reasons for the increased coal production in these two countries, which has enabled them to

<sup>40</sup>In 1974, Bolivia exported 1,546 billion cubic meters of natural gas to Argentina via the pipeline which extends from the fields near Santa Cruz and Chuquisaca to the Argentina border at Yacuiba and then down to major processing and consuming centres along the Rio de la Plata. This 150 billion cfd, 330-mile pipeline became operational in 1972. Between July and December, 1976, Chile sold 357 million cubic meters of natural gas to Argentina.

<sup>41</sup>In 1974, Mexico exported 12 million cubic meters of natural gas to the United States, from which it imported 376 million cubic meters in return. Mexico's exports are to the Brownsville (Texas) area, while its imports, secured from the (Texas) Laredo area, are obtained via the pipeline to Nueva Rosala.

<sup>42</sup>A pipeline project is planned to carry gas from Bolivia's gas fields in the Santa Cruz area all the way to the industrial centre of São Paulo in Brazil, some 1,200 miles distant. The cost of the project is estimated at 3 billion dollars; it will supply Brazil with 400 billion cfd of natural gas.

Table 30  
**LATIN AMERICA: PRODUCTION AND USE OF NATURAL GAS BY COUNTRY, 1955-1974**  
**(SELECTED YEARS)**  
*(Millions of m<sup>3</sup>)*

	<i>Produced</i>	<i>Reinjected</i> <i>a</i>	<i>Consumed</i> <i>b</i>	<i>Burned</i>	<i>Imported</i>	<i>Exported</i>	<i>Processed</i>
<i>Argentina</i>							
1955	1 065	6	719	719	—	—	...
1965	6 236	230	4 502	1 763	18	—	...
1970	7 665	8	6 102	1 598	—	—	...
1974	9 428	397	7 222	1 779	1 542	—	...
<i>Bolivia</i>							
1955	—	—	—	—	—	—	—
1965	212	76	80	56	—	—	—
1970	866	462	14	228	—	—	—
1974	4 081	1 924	72	449	—	1 546	...
<i>Brazil</i>							
1955	62	...	...	...	—	—	—
1965	683	263	90	331	—	—	—
1970	1 264	246	118	899	—	—	...
1974	1 488	658	429	399	—	—	...
<i>Colombia</i>							
1955	1 800	...	...	...	—	—	...
1965	2 658	795	875	1 100	—	—	...
1970	2 971	937	1 343	569	—	—	1 931
1974	3 303	884	1 735	555	—	—	1 926
<i>Chile</i>							
1955	466	324	80 <sup>c</sup>	...	—	—	329
1965	6 215	4 486	517 <sup>c</sup>	...	—	—	4 448
1970	7 628	4 954	1 219 <sup>d</sup>	...	—	—	4 111
1974	7 042	3 431	1 150*	...	—	—	4 710
<i>Ecuador</i>							
1955	180	...	...	...	—	—	—
1965	251	...	...	...	—	—	—
1970	172	13	66	22	—	—	28
1974	348	...	...	...	—	—	...
<i>Mexico</i>							
1955	3 412	391	1 684	1 714	558	...	...
1965	13 965	1 251	8 930	2 813	276	1 539	...
1970	18 839	294	12 206	4 908	505	1 260	...
1974	21 087	63	14 677	5 108	355	12	...
<i>Peru</i>							
1955	1 011	70	...	116	—	—	769
1965	1 847	439	341	599	—	—	933
1970	2 119	205	395	1 033	—	—	655
1974	1 956	80	897	979	—	—	...
<i>Trinidad and Tobago</i>							
1955	...	...	...	...	—	—	...
1965	3 263	392	1 174	...	—	—	273
1970	3 053	539	1 600	296	—	—	488
1974	3 616	162	1 418	270	—	—	230
<i>Venezuela</i>							
1955	24 308	3 891	2 748	17 353	—	—	316
1965	40 846	17 720	6 538	16 052	—	—	536
1970	48 427	20 110	8 979	18 444	—	—	881
1974	46 426	29 086	11 632	9 862	—	—	1 846
<i>Total</i>							
1955	32 304	4 682	5 231	19 902	558	—	1 414
1965	76 176	25 652	23 047	22 714	294	1 539	6 190
1970	93 004	27 768	32 042	27 997	505	1 260	8 094
1974	98 775	38 144	39 232	19 401	1 897	1 558	8 712

Source: CEPAL, on the basis of official data.

<sup>a</sup>Including dry gas in those countries where natural gas was liquefied.

<sup>b</sup>In importing countries, consumption includes imported natural gas (as in Argentina and Mexico).

<sup>c</sup>Consumed in the Magallanes gas fields, according to a publication of the Production Development Corporation (CORFO).

<sup>d</sup>Data published by PETROTECNIA of the Argentine Petroleum Institute.

Table 31

## LATIN AMERICA: PRODUCTION, IMPORTS, EXPORTS AND CONSUMPTION OF COAL BY COUNTRY, 1950, 1960 AND 1975

(Thousands of tons of coal equivalent)

	1950				1960				1975			
	Production	Imports	Exports <sup>a</sup>	Apparent consumption <sup>b</sup>	Production	Imports	Exports <sup>a</sup>	Apparent consumption <sup>b</sup>	Production	Imports	Exports	Apparent consumption
Argentina	26	1 465	—	1 491	175	1 465	—	1 640	502	1 037	3	1 536
Brazil	1 959	1 115	—	3 074	1 277	1 062	—	2 339	2 717	2 720	—	5 437
Chile	1 779	66	75	1 768	1 321	352	35	1 698	1 362	164	1	1 525
Colombia	1 010	—	—	1 010	2 600	—	—	2 600	3 200	—	17	3 183
Mexico	942	27	—	969	1 776	53	—	1 829	5 128	580	—	5 708
Peru	196	—	57	139	162	13	27	148	85	274	—	359
Venezuela	1	1	—	2	35	1	—	36	60	208	—	268
<i>Subtotal</i>	<i>5 913</i>	<i>2 674</i>	<i>132</i>	<i>8 453</i>	<i>7 346</i>	<i>2 946</i>	<i>62</i>	<i>10 290</i>	<i>13 054</i>	<i>4 983</i>	<i>21</i>	<i>18 016</i>
Bolivia	—	1	—	1	—	3	—	3	—	—	—	—
Uruguay	—	129	—	129	—	79	—	79	—	41	—	41
Cuba	—	62	—	62	—	63	—	63	—	119	—	119
Dominican Republic	—	—	—	—	—	1	—	1	—	1	—	1
Jamaica	—	16	10	6	—	—	—	—	—	1	—	1
Panama	—	—	—	—	—	—	—	—	—	16	—	16
Trinidad and Tobago	—	26	20	1	—	3	1	2	—	—	—	—
<i>Subtotal</i>	<i>—</i>	<i>234</i>	<i>30</i>	<i>199</i>	<i>—</i>	<i>149</i>	<i>1</i>	<i>148</i>	<i>—</i>	<i>178</i>	<i>—</i>	<i>178</i>
<i>Total</i>	<i>5 913</i>	<i>2 908</i>	<i>162</i>	<i>8 652</i>	<i>7 346</i>	<i>3 095</i>	<i>63</i>	<i>10 438</i>	<i>13 054</i>	<i>5 161</i>	<i>21</i>	<i>18 194</i>

Source: 1950 and 1960: United Nations, *World Energy Supplies, 1950-1974*; 1975: United Nations, *World Energy Supplies, 1971-1975*.<sup>a</sup>Including bunkers in Jamaica and Trinidad and Tobago.<sup>b</sup>Including changes in stocks in Chile and Trinidad and Tobago.

support increased volumes of metal production with relatively little marginal need to import higher grades of coal or coke.

In contrast, Brazil's indigenous coal is relatively poor in quality, which has made necessary greater reliance on imports of coking coal and coke for blending purposes in order to satisfy the technical requirements for coke in Brazil's expanding metals industry.

At the same time, technical progress since the fifties in the region's steel industry has reduced the volume of coke required per unit of steel output. This progress has constituted a brake on the rate of growth of regional requirements for indigenously supplied coking coal, and likewise for imported coals and coke. This downward pressure on the growth in coal requirements has been most important in those countries where the steel industry has in the past accounted for high fractions of total coal sales.<sup>43</sup>

Apart from steel, the other major market for indigenous coal in the region has been the electric power industry. Coal deliveries to this industry have provided a hedge in some Latin American countries against big losses to oil in traditional markets for local coal.<sup>44</sup>

In Colombia, and in some locations in Mexico, where the quality of indigenous coal and its location to markets are relatively more favourable, the loss of markets for coal to oil and gas has been moderate. Nevertheless, in almost every major coal-producing country in the region, the share of coal in domestic energy consumption declined during 1950-1975.<sup>45</sup>

Generally speaking, in those Latin American countries which produce both coal and oil, oil has replaced coal most significantly where indigenous coal has been relatively poor in quality and costly to extract and transport to domestic consumers, as in the cases of Argentina, Chile, and Venezuela. This comment aside, however, it is obvious that competition from oil has been the major force explaining the lack of dynamism in Latin America's coal industry in the post-war era. Despite the increased incentive in the seventies to replace oil with coal, the latter share in modern energy consumption in the region was lower in 1975 (5.0 per cent) than in 1970 (5.3 per cent).

Table 32 presents one estimate, published in 1972, of the extent of measured and potential reserves of coal in Latin America and in other countries and country groupings, as well as the volume of coal produced in those areas in 1975. The figures show the huge size of the identified physical stocks of coal compared with coal consumption. As in the case of natural gas, the major immediate problem in Latin America is not to add to the stock of identified coal reserves but rather to develop and produce more coal for both domestic and export markets from already identified stocks in response to the higher prices of world energy sources since 1973. Additionally, over time, there appears to be considerable opportunity in many Latin American countries for finding and developing new stocks of coal which will displace more expensive, existing stocks. In such cases, the role of the coal export market will be critical, the increased price of world oil since 1973 having provided a strong stimulus to Latin America's coal producers to capture a larger share of the now more attractive world coal market.

Foreign capital has never played an important role in the region coal industry. Typically, the State has protected the indigenous coal industry from collapse under the pressure of competition from oil and imported coal. Detailed discussion of the protection of the indigenous coal industry in the post-war period, however, is impeded by lack of data.

<sup>43</sup> In 1972, these shares were as follows: Argentina (44 per cent), Brazil (62 per cent), Mexico (68 per cent), Chile (27 per cent), Colombia (18 per cent), Peru (58 per cent), and Venezuela (93 per cent). See: R. Suárez, "El Carbón Latinoamericano y sus perspectivas", Annex I, pp. 259-286, in: Comisión Económica para América Latina, *América Latina y los Problemas Actuales de la Energía*, Fondo de Cultura Económica, Mexico, 1975.

<sup>44</sup> In 1972, the electric power industry accounted for the following percentage share of coal deliveries: Argentina (19), Brazil (35), Chile (35), Colombia (13), and Mexico (3). See: R. Suárez, "El Carbón Latinoamericano y sus perspectivas", *op. cit.*, Annex I, pp. 259-286.

<sup>45</sup> The only coal consuming countries in the region which recorded an increase in this ratio during the period were Mexico (from 6.6 per cent to 7.2 per cent) and Venezuela (from 0.5 per cent to 1.0 per cent).

(e) *Electric power*

(i) *Electricity consumption.* The electric power industry consists of three segments: generation, transmission, and distribution. Base load and peak power requirements are met by power stations which may draw on a wide variety of energy sources, including hydropower, refined oil products, natural gas, coal, vegetable fuels, and, more recently, nuclear materials. Electric energy is then transported in huge amounts and at very high voltages to locations nearer to consumers, often far from the site of generation, by way of transmission lines or interlinked grid networks. The power is then physically transformed and distributed to power consumers in the quantities and voltages required by each of them for the various productive applications.

Since 1950, Latin America's consumption of electric power has doubled, on average, every eight years. The 8.8 per cent annual average growth rate of the region's output of electric energy since 1950 puts electric power, together with oil refining, among Latin America's leading growth industries during the past quarter of a century.

The categories of demand supporting this growth are readily identified by the potential uses for electric energy: heat, mechanical power, light, and chemical energy. Given the region's pattern of industrial growth in the post-war era, the data in table 33 show the relative importance of these end-uses in specific national markets.

Manufacturing and mining industries have accounted for about one-half of the growth in regional power consumption since 1950. Growth not only in the relatively electricity-intensive industries but also in manufacturing output in general, together with the progressive mechanization of work processes and the spread of electric lighting, have been the pivotal forces supporting increased electric power consumption in Latin America since World War II. Much of the growth recorded by Latin America's secondary sector industries since the fifties would simply not have

Table 32  
**WORLD: COAL RESERVES AND PRODUCTION, 1975<sup>a</sup>**

(Billions of metric tons)

	<i>Production 1975</i>	<i>Reserves</i>		
		<i>Proven</i>	<i>Probable additional reserves</i>	<i>Total</i>
Latin America	0.01	20	10	30
North America	0.60	1 560	2 520	4 080
United States	(0.58)	(1 420)	(1 490)	(2 910)
Europe	0.70	560	190	750
Oceania	0.07	50	70	120
USSR	0.52	5 900	2 720	8 620
Asia	0.66	450	910	1 360
Africa	0.08	70	150	220
World	2.64	8 610	6 570	15 180

Source: Reserves: J. Darmstadter and others, *Energy in the World Economy*, published for Resources for the Future Inc. by Johns Hopkins Press, 1971, p. 46; production: United Nations, *World Energy Supplies, 1971-1975*, Series J, No 20.

<sup>a</sup>Estimates published in 1972.



Table 33  
LATIN AMERICA: CONSUMPTION OF ELECTRICITY BY PRINCIPAL USES AND COUNTRY, 1950, 1960 AND 1975  
(Percentages, and millions of KWH)

	1950							1960							1975						
	R and C	I and M			O	L	Total 10 <sup>6</sup> KWH	R and C	I and M			O	L	Total 10 <sup>6</sup> KWH	R and C	I and M			O	L	Total 10 <sup>6</sup> KWH
		PS	SS	Total					PS	SS	Total					PS	SS	Total			
Argentina	27.1	22.1	25.3	47.4	10.8	14.7	5 303	29.8	25.4	23.6	50.0	5.4	15.8	10 458	30.2	29.7	16.7	46.4	9.1	14.3	29 469
Bolivia	20.8	23.2	41.6	64.8	1.0	13.4	298	31.5	23.5	29.1	52.6	2.2	13.7	447	30.7	28.4	26.6	55.0	1.7	12.6	1 057
Brazil	19.4	25.0	8.2	33.2	30.4	17.0	8 208	24.5	29.2	18.1	47.3	15.1	13.1	22 865	28.4	46.0	5.5	51.5	10.6	9.5	80 293
Chile	11.9	14.8	57.6	72.4	7.6	8.1	2 943	13.7	19.8	46.6	68.4	8.6	11.3	4 592	20.7	31.5	29.0	60.5	9.7	9.1	8 732
Colombia	37.0	16.5	16.5	33.0	15.0	15.0	1 270	39.0	17.4	19.6	37.0	9.2	14.8	3 520	40.6	27.6	13.0	40.6	5.6	13.1	14 599
Costa Rica	54.9	6.6	12.6	19.2	3.4	22.5	182	67.4	7.3	5.5	12.8	5.7	14.1	438	57.3	14.0	1.4	15.4	2.5	24.8	1 493
Ecuador	27.6	5.3	26.3	31.6	9.9	30.9	152	41.6	12.4	19.5	31.9	12.3	14.2	389	37.1	30.3	10.4	40.7	10.3	11.9	1 848
El Salvador	20.5	19.3	23.9	43.2	19.3	17.0	88	40.2	27.0	2.7	29.7	17.6	12.5	256	30.8	26.4	1.1	27.5	10.4	31.3	1 026
Guatemala	33.6	20.7	20.7	41.4	8.6	16.4	116	38.1	18.0	19.7	37.7	6.8	17.4	310	30.0	30.7	15.7	46.4	9.8	13.8	1 117
Guyana	---	---	---	---	---	---	---	33.3	22.2	27.8	50.0	2.3	14.4	90	14.6	23.2	47.6	70.8	1.6	13.0	384
Haiti	---	---	---	---	---	---	---	18.9	12.2	32.2	44.4	4.5	32.2	90	19.1	29.3	13.6	42.9	13.0	25.0	184
Honduras	14.0	6.0	66.0	72.0	4.0	10.0	50	29.9	19.6	29.9	49.5	8.2	12.4	97	30.9	44.4	4.1	48.5	5.0	15.6	540
Jamaica	41.7	8.3	35.0	43.3	4.2	10.8	120	32.4	7.6	46.9	54.5	2.5	10.6	510	32.4	6.1	42.4	48.5	8.5	10.6	2 271
Mexico	14.7	31.6	18.8	50.4	20.3	14.6	4 424	19.4	32.6	18.9	51.6	15.8	13.3	10 728	21.0	47.2	9.4	56.6	11.1	11.4	43 506
Nicaragua	12.5	6.2	66.3	72.5	5.0	10.0	80	30.1	13.6	39.8	53.4	7.4	9.1	176	26.1	31.5	10.7	42.2	18.7	13.0	918
Panama	48.1	14.4	9.6	24.0	7.7	20.2	104	53.4	12.8	12.4	25.2	8.6	12.8	234	57.6	10.7	—	10.7	13.3	18.4	1 220
Paraguay	27.5	20.0	25.0	45.0	7.5	20.0	40	34.4	14.6	30.2	44.8	6.2	14.6	96	25.7	13.7	9.8	23.5	39.2 <sup>a</sup>	11.6	592
Peru	20.1	21.3	44.1	65.4	3.6	10.9	820	16.2	20.00	52.7	72.7	3.0	8.1	2 648	24.0	16.9	36.1	53.0	11.0	12.0	7 696
Dominican Republic	---	---	---	---	---	---	---	27.8	23.2	28.4	51.6	11.4	9.2	349	36.9	26.1	—	26.1	7.6	29.4	1 632
Trinidad and Tobago	12.5	10.0	66.2	76.2	1.9	9.4	160	15.1	23.2	42.3	65.5	2.8	16.6	470	30.2	49.2	7.4	56.6	0.8	12.4	1 220
Uruguay	31.3	40.1	—	40.1	9.4	19.2	616	38.3	38.6	—	38.6	4.9	18.2	1 244	46.8	29.5	2.9	32.4	3.1	17.7	2 444
Venezuela	17.4	18.0	49.5	67.5	4.3	10.8	1 153	23.7	17.3	34.9	52.2	12.1	12.0	4 570	21.2	37.1	11.8	48.9	16.0 <sup>b</sup>	13.9	21 179
Total	20.9	23.3	23.6	46.9	17.6	14.6	26 127	23.1	26.0	24.0	50.0	11.5	13.4	64 577	27.6	38.8	11.3	50.1	10.5	11.8	223 420

Source: CEPAL, on the basis of official data.

Note: R and C = Residential and commercial.

I and M = Industrial and mining.

O = Other (agriculture, street lighting, official, etc.).

L = Losses (including non-reported consumption).

PS = Public service.

SS = Self-suppliers.

<sup>a</sup> 202 GWH exported.

<sup>b</sup> Includes considerable consumption in sanitary works (pumping).





been physically possible without access to increasing supplies of electricity to sustain high intensity flows of mechanical work, on the one hand, and to support output gains in the electro-chemical and electro-metallurgical industries, on the other hand.

Households and commercial establishments account for about another one-third of the growth recorded in Latin America's consumption of electricity since 1950. In urban centres, electric lighting has become a commonplace in homes, offices and factories, which was not the case in the region in the 1940s. Indeed, the use of electric power as a source of heat may have been overstimulated from an economic point of view in some markets by the low prices set for electricity at some times by public power authorities. Increases in real family income throughout Latin America since World War II have stimulated the growth of the region's household electric power market. In terms of volume, this process has been most important in the large and more affluent countries of the region, such as Argentina, Brazil, Mexico and Venezuela.

In rural Latin America, the use of electricity has grown decidedly less than in urban and suburban areas. Public power authorities in Latin America did not focus seriously on the development of rural markets until the 1960s. Before then, the scarce capital that was available to the authorities was allocated, for the most part, to the development of urban and suburban power markets, while power flows in rural areas were expanded by less dramatic additions to private and public sector electric generating and supply capacity. The data in table 34 indicate that the consumption of electricity is still limited in rural Latin America, where it is used largely as a source of lighting and of power for relatively low-capacity electric motors. These motors are used in a multiplicity of ways on farms and in rural households and commercial establishments, and to a large extent they have been the means by which capital has been substituted for the low-intensity power flows historically supplied by human and animal labour.

It should be stressed, however, that the sectoral pattern of growth in the consumption of electric energy in specific Latin American countries, as shown in table 33, shows wide variations between countries. Furthermore, the regional pattern is heavily weighted, in a statistical sense, by a handful of countries such as Argentina, Brazil, Mexico and Venezuela. Bearing this in mind, the data in table 33 show that in some Latin American countries the major sources of growth in the power market since 1950 have been households and commerce, not manufacturing and mining.

The statistics provided in table 33 on the consumption of electric energy give no hint of the considerable gains achieved throughout Latin America in the post-war period in the quality of power service: i.e., the regularity with which power companies supply electricity in the volumes (i.e., kWh), forms (i.e., voltage, cycles), and at the times required by consumers willing and able to pay for it. The widespread and notable improvement in the quality of power service in the region since the 1950s is demonstrated by the steady decline in the frequency of black-outs and brown-outs. It is also partially reflected in the declining quantitative importance of power supplies produced by establishments other than power companies for their own use and often for sale on a small scale to others in their immediate area.<sup>46</sup> Improvements in the quality of the service rendered by electric power industries in the region should be recognized as one of their major accomplishments in the post-war era, quite apart from the impressive record of strictly physical output gains which they have also achieved during this period.

The declining quantitative importance of the self-suppliers warrants additional comment. In 1950, they accounted for 23 per cent of the electric energy generated in Latin America, although this ratio varied widely among individual countries in the region (see table 35). By 1975, however, they accounted for only 12 per cent of regional power generation, again with a wide pattern of country-by-country variation. Chief among the factors promoting the decline in the quantitative role of these self-suppliers has been the rapid growth in the integration of power networks serviced by the large power companies, particularly those in the public sector, and also the increased reliability of power supplies sold by these companies.

<sup>46</sup> Such small-scale power producers are labelled "self-suppliers".

Table 34  
LATIN AMERICA: SELECTED DATA ON RURAL ELECTRIFICATION,  
SELECTED YEARS AND COUNTRIES

Country	Census year	Number of dwellings		Number of dwellings with electricity	
		Total	Rural	Total	Rural
Barbados	1970	59 391	33 046	35 104	16 693
Brazil	1970	17 628 699	7 352 359	8 383 994	615 273
Colombia	1970	3 260 000	1 528 700	1 216 623	264 465
Chile	1970	1 715 248	393 756	1 289 198	110 351
El Salvador	1971	655 120	384 540	223 400	25 800
Mexico	1970	8 286 369	3 422 209	4 876 745	949 792
Nicaragua	1971	302 544	154 116	124 905	10 697
Panama	1970	273 875	140 191	148 118	22 731
Paraguay	1972	428 111	255 984	74 772	3 065
Peru	1972	2 686 471	1 156 136	862 007	31 347
Venezuela	1971	1 827 140	266 639	1 402 819	46 291

Source: CEPAL, on the basis of national censuses and other official data.

Rapid though it has been, however, the growth in the consumption of electric energy in Latin America since 1950 has not been outstanding by international standards. World power consumption during 1950-1975 expanded by 8.3 per cent per annum, while in Latin America electric power consumption grew at 8.8 per cent per annum (see table 36). The consumption of electricity in the developed countries during 1950-1974 increased at the somewhat slower rate of 8.1 per cent annually, but this slower growth proceeded from a 1950 level that was about thirty times the comparable Latin American level in that year. Thus, despite the high rate of growth in Latin America's power generation since the 1950s, the region still remains far behind the developed countries in terms of electric power generated, absolutely and per capita, as well as in terms of power generated per unit of total real output. Table 37 presents detailed information on these three aspects of electric power generation in twenty-seven Latin American countries in the post-war era.

(ii) *Installed capacity, generation and efficiency.* Tables 35 and 38 present data on the post-war growth pattern of Latin America's electric power generation and installed generating capacity. Both tables reveal the dominance of a handful of countries in the regional totals. In 1975, for example, five countries (Argentina, Brazil, Colombia, Mexico and Venezuela) accounted for about four-fifths of regional power generation and generating capacity. This pattern is, of course, what one would expect, given the heavy weight of these countries in Latin America's industrial output and population.

The impressive rate of expansion in Latin America's electric generating capacity since the 1950s was financially facilitated, to a significant extent, by the access of many Latin American countries to long-term capital from a variety of foreign institutions specializing, *inter alia*, in long-term power equipment and power project financing. The data presented in table 39 show that the cumulative flow of long-term financing for power projects from three such institutions



Table 35  
LATIN AMERICA: ELECTRICITY GENERATION BY SECTOR AND COUNTRY, 1950, 1960 AND 1975  
(GWH)

	1950						1960						1975					
	Public service			Total for the country			Public service			Total for the country			Public service			Total for the country		
	Hydro-electric	Thermal	Total	Hydro-electric	Thermal	Total	Hydro-electric	Thermal	Total	Hydro-electric	Thermal	Total	Hydro-electric	Thermal	Total	Hydro-electric	Thermal	Total
Argentina	153	4 370	4 523	183	5 120	5 303	870	6 993	7 863	927	9 531	10 458	5 120	19 434	24 554	5 197	24 272	29 469
Bahamas	—	16	16	—	16	16	—	76	76	—	76	76	—	660	660	—	660	660
Barbados	—	10	10	—	10	10	—	39	39	—	39	39	—	207	207	—	207	207
Bolivia	163	5	168	261	37	298	292	18	310	350	97	447	642	128	770	800	257	1 057
Brazil	6 700	800	1 500	7 198	1 010	8 208	14 831	3 683	18 514	18 384	4 481	22 865	71 866	3 980	75 846	73 836	6 457	80 293
Chile	959	200	1 159	1 649	1 294	2 943	2 172	170	2 342	2 977	1 615	4 592	5 321	882	6 203	6 135	2 597	8 732
Colombia	810	240	1 050	860	410	1 270	2 244	551	2 795	2 389	1 131	3 520	9 469	3 224	12 693	9 849	4 750	14 599
Costa Rica	158	—	158	175	7	182	380	33	413	392	46	438	1 254	174	1 428	1 269	224	1 493
Cuba	14	815	829	14	1 280	1 294	20	2 085	2 105	20	2 961	2 981	63	5 350	5 413	62	6 521	6 583
Ecuador	58	52	110	72	80	152	145	164	309	175	214	389	617	1 038	1 655	647	1 201	1 848
El Salvador	38	28	66	40	48	88	236	12	248	240	16	256	401	575	976	401	625	1 026
Grenada	—	1	1	—	1	1	—	4	4	—	4	4	—	27	27	—	27	27
Guatemala	71	20	91	83	33	116	126	120	246	143	167	310	282	660	942	282	835	1 117
Guyana	—	16	16	—	38	38	—	64	64	—	90	90	—	190	190	—	384	384
Haiti	—	18	18	—	38	38	—	60	60	—	90	90	145	10	155	145	39	184
Honduras	4	11	15	6	44	50	16	50	66	19	78	97	420	90	510	420	120	540
Jamaica	50	26	76	50	70	120	126	132	258	126	384	510	131	1 235	1 366	131	2 140	2 271
Mexico	1 850	1 700	3 550	1 950	2 474	4 424	4 965	3 624	8 589	5 149	5 579	10 728	14 970	24 430	39 400	15 076	28 430	43 506
Nicaragua	3	21	24	35	45	80	1	101	102	45	131	176	354	439	793	404	514	918
Panama	5	88	93	5	99	104	18	185	203	18	216	234	97	1 058	1 155	97	1 123	1 220
Paraguay	—	30	30	—	40	40	—	65	65	—	96	96	523	11	534	523	69	592
Peru	405	35	440	710	110	820	1 060	116	1 178	1 794	854	2 648	4 211	354	4 565	5 522	2 174	7 696
Dominican Republic	—	64	64	—	79	79	—	245	245	—	349	349	194	1 438	1 632	194	1 438	1 632
Surinam	—	8	8	—	35	35	—	39	39	—	79	79	—	70	70	1 020	580	1 600
Trinidad and Tobago	—	48	48	—	160	160	—	261	261	—	470	470	—	1 130	1 130	—	1 220	1 220
Uruguay	527	89	616	527	89	616	676	568	1 244	676	568	1 244	1 132	1 241	2 373	1 132	1 312	2 444
Venezuela	174	319	553	174	479	1 153	95	2 796	2 891	95	4 475	4 570	8 912	9 767	18 679	8 912	12 267	21 179
<i>Latin America</i>	<i>12 142</i>	<i>9 082</i>	<i>21 224</i>	<i>13 992</i>	<i>13 611</i>	<i>27 603</i>	<i>28 273</i>	<i>22 217</i>	<i>50 490</i>	<i>33 919</i>	<i>33 758</i>	<i>67 677</i>	<i>125 930</i>	<i>76 294</i>	<i>202 224</i>	<i>130 840</i>	<i>98 425</i>	<i>229 265</i>

Source: CEPAL, on the basis of official data.



Table 36  
**WORLD AND SELECTED GROUPINGS: GROWTH IN FUELS AND ELECTRICITY CONSUMPTION,  
 1950-1975**

	1950		1975		Average annual growth rates	
	<i>Fuel (millions of tons of petroleum equivalent)<sup>a</sup></i>	<i>Electricity (thousands of GWH)</i>	<i>Fuel (millions of tons of petroleum equivalent)</i>	<i>Electricity (thousands of GWH)</i>	<i>Fuel</i>	<i>Electricity</i>
Developed countries	1 266	825	3 084	5 741	3.6	8.1
Developing countries	98	50	775	698	8.6	10.8
Latin America	32	28	151	229	6.4	8.8
Others	66	22	624	469	9.4	13.0
<i>World</i>	<i>1 364</i>	<i>875</i>	<i>3 859</i>	<i>6 439</i>	<i>4.3</i>	<i>8.3</i>

Source: United Nations, *World Energy Supplies, 1950-1974* and *World Energy Supplies, 1971-1975*.

<sup>a</sup>Excluding fuels consumed in thermoelectric generation.

during 1946-1975 totalled 5.8 billion dollars. The share of long-term loan financing from such institutions in the total financing requirements of a power project varies widely, depending on a variety of factors such as the type and scale of project, the host country and the financial institutions involved. Historically, however, long-term debt financing by institutions such as the IBRD and IDB have probably accounted for between one-fifth and one-quarter of the total project value of the power schemes receiving such support.<sup>47</sup> To this extent, they have provided considerable support for the physical expansion of the region's electric power supply capacity in the post-war era.

In addition to this direct financial support, institutions such as the IBRD and IDB have also served as valuable conduits for the transfer of a broad range of technologies to Latin America's public power authorities. This has involved not only the promotion of technical knowledge of an engineering nature, in which equipment-supplying companies play the dominant role, but also the promotion of many other kinds of knowledge as well: power tariff policy, system control and planning, financial and economic project evaluation, personnel planning and training, contracting and cost control, debt management, and so on. Clearly, promotion of knowledge in these and related areas of business and institutional management was also aided in these countries through other corporate, national and international channels, but the contributory role of institutions such as the IBRD and IDB to this increased stock of knowledge has certainly been notable.

The data in table 35 show that the share of hydropower in Latin America's generation of electric power has increased slowly over the past 25 years, from 51 per cent in 1950 to 57 per cent in 1975.

Individual countries depart widely, however, from this regional pattern of hydropower generation. Thus, for example, five of the twenty-seven countries listed in table 35 did not generate hydroelectricity in 1975 while, at the other extreme, in three Latin American countries

<sup>47</sup> Between 1961 and 1974 the IDB granted 72 long-term loans for financing power projects in Latin America. The aggregate value of these loans was 1.6 billion dollars, or 28 per cent of the total cost (5.8 billion dollars) of the 72 projects.



**Table 37**  
**LATIN AMERICA: SELECTED ECONOMIC ASPECTS OF ELECTRIC POWER PRODUCTION BY COUNTRY,**  
**1950, 1960, 1975**

	<i>Per capita electric energy generation</i> <i>(KWH/inhabitant)</i>			<i>Generation of electric energy per</i> <i>unit of gross domestic product</i> <i>(KWH/US\$ 1 000)</i>		
	<i>1950</i>	<i>1960</i>	<i>1975</i>	<i>1950</i>	<i>1960</i>	<i>1975</i>
Argentina	310	507	1 161	375	557	853
Bahamas	203	673	3 529	...	...	...
Barbados	47	167	845	...	...	...
Bolivia	99	118	195	427	616	639
Brazil	157	320	732	670	966	1 214
Chile	486	605	852	884	892	1 166
Colombia	109	221	564	293	520	949
Costa Rica	214	350	749	611	739	961
Cuba	234	425	694	...	...	...
Ecuador	47	90	261	182	304	572
El Salvador	46	101	250	172	317	576
Grenada	14	...	...	...	...	...
Guatemala	38	78	184	131	241	387
Guyana	90	161	485	...	...	...
Haiti	11	22	31	95	186	291
Honduras	36	52	178	155	207	643
Jamaica	87	313	1 119	...	...	...
Mexico	166	295	735	342	470	735
Nicaragua	71	120	396	315	442	904
Panama	136	216	728	280	393	773
Paraguay	29	54	224	98	184	542
Peru	103	261	491	310	628	829
Dominican Republic	34	110	319	151	376	681
Surinam	163	272	3 478	...	...	...
Trinidad and Tobago	253	558	1 209	...	...	...
Uruguay	280	474	786	330	542	898
Venezuela	216	599	1 734	343	752	1 341
<i>Latin America</i>	<i>177</i>	<i>319</i>	<i>714</i>	<i>458</i>	<i>643</i>	<i>951</i>

Source: CEPAL, on the basis of official data.

Table 38  
LATIN AMERICA: INSTALLED GENERATING CAPACITY BY SECTOR AND COUNTRY, 1950, 1960 AND 1975  
(MW)

	1950						1960						1975					
	Public service			Total for the country			Public service			Total for the country			Public service			Total for the country		
	Hydro- electric	Thermal	Total	Hydro- electric	Thermal	Total	Hydro- electric	Thermal	Total	Hydro- electric	Thermal	Total	Hydro- electric	Thermal	Total	Hydro- electric	Thermal	Total
Argentina	43	1 303	1 346	49	1 701	1 750	317	1 970	2 287	340	3 134	3 474	1 507	5 779	7 286	1 531	7 728	9 259
Bahamas	—	6	6	—	6	6	—	22	22	—	22	22	—	250	250	—	250	250
Barbados	—	3	3	—	3	3	—	15	15	—	15	15	—	70	70	—	70	70
Bolivia	36	4	40	53	27	80	71	12	83	90	57	147	214	70	284	242	134	376
Brazil	1 455	265	1 720	1 536	347	1 883	2 920	863	3 783	3 642	1 158	4 800	15 780	2 590	18 370	16 193	3 385	19 578
Chile	262	127	389	371	403	774	483	116	599	594	548	1 142	1 354	508	1 862	1 462	1 158	2 620
Colombia	170	68	238	186	125	311	460	210	670	505	406	411	2 252	982	3 234	2 322	1 262	3 584
Costa Rica	37	—	31	46	2	48	74	26	100	80	30	110	229	135	364	239	165	404
Cuba	3	191	194	3	501	504	2	545	547	2	951	953	6	1 143	1 149	47	1 630	1 677
Ecuador	15	13	28	19	21	40	34	58	92	40	78	118	127	306	433	139	386	525
El Salvador	9	10	19	9	18	27	56	9	65	56	18	74	108	167	275	108	205	313
Grenada	—	1	1	—	1	1	—	2	2	—	2	2	—	8	8	—	8	8
Guatemala	18	9	27	18	15	33	27	32	59	27	46	73	96	130	226	96	156	252
Guyana	—	7	7	—	16	16	—	17	17	—	52	52	—	95	95	—	170	170
Haiti	—	6	6	—	13	13	—	13	13	—	28	28	47	18	65	47	36	83
Honduras	1	5	6	1	17	18	3	21	24	3	30	33	69	77	146	69	90	159
Jamaica	12	18	30	12	33	45	22	50	72	22	123	145	21	428	449	21	678	699
Mexico	530	386	916	607	628	1 235	1 250	1 058	2 308	1 328	1 693	3 021	4 095	5 807	9 902	4 175	7 210	11 385
Nicaragua	1	7	8	8	19	27	1	49	50	9	69	78	100	105	205	107	145	252
Panama	2	26	28	2	31	33	7	55	62	7	66	73	16	264	280	16	294	310
Paraguay	—	9	9	—	13	13	—	29	29	—	45	45	90	80	170	90	101	191
Peru	71	44	115	177	141	318	222	127	349	416	363	779	1 149	291	1 440	1 392	991	2 383
Dominican Republic	—	39	39	—	50	50	8	70	78	8	112	120	149	351	500	149	351	500
Surinam	—	4	4	—	20	20	—	11	11	—	29	29	—	21	21	180	121	301
Trinidad and Tobago	—	14	14	—	47	47	—	81	81	—	129	129	—	364	364	—	414	414
Uruguay	128	90	218	128	90	218	236	205	441	236	205	441	252	418	670	252	453	705
Venezuela	36	144	180	36	320	356	22	743	765	22	1 234	1 256	1 795	2 886	4 081	1 795	2 910	4 705
<b>Latin America</b>	<b>2 829</b>	<b>2 795</b>	<b>5 624</b>	<b>3 261</b>	<b>4 588</b>	<b>7 849</b>	<b>6 215</b>	<b>6 398</b>	<b>12 613</b>	<b>7 427</b>	<b>10 614</b>	<b>18 041</b>	<b>29 456</b>	<b>22 722</b>	<b>52 178</b>	<b>30 492</b>	<b>30 380</b>	<b>60 872</b>

Source: CEPAL, on the basis of official data.

Table 39

**LATIN AMERICA: CUMULATIVE EXTENSIONS OF LOANS BY INTERNATIONAL FINANCIAL INSTITUTIONS  
TO ELECTRIC POWER INDUSTRIES, BY COUNTRY AND INSTITUTIONS, 1946-1975 AND 1970-1975**

(Millions of US dollars)

	1946-1975			1970-1975		
	World Bank and AIDa	IDBb	EXIMBANKc	World Bank	IDB	EXIMBANK
Argentina	292.0	203.4	48.5	543.9	262.7	18.0
Barbados	—	—	0.4	0.4	—	—
Bolivia	28.4	15.1	—	43.5	—	6.0
Brazil	978.1	627.8	340.9	1 946.8	435.0	269.8
Chile	132.1	83.8	60.9	276.8	75.3	21.0
Colombia	350.1	238.1	40.0	628.2	135.6	10.0
Costa Rica	81.3	57.0	—	138.3	54.8	2.0
Cuba	—	—	20.0	20.0	—	—
Ecuador	16.8	75.8	12.1	104.7	79.2	0.9
El Salvador	58.3	38.3	—	96.6	38.1	—
Guatemala	22.0	108.2	—	130.2	105.0	—
Guyana	6.0	—	—	6.0	—	—
Haiti	—	—	—	—	—	—
Honduras	80.1	—	—	80.1	—	—
Jamaica	22.0	9.2	34.1	65.3	9.2	19.1
Mexico	714.8	—	121.4	836.2	—	81.1
Nicaragua	66.3	—	16.5	82.8	16.5	16.5
Panama	76.0	—	12.0	88.0	—	4.6
Paraguay	—	91.1	—	91.1	62.6	—
Peru	66.5	13.9	4.4	84.8	9.2	—
Dominican Republic	—	67.1	—	67.1	7.4	—
Trinidad and Tobago	25.0	—	4.5	29.5	—	4.5
Uruguay	73.6	—	—	73.6	36.1	—
Venezuela	145.0	19.6	27.1	191.7	—	3.0
Regional projects	—	174.4	—	174.4	61.3	—
<i>Total for the electricity sector</i>	<i>3 234.4</i>	<i>1 822.8</i>	<i>742.8</i>	<i>5 800.0</i>	<i>1 388.0</i>	<i>450.5</i>
<i>Total loans to Latin America</i>	<i>7 018.4</i>	<i>8 791.0</i>	<i>d</i>	<i>d</i>	<i>5 473.0</i>	<i>d</i>

Source: World Bank: annual reports; Inter-American Development Bank: annual reports; EXIMBANK: Foreign Credit by the United States Government, 30 June 1973 (1945-1973), and International Review Service (only incomplete data available for 1974 and 1975).

aWorld Bank: 1946-1975.

bInter-American Development Bank: 1961-1975.

cEXIMBANK, 1945-1975 (only long-term loans).

dNot available.



hydropower accounted for more than four-fifths of domestic power supplies in that year. Between these extremes, countries varied markedly in their reliance on hydropower in 1975.

It might seem strange, at first sight, that a region so richly endowed in economically exploitable hydropower potential as Latin America has not achieved an even higher degree of reliance on hydropower (*vis-à-vis* thermal power) than that revealed by the data in table 35. However, a number of practical considerations have combined to limit this reliance. Chief among these factors have been the following: the comparatively high capital requirements for generation and transmission associated with hydro projects *vis-à-vis* thermal power projects; the comparatively high social opportunity cost of capital in Latin America, which gives rise to a more powerful bias against the hydropower option, since it is usually more capital-intensive, than against the (non-nuclear) thermal power option; the secular decline in the real CIF price of imported oil during much of the post-war period; the growing concentration of population and power markets in large coastal cities with easy access to locally refined and imported oil products; and the need to increase thermal generating capacity, in part simply as insurance against the vagaries of future conditions of water availability.

The slow secular decline in the quantitative share of thermal stations in the regional generation of electric energy has been accompanied by greater reliance on oil and, to a lesser degree, on natural gas as the thermal power industry's leading fuels (see table 40). Power plants fired by vegetable fuels have now lost their earlier quantitative significance. A milestone event in Latin America's power industry was the introduction of nuclear power in 1974.<sup>48</sup>

Table 40

**LATIN AMERICA: TOTAL FUEL CONSUMPTION AND FUEL CONSUMPTION  
IN THE GENERATION OF ELECTRIC POWER, 1950, 1960, AND 1974**

(Millions of tons of petroleum equivalent)

Fuel	1950			1960			1974		
	Total	Electricity	Percentage	Total	Electricity	Percentage	Total	Electricity	Percentage
Derivates	29	4.2	14	58	10.2	18	126	19.0	15
Natural gas	3	0.6	20	9	2.2	24	34	6.0	18
Coal	6	0.3	5	6	0.6	10	11	1.6	15
Vegetable fuels	29	0.9	3	35	1.0	3	41	1.1	3
<b>Total</b>	<b>67</b>	<b>6.0</b>	<b>9</b>	<b>108</b>	<b>14.0</b>	<b>13</b>	<b>212</b>	<b>27.7</b>	<b>13</b>

Source: CEPAL, on the basis of official data.

The overall pattern of fuel-use in Latin America's electric power industry may be summarized as follows. Within integrated power systems, hydropower and nuclear power, when available, are used to the maximum extent possible. Fuel oil typically supplies the bulk of the remaining requirements for generating the base load, but coal-fired plants are used for this purpose in some countries. Peaking power is widely supplied from fuel oil stations and from many relatively small and high-cost diesel plants, although in some countries natural gas has been displacing diesel oil for this purpose. Hydropower also serves as a peaking fuel, subject to the availability of water.

<sup>48</sup> In 1974 the 319 megawatt nuclear power plant of Atucha, Argentina went operational.

The pattern of fuel-use in isolated power systems also varies widely. When the scale of power consumption is relatively large, requirements are often met using fuel oil, although depending on the local pattern of resource endowment, hydropower or coal may be employed to meet power needs in these larger systems. The more typical case, however, is the small isolated power system, reliant on old, comparatively high-cost diesel plants or, in rare cases, on vegetable fuels.

The application of technical change has promoted greater efficiency in fuel-use in Latin America's thermal power industry in the post-war era (see table 41). During 1960-1974 the average heat rate of public sector thermal stations declined from 3,700 to 3,200 kilocalories per kWh generated, i.e. on average, by 1.0 per cent per annum. By way of comparison, however, the average heat rate of central power plants in the OECD countries in 1973 was about 2,500 kilocalories/kWh.

A large part of these gains in thermal efficiency are explained by progress in a few countries, such as Argentina and Mexico, (see table 41). These countries are dominant in public sector generation of thermal power in the region, and have recorded significant improvements in thermal efficiency.

During the post-war period progress in the physical efficiency of fuel-use in Latin America's thermal power industry has been chiefly the result of meeting a demand for increasing volumes of power by substituting larger, and thermally more efficient, power plants for older plants to serve integrated networks which in turn have been expanding through interconnexions. In Argentina and Mexico, for example, the scale of market requirements has warranted the introduction of thermal plants in the 300-350 MW range. Such plants have heat rates of the order of 2,000 kcals/kWh when operating at design capacity. The use of thermal power plants such as these to meet base load requirements enabled some Latin American countries to put into reserve or scrap thermally less efficient plants; but the introduction of thermal power plants of this size has not been economically feasible in many Latin American countries, given the small scale of their power markets. In such countries, this last factor has been a major impediment to thermal efficiency gains in the thermal electric power industry.

Thermal power generation in Latin America has increased at a more-or-less steady rate, averaging 8.2 per cent per annum during 1950-1975. The rate of growth of thermal efficiency in the region's central thermal stations has been much slower, however, and has shown strong deceleration in recent years. In the power industry of Chile and in the public power systems of other Latin American countries (Argentina, El Salvador, and Guatemala), average heat rates have actually increased during the 1970s (see table 41). The more rapid rate of increase in thermal generation than in thermal efficiency gains has exerted upward pressure on fuel consumption in the industry, as it has on the index of energy input per unit of real output at the national level. The relative rate of growth of these two variables will play an important role in determining the volume of oil and modern energy consumption in the future.

The other major contribution to the decline in the heat rate of Latin American power systems has been the interconnexion of electrical systems, stimulated by advances in transmission technology in the developed countries. In 1950, electric power could be transported economically up to a limit of about 450 kilometers, in contrast with today's range of about 2,000 kilometers. This capability to transport electric energy economically over longer distances has made it possible not only to substitute hydropower for thermal power in Latin America, but also, given the pattern of generation capacity in the system, to substitute lower-cost for higher-cost power flows in the region's many thermal power systems as well.

At the regional level, the interconnexion of electric power systems across national frontiers holds considerable promise for thermal efficiency gains and for socio-economic progress in general in Latin America. So far, however, these gains remain largely untapped. The only international interconnexion schemes now operational in the region are those providing for one-way power flows from Paraguay to Brazil and Argentina, plus three others providing for two-way exchanges of power on a comparatively small scale between Uruguay and Brazil, between

Table 41

**LATIN AMERICA: GENERATION AND HEAT EFFICIENCY IN GENERAL POWER PLANTS,  
SELECTED COUNTRIES, 1960-1974 (SELECTED YEARS)**

		1960			1965			1970			1974		
		Genera- tion (GWH)	Effi- ciency (kcal/KWH)	Genera- tion (GWH)	Effi- ciency (kcal/KWH)	Genera- tion (GWH)	Effi- ciency (kcal/KWH)	Genera- tion (GWH)	Effi- ciency (kcal/KWH)	Genera- tion (GWH)	Effi- ciency (kcal/KWH)	Genera- tion (GWH)	Effi- ciency (kcal/KWH)
Argentina	(Public service)	6 993	3 870	9 994	3 152	15 315	2 952	17 070	3 100				
Bolivia	(Total)							229	3 565				
Brazil	(Total)					5 248	3 686	6 904	3 244				
Chile	(Total)	1 615	3 329	2 177	3 432	3 244	3 031	3 249	3 118				
Colombia	(Total)	600 <sup>a</sup>	2 567 <sup>a</sup>	1 573 <sup>a</sup>	3 810 <sup>a</sup>	1 916 <sup>a</sup>	4 395 <sup>a</sup>	4 380	4 120				
Costa Rica	(Public service)	34	5 015	80	4 704	47	4 106	167	3 237				
Ecuador	(Total)					544	3 699	905	3 304				
El Salvador	(Public service)	13	4 154	32	4 415	179	2 872	402	3 280				
Guatemala	(Public service)	127	3 951	323	3 506	332	3 259	540	3 498				
Honduras	(Public service)	52	4 493	36	5 911			59	2 828				
Jamaica													
Mexico	(Public service)			6 079	3 293	11 225	3 220	21 851	2 930				
Nicaragua	(Public service)	108	5 162	77	6 082	241	3 736	388	3 364				
Panama	(Public service)	197	4 934	420	4 102	761	3 612	999	3 482				
Paraguay	(Total)							65	6 096				
Peru	(Total)					1 708	6 248	2 055	3 923				
Dominican Republic	(Public service)					831	3 215	1 321	3 020				
Trinidad and Tobago	(Public service)								...				
Uruguay	(Public service)	261	3 862	542	3 456	908	3 126	911	3 211				
Venezuela	(Public service)	568	3 680	1 039	3 488	890	3 293						
	(CADAPE)					1 932	3 902	2 333	4 324				
	(Electricidad de Caracas)	1 247	3 172										
<i>Total</i>		11 815	3 683	22 372	3 332	45 321	3 377	63 828	3 219				
Thermoelectricity generation in the public service category in Latin America		22 217		31 883		49 984		68 282					
Total thermoelectricity generation in Latin America		33 758		48 670		69 821		90 401					

Source: CEPAL, on the basis of official data.

<sup>a</sup>Public service only.

Colombia and Venezuela, and between Ecuador and Colombia. In addition an interconnexion enables Mexico to import power, again on a relatively modest scale, from the United States.

Technical progress in Latin America's power industry has also been slow in the reduction of line loss. Such reductions generate direct savings in fuel inputs into thermal power systems, and they are a source of efficiency gains in the use of capital. In power systems that are short of spare generation capacity, line-loss reductions also make it possible to improve the quality of service to consumers.

The data in table 33 show that the ratio of transmission and distribution losses (including theft) to electric power consumed (i.e., the line-loss ratio) has declined slowly in the region since the 1950s, from 15 per cent in 1950 to 12 per cent in 1976.

In many Latin American power systems, line-loss ratios are much higher than the regional average would suggest. In 1975, for example, particularly high ratios were recorded in El Salvador (31 per cent), the Dominican Republic (29 per cent), Costa Rica (25 per cent) and Haiti (25 per cent). On the other hand, they have been reduced to relatively low levels in Brazil (9.5 per cent) and Chile (9.1 per cent). By way of comparison, line-loss ratios in the developed countries are about 10 per cent. Given the strong increase recorded in the cost of world energy supplies since 1973, the reduction of line loss now constitutes an even more promising area than in the past for cost-reducing investments in the power systems of many Latin American countries.

Changes in plant factor ratios<sup>49</sup> in Latin America's electric power industries in the post-war period warrant comment at this point. The average plant factor in the electric power industry has increased from 3,517 hours in 1950 to 3,774 hours in 1975. The ratios of individual countries vary considerably however. In countries with relatively high levels of industrial demand for power and/or with comparatively well-integrated power networks (such as Brazil and Venezuela), plant factors tend to be higher than in countries where the household component of power demand is dominant. On the one hand, a low plant factor may simply reflect an excess of installed generating capacity. On the other hand, a rate of growth in the consumption of electric energy that, over time, is outdistancing the rate of growth in generating capacity would put an upward pressure on the plant factor. Clearly, the diversity of factors influencing a nation's plant factor suggests caution in interpreting changes in it.

Developed countries, with high levels of industrial power demand and comparatively well-integrated power networks, have plant factors usually well in excess of 4,000 hours.<sup>50</sup> The plant factors of power systems in many of the underdeveloped countries outside Latin America fall in the range of 1,500-2,000 hours, whereas those for Latin America are concentrated in the 3,000-4,000 hour range. With due respect for the diversity of factors underlying this international pattern, a comparison of the plant factors and power markets of Latin America and the developed countries would suggest that there are three kinds of change that could promote desirable increases in Latin America's plant factors in the future; first, continued growth in the base load component of electric power consumption, where this is economically rational in the first place; second, progressive integration of electric grid systems; and, third, improvements in the area of peak power management.

A comment is in order at this point on the degree of progress made in the area of cycle standardization in post-war Latin America. In the early post-war period, there was a pronounced absence of cycle standardization in many national power markets of the region (see table 42). In general, however, this did not constitute an inordinately pressing problem from the point of view of system operation because, at that time, the degree of grid integration was relatively primitive. As the goal of grid integration became more widespread in the region, however, the lack of cycle

<sup>49</sup> The plant factor ratio is the volume of electricity generated in a given power system divided by the installed in-service generation capacity.

<sup>50</sup> In 1973, for example, the following plant factors were recorded: United States, 4,252 hours; Japan, 4,905; Canada, 4 823; West Germany, 4,819; Soviet Union, 4,677; East Germany, 5,378; Poland, 4,755.

standardization became a more serious problem. By and large, this problem has now been resolved.

In Brazil, for example, up to the 1960s some service areas were supplied with power of 50 Hertz, others with 60 Hertz. In 1964, however, 60 Hertz was established as the national standard, and by the early 1970s, Brazil has fully converted to this standard.

In Venezuela, 60 Hertz was also adopted in the early 1960s as the national standard, and work began on the task of cycle conversion, which was finally achieved in the early 1970s.

Power supplies in Mexico had long been generated using two cycles, and in 1950, they were about equally split between 50 and 60 Hertz. In the late 1960s however, 60 Hertz was adopted as the national standard, and by the early 1970s cycle standardization in Mexico was nearing completion.

By 1975, the situation with respect to cycle standardization in continental Latin America was the following: Argentina, Bolivia, Chile, Paraguay and Uruguay generate on 50 Hertz while the remaining countries in the region are in various stages of the process of cycle standardization, and when their conversion programmes are completed they will be generating exclusively on 60 Hertz. Generalizing for the region as a whole, therefore, cycle standardization at the national level is now virtually complete (see table 42). The fact that two cycles are in use in the region may at times constitute an obstacle to intra-regional trade in electricity and especially to the joint development of water resources for the production of hydroelectric power. Nevertheless, technical progress in the area of cycle standardization has contributed, in no small part, to increase efficiency in the use of fuels and capital in Latin America's electric power industry in the post-war era.

(iii) *Ownership.* One of the most striking changes in Latin America's power industry since the 1950s has been the rise of State ownership. Table 43 shows that in 1950 public power authorities in Latin America accounted for only 10 per cent of the power supplied by generating companies (including self-suppliers). By 1975, this ratio had increased to 78 per cent. In effect, during 1950-1975, the State has changed its role in regional power generation from one of a quantitatively minor supplier among established electric power companies to a virtual monopolist.

A similar rise to predominance is evident in the distribution segment of the region's electric power industry (see table 44). Generally speaking, the transmission of electric power in Latin America has traditionally been a public sector undertaking with private power companies in the region concentrating their investments in the delate thermal generation segment of the industry.

For the most part, the transition from private to public sector ownership was achieved through the purchase of assets by the State. The reasons underlying increased State ownership of the domestic power industry vary widely, of course, from country to country, but generally speaking they probably included one or more of the following considerations. First, the State could acquire the assets of domestic generating and distribution companies on favourable terms. Second, the fact of a major foreign presence in the domestic generating segment of some power industries in the region probably provoked considerable popular pressure for a State takeover. Third, in countries where the price of electricity was being kept below its long-run supply cost by the State, public ownership may have been chosen as a way to ensure increasing power supplies over time without extending politically embarrassing price increases or subsidies to power companies in general and to private foreign power companies in particular. Finally, in some cases the State may have been convinced, for a variety of reasons, that the attainment of its goals required a rate of expansion of the domestic power industry which was simply not consistent with private ownership of that industry.

Table 42

## LATIN AMERICA: GENERATING FREQUENCY, SELECTED COUNTRIES, 1950 AND 1975

Country	1950		1975		Remarks
	50 cycles	60 cycles	50 cycles	60 cycles	
Argentina	100.0	—	100.0	—	
Bolivia	100.0	—	100.0	—	
Brazil	42.0	58.0	—	100.0	
Chile	100.0	—	100.0	—	
Colombia	—	100.0	—	100.0	
Costa Rica	—	100.0	—	100.0	
Cuba	—	100.0	—	100.0	
Ecuador	—	100.0	—	100.0	
El Salvador	—	100.0	—	100.0	
Guatemala	—	100.0	—	100.0	
Guyana	100.0	—	...	...	Conversion to 60 cycles planned
Haiti	—	100.0	—	100.0	
Honduras	—	100.0	—	100.0	
Jamaica	100.0	—	100.0	—	
Mexico	53.0	47.0	...	...	Conversion to 60 cycles planned
Nicaragua	—	100.0	—	100.0	
Panama	—	100.0	—	100.0	
Paraguay	100.0	—	100.0	—	
Peru	—	100.0	—	100.0	
Dominican Republic	—	100.0	—	100.0	
Trinidad and Tobago	100.0	—	100.0	—	
Uruguay	100.0	—	100.0	—	
Venezuela	60.0	40.0	—	100.0	

Source: CEPAL, on the basis of official information.

Table 43

LATIN AMERICA: ELECTRIC POWER GENERATION BY SECTOR, SELECTED COUNTRIES, 1950, 1960 AND 1975  
(Millions of KWH and percentages)

	1950				1960				1975						
	Public service		Own- account	Total	Public service		Own- account	Total	Public service		Own- account	Total			
	Private capital	Public capital			Private capital	Public capital			Private capital	Public capital					
Argentina	3 920	603	4 523	780	5 303	4 242	3 621	7 863	2 595	10 458	2 293	22 261	24 554	4 915	29 469
Brazil	7 500	—	7 500	708	8 208	14 898	3 616	18 514	4 351	22 865	9 142	66 804	75 846	4 447	80 293
Mexico	3 050	500	3 550	874	4 424	200	8 389	8 589	2 139	10 728	—	39 400	39 400	4 106	43 506
Chile	780	379	1 159	1 784	2 943	751	1 591	2 342	2 250	4 592	—	6 203	6 203	2 529	8 732
Colombia	800	250	1 050	220	1 270	455	2 340	2 795	525	3 320	—	12 693	12 693	1 906	14 599
Peru	380	60	440	380	820	800	378	1 178	1 470	2 648	—	4 565	4 565	3 131	7 696
Venezuela	430	123	553	600	1 153	1 851	1 040	2 891	1 679	4 570	7 121	11 558	18 679	2 500	21 179
Rest	1 610	839	2 449	1 033	3 482	1 538	4 780	6 318	2 180	8 496	4 053	16 231	20 284	3 507	23 791
Total	18 470	2 754	21 224	6 379	27 603	24 735	25 755	50 490	17 189	67 677	22 609	179 615	202 224	27 041	229 265
Percentage of total															
Argentina	73.9	11.4	85.3	14.7	100.0	40.6	34.6	75.2	24.8	100.0	7.8	75.5	83.3	16.7	100.0
Brazil	91.4	—	91.4	8.6	100.0	65.2	15.8	81.0	19.0	100.0	11.4	83.2	94.6	5.4	100.0
Mexico	68.9	11.3	80.2	19.8	100.0	1.9	78.2	80.1	19.9	100.0	—	90.5	90.5	9.5	100.0
Chile	26.5	12.9	39.4	60.6	100.0	16.4	34.6	51.0	49.0	100.0	—	71.0	71.0	29.0	100.0
Colombia	63.0	19.7	82.7	17.3	100.0	13.7	70.5	84.2	15.8	100.0	—	86.9	86.9	13.1	100.0
Peru	46.3	7.3	53.6	46.4	100.0	30.2	14.3	44.5	55.5	100.0	—	59.3	59.3	40.7	100.0
Venezuela	37.3	10.7	48.0	52.0	100.0	40.5	22.8	63.3	36.7	100.0	33.6	54.6	88.2	11.8	100.0
Rest	46.2	24.1	70.3	29.7	100.0	18.1	56.3	74.4	25.6	100.0	17.0	68.2	85.2	14.8	100.0
Total	66.9	10.0	76.9	23.1	100.0	36.5	38.1	74.6	25.4	100.0	9.9	78.3	88.2	11.8	100.0

Source: CEPAL, on the basis of official information.

Table 44  
**LATIN AMERICA: DISTRIBUTION OF ELECTRIC POWER BY PRIVATE SECTOR  
COMPANIES, SELECTED COUNTRIES AND YEARS**

<i>Country</i>	<i>Beginning of period</i>		<i>End of period</i>	
	<i>Year</i>	<i>Percentage</i>	<i>Year</i>	<i>Percentage</i>
Argentina	1957	87.8	1975	8.2
Brazil	1957	91.2	1975	45.3
Mexico	1950	82.0	1975	0.0
Chile	1950	96.4	1975	5.1
Colombia	1950	76.2	1975	0.0
Peru	1952	94.3	1975	2.0
Venezuela	1959	66.2	1975	32.4

*Source:* CEPAL, on the basis of official information.