PN-ABQ-041

AN ENERGY STRATEGY FOR LATIN AMERICA AND THE CARIBBEAN

DRAFT REPORT

Prepared for:

Office of Energy and Infrastructure
Latin America and Caribbean Bureau
U.S. Agency for International Developement
Washington, DC

Prepared by:

RCG/Hagler, Bailly, Inc.
370 L'Enfant Promenade SW
Suite 700
Washington, DC 20024

November 1991

HBI Reference No. 90-4412

CONTENTS

EXECUTIVE SUMMARY

1. INTRODUCTION

Background 1.1
Objectives of the Study 1.2
Organization of the Report 1.3

2. ISSUES

Energy Resources and Use 2.1
Fossil Fuels 2.1
Renewables 2.2

Energy Supply and Demand 2.3

Energy and Economic Linkages 2.7
Energy Pricing Policies 2.7
Dependence on Energy Imports 2.8
Investment Requirements in the Energy Sector 2.11
Financial Problems of Electric Utilities 2.12
Electricity Shortages and Unreliable Electricity Supplies 2.15
Inefficiencies in Energy Supply and Use 2.16

Environmental Issues and Implications 2.17
Background 2.17
Environmental Impacts of Energy Supply and Consumption 2.18

3. RECOMMENDATIONS

Analysis of Energy Sector Opportunities 3.1

Recommendations on Energy Efficiency and Conservation 3.1
Power Subsector 3.3
Industrial Subsector 3.6

CONTENTS

Transport Subsector 3.7

Recommendations on the Promotion of Private Sector Involvement 3.8
Power Subsector 3.9
Oil and Gas Subsector 3.10

Recommendations on Environmental Protection 3.11

Recommendations on Small Renewable and Rural Energy Development 3.12

Conclusions 3.14

APPENDICES

1. Trends in Energy Production and Consumption in the LAC Region
2. Regional Installed Capacity Profile by Type of Plant 1990
3. Regional Electricity Generation by Type of Plant 1990
4. 1990-1999 Capital Expenditures for Power in the LAC Region
5. Domestic Consumer Prices (June 1991) in the LAC Region and Estimating Petroleum Product Prices in Three LAC Countries
6. Electric Sector Tariffs (June 1991)
7. 1990 Energy Import Classification of the LAC Region
8. Energy Balances for Selected Countries in the LAC Region
9. Donor Activities

BIBLIOGRAPHY

EXECUTIVE SUMMARY

1. INTRODUCTION

Profound and rapid changes are taking place in the energy sectors of Latin America and the Caribbean as the region prepares to resume economic growth after decades of stagnation caused by heavy external debt and political turmoil. The recent conference of Latin American leaders in Mexico had a simple but strong message to the world: the region is now open for business.

This statement is particularly relevant to the energy sector, as many countries are taking steps to demonopolize their power, gas and oil utilities. In the midst of these changes, A.I.D. faces new major challenges:

- Promote stability and growth in the increasingly privatized energy sectors.
- Ensure that energy-related environmental issues receive adequate attention in the face of a more diversified ownership of energy production means.
- Maintain a fertile climate for trade and investment by U.S. companies in this emerging market.

2. ENERGY AND THE ECONOMY

The economic growth of the Latin American and Caribbean (LAC) region in the 1980s was sluggish and often stagnant, although energy consumption continued to grow during this period. Between 1982 and 1989, real GDP in the region grew at an average rate of only 1.4 percent per year, and real per capita GDP fell by almost 1 percent per year. In this same period, energy consumption grew 2.6 percent per year. Per capita energy consumption doubled, from 514 kilograms oil equivalent (kgoe) in 1965 to 1010 kgoe in 1989.

The region's large external debt has been a major cause of the economic stagnation that has plagued LAC countries in the last decade. The external debt represents nearly US $1,000 per capita. The energy sector, and in particular the electric power sector, accounts for a significant share of total LAC debt. The Latin American Energy Organization (OLADE) has estimated that in 1989, the power sector accounts for 10 percent of the LAC region's total debt

on average. In 1989, the power subsector accounted for 28 percent of total debt in Colombia and Uruguay, and 25 percent in Honduras. The governments' budget contributions for the 1990s to the power subsector are now more limited than ever because of pressing social needs and other priorities in the economy, including keeping fiscal deficits within prudent limits.

While the oil and gas subsectors are generally healthy, many electric utilities in the LAC region are facing a financial crisis which threatens their ability to meet the electricity needs of their customers. Internal fund generation has been squeezed by low tariff levels and high debt service payments, while the availability of fresh credit has been greatly reduced by the poor credit standing of governments in the region and the weak financial position of the electric utilities themselves. The multilateral banks and other funding sources that sustained the massive expansion of the LAC power systems over the last several decades will not be able to supply more than a fraction of the funds that will be needed in the 1990s.

The expected higher economic growth for the 1990s for the region will spur an increase in energy demand. The International Monetary Fund (IMF) projects a 3 percent annual growth in real GDP for the region in the 1990s. The Mexico-US Free Trade Agreement and the Initiative of the Americas are expected to further boost economic growth in the region. The President of the Inter-American Development Bank (IDB) has stated "Latin America's ongoing market-oriented reforms not only will make the region more competitive as it seeks to participate in the expansion of world trade but also will make the region more attractive to foreign direct investment."

The World Bank has estimated that capital expenditures during the 1990s for the power subsector alone will be around US $155 billion. Capital availability in the region is highly constrained, and many government have found it increasingly difficult to allocate sufficient resources to the power subsector to ensure that demand is met. The economic cost of this electrical energy not served is very high: the World Bank has estimated that it could represent over twenty-fold the cost of producing the energy. With electricity demand growing on average at 6-7 percent per year for many countries, the installed generation capacity would have to double in the 1990s.

Several countries in the LAC region are already facing serious energy shortages. Guatemala and El Salvador are facing a period of drought, which has reduced electrical generation capacity by one third with serious macroeconomic consequences. During this drought (their systems are over 60 percent hydroelectric), the countries have resorted to rationing of up to 7

hours per day. The Guatemala Chamber of Industry reported that industrial productivity could be reduced by 20 percent (assuming the rationing would last for 5 months), and that for each month that electricity is rationed, the inflation would increase about 4 percent. In 1989, Argentina faced a severe power shortage caused by repairs on a major dam, an outage of thermal capacity due to lack of maintenance, low rainfall, and non-availability of a nuclear power plant. The power shortage necessitated rotating blackouts and power curtailments to large industrial users, as well as greater dependence on fossil-fired generation. For Brazil, although it does not have power shortages at this time, if demand grows in excess of 5 percent per year in the short run, the need for rationing could occur by the mid 1990s.

3. ENERGY AND THE ENVIRONMENT

Energy development, production, and use has serious local, regional, and global environmental impacts. Although the energy sector has helped fuel industrialization and economic growth and development in the LAC region, energy production and consumption has also been a major contributor to the deterioration of the region's natural environment. While there has been substantial success in implementing and enforcing urban regulations to reduce emissions from the transport sector, the agencies responsible for environmental control of the electricity, oil, and gas subsectors remain very weak in resources and authority.

Energy production is the single-largest contributor to man-made carbon dioxide (CO_2) in the atmosphere, which has a firm linkage to global climate change. The level of carbon monoxide (CO) in many urban areas in LAC is unacceptable, formed mainly due to the incomplete combustion of fuels and industrial process. Health effects from lead (Pb) poisoning can cause severe learning disabilities and other physiological impacts, and is airborne mainly from auto exhaust fumes and nonferrous metal smelters. Nitrogen oxides (NOx) formed partly in power plants plays a major role as a photochemical smog component, and causes respiratory illnesses and other physical impacts. Sulfur dioxide (SO2) caused by the combustion of sulfur containing fossil fuels, smelting of sulfur ores, industrial processes and volcanic eruptions, can cause significant respiratory tract disorders, increase mortality, and aggravate respiratory illnesses; further impacts include acid rain and acidification of lakes and reservoirs.

4. A.I.D. FOCUS

A.I.D. has been active in the energy sector of LAC. Many activities have been successful and it is not unlikely that the current thirst for change is, to some extent, the result of an awareness brought about by some of those activities. A.I.D. now needs to adjust its focus in response to the emergence of different demands. Few governments in LAC remain to be persuaded of the need for market prices or the advantages of private sector involvement. Most governments instead need much assistance in promoting those objectives, prioritizing and implementing energy efficiency programs, and developing regulatory policies and enforcing them.

Some of the issues that A.I.D. has been addressing in the last few years still exist in many countries and need attention. For instance, not all the prices of energy products everywhere are rapidly moving towards their true economic value and A.I.D. may need to insist on the issue of energy pricing in some isolated cases. Conservation and efficiency, rural development and the promotion of renewable sources of energy continue to offer fertile ground for assistance. Recommendations in those areas are shaped by the new trends in the region as well as from lessons learned by A.I.D.'s past involvement.

Regarding the environmental impacts of energy activities, it is important to recognize that the most remote areas of LAC's interior are rapidly being pressed into service to supply the energy-hungry periphery which now houses some of the largest cities in the world. The need for strong environmental protection will be critical in the years to come and A.I.D. can play a very useful role in helping with the implementation of powerful environmental protection agencies.

One persistent difficulty in developing a coherent energy strategy is in the clustering of necessary activities into major groups with specific guiding principles. The tendency to draw lines across energy subsectors or energy sources must be eluded because the elements that characterize policy are not peculiar to those boundaries. Instead, the clusters should reflect major areas of assistance each with well defined but mutually consistent policies.

Based on the considerations above it is concluded that use of A.I.D. funds in the energy sector of LAC should focus in the following broad areas and be guided by the following general principles:

- **Energy Efficiency and Conservation**

Not all, but many of the traditional problems of the inefficient production, transmission and distribution of power will be slowly but gradually corrected through the demonopolization and privatization of power utilities. Energy conservation in the transport sector will follow from the implementation of rational pricing policies. However, the residential and industrial subsectors may be slower to respond and need to learn a great deal about the means available to them to respond to those new prices without reducing essential use and without pricing themselves out of their current markets. For these reasons, it is recommended that A.I.D.'s focus on energy conservation and efficiency be placed increasingly on end-use as opposed to energy production or transformation.

- **Promotion of Private Sector Involvement**

The objective of those countries pursuing demonopolization appears to be the same: to achieve diversity of supply, freeing the state from financial burden and protecting the public by means of regulatory frameworks and legislation similar to those that exist in the United States. However, the U.S. energy sector evolved through many decades to its current system and in many LAC countries there are serious obstacles to such a rapid development. Notable among these is the lack of active local capital markets and slow administration of commercial law. Regulatory frameworks in LAC need to be simpler and local capital needs greater incentives and guarantees to become involved. Also, those countries that have already passed legislation to demonopolize their energy sectors seem concerned about the lack of immediate response from U.S. companies and it is also evident that many U.S. companies are not sufficiently aware of the opportunities available in LAC. The recommended policy is to assist in the development and adjustment of the emerging regulatory frameworks, promote the awareness of U.S. investors regarding the opportunities opening up in LAC, and help LAC governments understand the global market conditions in order to make their energy sectors attractive to private capital.

- **Environmental Protection**

Energy related environmental concerns will grow. If environmental protection from energy activities was weak under the monopolistic state utilities, it is likely to become even weaker under an increasingly private ownership. The embryonic environmental protection agencies in the region have little authority. They lack the know how, the instrumentation, and some of

the most basic logistic means to carry out their mandates or even to set policies and standards. It is recommended that A.I.D. offer assistance in the strengthening of these emerging institutions, helping them acquire state-of-the-art methodologies and instrumentation and to develop adequate standards and regulations for compliance.

- **Small Renewable and Rural Energy Development**

Renewable energy resources developed for large-scale power production include hydroelectricity and geothermal power. Small hydro, wind and solar energy are still very rare because they are not very economically attractive when connected to the grid, even without subsidies in fossil fuels. Small-scale uses of biomass will follow from the increasing interest in cogeneration from agricultural waste; indeed, cogeneration by sugar mills will in many countries become the first experiment in private power generation for public service. Some opportunities still exist to develop regional rural electrification networks in isolated regions powered by small hydro or biomass facilities, but these are relatively few. It is recommended that rural development in the energy sector focus on the increasing substitution of wood by commercial fuels and that the development of renewables be placed in the context of private power and be driven by market forces and promotional policies.

5. USE OF FUNDS

The leverage that can be obtained by co-funding activities with multilateral development agencies is important. A.I.D.'s cooperation with the World Bank and the Interamerican Development Bank is likely to be increasingly welcome when it comes to activities in the private sector where these agencies are less experienced. Existing cooperation agreements with these agencies should be reinforced as much as possible, and specific coordinators must be appointed for those activities were cooperation has been agreed. Some studies carried out with A.I.D. funding in recent years could provide excellent opportunities for World Bank and IDB lending to the private sector.

Among the lessons learned on the use of A.I.D. funds is that Agency funds will have greater impact if they are allocated for long-term (two or three years) activities rather than several smaller short-term activities. This will ensure continuity and greater scope in the activities undertaken, as well as guarantee the implementation of programs.

6. RECOMMENDED ACTIVITIES

Based on the economic, environmental, and energy trends into the 1990s, the following activities are recommended for A.I.D. assistance in the region:

RECOMMENDATIONS ON ENERGY EFFICIENCY AND CONSERVATION

Power Subsector

Electricity Tariff Development

- *Financial Analysis.* Determine the financial soundness of the utility, review the accounting procedures, and determine the cash flow revenue requirements.

- *Marginal Cost Analysis.* Determine the medium- to long-term marginal costs of the utility by customer class.

- *Tariff Design.* Based on the results of the financial and marginal cost analyses, develop tariffs that would reflect the true economic cost of providing service to the customer class, considering financial and socio-economic ramifications. Dynamic pricing mechanisms should be established with the introduction of time-of-use and interruptible tariffs.

End-Use Efficiency Improvement and Load Management

- *End-Use Efficiency.* Assess and prioritize end-use efficiency target areas, patterns, and technologies at the level of the national economy.

- *DSM Programs.* Develop and implement demand-side management programs. This will include pilot projects and technical and economic analyses of various DSM measures in comparison to electric power capacity increases on the supply side as part of an overall IRP concept for electric utilities.

- *Codes and Standards.* Define standards and codes for efficient appliances and industrial equipment.

Power Plant Rehabilitation

- *Feasibility Studies.* Prepare feasibility studies leading to a rehabilitation program and follow-up maintenance.

Reduction of Transmission and Distribution Losses

- *System Losses.* Assess T&D system losses and prepare loss reduction programs.

Industrial Subsector

Energy Efficiency Measures

- *Issues Analysis/Case Studies.* Analyze the technical and non-technical issues faced by the subsector in implementing energy efficiency measures. Perform case studies to analyze industrial energy consumption and the energy and environmental policy framework, and make recommendations. These case studies should be supported with the appropriate development of energy-efficiency standards for thermal and electrical equipment.

- *Energy Audits.* Perform preliminary site energy audits and make recommendations to plants. This should be followed up by providing designated energy staff with "know how" and monitoring equipment to continue the audit work. These audits should focus on overall industrial productivity, including long-term energy management, production efficiency, and quality control.

- *Cogeneration.* Foster the implementation of cogeneration projects. This would include supporting feasibility studies for possible demonstration project implementation and developing training courses that underscore the importance of cogeneration in reducing energy consumption and costs.

Transport Subsector

Fuel Efficiency

- *Standards.* Establish fuel efficiency standards for new vehicles as an effective means to improve the vehicle stock.

- *Awareness.* Increase awareness regarding proper vehicle care, fleet maintenance, driving habits, etc. to reduce fuel consumption.

- *Traffic Management.* Conduct studies to improve traffic flow in large cities and congested areas.

RECOMMENDATIONS ON THE PROMOTION OF PRIVATE SECTOR INVOLVEMENT

Power Subsector

Private Power

- *Competitive Bidding.* Promote competitive bidding processes for independent power and cogeneration projects as an alternative to agreeing to a specific purchase price. Provide assistance to develop standard offers with clear conditions and evaluation criteria, and help in the evaluation of bids and in the contractual negotiations phase.

- *Feasibility Evaluations.* Offer funding for feasibility evaluations to be made against known power purchase criteria and conditions. This should encourage the industrial subsectors to pressure their governments for clear rules and would improve the chances that attractive projects would go ahead unimpeded.

- *Legislation.* Promote the development of PURPA-type legislation as a means to protect investors and attract projects that are advantageous in terms of energy efficiency and environmental objectives.

Privatization of Power Utilities

- *Identify Investors.* Identify U.S. utilities and investors who are seriously interested in the region and help them stay up to date on regional privatization and private power developments through the dissemination of information.

- *Regulatory Context.* Develop a regulatory framework for the operation of a system of private electric utilities in generation, transmission, and distribution.

Oil and Gas Subsector

- *Investment Information.* Provide LAC governments interested in privatization with information on interested U.S. investors and also provide U.S. investors with information about investment opportunities in the LAC region.

- *Regulatory Framework.* Provide assistance in the development of regulatory policies for the distribution of oil and gas in those countries that are undergoing the privatization of this subsector.

- *Transportation Network.* Provide assistance in the development of effective transportation and storage networks.

RECOMMENDATIONS ON ENVIRONMENTAL PROTECTION ACTIVITIES

A.I.D. should provide support in the following areas to LAC governments:

- *Training.* Train staff on environmental standards, evaluation methodologies, available technologies, and instrumentation.

- *Regulations.* Assist in the development of regulations and compliance monitoring programs.

- *Instrumentation and Equipment.* Provide assistance in obtaining adequate tools and instruments, as well as equipment and transportation necessary for staff to perform their duties.

- *Special Studies.* Conduct specific studies on special problems in the protection of wetlands and other fragile environments and in the mitigation of impacts caused by effluents from geothermal plants.

- *Emergency Preparedness.* Provide assistance in the development of emergency preparedness plans to deal with the environmental impacts of spills and nuclear incidents.

- *Transport Standards.* Assist in developing standards and enforcement procedures to reduce emissions in the transport sector.

RECOMMENDATIONS ON SMALL RENEWABLE AND RURAL ENERGY DEVELOPMENT

Rural Electrification

- *Feasibility Studies.* Provide assistance to fund feasibility studies of small hydro projects and other renewables such as wind and photovoltaic to serve isolated systems in rural areas.

- *Project Promotion.* Provide assistance to promote these projects among developers in the U.S. who could be interested in joining forces with local capital for these developments.

Domestic Uses of Wood

- *Fuel Substitution.* Monitor the use of wood as a domestic fuel and conduct studies for the substitution of this fuel in those areas where its use exceeds the natural recovery capacity.

3.6 CONCLUSIONS

The LAC region has great interest in the largely private but carefully regulated energy industry of the United States. At the same time, there has never been so much interest in cooperation and trade, both between LAC countries and the U.S. and among the LAC nations themselves, and never has there been a greater need for that cooperation. While it is difficult to isolate the specific contribution of A.I.D. to these developments, it seems that, in general, past activities in the energy sector of the LAC have yielded very good return.

The next several years will present A.I.D. with both the opportunities and the challenge to provide effective and welcomed assistance in the energy sectors of the LAC region. A.I.D. can play a strong role in guiding LAC through the demonopolization process the region is so eager to accomplish. At the same time, A.I.D. can provide critical assistance to ensure that energy development is accomplished with due regard to local and global environmental concerns.

From its past strong focus on technical assistance to the public sector, A.I.D. should now shift to a stronger assistance to help the private sector do business in a region that is ready to welcome private capital, both foreign and local.

A.I.D. can be an important catalyst to private sector involvement and respond to public sector needs by providing information exchange, experienced advice and, in some case, financial support. Well focused assistance will yield a long lasting relationship of bilateral cooperation, help preserve the environment, and provide U.S. firms with a major share of the market opened by economic recovery in this region.

CHAPTER 1: INTRODUCTION

1.1 BACKGROUND

The Latin American and Caribbean (LAC) region is home to almost 500 million people who occupy one of the largest areas of the world. The region has abundant and largely unexploited natural resources, including large quantities of renewable energy resources. Currently, it is producing almost 20 percent of the world's hydroelectric generation and the potential for new hydroelectric development is huge. The region's 1990 oil reserves are estimated at 12.5 percent of the world's reserves, while its natural gas reserves account for 5.8 percent of the world total. Its coal reserves are a modest 1.7 percent of the world total.

The LAC region produced almost 3.73 billion barrels of oil equivalent (boe) during 1990, representing about 6.7 percent of total world energy production. During the same year, the region consumed 2.99 billion boe, representing around 5.4 percent of world consumption. The remaining 0.74 boe was exported, primarily oil from Mexico and Venezuela and coal from Colombia.

Although annual per capita energy consumption in the region varies widely (for example, 9.4 boe in Mexico vs. 0.015 boe in Haiti), on average, it is substantially lower than in the high-income economies of the OECD (7.4 boe in the LAC region vs. 37.8 boe in the OECD in 1989).[1] Despite this lower consumption, population growth and rising incomes will spur a tremendous growth in energy demand over the next decade. The demand for energy, especially electricity, is projected to increase at high rates in most LAC countries at least through 2025.[2] Meeting these growing energy needs will require huge capital investments.

Despite the region's uncertain political climate and dismal economic performance throughout the 1980s, its future is optimistic. By past Latin American and Caribbean standards, the inflation levels and growth prospects for most countries in the region look extremely promising. In addition, the region has embarked on political reform towards democracy and is

---

[1] World Bank. *World Development Report 1991*. New York, Oxford University Press, 1991, pp. 212-213.

[2] The Intergovernmental Panel on Climate Change has projected energy use in developing countries as part of their "Response Strategies Working Group Steering Committee, Task A." Several scenarios are presented with different economic growth and policy assumptions. The Panel estimates that energy consumption in the LAC region will grow from 2.75 billion boe/year in 1985 to 8.6 billion boe/year in 2010.

now interested in privatizing its markets. Most LAC countries are facing the challenging process of transforming their energy enterprise ownership structure to foster competition and efficiency.

In most LAC countries, parliamentary procedures, elections and the investigative press have made great advances. The stage has been set for building an infrastructure for stable political governance and economic growth for the long term. In parallel to these developments, economic policy reform is under way. The region's governments have demonstrated remarkable strength when harsh economic adjustments had to be made, e.g., debt stipulations.

The market approach to development was rediscovered by a government leaders eager to put the region back on track. Despite significant domestic and external imbalances, the LAC region embarked upon difficult fiscal deficit reduction to control the major variables of inflation and exchange rate adjustments to control the balance of payments deficit. Further, most of the governments also demonstrated that they were capable of bringing about these changes in a much broader agenda of economic reform. The development of market forces bodes well for the energy sector -- lower costs, improved production and distributive efficiency, enhanced safety, environmental management, and reliability are only some of the benefits.

During the 1990s, the LAC region will be relying primarily on hydroelectricity, petroleum and gas to meet their energy needs. As has been shown in the newly industrializing economies of Asia, the process of planned industrialization and urbanization together can provide the region with an increased standard of living. It is this irreversible drive towards development, coupled with a swiftly growing population, that creates the need for appropriate energy planning in the area.

1.2 OBJECTIVES OF THE STUDY

The growing impact of the LAC energy sector upon the world's economic and environmental well being, together with its close proximity to the United States both geographically and in terms of economic and political influence, are strong arguments for continued assistance from A.I.D. to the LAC region so that it can develop and implement sound energy policies.

Exhibit 1-1 displays a list of countries in the LAC region arranged according to their income status and whether they have been recipients of A.I.D.-sponsored assistance. This assistance

has included projects and policy development to promote energy efficiency, rural electrification, renewable resources, and private power development. Although A.I.D. and other bilateral donors have also sometimes provided some form of capital investment assistance to the region's nations, such investments are generally provided by multilateral agencies such as the World Bank and the Interamerican Development Bank (see Appendix 9 for a discussion of donor activities in the LAC energy sector).

The purpose of this study is to assist the Energy Department of the Latin America and Caribbean Bureau to develop a strategy for A.I.D. assistance in the energy sector of the LAC region by:

- identifying those areas in the energy sector of the LAC region where there exist opportunities for the effective use of A.I.D funds to promote economic growth and development and to minimize environmental impacts

- recommending the most effective actions to maximize the use of funds in providing assistance in those areas.

1.2 ORGANIZATION OF THE REPORT

Chapter 2 of this report presents an overview of the LAC energy sector, and discusses its current energy sector issues, including energy-economy linkages and the energy related environmental concerns faced by the region. Chapter 3 provides an analysis of the options available to improve overall energy sector efficiency and performance within the LAC region. Based on this analysis, recommendations regarding the areas of opportunity for focusing A.I.D. program assistance are presented.

This report includes several appendices that contain LAC energy sector data and other information to support the analysis. It was prepared by RCG/Hagler, Bailly, Inc. and was funded through the LAC Bureas of A.I.D.

Exhibit 1-1
Classification of the Economies in the LAC Region

Low Income	Middle Income		High Income
	Lower	Upper	
Guyana	Argentina*	Antigua	Aruba*
Haiti	Belize	Brazil	Barbados*
	Bolivia	St. Kitts, Nevis	Bahamas*
	Chile	Suriname	Puerto Rico*
	Colombia	Trinidad &	Virgin Islands*
	Costa Rica	Tobago*	
	Dominica	Uruguay	
	Dom.Rep.	Venezuela	
	Ecuador		
	El Salvador		
	Grenada		
	Guatemala		
	Honduras		
	Jamaica		
	Mexico		
	Nicaragua		
	Panama		
	Paraguay		
	Peru		
	St. Lucia		
	St. Vincent		

Notes:

- high-income economies are those with GNP per capita of $6,000 or more in 1990
- middle-income economies are those with GNP per capita between $581 and $5,999 in 1990
- low-income economies are those with GNP per capita of $580 or less in 1990.

* countries that are not A.I.D.-assisted countries

Source: Derived from the World Bank, *Global Economic Prospects and the Developing Countries, 1991.* Washington, DC, 1991.

16

CHAPTER 2: ISSUES

This chapter examines the current and projected energy situation in the LAC region and identifies the key macroeconomic and environmental issues affecting the energy sector.

2.1 ENERGY RESOURCES AND USE

Although the energy sectors of LAC countries vary widely by resource endowment, production, and patterns of use, they also share many common characteristics and trends. This section examines the LAC region's general energy situation and trends; Appendix 8 presents detailed country energy balances.[1] These balances offer a general understanding of energy flows, but should be interpreted with caution as they are derived from statistics that were not all prepared following uniform methodologies or data sources.

2.1.1 Fossil Fuels

The region's oil reserves are estimated at 125.2 billion barrels (12.5 percent of the world total) -- the second largest oil reserves after the Middle East. Its natural gas reserves are also substantial at 1.4 billion barrels of oil equivalent (boe) or 5.8 percent of the world total, which is similar to the level of reserves of the United States and Canada combined. The region's largest oil and gas reserves are located in Venezuela, with 59 billion barrels of conventional oil reserves and 640 billion boe of natural gas reserves (as of January 1, 1991) and Mexico, with 52 billion barrels of oil reserves and 432 billion boe of natural gas reserves.[2] The next-largest oil reserve holder is Brazil, with less than 3 billion barrels of oil. Although Colombia and Ecuador export oil, their reserves are relatively small at 2.0 and 1.3 billion barrels, respectively. The region's coal reserves are modest, estimated at 94 billion boe or about 1.7 percent of the world total. The major LAC coal producers are Colombia, Brazil, Mexico, and Venezuela, with Colombia dominating.

---

[1] International Energy Agency. *World Energy Statistics and Balances, 1985-1988.* Paris: OECD, 1991.

[2] British Petroleum Company. *BP Statistical Review of World Energy.* London, June 1990.

Oil & Gas Journal, Houston, Texas, December 31, 1990, p. 45.

The LAC region produced almost 2.5 billion barrels of oil (or almost 11.3 percent of world production) in 1989. Venezuela and Mexico are clearly the region's dominant oil producers, accounting for almost two thirds of the region's production. Other producers include Brazil, Ecuador and Colombia.

The region's natural gas production during 1989 amounted to 581 million boe (or about 5.4 percent of world production). Mexico alone accounts for about 30 percent of the region's production, but almost 54 percent of overall production lies in the non-A.I.D. assisted countries of Argentina, Trinidad & Tobago and Venezuela. Only 66 percent of LAC natural gas production is marketed, roughly 12 percent is flared or vented, and the remaining 22 percent is re-injected in the field during oil production. In 1988 the volume of gas flared and vented in the LAC region (2.5 billion boe), or 12.9 percent of gross production) was three times that in the United States (0.86 billion boe, or 0.7 percent of gross production).

During 1989, the region produced almost 194.4 million boe of hard coal (bituminous coal and anthracite), with Colombia (the largest coal producer and coal exporter in the region) and Mexico accounting for 96 million boe and 50.0 million boe, respectively.

2.1.2 Renewables

The LAC region is well endowed with renewable energy resources. Its hydroelectric potential is tremendous, estimated by the Latin American Energy Organization (OLADE) at almost 700,000 MW, or about four times that of the entire United States. Geothermal fields have been identified in Mexico, Guatemala, El Salvador, Nicaragua, Costa Rica, Honduras, Panama, Colombia, Peru, Bolivia, Chile, Argentina, Ecuador, the Dominican Republic, Jamaica, Guadalupe, Saint Lucia, Venezuela, San Vincent, and Dominica. As of 1990, only a few LAC countries had operating geothermal power plants, which are used for the production of both process steam and electricity. Mexico has 700 MW of geothermal capacity, El Salvador has 95 MW, Nicaragua has 70 MW, and Argentina has 1 MW. No regional data were available on the size and potential of the region's biomass, wind, and solar energy resources. However, biomass (specifically fuelwood in rural areas and sugarcane residue-fired power generation) represents a significant energy resource.

Latin America has by far the largest share of installed hydroelectric capacity in the world, accounting for almost 20 percent of global hydroelectric generation. In 1989, the LAC region had 93,513 MW of installed hydroelectric capacity (almost 61 percent of total installed

capacity), which provides about 60 percent of its electricity needs. By comparison, during the same year, hydroelectricity met 27 percent of the electricity needs in Western Europe and 19 percent in North America. Brazil, Colombia, Uruguay, Paraguay, Peru, and Central America all depend heavily on hydroelectricity to meet their power needs. At present the region has very little coal-fired generating capacity, which totaled 4,236 MW in 1989.

Historically, renewable energy sources have met much of Latin America's energy needs. The rural sector has traditionally relied more heavily on renewable energy, given its close proximity to forest and agricultural biomass and small-scale hydro resources. After hydropower, biomass represents the second-most important source of renewable energy consumption in the region. Given the traditional reliance on fuelwood to meet household energy needs and the importance of agro-industries such as sugar in rural economies, wood and bagasse are the predominant fuels in rural areas in almost all LAC countries. Other biomass resources often used in agro-industries are peat, rice husks, coffee husks, and other agricultural residues. In Brazil, the transport sector is largely fueled with biomass alcohol.

2.2 ENERGY SUPPLY AND DEMAND

The LAC region produced almost 3.73 billion boe during 1990, accounting for about 6.7 percent of total world energy production. During the same year, the region consumed 2.99 billion boe, including consumption in transformation and losses, representing about 5.4 percent of world consumption. The remaining 0.74 billion boe that were not consumed were exported. These energy exports consisted primarily of oil from Mexico, Venezuela and Ecuador and coal from Colombia. Exhibits 2-1 and 2-2 illustrate the region's energy production/consumption and electricity generation and how they compare with the rest of the world.

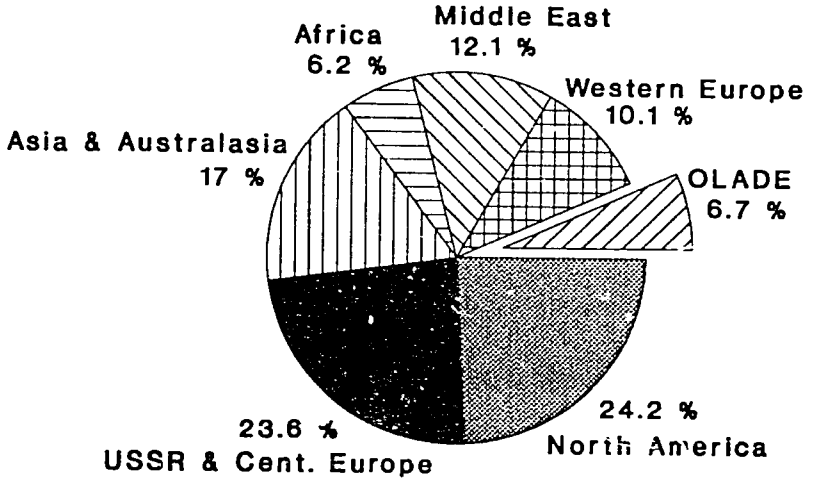
Energy consumption in the region is outstripping production, which increased by 2.5 percent annually between 1977 and 1987. Over the same period, the region's commercial energy consumption increased 2.6 percent per year, from 1.8 billion boe to 2.42 billion boe,[3] despite

[3] World Resources Institute. *World Resources 1990-1991*. Washington, D.C., 1991.

Exhibit 2-1. World Energy Production and Consumption

ENERGY

WORLD ENERGY PRODUCTION

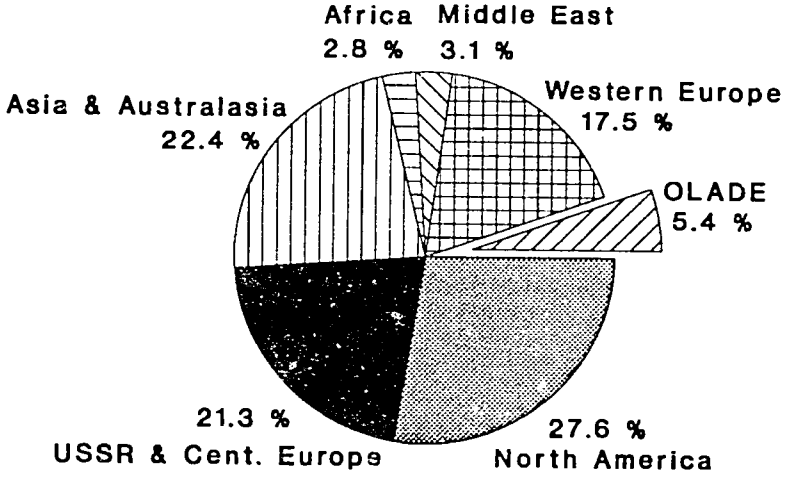


TOTAL 55.71 (10(9) billion barrels of oil equivalent)

OLADE Member Countries:

ARGENTINA	GUATEMALA	SURINAME
BARBADOS	GUYANA	TRINIDAD & TOBAGO
BOLIVIA	HAITI	URUGUAY
BRAZIL	HONDURAS	VENEZUELA
COLOMBIA	JAMAICA	
COSTA RICA	MEXICO	
CUBA	NICARAGUA	
CHILE	PANAMA	
ECUADOR	PARAGUAY	
ELSALVADOR	PERU	
GRENADA	DOMINICAN REP.	

WORLD ENERGY CONSUMPTION



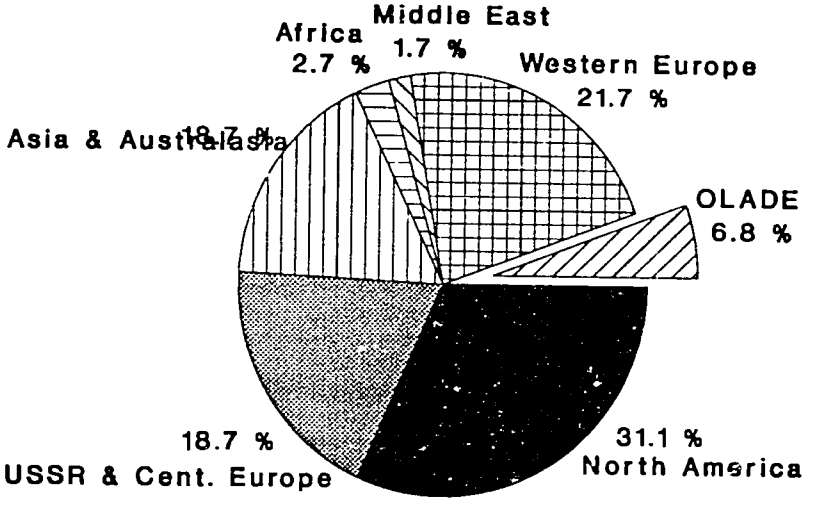
TOTAL 55.45 (10(9) billion barrels of oil equivalent)

Source: OLADE. Sistema de Informacion Economica-Energetica (SIEE), Ecuador: OLADE, 1991

Exhibit 2-2. World and LAC Electricity Generation

ELECTRICITY

WORLD GENERATION

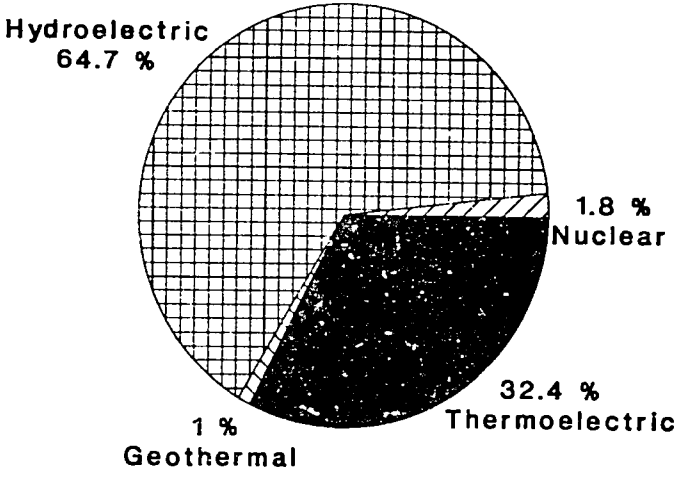


WORLD TOTAL: 10,824.3 (TWh)

OLADE Member Countries:

ARGENTINA	GUATEMALA	SURINAME
BARBADOS	GUYANA	TRINIDAD & TOBAGO
BOLIVIA	HAITI	URUGUAY
BRAZIL	HONDURAS	VENEZUELA
COLOMBIA	JAMAICA	
COSTA RICA	MEXICO	
CUBA	NICARAGUA	
CHILE	PANAMA	
ECUADOR	PARAGUAY	
ELSALVADOR	PERU	
GRENADA	DOMINICAN REP.	

LATIN AMERICA & CARIBBEAN GENERATION



REGIONAL TOTAL: 590,343 (GWh)

Source: OLADE. Sistema de Informacion Economica-Energetica (SIEE), Ecuador: OLADE, 1991

the economic crisis it experienced during the 1980s. Electricity consumption in particular has grown rapidly, by about 7.4 percent per year between 1973 and 1987.[4]

In 1987, 38 percent of final energy consumption in the LAC region was accounted for by industry, 38 percent by transportation, and 24 percent by the buildings and agriculture sectors.[5] Due to the predominantly urban population of the LAC region, transport accounts for an exceptionally high proportion of total energy use.

Population growth and the continued expansion and industrialization of the region's economies will spur increased demand for energy, especially electricity, well into the next century. For example, Brazil's "Plano 2010," published in December 1987, projected that electricity demand would grow 5.5 percent per year between 1986 and 2010.[6] In 1989, Mexico's public utility projected that its electricity sales would increase at an average rate of 6.3 percent per year between 1987 and 1998.[7] In May 1988, a government planning committee representing the major electric utilities in Venezuela projected that electricity demand would grow at an average rate of 6.9 percent per year between 1987 and 2000.[8] The rate of growth in energy demand will depend in large part on the pace of economic recovery in the region. However, it is significant that energy consumption, particularly electricity, grew during the 1980s when there was little economic growth in the region. This trend suggests that energy demand will continue to increase even if LAC economies are stagnant because significant unmet demand still exists.

A recent study on energy in developing countries has projected energy consumption for the LAC region using several scenarios based on differing rates of economic growth, emissions, and policies. The reference scenario estimates that LAC energy consumption will grow by

---

4 Mark D. Levine et al. *Energy Efficiency, Developing Nations, and Eastern Europe.* A report to the U.S. Working Group on Global Energy Efficiency. April 1991.

5 Mark D. Levine et al., op. cit. Data based on International Energy Agency. *World Energy Statistics and Balances 1971-1987, 1985-1988.* Paris: 1989, 1990.

6 Stephen Meyers et al. *Plans for the Power Sector in 13 Major Developing Countries.* Lawrence Berkeley Laboratory. LBL-27764. October 1989, pp. 12-14.

7 Ibid., pp. 13-14.

8 Ibid., pp. 14-21.

almost 2.5 percent through the year 2025[9]. To meet this growing demand, most LAC countries will rely primarily on hydroelectricity, oil, and natural gas. Countries in the region also plan to add almost 10,600 MW of new coal-fired capacity during the 1990s, with Mexico and Brazil, anticipating additions of 4,000 MW and 2,800 MW, respectively. The next section discusses the economic and environmental implications of the region's energy trends.

2.3 ENERGY AND ECONOMIC LINKAGES

Over the last ten years, many LAC countries have faced serious energy sector problems, particularly in the electricity subsector. These include subsidized energy prices in many countries, a dependence on petroleum imports, the massive investment requirements of the power subsector, the serious financial problems of electric utilities, electricity shortages and unreliable electricity supplies, and inefficiencies in energy supply and use. These problems and their increasingly serious effects on the region's economies are discussed below.

2.3.1 Energy Pricing Policies

Energy pricing is the most effective means of controlling patterns of energy use. On the other hand, energy prices that are subsidized fail to reflect real economic costs, thus encouraging energy waste and inefficiency. While several governments in the LAC region have taken steps to implement sound energy pricing policies, many still subsidize energy prices for certain energy products and consumer categories. By encouraging energy consumption and discouraging energy efficiency, these policies are exacerbating the region's already serious economic and financial problems.

Petroleum Products. Data on domestic petroleum product prices provided by the OLADE suggest that as of June 1991, the only countries in Latin America with heavily

[9] Intergovernmental Panel on Climate Change. *The Appendix Report of the Expert Group on Emissions Scenarios*, April 1990. The Panel's high growth/high emissions scenario is similar to the forecast results presented by Alan S. Manne and L. Schrattenholzer, *International Energy Workshop: Overview of Poll Responses*, Stanford University, 1989.

subsidized petroleum product prices are Venezuela, Ecuador, and Colombia.[10] In Exhibit 2-3, the LAC countries are organized into five groups according to their oil import/export position and their petroleum product price levels.[11] Where data were available, conclusions are drawn about the degree of subsidization and the cost of petroleum product subsidies to the country's economy.

Electric Power. Few countries in the LAC region have electricity tariffs that are in line with economic or even financial costs, although current trends are to move towards the application of marginal cost principles. At present, average tariffs for the LAC region cover only 71 percent of the average incremental cost of electricity.[12] For the LAC region, this subsidy roughly represents over US $13 billion in lost revenues during 1990.[13] Appendix 6 presents the average incremental cost, the average tariff contribution to long-run marginal cost (LRMC), and the tariff contribution to incremental cost for LAC countries.

2.3.2 Dependence on Energy Imports

The LAC region has several oil producers, including Argentina, Brazil, Colombia, Ecuador, Mexico, Peru, and Venezuela; of these, Colombia, Ecuador, Mexico, and Venezuela are oil exporters.[14] However, many LAC countries are totally dependent on energy imports, which has been a serious drain on their balance of payments. Exhibit 2-4 displays the current energy classification of LAC countries and net oil imports as a percentage of commercial energy demand among LAC importers.

---

[10] In conducting this analysis, domestic country prices for petroleum products were compared against the Caribbean spot price for the same products.

[11] Several small Caribbean countries (e.g., Belize, Dominica, St. Kitts, St. Lucia) were not included in the OLADE data set. It was assumed that these countries fall into the fifth category.

[12] OLADE, 1991.

[13] The subsidy has been estimated based on the price of electricity and the total sales in the region. The calculation was based on OLADE data.

[14] Energy Information Administration. *International Energy Annual 1988.* U.S. Department of Energy, 1989.

Exhibit 2-3
Analysis of Petroleum Product Subsidies in the LAC Region

Energy Classification	Country	Description
Major oil producers	Venezuela, Mexico	Venezuela and Mexico are the leading oil and gas producers and exporters in the LAC region. The product prices in Venezuela are low, and price reform would be necessary to develop a market-driven approach to efficient energy use. In Venezuela, the retail price of gasoline is about 34 percent of the spot Caribbean refinery price (June 1991). The cost of petroleum product subsidies to the Venezuelan economy has been estimated here at around $1 billion per year. Mexico has a long history of subsidized prices for petroleum products. However, a major effort has been made in recent years to increase prices to economic levels. Currently, prices are close to or above Caribbean spot price levels.
Lesser oil producers with subsidized prices	Colombia, Ecuador	Colombia and Ecuador are smaller oil producers and exporters. Their product prices are low and tend to discourage the efficient use of energy. Regular gasoline at the retail level in Colombia is about 85 percent of the spot Caribbean refinery price, while in Ecuador it is about 60 percent (June 1991). Petroleum product subsidies in these countries amount to approximately $100 million per year.
Lesser oil producers with economic pricing	Argentina, Trinidad & Tobago	Argentina and Trinidad and Tobago export modest amounts of oil but have moderate to high product prices. Product prices are above the economic cost. Therefore, there is little or no need for price reform in this respect.
Oil importers with subsidized prices for certain petroleum products	Brazil, El Salvador, Guyana, Honduras, Jamaica and Peru	On average, prices are very close to or above Caribbean spot prices. Nevertheless, kerosene prices and/or diesel prices are low by U.S. standards, although these countries' gasoline prices are roughly equal to or higher than U.S. gasoline prices.
Oil importers with full economic pricing	Barbados, Bolivia, Costa Rica, Chile, Dominican Republic, Grenada, Guatemala, Haiti, Nicaragua, Panama, Paraguay, Suriname and Uruguay	These oil importers show moderate to high price levels for kerosene and diesel. There is little or no need for price reform in the petroleum sectors of these countries.

Exhibit 2-4
1990 Energy Classifications of LAC Countries

Net Oil Exporters		Net Oil Importers: Imports as a Percentage of Final Energy Consumption[1]			
OPEC	Non-OPEC	0-25	26-50	51-75	76-100
Venezuela Ecuador	Mexico Peru Trinidad & Tobago	Bolivia Colombia Paraguay Haiti	Brazil Guatemala Honduras El Salvador Nicaragua	Chile Guyana Costa Rica Uruguay	Jamaica Panama Dominican Rep. Grenada

Notes:
1. Oil refers to crude oil and petroleum products.
2. There were no data for Dominica, St. Kitts, Belize, Antigua, and St. Lucia.
Source: OLADE, Ecuador, 1990, Exhibit 2.2.

In 1989 energy imports were equivalent to 54 percent of merchandise exports in Panama, 26 percent in Paraguay, 24 percent in Jamaica, 14 percent in Brazil, and 13 percent in El Salvador and the Dominican Republic.[15] Even Mexico, Colombia, and Venezuela have imported small amounts of refined petroleum products in recent years.[16] If current trends continue, by the end of the 1990s, Mexico could become a net importer of some petroleum products because its domestic oil production and refining would not have been able to keep pace with growth in energy demand.

[15] World Bank. *World Development Report 1991*, p. 212.

[16] EIA, op. cit., 1989.

2.3.3 Investment Requirements of the Energy Sector

Between 1982 and 1989, real Gross Domestic Product (GDP) in the LAC region grew at an average rate of only 1.4 percent per year while real per capita GDP fell by almost 1 percent per year. Despite this sluggish and often stagnant economic growth, energy consumption continued to increase during this period at a higher rate than GDP (Exhibit 2-5).

Economic projections for the region are more optimistic. The International Monetary Fund (IMF) projects 3 percent annual growth in real GDP through the mid-1990s, and the United Nations Economic Commission for Latin America and the Caribbean has indicated that "...there has been an increase in the number of countries which are back on the road to economic growth, although in most cases the growth is modest and its foundations are fragile." The Mexico-U.S. Free Trade Agreement and the Initiative of the Americas is expected to further boost economic growth in the region.

The expected improvements in economic growth will spur an increase in energy demand, which will in turn require large capital investments in the energy sector during the 1990s. Historically, such capital investments have accounted for a significant share of total investment in the LAC region, and this trend is expected to continue. For example, between 1974 and 1986, about $48 billion was invested in Brazil's power sector, accounting for 9 percent of all public and private investment.[17] Estimated annual energy investment as a percentage of annual total public investment during the early 1980s is shown below for selected countries.

10-20 percent	20-30 percent	30-40 percent	> 40 percent
Jamaica	Costa Rica	Ecuador	Argentina Brazil Colombia Mexico

Source: Mohan Munasinghe, *Electric Power Economics*, Butterworths, London, 1990.

[17] Stephen Meyers et al., op. cit., pp. 12-16.

The World Bank has estimated that during the 1990s, capital expenditures for the power sector alone will be around $155 billion for 17 LAC countries (see Appendix 4). About 30 percent of the total investment is expected to be financed through external debt and 70 percent locally. The high local component reflects the ability of LAC countries, particularly Brazil and Mexico, to construct hydro projects using largely local resources. However, for some countries, 70 percent of the investment will need to be financed through external debt.

The LAC region's large external debt (nearly US $1,000 per capita) has been a major cause of the economic stagnation that has plagued the region in the last decade. At the end of the 1980s, long-term debt was equivalent to almost 30 percent of Brazil's GNP, almost 60 percent of Mexico's GNP, and 90 percent of Ecuador's GNP. The energy sector, and in particular the electric power subsector, has accounted for a significant share of total LAC debt. OLADE has estimated that the power sector accounts for 10 percent (weighted average) of the LAC region's total debt. As shown in Exhibit 2-6, between 1985 and 1989, debt originating in the power subsector accounted for 27 percent of total debt in Colombia and Uruguay, 25 percent in Honduras, 18 percent in Haiti, 16 percent in Brazil, and 14 percent in Costa Rica.

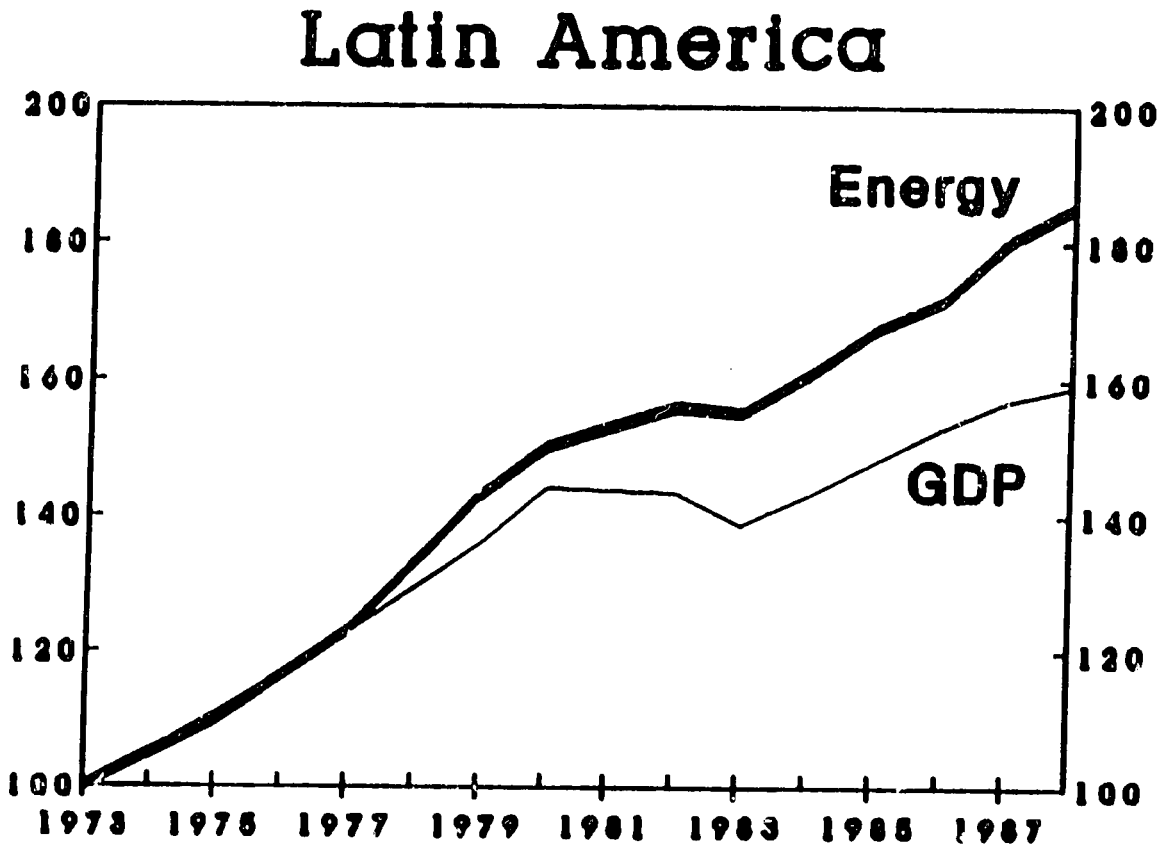
The multilateral banks and other funding sources that sustained the massive expansion of LAC power systems over the last several decades will not be able to supply more than a fraction of the funds that will be needed in the 1990s. Capital availability in the region is already highly constrained, and as demand for electricity has grown, many governments have found it increasingly difficult to allocate sufficient resources to the power sector to ensure that demand is met. Thus, the energy sector in general, and the electric power subsector in particular, will continue to be a serious burden on the region's fiscal resources and foreign debt, and could become a constraint on economic development if the reliability and availability of service are allowed to deteriorate.

2.3.5 Financial Problems of Electric Utilities

Most electric utilities in the LAC region are facing a financial crisis which threatens their ability to meet the needs of their customers. Internal fund generation has been squeezed by low tariff levels (for example, in 1988 the revenues of Mexico's utility covered only 60 to 65 percent of its operating costs[18]) and high debt service payments, while the availability of

[18] Stephen Meyers et al., op. cit., pp. 13-16.

Exhibit 2-5
Indices of Primary Commercial Energy and GDP in the LAC Region
(1973-1988)



Note: Energy data were derived from the International Energy Agency, *World Energy Statistics and Balances 1971-1987, and 1985-1989.* Paris: OECD, 1989, 1990. GDP data were derived from the Chevron Corporation and the Asian Development Bank.

Source: Mark D. Levine et al. *Energy Efficiency, Developing Nations and Eastern Europe.* A report to the U.S. Working Group on Global Energy Efficiency, Washington, DC, June 1991.

Exhibit 2-6
Energy Sector Debt as a Percentage of Country Debt
(1985-89)

Country	Sector Debt as a % of Country Debt	Country	Sector Debt as a % of Country Debt
Argentina	7.0	Honduras	25.2
Barbados	6.2	Jamaica	3.7
Belize	4.5	Mexico	3.4
Bolivia	3.8	Nicaragua	1.5
Brazil	15.7	Panama	10.0
Chile	6.0	Paraguay	6.9
Colombia	27.3	Peru	11.8
Costa Rica	14.2	St. Lucia	na
Dominica	na	St. Vincent	38.5
Dominican Rep.	7.3	Suriname	na
Ecuador	12.7	Trinidad/Tobago	7.1
El Salvador	11.2	Uruguay	27.4
Guatemala	11.1	Venezuela	3.2
Guyana	0.4		
Haiti	17.8	LAC Region	10.0

Source: OLADE - Latin America and the Caribbean Technical Department (Report No. 7), 1991

fresh credit has been greatly reduced by the poor credit standing of governments in the region and the weak financial position of the utilities themselves. Government budget contributions will also be limited if pressing social needs, which compete for scarce resources, are to be met and if fiscal deficits are to be kept within prudent limits.

The lack of internal funds and difficulty of attracting external financing mean that many utilities will need to focus on the rehabilitation of existing electricity capacity rather than the construction of new capacity. Some countries, such as Argentina, already plan to focus their near-term efforts on the rehabilitation of existing thermal power plants and the completion of plants now under construction.[19]

2.3.5 Electricity Shortages and Unreliable Electricity Supplies

Several of the LAC region's countries are facing serious energy shortages. Guatemala and El Salvador are experiencing a drought that has reduced electrical generation capacity by one third and could have very serious macroeconomic consequences. Both countries have resorted to power rationing of up to 7 hours per day. As a result, industrial productivity in Guatemala may be reduced by up to 20 percent if the drought and the power deficit situation continue until the end of 1991. The Guatemala Chamber of Industry has estimated that for each month that electricity is rationed, inflation will increase by about 4 percent[20] In 1989, Argentina faced a severe power shortage caused by repairs on a major dam, an outage of thermal capacity due to lack of maintenance, low rainfall, and non-availability of a nuclear power plant.[21] The power shortage necessitated rotating blackouts and power curtailment to large industrial users, as well as greater dependence on fossil-fired generation.[22] Although Brazil does not face power shortages or electricity reliability problems at this time, if demand grows

[19] Ibid., pp. 11-14.

[20] RCG/Hagler, Bailly, Inc., in communication with the Guatemalan Chamber of Industry during the recent A.I.D.-sponsored emergency assistance program, September, 1991.

[21] Stephen Meyers et al., op. cit., pp. 11-21.

[22] Ibid.

in excess of 5 percent per year in the short run, electricity shortages and the need for rationing could occur by the mid-1990s.[23]

The impact of energy shortages on economic growth and development has been well documented and it is clear that a lack of fuels for transportation and industry and a lack of electricity for basic economic activities can have devastating effects. While it is difficult to obtain precise measurements of the value of energy to economic growth, it has been estimated that the value of lost production due to energy shortfalls is between 10 and 40 times the cost of the energy that is not available when needed.

2.3.6 Inefficiencies in Energy Supply and Use

Although many LAC countries have initiated programs to improve energy efficiency, often with assistance from international donors and lending institutions (see Chapter 3), energy inefficiency is still a serious problem across all sectors in all LAC countries. For example, while electricity transmission and distribution (T&D) losses should normally be below 10 percent of gross generation (economically optimal losses may be as low as 5 percent),[24] in many LAC countries these losses are over 20 percent. In 1987, T&D losses were 24 percent in Colombia, 32 percent in the Dominican Republic, 21 percent in Ecuador, 30 percent in Haiti, 24 percent in Jamaica, and 22 percent in Uruguay.[25] The thermal efficiency of LAC steam power plants is often low by international standards. For example, the average efficiency of power plants is only 32.8 percent in Mexico and 26 percent in Venezuela.[26] The efficiency of thermal power plants in Argentina is low due to chronic poor maintenance.[27]

---

[23] Howard S. Geller. *Electricity Conservation in Brazil: Status Report and Analysis*. American Council for an Energy-Efficient Economy. August 1990, p. 8.

[24] U.S. Agency for International Development. *Power Shortages in Developing Countries: Magnitude, Impacts, Solutions, and the Role of the Private Sector*. Report to Congress. March 1988, p. 36.

[25] Jose R. Escay. *Summary Data Sheets of 1987 Power and Commercial Energy Statistics for 100 Developing Countries*. The World Bank, 1989.

[26] Stephen Meyers et al., op. cit., pp. 13-16.

[27] Ibid., pp. 11-15.

For the LAC region, the industry and transport sectors represent 39 and 38 percent, respectively, of final energy consumption[28]. A recent study performed by SEPAFIN[29] on the Mexican steel industry revealed that the sintering stage of the steel making process alone consumed 40 percent more energy than international levels. Successive stages of the process were between 17 to 40 percent more energy inefficient than specified by current standards. Transportation energy use in the LAC region is highest among developing countries. A recent program[30] in Brazil, in response to growing fuel consumption needs, implemented an incentive system to switch transport modes, realizing significant savings in per capita automobile fuel consumption.

2.4 ENVIRONMENTAL ISSUES AND IMPLICATIONS

2.4.1 Background

The LAC region is not in itself a geographic entity because it includes parts of the North American continent and the Caribbean islands. However, as a geopolitical unit, this region is the earth's third-largest contiguous land mass, extending from the Mexican Rio Grande in the north to the Chilean Tierra Del Fuego Islands in the south, comprising almost 7.6 million square miles and 500 million inhabitants. The region contains all of the principal world climatic conditions and vegetation, and houses some of the most important and fragile ecosystems in the world.

Until the middle of this century, the sheer size of the LAC landmass and its formidable natural obstacles sheltered the ecosystems in the region's interior from major human activities. Indeed, until very recently, it embraced two well-defined subregions: 1) the relatively developed and fast growing periphery where most large urban settlements existed and 2) the much less developed, slow moving interior which, with the exception of a few industrial settlements, remained oblivious to the changes taking place outside. However, in recent

[28] International Energy Agency. *World Energy Statistics and Balances, 1985-1988.*

[29] O. Guzman et al. *Energy Efficiency and Conservation in Mexico.* SEPAFIN, 1986.

[30] U.S. Working Group on Global Energy Efficiency. *Energy Efficiency, Developing Nations and Eastern Europe*, 1991.

37

years, the pressing economic needs of the periphery have resulted in the rapid development of parts of the interior. In addition to legal economic activities, the drug trade has sparked settlements in interior areas.

The current population in the LAC region is estimated at 500 million people, but it is growing at an average annual rate of 2.1 percent (reaching 1 billion by about 2025).[31] Between 1990 and 1995, the region's urban population is expected to grow by approximately 3 percent per year. This population growth will put severe pressure on the natural environment of the region. Economic policies, especially those regarding market structure and regulation, and a history of subsidized energy prices have contributed to higher levels of energy consumption and inefficiency and contributed to worsening environmental conditions.

Public and government awareness of environmental degradation in the LAC region has increased. A recent opinion poll on the perceived change in the environment over the last 10 years displays some interesting trends.[32] The question asked was "Do you feel that the environment where you live has become any better or worse in the last 10 years, or has it remained about the same? Argentina and Brazil were two countries in the LAC region that were sampled. In Argentina, 76 percent of the public and 92 percent of government leaders interviewed responded "yes, the environment has worsened." In Brazil, 52 percent of the public and 82 percent of the leaders responded "yes" to this question.

2.4.2 Environmental Impacts of Energy Supply and Consumption

Although the energy sector has helped fuel industrialization and economic growth and development in the LAC region, energy production and consumption has also been a major contributor to the deterioration of the region's natural environment. All energy production and consumption systems pose some risk to humans and the environment, but it is extremely

[31] World Resources Institute. *World Resources: A Guide to the Global Environment*, 1991.

[32] Louis Harris and Associates. *1989 Public and Leadership Attitudes to the Environment in Four Continents: A Report of a Survey in 16 Countries*. New York, 1989.

34

difficult to quantify these risks accurately. Exhibits 2-7 and 2-8 present a qualitative on of the environmental consequences of energy production[33] and consumption in the LAC region.

Most LAC governments have become increasingly aware of the environmental impacts of energy production and use through the serious air quality problems of major cities in the region and the growing pressure of lending agencies for environmental impact assessments of energy projects. Despite the scarce financial resources and social/political constraints, countries such as Mexico, Brazil, Costa Rica and Ecuador have mounted programs for environmental impact mitigation in their energy sectors.

While there has been substantial success in implementing and enforcing urban regulations to reduce emissions from the transport sector, the agencies responsible for environmental control of the electricity, oil, and gas sectors remain very weak. For example, one official responsible for environmental protection at the energy ministry level in a large LAC country recently complained that in order to investigate compliance with environmental regulations at several project sites, it was necessary to seek transportation support from the very agencies being investigated. Another common complaint is the lack of instrumentation, basic analytical tools, training, and materials.

[33] Energy production includes oil and gas exploration, development and transportation, (petroleum refineries and petrochemical plants are also included as they produce essential liquid fuels). Electricity production includes fossil-fuel-fired combustion, hydro and renewable energy.

Exhibit 2-7 Environmental Consequences of Energy Production

Principal Sources	Environmental Effects	Country Impacted
Oil and natural gas ▸ onshore drilling rig ▸ offshore oil and gas platforms ▸ gas processing plant ▸ on/offshore fabrication facility ▸ petroleum refinery ▸ petrochemical facility (multiproduct)	1. Blowouts: uncontrolled releases of oil or gas; these tend to be more frequent in offshore drilling. 2. Brine: disposal of production waters. 3. Construction: routine plant and equipment activity. 4. Ecosystem: intensification of land, ocean and coastal zone usage often brings reduction of area available for agriculture, coastal areas, natural habitats, including wetlands and forests. Socioeconomic: large resource projects create a demand for housing, infrastructure and people. Often the community can double or even triple in size, bringing about an expansion of infrastructure.	Argentina, Brazil, Mexico, Venezuela
Coal ▸ underground mining ▸ surface mining	1. Emissions: potential for severe pollution of the land, water, and air with dust, methane, fires causing sulfur dioxides, carbon monoxide. 2. Surface mining: damage to surrounding ecosystems, erosion, climate change, air quality, aesthetics and climate change. The activities related to the development of a coal mine, including road building, mine entries, dynamite use, buildings, and intensive use of transport (rail or truck), cause reductions in air and water quality and affect nearby communities	Argentina, Brazil, Colombia
Electric power production ▸ fossil fuel generating facilities ▸ hydroelectric	1. Both coal- and oil-fired plants contribute air pollution (SO2, CO2, NOx and other hydrocarbons), water pollution (heavy metals and thermal effects), and solid wastes. A facility using coal without emissions control is considered a major source of pollution. Oil-fired facilities usually generate less emissions than a coal facility but still need emissions control to meet standards. 2. The size of hydro developments greatly influences the type and magnitude of social, environmental and health impacts. Social impacts tend to be the most complex problem; reservoirs creation may require flooding and resettlement of communities, environmental impacts include changes in local ecology that affect wildlife, fisheries and possibly downstream activities, health impacts due to the propagation by water borne disease vectors that could breed in the reservoirs.	All countries
Renewable energy ▸ solar ▸ biomass ▸ wind	Solar: direct impacts include land usage, toxicity of additives in heat transfer medium. Indirect impacts include emissions during manufacture of cells (copper, aluminum, steel, glass, fiberglass, and cement). Biomass: direct impacts include deforestation and emissions of particulate, CO, NOx, ash, and organics. Indirect impacts include increased transportation of fuel as the fuel value of biomass is roughly half to two-thirds of coal, effluent during biomass conversion to liquid fuels pollute surface waters and groundwater, removal of large quantities of biomass can affect local soil and aquatic biota causing further changes in the ecology.	Brazil, Caribbean Islands

Source: RCG/Hagler, Bailly, Inc., November, 1991.

Exhibit 2-8 Environmental Consequences of Energy Consumption

Principal Sources	Major Emissions and Environmental Effects	Country Impacted
▸ Industrial operations ▸ Combustion of fuels for heating and energy production ▸ Solid waste disposal facilities ▸ Motor vehicles and other mobile sources	Carbon dioxide (CO2): energy production is the single-largest contributor to man made CO2 in the atmosphere. Other contributors include emissions of CFCs from aerosols and refrigerants, methane from rice cultivation, deforestation and cement production. CO2 is now shown to have a firm linkage with global climate change. Carbon monoxide (CO): formed due to the incomplete combustion of fuels, industrial processes, forest fires, and organic decomposition. Note that natural causes produce many times the quantity of CO as automobile and industrial sources combined. The issue is unacceptable concentrations in urban areas. Hydrocarbons (HC): formed due to the incomplete combustion of fuels, industrial processes, use and distribution of petroleum products (gasolines, solvents) and atmospheric reactions. Lead (Pb): airborne lead from auto exhaust fumes, nonferrous metal smelters, agricultural use of leaded arsenates, and lead salts. Health effects are primary concern as Pb poisoning can cause severe learning disabilities and other physiological impacts. Nitrogen oxides (NOx): formed primarily in I-C engines, power plants and atmospheric reactions. NOx plays a major role as a photochemical smog component, and can cause respiratory illnesses and other physical impacts. Particulates: natural events such as earthquakes, landslides, erosion, and volcanic eruptions. Man made sources include combustion engines, especially coal-fired power plants, industrial processes and construction activity. Particulates affect general aspects of human health and are an aesthetic sore. Further aggravation of gaseous pollutants may occur. Sulfur dioxide and other oxides of sulfur (SO2 and SOx): caused by the combustion of sulfur-containing fossil fuels, smelting of sulfur ores, industrial processes and volcanic eruptions. SO2 and SOx can cause significant respiratory tract disorders, increase mortality and can aggravate respiratory illnesses; further impacts include acid rain and acidification of lakes and reservoirs.	All countries. In particular, Argentina, Brazil, Mexico, and Venezuela are major industrial economies that consume globally significant quantities of fossil fuels.

Source: RCG/Hagler, Bailly, Inc., November, 1991.

CHAPTER 3: RECOMMENDATIONS

3.1 ANALYSIS OF ENERGY SECTOR OPPORTUNITIES

Based on the issues discussed in Chapter 2, opportunities for A.I.D. assistance in the LAC region in the 1990s have been identified in four areas: energy efficiency and conservation, the privatization of the energy sector, environmental protection, and renewable and rural energy development. Each of these areas covers a number of subsectors, for example, the energy efficiency and conservation area has elements in the industrial, power, and transportation subsectors. Also, some activities, such as assistance in energy pricing, are relevant to most areas and energy subsectors.

Exhibit 3-1 shows the results of an analysis of the potential contribution of these major areas of opportunity to overall sector efficiency, energy savings, and environmental impact mitigation. It also includes a consideration of A.I.D.'s experience in providing related assistance and to the Agency's priority target areas. Together, the rankings assigned to each area provide an overall appreciation of the value of each area, which forms the basis for the recommended LAC energy strategy.

3.2 RECOMMENDATIONS ON ENERGY EFFICIENCY AND CONSERVATION

Given the current problem of capital and environmental constraints to meeting the region's energy needs, the promotion of energy efficiency and conservation activities is a cost-effective and environmentally sound option. Experience in the LAC and other regions has shown that energy savings of 20 to 25 percent are possible with a payback period of two years or less.[1] Energy efficiency and conservation activities need to be pursued in the power, industry, and transport subsectors of the LAC region.

[1] See Mark D. Levine et al., op. cit.

Exhibit 3-1 Prioritization of Technical Assistance Areas

Area/ Subsector	Contribution to Overall Sector Efficiency	Estimated Energy Savings	Estimated Env. Impact Mitigation Potential	A.I.D. Experience	Relevance to A.I.D. Target Areas	Composite Score Ranking
Energy Efficiency and Conservation						
Power Subsector	High	High	High	High	High	High
Industrial Subsector	High	High	High	High	Medium	High
Transport Subsector	Medium	Medium	High	Medium	Medium	High
Promotion of Private Sector Involvement						
Power Subsector	High	Medium	Low	High	High	High
Oil and Gas Subsector	Medium	Low	Low	Medium	Medium	Medium
Environmental Protection	Low	Low	High	High	High	Medium
Renewable and Rural Energy Development						
Rural Electrification	Low	Low	Low	High	Medium	Low
Domestic Fuels	Low	Low	High	Medium	High	Medium

3.2.1 Power Subsector

There is a large untapped potential for savings in both capacity and energy in all end-use subsectors in the LAC region. For example, A.I.D. has recently completed an assessment of the potential for improving power subsector efficiency in Costa Rica.[2] This study found that the country's incremental capacity requirements to the year 2005 could be reduced by 16 percent. In Mexico, new time-of-day tariffs were recently introduced and savings of 500 MW for 64 customers have reportedly been achieved.[3] This measure could not only defer billions of dollars in investment in new generation capacity for Mexico, but also reduce CO_2 emissions by several millions tonnes per year.

Increasingly, the region's electric utilities are shifting away from conventional utility supply planning and toward the concept of integrated resource planning (IRP). Under IRP, conservation competes directly with generating resources as a way of meeting the electric utility's future load growth requirements. Conservation is viewed as a resource for the electric power system that can be estimated, forecast, scheduled, and purchased. Demand-side management (DSM) programs can be established to control energy consumption on the customer's side, and include conservation (the efficient end-use of energy) and load management.[4] DSM programs also have important environmental benefits by reducing energy production requirements, which mitigate the negative environmental impacts of energy resource exploration, development, and production.

A.I.D. has conducted and is currently involved in power subsector efficiency assessments in Costa Rica, Guatemala, and Mexico. These efforts have been well received and the recommendations provided are being implemented. Although the Agency should continue with this approach, the following lessons learned should be taken into account:

- There is more potential for the effective use of A.I.D. funding in the end use and demand-side management areas than on the supply side. This is

---

[2] A.I.D. Office of Energy and Infrastructure. *Costa Rica Power Sector Efficiency Assessment*, 1990.

[3] Communication with the Comision Federal de Electricidad (CFE), Mexico, 1991.

[4] Load management involves changing the shape or characteristics of the power utility's load curve by shifting electricity consumption from peak to off-peak periods, and could substantially reduce the cost of electricity supply in LAC countries.

particularly true in countries with extensive hydroelectric generation, where effective supply-side efficiency improvements can be found almost exclusively in the area of power distribution. Furthermore, traditionally, the multilateral agencies have provided more financing for efficiency improvements on the supply side.

- Not enough public awareness campaigns have been implemented that link the proposed conservation opportunities with lower energy costs to the end user and considerable advantages for the national economy.

- The power subsector efficiency programs on the demand side will not reach their full potential if the utilities do not include conservation potential as a resource that is comparable to other supply options in an integrated least-cost plan. A sound least-cost plan is generally a prerequisite to lending by multilateral funding agencies, who should find it attractive to co-fund such plans with A.I.D.

The types of activities that are needed include:

Electricity Tariff Development. While few LAC nations have electricity tariffs that are in line with economic or even financial costs, current trends in the region are to move towards the application of marginal cost principles. However, electricity tariffs on average for the region still reflect only about 70 percent of cost.

A.I.D., in coordination with the World Bank and the IDB, should continue providing technical support in the following areas:

- *Financial Analysis.* Determine the financial soundness of the utility, review the accounting procedures, and determine the cash flow revenue requirements.

- *Marginal Cost Analysis.* Determine the medium- to long-term marginal costs of the utility by customer class.

- *Tariff Design.* Based on the results of the financial and marginal cost analyses, develop tariffs that would reflect the true economic cost of providing service to the customer class, considering financial and socio-economic ramifications.

Dynamic pricing mechanisms should be established with the introduction of time-of-use and interruptible tariffs.

End-Use Efficiency Improvement and Load Management. End-use conservation programs and load management, if strongly supported by electric utilities, could lower demand growth rates significantly. Based on the results of past audits, a large savings potential exists in the industrial, commercial, and residential subsectors. In many LAC countries, there is also a need to standardize norms for electric appliances.

A.I.D. should provide technical support in the following areas:

- *End-Use Efficiency.* Assess and prioritize end-use efficiency target areas, patterns, and technologies at the level of the national economy.

- *DSM Programs.* Develop and implement demand-side management programs. This will include pilot projects and technical and economic analyses of various DSM measures in comparison to electric power capacity increases on the supply side as part of an overall IRP concept for electric utilities.

- *Codes and Standards.* Define standards and codes for efficient appliances and industrial equipment.

Power Plant Rehabilitation. Thermal plants built during the period of cheap and plentiful petroleum have serious operational difficulties such as corroded boiler tubes, inefficient control systems, no multi-fuel capabilities, and worn fuel-handling facilities. Generation losses could be reduced by using new auxiliary equipment, replacing old boilers, and adding better instrumentation and controls.

A.I.D. should provide technical support in the following area:

- *Feasibility Studies.* Prepare feasibility studies leading to a rehabilitation program and follow-up maintenance.

Reduction of Transmission and Distribution Losses. Transmission and distribution losses in the LAC region are generally very high: 20 percent or more for some countries. The decline in the financial position of the national electric utilities and distributors has led to reduced investment and system maintenance. Meanwhile, system losses drive up supply costs and increase the financial burden of the subsector.

A.I.D. should provide technical support in the following area:

- *System Losses.* Assess T&D system losses and prepare loss reduction programs.

3.2.2 Industrial Subsector

There are extensive opportunities to improve the energy balance of industrial facilities in the LAC region in addition to the savings obtained by demand-side management techniques (see above). This can be achieved by regular energy audits, proper maintenance of plant and machinery, and by promoting the use of energy-efficient equipment.

A.I.D.-funded energy conservation programs such as the Regional Industrial Efficiency Program (ROCAP, 1983-1987) and the Office of Energy audits and training in Ecuador (1985) represent valuable efforts to improve industrial energy efficiency. While far from all of the measures identified were implemented, these programs could nevertheless claim significant successes. The recipient institutions were strengthened, and five years later, in both the university in Quito and in ICAITI in Central America, energy efficiency programs remain a part of the regularly scheduled activities. The projects also spawned several private sector groups in energy efficiency that are currently active in the field, the awareness of hundreds of engineers was raised through training courses, and many industries benefitted from savings. Even today, many of the energy audits performed during those projects are still being used, either as models for new audits or as sources of information for potential electric utility-based conservation efforts (as is currently the case in Guatemala).

Energy Efficiency Measures. Industry typically accounts for nearly 30-40 percent of energy use in the LAC region. Plant audits and energy intensity indicators of the World Bank and others indicate that in many LAC countries, 10 to 20 percent of this energy use could be saved through simple "housekeeping" measures and other measures with short payback.

However, a number of barriers reduce the extent to which such measures can be implemented. Technical barriers include a lack of energy conservation data and experience, and insufficient access to energy-efficient equipment. Non-technical barriers include high taxes on imported equipment and a basic lack of awareness of current efficiency measures among plant owners and operators.

A.I.D. should provide technical support for the following activities:

- *Issues Analysis/Case Studies.* Analyze the technical and non-technical issues faced by the subsector in implementing energy efficiency measures. Perform case studies to analyze industrial energy consumption and the energy and environmental policy framework, and make recommendations. These case studies should be supported with the appropriate development of energy-efficiency standards for thermal and electrical equipment.

- *Energy Audits.* Perform preliminary site energy audits and make recommendations to plants. This should be followed up by providing designated energy staff with "know how" and monitoring equipment to continue the audit work. These audits should focus on overall industrial productivity, including long-term energy management, production efficiency, and quality control.

- *Cogeneration.* Foster the implementation of cogeneration projects. This would include supporting feasibility studies for possible demonstration project implementation and developing training courses that underscore the importance of cogeneration in reducing energy consumption and costs.

3.2.3 Transport Subsector

Energy consumption for transportation averages over 50 percent of total oil consumption in Bolivia, Uruguay, Costa Rica, Ecuador, Colombia, Haiti, Venezuela, Chile, Panama, El Salvador, Argentina, and Guatemala. In most developing countries, 80 percent of fuel consumed in the transport subsector is consumed in road transport, and for several LAC countries this share is even higher (e.g., Argentina 88 percent, Brazil 84 percent, Chile 82

percent, Mexico 93 percent[5]). Many Latin American countries have seen an explosion in automobile use in the last 20 years. The impacts of this growth can be seen in pollution and traffic problems in the region's large cities and in large energy import bills. As a result, any policies or programs that affect transportation energy use can make a significant impact on a country's total energy bill and the environment.

The types of activities that are needed include:

Fuel Efficiency. Projects that work to improve regulations, prices, and policies can have a significant impact. For example, creating or revising regulations governing the size, efficiency, and fuel use of vehicles imported into developing countries can have a very large impact on fuel efficiency and emissions.

A.I.D. should provide technical support in the following area:

- *Standards.* Establish fuel efficiency standards for new vehicles as an effective means to improve the vehicle stock.
- *Awareness.* Increase awareness regarding proper vehicle care, fleet maintenance, driving habits, etc. to reduce fuel consumption.
- *Traffic Management.* Conduct studies to improve traffic flow in large cities and congested areas.

3.3 RECOMMENDATIONS ON THE PROMOTION OF PRIVATE SECTOR INVOLVEMENT

Given the serious financial and operational problems of publicly-owned and controlled energy supply systems, private sector participation in the energy sector could help improve the overall efficiency of the energy sector and provide essential financial resources.

[5] Joy Dunkerley et al. *Transport Energy: Determinants and Policy.* USAID/Resources for the Future, September 1985.

3.3.1 Power Subsector

There are two major areas in the promotion of private sector participation: private power by independent producers and the privatization of electric utilities.

Private Power. A.I.D. is currently active in this area, and has learned several lessons from its involvement. Despite extensive studies and negotiations sponsored by the Agency, and despite the professed enthusiasm of many governments for private power, there is hardly any independent power being sold to the grid with a formal agreement binding the utility to purchase it.

It appears that much of the problem is caused by the difficulty in arriving at what could be fair and long lasting conditions. In addition, there is not enough funding for specific feasibility studies of independent power and cogeneration projects, and there is insufficient knowledge about interested U.S. investors that could help finance the projects.

A.I.D. should provide technical support in the following areas:

- *Competitive Bidding.* Promote competitive bidding processes for independent power and cogeneration projects as an alternative to agreeing to a specific purchase price. Provide assistance to develop standard offers with clear conditions and evaluation criteria, and help in the evaluation of bids and in the contractual negotiations phase.

- *Feasibility Evaluations.* Offer funding for feasibility evaluations to be made against known power purchase criteria and conditions. This should encourage the industrial subsectors to pressure their governments for clear rules and would improve the chances that attractive projects would go ahead unimpeded.

- *Legislation.* Promote the development of PURPA-type legislation as a means to protect investors and attract projects that are advantageous in terms of energy efficiency and environmental objectives.

Privatization of Power Utilities. The success of Chile in the privatization of its power subsector has sparked a great deal of interest, and privatization plans are now under way in

other LAC countries (in some cases, such plans are being implemented). Utilities in Europe are following this trend closely with a view towards acquiring interests in LAC utilities. U.S. utilities have also expressed a moderate interest subject to the expected reform of U.S. legislation that currently restricts such acquisitions.

A.I.D. should provide technical support in the following areas:

- *Identify Investors.* Identify U.S. utilities and investors who are seriously interested in the region and help them stay up to date on regional privatization and private power developments through the dissemination of information.

- *Regulatory Context.* Develop a regulatory framework for the operation of a system of private electric utilities in generation, transmission, and distribution.

3.3.2 Oil and Gas Subsector

Private sector ownership of oil and gas resources has always been a very delicate political issue and will remain so. However, there are less sensitive areas in this subsector where opportunities exist, such as the privatization of distribution or transportation networks and in the dissemination of information.

A.I.D. should provide technical support in the following areas:

- *Investment Information.* Provide LAC governments interested in privatization with information on interested U.S. investors and also provide U.S. investors with information about investment opportunities in the LAC region.

- *Regulatory Framework.* Provide assistance in the development of regulatory policies for the distribution of oil and gas in those countries that are undergoing the privatization of this subsector.

- *Transportation Network.* Provide assistance in the development of effective transportation and storage networks.

3.4 RECOMMENDATIONS ON ENVIRONMENTAL PROTECTION ACTIVITIES

Most LAC governments have become increasingly sensitized about the environmental impacts of energy production and use through the serious air quality problems faced by some of the region's urban areas and the growing pressure of lending agencies for environmental impact assessments of energy projects. Nevertheless, while there has been some success in implementing and enforcing urban regulations to reduce emissions from the transport sector, the agencies responsible for environmental control of the electricity, and gas and oil subsectors remains very weak.

A.I.D. should provide support in the following areas to LAC governments:

- *Training.* Train staff on environmental standards, evaluation methodologies, available technologies, and instrumentation.

- *Regulations.* Assist in the development of regulations and compliance monitoring programs.

- *Instrumentation and Equipment..* Provide assistance in obtaining adequate tools and instruments, as well as equipment and transportation necessary for staff to perform their duties.

- *Special Studies.* Conduct specific studies on special problems in the protection of wetlands and other fragile environments and in the mitigation of impacts caused by effluents from geothermal plants.

- *Emergency Preparedness.* Provide assistance in the development of emergency preparedness plans to deal with the environmental impacts of spills and nuclear incidents.

- *Transport Standards.* Assist in developing standards and enforcement procedures to reduce emissions in the transport sector.

3.5 RECOMMENDATIONS ON SMALL RENEWABLE AND RURAL ENERGY DEVELOPMENT

Large-scale renewable resources such as conventional hydroelectric and geothermal projects are part of current utility expansion plans. A.I.D. technical support in private power and in the privatization of electric utilities would therefore apply to these projects.

In this section, support for the development of small-scale renewables and fuel substitution in the domestic sector of rural areas will be addressed.

Rural Electrification. The backbone of A.I.D. policy in rural development has been rural electrification assistance in the form of efforts to implement rural power systems based on the U.S. rural electric coop model and largely fed by the national grid. This assistance has been successful, but it must be pointed out that national power systems are having increasing difficulty in financing new capacity expansions and maintaining the efficient and reliable performance of existing capacity.

It is recommended that assistance in rural electrification be realistically counter-balanced with the available financial resources and power capacity availability. Within this context, the application of agro-industrial biomass, small-scale hydro, photovoltaic, and wind turbines as part of rural electrification strategies can play a viable role in remote areas with sufficient local economic resources. The ability of local communities and industries to organize and partially finance these projects at a grass-roots level needs to be explored as much as possible.

For example, small hydro is still rare in LAC, largely because its development is entrusted to power utilities who are more interested in large hydro or other major methods of generation. If small hydro is to be developed, it is more likely to be through the efforts of private promoters who see opportunities for the sale of cheap power to the grid or through rural communities interested in harnessing hydro to complement diesel generation in isolated systems.

A.I.D. should provide technical support in the following areas:

- *Feasibility Studies.* Provide assistance to fund feasibility studies of small hydro projects and other renewables such as wind and photovoltaic to serve isolated systems in rural areas.

- *Project Promotion.* Provide assistance to promote these projects among developers in the U.S. who could be interested in joining forces with local capital for these developments.

Domestic Uses of Wood. The widespread use of wood and charcoal as fuels for cooking in rural areas, coupled with major population growth, poor timber resource management, and pressures to clear land for other agricultural purposes, is resulting in widespread deforestation in the LAC region. The rapidly dwindling forests are putting pressure on people to utilize wood more efficiently through better cook stove technology or to switch to other non-renewable fuels such as kerosene or LPG.

A.I.D. should provide technical support in the following area:

- *Fuel Substitution.* Monitor the use of wood as a domestic fuel and conduct studies for the substitution of this fuel in those areas where its use exceeds the natural recovery capacity.

3.6 CONCLUSIONS

The LAC region has great interest in the largely private but carefully regulated energy industry of the United States. At the same time, there has never been so much interest in cooperation and trade, both between LAC countries and the U.S. and among the LAC nations themselves, and never has there been a greater need for that cooperation. While it is difficult to isolate the specific contribution of A.I.D. to these developments, it seems that, in general, past activities in the energy sector of the LAC have yielded very good return.

The next several years will present A.I.D. with both the opportunities and the challenge to provide effective and welcomed assistance in the energy sectors of the LAC region. A.I.D. can play a strong role in guiding LAC through the demonopolization process the region is so eager to accomplish. At the same time, A.I.D. can provide critical assistance to ensure that energy development is accomplished with due regard to local and global environmental concerns.

From its past strong focus on technical assistance to the public sector, A.I.D. should now shift to a stronger assistance to help the private sector do business in a region that is ready to welcome private capital, both foreign and local.

A.I.D. can be an important catalyst to private sector involvement and respond to public sector needs by providing information exchange, experienced advice and, in some case, financial support. Well focused assistance will yield a long lasting relationship of bilateral cooperation, help preserve the environment, and provide U.S. firms with a major share of the market opened by economic recovery in this region.

APPENDICES

Appendix 1 Trends in Energy Production and Consumption in the LAC Region.

	Average Annual Growth Rate				Per Capita Energy Consumption	Energy Imports/ Merchandise Exports	1988 Population	Forecast 2000 Population
	Energy Production 1965–80 (%)	Energy Production 1980–89 (%)	Energy Consumption 1965–80 (%)	Energy Consumption 1980–89 (%)	(kgoe)	(%)	(million)	(million)
Bolivia	10	(0)	8	(2)	249	3	7	10
Brazil	9	9	10	4	813	13	144	178
Chile	2	3	3	2	832	4	13	15
Colombia	1	11	6	2	755	4	32	38
Costa Rica	8	8	9	3	557	12	3	3
Dominican Rep	11	5	12	2	332	36	7	9
Ecuador	35	(4)	12	1	573	3	10	13
El Salvador	9	3	7	2	215	14	5	6
Guatemala	13	7	7	(1)	168	14	9	12
Haiti	na	4	8	2	57	13	6	8
Honduras	14	7	8	3	203	14	5	7
Jamaica	(1)	5	6	(3)	855	22	2	3
Mexico	10	2	8	1	1,305	1	84	105
Nicaragua	3	(0)	7	2	252	42	4	5
Panama	7	10	6	4	1,627	57	2	3
Paraguay	na	12	10	5	224	12	4	6
Peru	7	(1)	5	1	478	1	21	26
LAC region	2	3	7	2	952	7	414	514

Source: The World Bank, WDR 1990, August 1990.

Appendix 2 Regional Installed Capacity Profile by Type of Plant 1990 (MW)

Country	Hydro	Geotherm	Nuclear	Thermal	Total	Hydro	Geotherm	Nuclear	Thermal	Total
Argentina	6,473	1	1,018	7,721	15,213	43%	0%	7%	51%	100%
Barbados	0	0	0	159	159	0%	0%	0%	100%	100%
Bolivia	334	0	0	393	727	46%	0%	0%	54%	100%
Brazil	45,587	0	657	6,797	53,041	86%	0%	1%	13%	100%
Chile	2,425	0	0	1,879	4,304	56%	0%	0%	44%	100%
Colombia	6,749	0	0	2,424	9,173	74%	0%	0%	26%	100%
Costa Rica	740	0	0	157	897	82%	0%	0%	18%	100%
Cuba	49	0	0	3,939	3,988	1%	0%	0%	99%	100%
Dominican Republic	206	0	0	1,927	2,133	10%	0%	0%	90%	100%
Ecuador	898	0	0	842	1,740	52%	0%	0%	48%	100%
El Salvador	404	95	0	167	666	61%	14%	0%	25%	100%
Grenada	0	0	0	13	13	0%	0%	0%	100%	100%
Guatemala	462	0	0	334	796	58%	0%	0%	42%	100%
Guyana	0	0	0	152	152	0%	0%	0%	100%	100%
Haiti	54	0	0	132	186	29%	0%	0%	71%	100%
Honduras	424	0	0	128	552	77%	0%	0%	23%	100%
Jamaica	20	0	0	677	697	3%	0%	0%	97%	100%
Mexico	7,760	700	675	16,157	25,292	31%	3%	3%	64%	100%
Nicaragua	105	70	0	253	428	25%	16%	0%	59%	100%
Panama	551	0	0	401	952	58%	0%	0%	42%	100%
Paraguay	6,491	0	0	38	6,529	99%	0%	0%	1%	100%
Peru	2,396	0	0	1,741	4,137	58%	0%	0%	42%	100%
Surinam	189	0	0	202	391	48%	0%	0%	52%	100%
Trinidad & Tobago	0	0	0	1,253	1,253	0%	0%	0%	100%	100%
Uruguay	1,196	0	0	370	1,566	76%	0%	0%	24%	100%
Venezuela	10,000	0	0	8,520	18,520	54%	0%	0%	46%	100%

Source: OLADE – Sistema de Informacion Economica–Energetica (SIEE), 1991

Appendix 3 Regional Electricity Generation by Type of Plant 1990 (GWh)

Country	Hydro	Geotherm	Nuclear	Thermal	Total	Hydro	Geotherm	Nuclear	Thermal	Total
Argentina	19,138	0	7,280	22,453	48,871	39%	0%	15%	46%	100%
Barbados	0	0	0	562	562	0%	0%	0%	100%	100%
Bolivia	1,290	0	0	843	2,133	60%	0%	0%	40%	100%
Brazil	203,077	0	2,237	15,678	220,992	92%	0%	1%	7%	100%
Chile	8,677	0	0	9,133	17,810	49%	0%	0%	51%	100%
Colombia	27,260	0	0	8,133	35,393	77%	0%	0%	23%	100%
Costa Rica	3,391	0	0	77	3,468	98%	0%	0%	2%	100%
Cuba	99	0	0	14,442	14,541	1%	0%	0%	99%	100%
Dominican Republic	497	0	0	3,206	3,703	13%	0%	0%	87%	100%
Ecuador	4,853	0	0	1,508	6,361	76%	0%	0%	24%	100%
El Salvador	1,648	419	0	151	2,218	74%	19%	0%	7%	100%
Grenada	0	0	0	56	56	0%	0%	0%	100%	100%
Guatemala	2,232	0	0	91	2,323	96%	0%	0%	4%	100%
Guyana	0	0	0	320	320	0%	0%	0%	100%	100%
Haiti	123	0	0	449	572	22%	0%	0%	78%	100%
Honduras	2,288	0	0	9	2,297	100%	0%	0%	0%	100%
Jamaica	0	0	0	2,416	2,416	0%	0%	0%	100%	100%
Mexico	23,333	5,124	2,937	82,923	114,317	20%	4%	3%	73%	100%
Nicaragua	434	386	0	579	1,399	31%	28%	0%	41%	100%
Panama	2,213	0	0	448	2,661	83%	0%	0%	17%	100%
Paraguay	23,970	0	0	50	24,020	100%	0%	0%	0%	100%
Peru	10,473	0	0	3,344	13,817	76%	0%	0%	24%	100%
Surinam	756	0	0	538	1,294	58%	0%	0%	42%	100%
Trinidad & Tobago	0	0	0	3,577	3,577	0%	0%	0%	100%	100%
Uruguay	7,009	0	0	363	7,372	95%	0%	0%	5%	100%
Venezuela	37,081	0	0	20,769	57,850	64%	0%	0%	36%	100%

Source: OLADE – Sistema de Informacion Economica-Energetica (SIEE), 1991

Appendix 4 1990–1999 Capital Expenditures for Power in the LAC Region

Country	Capital Expenditures (1989 US$ million)				
	Generation	Transmission	Distribution	Other	Total
Argentina	10,336	2,053	2,325	1,523	16,237
Bolivia	365	72	145	60	642
Brazil	36,337	21,197	13,121	5,047	75,702
Chile	1,754	284	627	260	2,925
Colombia	4,186	718	1,915	940	7,759
Costa Rica	1,391	94	223	170	1,878
Dominican Rep.	1,448	143	357	115	2,063
Ecuador	1,203	309	460	28	2,000
El Salvador	436	51	136	60	683
Guatemala	1,323	77	212	167	1,779
Haiti	na	na	na	na	na
Honduras	239	85	217	38	579
Jamaica	425	35	97	68	625
Mexico	20,571	6,335	6,148	3,628	36,682
Nicaragua	50	14	37	12	113
Panama	218	42	112	38	410
Paraguay	na	na	na	na	na
Peru	2,183	336	896	440	3,855
Trinidad/Tobago	na	na	na	na	na
Uruguay	168	228	568	76	1,040
Venezuela	na	na	na	na	na
Total	82,633	32,073	27,596	12,670	154,972

Source: The World Bank, Capital Expenditures for Electric Power in Developing Countries, PPR, February 1990

Appendix 5

Domestic Consumer Prices (June 1991) in the LAC Region.

	Domestic Fuels (US$/gallon)			
	Regular Gasoline	Diesel Oil	Household Kerosene	Fuel Oil
Argentina	2.07	1.13	0.93	0.50
Bolivia	1.58	1.27	0.85	1.22
Brazil	1.57	0.79	0.93	0.47
Chile	1.39	1.25	1.04	0.49
Colombia	0.58	0.58	0.58	0.32
Costa Rica	1.48	1.22	1.22	0.58
Dominican Rep.	1.57	1.07	1.41	0.63
Ecuador	0.40	0.38	0.05	na
El Salvador	1.47	0.88	1.00	0.54
Guatemala	1.80	1.19	1.70	0.68
Haiti	na	1.68	1.49	0.46
Honduras	1.40	1.26	0.56	0.88
Jamaica	na	1.00	0.62	0.24
Mexico	0.89	0.71	0.71	0.23
Nicaragua	2.00	1.20	1.20	0.65
Panama	1.78	1.15	1.02	0.48
Paraguay	1.97	1.37	1.32	0.74
Peru	1.75	0.79	0.85	0.58
Trinidad/Tobago	1.29	0.80	0.80	na
Uruguay	2.86	1.62	1.18	0.90
Venezuela	0.23	0.17	0.15	0.18

Estimating Petroleum Product Subsidies in 3 LAC-Countries

	Retail Price ($/gal)	Intl. Price 1/ ($/gal)	Subsidy ($/gal)	Subsidy ($/bbl)	Consump./year (bbl/year)	Product Subsidy 2/	Total Subsidy 3/
Venezuela							
Regular Gasoline	0.23	0.68	0.45	18.90	37,887,000	66%	63%
Diesel Oil	0.17	0.52	0.35	14.70	25,258,000	67%	33%
Fuel Oil	0.18	0.23	0.05	2.10	24,090,000	22%	4%
Ecuador							
Regular Gasoline	0.40	0.68	0.28	11.76	6,351,000	41%	75%
Diesel Oil	0.38	0.52	0.14	5.88	4,234,000	27%	25%
Fuel Oil	na	0.23	na	na	na	na	na
Colombia							
Regular Gasoline	0.58	0.68	0.10	4.20	22,119,000	15%	na
Diesel Oil	0.58	0.52	-0.06	-2.52	14,746,000	-12%	tax
Fuel Oil	0.32	0.23	-0.09	-3.78	12,410,000	-39%	tax

1/ Caribbean spot prices June, 1991, used here as a rough reference price for economic comparisons.
2/ Product subsidy is defined as the ratio of ($/gal) subsidy to the international price.
3/ Total subsidy denotes the proportion of subsidy between fuels.

Source: OLADE - Sistema de Informacion Economica-Energetica (SIEE), 1991;
DOE International Energy Outlook, 1991; RCG/Hagler, Bailly, Inc., November 1991.

Appendix 6 Electric Sector Tariffs (June 1991)

Country	Electricity Tariffs (US cents/kWh)					Tariff Contribution to Incremental Cost (%)
	Residential	Commercial	Industrial	Average	Average Incremental Cost	
Argentina	9.43	10.62	6.31	3.20	6.60	48
Bolivia	5.46	10.40	5.81	5.00	5.70	88
Brazil	5.13	5.71	2.92	6.30	8.30	76
Chile	11.11	10.23	6.32	na	na	na
Colombia	2.52	7.64	5.69	4.10	4.20	98
Costa Rica	9.09	10.23	8.49	4.80	6.50	74
Dominica	na	na	na	19.80	16.30	121
Dominican Rep.	7.60	8.15	10.82	6.00	10.70	56
Ecuador	2.00	3.60	3.69	2.40	6.20	39
El Salvador	3.50	4.22	4.17	4.30	4.60	93
Guyana	na	na	na	8.90	23.40	38
Guatemala	3.65	5.53	5.33	6.10	7.70	79
Haiti	18.73	18.29	13.27	na	na	na
Honduras	5.13	3.77	3.40	8.50	6.10	139
Jamaica	14.69	11.10	9.82	12.10	19.40	62
Mexico	5.19	11.36	5.16	4.10	6.40	64
Nicaragua	6.60	9.68	6.64	na	na	na
Panama	12.20	11.52	10.09	11.20	11.20	100
Paraguay	4.81	6.48	4.47	na	na	na
Peru	4.74	4.71	2.36	2.90	14.50	20
Trinidad/Tobago	4.00	3.00	2.00	3.10	4.40	70
Uruguay	7.05	8.05	6.80	6.20	10.90	57
Venezuela	2.33	6.74	4.74	2.00	2.90	69
Average	6.30	7.44	5.58	5.26	7.65	60.48

Source: OLADE - Sistema de Informacion Economica-Energetica (SIEE), 1991

OLADE - Latin America and the Caribbean Technical Department (Report No. 7), 1991

Appendix 7 1990 Energy Import Classification of the LAC Region

	Name of Country	Final Energy Consumption ('000boe)	Annual Imports of Oil ('000boe)	Oil Imports as a % of Final Energy Consumption (%)
1	Antigua	na	na	na
2	Belize	na	na	na
3	Bolivia	15,390	0	0.0%
4	Brazil	827,582	238,710	28.8%
5	Chile	82,586	42,924	52.0%
6	Colombia	144,533	9,965	6.9%
7	Costa Rica	13,356	7,592	56.8%
8	Dominica	na	na	na
9	Dominican Republic*	21,980	21,718	98.8%
10	Ecuador	39,636	2,811	7.1%
11	El Salvador	15,629	5,950	38.1%
12	Grenada*	293	292	99.7%
13	Guatemala	30,412	10,220	33.6%
14	Guyana	5,115	2,774	54.2%
15	Haiti	9,867	2,227	22.6%
16	Honduras	16,896	5,731	33.9%
17	Jamaica	9,933	7,884	79.4%
18	Mexico	672,711	38,325	5.7%
19	Nicaragua	11,123	4,818	43.3%
20	Panama	10,380	9,965	96.0%
21	Paraguay	22,700	2,263	10.0%
22	Peru	74,807	11,425	15.3%
23	St. Kitts	na	na	na
24	St. Lucia	na	na	na
25	Uruguay	13,979	9,855	70.5%
	LAC Region Total	2,038,908	435,445	
	LAC Region Average	81,556	17,418	21%

Source: RCG/Hagler, Bailly, Inc., November, 1991.
Data from OLADE, 1990
* estimates based on OLADE data.

Appendix 8 Energy Balances for Select Countries in the LAC Region

1. Bolivia
2. Brazil
3. Chile
4. Colombia
5. Ecuador
6. Guatemala
7. Jamaica
8. Mexico
9. Panama
10. Paraguay
11. Peru
12. Uruguay

Source: International Energy Agency, World Energy Balances 1985-1988, OECD, Paris, 1990.

Bolivia

Thousand toe

1987	Coal	Oil	Gas	Hydr/Oth	Electricity	Total
Indigenous Production	.	1099.2	2374.8	257.1	.	3731.1
Imports	.	.	.	.	.	.
Exports	.	-63.1	-1777.8	.	.	-1840.9
Intl Marine Bunkers	.	.	.	.	.	.
Stock change (+/-)	.	10.2	.	.	.	10.2
TOTAL ENERGY REQUIREMENT	.	1046.2	597.1	257.1	.	1900.4
Petroleum Refineries	.	-15.8	.	.	.	-15.8
Electricity Generation	.	-93.1	-72.0	-257.1	149.1	-273.1
Other Transformation [1]	.	12.7	-298.6	.	-63.1	-349.0
TOTAL FINAL CONSUMPTION	.	950.0	226.4	.	86.0	1262.4
TOTAL INDUSTRY	.	8.6	226.4	.	30.1	265.2
Iron and Steel	.	.	.	.	.	.
Chemical	.	.	.	.	.	.
Non-Metallic Minerals	.	.	.	.	.	.
Unspecified	.	8.6	226.4	.	30.1	265.2
TOTAL TRANSPORT	.	671.9	.	.	.	671.9
Road	.	577.4	.	.	.	577.4
Air	.	84.2	.	.	.	84.2
Unspecified	.	10.3	.	.	.	10.3
TOTAL OTHER	.	260.8	.	.	55.9	316.7
Agriculture	.	10.4	.	.	.	10.4
Public/Commerce	.	.	.	.	3.4	3.4
Residential	.	245.3	.	.	39.6	284.8
Unspecified	.	5.1	.	.	12.9	18.1
Non-Energy Use	.	8.6	.	.	.	8.6
Electr. Generated (GWh)		*253*	*330*	*1151*		*1734*

1988	Coal	Oil	Gas	Hydr/Oth	Electricity	Total
Indigenous Production	.	1109.5	2574.6	277.7	.	3961.8
Imports	.	.	.	.	.	.
Exports	.	-101.8	-1868.5	.	.	-1970.2
Intl Marine Bunkers	.	.	.	.	.	.
Stock change (+/-)	.	-27.2	.	.	.	-27.2
TOTAL ENERGY REQUIREMENT	.	980.6	706.1	277.7	.	1964.4
Petroleum Refineries	.	-7.1	.	.	.	-7.1
Electricity Generation	.	-93.1	-75.6	-277.6	160.1	-286.2
Other Transformation [1]	.	12.0	-404.2	.	-60.2	-452.4
TOTAL FINAL CONSUMPTION	.	892.3	226.3	.	99.9	1218.5
TOTAL INDUSTRY	.	4.8	226.3	.	.	231.1
Iron and Steel	.	.	.	.	.	.
Chemical	.	.	.	.	.	.
Non-Metallic Minerals	.	.	.	.	.	.
Unspecified	.	4.8	226.3	.	.	231.1
TOTAL TRANSPORT	.	649.0	.	.	.	649.0
Road	.	567.0	.	.	.	567.0
Air	.	82.0		.	.	82.0
Unspecified	.	.	.	.	.	.
TOTAL OTHER	.	228.8	.	.	.	228.8
Agriculture	.	.	.	.	.	.
Public/Commerce	.	.	.	.	.	.
Residential	.	228.8	.	.	.	228.8
Unspecified	.	.	.	.	.	.
Non-Energy Use	.	9.6	.	.	.	9.6
Electr. Generated (GWh)		*269*	*350*	*1243*		*1862*

(1) Includes Returns, Transfers, Statistical Difference, Own Use and Losses.

Brazil 1988

Thousand toe

	Coal	Oil	Gas	Nuclear	Hydr/Oth	Electr	Heat	Total
Indigenous Production	3225.6	34257.6	2468.0	13.4	45458.3	.	.	85422.9
Imports	7331.5	36726.8	.	.	.	1543.8	.	45602.1
Exports	.	-7358.1	.	.	.	-0.7	.	-7358.8
Intl. Marine Bunkers	.	-879.0	.	.	.	.	.	-879.0
Stock Change	126.1	-736.5	.	.	.	.	.	-610.4
TOTAL ENERGY REQUIRE.	10683.3	62010.8	2468.0	13.4	45458.3	1543.1	.	122176.8
Returns and Transfers	.	-125.6	.	.	.	.	.	-125.6
Statistical Differences	-28.9	-37.4	520.7	.	.	.	.	454.4
Gas Works	.	-195.6	188.1	.	.	.	.	-7.5
Petroleum Refineries	.	-3477.6	.	.	.	.	.	-3477.6
Liquefaction	.	.	.	.	.	.	.	.
Public Service Electricity	-958.5	-1625.9	.	-13.4	-43654.9	17583.5	.	-28669.3
Autoproducers of Electr.	-29.2	-435.0	.	.	-1803.3	830.6	.	-1437.0
Other Transformation	.	.	.	.	.	.	.	.
Own Use	-332.0	.	-836.0	.	.	-412.0	.	-1580.0
Distrib. and Transf. Losses	-709.7	-49.4	-26.0	.	.	-2510.9	.	-3296.0
TOTAL FINAL CONSUMP.	8624.9	56064.3	2314.8	.	.	17034.2	.	84038.1
TOTAL INDUSTRY	8618.9	13115.5	2097.8	.	.	9631.3	.	33463.5
Iron and Steel	7203.3	741.7	271.0	.	.	1721.7	.	9937.6
Chemical and Petrochemical	289.5	7434.2	1303.0	.	.	1159.3	.	10186.0
(of which: Feedstocks)	87.9	5740.5	582.0	.	.	.	.	6410.4
Non-Ferrous Metals	8.1	296.8	26.0	.	.	2062.1	.	2393.1
Non-Metallic Minerals	841.6	707.9	111.0	.	.	597.1	.	2257.6
Transp. Equip. and Machinery	.	.	.	.	.	.	.	.
Mining and Quarrying	32.4	671.3	60.9	.	.	504.7	.	1269.3
Food and Tobacco	91.2	708.5	87.9	.	.	852.0	.	1739.7
Paper, Pulp and Printing	119.2	469.8	31.0	.	.	626.3	.	1246.2
Wood and Wood Products	.	.	.	.	.	.	.	.
Construction	.	.	.	.	.	.	.	.
Textile and Leather	4.0	409.6	10.0	.	.	519.1	.	942.7
Unspecified	29.6	1675.8	197.0	.	.	1588.9	.	3491.3
TOTAL TRANSPORT	6.0	29897.6	.	.	.	102.7	.	30006.3
Air	.	1915.2	.	.	.	.	.	1915.2
Road	.	26518.7	.	.	.	.	.	26518.7
Rail	6.0	599.3	.	.	.	102.7	.	707.9
Internal Navigation	.	864.5	.	.	.	.	.	864.5
Unspecified	.	.	.	.	.	.	.	.
TOTAL OTHER	.	9163.1	217.0	.	.	7300.2	.	16680.3
Agriculture	.	3501.8	.	.	.	537.6	.	4039.4
Commerce	.	354.8	53.0	.	.	1841.9	.	2249.8
Public Services	.	340.5	8.0	.	.	1427.9	.	1776.5
Residential	.	4805.5	156.0	.	.	3492.7	.	8454.2
Unspecified	.	160.5	.	.	.	.	.	160.5
Non-Energy Use	.	3888.0	.	.	.	.	.	3888.0
MEMO ITEMS:								
Electricity Generated (GWh)	*3120*	*7432*		*60*	*203505*			*214117*
Public	*3029*	*5938*		*60*	*195432*			*204459*
Autoproducers	*91*	*1494*			*8073*			*9658*

* For Brazil oil includes alcohol fuels.

Chile 1988

Thousand toe

	Coal	Oil	Gas	Nuclear	Hydr/Oth	Electr	Heat	Total
Indigenous Production	1322.1	1421.3	440.0	.	2620.2	.	.	5803.7
Imports	336.8	4565.5	.	.	.	.	.	4902.3
Exports	.	-157.4	.	.	.	.	.	-157.4
Intl. Marine Bunkers	.	-49.0	.	.	.	.	.	-49.0
Stock Change	114.8	-157.8	.	.	.	.	.	-43.1
TOTAL ENERGY REQUIRE.	1773.6	5622.6	440.0	.	2620.2	.	.	10456.5
Returns and Transfers	.	28.8	.	.	.	.	.	28.8
Statistical Differences	-2.7	-9.2	.	.	.	.	.	-12.0
Gas Works	-16.3	-41.0	135.3	.	.	.	.	78.0
Petroleum Refineries	.	-459.6	.	.	.	-16.1	.	-475.6
Liquefaction	.	.	.	.	.	.	.	.
Public Service Electricity	-353.9	-66.0	-66.3	.	-2463.8	1077.6	.	-1872.5
Autoproducers of Electr.	-543.9	-192.0	.	.	-156.4	377.0	.	-515.2
Other Transformation	.	.	.	.	.	.	.	.
Own Use	-23.8	-1.1	-9.7	.	.	-37.0	.	-71.6
Distrib. and Transf. Losses	-100.5	.	.	.	.	-215.4	.	-315.9
TOTAL FINAL CONSUMP.	732.7	4882.5	499.2	.	.	1186.1	.	7300.6
TOTAL INDUSTRY	712.3	1283.3	309.7	.	.	776.6	.	3081.9
Iron and Steel	264.9	83.5	65.5	.	.	54.9	.	468.8
Chemical and Petrochemical	.	.	227.0	.	.	20.2	.	247.2
(of which: Feedstocks)	.	.	.	.	.	20.2	.	20.2
Non-Ferrous Metals	.	121.1	.	.	.	307.1	.	428.2
Non-Metallic Minerals	92.3	53.3	.	.	.	20.9	.	166.5
Transp. Equip. and Machinery	.	.	.	.	.	.	.	.
Mining and Quarrying	60.4	368.5	.	.	.	17.9	.	446.8
Food and Tobacco	120.2	1.1	.	.	.	6.9	.	128.1
Paper, Pulp and Printing	3.4	60.0	.	.	.	96.1	.	159.4
Wood and Wood Products	.	.	.	.	.	.	.	.
Construction	.	.	.	.	.	.	.	.
Textile and Leather	.	.	.	.	.	.	.	.
Unspecified	171.1	595.8	17.2	.	.	252.7	.	1036.8
TOTAL TRANSPORT	.	2810.6	.	.	.	18.8	.	2829.5
Air	.	231.1	.	.	.	.	.	231.1
Road	.	2382.8	.	.	.	7.4	.	2390.2
Rail	.	24.8	.	.	.	11.4	.	36.3
Internal Navigation	.	171.8	.	.	.	.	.	171.8
Unspecified	.	.	.	.	.	.	.	.
TOTAL OTHER	20.4	769.4	189.5	.	.	390.7	.	1370.0
Agriculture	.	.	.	.	.	2.6	.	2.6
Commerce	.	.	.	.	.	137.6	.	137.6
Public Services	.	.	.	.	.	34.4	.	34.4
Residential	.	675.0	.	.	.	216.1	.	891.1
Unspecified	20.4	94.5	189.5	.	.	.	.	304.4
Non-Energy Use	.	19.2	.	.	.	.	.	19.2
MEMO ITEMS:								
Electricity Generated (GWh)	*3894*	*1110*	*180*		*11730*			*16914*
Public	*1150*	*170*	*180*		*11030*			*12530*
Autoproducers	*2744*	*940*			*700*			*4384*

Colombia 1988

Thousand toe

	Coal	Oil	Gas	Nuclear	Hydr/Oth	Electr	Heat	Total
Indigenous Production	9930.1	20456.9	2880.8	.	5466.5	.	.	38734.2
Imports	.	1372.3	.	.	.	.	.	1372.3
Exports	-7057.2	-11714.2	.	.	.	.	.	-18771.5
Intl. Marine Bunkers	.	-57.4	.	.	.	.	.	-57.4
Stock Change	293.8	54.8	.	.	.	.	.	348.6
TOTAL ENERGY REQUIRE.	3166.6	10112.4	2880.8	.	5466.5	.	.	21626.3
Returns and Transfers	.	19.5	.	.	.	.	.	19.5
Statistical Differences	59.2	-447.1	221.5	.	.	-192.0	.	-358.5
Gas Works	.	.	.	.	.	.	.	.
Petroleum Refineries	.	-368.5	.	.	.	.	.	-368.5
Liquefaction	.	.	.	.	.	.	.	.
Public Service Electricity	-588.9	-46.8	-1502.9	.	-5405.5	2663.5	.	-4880.5
Autoproducers of Electr.	-279.2	-30.5	-354.7	.	-61.0	191.8	.	-533.6
Other Transformation	.	.	.	.	.	.	.	.
Own Use	-40.5	.	-311.1	.	.	-126.6	.	-478.2
Distrib. and Transf. Losses	-286.3	-358.2	.	.	.	-451.2	.	-1095.7
TOTAL FINAL CONSUMP.	2030.9	8880.9	933.6	.	.	2085.5	.	13930.8
TOTAL INDUSTRY	1848.9	1213.4	844.4	.	.	723.6	.	4630.2
Iron and Steel	94.0	57.1	24.9	.	.	142.4	.	318.4
Chemical and Petrochemical	78.9	102.4	355.7	.	.	188.9	.	725.9
(of which: Feedstocks)	.	.	.	.	.	.	.	.
Non-Ferrous Metals	29.3	.	.	.	.	.	.	29.3
Non-Metallic Minerals	1049.1	185.6	312.8	.	.	103.1	.	1650.6
Transp. Equip. and Machinery	1.0	98.1	32.0	.	.	28.9	.	160.0
Mining and Quarrying	.	.	.	.	.	.	.	.
Food and Tobacco	122.2	222.6	53.6	.	.	115.3	.	513.8
Paper, Pulp and Printing	236.0	84.5	41.0	.	.	58.1	.	419.5
Wood and Wood Products	.	1.0	14.5	.	.	6.5	.	22.0
Construction	.	85.4	.	.	.	.	.	85.4
Textile and Leather	135.2	84.1	5.9	.	.	77.1	.	302.3
Unspecified	103.4	292.5	3.8	.	.	3.4	.	402.9
TOTAL TRANSPORT	2.6	5561.7	.	.	.	0.3	.	5564.5
Air	.	529.5	.	.	.	.	.	529.5
Road	.	4882.7	.	.	.	.	.	4882.7
Rail	2.6	25.8	.	.	.	0.3	.	28.6
Internal Navigation	.	123.7	.	.	.	.	.	123.7
Unspecified	.	.	.	.	.	.	.	.
TOTAL OTHER	179.4	1838.0	89.2	.	.	1361.6	.	3468.2
Agriculture	.	261.9	.	.	.	4.0	.	266.0
Commerce	.	210.7	0.9	.	.	383.1	.	594.7
Public Services	.	.	.	.	.	.	.	.
Residential	179.4	774.8	85.3	.	.	958.5	.	1997.9
Unspecified	.	590.6	3.0	.	.	16.0	.	609.6
Non-Energy Use	.	267.8	.	.	.	.	.	267.8
MEMO ITEMS:								
Electricity Generated (GWh)	*2630*	*199*	*5900*		*24472*			*33201*
Public	*1870*	*117*	*4785*		*24199*			*30971*
Autoproducers	*760*	*82*	*1115*		*273*			*2230*

Ecuador

Thousand toe

1987	Coal	Oil	Gas	Hydr/Oth	Electricity	Total
Indigenous Production	.	9198.0	.	1020.8	.	10218.8
Imports	.	1672.5	.	.	.	1672.5
Exports	.	-5960.0	.	.	.	-5960.0
Intl Marine Bunkers	.	-105.7	.	.	.	-105.7
Stock change (+/-)	.	-79.2	.	.	.	-79.2
TOTAL ENERGY REQUIREMENT	.	4725.6	.	1020.8	.	5746.4
Petroleum Refineries	.	-379.1	.	.	.	-379.1
Electricity Generation	.	-264.8	.	-1020.8	463.0	-822.6
Other Transformation [1]	.	-348.0	.	.	-104.1	-452.1
TOTAL FINAL CONSUMPTION	.	3733.7	.	.	359.0	4092.6
TOTAL INDUSTRY	.	619.8	.	.	117.0	736.7
Iron and Steel	.	.	.	.	.	.
Chemical	.	.	.	.	.	.
Non-Metallic Minerals	.	.	.	.	.	.
Unspecified	.	619.8	.	.	117.0	736.7
TOTAL TRANSPORT	.	2058.5	.	.	.	2058.5
Road	.	1377.9	.	.	.	1377.9
Air	.	169.3	.	.	.	169.3
Unspecified	.	511.3	.	.	.	511.3
TOTAL OTHER	.	1001.6	.	.	242.0	1243.6
Agriculture	.	225.7	.	.	.	225.7
Public/Commerce	.	83.5	.	.	42.0	125.4
Residential	.	340.4	.	.	143.0	483.4
Unspecified	.	352.0	.	.	57.0	409.1
Non-Energy Use	.	53.8	.	.	.	53.8
Electr. Generated (GWh)		*814*		*4570*		*5384*

1988	Coal	Oil	Gas	Hydr/Oth	Electricity	Total
Indigenous Production	.	15889.4	.	1046.7	.	16936.1
Imports	.	190.3	.	.	.	190.3
Exports	.	-11224.8	.	.	.	-11224.8
Intl Marine Bunkers	.	.	.	.	.	.
Stock change (+/-)	.	.	.	.	.	.
TOTAL ENERGY REQUIREMENT	.	4854.9	.	1046.7	.	5901.7
Petroleum Refineries	.	-695.2	.	.	.	-695.2
Electricity Generation	.	-220.2	.	-1046.7	470.0	-797.0
Other Transformation [1]	.	-49.9	.	.	-88.0	-138.0
TOTAL FINAL CONSUMPTION	.	3889.4	.	.	382.0	4271.4
TOTAL INDUSTRY	.	506.9	.	.	121.0	627.9
Iron and Steel	.	.	.	.	.	.
Chemical	.	.	.	.	.	.
Non-Metallic Minerals	.	.	.	.	.	.
Unspecified	.	506.9	.	.	121.0	627.9
TOTAL TRANSPORT	.	2184.7	.	.	.	2184.7
Road	.	1476.1	.	.	.	1476.1
Air	.	177.9	.	.	.	177.9
Unspecified	.	530.7	.	.	.	530.7
TOTAL OTHER	.	1037.6	.	.	261.0	1298.6
Agriculture	.	196.8	.	.	.	196.8
Public/Commerce	.	90.6	.	.	43.0	133.6
Residential	.	386.4	.	.	147.0	533.4
Unspecified	.	363.8	.	.	71.0	434.8
Non-Energy Use	.	160.3	.	.	.	160.3
Electr. Generated (GWh)		*779*		*4686*		*5465*

(1) Includes Returns, Transfers, Statistical Difference, Own Use and Losses.

Guatemala

Thousand toe

1987	Coal	Oil	Gas	Hydr/Oth	Electricity	Total
Indigenous Production	.	182.5	.	151.9	.	334.4
Imports	.	1123.0	.	.	.	1123.0
Exports	.	-178.5	.	.	.	-178.5
Intl Marine Bunkers	.	-124.2	.	.	.	-124.2
Stock change (+/-)	.	-25.9	.	.	.	-25.9
TOTAL ENERGY REQUIREMENT	.	976.9	.	151.9	.	1128.8
Petroleum Refineries	.	-9.2	.	.	.	-9.2
Electricity Generation	.	-302.3	.	-151.9	152.3	-301.9
Other Transformation [1]	.	-3.3	.	.	-27.1	-30.4
TOTAL FINAL CONSUMPTION	.	662.1	.	.	125.1	787.2
TOTAL INDUSTRY	.	na	.	.	34.4	na
Iron and Steel	.	.	.	.	.	.
Chemical	.	.	.	.	.	.
Non-Metallic Minerals	.	.	.	.	.	.
Unspecified	.	na	.	.	34.4	na
TOTAL TRANSPORT	.	439.7	.	.	.	439.7
Road	.	393.9	.	.	.	393.9
Air	.	45.8	.	.	.	45.8
Unspecified	.	.	.	.	.	.
TOTAL OTHER	.	140.3	.	.	90.7	231.1
Agriculture	.	51.7	.	.	.	51.7
Public/Commerce	.	.		.	2.6	2.6
Residential	.	88.7	.	.	50.7	139.4
Unspecified	.	.	.	.	37.4	37.4
Non-Energy Use	.	40.3	.	.	.	40.3
Electr. Generated (GWh)		*1090*		*680*		*1770*

1988	Coal	Oil	Gas	Hydr/Oth	Electricity	Total
Indigenous Production	.	202.8	.	151.9	.	354.7
Imports	.	1110.7	.	.	.	1110.7
Exports	.	-101.4	.	.	.	-101.4
Intl Marine Bunkers	.	-129.4	.	.	.	-129.4
Stock change (+/-)	.	-52.4	.	.	.	-52.4
TOTAL ENERGY REQUIREMENT	.	1030.2	.	151.9	.	1182.1
Petroleum Refineries	.	-51.9	.	.	.	-51.9
Electricity Generation	.	-314.0	.	-151.9	153.6	-312.3
Other Transformation [1]	.	.	.	.	-27.1	-27.1
TOTAL FINAL CONSUMPTION	.	664.4	.	.	126.4	790.8
TOTAL INDUSTRY	.	na	.	.	34.4	na
Iron and Steel	.	.	.	.	.	.
Chemical	.	.	.	.	.	.
Non-Metallic Minerals	.	.	.	.	.	.
Unspecified	.	na	.	.	34.4	na
TOTAL TRANSPORT	.	454.6	.	.	.	454.6
Road	.	407.8	.	.	.	407.8
Air	.	46.9	.	.	.	46.9
Unspecified	.	.	.	.	.	.
TOTAL OTHER	.	137.3	.	.	92.0	229.3
Agriculture	.	44.3	.	.	.	44.3
Public/Commerce	.	.	.	.	2.6	2.6
Residential	.	93.0	.	.	51.6	144.6
Unspecified	.	.	.	.	37.8	37.8
Non-Energy Use	.	35.5	.	.	.	35.5
Electr. Generated (GWh)		*1105*		*680*		*1785*

(1) Includes Returns, Transfers, Statistical Difference, Own Use and Losses.

Jamaica

Thousand toe

1987	Coal	Oil	Gas	Hydr/Oth	Electricity	Total
Indigenous Production	.	.	.	27.9	.	27.9
Imports	.	1683.6	.	.	.	1683.6
Exports	.	-24.9	.	.	.	-24.9
Intl Marine Bunkers	.	-21.1	.	.	.	-21.1
Stock change (+/-)	.	.	.	.	.	.
TOTAL ENERGY REQUIREMENT	.	1637.5	.	27.9	.	1665.5
Petroleum Refineries	.	-12.4	.	.	.	-12.5
Electricity Generation	.	-431.9	.	-27.9	153.4	-306.4
Other Transformation [1]	.	.	.	.	-37.3	-37.3
TOTAL FINAL CONSUMPTION	.	1193.3	.	.	116.1	1309.4
TOTAL INDUSTRY	.	510.7	.	.	68.9	579.6
Iron and Steel	.	.	.	.	.	.
Chemical	.	.	.	.	.	.
Non-Metallic Minerals	.	58.4	.	.	.	58.4
Unspecified	.	452.3	.	.	68.9	521.2
TOTAL TRANSPORT	.	454.9	.	.	.	454.9
Road	.	312.2	.	.	.	312.2
Air	.	142.7	.	.	.	142.7
Unspecified	.	.	.	.	.	.
TOTAL OTHER	.	200.8	.	.	47.2	248.0
Agriculture	.	41.6	.	.	.	41.6
Public/Commerce	.	.	.	.	2.6	2.6
Residential	.	98.2	.	.	35.9	134.0
Unspecified	.	61.0	.	.	8.7	69.8
Non-Energy Use	.	26.9	.	.	.	26.9
Electr. Generated (GWh)		*1659*		*125*		*1784*

1988	Coal	Oil	Gas	Hydr/Oth	Electricity	Total
Indigenous Production	.	.	.	22.6	.	22.6
Imports	.	1777.6	.	.	.	1777.6
Exports	.	.	.	.	.	.
Intl Marine Bunkers	.	-13.5	.	.	.	-13.5
Stock change (+/-)	.	-34.6	.	.	.	-34.5
TOTAL ENERGY REQUIREMENT	.	1729.7	.	22.6	.	1752.2
Petroleum Refineries	.	-43.5	.	.	.	-43.5
Electricity Generation	.	-471.5	.	-22.6	149.8	-344.3
Other Transformation [1]	.	.	.	.	-38.1	-38.1
TOTAL FINAL CONSUMPTION	.	1214.6	.	.	111.7	1326.4
TOTAL INDUSTRY	.	31.1	.	.	65.9	96.9
Iron and Steel	.	.	.	.	.	.
Chemical	.	.	.	.	.	.
Non-Metallic Minerals	.	10.4	.	.	.	10.4
Unspecified	.	20.7	.	.	65.9	86.5
TOTAL TRANSPORT	.	494.7	.	.	.	494.7
Road	.	350.9	.	.	.	350.9
Air	.	143.8	.	.	.	143.8
Unspecified	.	.	.	.	.	.
TOTAL OTHER	.	154.2	.	.	45.8	200.1
Agriculture	.	41.4	.	.	.	41.4
Public/Commerce	.	.	.	.	2.2	2.2
Residential	.	107.6	.	.	34.9	142.6
Unspecified	.	5.2	.	.	8.7	13.9
Non-Energy Use	.	32.6	.	.	.	32.6
Electr. Generated (GWh)		*1641*		*101*		*1742*

(1) Includes Returns, Transfers, Statistical Difference, Own Use and Losses.

Mexico 1988

Thousand toe

	Coal	Oil	Gas	Nuclear	Hydr/Oth	Electr	Heat	Total
Indigenous Production	3276.7	146896.7	22689.4	.	5648.1	.	.	178510.9
Imports	150.5	3915.8	58.2	.	.	14.4	.	4138.9
Exports	-89.5	-75070.0	.	.	.	-171.7	.	-75331.2
Intl. Marine Bunkers	.	-369.6	.	.	.	.	.	-369.6
Stock Change	69.8	-617.1	-89.7	.	.	.	.	-637.1
TOTAL ENERGY REQUIRE.	3407.5	74755.7	22657.9	.	5648.1	-157.4	.	106311.8
Returns and Transfers	.	-15.8	.	.	.	.	.	-15.8
Statistical Differences	-22.3	-276.6	0.9	.	.	0.1	.	-297.9
Gas Works	.	.	.	.	.	.	.	.
Petroleum Refineries	.	-6579.0	.	.	.	.	.	-6579.0
Liquefaction	.	.	.	.	.	.	.	.
Public Service Electricity	-1824.9	-13888.4	-2510.0	.	-5648.1	8763.8	.	-15107.5
Autoproducers of Electr.	.	.	.	.	.	.	.	.
Other Transformation	.	.	.	.	.	.	.	.
Own Use	-3.3	.	-6044.6	.	.	-416.9	.	-6464.8
Distrib. and Transf. Losses	-199.1	.	.	.	.	-668.4	.	-867.4
TOTAL FINAL CONSUMP.	1357.9	53995.9	14104.2	.	.	7521.2	.	76979.2
TOTAL INDUSTRY	1357.9	13291.8	13415.4	.	.	4147.7	.	32212.8
Iron and Steel	1357.9	.	.	.	.	.	.	1357.9
Chemical and Petrochemical	.	6146.0	7633.6	.	.	.	.	13779.6
(of which: Feedstocks)	.	1798.5	2649.0	.	.	.	.	4447.4
Non-Ferrous Metals	.	.	.	.	.	.	.	.
Non-Metallic Minerals	.	.	.	.	.	.	.	.
Transp. Equip. and Machinery	.	.	.	.	.	.	.	.
Mining and Quarrying	.	.	.	.	.	.	.	.
Food and Tobacco	.	.	.	.	.	.	.	.
Paper, Pulp and Printing	.	.	.	.	.	.	.	.
Wood and Wood Products	.	.	.	.	.	.	.	.
Construction	.	.	.	.	.	.	.	.
Textile and Leather	.	.	.	.	.	.	.	.
Unspecified	.	7145.8	5781.8	.	.	4147.7	.	17075.3
TOTAL TRANSPORT	.	25410.3	.	.	.	67.9	.	25478.2
Air	.	1299.3	.	.	.	.	.	1299.3
Road	.	17287.2	.	.	.	.	.	17287.2
Rail	.	.	.	.	.	67.9	.	67.9
Internal Navigation	.	.	.	.	.	.	.	.
Unspecified	.	6823.8	.	.	.	.	.	6823.8
TOTAL OTHER	.	13071.5	688.8	.	.	3305.6	.	17065.8
Agriculture	.	1888.4	.	.	.	551.2	.	2439.6
Commerce	.	.	.	.	.	.	.	.
Public Services	.	.	.	.	.	.	.	.
Residential	.	6676.9	688.8	.	.	2275.3	.	9641.0
Unspecified	.	4506.1	.	.	.	479.1	.	4985.2
Non-Energy Use	.	2222.4	.	.	.	.	.	2222.4
MEMO ITEMS:								
Electricity Generated (GWh)	*7911*	*59788*	*8921*		*25285*			*101905*
Public	*7911*	*59788*	*8921*		*25285*			*101905*
Autoproducers								

Panama

Thousand toe

1987	Coal	Oil	Gas	Hydr/Oth	Electricity	Total
Indigenous Production	.	.	.	453.9	.	453.9
Imports	3.1	3421.6	.	.	.	3424.7
Exports	.	-348.7	.	.	.	-348.7
Intl Marine Bunkers	.	-2153.2	.	.	.	-2153.2
Stock change (+/-)	.	.	.	.	.	.
TOTAL ENERGY REQUIREMENT	3.1	919.6	.	453.9	.	1376.6
Petroleum Refineries	.	-132.3	.	.	.	-132.3
Electricity Generation	.	-253.7	.	-453.9	249.6	-458.1
Other Transformation [1]	-3.1	.	0.5	.	-61.2	-63.8
TOTAL FINAL CONSUMPTION	.	533.6	0.5	.	188.3	722.4
TOTAL INDUSTRY	.	114.3	.	.	26.2	140.5
Iron and Steel	.	.	.	.	.	.
Chemical	.	10.8	.	.	.	10.8
Non-Metallic Minerals	.	.	.	.	.	.
Unspecified	.	103.5	.	.	26.2	129.7
TOTAL TRANSPORT	.	322.1	.	.	.	322.1
Road	.	275.2	.	.	.	275.2
Air	.	46.9	.	.	.	46.9
Unspecified	.	.	.	.	.	.
TOTAL OTHER	.	73.2	0.5	.	162.1	235.8
Agriculture	.	.	.	.	.	.
Public/Commerce	.	.	.	.	3.5	3.5
Residential	.	73.2	0.5	.	57.0	130.7
Unspecified	.	.	.	.	101.6	101.6
Non-Energy Use	.	24.0	.	.	.	24.0
Electr. Generated (GWh)		*870*		*2032*		*2902*

1988	Coal	Oil	Gas	Hydr/Oth	Electricity	Total
Indigenous Production	.	.	.	426.2	.	426.2
Imports	9.2	3452.7	.	.	.	3461.9
Exports	.	-350.5	.	.	.	-350.5
Intl Marine Bunkers	.	-2168.0	.	.	.	-2168.0
Stock change (+/-)	.	.	.	.	.	.
TOTAL ENERGY REQUIREMENT	9.2	934.1	.	426.2	.	1369.5
Petroleum Refineries	.	-136.8	.	.	.	-136.7
Electricity Generation	.	-254.1	.	-426.2	238.9	-441.4
Other Transformation [1]	-9.2	.	0.5	.	-60.2	-69.0
TOTAL FINAL CONSUMPTION	.	543.3	0.5	.	178.7	722.4
TOTAL INDUSTRY	.	114.3		.	na	na
Iron and Steel	.	.	.	.	.	.
Chemical	.	10.8	.	.	.	10.8
Non-Metallic Minerals	.	.	.	.	.	.
Unspecified	.	103.5	.	.	.	103.5
TOTAL TRANSPORT	.	323.3	.	.	.	323.3
Road	.	275.4	.	.	.	275.4
Air	.	47.9	.	.	.	47.9
Unspecified	.	.	.	.	.	.
TOTAL OTHER	.	78.8	0.5	.	na	na
Agriculture	.	.	.	.	.	.
Public/Commerce	.	.	.	.	.	.
Residential	.	78.8	0.5	.	.	79.2
Unspecified	.	.	.	.	.	.
Non-Energy Use	.	26.9	.	.	.	26.9
Electr. Generated (GWh)		*870*		*1908*		*2778*

(1) Includes Returns, Transfers, Statistical Difference, Own Use and Losses.

Paraguay

Thousand toe

1987	Coal	Oil	Gas	Hydr/Oth	Electricity	Total
Indigenous Production	.	.	.	4071.0	.	4071.0
Imports	.	550.8	.	.	0.2	550.9
Exports	.	.	.	.	-1421.8	-1421.8
Intl Marine Bunkers	.	.	.	.	.	.
Stock change (+/-)	.	.	.	.	.	.
TOTAL ENERGY REQUIREMENT	.	550.8	.	4071.0	-1421.7	3200.1
Petroleum Refineries	.	-16.4	.	.	.	-16.4
Electricity Generation	.	-1.0	.	-4071.0	1567.7	-2504.3
Other Transformation [1]	.	-1.1	.	.	0.2	-0.9
TOTAL FINAL CONSUMPTION	.	532.3	.	.	146.2	678.5
TOTAL INDUSTRY	.	23.0	.	.	60.2	83.2
Iron and Steel	.	.	.	.	.	.
Chemical	.	.	.	.	.	.
Non-Metallic Minerals	.	.	.	.	.	.
Unspecified	.	23.0	.	.	60.2	83.2
TOTAL TRANSPORT	.	451.6	.	.	.	451.6
Road	.	417.5	.	.	.	417.5
Air	.	34.1	.	.	.	34.1
Unspecified	.	.	.	.	.	.
TOTAL OTHER	.	45.2	.	.	86.0	131.2
Agriculture	.	.	.	.	.	.
Public/Commerce	.	.	.	.	6.9	6.9
Residential	.	45.2	.	.	68.8	114.0
Unspecified	.	.	.	.	10.3	10.3
Non-Energy Use	.	12.5	.	.	.	12.5
Electr. Generated (GWh)		*4*		*18225*		*18229*

1988	Coal	Oil	Gas	Hydr/Oth	Electricity	Total
Indigenous Production	.	.	.	4414.1	.	4414.1
Imports	.	589.1	.	.	.	589.0
Exports	.	.	.	.	-1543.8	-1543.8
Intl Marine Bunkers	.	.	.	.	.	.
Stock change (+/-)	.	-78.0	.	.	.	-78.0
TOTAL ENERGY REQUIREMENT	.	511.0	.	4414.1	-1543.8	3381.4
Petroleum Refineries	.	-4.2	.	.	.	-4.2
Electricity Generation	.	.	.	-4414.1	1699.4	-2714.7
Other Transformation [1]	.	.	.	.	.	.
TOTAL FINAL CONSUMPTION	.	506.8	.	.	155.7	662.4
TOTAL INDUSTRY	.	21.1	.	.	60.2	81.3
Iron and Steel	.	.	.	.	.	.
Chemical	.	.	.	.	.	.
Non-Metallic Minerals	.	.	.	.	.	.
Unspecified	.	21.1	.	.	60.2	81.3
TOTAL TRANSPORT	.	431.8	.	.	.	431.8
Road	.	396.6	.	.	.	396.6
Air	.	35.2	.	.	.	35.2
Unspecified	.	.	.	.	.	.
TOTAL OTHER	.	45.2		.	95.5	140.7
Agriculture	.	.	.	.	.	.
Public/Commerce	.	.	.	.	6.9	6.9
Residential	.	45.2	.	.	78.3	123.5
Unspecified	.	.	.	.	10.3	10.3
Non-Energy Use	.	8.6	.	.	.	8.6
Electr. Generated (GWh)				*19761*		*19761*

(1) Includes Returns, Transfers, Statistical Difference, Own Use and Losses.

Peru

Thousand toe

1987	Coal	Oil	Gas	Hydr/Oth	Electricity	Total
Indigenous Production	74.9	8308.9	539.8	2467.0	.	11390.6
Imports	100.0	922.0	.	.	.	1022.0
Exports	.	-2681.0	.	.	.	-2681.0
Intl Marine Bunkers	.	-62.7	.	.	.	-62.7
Stock change (+/-)	.	101.7	.	.	.	101.7
TOTAL ENERGY REQUIREMENT	174.9	6588.9	539.8	2467.0	.	9770.5
Petroleum Refineries	.	-633.1	.	.	.	-633.2
Electricity Generation	.	-731.8	-85.4	-2467.0	1204.9	-2079.3
Other Transformation [1]	-74.9	451.2	.	.	-170.9	205.3
TOTAL FINAL CONSUMPTION	99.9	5675.1	454.4	.	1034.0	7263.4
TOTAL INDUSTRY	99.9	1306.8	454.4	.	613.0	2474.1
Iron and Steel	29.9	.	.	.	.	29.9
Chemical	.	.	.	.	.	.
Non-Metallic Minerals	.	.	.	.	.	.
Unspecified	70.0	1306.8	454.4	.	613.0	2444.2
TOTAL TRANSPORT	.	2627.1	.	.	.	2627.1
Road	.	2179.7	.	.	.	2179.7
Air	.	291.8	.	.	.	291.8
Unspecified	.	155.6	.	.	.	155.6
TOTAL OTHER	.	1586.7	.	.	421.0	2007.7
Agriculture	.	248.0	.	.	51.0	299.0
Public/Commerce	.	95.1	.	.	43.0	138.1
Residential	.	1086.3	.	.	327.0	1413.3
Unspecified	.	157.3	.	.	.	157.3
Non-Energy Use	.	154.6	.	.	.	154.6
Electr. Generated (GWh)		*2686*	*280*	*11044*		*14010*

1988	Coal	Oil	Gas	Hydr/Oth	Electricity	Total
Indigenous Production	91.0	7804.5	515.9	2498.7	.	10910.1
Imports	72.5	1621.5	.	.	.	1694.0
Exports	-21.0	-2443.2	.	.	.	-2464.2
Intl Marine Bunkers	.	-59.8	.	.	.	-59.8
Stock change (+/-)	.	-355.0	.	.	.	-355.0
TOTAL ENERGY REQUIREMENT	142.5	6567.9	515.9	2498.7	.	9725.0
Petroleum Refineries	.	-544.6	.	.	.	-544.6
Electricity Generation	.	-702.0	-63.0	-2498.7	1215.6	-2048.1
Other Transformation [1]	-42.9	11.6	.	.	-172.0	-203.3
TOTAL FINAL CONSUMPTION	99.6	5333.1	452.9	.	1043.6	6929.1
TOTAL INDUSTRY	99.6	na	452.9	.	na	na
Iron and Steel	43.6	.	.	.	.	43.6
Chemical	.	.	.	.	.	.
Non-Metallic Minerals	.	.	.	.	.	.
Unspecified	56.0	64.4	452.9	.	.	573.2
TOTAL TRANSPORT	.	na	.	.	.	na
Road	.	.	.	.	.	.
Air	.	350.4	.	.	.	350.4
Unspecified	.	.	.	.	.	.
TOTAL OTHER	.	na	.	.	na	na
Agriculture	.	.	.	.	.	.
Public/Commerce	.	.	.	.	.	.
Residential	.	1074.1	.	.	.	1074.1
Unspecified	.	.	.	.	.	.
Non-Energy Use	.	98.9	.	.	.	98.9
Electr. Generated (GWh)		*2719*	*230*	*11186*		*14135*

(1) Includes Returns, Transfers, Statistical Difference, Own Use and Losses.

Uruguay

Thousand toe

1987	Coal	Oil	Gas	Hydr/Oth	Electricity	Total
Indigenous Production	.	.	.	986.5	.	986.4
Imports	0.6	1323.2	.	.	.	1323.8
Exports	.	.	.	.	.	.
Intl Marine Bunkers	.	-100.7	.	.	.	-100.7
Stock change (+/-)	.	47.8	.	.	.	47.8
TOTAL ENERGY REQUIREMENT	0.6	1270.3	.	986.5	.	2257.3
Petroleum Refineries	.	-116.3	.	.	.	-116.3
Electricity Generation	.	-74.1	.	-986.5	402.6	-658.0
Other Transformation [1]	.	-27.7	9.6	.	-97.1	-115.1
TOTAL FINAL CONSUMPTION	0.6	1052.2	9.6	.	305.5	1368.0
TOTAL INDUSTRY	0.6	201.8	1.2	.	109.5	313.0
Iron and Steel	.	.	.	.	.	.
Chemical	.	16.3	.	.	12.4	28.7
Non-Metallic Minerals	.	72.0	.	.	5.8	77.8
Unspecified	0.6	113.5	1.2	.	91.3	206.5
TOTAL TRANSPORT	.	474.6	.	.	1.5	476.1
Road	.	410.7	.	.	.	410.7
Air	.	35.2	.	.	.	35.2
Unspecified	.	28.7	.	.	1.5	30.2
TOTAL OTHER	.	314.4	8.5	.	194.5	517.4
Agriculture	.	127.4	.	.	5.0	132.4
Public/Commerce	.	52.4	3.3	.	53.9	109.6
Residential	.	131.5	5.1	.	135.6	272.2
Unspecified	.	3.1	.	.	.	3.2
Non-Energy Use	.	61.4	.	.	.	61.4
Electr. Generated (GWh)		*265*		*4416*		*4681*

1988	Coal	Oil	Gas	Hydr/Oth	Electricity	Total
Indigenous Production	.	.	.	764.8	.	764.8
Imports	.	1687.0	.	.	.	1687.0
Exports	.	.	.	.	.	.
Intl Marine Bunkers	.	-99.3	.	.	.	-99.3
Stock change (+/-)	.	16.0	.	.	.	16.0
TOTAL ENERGY REQUIREMENT	.	1603.8	.	764.8	.	2368.6
Petroleum Refineries	.	-125.8	.	.	.	-125.8
Electricity Generation	.	-389.9	.	-764.8	427.2	-727.5
Other Transformation [1]	.	-15.8	10.0	.	-98.1	-103.9
TOTAL FINAL CONSUMPTION	.	1072.3	10.0	.	329.0	1411.3
TOTAL INDUSTRY	.	199.2	1.3	.	117.1	317.6
Iron and Steel	.	.	.	.	.	.
Chemical	.	16.3	.	.	11.0	27.3
Non-Metallic Minerals	.	65.3	.	.	4.7	70.0
Unspecified	.	117.6	1.3	.	101.4	220.3
TOTAL TRANSPORT	.	485.4	.	.	1.5	486.8
Road	.	439.0	.	.	.	439.0
Air	.	32.0	.	.	.	32.0
Unspecified	.	14.4	.	.	1.5	15.8
TOTAL OTHER	.	329.2	8.7	.	210.4	548.3
Agriculture	.	136.7	.	.	5.2	141.8
Public/Commerce	.	34.7	3.4	.	58.2	96.4
Residential	.	151.5	5.3	.	147.1	303.9
Unspecified	.	6.3	.	.	.	6.2
Non-Energy Use	.	58.6	.	.	.	58.6
Electr. Generated (GWh)		*1543*		*3424*		*4967*

(1) Includes Returns, Transfers, Statistical Difference, Own Use and Losses.

APPENDIX 9: DONOR ACTIVITIES

All of the major international development organizations have been active in the LAC energy sector to different degrees over the years. This appendix summarizes the recent LAC energy activities of A.I.D., the World Bank, and other donors, and discusses some of the most important lessons learned from this experience.

The World Bank (IBRD) and the Interamerican Development Bank (IDB), and their affiliate organizations, such as the Caribbean Development Bank (CDB) and the Central American Bank for Economic Integration (CABEI), are the major lenders in the region. Among other multilateral agencies working in the region are the United Nations (UN), the European Economic Community (EEC), and the Organization for American States (OAS). Among the most active bilateral agencies are A.I.D., the Canadian International Development Agency (CIDA), and development agencies from European nations and Japan.

The energy activities of these organizations have been very diverse and largely independent. There has been substantial effort by A.I.D. to coordinate assistance with the IBRD and IDB to help avoid the duplication of assistance and to avoid leaving gaps. Most other development assistance, both bilateral and multilateral, is not coordinated except by the local authorities who channel the funds. As a result, there is evidence of some duplication of effort and a lack of information sharing about project results. Exhibits A9-1 through A9-3 summarize the recent energy programs and activities A.I.D. and other major energy donors in the region.

In general, the IBRD and IDB provide financing for capital investments in the energy sector, while bilateral agencies offer assistance for front-end and support work (master plans, feasibility studies, planning and policy development). However, both banks have also financed numerous studies, particularly in the electric subsector, and many bilateral agencies, including A.I.D., provide some form of capital investment.

Until recently, lending by development banks was almost exclusively to the public sector and, to some extent, this contributed to the excessive expansion of state-owned public utilities and high indebtedness. Now, however, the banks are considering providing more financial assistance to promote private sector involvement in energy projects. A.I.D. has been at the forefront of the promotion of private sector involvement and has organized seminars on private power development, funded feasibility studies, conducted studies of avoided cost, and provided recommendations on regulatory policies for privatization. A.I.D. has also supported

numerous activities to promote energy conservation and efficiency and to reduce the environmental impacts of the energy sector (e.g., Costa Rica, Guatemala, Mexico and Brazil).

The development of renewable energy resources and rural electrification in Latin America has been substantially assisted by programs supported by A.I.D. and the IDB. A.I.D. has played a substantial role in the development of mini-hydro, geothermal, biomass, and solar energy and in rural electrification programs. The IDB has provided major loans for hydro and geothermal projects and has played an active role in biomass energy development.

Exhibit A9-1
Recent or Current AID Activities in the LAC-Region (1990-1991)

Countries	Program Description
Costa Rica	▸ Power Sector Efficiency Assessment with comprehensive least-cost planning methodology ▸ Funding pre-investment studies for capacity expansion by private sector ▸ Co-funding with ROCAP for the establishment of an electrical generation and transmission association ▸ Funding study tour to California regarding private power generation and sales
Guatemala	▸ Developing a methodology for estimating the national electric utility's avoided costs in purchasing electricity from private sector producers ▸ Developing market for improved woodstoves ▸ Evaluated policy, management, and technical issues related to efficiency of operations of isolated diesel power utilities
Honduras	▸ Co-funding feasibility of private power generation
Belize	▸ Co-funding feasibility of private power generation
El Salvador	▸ Organizing workshop on private power generation ▸ Organizing study tour of U.S. state commissions and private power developer
Panama	▸ Providing speaker for workshop on private power generation
Central America Region	▸ Background reports for development of energy strategy ▸ With ROCAP designing desk study of Nicaragua's power sector
Dominican Republic	▸ Private power generation assessment ▸ Assisted U.S. private power developer in feasibility study ▸ Determining appropriateness and attractiveness of private power generation from waste
Jamaica	▸ Co-sponsored conference on private power generation and efficiency ▸ Assisted U.S. private power developer in feasibility study
Bolivia	▸ Investigation of potential for private power projects
Colombia	▸ Organizing workshop on private power generation
Brazil	▸ With German foreign aid agency, World Bank, and IDB, creation of a semi-private institute that will promote energy efficiency ▸ Examining impact of cogeneration in sugar and ethanol industries ▸ Coordinating development of advanced gas turbine systems fueled with biomass ▸ Funding a pre-investment study for advanced technologies to convert wood to charcoal
Mexico	▸ As part of the Agency's Global Warming Initiative, sending definitional mission to Mexico to determine effective low-budget activities for implementation. Activities include power sector efficiency improvements and renewable energy projects.

Source: A.I.D., Office of Energy and Infrastructure, 1991.

Exhibit A9-2
Activities of the World Bank Group in the LAC Energy Sector (1990-1991)

Project Status	Countries	Program Description	Total Loans (millions US$)
Projects Approved by the IBRD and IDA for Fiscal Year 1990 Only	Brazil	▸ Electricity transmission investment and energy conservation	383
	Mexico	▸ Improving efficiency and meeting part of the financial obligations of national utilities	450
	Uruguay	▸ Program of investments and technical assistance	62.5
Projects Under Consideration in 1991 (Excludes Non-A.I.D. Assisted Argentina and Venezuela)	Brazil	▸ Hydrocarbon transport and processing assistance to PETROBRAS to develop product distribution network, gas utilization, and technical assistance in transport planning. ▸ Financing of time-slice of power distribution and conservation investments in selected countries	up to 260.0 up to 300.0
	Colombia	▸ Power sector investment to ensure sound power investment policies	200.0
	El Salvador	▸ Power sector technical assistance for reform and promotion of private sector participation	11.0 (approved 7/11/91)
	Haiti	▸ Ensure supply and distribution of power to keep pace with demand growth and institutional support	25.0
	Honduras	▸ Assistance to national power utility, efficiency improvements, exploration, and supply management	50.0
	Jamaica	▸ Private sector energy development, distribution, and supply of power to meet demand growth	50.0
	Mexico	▸ Rehabilitation of power sector, improvement of operation, maintenance and utility management	450.0

Historical Lending to Energy Sector Borrowers in the LAC Region for Fiscal Year 1981-1990 ($ millions)

Energy Sector	Annual Average 1981-1985	1986	1987	1988	1989	1990
Oil/Gas/Coal	145.1	131.0	104.4	--	84.0	--
Power	571.3	819.2	423.8	423.0	736.0	897.5
Total	716.4	950.2	528.2	423.0	830.0	897.5

Exhibit A9-3
Activities of Other Multilateral and Bilateral Agencies in the Energy Sector (1990)

Institution	Countries	Program Description/Title	Total Loans (millions US$)
Inter-American Development Bank (adapted from statement of approved loans during 1990)	Bolivia	▸ Electrical generation, transmission and distribution program	80
	Brazil	▸ Segredo Hydroelectric Project	135
	Jamaica	▸ Electricity System Improvement	82
	Mexico	▸ Electric Sector Investment Program	330
	Others	▸ General Energy Sector Assistance	38
Caribbean Development Bank (adapted from statement of approved loans during 1990)	Antigua	▸ Assisting government in financing expansion, upgrading electricity services	2.5
	Belize	▸ Services of consultant/general manager	0.13
European Economic Community	Mexico	▸ Energy Sector Program	1.24
	Ecuador	▸ Control of electric load	0.74
	Peru	▸ Rational use of energy	1.12
United Nations	LAC	▸ Support OLADE in developing and implementing energy balance systems; providing assistance for training and energy efficiency	0.35

Source: *The World Bank Annual Report 1990*, 1990.
ESMAP, *Information and Status Report*, September 1990.
The World Bank. *Monthly Operational Summary*, August 1991.
Inter-American Development Bank, *Annual Report 1990*, 1991.
Caribbean Development Bank, *Annual Report 1990*, 1991.
Commission of the European Communities, Directorate-General for Energy (DG-XVII), November 1991.

BIBLIOGRAPHY

1. Bechelli, Carlos M. and Roberto D. Brandt. "Six Latin American Countries Could Join in New Gas Market." *Oil & Gas Journal Special*, October 21, 1991, pp. 46-52.

2. British Petroleum Company. *BP Statistical Review of World Energy*. Economics Unit, London, England: British Petroleum Company, June 1990.

3. Caribbean Development Bank. *Annual Report 1990*. Washington DC: Caribbean Development Bank, 1991.

4. Choucri, Nazli. *Energy and Development in Latin America*. Toronto: Lexington Books, 1982.

5. Commission of the European Communities, Directorate-General for Energy (DG-XVII). Personal communication. Brussels/Belgium: November 1991.

6. Dunkerley, Joy et al. *Transport Energy: Determinants and Policy*. USAID/Resources for the Future, September 1985.

7. Energy Information Administration. *International Energy Annual 1982*. Washington, DC: U.S. Department of Energy, 1989.

8. Escay, Jose R. *Summary Data Sheets of 1987 Power and Commercial Energy Statistics for 100 Developing Countries*. Washington, DC: The World Bank, 1989.

9. Geller, Howard S. *Electricity Conservation in Brazil: Status Report and Analysis*. American Council for an Energy Efficient Economy, August 1980.

10. Geller, Howard S. "Electricity Conservation in Brazil: Potential and Progress." *Energy*, vol. 3, no. 6, 1980.

11. Guzman, O. et al. *Energy Efficiency and Conservation in Mexico*. SEPAFIN, 1986.

12. Intergovernmental Panel on Climate Change. *The Appendix Report of the Expert Group on Emissions Scenarios*. April 1990.

13. Inter-American Development Bank. *Annual Report 1990*. Washington DC: Inter-American Development Bank, 1991.

14. International Energy Agency. *Coal Information 1991*. Paris/France: OECD, 1991.

15. International Energy Agency. *Energy in Non-OECD Countries, Selected Topics 1991*. Paris/France: OECD, 1991.

16. International Energy Agency. *World Energy Statistics and Balances 1985-1988*. Paris/France: Organisation for Economic Co-ordination and Development (OECD), 1990.

17. "Latin Finance." *Privatization in Latin America*. A Latin Finance Supplement, Coral Gables, Florida: Latin Finance, March 1991.

18. Levine, Mark D. et al. *Energy Efficiency, Developing Nations, and Eastern Europe*. A report to the U.S. Working Group on Global Energy Efficiency, April 1991.

19. Louis Harris and Associates. *1989 Public and Leadership Attitudes to the Environment in Four Continents: A Report of a Survey in 16 Countries*. New York: 1989.

20. Meyers, Stephen et al. *Plans for the Power Sector in 13 Major Developing Countries*. Lawrence Berkeley Laboratory. LBL-27764. October, 1989.

21. Munasinghe, Mohan. *Electric Power Economics*. London: Butterworths, 1990.

22. *Oil and Gas Journal*, Houston, Texas, December 31, 1990.

23. Organizacion Latinoamericana de Energia (OLADE). "Participation of Private Initiatives in the Energy Sector," *Energy Magazine*, year 15, no. 1, January-April 1991. Ecuador: OLADE, April 1991.

24. OLADE. *The Evolution, Situation, and Prospects of the Electric Power Sector in the Latin American and Caribbean Countries, Volume 1, Regional Report*. Latin American and the Caribbean Technical Department, Regional Studies Program, Report No. 7, Infrastructure and Energy Division, August 1991.

25. OLADE. *Sistema de Informacion Economica-Energetica (SIEE)*. Ecuador: OLADE, 1991.

26. U.S. Agency for International Development. *Power Shortages in Developing Countries: Magnitude, Impacts, Solutions, and the Role of the Private Sector*. Report to Congress. March 1988.

27. U.S. Agency for International Development, Office of Energy and Infrastructure. Personal communication. Washington, DC: November 1991.

28. U.S. Agency for International Development, Office of Energy and Infrastructure. *Costa Rica Energy Sector Assessment*. Washington, DC: 1990.

29. U.S. Department of Energy, Energy Information Administration, Office of Energy and End Use. *International Energy Outlook 1991*. Washington DC: U.S. Department of Energy, 1991.

30. U.S. Working Group on Global Energy Efficiency. *Energy Efficiency, Developing Nations, and Eastern Europe*. 1991.

31. The World Bank. *Capital Expenditures for Electric Power in Developing Countries*. Industry and Energy Department Working Paper, Energy Series Paper No. 21. Washington DC: The World Bank Industry and Energy Department, PRE, February 1990.

32. The World Bank. *Global Economic Prospects and the Developing Countries, 1991*. Washington, DC: The World Bank, 1991.

33. The World Bank. *Prospects for Gas-Fueled Combined-Cycle Power Generation in the Developing Countries*. Industry and Energy Department Working Paper, Energy Series Paper No. 35. Washington DC: The World Bank Industry and Energy Department, PRE, May 1991.

34. The World Bank. *A Review of Regulation of the Power Sectors in Developing Countries*. Industry and Energy Department Working Paper, Energy Series Paper No. 22. Washington DC: The World Bank Industry and Energy Department, PRE, February 1990.

35. The World Bank. *Review of Electricity Tariffs in Developing Countries During the 1980s*. Industry and Energy Department Working Paper, Energy Series Paper No. 32. Washington DC: The World Bank Industry and Energy Department, PRE, November 1990.

36. The World Bank. *The World Bank Annual Report 1990*. Washington DC: The World Bank, 1990.

37. The World Bank. *World Development Report 1991.* New York: Oxford University Press, 1991.

38. The World Bank/UNDP/Bilateral Aid. *Energy Sector Management Assistance Program (ESMAP), Information and Status Report, September 1990.* Washington DC: The World Bank/UNDP, 1990.

39. World Resources Institute. *World Resources 1990-1991.* Washington, DC: 1991.

40. World Resources Institute. *World Resources: A Guide to the Global Environment.* Washington, DC: 1991.