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A Report To Congress

POWER SHORTAGES IN DEVELOPING COUNTRIES: MAGNITUDE, IMPACTS, SOLUTIONS, AND THE ROLE OF THE PRIVATE SECTOR

U.S. Agency for International Development
Washington, D.C.

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AGENCY FOR INTERNATIONAL DEVELOPMENT
WASHINGTON D C 20523

THE ADMINISTRATOR

April 14, 1988

The Honorable David R. Obey
Chairman
Subcommittee on Foreign Operations
Committee on Appropriations
House of Representatives
Washington, D. C. 20515

Dear Mr. Chairman:

I am pleased to submit the enclosed report on "Power Shortages in Developing Countries: Magnitude, Impacts, Solutions, and the Role of the Private Sector," as requested in House Report 100-283.

Our analysis reveals that power shortages exist in over half of the countries assisted by the Agency for International Development (A.I.D.). These shortages often exceed 10% of existing generation capability, causing significant reductions in economic growth. If current trends of increasing energy demand continue, over $125 billion per year in capital requirements would be needed over the next twenty years. Since developing countries already spend on the average 25% of their public development budgets on power, such capital expenditures are simply not available. Moreover, the environmental implications of such growth in the power sector--for example, air pollution and acid rain problems, land disruption, and global warming--would be severe. Such trends are clearly not sustainable and new approaches will have to be developed if economic growth is not to be constrained.

Eliminating these electric power shortages will require a commitment to an aggressive, three pronged approach. First, rapid adoption of end use efficiency programs and improved technology is needed to reduce requirements for new generating capacity. If developing economies could replicate the energy efficiency accomplishments of the United States and other developed countries over the past 15 years, capital requirements for new power facilities could be reduced by 40%. Achieving such levels of energy efficiency, however, will be most difficult and will require significant improvement in energy sector institutions.

The second approach involves assisting developing countries to restructure their electricity tariffs to reflect more accurately the true capital and operating costs of power generation and distribution. In collaboration with the World Bank and other donors, A.I.D. is helping Egypt, Bangladesh, Pakistan, and other countries to develop and implement economic pricing policies that will alleviate current and future demand for power and improve the financial standing of electric utilities.

The third approach is to lower barriers to private sector participation in power development. The interest expressed by private investors in Turkey, Pakistan, Indonesia, and the Caribbean suggests that under the right conditions, equity investments will be forthcoming. In the case of Turkey, United States consortia have been able to develop with the Export-Import Bank of the United States and commercial banks an acceptable approach to risk sharing. Pakistan is developing a private sector financing window for power projects.

The electric power sector in developing countries provides a major market opportunity for equipment and services ranging from $370 to $900 billion over the next twenty years. United States exports now represent less than 10% of the total power generation equipment and services exports to developing countries, down from 17% just 5 years ago and down from over 20% in the late 1970's.

A.I.D. has been in the forefront of adapting the private power concept to developing countries, and Agency efforts at the policy level with multi-lateral development banks have been quite successful. Looking to the future, A.I.D. anticipates playing a special role, outlined in this report, in helping to mobilize and direct private sector resources in developing countries. A.I.D.'s role will be to work for policy reform, especially on pricing and private sector policy; to improve electric utility institutions; to transfer appropriate energy conservation, biomass and other viable renewables, and clean coal technologies; and to foster private sector involvement.

Sincerely,

Alan Woods

Enclosure: As stated

CONTENTS

	TITLE	PAGE
LIST OF ACRONYMS		i
LIST OF EXHIBITS		ii
EXECUTIVE SUMMARY		iii
INTRODUCTION		1
CHAPTER 1:	MAGNITUDE OF THE POWER CRISIS	2
	Characteristics of Power Crisis	5
	Outlook for Power Shortages: Current Trend Scenarios	9
	Alternative Future: Conservation Scenario	10
CHAPTER 2:	IMPACTS OF INADEQUATE POWER SYSTEMS AND IMPORTANCE TO THE UNITED STATES	14
	Electric Power and Economic Development	14
	Environmental Impacts of Electric Power Systems	15
	Impacts of Unreliable Supplies of Electricity Services	16
	Electricity Reliability and Quality	16
	Measuring the Impacts of Unreliable Power Supply	17
	Country-Specific Examples: India and Pakistan	18
	Overall Assessment of Reliability Costs	20
	Impacts of Shortages of Electric Power	22
	Challenge for Productive Activities	22
	Failure to Meet Social Expectations	23
	Impacts of Investments to Meet Power Needs	24
	Size of the Investment	25
	Sources of Capital	25
	Impacts of Reallocating Capital: Sectoral Investment Trade-offs	26
	Impacts of Borrowing Additional Capital	27
	Importance to U.S. Development and Foreign Policy Objectives and to U.S. Trade	28

Page

CHAPTER 3: APPROACHES FOR IMPROVING POWER SITUATION 31

Policy Approaches 31
Institutional Approaches 32
Utility Management, Planning, and Operational Improvements 33
Institutional Development in the Power R&D Industry 34
Strengthening of Power Sector Financing Institutions 34
Strengthening Institutions Related to End-Use Efficiency 34
Technological Approaches 35
Power Plant Performance Improvement 35
Transmission and Distribution Loss Reduction 36
End-Use Efficiency Improvement 37
Load Management 38
Cogeneration 38
New Generation Technologies 40

CHAPTER 4: THE PRIVATE SECTOR ROLE AND APPROPRIATE INCENTIVES 41

Recent Developments 41
Benefits of Private Sector Involvement 43
Approaches for Private Sector Involvement in Power Sector 44
A.I.D. Commitment to Private Sector Program Development 44
Need for Incentives 45
Policy and Institutional Barriers 45
Weak Domestic Economies 45
Political Risk 46
Technical Risk 46
Financial Risk 46
Private Sector Electric Power Strategy 47
Goal 47
Objectives 47
Objective A: Improve Public Policy Institutional Climate for Private Sector Participation in Electric Power Systems of Developing Countries 48

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Page

Objective B: Facilitate Development of Private Sector Power Projects and Trade Opportunities 52
Objective C. Assist with Financing Private Sector Power Investment Projects and Trade Opportunities 58
Objective D. Coordinate and Target Various Programs and Resources of U.S. Government and Those of other Donor Nations and Multilateral Development Banks 65

CHAPTER 5: ROLE OF A.I.D. 68

Involvement of A.I.D. with Electric Power Development 68
Current and Future Activities 69
Policy Dialogue 69
Institutional Improvements 71
Technology Transfer 72
Private Sector Involvement 73

LIST OF ACRONYMS

A.I.D.	Agency for International Development
AFBC	Atmospheric Fluidized Bed Combustion
BOO	Build Own Operate
BOT	Build Operate Transfer
CORECT	Committee on Renewable Energy Commerce and Trade
DOC	Department of Commerce
DOE	Department of Energy
DOS	Department of State
ENERCON	National Energy Conservation Center of Pakistan
Eximbank	Export-Import Bank of the United States
FCIA	Foreign Credit Insurance Association
GRIP	Guaranteed Recovery of Investment Principal
IFC	International Finance Corporation
IGCC	Integrated Gasification Combined Cycle
ITA	International Trade Administration
MIGA	Multilateral Investment Guarantee Agency
NCAER	National Council of Applied Economic Research
OECD	Organization for Economic Cooperation and Development
OPIC	Overseas Private Investment Corporation
PACER	Program for the Advancement of Commercial Energy Research
PACT	Program for the Advancement of Commercial Technology
PRE	Bureau for Private Enterprise
PURPA	Public Utility Regulatory Policies Act
SBA	Small Business Administration
T&D	Transmission and Distribution
TDP	Trade and Development Program
USIA	United States Information Agency
WAPDA	Water and Power Development Authority of Pakistan

LIST OF EXHIBITS

		Page
Exhibit 1:	Distribution of World Electricity Consumption (1984)	3
Exhibit 2:	Electricity Generation Capacity Requirements for Developing Countries (1988-2008) (Current Trend Scenarios)	11
Exhibit 3:	Comparison of Electricity Generation Capacity Requirements in Developing Countries Under Current Trend and Conservation Scenarios (1988-2008)	12
Exhibit 4:	Costs of Power Shortages in Selected Developing Countries (1978 US$)	21
Exhibit 5:	Power Equipment and Services Export Potential to Developing Countries: 1988-2008	30
Exhibit 6:	Potential Electricity Savings in Pakistan's Industrial and Commercial Sectors in the Year 2005	39

EXECUTIVE SUMMARY

BACKGROUND AND PURPOSE

Recognizing that "energy shortfalls are causing a serious constraint to development in over half of all A.I.D.-assisted countries," the Committee on Appropriations of the U.S. House of Representatives requested a report from the U.S. Agency for International Development (A.I.D.) on the "magnitude of the crisis, its implications for future economic and social development and the potential for U.S. technologies and services to address this problem," including an assessment of "appropriate incentives for private sector participation and the feasibility of an Energy Guaranty Program modeled on A.I.D's Housing Guaranty Program."

The need to provide adequate electricity in developing countries is of critical importance to the U.S. Energy is critical for sustainable economic development. As growth proceeds, developing countries require more electric power to satisfy the requirements of their agricultural, industrial, transport and commercial sectors. As a prerequisite for economic development, electric power is vital to efforts to improve living standards in the Third World and to satisfy the demands of their citizens within a stable political context. Also, the electric power market in developing countries provides significant trade opportunities for U.S. businesses.

In response to the Congressional request, this report highlights the dilemma faced by developing countries and seeks to initiate a discussion about potential solutions, the appropriate role of the private sector, and implications for the U.S. foreign assistance program.

1. MAGNITUDE OF THE POWER CRISIS

An adequate and reliable supply of electricity is essential for the continued development of the Third World. Demand for electricity has been growing at over 7 percent per year over the past 20 years. Yet, developing countries -- with a population of 3.4 billion, over 75 percent of the world's population -- account for only 18 percent of all the electricity used in the world. A.I.D.-assisted countries are among the poorest developing countries, consuming only 250 kWh (kilowatts hours) per capita per year. By contrast, developed countries consume substantially more -- 10,500 kWh per capita in the U.S. and 6,000 kWh per capita in Europe and Japan.

Faced with high demand growth rates, many countries now experience power shortages of over 10 percent of their generation capability. In Pakistan, for example, during the past five years, power shortages have been over 25 percent of demand; in India, over 10

percent; and in the Dominican Republic, over 15 percent. The impact of these shortages has been severe.

The fundamental problem is that developing countries need more electric power for sustainable socioeconomic development than they are now able to produce. They lack the financial resources to rely primarily on the further expansion of generation capacity alone.

To avoid serious environmental and financial consequences, developing countries with grossly inefficient systems face major challenges in improving pricing and other policies, mobilizing capital for new investments, implementing more cost-effective and environmentally benign technologies, and improving management and organizational systems.

The Outlook for the Future

To determine a general level of magnitude of the future demand for electric power, the report projects future growth scenarios from 1988 to 2008. The **Current Trend Scenario** assumes that the performance of the power systems will remain the same as today with no major conservation or efficiency improvements. To clearly illustrate the power problem, it analyzes the existing prevalent view of new generating capacity as the primary means to satisfy future demand.

Under this Current Trend Scenario, with a medium rate of economic growth of 4.5 percent per year, 1,500 GW (gigawatts) of additional generating capacity and related transmission and distribution facilities would be needed by the year 2008. This would cost over $2.6 trillion, or an average of over $125 billion per year (compared with the estimated $50-$60 billion currently being spent per year).

The report, however, proposes an alternative future, the **Conservation Scenario** that incorporates substantial improvements in generating plant operational efficiencies, sharp reductions in transmission and distribution losses, and considerable improvements in electricity conservation and end-use efficiency. Under the Conservation Scenario, based on a medium economic growth rate of 4.5 percent per year, developing countries can satisfy the demand for electricity and reduce the need for additional generation capacity from 1,500 GW under the Current Trend Scenario to only 700 GW. The conservation scenario with high economic growth would reduce the need for additional generation capacity to approximately 1,200 GW.

With typical costs of conservation equipment, the conservation scenario would reduce capital requirements to $75 billion to $110 billion per year. Thus, conservation could have considerable impact. It should be noted, however, that even with conservation, other sources of capital -- private capital -- will have to be mobilized to forestall electric power induced restrictions on economic growth.

2. THE IMPACT OF INADEQUATE ELECTRIC POWER SYSTEMS

While not sufficient unto itself, reliable electric power is necessary for economic development in the Third World, just as it is in developed countries. Despite the major changes since the Arab oil embargo, the overall relationship between energy growth and gross domestic product growth in industrial countries has been close to one-to-one. Expansion of developing countries agriculture and industry, in particular, depends heavily on electricity in all but the most primitive economies.

As these nations modernize, electricity use in the commercial and residential sectors is rising sharply, and in some countries has outstripped industrial-sector consumption. Also, most developing countries have adopted aggressive plans for rural electrification in an effort to decentralize their populations and to distribute the benefits of economic growth and modern services.

Consequently, the demand for electric services has risen more rapidly than supply, and many developing countries now face critical power shortages of over 10 percent of their generation capability (e.g., the Dominican Republic = 15+ percent, Sierra Leone = 10 percent, India = 10 percent, and Pakistan = 25+ percent).

These power shortages and unmet demands for power present significant economic problems. In Pakistan, for example, estimates are that load shedding in the industrial-sector alone has led to a 1.8 percent decrease in Gross Domestic Product and a 4.2 percent decrease in the country's foreign exchange earnings. In India, the current 10 percent average supply cut to the industrial-sector is estimated to cause an annual production loss of over $6 billion -- equivalent to 12 percent of the country's industrial output.

Environmental Impacts of Electric Power Systems

An expansion of electric power production in developing countries based on the current trend scenario could threaten significant environmental damage. Projections of power supply expansion show large increases in hydropower and steam thermal (mainly coal) facilities. Large-scale hydropower plants often require the relocation of sizable populations and alteration of river basin ecosystems. Coal-fired power generation has historically been associated with emissions of particulate materials, sulfur dioxide, oxides of nitrogen and other pollutants from related mining, cleaning, generating, and storage operations. The problem of global climatic change will accompany any substantial expansion of coal-burning plants.

Systematic conservation and the use of innovative renewable and conventional technologies, however, offer opportunities to reduce significantly the environmental impacts associated with the current trends that concentrate primarily on the expansion of generating capacity.

Financial Impacts

Due to inadequate economic growth rates and substantial debt burdens, developing countries lack the financial resources needed to satisfy the $1.7 trillion to $4.0 trillion investment projected under the Current Trend Scenario.

Developing countries already have had to devote up to 25 percent of their development budgets to electric power. Further increases would adversely affect agriculture, transportation, education, housing, and health care.

The report projects the level of future funds that can be contributed by developing countries, multilateral development banks, and bilateral development agencies. **Based on the Conservation Scenario, these combined sources of funding can provide only 40-60 percent of the capital needed -- leaving a potential shortfall of $900 - 1,200 billion over the next 20 years, or $45 - 60 billion per year. Additional sources of funds will be needed to fill this power finance "gap."**

Importance of Third World Power Development to the U.S.

The power situation in developing countries directly concerns the U.S. in several ways:

- Foremost is a humanitarian concern for the living conditions of people in these countries, their employment opportunities, and their prospects for achieving sustainable socioeconomic development.
- Electric power -- in sufficient supply and efficiently used -- is needed for A.I.D.'s development assistance efforts as infrastructure to support agricultural, health, housing, and economic development.
- Power shortages and the limited availability of power, especially to rural populations, have become issues affecting sociopolitical stability in developing countries.
- The electric power sector in developing countries provides a major market opportunity for U.S. suppliers of equipment and services to increase their export sales and a potential location for private capital investment.

Importance for U.S. Trade

The Committee on Appropriations specifically asked for an analysis of the potential for U.S. technologies and services to address the power problems of developing countries. The report projects the total export market for power generation, transmission and distribution equipment and related services to range from $370 billion to $900 billion over the next 20 years, depending on the growth scenario.

The competitiveness of U.S. suppliers in the power industry, however, has declined dramatically in recent years. **U.S. exports now represent less than 10 percent of the total power generation equipment and services exports to developing countries, down from 17 percent just 5 years ago and down from over 20 percent in the late 1970s.**

If this trend were to continue, the United States' share of developing country power market sales would be limited to about 5 percent of the estimated export potential through the end of the century. Reversing the trend is possible. With recent changes in the value of the dollar, U.S. products are becoming more competitive with equipment sold by European and Japanese manufacturers. However, the limited availability of export financing for U.S. companies remains a problem. The U.S. export position could be improved substantially if additional export financing assistance -- loan guarantees and other incentives -- were made available. The U.S. position could also be improved by targeting incentives toward those technologies and services where U.S. suppliers have a competitive edge.

3. APPROACHES FOR IMPROVING POWER SITUATION

Utility authorities in developing countries have traditionally attempted to solve their electric-power supply problems primarily by expanding generating capacity. Given the enormous financial and environmental costs of this approach, it is not sustainable. Consequently, developing countries must seek to:

- Improve the ability of utility authorities to raise capital by reforming tariffs and encouraging private sector involvement
- Reduce demand through conservation and end-use efficiencies
- Provide electricity at least cost by considering improved forms of generation
- Reduce production costs by technical, managerial, and operational efficiency improvements.

Policy Approaches

Policy reform can play a major role in improving the quality of electricity supply, increasing the efficiency of electricity use, and alleviating adverse environmental impacts. Reform is needed in pricing policy, environmental policy, energy conservation policy, and private sector policy.

Institutional Approaches

Existing institutional structures in most developing countries are not well matched to the present and future power situation, which will require innovative approaches, an emphasis on conservation, involvement of the private sector, and more efficient operation. Efforts are needed on :

- Utility management improvements
- Research and development
- Strengthening financing institutions appropriate to the power sector
- Strengthening institutions related to conservation and end-use efficiency
- Private sector participation in utility functions.

Technological Approaches

Increasing efficiency and power output from existing and future facilities can be achieved by technological improvements:

- Power plant performance improvement
- Transmission and distribution loss reduction
- End-use efficiency improvement
- Load management
- Cogeneration
- New generation technologies.

Private Sector Approaches

Directly involving the private sector in the power development of developing countries promises part of a realistic answer to the power problem. The private sector has greater incentive and ability than does government to manage and operate efficiently and productively. The private sector has access to private sources of financing that are unavailable to state-owned utilities. In the limited instances where private companies are generating and selling power in developing countries, there is clear evidence of their greater efficiency and reliability.

4. PRIVATE SECTOR ROLE AND APPROPRIATE INCENTIVES

Given the serious financial and operational problems of publicly owned and controlled utility systems, there is a significant opportunity for the private sector in developing countries and the United States to contribute to alleviating the power crisis. Over the past few years, interest in private sector participation has expanded considerably.

The major benefits that private sector involvement can bring to developing countries are the introduction of market forces of competition and efficiency and the attraction of additional financial resources.

Approaches for Private Sector Involvement

Participation by the private sector can take a variety of forms:

- Ownership and operation
- Contracting out
- Lease-back
- Investment in debt.

Since the power sector has been publicly controlled, the traditional role of the private sector has been restricted to selling goods and services to utilities. For the U.S., this has contributed to the declining trade in electric equipment and services. Recently, developing countries have begun to express interest in having the private sector own and invest in new generating plants that would sell power to utilities on long-term contracts.

Need for Incentives

Despite the advantages of private sector participation and the expressed interest of private firms and developing countries, numerous obstacles still exist:

- Policy and institutional barriers
- Weak domestic economies
- Political risk
- Technical risk
- Financial risk.

PRIVATE SECTOR ELECTRIC-POWER STRATEGY

A.I.D.'s private sector electric-power strategy is designed to facilitate developing country efforts to use the financial and technical resources of the private sector, both domestic and international, to expand their electric generation capacity. While no private power projects have yet been completed, the immense interest in the concept and the clear benefits to potential investors and developing countries make it apparent that projects soon will be implemented.

Four specific objectives are being pursued by A.I.D.:

- Improve public policy and institution climate
- Facilitate development of power projects and trade
- Assist in financing power investment and trade opportunities
- Coordinate with other U.S. agencies and other donor agencies.

Initially, A.I.D. is focusing on removing policy and institutional barriers to private sector participation in the power sector and on assisting the implementation of a limited number of projects to provide some experience with this innovative approach.

As this report describes, A.I.D. will continue to :

- Provide technical assistance and training to both the public and private sectors related to the institutionalization of private power policies
- Integrate private power into national energy power policies and investment programs
- Stimulate interest on the part of the World Bank, regional development banks, and other donors in private power projects
- In special cases where A.I.D. has substantial resources, for example, Pakistan, fund project development and even the capital costs of U.S. companies
- Promote communication with the Trade and Development Program, Department of Commerce, Eximbank, Overseas Private Investment Corporation, and Department of State on opportunities for investment and financial needs vis-a-vis competitors.

The Committee on Appropriation's emphasis of the energy loan guarantee program warrants a specific recommendation on this option. After analysis of the A.I.D Housing

Guaranty Program, the OPIC and Eximbank loan guarantee programs, and the status of numerous private sector power projects, it appears premature for A.I.D. to establish a separate loan guarantee program. There are not yet enough private sector power projects being considered to require the establishment and funding of a new loan guarantee program, although the situation could change in the near future.

In the near term, A.I.D. should help project developers and developing countries work with existing loan guarantee programs in OPIC and Eximbank. A.I.D. should use these opportunities to explore the sufficiency of existing loan guarantee funding authority and to further study the financial and administrative details of implementing an energy loan guarantee program at A.I.D.

The central issue is clearly the need to rely on investors to assume normal commercial risks associated with power development projects while providing incentives to reduce political and other risks associated with doing business in developing countries. A.I.D. is in the nascent stage of developing a program in this area and its approach will undoubtedly evolve as it learns from experiences in Turkey, Pakistan, and elsewhere.

5. ROLE OF A.I.D.

Energy development, including electric-power, to support socioeconomic growth in developing countries has been a priority of A.I.D. Over the past five years, A.I.D. has provided slightly less than an average of $200 million per year in energy-sector assistance to developing countries. In the FY 1986 budget, $180 million was spent for electric-power out of a total of $254 million for all forms of energy. Rural electrification assistance accounted for 22 percent of the funds invested in power. Funding for energy activities in 23 countries included energy planning, demand management, fuelwood reforestation, resource assessments, and renewable energy.

A.I.D. will continue to play a pivotal role in assisting developing countries to alleviate their electric-power problems. Building on its experience, the Agency can contribute in the following areas:

Policy Dialogue

- Pricing policy. Based on its efforts in Egypt, Bangladesh, Pakistan, and elsewhere, A.I.D. will continue to focus its activities on inducing pricing reform policies that reduce or eliminate uneconomic pricing and alleviate current and projected demands for power

- Conservation policy. A.I.D. will continue to assist developing countries to develop and implement national energy conservation plans that address generation, transmission and distribution, and end-use consumption of power

- Environmental policy. A.I.D. will assist developing countries to develop, adopt, and implement systematic policies, standards, and practices for environmental management for power sector activities

- Private sector policy. A.I.D. is expanding its current efforts to encourage the implementation of policies, laws, and regulations that encourage private sector participation in the power sector.

Institutional Improvements

A.I.D., through the technical expertise it has available and its ability to provide effective training, is focusing particular attention on improving electric utility institutions in developing countries. The Agency is concentrating resources on the following:

- Improving utility management

- Supporting development of innovative and improved technologies suited to developing countries

- Assisting institutions involved with conservation and end-use efficiency.

INTRODUCTION

Recognizing that "energy shortfalls are causing a serious constraint to development in over half of A.I.D.-assisted countries," the Committee on Appropriations of the U.S. House of Representatives requested a report on the "magnitude of the [power] crisis, its implications for future economic and social development and the potential for U.S. technologies and services to address this problem." The Committee also requested that the study "assess appropriate incentives for private-sector participation and the feasibility of an Energy Guaranty Program modeled on A.I.D.'s Housing Guaranty Program."

This report analyzes the magnitude, causes, and impacts of power shortages in developing countries, identifies possible solutions, describes a role for the private sector, and identifies an appropriate role for A.I.D.

This report consists of five chapters. In Chapter 1, the power crisis in developing countries is defined and the prospects for future impacts on developing countries analyzed. In Chapter 2, the role of electricity in economic development is discussed as is the importance of electric power development in developing countries to the United States. In Chapter 3, possible approaches to resolve power shortages in developing countries are identified. In Chapter 4, the role of the private sector in alleviating power supply problems is analyzed and appropriate incentives for its participation identified. In Chapter 5, A.I.D.'s role in addressing the power crisis is defined.

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CHAPTER 1
MAGNITUDE OF THE POWER CRISIS

The process of economic development involves a transition from low levels of energy consumption to higher levels. Such diverse activities as agricultural development, improvements in health services, and industrial expansion are closely tied to changes in the quantity and form of energy consumed. Prospects for growth are closely linked to the provision of adequate and reliable supplies of energy.

Electricity, as an especially high grade of energy, has a large role in the development process. Review of the previous patterns of electricity consumption in developed and developing countries indicates that energy use, particularly electricity, and Gross Domestic Product (GDP) have been, and probably will continue to be, strongly correlated. Between 1970 and 1980, GDP in developing countries grew at rates of 3.5-5.5 percent per year while total energy consumption grew by 5.9 percent and electricity consumption increased by over 7 percent per year.[1] In developing countries, about 50 percent of the electricity production is used by industry, with the remaining used in agriculture, primarily for irrigation, in the commercial sector, and for residential use.

The fundamental problem is that developing countries need more electrical power for sustainable social and economic development that they are able to produce. They also do not have enough financial resources to expand their supply systems fast enough to keep pace with growing demand.

Over the past 20 years, the demand for electricity in developing countries has been growing at over 7 percent per year. In spite of this high growth rate, developing countries with a population of 3.4 billion -- over 75 percent of the world population -- consume only 18 percent of all the electricity used in the world. On average, they use only 500 kWh (kilowatt hours) of electricity per capita per year, compared with over 10,500 kWh per capita in the United States and over 5,000 kWh per capita in Europe and Japan (see Exhibit 1). A.I.D.-assisted countries, which are among the poorest of the developing countries, use on average only 250 kWh per capita per year.[2]

A serious imbalance between the supply and demand of electric power in developing countries is constraining efforts to achieve sustainable social and economic growth. The projected demands of the private and public sectors in developing countries for increased modernization, high rates of economic growth, and enhanced standards of living will require more electrical power that is more reliable and more widely

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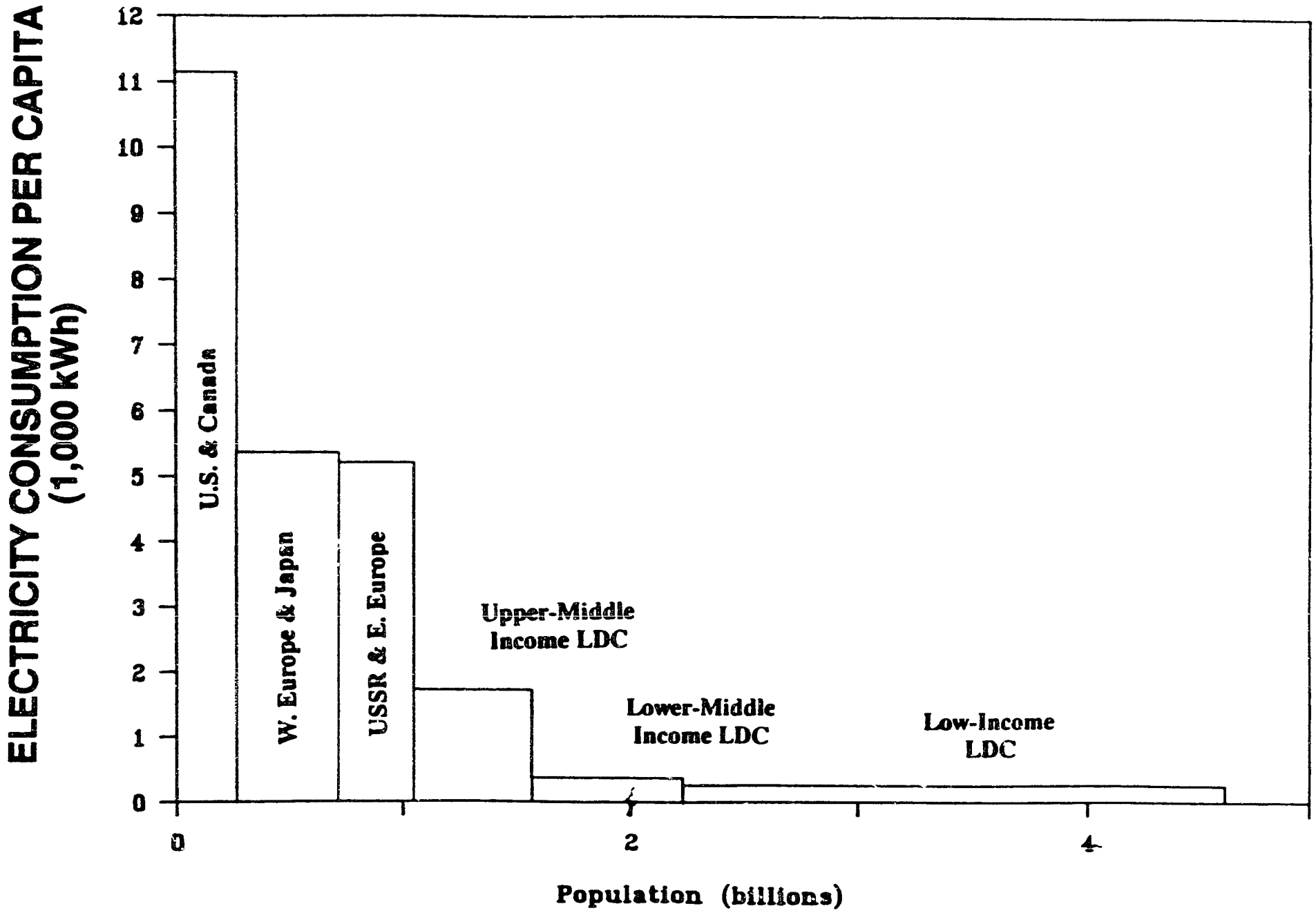
1 World Bank, "The Energy Transition in Developing Countries," 1983 and "World Development Report," 1984.

2 United Nations, "1984 Energy Statistics Yearbook," New York, 1986.

Exhibit 1

Distribution of World Electricity Consumption (1984)



Source: United Nations

distributed. Developing countries will be hard pressed to meet the demands of their industrial, agricultural, and commercial sectors, much less the demands of residential consumers.

Faced with high demand growth rates, many countries now experience power shortages of over 10 percent of their generation capability. In Pakistan, for example, during the past five years, power shortages have been over 25 percent of demand, in India, over 10 percent, and in the Dominican Republic over 15 percent. The impact of these shortages on the growing economies of developing countries has been tremendous. In Pakistan, for example, load shedding to the industrial sector alone has resulted in an estimated 1.8 percent decrease in GDP and a 4.2 percent decrease in the country's foreign exchange earnings.[3] The poor quality and reliability of existing electricity services has not only significantly impaired industrial, agricultural, and commercial productivity, but also has diverted much needed investment capital for redundant, standby electrical generating capacity.

At the same time, as demand for electricity has grown in developing countries, many governments have found it increasingly difficult to allocate sufficient resources to the power sector to ensure that demand is met. In many countries the power sector spends more than 20 percent of the government's total development budget. Foreign borrowing for the power sector is greater than 40 percent of total foreign debt in many countries. For many, low development growth rates, very low per capita incomes, substantial debt servicing problems, political instability, and continued expenditure requirements for imported oil combine to restrict the availability of investment capital from domestic and foreign sources.

Furthermore, the environmental consequences of an unbridled expansion of generating capacity along traditional lines would result in unacceptable impacts. The air and water quality impacts of conventional thermal power plants and the ecological, land use, and resettlement impacts of hydroelectric power require systematic attention and a commitment to their minimization.

Developing countries must now confront the problem of how to match the demand for additional electrical power with their financial ability to provide it. As will be seen, serious policy, institutional, and technological problems face developing countries.

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3 EBASCO, AEPES, ITECO, "The Financial Impact of Power Interruption and Load Shedding in the Industrial Sector in Pakistan," prepared for WAPDA and A.I.D., March 1987.

CHARACTERISTICS OF THE POWER CRISIS

Power shortages and lack of sufficient financial resources to expand the supply capacity are two symptoms of the power crisis in developing countries. Underlying these symptoms are:

- High demand growth rates
- Financial difficulties of utility systems
- Inefficient institutions, management, and planning
- Uneconomic pricing
- Inefficient production, delivery, and use of electricity
- Environmental impacts
- Indigenous fuel limitations.

High Demand Growth Rates

While the demand for electricity in industrialized countries has leveled off in recent years and has been growing at under 2 percent since 1980, electricity demand in most developing countries is growing at over 7 percent per year. In Bangladesh, for example, electricity demand has been growing at an annual rate of over 11 percent[4] in India,[5] over 10 percent in Colombia,[6] and over 12 percent in Pakistan.[7] This high growth rate in electricity demand can be traced in part to the very low level of development in these countries. In less industrialized countries, productive uses of power in industry and modern agriculture are counterbalanced by comparatively large unproductive uses in fast growing urban residential sectors. Therefore, for the same economic growth rate (growth in GDP), developing countries require a higher growth rate in electricity consumption than industrialized countries. Production in emerging economies also tends to emphasize energy-intensive processing and manufacturing rather than the less energy-intensive service activities of developed countries like the United States.

Over 80 percent of the population in developing countries lives in rural areas, most with no electricity. For example, in Guatemala, Honduras and El Salvador, out of a rural population of about 15 million, only 10 percent have electricity.[8] Therefore, to promote rural development, many countries have extensive rural electrification programs that severely strain their power sector budgets. Extension of the power grid to rural areas is very costly because of the low electricity use intensity by rural customers, which also results in higher system losses and lower system load factor. However, there are

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4 UNDP/World Bank, "Bangladesh: Issues and Options on the Energy Sector," October 1982.

5 Centre for Monitoring Indian Economy, "Current Energy Scene in India," July 1986.

6 UNDP/World Bank, "Basis for the Formulation of a Colombian Energy Policy," December 1986.

7 Water and Power Development Authority, "Power System Statistics, Ninth Issue," November 1984.

8 National Rural Electric Cooperative Association, "Central American Rural Electrification Study," 1987.

options available to rural areas to otherwise be electrified. Some rural areas have access to hydro, or indigenous coal or gas, or renewable energy sources that lend themselves to small-scale decentralized power generation and use. However, as rural electricity consumption increases, the need to improve supply reliability may necessitate grid connection.

Rural customers do not have the same buying power as urban customers. Therefore, at least during the early stages of rural electrification, governments need to substantially subsidize electricity prices.

Financial Difficulties of Utility Systems

Electric utilities in developing countries are in general state controlled and are characterized by inefficient planning and management. Many utilities in developing countries do not generate enough revenue to cover their operating and capital expansion expenses. As a result, they depend on the government for supplementary funds. In India, for example, among the 15 state electricity boards in the country, 13 had operating losses in 1984, adding up to over billion or equivalent to over 20 percent of the country's power sector budget in that year.[9]

Due to their financial difficulties, many utilities in developing countries do not qualify for loans from international development or commercial banks, a fact that has made the prospects for improved power supply more uncertain. For many developing countries, the rate of return on invested capital in the power sector declined from 12 percent to 8 percent in the 1960s and now stands at about 5 percent, making it difficult to attract capital from private commercial investors.[10] For this and other reasons, foreign lending from private banks for energy projects has dropped dramatically in the past few years.

Inefficient Institutions, Management, and Planning

Many utilities in developing countries are large, entrenched bureaucracies. They are often overstaffed, pay low salaries and have poor management practices. The customer/employee ratio is one measure of institutional efficiency. In Japan, the ratio is one employee to 429 customers, while it is one to 38 in Pakistan and one to 93 in Malaysia.

Many developing country utilities are characterized by inefficient planning and management. Management problems range from inefficient use of the supply system to the inability to stop theft on distribution lines. In part, this results from the inability of

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9 Centre for Monitoring Indian Economy, 1986.

10 A.I.D. "Workshop Summary on Policy and Financing Strategies to Implement Innovation," July 16, 1987.

utilities to attract and retain a sufficient number of qualified engineers, planners, and managers. This has restricted the ability of utilities to adopt modern least-cost system planning, energy conservation, and load management programs. Consequently, utilities in developing countries tend to follow the traditional approaches to their power problems -- defining them as strictly lack of generation capacity, and designing and building power plants without considering alternative approaches and energy conservation strategies.

Uneconomic Pricing

One of the major causes of utilities' financial difficulties is their uneconomic pricing of electricity. Many governments, for a number of social and political reasons, choose to subsidize electricity prices to all or certain groups of consumers. In almost all developing countries, the electricity provided to agricultural and residential consumers, for example, is heavily subsidized.

In some countries, the amount of the subsidy to agricultural and residential consumers is staggering. In India, for example, the cost of supplying one kWh of electricity to an agricultural customer is over 14 U.S. cents, while the customer is charged less than 3 U.S. cents.[11] In Egypt, electricity prices are only 40 percent of the utility's marginal cost of supply.[12]

Inefficient Production, Delivery, and Use of Electricity

The power supply in developing countries is characterized by low fuel-use efficiency and low availability factor (the amount of time a plant is ready for operation) for thermal power plants. While typical steam plants in the United States require 9,000 to 11,000 Btu of fuel per kWh of electricity, in many developing countries the fuel requirement is over 13,000 Btu per kWh. In addition, because of the frequent breakdown of power plants and lack of proper maintenance, many power plants in developing countries are available for operation only 50 - 60 percent of the time, compared with over 80 percent in the United States and other industrialized countries.

The poor performance of thermal plants is caused by unsatisfactory repair and maintenance of plants, unavailability of spare parts, improper operations management, and poor fuel quality.

A common characteristic of power supply in developing countries is the extremely high losses of electricity in the transmission and distribution (T&D) network. While T&D losses should normally be below 10 percent of gross generation (economically optimal

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11 A.I.D., "Summary of Workshop on Non-utility Power Generation in India," November 1987.

12 Charles Richter, "The Energy Problem," USAID Staff Working Papers, November 6, 1986.

losses may be as low as 5 percent), in many developing countries they are over 20 percent. For example, T&D losses in Pakistan are 27 percent, in the Dominican Republic over 34 percent, in Egypt over 22 percent, and in Bangladesh over 30 percent.[13]

These losses are attributable to technical problems and theft. Technical losses are caused by improper design of the T&D system, overloading of the lines, and inadequate maintenance. Theft of electric power through illegal interconnection into the system accounts for up to one-quarter of the total electricity lost.

Few achievements have been made in developing countries in using electricity more efficiently. There are significant opportunities for conserving energy by improving the efficiency of electric motors, lighting, air conditioning, and refrigeration equipment. In-depth studies in a few developing countries, e.g., Brazil, Pakistan, show that electricity demand can be reduced by more than 30 percent through rigorous energy conservation and efficiency improvement efforts.[14] But because of the lack of capability to develop and implement conservation programs, the lack of financial incentives, and the lack of know-how, few countries have taken advantage of efficiency improvement opportunities.

Environmental Impacts

Projections of power supply expansion show large increases in hydropower and steam thermal (mainly coal) facilities. Large-scale hydropower plants often require the relocation of sizable populations and alteration of river basin ecosystems. Coal-fired power generation has historically been associated with the emissions of particulate materials, sulfur dioxide, oxides of nitrogen, and other pollutants from related mining, cleaning, generating, and storage operations. The problem of global climatic change will accompany any substantial expansion of coal-burning plants.

Careful studies and attention to the environmental risks and the implementation of programs to mitigate these effects can alleviate some of the most serious environmental consequences. There will be environmental consequences of power expansion, but most of these can be dealt with directly with new, cleaner fossil technologies and, in the long run, with increased contributions from biomass and other renewable technologies. In the near term, the key is swift adoption of end-use efficiency programs.

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13 World Bank, "1982 Power Data Sheets for 104 Developing Countries," July, 1985.

14 Howard S. Geller, "The Potential for Electricity Conservation in Brazil," Companhia Energetica de Sao Paulo, Sao Paulo, February 1984 and National Energy Conservation Centre of Pakistan, "The Potential for Electricity Conservation in the Industrial and Commercial Sector in Pakistan," Islamabad, October 3, 1986.

Indigenous Fuel Limitations

Faced with growing oil import bills, most developing countries have tried to limit the use of petroleum products for power generation, emphasizing instead the use of indigenous non-petroleum energy resources for future power plants. In most countries, however, the supply options are limited to coal and hydro. The available coal in many countries is of very poor quality, and its expanded use can lead to increasing levels of environmental pollution. In addition, the development of indigenous coal resources has been very costly in most countries. Similarly, development of hydro facilities is becoming more and more expensive, since the most attractive sites have generally been developed and the remaining potential sites require additional capital investment.

Although electric utilities have tried to shift away from the use of petroleum fuels, the prevailing power shortage in many countries has had the reverse impact of increasing petroleum fuel use for power generation by nonutility generators, particularly in the industrial and commercial sectors. In many countries faced with power shortages, industrial and commercial customers install their own backup units. These units are often diesel engines, which are easy to operate but use petroleum fuels. In some cases, government policies have even encouraged this trend. In India, for example, the government decided in 1987 to reduce excise taxes on oil used for power generation by industrial customers, to reduce the impact of the country's severe power shortages.

OUTLOOK FOR POWER SHORTAGES: CURRENT TREND SCENARIOS

To determine a general level of magnitude of the future demand for electric power generating capacity, the report projects growth from the year 1988 to 2008 using historical data. The probability of the accuracy of these future growth rates is low, given the long period of the projection. The results do give some indication, however, of the future upon which important questions can be asked about the power systems growth requirements and constraints.

The Current Trend Scenarios assume (1) that the performance characteristics of the power systems in developing countries will remain the same, with no major conservation or efficiency improvements, and (2) that the installation of generating capacity will be seen as the primary means to satisfy future demand. Three projections of electric power demand, corresponding to three economic growth projections, have been made. In all three scenarios, the ratio of electricity consumption to economic growth rate is assumed to remain constant at an average 1.4, the ratio experienced by developing countries over the past two decades.[15] World Bank projections[16] were used for the low and high economic growth rates through the year 1995, and extrapolated for

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15 Derived from electricity consumption data from United Nations Yearbooks of World Energy Statistics and World Bank Development Reports, various issues.

16 World Bank, "World Development Report 1987".

the remaining years of the analysis. For the medium growth scenario, the mid-point of the low and high growth rates was used. In the low economic growth scenario, developing countries will experience an average annual growth of 3.5 percent, in the medium growth scenario, 4.5 percent, and in the high growth scenario, 5.5 percent per year.

Under the Current Trend Scenarios and the World Bank economic growth estimates, electricity consumption will grow at an annual rate of 7.5 percent per year for high economic growth, 6.1 percent for medium economic growth, and 4.9 percent for low economic growth over the next 20 years. As a result, an additional 2,300 GW of generating capacity would be needed for the high economic growth scenario, 1,500 GW for the medium, and 1,000 GW for the low (see Exhibit 2).

Assuming average installed costs of $1,280 per kW for generating plant costs and $550 per kW for transmission and distribution (World Bank estimates, in 1987 dollars), the capital required to satisfy the electricity requirements for the medium economic growth rate of 4.5 percent per year would be over $2.5 trillion, or on average over $125 billion per year, compared with $50 - 60 billion being spent now annually. The power sector investment requirements under the high economic growth scenario would be $4 trillion and under the low economic growth scenario about $1.7 trillion over the next 20 years.

The impact of this current trend on the capital budgets of developing countries and the overall environmental impact of such an expansion using available technologies -- which tend to be environmentally costly -- would be enormous. It is unlikely that the developing countries' economies or their environments could sustain this trend; several factors, including technological and demographic shifts, and structural changes in their economies, would tend to keep the demand for electricity at more manageable levels.

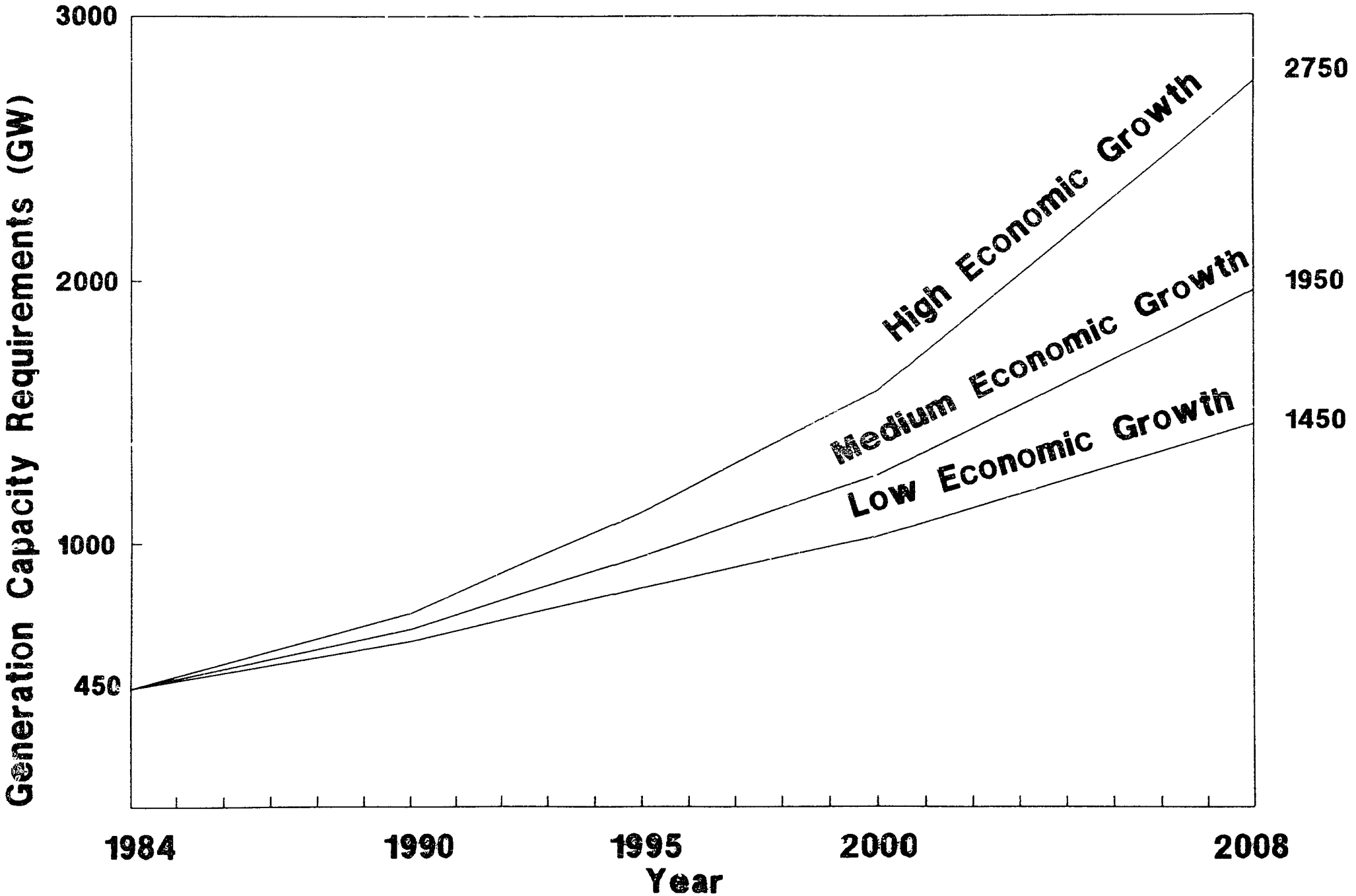
ALTERNATIVE FUTURE: CONSERVATION SCENARIO

The Conservation Scenario assumes the rapid implementation of operational efficiency improvements, significant conservation measures, and substantial end-use efficiency improvements. Exhibit 3 compares generation capacity requirements for medium economic growth (4.5 percent per year) under Current Trend and Conservation Scenarios. Under the Conservation Scenario, the projections assume that developing countries will reduce the ratio of electricity consumption to income growth rates from 1.4 to 0.9 by the year 2000.

Reductions in this ratio are in line with estimates made by other studies. For example, in its energy efficient scenario, the World Resources Institute projects demand growth of about 6 percent per year over the next 40 years in conjunction with an annual

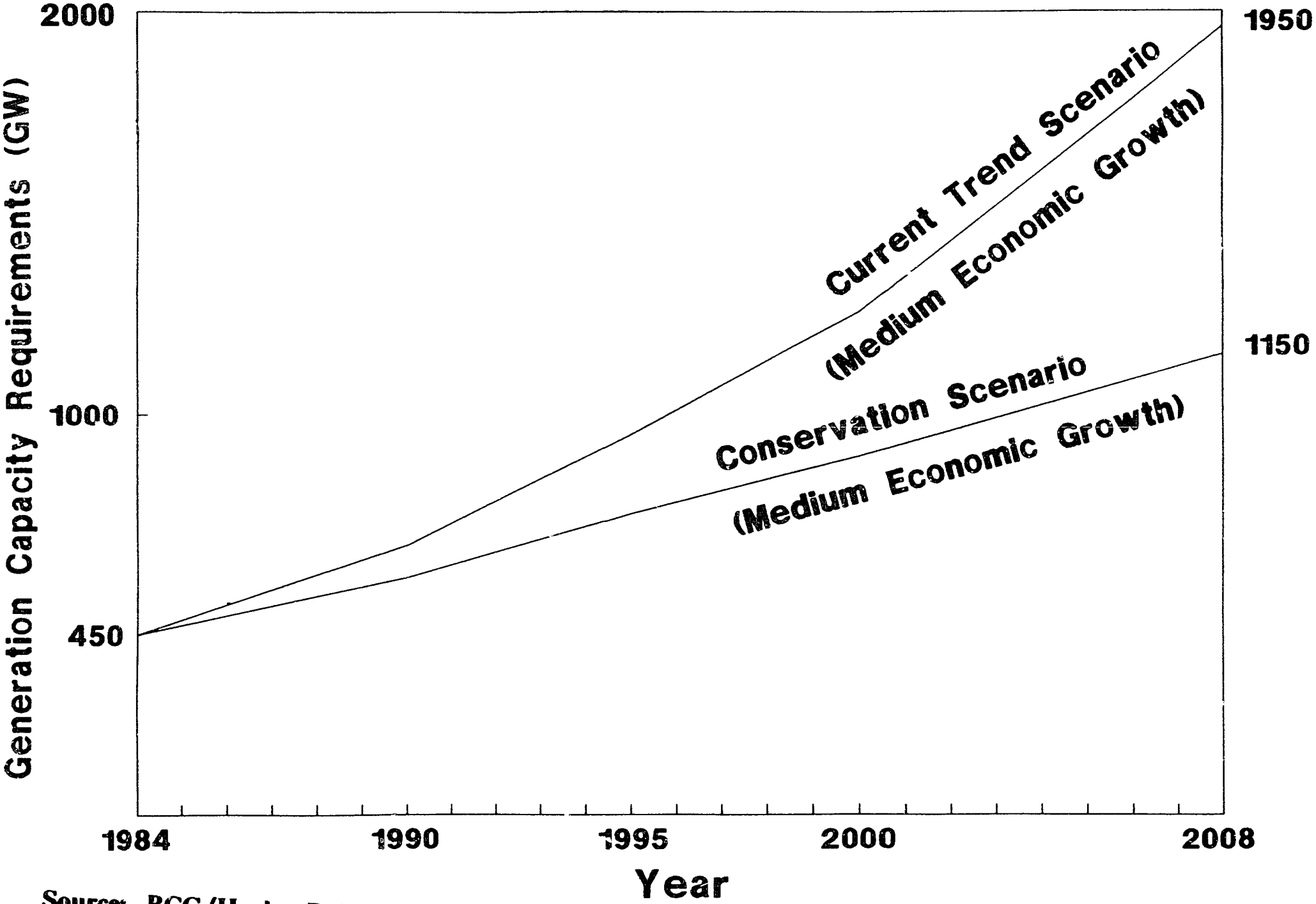
Exhibit 2

Electricity Generation Capacity Requirements for Developing Countries (1988–2008), Current Trend Scenarios



Source: RCG/Hagler, Bailly, Inc.

Comparison of Electricity Generation Capacity Requirements in Developing Countries Under Current Trend and Conservation Scenarios (1988-2008)



Source: RCG/Hagler, Bailly, Inc.

economic growth rate of about 7 percent, or a ratio of 0.86 in electricity growth to GDP growth.[17]

These are rather dramatic reductions and, while technically possible, will face institutional and political barriers in their implementation. A significant reduction in the relationship of electric power demand growth to economic growth could be achieved if developing countries were able to set and meet the following targets, which represent total conservation and operational improvements over the 1988 to 2008 period:

- Achieve a 10 percent to 20 percent improvement in plant capacity factor, resulting from improved operation and maintenance of power plants and concerted load management efforts
- Reduce transmission and distribution losses from the current 25 percent to 15 percent to 20 percent
- Achieve a 20 percent to 30 percent improvement in the end-use efficiency of electric equipment such as motors, lighting, and refrigeration systems.

By achieving these improved performance levels, developing countries can reduce the need for additional generation capacity from 1,500 GW to only 700 GW by the year 2008 and reduce the need for additional investment in power supply expansion by $1.4 trillion over the next 20 years. A high economic growth rate scenario would require 1,000 GW of additional capacity and $ 1.7 trillion of investment.

Even with strong conservation efforts, however, developing country governments will be hard pressed to mobilize sufficient additional capital investment.

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17 World Resources Institute, "Energy for Development," September 1987 and communication with Robert H.Williams, one of the co-authors of this Report.

CHAPTER 2

IMPACTS OF INADEQUATE POWER SUPPLY AND IMPORTANCE TO THE UNITED STATES

The electric power demand and supply situation in developing countries summarized in Chapter 1 has sobering implications. At least in the case of the higher growth scenarios, there is a very high probability that, in the relatively near future, either (1) insufficient electricity services will be available to meet development needs in many countries, or (2) because of the capital investments required to provide electricity services, insufficient capital will be available to meet development needs in other sectors. In either case, the development process will suffer.

ELECTRIC POWER AND ECONOMIC DEVELOPMENT

Economic development is a multifaceted process, but one part of the process is the substitution of more mechanized, energy-intensive production processes for less mechanized, less energy-intensive production processes. Urbanization, which accompanies the evolution of the production structure but is distinct from it, fosters additional energy use as well as substitutions of modern energy for traditional energy. Overall, during the long term of economic development, a 1 percent increase in per capita income is associated with a 1 percent to 1.3 percent increase in the use of energy services per capita, but with as much as a 2 percent increase in modern energy use (i.e., electricity and liquid and gas fuels) per capita.

In developing countries, the energy requirements of productive activities tend to emphasize services such as shaftpower and heat, and it can be argued that electricity requirements can be reduced by encouraging shifts away from electricity, especially when its price is inefficiently low. But there are three problems with such a strategy, taken to an extreme. First, shifting to a different delivery form for energy usually requires a change in end-use equipment; when half or more of the electricity in a developing country is used in industry, the economy includes a substantial investment in capital stock to use that electricity. Unless the electricity is supplied, this investment is not repaid. Second, many users prefer electricity as the delivery form, even at a somewhat higher price. Compared with other options, electricity is often cleaner, more convenient, and poses fewer maintenance problems (consider, for instance, powering looms in a cottage industry). Third, even if a productive activity shifts from electricity to another delivery form for its modern energy supplies, the requirement for investments in an energy system continues. Investment requirements for the electricity system may decline, but they are replaced by investment requirements for the alternatives. From a national point of view, sizable investment is still needed to keep energy shortages from constraining development.

ENVIRONMENTAL IMPACTS OF ELECTRIC POWER SYSTEMS

One of the lessons of the past 30 years, in the United States and developing countries alike, is that electric power production has a dark side. Extracting energy resources and converting them into electricity has often meant paying a price in environmental quality. One of the first motivations for an energy conservation movement in the United States, in fact, was a concern that energy production was leading to environmental problems: air pollution from coal-fired power plants, water pollution from mine drainage, oil spills, threats to scenic landscapes and endangered species, and similar consequences, along with impacts on human health and safety.

A massive expansion of electric power production in developing countries, especially during a time when increasing a country's dependence on petroleum fuels is not well-advised, threatens environmental damage as well as pressures on capital markets. Projections of power supply capacity by 2008 show large increases in hydropower and steam thermal (mainly coal) facilities, when these particular options are likely to have serious environmental consequences. Hydropower developments on a relatively large scale often require the relocation of sizable populations and change river basin ecologies dramatically; careful studies of environmental impacts and risks in the more affluent countries have sharply reduced the use of this alternative. Coal-fired power generation has historically been associated with emissions of particulate materials, sulfur dioxide, oxides of nitrogen, and other substances that eventually cause undesirable environmental and health impacts -- not only air emissions from the power plants themselves but water emissions from mining, cleaning, and storage facilities. The problem of global climatic change is serious: a rise in temperature, shifts in climatic zones, a rise in the sea level, and other disruptive impacts that may result from growing concentrations in the earth's atmosphere of carbon dioxide and other byproducts of fossil fuel use.

A simple example will illustrate the environmental implications of the higher growth scenarios for developing country power production. Assume that coal-fired power production in the year 2008 is 139 GW -- the high projection, not counting combined-cycle plants. Without the extensive use of state-of-the-art technologies to control sulfur dioxide emissions, total emissions in developing countries can be expected at least to triple over the next 20 years. If more coal is used, the impacts will be greater, often combining with increased emissions from coal use in industry and fossil fuel use in transportation. In some of the larger developing countries planning a major commitment to coal, such as India and China, the impacts are likely to be far more serious than the average.

Of course, because developing countries enjoy such limited access to electric power, their contributions to widescale environmental problems is small relative to that of the developed world. The United States alone has over 650 GW of installed capacity compared with 450 GW in the entire developing world. For example, the industrialized countries produce 70 percent of the world's energy-related carbon dioxide. The middle-

income countries contribute approximately an additional 20-25 percent. The countries A.I.D. assists contribute only 5-10 percent of the total energy-related carbon dioxide being added to the atmosphere at the present time. While this contribution is small, actions taken by developing countries to curtail their contribution to the greenhouse effect are important.

Confronting a developing country with the necessity to make a choice between electricity services and environmental management is itself an undesirable prospect. In fact, one of the most compelling reasons to look for ways to reduce capital requirements for power system expansion is that those ways are virtually certain to reduce environmental impacts associated with electricity services. The conservation scenario, if implemented, will produce a significant reduction in power-related environmental damage.

IMPACTS OF UNRELIABLE SUPPLIES OF ELECTRICITY SERVICES

Electricity services involve certain expectations about the reliability of electricity supply: continuity of supply and the ability to supply larger or smaller amounts of energy as equipment is switched on or off. They also include expectations that the power will be of reliable quality, i.e., that the current and voltage will be reasonably uniform over time and space. An electric power system is adequate only if it is capable of meeting the demands of its customers at an acceptable level of reliability. Generally, this requires some excess power generation and transmission capacity to meet special needs (a "reserve margin") and the capability to add power generation to meet needs during peak periods, both of which add to investment requirements. Countries and societies may differ in their expectations in this regard, but investment in end uses that depend on electricity usually assume a high level of reliability in supply.

Electricity Reliability and Quality

In the United States, power system reliability expressed as the percentage of electricity demand met is on the order of 99.98 percent. Service interruptions owing to generation capacity deficiencies are virtually unknown. The overwhelming majority of outages (98+ percent) that U.S. consumers face are because of faults in the transmission and distribution network. Most of these outages are of short duration, typically lasting from a few minutes to an hour or two. Studies of several U.S. utilities indicate that most consumers face perhaps two to five such interruptions annually, with customers in rural areas experiencing a somewhat higher frequency of outages.

In contrast, the reliability picture in many developing countries is substantially different. Most developing economies are capital constrained and therefore unable to provide adequate reserve margins or peaking capabilities, especially when power production depends partly on seasonal hydropower and when operational inefficiencies (e.g., maintenance deficiencies) lead to frequent outages of generation and transmission

equipment. This situation is often exacerbated by having small power supply systems with small numbers of plants, where reserve capacity is relatively more expensive to build and maintain. In addition, the operating availability of power plants in many developing countries is poor compared with that in developed countries. While the specific factors vary by country, the most common reasons for poor plant availability include inadequate preventive maintenance, lack of spare parts, limited fuel supply or fuel of inferior quality, and labor problems. In developing countries, it is not uncommon to find plant availability factors of 0.35 to 0.5. In contrast, U.S. plant availability factors are of the order of 0.7 to 0.85. The poor state of transmission and distribution systems, often overloaded and overextended, is another common problem in developing countries in assuring reliable electricity supplies.

Measuring the Impacts of Unreliable Power Supply

An unreliable power supply results in both short- and long-term costs to an economy. Costs are measured in terms of the adjustments that the consumers (such as firms) facing unreliable power supplies make to mitigate their losses. The short run is the period of time in which a customer can make changes in operating routines but is constrained to use its currently fixed capital equipment. The long run is the period in which the customer can also make adjustments to its fixed capital stock, given its expectations of future power unreliability.

Such impacts and interactions can be illustrated in the context of a business or manufacturing firm. When faced with a curtailment in electricity supply, the firm must adopt an alternative to the use of grid-supplied electricity. Typically, production must be deferred to a later time when supply is resumed. If the plant was already operating at capacity, then overtime production involving additional costs will be necessary. If the enterprise uses a continuous three shift, round-the-clock process and is operating at capacity, then this avenue is not available and the shortage may result in a loss of sales. If the firm owns standby generation, then some of these adverse effects are mitigated, although the decision to acquire standby generation capacity would be a long-run adjustment. However, the use of such equipment entails the additional expense of fuel to operate it, and the fuel may entail foreign exchange costs.

In addition, service interruptions may trigger costs related to product spoilage and damage to equipment. Under a situation of controlled load shedding, the firm can reduce such losses, as well as idle factor costs, by rescheduling activities and by implementing controlled and orderly procedures for shutting down and restarting the production processes. The extent of these direct economic costs also depends on a host of factors such as advance notification, duration of the interruption, and timing. The latter refers not only to the time of day or season but also to the prevailing market conditions regarding the demand for the firm's output. These direct costs can be very high, particularly under conditions of uncontrolled load shedding and transmission and distribution outages -- sudden interruptions in service without advance notification. In

addition to the direct costs noted above, there are indirect costs to the economy because of the secondary effects that arise as a result of the interdependence between one firm's output and another firm's input.

Finally, chronic electricity shortages and poor reliability of supply trigger long-run adjustments. If firms' expectations are that shortages and unreliable service will persist, then they will respond in one or more ways. The installation of back-up diesel generator sets is the most common long-run adjustment taken by industrial firms. It has been estimated that a substantial amount of the total installed generating capacity in many developing countries (on the order of 20+ percent) is in the form of standby generation on customer premises.

Country-Specific Examples: India and Pakistan

There is a paucity of reliable quantitative information on the economic impacts of electricity shortfalls in developing countries. Two recently completed studies, nevertheless, underscore the point that the short- and long-run economic costs of power shortfalls can be high.

India

Power shortages and unreliability, which were mostly sporadic in the 1950s and 1960s, have since the 1970s become a chronic national problem that now affects most of the Indian states. A recent study (1985) by the National Council of Applied Economic Research (NCAER) in India has estimated the impact of power shortages in the industrial sector over the 1982-1984 period.[1] In 1986, the industrial sector accounted for 40 percent of national electricity consumption.

NCAER's survey of 15,000 bulk electricity-using industrial establishments reported substantial variation in the extent of capacity utilization and its cause, but power shortage was a major culprit in all industries and in all regions. Total production losses in 1983-1984 are estimated to have been approximately $2.7 billion in mid-1987 prices, or about 1.5 percent of GNP. A comparable estimate for the 1982-1983 period based on the NCAER study is approximately $2.1 billion in mid-1987 prices. Production losses vary considerably by industry and region. For example, the loss in the iron and steel industry was about 43 percent in the southern region, but only 3.5 percent in the western region. Averaged across all large industries in a region, production losses range from 1.46 percent in the western region to 13.16 percent in the eastern region.

Long-run capital adjustments mitigate the short-run production losses from unreliable electricity, but they entail costs of their own. The electricity reliability problems are

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1 See "Impacts of Power Shortages in Agriculture and Industry," report prepared for the Central Electricity Authority by NCAER, July 1985.

evidence of too little capital in the grid, and the evidence on autogeneration suggests that at least some of the additional capital is being supplied privately.

It cannot be said that the full value of self-generation equipment is an additional cost of unreliable power, because it is by and large a substitute for additional capacity that utilities do not have. However, if the grids could expand and could upgrade their management to maintain quality service, grid-supplied electricity could be produced with greater economies of scale than autogeneration can offer. These are major qualifications to the present environment, however. The difference in the electricity supply costs of the grid and self-generation methods is a long-run cost.

Pakistan

Increases in residential demand, together with high water pumping loads and the rural electrification program, have contributed in large measure to the deterioration of Pakistan's Water and Power Development Authority (WAPDA) system load factor from approximately 66 percent in 1975-1976 to 56.5 percent in 1985-1986.[2] WAPDA's generation capacity additions have not kept pace with demand, which, since the 1980s, has risen at an average annual rate of over 11.2 percent. Consequently, the country has had recurrent power shortages since 1982. These shortfalls are expected to continue for at least the rest of this decade. Load shedding previously was restricted principally to the period December through June, but in recent years it has become a year-round phenomenon.

A recent study (1987) prepared for WAPDA and A.I.D. estimates the impact of power interruption and load shedding in the industrial sector in Pakistan to be a 8.2 percent reduction in value added.[3] This reduction is equivalent to a decline in value added of approximately $350 million in 1987 U.S. dollars. The study further estimates that these direct costs to the economy should be escalated by a multiplier of 1.34 to account for the indirect multiplier effects. The resulting total -- direct plus indirect cost of the shortfall -- represents a 1.8 percent reduction of GDP. Additionally, the study estimates the adverse impact on national exports of manufactured goods as a consequence of power shortages to be about 4.2 percent of manufactured exports. This translates into a reduction in exports of about $75 million in hard currency.

The study also estimates that the cost of load shedding to industry ranges from a low of $0.29/kWh for textiles to a high of $1.77/kWh for the machinery and equipment industry, with an average of approximately $0.50/kWh. In contrast, under situations of uncontrolled load shedding (i.e., outages with no advance notification) the average cost to industry is approximately 60 percent higher, at $0.81/kWh. In both instances,

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2 System load factor is the ratio of actual utilization of all generating plants to the maximum possible utilization level of 8760 hours/year. Higher load factors imply more efficient utilization of generating plants.

3 See "The Financial and Economic Impact of Power Interruption and Load Shedding in the Industrial Sector in Pakistan," report prepared for WAPDA and A.I.D. by EBASCO, AEPES, and ITECO, March 1987.

spoilage cost -- damage to machinery and goods -- is a significant component of total cost, accounting for over 60 percent of total direct cost and about 15 percent of total outage cost.

Industrial electricity users have resorted to substantial self-generation to mitigate losses from unreliability. The study estimates that the total cost per kWh of ranges from a low of $0.14/kWh to a high of $0.74/kWh. In contrast, WAPDA's system-wide average, long-run marginal cost of supply is estimated to be $0.076/kWh. Thus, the economic cost of grid supply by WAPDA ($0.076/kWh) is substantially (between two- and ten-fold) lower than the self-generation cost incurred by industry. The extent of this divergence provides some indication of the resource costs to the economy because of this inefficiency.

Other Countries

A number of other developing country studies have attempted to develop estimates of the costs of electricity shortfalls. However, most of these estimates relate to unplanned outages. Exhibit 4 summarizes the results of these studies. Electricity interruption costs are typically in the $0.50/kWh to $5.00/kWh range. With average electricity tariffs in the range of $0.08/kWh to $0.12/kWh, these data indicate that in the short run, customers would be willing to pay from five to fifty times the average tariff to avoid the adverse effects of power supply interruptions.

Overall Assessment of Reliability Costs

For India, the cost of unreliability in electricity supply to the industrial sector has been estimated at 1.5 percent of GDP, while in Pakistan, the cost of reliability problems in the industrial sector has been estimated at 1.8 percent of GDP. Neither estimate includes the value of foregone services associated with residential and commercial outages. To put these percentage figures in a more familiar perspective, they may be compared with the magnitude of the 1982 recession in the United States: between December 31, 1981 and December 31, 1982, real GNP in the United States fell by 1.8 percent.

The foreign exchange cost estimate probably understates the total foreign exchange cost of outages by failing to include the hard currency cost of imports purchased to substitute for domestic consumption of affected industries' outputs. Some, but probably not all, of this effect may be captured in the 4.2 percent figure cited for Pakistan.

Based on the studies conducted to date, it appears that reliability losses could be as high as 4 percent of GDP in the short run. After a short period of time, however, electricity users will begin meeting their needs in other ways, e.g., liquid fuels, self-generation shutting down operations, although alternative power production methods are costly themselves.

Exhibit 4

Costs of Power Shortages in Selected Developing Countries (1978 US$)

Country	Sector(s)	Type of Shortfall	Cost of Shortage
Bangladesh	All	Unplanned outages	1.00$/kWh
Brazil	Households	Unplanned outages	1.95-3.00$/kWh
Chile	Households	Unplanned outages	0.53$/kWh
	Industry	Unplanned outages	Range: 0.25-12.00 $/kWh Central Tendency 1.50-6.00 $/kWh
Costa Rica	Households	Unplanned outages	--
Egypt	Industry	Unplanned	0.40 $/kWh
India	Industry	Controlled load shedding	Annual cost ranges from 1 to 3% of GDP (1.5 to 3 billion dolars annually)
Jamaica	Industry	Unplanned outages	1.25 $/kWh
Pakistan	Industry	Controlled load shedding	Range: 0.26-1.77 Average: 0.46 $/kWh
		Unplanned outages	Range: 0.36-2.54 Average: 0.81 $/kWh
		Controlled and Uncon-trolled load shedding	$350 million in 1984-85
Paraguay	Residential		--
Taiwan	Industry		0.06-2.16$/kWh
Tanzania	Households		0.50 $/kWh
	Industry		0.70-1.40 $/kWh
	Commercial		1.00 $/kWh
	All sectors		0.70-1.10 $/kWh

Source: Oak Ridge National Laboratory, "The Impact of Inadequate Electricity Supply in Developing Countries", January 1988.

Inclusion of commercial and government sector losses might raise this figure by one half to one percentage point, although commercial sector electricity unreliability affects comfort as well as output. While the Indian study suggested that Indian agriculture was not particularly hurt by reliability problems, agriculture in drier countries like Sudan and Egypt might be more susceptible to poor electricity reliability. However, the agricultural output in Sudan that relies on electricity for irrigation pumping accounts for only around 3 percent of GDP. Unreliability of liquid fuel supply is as big a concern for Sudanese irrigation as electricity reliability. Pakistani irrigation, however, relies much more heavily on electric pumping, but tariffs for agriculture are well-subsidized.

Figures in the range of 1.5 percent to 2 percent of GDP or GNP are certainly large enough to cause concern, but as static, single-period estimates they may understate the long-term costs. Dynamic costs include not only the current period's income losses but the income that is lost in future periods as a result of the current losses. They may be far higher than the static, single-period costs. If the affected sectors have higher-than-average savings rates, investment may be seriously disrupted by the reduction in profits; and the rate of growth of the capital stock and of income, will be retarded. The rate of entry of new technology in the form of new equipment would be slowed. To the extent that these investment/capital accumulation forces are prime movers of development as well as of simple income growth -- the forces that produce the strongest demands for improvement in human capital -- the entire development process could be impeded well beyond what the small share of GDP loss would suggest.

IMPACTS OF SHORTAGES OF ELECTRIC POWER

Estimating the impacts of electric power shortages, in the sense of shortfalls of delivered electric power even under the best of conditions, is a more difficult matter. For example, the concept of shortage is related to price; prices rise with scarcity and demand generally drops, affecting perceptions of "shortages." And shortages in electric power are first felt by users as increased unreliability, rather than more general shortfalls. Moreover, shortages from one source may provoke actions to meet needs from other sources; for example, a shortage of power from a central grid very often leads to increased investment in self-generation. Clearly, however, a shortage in dependable baseload electric power from a country's central grid is likely to make it harder for many productive activities to succeed and is likely to result in a failure to meet social expectations.

Challenge for Productive Activities

The availability of electricity makes some developments possible that would otherwise be impossible or far less convenient. Here, the issue shifts from the quantity of electricity regularly provided to whether electricity is available at all at certain locations for certain purposes, and from the value of well-defined income or productivity losses to less precise valuations of contributions that electrification can make to development. In

addition, the emphasis shifts from the reliability of power supply in current areas of service to the costs and benefits of supply in future areas.

In the absence of an electricity supply and distribution system, a firm or a family desiring the services associated with electricity must either do without or take steps to provide the services independently through self-generation. In almost every case, this increases the cost of operation compared with power from an efficiently run central grid or minigrid. In particular, it increases the capital costs to an entrepreneur of starting up a productive activity, and it increases the management and technical challenge to an activity that is aimed at industrial or agricultural production, not energy production.

Obviously, the extent of the increased financial and management burden on productive activity -- and especially private-sector initiatives -- varies considerably from country to country and case to case, but it is especially great for small-scale initiatives by indigenous entrepreneurs. Almost certainly, many such initiatives cannot succeed without the convenience and cost reductions of an infrastructure providing adequate electricity supplies.

Failure to Meet Social Expectations

A rich body of anecdotal evidence indicates that electricity has numerous other socioeconomic benefits. Although very little rigorous research has been done to verify such benefits and measure them, it does appear that in many instances electricity services have been associated with benefits ranging from improved literacy to improved general quality of life to improved economic productivity to reduced incentives for rural-to-urban migration. Especially compelling is evidence that even very poor people are willing to make sacrifices -- when electricity is available -- to purchase and operate appliances such as electric lights, televisions, and fans. People in developing countries perceive benefits to electricity use. This does not necessarily mean that the benefits are large enough for a nation to continue to subsidize electricity prices or the expansion of rural electrification or to bear the environmental costs of unlimited power production, and it does not establish how much the benefits are reduced when electricity supplies are unreliable or the power is of poor quality. But people, rich and poor, do seem to want electricity and the services it enables.

As a part of the more general development process, electrification alone is unlikely to have a great deal of benefit, any more than highways alone spur development; people need jobs, income, and complementary improvements in socioeconomic conditions. On the other hand, an integrated development project that makes electricity available and, at the same time, improves the access of households and small firms to capital and makes public investments in agriculture, education, health services, water supplies sanitation, and housing can greatly improve economic productivity and quality of life. It is not possible from available evidence to isolate the contribution that electricity makes to such an integrated project other than to say that electricity becomes an integral part

of the project once the project has made investments in electrical end-use equipment for irrigation, public lighting, or healthcare. The following examples, however, illustrate some of the ways in which electricity is often associated with socioeconomic benefits.

Vaccination. Vaccines for many human and livestock diseases require refrigeration. The total annual worldwide losses from diseases that could have been prevented by vaccination if refrigeration were more widespread are probably in the billions of dollars. Although refrigeration can be provided through non-electric technologies, expansion of electric refrigeration would simplify the effort.

Education. Electricity is associated with information transfer, classroom conditions, and study habits. For instance, studies have found that children who can read by electric lights spend more time reading at home than those who lack electric lights.

Income and employment. Although there is a lack of reliable information on this subject, electricity use can increase productivity, income, and employment. For example, rural households could increase their income by undertaking cottage industrial activity using electric lights in the evening and electricity for shaftpower.

Quality of life. Electrification can increase the quality of life for all socioeconomic groups, although it probably widens the gap in the quality of life between the rich and middle classes and the very poor, because the very poor cannot afford the electricity or end-use equipment and associated benefits. Electricity is particularly closely associated with such benefits as air-conditioning, refrigeration, communication, and household conveniences.

Migration. Cities and larger towns and villages are more likely to have electricity than small villages and rural areas, and it has been suggested that rural electrification, by reducing this disparity and improving the quality of rural life, might reduce the rate of rural-to-urban migration.

Political stability. Development, rather than electrification, is the key to building support for an government or political system. It is clear from anecdotal evidence, however, that a failure to maintain reliable electricity services and acceptable prices of electricity for existing users can result in general public dissatisfaction and even riots.

IMPACTS OF INVESTMENTS TO MEET POWER NEEDS

The benefits of an adequate power supply are substantial. However, providing this power is by no means costless. Several possibilities must be considered. First, a country might attempt to make the additional power-sector investments without reducing development spending in other sectors such as agriculture and transportation. Additional capital would have to be raised -- domestically or externally -- which would have far-reaching effects. Alternatively, if capital availability is highly constrained, expansion of capital spending in the power-sector would require curtailments in other

development areas. Finally, some combination of these two unattractive situations might be forced upon a country: It might have to increase its overall level of capital expenditure and at the same time reduce some of its non-power investments.

Size of the Investment

Even with conservation, developing countries utilities will not have access to sufficient capital to meet the electricity demands of their hoped-for economic growth. While this report does not perform an in-depth analysis of the costs of an energy conservation scenario, a rough estimate of equivalent costs of capacity avoided are on the order of $200-$300 per kilowatt, based on experience in the United States. The high economic growth conservation scenario would thus require approximately $2.2 trillion or $110 billion per year; the medium economic growth scenario would require $1.5 trillion or $75 billion per year. Of these amounts, approximately 45 percent is expected to be in foreign exchange and the balance in local currencies. The financial requirements are thus impressive, regardless of the growth scenario selected. Given existing levels of government subsidies, such expenditures will not be sustainable. Either growth will suffer, or new sources of capital as well as new and more efficient management approaches will have to be identified and developed. Such approaches are discussed in Chapter 3.

Sources of Capital

External capital flows into the power-sector of developing countries from three sources: (1) development lending agencies, (2) bilateral concessional lending or aid, and (3) commercial loans. Using information on past lending, a reasonable estimate of future lending can be developed for the first two sources. From 1975 to 1987, annual lending from the World Bank for electric energy loans grew from $584 million to $3.02 billion. Lending between 1975 and 1981 occurred in an atmosphere of rising energy prices and it increased rapidly. The situation began to change in 1981, however. The end to rising oil prices and the beginning of the developing country debt crisis, together with a general slowdown in the growth of the industrial nations, have acted to slow energy investments from the World Bank. Assuming a most favorable scenario -- that World Bank investments in the power-sector would grow at 5.5 percent from 1987 to 2008 (similar to the growth rate during the 1975 to 1987 period) -- lending would grow from $3.02 billion in 1987 to $9.3 billion in the year 2008.

From 1975 to 1981, other development organizations lent approximately 75 percent as much money for power projects as the World Bank. Assuming that this trend continues over the next 20 years, funding for power projects by other development organizations would grow from $2.3 billion in 1987 to $6.9 billion in the year 2008.

According to recent estimates, bilateral concessional lending in the power-sector of developing countries is approximately 68 percent of World Bank lending. Thus,

assuming the relative shares will remain constant, bilateral concessional loans would grow from $2.6 billion in 1987 to $6.3 billion in the year 2008.

Assuming past trends in power lending prove a reasonably reliable predictor of the future, lending by the World Bank and other development agencies, plus bilateral concessional lending, will increase from $7.3 billion in 1987 to $22.5 billion in the year 2008. Total investment from these sources between 1988 and 2008 will amount to $292.3 billion.

Clearly, the resources available from international development and financial organizations will cover only a fraction of the developing countries' capital requirements for their power investments -- on average, between 20 percent and 40 percent of the total, depending on the electricity consumption growth scenario. But few public utilities raise enough revenue to make a sizable contribution to their capacity expansion needs. In fact, many utilities operate at large losses requiring tremendous government subsidies. In Pakistan, for example, utility revenues cover only 40 percent of their cost, in India less than 80 percent.

Assuming that utilities will be able to generate enough revenue from the sale of electricity to cover 20 percent of the capital requirements of their expansion needs, under the conservation scenario, the developing countries will still have to secure an additional $900 billion to $1,200 billion or $45-60 billion per year over the next 20 years.

Of course, rising domestic savings rates and market determined foreign exchange rates may have a significant impact on this picture. Countries may be able to improve their access to foreign exchange through increased exports, and domestic investors will be able to bid for needed foreign exchange in local financial markets. The traditional link between direct and dedicated access to foreign exchange to finance a given (power) project can -- and should -- be broken.

Impacts of Reallocating Capital: Sectoral Investment Trade-offs

Suppose developing countries undertook these major power-sector investments but were determined not to expand their total levels of foreign borrowing beyond what they would have been without this major investment push in one sector. This is an unlikely scenario, but it is one end of the spectrum of choices between simply adding the additional power-sector bill to the rest of the development investment list, and towing the line on foreign borrowing and taking the power-sector investment out of other expenditure items.

Additionally, it highlights the potential costs of power-sector spending in terms of other foregone development investments. However, getting an empirical handle on this scenario is complicated by the dispersed and inconsistent character of data on public investment in developing countries.

The major sectoral claimants on public capital development expenditures are energy, agriculture and rural development, transportation, and industry. Education, urban development, and population, health, and nutrition are comparatively minor claimants in terms of monetary costs. The most likely sectors to be able to attract commercial loans are the utility, industrial, and mining sectors, and possibly road projects. Agricultural and rural development projects are less likely destinations of commercial loans, as are education and urban infrastructure projects. Population, health and nutrition projects are almost certain to be officially funded through loans or grants, or both.

In most developing countries that face severe power shortages, the increase in annual power-sector investment will not be fully covered by GNP growth, and in the next 10 years, the shortfall will be even greater. This is even true for Thailand, which has one of the best-run electricity systems. To keep from expanding aggregate borrowing more than proportionally to the growth of the Thai economy, the share of national public investment going to the power-sector might have to rise to as much as 50 percent in the late 1980s, gradually falling to 32 percent by 1995, and new, more efficient management approaches will have to be developed. Development funds going to other sectors such as agriculture, transport, communications, and industry would be squeezed correspondingly. The prospects for other developing countries entail equivalent or harder squeezes on competing sectors.

Impacts of Borrowing Additional Capital

The alternative end of the spectrum of choices to finance the power-sector expansions of the coming decade is to borrow. Currently, it is often a very restricted option, given the external debt of many countries, but it is useful to explore the impacts that such borrowing could have on the aggregate economy of a developing country, particularly in light of the recent debt crisis. Foreign borrowing and public sector deficits to the extent potentially involved in power-sector investments of the magnitudes of those envisioned in India, Indonesia, Pakistan, and the Philippines could precipitate some undesirable consequences that, once under way, could be difficult to control. The borrowing and the deficits could fuel spending on nontraded goods and services such as housing, causing the exchange rate to become overvalued and the trade balance to deteriorate. Domestic interest rates could shoot up, effectively choking off domestic investment demand. If developing countries succeed in exporting more heavily to repay foreign debts, pressure on the current accounts of the industrialized countries could lead to political pressures for countermeasures against developing countries, further aggravating the debt repayment problem. The exporting required to service the debt on an aggregate of $200 billion to $300 billion of additional debt for power-sector loans could be large enough to initiate such countermeasures.

IMPORTANCE TO U.S. DEVELOPMENT AND FOREIGN POLICY OBJECTIVES AND TO U.S. TRADE

The power situation in developing countries directly concerns the United States in a number of ways. First, a reliable and adequate supply of electricity is necessary for the rural development, economic growth, and modernization of developing countries. If a sufficient and consistent supply of electricity is not available, the results of such development programs are cast into doubt. Second, the power crisis has started to have sociopolitical stability ramifications for many governments of importance to U.S. foreign policy. In Pakistan, for example, the government's inability to provide an adequate power supply, especially to urban areas, is causing mounting discontent. Third, the United States has a direct interest in the ability of a number of developing countries to service their debts to international development and commercial banks. The repayment of these loans to a large extent depends on strong economic growth, which in turn requires a sufficient and reliable supply of electricity. Fourth, the developing country power problem is an area in which U.S. technologies and services are particularly strong. Thus, a significant trade opportunity exists.

Since slow economic growth and energy conservation efforts have limited demand for power systems in the United States in recent years, the importance of power markets in developing countries has increased. Nevertheless, the U.S. market share of power generation exports to developing countries has declined in recent years. U.S. exports currently represent less than 10 percent of total power generation exports to developing countries, while they accounted for over 17 percent 5 years ago and over 20 percent in the late 1970s. The deterioration in U.S. competitiveness is obvious in certain markets, such as hydropower, where there is no surviving U.S. supplier of hydroturbines. Competition in new orders for boilers, combustion turbines, and steam engines is growing increasingly keen.[4] Sales of specialized construction services are now beyond the reach of U.S. suppliers, for all practical purposes.

Developing country power markets, however, represent significant trade opportunities for U.S. suppliers of power generation, transmission, and distribution equipment and related services. Developing countries will need to import an estimated $370 billion to $900 billion worth of power equipment and services between 1988 and 2008, if they want to achieve economic growth rates of 3.5 percent to 5.5 percent per year, respectively, over this period (see Exhibit 5). These are conservative projections that take into account the large potential for electricity supply and use efficiency improvements in developing countries.

If the current trend of declining U.S. exports persists, the U.S. share of the developing country power market will be limited to about 5 percent of the estimated export

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4 U.S. exports of power boilers, for example, have fallen from a high of $1.5 billion in 1982 to less than $1 billion in the last 2 years.

Exhibit 5

Power Equipment and Services Export Potential
to Developing Countries: 1988-2008
(Billions of 1987 dollars)

Equipment/ Service Category	Exports as a Share of Total Orders (%)	Economic Growth Scenario		
		Low	Medium	High
FUEL PREPARATION	60%	8	12	21
BOILERS	60%	38	61	93
COMBUSTION TURBINES	80%	11	16	93
STEAM TURBINES	80%	37	60	94
HYDRO TURBINES	90%	35	55	84
NUCLEAR REACTORS	90%	10	17	32
WIND TURBINES	85%	0	1	2
SOLAR EQUIPMENT	70%	1	1	2
EMISSION CONTROLS	72%	12	19	30
BALANCE OF POWER PLANT	35%	7	12	20
ENGINEERING	65%	25	40	63
CONSTRUCTION	10%	30	48	73
PROJECT MANAGEMENT	70%	20	31	49
TRANSMISSION/DISTRIBUTION	50%	132	208	323
TOTAL EXPORT POTENTIAL		365	582	908

Source: RCG/Hagler, Bailly, Inc. "Importance of LDC Power Market to U.S. Suppliers", Washington, D.C., 1987

potential during the next 20 years. That percentage is an average, as U.S. market share may decrease from the current 10 percent to under 4 percent over that period.

In order for the United States to increase its share of the power market in developing countries, reversing the current trend and lessening the burden of the power crisis on developing countries, it must exercise its competitive advantage in certain technologies. For example, U.S. suppliers have a competitive edge in the export of transmission, distribution, and emission control equipment. U.S. suppliers have also managed to remain competitive in providing fuel preparation and balance-of-power plant equipment, and engineering and project management services. The United States also leads in the development of high-temperature gas turbines, coal emission control technology, and atmospheric fluidized-bed boiler systems. Furthermore, U.S. suppliers have obtained considerable experience in project financing as a result of the burst of cogeneration and small power projects that occurred in the U.S. since the passage of the Public Utility Regulatory Policies Act (PURPA) in 1978.

If U.S. suppliers could raise their market share in developing countries to the level existing in the late 1970s, the value of exports would be equivalent to $80 billion to $180 billion. This is substantial enough to justify a concerted effort to capture a larger portion of the export market.

CHAPTER 3

APPROACHES FOR IMPROVING POWER SITUATION

The traditional approach of power planners in developing countries and development organizations has been to focus almost exclusively on building additional generating plants in order to meet growing power demands. There are, however, additional approaches available to developing countries that will lead to improved power supply at substantially reduced costs.

In simple terms, the focus of power supply strategy should be revised to include: (1) reducing the need to expand generating facilities through conservation and other means, (2) reducing or containing electricity production costs through technical, managerial, and operational efficiency improvements, and (3) improving the financial status of the power-sector by implementing economically efficient pricing policies and by encouraging private sector participation in power supply activities.

This chapter outlines briefly the major elements of such a strategy in three categories of policy, institutional, and technical approaches. Private sector issues are treated separately in Chapter 4 because they are an increasingly important focus of donor and developing country activities.

POLICY APPROACHES

While government policies could play a major role in improving the quality of electricity supply, increasing the efficiency of electricity use, and alleviating the environmental impact of growing electricity consumption in developing countries, in practice, energy and power-sector policies have often failed to achieve these objectives. In the following paragraphs, the importance of pricing, conservation, and environmental policies to the power situation in developing countries is discussed. There are, however, a host of other policies dealing with the use of indigenous and often nonconventional energy resources for power supply and the importing of appropriate power technologies; they are not discussed here for reasons of space. Policies dealing with the privatization of the power supply in developing countries are discussed in the next chapter.

From the perspective of most development assistance agencies in the 1980s, the major energy policy problem in many developing countries is energy prices. Rising energy costs during the 1970s led many countries to introduce energy price controls or subsidies, especially for electricity. As energy costs stabilized in the 1980s, many of these policy interventions have stayed in place, and energy continues to be supplied at a

price well below its cost to the national economy. In this direct way, energy pricing policies in many countries are encouraging an inefficient allocation of resources and imposing a heavy economic burden on developing economies.

The impacts of such pricing policies are substantial on the energy sector alone. Unrealistically low prices for particular energy delivery forms undermine the financial viability of energy supply institutions. In many countries, pricing policies are major contributors to the financial weakness of electric utilities. Furthermore, low prices reduce the incentives for private sector entrepreneurship in the energy sector, and they slow the introduction and use of energy technologies that can contribute to job creation and skill improvement.

Few developing countries have adequately considered the substantial impact that energy conservation policies and strategies can have on the provision of additional power while reducing the need for expensive new generation capacity. Government policies could establish equipment standards, building codes, and import restriction or promotion to increase electricity use efficiency in the country.

Power supply expansion in most developing countries has been accomplished with very little concern for the environment. Electric utilities and most donor agencies have traditionally favored large power plants, often with adverse impacts on the environment. Environmental protection will favor cleaner fuels, lower emissions, and smaller plants with less local environmental impact. However, a host of technologies and power generation options which minimize environmental impacts are becoming available to most developing countries. Newer technologies, such as fluidized bed combustion of coal, are commercially available and would allow developing countries to reduce the adverse impact of power supply on the environment. Providing small hydroelectric facilities in rural areas, cogenerating heat and electricity in industrial facilities, and above all, using electricity more efficiency are viable and effective options for reducing the adverse impact of power supply and use on the environment. For such developments to materialize, developing countries need to consider environmental impact as one of the major concerns in deciding on a power supply strategy.

Development of policies defining limits on combustion emissions and restrictions on the impact of power generation on water resources, air quality, and lifestyle of the population are all important issues that need to be integrated in power-sector planning by developing countries.

INSTITUTIONAL APPROACHES

Once a sound policy is established -- on which a sustainable power development strategy can be built, institutions must be created or improved to implement that strategy. Existing institutional structures in most developing countries are not well matched to their present power predicament. Developing country power institutions face uncertainty and capital shortage problems, and the political, economic, and

technological climate in which they operate is shifting rapidly. Traditional power-sector institutions, however, are typically state controlled and are designed to implement publicly financed additions to the power system and operate them using typical public sector management methods. Such methods tend to be inefficient and rigid in adapting to changing situations.

Approaches to institutional development in developing country power-sectors can be categorized as follows:

- Improving institutional structures for utility management, planning, and operations
- Developing capabilities for research and development in the power industry
- Strengthening power-sector financing institutions
- Supporting the institutions necessary for conservation and end-use efficiency improvement.

Utility Management, Planning, and Operational Improvements

While many of the inefficiencies in the power-sector of developing countries are the direct result of ineffective and inappropriate policies, such as irrational prices and other forms of subsidy, they are also caused simply by poor management, planning, and operating practice. The most pressing problems include:

- Lack of attention to manpower development
- Lack of management objectives to operate efficiently
- Lack of know-how to improve planning, operation, and management of utilities.

A new approach is needed to systematically focus utility management on efficient operation. Of prime importance is manpower development. Steps to follow in such a management improvement program include:

- Review and improve each organization's or sub-organization's goals and plans, and assess the manpower resources needed to achieve those goals
- Establish a detailed operating program to achieve determined efficiency targets
- Create instrumentation and monitoring programs to assess progress towards efficiency targets

- Develop recruitment and succession plans, career paths -- including individual training plans -- and personnel data bases.

Institutional Development in the Power R&D Industry

Traditional technologies will be insufficient to meet projected demands for electricity services, and the widespread use of new technology will require indigenous capacity for technological adaptation and innovation. Policies and institutional reforms are required to accelerate the pace of research and development. Developing countries, even more technically advanced ones like India and Brazil, devote a comparatively small fraction of their budgets to relevant research and development in the power-sector. In addition, institutional mechanisms to transfer technologies to the marketplace are required.

Strengthening of Power-sector-Related Financing Institutions

While considerable attention has been paid to development financing institutions in developing countries, especially in the agricultural and industrial sectors, little systematic attention has been paid to institutions that finance, or that could finance, power development projects. Since power has been so strongly rooted in the public sector, there has been little need or demand for such institutions. Some innovation has occurred to mobilize private capital to finance public power projects and this will undoubtedly have its effects on private project financing. In Pakistan and India, industrial development financing institutions are being used to financing private sector power projects. This experience will be useful in developing power financing institutions needed elsewhere.

Strengthening Institutions Related to End-Use Efficiency

Institutional needs related to achieving end-use efficiency improvements include::

- Development of institutions (both public and private) to effectively develop and implement a national electricity conservation program

- Establishment of an integrated approach that combines engineering, management and financial aspects of electricity conservation into a unified process; in practical terms, for example, utilities require demand management departments staffed with specialists from a variety of disciplines including equipment performance, consumer behavior, and end-use analysis

- Establishment of information and training programs to increase awareness of end use efficiency benefits

- Development of capability within local engineering firms to build a long-term energy conservation services capability
- Development of equipment research and development, demonstration, and performance testing capabilities; governments can assist entrepreneurs that are attempting to manufacture and/or market energy-efficient products and services by offering financing, training, and support for technology transfer
- Establishment of financing programs, including utility financing options, as well as government and third-party financing incentives.

TECHNOLOGICAL APPROACHES

With proper policies and institutions in place, developing countries can take advantage of a large variety of technical improvements that can lead to an improved power situation. This section provides a thumbnail sketch of six options available to developing countries to supplement their traditional generation capacity expansion in meeting their burgeoning power demand in a sustainable fashion. The options are not meant to be inclusive; other approaches could be added, but those presented below include the major elements of a sustainable power development strategy. The six options are:

- Power plant performance improvement
- Transmission and distribution loss reduction
- End-use efficiency improvement
- Load management
- Cogeneration
- New generation technologies

Power Plant Performance Improvement

The majority of thermal power plants in developing countries operate at lower-than-design capacity and efficiency, and the amount of time they are unavailable for operation is far greater than in developed countries. In some developing countries, aging plants operate at below 80 percent of their rated capacity. The availability factor of many thermal power plants in developing countries is under 60 percent, compared with over 85 percent in the United States. Moreover, they use over 13,000 Btu of fuel per kWh of output, compared with 9,000 - 11,000 Btu per kWh for efficient plants.

The poor performance of thermal power plants is caused by unsatisfactory repair and maintenance, unavailability of spare parts, improper operation management, and poor fuel quality. Resolving these problems -- through a combination of technical, operational, and managerial measures -- requires a concerted effort on the part of electric utilities and power-sector planners to allocate sufficient resources and importance to improved performance of power plants.

The attractive economics of such measures and their positive impact on improved use of power plants, however, more than justifies the allocation of resources needed. A study of power plant performance improvements in Pakistan, for example, indicates that it is possible to improve fuel use efficiency by 12 percent, and to recover an additional generation capacity of 300 MW for the existing thermal power plants of the Water and Power Development Authority; total costs would be approximately $170 million. The payback period for this investment is estimated at under 3 years.[1]

While a comprehensive analysis of the total potential of power plant rehabilitation has not been carried out for developing countries, the limited data available indicate that, for an inefficiently run system, power plant rehabilitation can increase the available generation capacity by 8 percent to 10 percent, and result in equally sizable improvements in generation efficiency.

Transmission and Distribution Loss Reduction

While 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), in many developing countries they are over 20 percent. In Pakistan, 27 percent of all electricity generated is lost in the T&D grid,[2] in the Dominican Republic, over 34 percent, in Egypt, over 22 percent, and in Bangladesh, over 30 percent.[3]

As a rough illustration, in a country like India with an annual electricity production of about 183 billion kWh (1985-86) and T&D losses of 21 percent, assuming a value of U.S. $0.06 per kWh, reducing the losses to 15 percent of generation would yield an annual saving of over $650 million to the country or about 12 percent of the country's annual power-sector budget. Such savings can be realized through a rather modest expenditure in additional hardware to improve the system.

The technical solutions to high T&D losses are straightforward and do not require any advanced technologies. One of the major causes of high T&D losses in developing countries is low power factor in primary distribution lines. Installation of capacitors

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1 Stone & Webster Engineering Corporation, " Program Design for Efficiency Improvement of Thermal Power Plants in Pakistan," October 1985.

2 Water and Power Development Authority, "Power System Statistics," November 1985.

3 World Bank, "Power Data Sheets for 104 Developing Countries," 1985.

could easily remedy this problem. A World Bank study of power systems loss reduction in Sudan (where T&D losses are 32 percent of generation), for example, indicates that installation of static capacitors in the Blue Nile grid at a cost of under $1million dollars will release 9.4 MW of generation capacity (about 5 percent of total generation capacity in the grid) and about 4.8 GWh of electricity.[4] The benefits from generation capacity saving alone would be over $12 million.

A significant problem in distribution losses is theft. In many cases, half of the distribution losses that are controllable -- that is non-impedance losses -- are a result of theft. It is not possible to estimate the feasibility of theft reduction programs since, in one sense, they have to be considered in the same light as government subsidy.

End-Use Efficiency Improvement

Despite the fact that industrialized countries have made major strides in using electricity more efficiently over the last decade, few achievements have been made in developing countries in using electricity more efficiently. The opportunities for improvements are tremendous, and the cost is only a fraction of the generation expansion option.

Over 40 percent of electricity in developing countries is used by electric motors. Use of more efficient motors and speed controls could dramatically reduce this consumption. In the United States, for example, the use of variable frequency drive controls in the industrial sector is estimated to reduce electricity needs by 20 percent to 30 percent for each motor and result in a 7 percent reduction in total electricity consumption in the country.[5] The overall savings potential could be greater in developing countries, because industrial electricity use is of greater importance and there may be more motor operation at partial load.

Similarly attractive efficiency improvement opportunities exist in air-conditioning, water pumping, refrigeration, and other electricity end-use applications.

The literature indicates that it is technically possible to increase electricity use efficiency in developing countries by 30 percent at financially attractive terms. A study of Pakistan's industrial and commercial sectors found that they have a cost-effective savings potential of 30 percent of their projected electricity demand in the year 2005. These savings translate into 25,000 GWh of avoided electricity generation and 3,200

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4 UNDP/World Bank, "Sudan Power System Efficiency Study," June 1984.

5 Masher, D.P., and J.S. Smith, "Impact of Advanced Power Semiconductor Systems on Utilities and Industry," EPRI EM-2112, Palo Alto, 1981.

MW of avoided generation capacity, over 20 percent of the country's generation capacity expansion requirements (see Exhibit 6).[6]

Load Management

In developing countries where peak demand grows at considerably faster rates than average load, load management -- reduction of peak load (peak clipping), the development of off-peak load (valley filling), and the transfer of load from on-peak to off-peak periods (load shifting) -- presents an attractive opportunity for reducing the need for additional generation capacity.

The available information suggests a sizable potential for reducing peak load at attractive terms. In Cost Rica, for example, a study of 12 industrial plants indicates that it is possible to reduce the peak load of these facilities by 21 percent (4,800 kW) at a cost of $50,000 to the utility and $73,000 to the industrial plants.[7] The resulting savings to the utility would be over $500,000, while industry would recover its cost in less than one year.

Cogeneration

Cogeneration -- the simultaneous production of electricity and useful thermal energy -- is an important power generation option that has not been fully used in developing countries. Combining the generation of thermal energy and electricity allows industrial and large commercial users to use the waste heat from power generation for process or other thermal needs and to reduce their total energy costs. This option will increase the overall energy efficiency in developing countries and reduce the need for generation capacity expansion of electric utilities.

There is a large potential for cogeneration in developing countries, particularly in industrial and commercial sectors. A study of the cogeneration potential in Pakistan, sponsored by A.I.D., estimates the potential in industrial plants at about 900 MW, although only about 200 MW has been developed (1985).[8] A similar study in the Indian states of Gujarat and Maharashtra estimates the economically and financially attractive cogeneration potential over the next 10 years more than over 2,100 MW, compared with current generation capacity of about 10,000 MW.[9] Other studies in Indonesia, the

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6 The National Energy Conservation Center, "The Potential for Electricity Conservation in the Industrial and Commercial Sectors in Pakistan," 1986.

7 U.S.A.I.D., "Costa Rica Load Management Project," Draft Report, December 1987.

8 U.S.A.I.D., "Private Sector Power Generation in Pakistan: Potential, Impediments, and Policy Issues," Washington, D.C., June 1986.

9 Hagler, Bailly & Company, "Non-Utility Power Generation in The Indian States of Gujarat and Maharashtra: Potential, Impediments, and Policy Issues," Prepared for U.S.A.I.D., Washington, D.C., June 1987.

Exhibit 6

Potential Electricity Savings in Pakistan's Industry and Commercial Sectors in the Year 2005

A. Industry

	Power Savings (MW)	Energy Savings at Generation
E. E. Motors	220	1,340
Speed Controls	840	5,190
Lighting	110	670
Load Management	830	---
Power Factor	230	1,440
SUBTOTAL	1,400	8,640

B. Commercial

	Power Savings (MW)	Energy Savings at Generation
Fluorescent Tubes	1,020	6,330
High Eff. Ballasts	230	1,440
Compact Fluorescents	550	3,340
Fans	270	400
Room Air Conditioners	1,100	1,650
Thermal Insulation	2,000	3,030
SUBTOTAL	1,800	16,200
TOTAL	3,200	24,840

Source: The National Energy Conservation Center of Pakistan

Philippines, Costa Rica, and the Dominican Republic have indicated similarly sizable cogeneration potential in those countries.

New Generation Technologies

There is a variety of new generation technologies that can be used in developing countries to generate electricity more efficiently and reduce the environmental impact of power generation. In addition, some new technologies enable developing countries to increase the use of their indigenous natural resources, thus reducing their imported fuel requirements.

For example, advanced gas turbines have been developed in recent years that have overall energy conversion efficiencies of 50 percent, requiring 20 percent less fuel than the most efficient conventional large thermal power plants. These units combine modularity, short lead times for planning and commissioning, and attractive costs. Recent advancements in coal combustion technologies -- in particular, atmospheric fluidized bed combustion (AFBC) and integrated gasification combined cycle (IGCC) systems -- combine superior technical and environmental performance with modular design, and construction. These characteristics are directly relevant to the needs of the power-sector in many developing countries.

There are also a wide range of indigenous renewable resources that can be used in small power generation facilities that are suitable, in particular, to electricity needs in rural areas. Low-head hydropower, biomass from agricultural residues, wind, and solar systems can offer cost-effective ways to bring electricity to rural areas. Although there is considerable potential for such power generation options, they have been largely ignored by power planners in most developing countries.

CHAPTER 4
THE PRIVATE SECTOR ROLE AND APPROPRIATE INCENTIVES

The Committee on Appropriations of the U.S. House of Representatives specifically requested that this report include an assessment of appropriate incentives for private sector participation in solving the power crisis in developing countries and an analysis of the feasibility of an energy loan guarantee program. This chapter begins by briefly reviewing the recent interest in private sector involvement in the power sectors of developing countries and then discusses some of the various forms that such participation might take. Next, the benefits of, and impediments to, such involvement are discussed.

Finally, the report sets forth a strategy for enhancing the role of the private sector in resolving the power crisis in developing countries. Four specific objectives that the U.S. government could pursue through incentive programs to assist the private sector are identified:

- Improving the policy and institutional climate
- Facilitating project development and trade
- Assisting with investment and trade financing
- Coordinating and targeting incentive programs.

This report presents specific "incentive options" for each of these objectives.

RECENT DEVELOPMENTS

Given the serious financial and operational problems of publicly owned and controlled utility systems, there is a potential opportunity for the private sector in developing countries and the United States to make substantial contributions to alleviating the power crisis.

The private sector, with its market orientation, can inject efficiency, competitiveness, leadership, and additional financial resources into a sector of the economy that is essential for sustainable economic and social development.

The development, operation, and regulation of electric power systems in developing countries lies generally within the public sector. Limited participation of privately owned or operated utility systems or facilities is the exception rather than the rule.

Nevertheless, over the past few years, interest in private sector participation in the power sector of developing countries has expanded significantly from the area of trade to include the area of investment. Traditionally, the private sector, in developing and developed countries, has been restricted primarily to the sale of goods and services to state-owned utilities, which owned and operated their power facilities. For the U.S. private sector this has amounted to a substantial, though declining, overseas trade in electrical power equipment and services. In FY 1986, the Export-Import Bank of the United States (Eximbank) -- the official export credit agency for the United States -- supported about $124 million in trade of U.S. electric power equipment and services through direct loans or loan guarantees.[1]

Export-Import Bank of the United States, Annual Report, "FY 1986 Direct Credits and Financial Guarantees." This represented approximately 11 percent of all Eximbank loan and guarantee activity.

Recently, significant opportunities for more direct participation by local and foreign private sector companies in the ownership and operation of power sector facilities within developing countries have emerged. In the past few years, many A.I.D.-assisted countries, including the Philippines, Indonesia, Pakistan, the Dominican Republic, and India, have instituted laws and national policies that allow and encourage private sector participation in their power systems. A.I.D-sponsored studies on private sector power generation or privatization of utility functions have been completed for Barbados, Pakistan, Thailand, India, the Philippines, and the Dominican Republic. These studies identified barriers to private sector participation and possible opportunities, especially in the construction and operation of generating plants and in the cogeneration of electricity by industrial plants.

In Jamaica, Indonesia, Thailand, and Pakistan, private sector power generation projects are currently being negotiated with the respective governments. Reflecting growing international interest, in the fall of 1987, A.I.D and the government of Thailand co-sponsored an Asia/Near East workshop on private power generation attended by public and private officials from Egypt, India, Indonesia, Jordan, Malaysia, Morocco, Pakistan, the Philippines, Singapore, Sri Lanka, Thailand, Turkey, and the United States.

Many advanced developing countries that do not receive A.I.D development assistance, such as Turkey, Singapore, Brazil and Argentina, are also seriously considering direct private sector participation in their power sectors -- primarily in the ownership, construction, financing, and operation of generating plants.

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1 Export-Import Bank of the United States, Annual Report, "FY 1986 Direct Credits and Financial Guarantees. "This represented approximately 11 percent of all Eximbank loan and guarantee activity

Turkey, in particular, is attracting international attention to its extensive privatization efforts, which are expected to serve as a model for many developing countries. In the electric power sector, the Turkish government's program of privatization calls for the private sector to finance, build, own, and, after a number of years, transfer major electric power plants to the state utility authority. Turkey is currently considering five proposals from foreign consortia -- one of which is led by the Bechtel Company of the United States -- for thermal power plants from 960 MW to 1,200 MW in size.

BENEFITS OF PRIVATE SECTOR INVOLVEMENT

As used in this report, "private sector" refers to that segment of a country's economy comprised of enterprises owned and managed by individuals, groups, or corporate entities that can operate in an open market to provide goods and services and a return on the investments of the owners, with minimal governmental intervention. In contrast, the "public sector" refers to that segment where government organizations or entities owned and controlled by governments provide goods and services to the public.

The major benefits that private sector involvement can bring to developing countries are the introduction of market forces into the electric power sector and the attraction of additional financial and other resources, accessible only to the private sector. The introduction of market forces can bring two critical elements: competition and efficiency. This can result in improved system management and mobilization of added resources.

The power sectors of developing countries tend to be inefficient both at the plant and the system levels. In developing countries, electric power is sometimes viewed as a political good rather than as infrastructure for development. Hence, electric power prices can be distorted and highly subsidized for those groups considered politically important.

An analysis of numerous comparative studies of publicly and privately owned and operated utilities in the United States reveals that private enterprise can substantially improve electric power systems. First, private ownership and operation tend to result in prices being set to cover operational and capital expansion costs. Second, the cost of constructing new capacity is lower for private firms than for public utilities, owing to efficiencies in system design, procurement, and construction management. Third, operating costs of private firms were generally less than costs incurred by public utilities. Fourth, private firms have been shown to adopt innovations at a more rapid rate than public electric enterprises. Finally, publicly owned utilities receive less strict monitoring and oversight than do private utilities, allowing public managers more discretion in responding or not responding to customer demands.[2]

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2 L. De Alessi, "The Economics of Property Rights: A Review of the Evidence, "Research in Law and Economics, Vol. 2, 1980.

Approaches for Private Sector Involvement in Power Sector

The involvement of the private sector can take many approaches, depending on the interests of the national government, its utility authorities, and local and foreign private interests. The approaches for private involvement include (1) private ownership and operation of discrete components of the system, such as generating plants or transmission and distribution systems; (2) complete private ownership and operation of the entire electric utility system; (3) contracting out by the utility authority to private businesses to perform certain functions, such as revenue collection or plant operation and maintenance; (4) temporary private ownership where the utility authority sells certain assets for later lease-back or buy-back; and (5) investment of private funds into publicly held utility systems through debt instruments, loans, and bonds. The approaches listed above are often referred to as "privatization," where existing enterprises are shifted from public to private ownership or operation.

Developing countries currently appear most interested in having local and foreign private companies invest in new electric generating plants. The most common models involve the Build-Own-Transfer (BOT) and Build-Own-Operate (BOO) approaches. Under BOT, a private company owns, finances, constructs, and operates for a number of years (normally 15-20 years) a power generating plant and sells the power directly to the government or the utility authority. Once the debt for constructing the facility has been repaid, the plant is "transferred" to the government or utility authority. The BOO approach is essentially the same as the BOT approach, except that the plant is not transferred to the government or utility authority but remains permanently in private hands. Partly because of developing countries' interest in private investment in generation, A.I.D. energy programs have focused much of their activity on the BOO approach.

A.I.D. COMMITMENT TO PRIVATE SECTOR PROGRAM DEVELOPMENT

Since 1981, A.I.D. has supported programs to increase the use of private enterprise to stimulate economic growth and meet the development needs of developing countries. Section 108 of the Foreign Assistance Act declares that private enterprise development "is a vital factor in the stable growth of developing countries" and that it is in the best interests of the United States "to assist the development of the private sector in developing countries and to engage the United States private sector in that process."

All A.I.D. Bureaus and Missions are charged with the responsibility of developing and administering programs to effectively assist private enterprise development. These include: (1) removing roadblocks to private business investment; (2) providing credit to a limited number of small and medium-sized businesses in developing countries; (3) supporting appropriate institution building; and (4) assisting host country governments to design and implement private sector projects.

The specific programs of A.I.D. for encouraging private sector involvement in electric power are discussed in subsequent sections of this chapter.

Need for Incentives

Despite the advantages of private sector participation in the development of electric power and the expressed interest of private firms and developing countries, to date only a few private power generation projects are in operation. Unfortunately, numerous barriers have discouraged private investment in the power sectors of developing countries. These barriers can be grouped into five categories:

- Policy and institutional barriers
- Weak domestic economies
- Political risk
- Technical risk
- Financial risk.

Policy and Institutional Barriers

Many of the initial barriers to private sector participation in the power sector relate to public policies, regulations, and practices in developing countries that prohibit or discourage private sector involvement. Before private investment can take place, policy issues related to private sector investment, such as import tariff rates, repatriation of profits, foreign ownership of companies, guarantees of payment on contracts, must be resolved.

Often the institutional structure of the power sector is resistant to change, unnecessarily complicated, and involves numerous government agencies in the planning, construction, procurement, and operation of activities and facilities. Also, the personnel of the utility authority often lack adequate knowledge and training in the management and technical skills needed for the operation of utility systems, much less the skills needed to administer new private sector power agreements.

Weak Domestic Economies

Private sector companies seeking to sell goods and services or invest in the power sector need a stable economic and investment environment in developing countries. In recent years, developing countries have experienced low economic growth, crippling debt

burdens, and monetary instability, reversing the hopeful trends of higher economic growth rates of the 1960s and the 1970s.

Economic growth in developing countries has slowed dramatically. For these countries, the average annual growth rate of Gross Domestic Product has fallen from 6.4 percent in 1965-1973, to 5.4 percent in 1973-1980 and to only 3.6 percent in 1980-1986.[3]

Political Risk

The recent economic problems of developing countries have only increased the already high level of political instability. Private investors and financial institutions, when considering political risk, are concerned with (1) nationalization and expropriation, (2) inconvertibility of currency, and (3) war and political unrest.

While sudden and outright expropriations receive more publicity, "creeping expropriation" is equally insidious. This type of interference can take the form of repressive taxes, changes in regulations affecting ownership and operations, breach of contract, price and production controls, and profit-level restrictions. For electric power, which has a long tradition of public ownership and operation, the threat of possible complete or creeping expropriation of private sector power operations is even greater.

Technical Risk

Private power project developers are generally able to assume, and expect to assume, the risk of the technical performance of their facilities. Nevertheless, there can be unusual and unexpected technical risks in developing countries, such as the use of domestic, low-quality fuel resources, the inadequacy of the infrastructure on which their operations depend, the unavailability or disruption of fuel supplies, and the shortage of skilled operating personnel. Additional technical risks are involved when innovative power generation technologies are being considered.

Financial Risk

One of the most serious impediments to private sector participation in electric power in developing countries is the risk of losing the equity and debt capital that must be invested in power system projects. The private sector is concerned that the unstable economies and governments of developing countries may result in an inadequate return on investment, nonpayment of loans, and possible uncompensated expropriation of assets.

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3 World Bank, World Development Report 1987, Oxford University Press, 1987, p.16.

Consequently, there continues to be a significant downward trend in international lending by U.S. banks to developing countries. From 1983 to 1986, foreign claims by all U.S. banks on developing nations declined by 20 percent, from $153.7 billion to $122.5 billion.[4]

Cutbacks in international lending by U.S. banks also appears to be associated with their growing reluctance to finance U.S. trade exports -- especially exports by small and medium-sized U.S. companies to developing nations. During 1986, U.S. bank trade financing with developing countries fell by 15 percent, from $43.1 billion in March 1986 to $36.6 billion in December 1986.[5]

In addition to the problem of the unavailability of external capital, raising capital within developing countries is often difficult owing to weak local capital markets.

PRIVATE SECTOR ELECTRIC POWER STRATEGY

Presented in this section is a possible Private Sector Electric Power Strategy for alleviating the power crisis in developing countries by involving the private sector of developing countries and the United States.

Goal

The goal of the private sector electric power strategy is to increase the amount of reliable, affordable, and sustainable electric power available for productive end uses by providing incentives for the increased participation of private sector enterprises in the electric power sector of developing countries.

Objectives

To achieve this goal, the strategy seeks to accomplish the following objectives, which can be favorably affected by the implementation of incentives by A.I.D. and other agencies of the U.S. government:

A. Improve the public policy and institutional climate for private sector participation in the electric power systems of developing countries

B. Facilitate the development of private sector power projects and trade opportunities

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4 County Exposure Lending Survey, FFIEC Release E.16.

5 W.F. Kolarik and T. Perera, "U.S. Banks' Retreat from Export Financing: Implications for U.S. Trade," OTIA Staff Report DIE-07-86, July 1987

C. Assist with financing private sector power projects and trade opportunities

D. Coordinate and target the various programs and activities of the U.S. government and those of other donor nations and multilateral development banks.

A.I.D., other U.S. government agencies, and multilateral development agencies have a variety of programs that can be brought to bear to advance this private sector strategy. These will be discussed briefly under the specific objectives that they serve best.

The analysis undertaken for this report, nevertheless, reveals a number of shortcomings in these programs that could be addressed by additional, appropriate incentives for private sector participation in the power systems of developing countries. These are identified as "incentive options." Following a brief description of each option, there is a note concerning the "resource/policy implications" they present, -- whether they will require additional resources or legislative authority.

OBJECTIVE A. IMPROVE PUBLIC POLICY AND INSTITUTIONAL CLIMATE FOR PRIVATE SECTOR PARTICIPATION IN ELECTRIC POWER SYSTEMS OF DEVELOPING COUNTRIES

To succeed with any significant private participation in the power sector, it is necessary to pay considerable attention to the general public policy and institutional context of the power sector.

The governments of most developing countries have created parastatal utilities (i.e., state-authorized public monopolies) in which efficient management is often subordinated to political and social objectives. The result is severe market distortions that make investment by local and foreign private sector firms risky and unprofitable.

To foster significant private sector involvement in power generation, it is necessary to have:

- A generally rational private investment climate
- A clear legal and policy framework that allows private investment in power generation
- A realistic energy policy and planning approach that effectively incorporates private interests
- Institutional capability and processes in the government, utility, and private sector

- A financial capacity in the country and its financial institutions to adapt to and accommodate private sector power generation (including capital markets and the availability of appropriate financial instruments)
- A policy framework providing access to fuels for private power generation.

Some of the specific concerns of private sector firms exploring investment in power generation are:

- Uncertainty of the process to solicit, review, approve, and develop private power generation projects
- Lack of government experience to carry out a private power program
- Uncertainty over the price the utility will be willing to pay for the power
- Restrictions on repatriating profits in hard currencies to service debt and equity obtained from foreign sources
- Restrictions on foreign ownership and management control of private companies
- Restrictive policies on licensing, taxation, duties, interest rates, and credit
- Lack of legal protection and arbitration mechanisms to ensure contract compliance by host governments and utilities
- Complex, time-consuming administrative procedures resulting in costly delays.

Three groups are emerging in developing countries with an interest in promoting private sector involvement in the power sector: (1) government energy officials concerned about the inability of the traditional, centralized parastatal utilities to provide adequate and reliable power, (2) finance and planning officials concerned about power sector demands on the capital budget and foreign exchange, and (3) private sector industries and agricultural business affected by inadequate power systems.

Current Programs

Implementing policy and institutional reform and expanding the role of the private sector are two of the primary goals of A.I.D. In most countries, A.I.D. supports macroeconomic and sector policy dialogue (e.g., in energy, agriculture, health) and institutional reform needed for efficient economic growth. Particular emphasis is given to support for private sector initiatives as vehicles for sustained development.

In the past three years, A.I.D. has begun to examine the policy, institutional, and financial barriers and opportunities for private sector participation in the generation of power for sale to the national utilities. Assessments undertaken in Pakistan, India, Thailand, Indonesia, the Philippines, Jamaica, and the Dominican Republic indicate a significant potential and public and private sector interest.

In response to Pakistani government interest, A.I.D. has undertaken a $150 million private sector power project in coordination with the World Bank. The project is designed to provide technical and financial assistance and training to support the government's effort to develop a private power program that could produce 1,300-2,000 MW over the medium term. This would result in approximately $1-2 billion of private investment and place nearly one-quarter of the total electrical generation capacity of Pakistan under private ownership and operation -- a major structural shift.

In addition to the policy and private sector programs executed in A.I.D. Missions, the Agency commitment to expanding the role of the private sector in development is also supported by the Regional, Science and Technology, and Private Enterprise Bureaus' activities. The Private Enterprise Bureau also supports the Center for Privatization, which assists developing countries and their private sector interests to plan and implement the divestiture of government enterprises.

In addition to technical assistance for policy and institutional reform, one of A.I.D.'s most effective programs is training. Currently, there is no training program for key decisionmakers, management, and technical personnel from developing countries interested in expanding the private sector role in power.

The World Bank has played a significant role in the power sector through its support for policy and institutional reform using loans conditioned on reforms in pricing, management, and efficiency improvements. Recently, there has been some interest in fostering the role of the private sector in power generation as well. The World Bank, at the request of the Government of Pakistan, has taken the lead on the development of a private sector energy project that will include major support for private sector power generation projects.

Incentive Option A-1. Country-Specific Private Sector Power Assistance

Private sector power policy assistance can provide:

Assessment Studies and Workshops

Studies to define the potential for and impediments to private sector power generation (and other forms of private sector involvement) such as those undertaken to date are valuable tools for countries' initial examination of private sector issues. Workshops to

review findings and define strategy options are important vehicles for sharpening public and private sector interests and issues.

Policy Analysis

Key policy dialog issues can be elucidated to foster policy reform. Such work may include:

- Analysis of private sector power generation impact on foreign exchange, capital development budgets, and private capital market development
- Analysis of legal and regulatory approaches for expanded private involvement
- Analysis of economic and financial policies and practices, including taxes, tariffs, and credit constraints and issues
- Analysis of the role of the private sector in providing power for rural needs.

Technical Assistance

The provision of technical assistance for the development of strategies and the implementation of private sector power programs can include support for such activities as:

- Development of institutional arrangements and capacity to plan, solicit, analyze, select, and monitor private sector power generation programs
- Establishment of sound legal and regulatory frameworks
- Development of model power purchase agreements and related mechanisms that are key to fostering private investor interest.

Resource/Policy Implications

No additional authority is required; two or three country assessments can be undertaken using existing resources.

Incentive Option A-2. Private Sector Power Training Program

A.I.D. could create a Private Sector Power Training Program aimed at government officials, state utility officials, and businessmen from developing countries and

businessmen in the U.S. power industry. Where possible, the program would be coordinated with courses offered by the Eximbank, DOC, and A.I.D.

The subject matter covered in the program would include:

Creating Favorable Policy/Institutional Environment. Aimed at government officials and state utility company personnel and local businessmen in developing countries, this course would address the policy and institutional reforms needed for private power.

Promoting Private Power Investments. To assist in promoting private power, a special short course or courses could be prepared for businessmen from the United States and developing countries.

Financing Private Power Projects. The subjects to be addressed in training on project financing should include financing programs, financial requirements of developing countries, the preparation of financing packages, and the structuring of business equity and ownership.

Resource/Policy Implications

No additional authority is required; one training program for key decisionmakers and one for administrative/technical personnel can be initiated using existing resources.

OBJECTIVE B: FACILITATE DEVELOPMENT OF PRIVATE SECTOR POWER PROJECTS AND TRADE OPPORTUNITIES

The process of developing privately owned power projects and trade opportunities is often complex and difficult for both U.S. and host country private firms. First, a market for developing a specific power project or trading specific goods and services must be identified and contact made between the appropriate parties. Distinguishing the true opportunities from the range of possibilities requires diligence and perseverance that can result in expensive upfront costs, especially for small and medium-sized firms.

Private sector firms have indicated that the difficulty of raising the funds to pay for the upfront development costs has been a major deterrent to their involvement in private sector power investments in developing countries. They frequently expressed an interest in the establishment of some form of cost-sharing program with the U.S. government, under which the government share would be repaid if the project went ahead.

Many small and medium-sized U.S. companies avoid marketing in developing countries for a number of reasons. Some simply lack experience with overseas markets, since until recently the U.S. domestic power market had created sufficient demand for their products and services. Also, some firms do not have the resources to travel and develop

contacts overseas on their own. And some firms lack knowledge of the assistance programs available from the U.S. government and elsewhere. The U.S. government, unlike many of its trading competitors, has not devoted significant resources to the coordinated development of marketing and promotional activities in the power sector.

For private power projects, such as the construction and operation of a generating facility, the process is even more difficult. After identifying possible projects, private firms must then undertake prefeasibility and feasibility studies. A prefeasibility study typically addresses project location, fuel types and sources, market potential, type of technology, project size, operational issues, construction and operating costs, revenues projections, management arrangements, preliminary design, and legal and environmental issues. The prefeasibility study is the key decision document on which to seek financing and decide whether to proceed with the project.

A feasibility study is undertaken next, usually after there is some assurance through a letter of intent or other form of commitment that the host country and utility will agree to the project. This study includes engineering designs and specifications and bid packages, detailed financial plans, facility management and operation plans, fuel supply and grid connection plans, and environmental mitigation measures.

Current Programs

Although there is no marketing program solely targeted toward private participation in the power sector of developing countries, U.S. businessmen can obtain some marketing assistance from A.I.D., the Committee on Renewable Energy Commerce and Trade (CORECT), the Overseas Private Investment Corporation (OPIC), the International Trade Administration (ITA) of the Department of Commerce (DOC) and the Department of State (DOS). These agencies can provide information on markets for products, business laws and regulations, sources of financial assistance, economic and demographic statistics on developing countries, and business contacts overseas. The Office of Energy of A.I.D. has completed a number of studies of the potential for private power in selected developing countries, has initiated a limited data base of project opportunities and industry contacts, and has conducted definitional missions to Indonesia, Africa, and Thailand. CORECT, which is staffed by the Department of Energy (DOE), conducts informational missions and disseminates information about renewable energy opportunities and trade.

Only limited assistance for prefeasibility and feasibility studies is available. The U.S. Trade and Development Program (TDP) has a program to fund prefeasibility and feasibility studies for private investment projects, but has reduced its involvement with such projects in favor of public sector projects, given the long lead times from feasibility phase to construction. OPIC had a feasibility study fund, but funding for FY 88 was disapproved by OMB. A.I.D. has conducted general studies on private sector power,

but has only been able to fund prefeasibility study or feasibility study work in a few countries, including Pakistan, Jamaica, and Thailand.

The U.S. government has not yet set a clear policy direction on the promotion of energy, or more specifically, electric power, as a part of its trade and aid strategies. When viewed from their ability to promote private sector power programs and projects, the existing programs of the U.S. government have significant limitations. The overseas marketing programs of DOC have been weakened by recent budgetary cutbacks. In addition, the U.S. government has few programs to help businessmen defray the costs of marketing their goods and services overseas. Currently, there is no training program offered by any agency on private power, although A.I.D. does provide some courses on planning and operating public power systems.

The project development assistance funds of A.I.D., TDP, and DOE can support a small number of projects for prefeasibility and feasibility studies.

Incentive Option B-1. Private Sector Power Investment Promotion Program

In response to the expressed concern of U.S. businesses, a Private Sector Power Investment Promotion Program could be established to help companies obtain information and technical assistance on potential market opportunities, government policies and regulations, business assistance programs, and contacts in developing countries. Following in part the model of A.I.D.'s Investment Promotion Office in Egypt, A.I.D. could establish a project to identify power sector market opportunities and joint venture partners in developing countries and the United States. This project could also coordinate assistance to prospective private power ventures from various federal programs.

Similar to the programs in other developed countries, the Private Sector Power Investment Promotion Program would provide businesses a single point of contact for information and technical assistance, and would follow up with each interested company as project opportunities arose.

Also, the Investment Promotion Program could undertake an analysis of the feasibility of a cost-sharing program, in which the U.S. government might pay for a portion of all development costs (in addition to sharing the costs of prefeasibility and feasibility studies, which is discussed below in Incentive Option 7) through reimbursable grants.

The program could draw on A.I.D., DOC, DOE, and TDP resources, including their extensive contacts in both the power industry and developing countries.

Resource/Policy Implications

No additional authority is required; existing resources are sufficient to initiate a pilot program.

Incentive Option B-2. Private Sector Power Data Base

Given its current program priorities and recent experience with private sector participation in the power sectors of developing countries, A.I.D. could develop a Private Sector Power Data Base to track specific project opportunities. Building on its extensive network of A.I.D. Missions, such activity would be coordinated with the DOC Foreign Commercial Service and the DOC International Major Project Tracking System, as well as with interagency activities carried out under the programs of CORECT.

The data base would provide an updated inventory of: (a) project opportunities by country; (b) U.S. suppliers of power equipment and services; (c) key contact people, firms, and agencies in the public and private sectors of developing countries; (d) current information on laws and regulations on private power; and (e) information about the economic and trade impacts of specific projects, including jobs created, value of U.S. exports of goods and services, and estimates of annual income generated.

Resource/Policy Implications

No additional authority is required; a Private Sector Power Data Base on three to four countries could be initiated and maintained with existing resources.

Incentive Option B-3. Definitional Missions

Definitional Missions: In collaboration with DOC and TDP, A.I.D. could increase the number of definitional missions to countries that have adopted, or are about to adopt, favorable policies toward private participation in the power sector and that have a significant power sector market. These missions would involve identifying potential power projects and the key public and private parties in developing countries and bringing them together with U.S. private companies that want to participate in such projects. The aim of the missions would be to develop contacts between U.S. businesses and appropriate government and state utility officials, potential local joint-venture partners, and local suppliers of goods and services.

Funds could be made available to assist small and medium-sized companies to travel on the missions; the cost would be reimbursable if the companies subsequently transacted business. These missions would draw on the resources of the Private Sector Power Data Base, the in-country A.I.D. Mission, DOS and DOC staff, and A.I.D./Washington.

Trade Conferences: Regional and country-specific conferences could be organized on the subject of private power project development opportunities. The target audiences could include government officials, state utility officials, financial institution representatives and private businessmen from the developing country, U.S. government officials, expert technical advisors, and representatives of private U.S. companies that supply equipment and services. Participation in these conferences would provide U.S. businessmen with the opportunity to learn more about private power opportunities and to introduce their products and services.

Also, A.I.D. could build on trade conferences scheduled in developing countries by cosponsoring these conferences if they are expanded to encompass power sector opportunities.

Resource/Policy Implications

No additional authority in required; one or two definitional missions and participation in one or two trade conferences could be initiated with existing resources and legislative authority. No financial assistance could be given to private sector firms without additional resources.

Incentive Option B-4. Innovative Technology and Environmental Assessment Program

The Innovative Technology and Environmental Assessment Program would provide resources for conducting assessments of innovative energy technologies applicable to private power projects as well as assessments of environmental effects of projects and the means to minimize adverse effects. Aimed at specific technologies in which the United States has, or intends to develop, a competitive position, this program would provide more support for detailed technology assessments of emerging and environmentally clean technologies, e.g., fluidized bed combustion systems, renewable energy technologies, cogeneration systems.

Also, environmental assessments would ensure that private power projects adequately consider and address such issues as air quality, atmospheric warming, impacts on biological diversity and habitat, potential forced resettlement of local populations, and alternatives to conventional, coal-fired, and hydro plants. This program could supplement the funding of other U.S. agencies that support prefeasibility and feasibility work.

Resource/Policy Implications

No additional authority is required; two or three studies could be initiated with existing resources.

Incentive Option B-5. Private Sector Power Feasibility Study Program

In collaboration with TDP, DOE, OPIC and Eximbank, A.I.D. could help establish a Private Sector Power Feasibility Study Program. Using formal program opportunity announcements as well as informal solicitations, the program could seek viable private power project opportunities, focused on technologies in which the U.S. private sector has a competitive edge.

The administering agency could make reimbursable grants of up to 50 percent of the total cost of prefeasibility and feasibility studies to private firms whose projects satisfy preset project selection criteria.

The program could increase the number of private power projects being considered. Since prefeasibility and feasibility studies are the key decision documents, such assistance could provide U.S. firms with advance information about trade opportunities. Properly designed, they are effective means of developing consensus between industry and government on the scope and cost of power projects.

Resource/Policy Implications

No additional authority is required; two or three prefeasibility and feasibility studies could be initiated with existing resources.

Incentive Options B-6. Negotiation and Technical Advisory Team

A.I.D. and the A.I.D. Missions could create a pool of technical consultants that could provide assistance to the parties in private power contract negotiations. This is especially important for the government agencies of developing countries, including the state utility authority. The International Executive Service Corps of A.I.D. could be used to provide the assistance of retired executives at little cost to developing countries.

The consultants would have special expertise and experience in utility law and regulation, utility power purchase agreements, international law, negotiating with private power providers, international financing and project financing, political and commercial risk insurance, utility engineering, design and construction, and market analysis.

Developing countries and private power developers could obtain assistance in negotiating agreements. Especially for developing countries, this assistance could help increase their level of confidence in dealing with private sector power firms, thereby reducing the amount of time spent on the expensive development phase.

Resource/Policy Implications

No additional authority is required; a limited amount of negotiation and advisory assistance could be initiated with existing resources.

OBJECTIVE C. ASSIST WITH FINANCING PRIVATE SECTOR POWER INVESTMENT PROJECTS AND TRADE OPPORTUNITIES

As has been discussed, lack of financing is one of the most significant problems facing developing countries in their efforts to improve and expand their electric power systems. The attractiveness of private sector involvement to the governments of developing countries lies in the opportunity to access additional capital, which the governments and their utilities cannot provide.

Funds for private sector power investment projects can come from two sources: equity and debt. Equity is the money that the project developers and their partners contribute toward the development and construction of a project. Equity commonly accounts for between 20 percent to 40 percent of total project costs, with borrowed funds (i.e., "debt") accounting for the remainder. Given the uncertainties and risks in initial private power projects, it has proven difficult to raise the required equity.

Generally, equity funds are applied toward the high-risk, upfront project development activities that are essential for proper project structuring and risk reduction. According to developers interviewed by A.I.D., the primary, if not exclusive, sources of equity to date have been project developers, equipment suppliers, and construction firms that have an interest in the project.

Private sector firms have expressed an interest in having the host country or its utility authority as minority equity partners. In the mind of project developers and lenders, this would reduce the risk of project delays and nonpayment on power purchase agreements. Also, these firms have suggested that there be some form of a guarantee of the power sales agreement between the utility authority and the private firm that builds, owns, and operates a generating plant.

The primary sources of debt (or loan) financing include internationally active commercial banks, multilateral development banks, export credit agencies, and development assistance agencies of developed countries. The key issue for these lenders is the security of the cash flow of project revenues needed to repay the principal and interest on the loan. Commonly, private commercial banks, multilateral development banks, and donor country export credit and development assistance agencies require "sovereign guarantees" from the government of a developing country to secure their loans. This represents a full faith and credit guarantee by the central government to fulfill the obligations of the loan if the project, for financial or nonfinancial reasons, cannot make the required debt payments. At the other extreme is what has come to be

called the pure "project financing" approach, wherein lenders rely solely on the project's revenues, assets, and contractual arrangements as security.

Given the uncertainties of investing in developing countries, most lenders will require more than just the project revenues and assets to secure their loans. Developing country governments have, however, been reluctant to given full "sovereign guarantees," since these would appear as obligations on the financial statements of the countries and reduce their ability to borrow for other purposes. Consequently, nearly all private sector power projects to date are being structured with what is referred to as "limited recourse financing," under which the lenders require the project owners and the host government or utility to provide certain additional types of backstopping guarantees to cover loan default or delinquency, without going so far as to require full sovereign guarantees.

The promise of private power is currently constrained by the limited availability of equity and debt capital for investment, which is directly related to the problem of the extent of backstopping guarantees.

For trade opportunities -- the sale of electric power goods and services to developing countries -- the most common type of financial assistance is through commercial bank lending and direct loans or loan guarantees of developed country export credit agencies.

Current Programs

U. S. government assistance programs to help finance and ensure the sale of equipment, materials, services and construction for overseas projects involving U.S. companies is available from Eximbank, and to a limited extent from A.I.D. Eximbank is the U.S. government agency that helps finance export sales of U.S. goods and services. It accomplishes this through two programs: (1) financial assistance programs of direct loans and loan guarantees, and (2) insurance programs offered through the Foreign Credit Insurance Association (FICA). Eximbank financing programs have provided $1.6 billion to $2 billion annually, two-thirds in loan guarantees and one-third in direct loans. Eximbank has also financed the sale of electric power equipment, such as gas turbines and coal-fired power plants, to public utilities overseas. Currently, Eximbank is involved with an approximately $340 million loan guarantee for the Terkidag private power project in Turkey for a consortium led by the Bechtel Company.

Through its Commodity Import Program, A.I.D. can provide financing for power equipment, supplies, and construction materials, and through its Economic Support Funds can participate in a limited number of concessionary financing arrangements for specific trade projects.

The other significant export sales program is the mixed-credit, tied-aid program administered by Eximbank and A.I.D. Under this program, the United States can help American companies compete with subsidized offers on long-term transactions by firms

from other nations in international tenders for electric power equipment and services. Designed to act only defensively, Eximbank or A.I.D. can offer up to 35 percent of the project cost as a grant to the developing country to match offers made by competitors. Unfortunately, the restricted level of funding and the difficulty of swiftly responding to bids by other countries has limited the effectiveness of the U.S. program. Basically, U.S. policy has been to discourage the use of mixed credits by all countries, since they involve subsidies that distort normal competitive markets.

Concerning investment in power sector projects, assistance is available from OPIC, Eximbank, A.I.D., and the multilateral development agencies. OPIC can provide direct loans to small and medium-sized firms in the range of $2-4 million and can provide loan guarantees up to $50 million. Also, OPIC can offer to eligible applicants political risk insurance that covers nationalization and expropriation, war and civil unrest, and currency inconvertibility. All of Eximbank's programs are applicable to potential private power investment projects, although the only experience to date has been with the proposed Terkidag power plant project in Turkey, which has yet to be finalized.

In addition, A.I.D. is considering participating with the World Bank and other donors in a private sector energy loan program that could provide direct loans of up to 30 percent of the cost of eligible projects. A.I.D. has a Private Sector Revolving Fund that can make loans of up to $5 million to private sector companies in developing countries, but funding is limited.

Currently, the U.S. government has no program for equity participation in power sector investment projects. OPIC is requesting authority from Congress to initiate such a program in Africa and the Caribbean Basin. All other donor nations, however, have some assistance program that helps project investors to raise the required equity. Also, the United States has no program that could guarantee payment under the power sales agreement.

Multilateral development institutions such as the World Bank, the International Finance Corporation (IFC), the Asian Development Bank, and the Inter-American Development Bank also have programs that are applicable to the development of private power projects. The Asian Development Bank has a specific lending program in place applicable to private power project investments. Although they can provide some limited amount of technical and feasibility study assistance, the multilateral development institutions typically prefer to use their resources for project or sector loans. The World Bank, for example, is considering an innovative loan program exclusively for private sector energy projects in Pakistan.

The IFC, in addition to providing direct loans for private investment projects, can also acquire equity in projects they believe are sound and contribute to the economic development of a country. In the near future, the World Bank, through a newly affiliated Multilateral Investment Guaranty Agency (MIGA), will shortly begin offering political risk insurance for private investments made in developing countries.

Incentive Option C-1. Energy Loan Guarantee Program

The Committee on Appropriation's emphasis on an energy loan guarantee program warrants a specific recommendation on this option. After analysis of the A.I.D. Housing Guaranty Program, the OPIC and Eximbank loan guarantee programs, and the status of numerous private sector power projects, it appears premature for A.I.D. to establish a separate energy loan guarantee program at this time. There are not yet enough private sector power projects being negotiated to require the establishment and funding of a totally new loan guarantee program strictly devoted to energy, although the situation could change in the future.

In the near term, A.I.D. could help project developers and developing countries work with the existing loan guarantee programs in OPIC and Eximbank, using these opportunities to explore the sufficiency of existing loan guarantee funding authority and to further study the financial and administrative details of implementing an energy loan guarantee program at A.I.D. Also, A.I.D. could respond to the expressed interest of private sector firms by considering how a program to guarantee power sales agreements might work.

A.I.D.'s Office of Housing and Urban Programs, Bureau for Private Enterprise, has been operating the Housing Guaranty Program since 1961. As part of the foreign assistance program, it has improved the quality of housing in developing countries. Over $1.3 billion in guarantees are now outstanding to A.I.D.-assisted countries.

Under the Housing Guaranty Program, the U.S. government provides a full guarantee against default on loans made by private U.S. financial institutions to host country governments for investments in their housing sectors. The host governments, in turn, provide a sovereign guarantee to the U.S. government to repay the loan in the event of delinquency or default. Originally, the program operated without a sovereign guarantee. The program supports itself by charging the borrower a fee as part of the loan package. Loans are attractive to host countries because they are at lower rates and longer repayment periods than could otherwise be obtained and because some of the foreign exchange is generally available for other purposes if local currency can be employed for a portion of the required goods and services.

The approach to an Energy Loan Guarantee Program (ELGP) builds on the experience gained under the Housing Guaranty Program and the loan guarantee programs of OPIC and Eximbank. Under ELGP, a U.S. government agency could guarantee the repayment of a loan for all or a portion of the required project debt made by a U.S. financial institution for an eligible project. The guaranteed loan could be made either to the host government, which would lend the funds to a private investment intermediary (such as a development bank or venture capital investment firm) or directly to the eligible private sector power investment project. The responsible agency would review the projects for technical, financial, economic, and political risk.

The loans could be at competitive market rates for similarly guaranteed loans. The program operating costs would be paid for out of a fee charged to the borrower. Maturities would be from 15 to 20 years, plus a grace period on repayments of principal and interest during construction and start-up.

The guaranteed loan would be one element of the entire financing package, which would include a set percentage of equity participation from the developers and investors and additional debt financing. Also, ELGP might not require a sovereign guarantee of its repayment from the host government, which would increase the flexibility of the program and serve the desire of host governments to minimize government debt guarantees.

Resource/Policy Implications

If restricted to the further study of the possible need, structure, and funding of an Energy Loan Guarantee Program and assisting a limited number of private investment and trade opportunities to use existing programs, this activity could be undertaken with existing resources. Should there be a need for a specific loan guarantee program, new funding and authorizing legislation would be necessary. A host country loan guarantee program could be established with existing authority and with existing resources.

Incentive Option C-2. Energy Direct Loan Program

Before initiating additional direct loan programs for private sector power, the Agency could consider using the existing A.I.D., OPIC and Eximbank loan programs for private sector investment projects. Also, the Agency could closely observe the creation and operation of the Pakistan private sector energy loan program proposed by the World Bank and the A.I.D. Pakistan Mission for possible replication in other A.I.D.-assisted countries. Currently, the Agency is considering joining with the World Bank and other donors in establishing a private sector power lending window in Pakistan. If implemented, this window would provide up to 30 percent of the financing needed for private sector power projects.

Several models or precedents exist within A.I.D., other U.S. government programs, and elsewhere for direct loans to private sector firms in developing countries. The A.I.D. Private Sector Revolving Fund, the Eximbank direct loan program, the OPIC direct loan program, and the World Bank's and the International Finance Corporation's programs all can provide funds for private power projects. However, the PRE and OPIC loan programs are limited by available funds to financing only small-scale projects from $500,000 to $5 million in total project cost.

The following describes how a direct loan program might work. Direct energy loans, unlike guarantees, would involve the lending of U.S. Treasury funds for specific private power projects. The loans would be made directly to the eligible private investment

project developer or to a financial intermediary, such as a development bank, in the developing country for lending to the project developer. A direct project loan of this type adds scarce financial resources to the project, but more importantly, it brings the stature of the U.S. government to the project, which tends to reduce the perceived risk.

In an Energy Direct Loan Program, the terms of the loans would be at prevailing market interest rates. The maturities would be from 8 to 15 years plus a grace period. Except for small-scale and innovative technology power projects (where loan could possibly be for up to 80 percent of project cost), the loan would be used to cover only a portion (e.g., 30-50 percent) of the debt. Substantial additional debt and equity could be required from other sources, including U.S. and host country private investors.

Resource/Policy Implications

If restricted to the further study of the possible need, structure, and funding of an Energy Direct Loan Program and assisting a limited number of private investment and trade opportunities to use existing programs, this activity could be undertaken with existing resources. Should there be a need for a specific loan program, new funding and authorizing legislation would be necessary. A direct loan program by a host country, such as is being considered in Pakistan, could be established within existing authority and resources.

Incentive Option C-3. Energy Grant and Export Credit Program

The mixed-credit, tied-aid program administered by Eximbank and A.I.D. combines grant or soft loan financing of up to 35 percent of the cost with export credit financing loans. In international competitive procurements for goods and services, some industrialized countries provide a combination of grants and concessionary loans to developing countries to improve the competitive position of their firms.

The current U.S. government policy is to employ this program defensively -- after another country has submitted a mixed credit offer to provide grant funds and concessionary loans to assist its companies in international competition. Transactions involving mixed credits are estimated for all countries to have been $2.5-5 billion over the last few years.

Resource/Policy Implications

If restricted to the further study of the possible need, structure, and funding of applying mixed credit programs for electric power and assisting a limited number of private investment and trade opportunities to use existing programs, this activity could be undertaken with existing resources. Should there be a need for increased funding, a

revision in mixed credit policy, or an increase in appropriations, new funding and authorizing legislation would be necessary.

As most private sector power projects are still in the preparation and negotiation stages, it appears premature to alter U.S. policies on mixed credits and tied aid. Instead, the Agency should help the private sector use existing authority and analyze the need for policy changes or additional funding authority.

Incentive Option C-4. Energy Equity Participation Program

Securing sufficient equity funds has proven to be a significant obstacle to the initiation of private sector power investments. Commonly, the funds are needed at the beginning of project development to pay for the higher-risk costs of identifying sound investment projects, determining feasibility, negotiating necessary agreements, and arranging financing.

Basically, there are four proven approaches to providing equity funds:

(1) Indirectly through loans to an intermediary such as a venture capital company that in turn purchases equity, such as has been set up on a small scale through A.I.D.'s Private Sector Revolving Fund

(2) Direct purchases of equity, such as is often done by IFC

(3) Guaranteeing the purchase of equity by others, similar to the new approach under IFC's Guaranteed Recovery of Investment Principal program

(4) Direct equity grants for host countries to purchase equity participation.

Direct equity purchase with A.I.D. funds runs counter to existing Agency policy and practice, but indirect equity participation is being examined.

Unlike the energy loan guarantee and direct energy loan options, an Energy Equity Participation Program could involve the use of U.S. Treasury funds as equity or to guarantee equity funds for private power generation projects in developing countries. This incentive option could be used where sufficient debt could be raised from other sources but insufficient equity is available to meet the lenders' debt-to-equity ratio requirements. Indirect equity participation would serve as a "pump priming" mechanism, in which the U.S. government could assist in providing equity to a project in order to overcome the inertia of other investors. The objective would be to sell the equity raised under this program to local or U.S. investors as soon as possible. This would create a revolving capital or guarantee fund, thereby increasing the number of projects that could be launched.

This program could be operated by A.I.D., OPIC, or through a special window at the IFC. Another approach would be to fund a specially created venture capital firm or development finance agency (possibly one in each participating developing country) that would receive the funds and then make the appropriate investments in private power projects.

Resource/Policy Implications

A.I.D. could consider assisting selected private sector power investment projects to use available resources, and could consider supporting OPIC's legislative efforts to obtain Congressional authorization for a pilot equity participation program in Africa and the Caribbean Basin. If restricted to the further study of the possible need, structure, and funding of an Energy Equity Participation Program and assisting a limited number of private investment projects to use existing programs, this activity could be undertaken with existing resources. Should there be a need for a specific equity participation program, new funding and authorizing legislation would be necessary.

OBJECTIVE D. COORDINATE AND TARGET THE VARIOUS PROGRAMS AND RESOURCES OF THE U.S. GOVERNMENT AND THOSE OF OTHER DONOR NATIONS AND MULTILATERAL DEVELOPMENT BANKS.

Unlike many competing nations such as Japan, the United States has no central coordinating body for its export assistance, investment assistance, and foreign assistance programs. In fact, the U.S. government has frequently avoided the interconnection of trade and investment with foreign assistance. Private U.S. companies have expressed a clear dissatisfaction with the apparent lack of coordination among U.S. government agencies.

There has been a substantial amount of discussion and attention paid to the importance of reconciling the trade and aid activities of the U.S. government. The President's Task Force on International Private Enterprise in 1984 recognized the need to clarify government policy to combine national interests in trade and foreign aid:

> The U.S. Government must develop an aggressive, consistent trade policy that mixes aid and trade resources, enables U.S. firms to be more competitive in world markets, and meets the challenges posed by the growing governmental role in world competition.[6]

The increased interest of developing countries and the private sector in the potential for private participation in the power sector has attracted the attention of numerous U.S. agencies, multilateral development banks, and other donor nations. There is a

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6 The President's Task Force on International Private Enterprise, Executive Summary, December 1984, p.8.

need for coordinated action by all of these parties. A.I.D., owing to its early involvement in encouraging private sector involvement in power systems, is aptly situated to undertake this coordination.

Given the enthusiasm for private power investment, what is needed now is a successful demonstration of the practicality of private power. Such a demonstration would have the benefit of providing to others a policy and project model on which to propose private power in other developing countries. The presence of one successful project would significantly reduce the problem of financing other projects by demonstrating the level of risk.

Private sector power project developers, private and government financial institutions, government agencies, and others have expressed disappointment that of the many private power projects being considered, none has begun construction or operation. Many projects are still involved in the lengthy stage of negotiating project agreements, particularly power purchase agreements.

Incentive Option D-1. Private Sector Power Working Group

A Private Sector Power Working Group composed of U.S. government agencies, multilateral development institutions, and other interested donor countries is developing a coordinated approach to private sector involvement in the power sector of developing countries. Its purpose is to develop and oversee the implementation of a coordinated initiative for the promotion and implementation of pilot private power projects in developing countries.

Such a working group could have responsibility for developing a U.S. government and multi-donor policy on private sector power and a specific private sector power strategy focused on a select number of pilot projects. The members of the working group could include A.I.D., DOS, DOC, TDP, OPIC, Eximbank, DOE, Office of Trade Representative, Office of Management and Budget, Small Business Administration, CORECT, World Bank, Asian Development Bank, Inter American Development Bank, IFC, Multilateral Investment Guarantee Agency, and representatives of other interested industrialized nations.

Also, an industry advisory board composed of representatives from electric power industry equipment manufacturers, suppliers, and services could be established to ensure direct private sector involvement.

A.I.D., through the Private Sector Power Working Group, could also consider clarifying the trade and aid policies of the U.S. government as they relate to private sector power efforts in developing countries. The working group could develop a policy incorporating any necessary legislative or regulatory changes required for its implementation.

The following could be considered:

- Existing government policies on trade and development assistance
- Policies of other nations
- Interests of developing nations and the U.S. electric power industry
- Role of mixed-credit, tied-aid financing offers for selected private power projects.

Resource/Policy Implications

No additional authority is required to create an informal working group, as it already exists; a limited staffing effort can be undertaken with existing resources. The study of approaches to integrate trade and foreign assistance policy could be done within existing authority and resources. Implementing such trade and aid policy integration might require additional legislative authority and resources.

Incentive Option D-2. Private Sector Power Pilot Program

Through the Working Group or by A.I.D. alone, a Private Sector Power Pilot Program could be set up to concentrate limited resources on a few viable projects. The program could target for assistance projects where there is a favorable policy and institutional environment and where specific investment arrangements are being proposed or negotiated. The combined resources of various parties would be brought to bear for the necessary policy assistance, development phase assistance, or financing assistance.

Resource/Policy Implications

No additional authority is required, but only a limited pilot program can be initiated within existing resources.

CHAPTER 5
ROLE OF A.I.D.

INVOLVEMENT OF A.I.D. WITH ELECTRIC POWER DEVELOPMENT

In the International Development and Cooperation Act of 1979, Congress found that "energy development and production are vital elements in the development process, that energy shortages in developing countries severely limit the development process in such countries . . . [and have] resulted in considerable economic hardship for many developing countries.[1]"

Implied in this statement is the charge by Congress to support energy development and electric power production. Energy development, particularly to support countries' power sectors, has been a priority of A.I.D.

A.I.D. provides for a wide range of energy programs. "Assistance is provided in the form of training and institution building, technical assistance, research and technology transfer. A.I.D. provides capital assistance in only a few countries, and therefore A.I.D. seeks to leverage funds from the private sector and the major development banks. Since private investment represents the major source of capital for the development of new energy supplies and the technologies to exploit these resources, A.I.D. works with host country governments to develop and implement sound policies to encourage such investments."[2]

Over the past five years, A.I.D. has provided nearly $200 million per year in energy-sector assistance to developing countries. This is relatively modest compared with the need. According to the most conservative estimates, between $40 billion and $60 billion per year is spent on capital expenditures in the electric power sector in developing countries.

The majority of A.I.D. energy funds are committed to Pakistan and Egypt; smaller amounts are allocated to 15 to 20 other countries. Because of budgetary limitations, the Agency is not expected to be a major source of capital for the power sector in the future.

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1 Legislation on Foreign Relations Through 1986 - Volume I, Committee on Foreign Relations, March 1987.

2 Congressional Presentation, Fiscal Year 1987, Agency for International Development

A review of the Agency's list of energy projects for fiscal years 1985 and 1986 shows the following:

- Of the total FY 1985 agency budget of $193 million for energy, $125 million was for the power sector. Of that, Egypt received $56 million, Pakistan $48 million, and Bangladesh $11 million.

- The FY 1986 budget was similar. Of $254 million budgeted for energy, $180 million was for electricity. Egypt received $100 million, Pakistan $70 million, and Bangladesh $9 million.

- Rural electrification accounted for 22 percent of the funds invested in the power sector in FY 1986.

- Twenty-three other countries received funding for various other energy programs, including planning, demand management, reforestation, resource assessments, and renewable energy

- Central and regional funds were used worldwide for training, fuel wood resources, planning and development, conventional energy technical assistance, and energy conservation.

CURRENT AND FUTURE ACTIVITIES

A.I.D.'s basic approach in energy development involves conducting dialogues with governments about rationalizing their energy policies (including pricing), reforming energy-sector institutions, participating with countries in technology research and transfer, and fostering private sector development in the energy sector.

Policy Dialogue

A.I.D. has worked to reform unsuitable policies in the power sector in select developing countries. It has supported research and policy studies that have shown that the lack of market forces in the power sector contribute to developing countries' power problems. The studies have found that rational pricing and private sector participation in power development are needed to improve power systems. Environmental policy reform has also recently emerged as an important policy focus. The United States has considerable experience in these areas and will continue to contribute to the dialogue for improving policies.

Pricing Reform

A recent World Bank study[3] of bank lending to the electric power sectors of developing countries from 1965 to 1983 concluded that improving management and financial performance would require significant restructuring of electricity tariffs. This conclusion enjoys a strong consensus in the development community. A.I.D. has carried out tariff reform research and planning in Egypt, Bangladesh, Pakistan, and elsewhere. A.I.D. will continue pricing reform by:

- Collaborating with the World Bank and other major power sector donors to develop tariff reform strategies that are based on the long-run marginal costs of electricity production
- Continuing to emphasize strategies that minimize short-term social and economic problems, including energy conservation, peak load pricing, and time-of-day pricing
- Encouraging strategies that provide adequate incentives to mobilize private capital for power sector expansion.

Conservation and End-Use Efficiency

A.I.D. has assisted a number of developing countries in developing their capability in planning and implementing national energy conservation policies and programs. In Pakistan, for example, the National Energy Conservation Center (ENERCON), sponsored by A.I.D., has developed a program plan for national energy conservation, trained a large number of local engineers to undertake energy audits, developed various energy efficiency standards and codes, undertaken national energy conservation awareness campaigns, and performed feasibility studies of various conservation projects.

Environmental Policies

Most developing countries lack systematic standards and policies for environmental management. A number of developing countries are establishing such policies. Recent legislation requires A.I.D. and other U.S. government agencies to ensure that projects funded by the multilateral development banks are environmentally sound. Environmental assessments are to be conducted for projects proposed for funding and

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3 Hugh Collier, Developing Electric Power: Thirty Years of World Bank Experience (Baltimore: Johns Hopkins University Press, 1984.

appropriate steps taken to mitigate any possible adverse effects. A.I.D. has the opportunity to introduce environmental policy reforms by:

- Providing technical assistance for preparing environmental standards for emissions and ambient levels of pollutants and the associated regulations and permitting processes

- Conducting assessments of the environmental impacts of power sector investment plans

- Collaborating with public and private environmental organizations, the World Bank, and other multilateral institutions to explore the implications of alternative global energy development paths; several such organizations are already working to understand the impact of increased atmospheric carbon on global climate patterns.

Private Sector Policy Reform

A.I.D. has made significant efforts to improve the policy climate in developing countries to allow the private sector to participate in resolving the power crisis.

Institutional Improvements

Most electric utilities in developing countries are state controlled, and tend to be inefficiently managed and slow in adapting to change. Developing countries often face capital shortage problems and political, economic, and technological uncertainty that contribute to the ineffective management of the power companies.

A.I.D. has supported programs for improving power sector management. The Agency's continuing role in assisting utilities includes:

- **Improving utility management**, including conducting manpower needs assessments and supporting training programs, preparing detailed operating programs to achieve efficiency improvements, and providing instruments for monitoring progress toward energy efficiency targets

- **Supporting research and development institutions**, such as the Program for the Advancement of Commercial Energy Research (PACER)[4] project in India; increasing coordination of electric power research similar to the Electric Power Research Institute activities in the United States;

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4 The objective of PACER is to commercialize energy research activities and to increase donor coordination on power R&D in India.

establishing sister utility relationships between utilities in developing countries and the United States

- **Strengthening institutions that promote end-use efficiency improvements,** by developing policies and plans to implement conservation programs; developing local engineering capability to undertake energy audits, supporting data collection programs, conducting information and training programs; supporting legislative and regulatory reform, including equipment standards and building codes; designing tax incentives and grant programs

- **Providing policy and management assistance in privatizing parastatal utility functions,** through identification of barriers to private sector participation and possible solutions

- **Strengthening financing institutions** that lend capital for power development by working with the World Bank and other large power sector donors to establish and strengthen the capabilities of local financial institutions.

Technology Transfer

The developing countries need to incorporate new and more productive technologies into their power systems, which presents an opportunity for expanding U.S. trade. Although trade is not a primary consideration of A.I.D., its implications cannot be ignored.

U.S. industry has a competitive advantage in equipment to improve power-plant performance, transmission-and-distribution loss reduction technologies, end-use efficiency equipment, load management, and cogeneration. U.S. industry also has special strength in turbine technologies, "clean coal" technologies, including fluidized bed combustion systems and integrated gasification combined cycle systems, biomass power generation systems, and to a lesser extent photovoltaic systems. The United States. does not currently compete successfully against Germany, Japan, and other countries in other power generation equipment.

A.I.D. has played an important role in promoting the transfer of power systems technologies to developing countries and will continue to do so. The Agency has worked with other federal agencies, most notably the Trade and Development Program and the Department of Energy, to transfer U.S. technologies.[5]

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5 More detail on technology transfer options for A.I.D. can be found in Discussion Draft, Options to Increase Private Participation in Electric Power Development in A.I.D.-Assisted Countries, December 23, 1987.

Private Sector Involvement

Developing countries' interest in private power is growing. Several countries[6] are formulating, and in some cases, implementing private power policies. Yet, despite the clear advantages of private power, numerous barriers are discouraging private sector investors.

A.I.D. has a responsibility to encourage private sector participation in power, because a fundamental agency objective is to mobilize market forces to foster economic growth. Furthermore, A.I.D. has an opportunity to assist the U.S. electricity industry. A.I.D. has devoted substantial resources to encourage private power through its development assistance and economic support programs.

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6 Pakistan, the Philippines, Indonesia, Jamaica, the Dominican Republic, Costa Rica, Brazil, Turkey.