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PRIVATE POWER GENERATION IN DEVELOPING COUNTRIES

TECHNOLOGY TRANSFER TEAM MEETING NO. 4

Sponsored by:

U.S. Agency for International Development
Bureau for Science & Technology
Office of Energy

Organized by:

Hagler, Bailly & Company
2301 M Street, N.W., Suite 400
Washington, D.C. 20037

Westin Hotel
Washington, DC

3 June 1987

AGENCY FOR INTERNATIONAL DEVELOPMENT
WASHINGTON, D.C. 20523

3 June 1987

Dear Members of the Technology Transfer Team:

Welcome to the fourth meeting of the group. It is encouraging that so many of the companies and organizations that we invited have sent a representative to today's meeting.

The participation of U.S. companies in our programs is one of AID's major goals. The work that the Office of Energy through the Energy Conservation Services Program has supported over the last few years has given indication of a number of business and project opportunities for U.S. companies in developing countries. The Technology Transfer Team is one way to share this information with the U.S. business community.

Initially, the program promoted energy conservation technologies, particularly industrial cogeneration, while facilitating both U.S. and local private sector investment. With this meeting we are expanding our focus to energy technologies in the power sector generally.

We feel certain you will find today's meeting informative and we hope it will lead to greater involvement of your companies and organizations in business ventures in developing countries.

Sincerely yours,

Alberto J. Sabadell
Energy Conservation Project Officer
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3 June 1987

Dear Members of the Technology Transfer Team:

I am pleased that you have joined us today. For those of you who have attended previous meetings it is encouraging that you have found them valuable enough to continue to attend. And a special welcome for those of you here for the first time.

The purpose of today's meeting is to share with you some of our insights gained in working for AID's Office of Energy on issues of private power in developing countries. There are serious shortages of electric power in most developing countries and a new willingness in a number of these countries to consider a new or expanded role for the private sector -- both domestic and foreign investors -- in seeking solutions.

The information we have to share with you today on Pakistan, Morocco, India, Indonesia, and the Caribbean and Central American offers real business opportunities for a number of U.S. companies. There are opportunities to sell equipment, to provide project development services, and to finance projects.

We look forward to hearing your reactions to all these matters and we are hoping that a number of you will join us in our future efforts.

Sincerely yours,

Alain Streicher
Senior Vice President

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Morocco: Prospects for Private Power Generation

Indonesia Private Power Market Information

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TECHNOLOGY TRANSFER TEAM & AID'S PRIVATE POWER PROGRAM

The trend toward private, non-utility power generation in developing countries is very strong. In countries such as Thailand, Pakistan, and the Dominican Republic, governments are increasingly supporting private sector activities in an attempt to reduce pressure on national budgets and to make better use of local resources to spur development. In their efforts to increase private sector activities in power generation, developing countries are hampered by a lack of knowledge of and access to efficient technologies. U.S. equipment manufacturers, for their part, are very eager to market their technologies in developing countries but they face many barriers. The Office of Energy at AID used the Energy Conservation Services Program (ECSP) to promote solutions by bringing the two sides together through the Technology Transfer Team concept.

The Technology Transfer Team (TTT) activity is being developed to encourage private sector participation in the power sector in developing countries while exploring ways to increase U.S. competitiveness in emerging power sector markets. TTT's aims are to:

- Strengthen the private sector in developing countries
- Enhance the private-sector's knowledge, experience, and capabilities in power generation to assist in reducing power shortages
- Encourage direct contact between the private sectors in the United States and in developing countries, thus increasing the efficiency and impact of U.S. aid to developing countries
- Stimulate business opportunities for U.S. companies.

Also as U.S. domestic markets mature and international marketing expands, direct contact between companies in the United States and developing countries becomes increasingly important. This contact is vital for businesses in developing countries that want to take advantage of the knowledge and skills of the industrialized nations. In addition, as international competition grows more intense, such contact is increasingly important for the financial health of U.S. companies.

The TTT includes technical personnel from private U.S. firms with experience in selected technologies and interest in business promotion in and technology transfer to developing countries. The TTT works to identify and implement projects for a specific technology. The first efforts of the group centered on cogeneration because it is a proven technology with a broad range

of equipment options. Currently, many developing countries are experiencing an imbalance between the supply and demand for electricity where the growth in the demand for electricity is constrained by the rate at which new power plants can be built. Cogeneration offers a means of increasing electric generation capacity without additional construction of central power stations. It can be an alternative to conventional electric utility generation while at the same time conserving energy. The TTT is now looking to expand its area of attention to the power sector generally and to involve U.S. companies with power sector experience beyond conservation and cogeneration.

Private sector participation is key to the long-term success of AID's strategy in many areas. In AID's work in the power sector, the involvement of the U.S. private sector is particularly crucial as they can provide technical expertise and training to assist AID-assisted countries. There are also opportunities for U.S. companies to finance, design, equip, install, and run energy projects while training and transferring technology to developing countries.

First Meeting

At the first meeting of the Technology Transfer Team in Washington, DC on February 5, 1986, ECSP staff and officials from AID, introduced this concept to a group private U.S. companies interested in business in developing countries. This first meeting had three objectives:

1) to provide team members with background information on the program and its goals

2) to review the search for promising project opportunities in developing countries

3) to establish a work plan for the future.

ECSP staff presented team members with information on several studies then underway to analyze cogeneration technology transfer opportunities in AID-assisted countries.

Second Meeting

At the second meeting the Technology Transfer Team on June 24, 1986 ECSP staff and officials from AID discussed with the participating U.S. companies the most appropriate ways for them to participate in the emerging cogeneration markets, especially in Asia. The meeting began with a presentation on the cogeneration market in several AID-assisted countries (Pakistan, Thailand, Indonesia, Dominican Republic, Ecuador, and Costa Rica).

The presentation was based, in large part, upon the findings of the AID-sponsored assessments of cogeneration and private sector power production potential, impediments, and policy issues in Pakistan and Thailand. The setting for cooperation between the U.S. private-sector and developing countries is particularly attractive in Pakistan. The Government of Pakistan encourages joint ventures, and the funding available from international aid and development organizations is more than sufficient for modest projects.

Thailand also presents significant possibilities for cooperation in cogeneration. Approximately 600-940 MW of cogeneration and small-scale power generation systems could be built by the private sector over the next 10 years at costs competitive with utility electricity prices. Approximately 377 MW of private industrial cogeneration already exists in Thailand.

At their June meeting, TTT members also discussed barriers to U.S. private sector participation in emerging cogeneration markets. They stated that the major constraint is the difficulty U.S. equipment manufacturers have competing in overseas markets. "Our components have not been price competitive," explained one engineering firm executive. "It is tough to compete with the European and Japanese machines, especially in the market for larger power systems." Another team member noted, "The international consortia that bid against the U.S. are much better at bringing their projects on-line below cost and ahead of schedule." The higher cost of U.S. equipment stems partly from the higher cost of manufacturing in the United States, and partly from the government subsidies and special financing support available to competitors in Europe and the Far East.

TTT members talked about steps that could be taken to improve the competitiveness of the U.S. industry and their ability to cooperate with companies in developing countries. Among the more promising options identified were:

- Focusing on either smaller, "packaged" power systems or forming joint ventures to minimize the installed costs of medium- to large-scale power systems
- Improving private sector access to innovative financing
- Focusing on specialized technologies or situations ("market niches") where U.S. companies have specific advantages and expertise
- Receiving better market and project information.

TTT members were optimistic about the success of their efforts. According to one cogeneration equipment manufacturing executive, "U.S. equipment manufacturers and developers definitely have an advantage over our competitors in certain areas. The U.S. has the largest cogeneration capacity.

We have a proven track record and the experience and operating capability that other countries cannot match."

Asia Trip

In the fall of 1986 some members of the Technology Transfer Team attended the Asia/Near East Workshop on Energy Conservation and Private Power Generation in Bangkok, toured potential cogeneration sites, and visited with officials in Thailand and travelled on to Pakistan. In all TTT members held discussions with representatives of 13 countries: Egypt, India, Indonesia, Jordan, Malaysia, Morocco, Pakistan, Philippines, Singapore, Sri Lanka, Thailand, and Turkey. Members discussed the potential for private power generation with representatives of these countries and identified several specific potential energy project investments. The Technology Transfer Team found that there is an awakening interest in many AID-assisted countries in private power generation investments and particularly in cogeneration.

Third Meeting

At the TTT's third meeting on January 28, 1987, members expressed strong interest in forming joint ventures with counterparts in AID-assisted countries and the potential for power sector activities in the Latin American and Caribbean region, where U.S. manufacturers are well positioned to enter the market. To begin the meeting, ECSP staff presented an overview of the TTT's principal objectives, activities, and lessons learned over the last year. Next, the most recent private power assessments in India and the Dominican Republic were reviewed and updated information on the situation in Pakistan was presented to the team. Each member expressed his opinion on the future direction of the TTT and identified the major needs, issues, and obstacles.

Future activities

AID believes that Technology Transfer Team's efforts can promote independent initiatives between the U.S. private sector and private industries in developing countries. At recent informal survey of the individuals who have participated in TTT activities to day brought forth the following comments:

- "It is difficult for firms such as ours to identify the kind of project/business opportunities that have been discussed at TTT meetings. A working group is a good vehicle to gain such information....specific opportunities are being pursued in

the private sector of one country on the basis of information gained at TTT meetings."

- "TTT is the first serious commitment my company has ever made to exploring investment opportunities overseas. There is now an appreciation within the company that cogeneration market opportunities do exist that are worth pursuing. Information and insights gained from TTT participation are being factored into corporate planning; personnel are being allocated on the basis of identified leads. We are more likely to pursue opportunities in this hemisphere than Asia."

- "My company is involved in a self-financed market study on the cogeneration potential in Asia. I found it very helpful to be able to compare results discussed at the TTT meeting with our own work."

- "The principal benefit has been learning about projects that we otherwise would not have known about and also learning kinds of information about potential clients that only come from first hand contacts. The meetings have provided a good understanding of the specific needs of potential clients, especially the January meeting. Our overseas personnel are following-up on leads gathered at TTT meetings. The reports distributed have been of good quality and provided valuable background and market information."

Future activities of the Technology Transfer Team include a plan trip to Jamaica and the Dominican Republic to explore private power activities in those two countries, meet with key officials in the public and private sectors, and visit some project sites. Members of TTT will also be asked to participate in the planning for a Caribbean and Central America regional workshop on private power issues tentatively scheduled for the fall.

The next meeting of the TTT is tentatively scheduled for the week of September 21st to hear reports on the tour, discuss the agenda for the workshop, to continue discussion of country-specific developments and opportunities, and adapt, if need be, the team's structure and activities to meet changing conditions int he international market place.

(Paper 32)

PRIVATE-SECTOR POWER GENERATION IN DEVELOPING COUNTRIES

Alain Streicher
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ABSTRACT: **PRIVATE SECTOR POWER GENERATION IN DEVELOPING COUNTRIES**

The purpose of this paper is to review the findings of three recent studies on the potential for and impediments to private sector power generation in Pakistan, Thailand, and the Philippines. First, the background of these studies and their objectives are explained. Next, the results of each study are presented, and finally, the implications of the results for other developing countries are discussed.

Under the sponsorship of USAID, studies on private-sector power generation in Pakistan, Thailand, and the Philippines have been completed to date and a study is under way on India. These studies concentrate on industrial cogeneration and power generation using domestic resources such as agricultural waste or locally available fossil fuels. However, during the early stages of these studies it was recognized that there is no reason to exclude the private sector from the installation and operation of large-scale power plants. In fact, negotiations on private-sector operation of large plants are under way in Pakistan, India, and Thailand.

There is a sizable potential for private-sector power generation in developing countries. Industrial cogeneration and power production from waste fuels such as bagasse and rice husks represent the most attractive options for small scale power systems. Since over 50 percent of demand for electricity in developing countries comes from the industrial sector, development of cogeneration opportunities could substantially reduce the overall growth in electricity demand. The potential for industrial cogeneration in most developing countries is 10-15 percent of current national electric capacity. About half of this potential is in plants that will be built in the next 10 years. Because of the importance of agro-industries, there is substantial potential for biomass-based power generation in almost all countries in the region.

Among the paper's conclusions is the view that there is a sizable potential for private-sector power generation in the three countries studied and that each country is interested in promoting private sector involvement in power generation.

Streicher, Sharafi

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EXCHANGE RATES AS OF MID-1986

Country	Currency	Rate for 1 U.S. Dollar
Pakistan	Rupee	16.5
Thailand	Baht	26.5
Philippines	Peso	25.0

PRIVATE-SECTOR POWER GENERATION IN DEVELOPING COUNTRIES

OBJECTIVE

The purpose of this paper is to review the findings of three recent studies on the potential for and impediments to private-sector power generation in Pakistan, Thailand, and the Philippines. First, the background of these studies and their objectives are explained. Next, the results of each study are presented, and finally, the implications of the results for other developing countries are discussed.

BACKGROUND

Most developing countries are experiencing severe power shortages that hamper their development plans and economic activities. Among Asian countries, for example, the Philippines has a power shortage of about 8 percent of demand, Pakistan, over 25 percent, Bangladesh, about 20 percent, and India, 15 percent. Since the electric utilities in developing countries are owned and operated by the government, the countries' power expansion requirements have become a major financial burden to the national budget. In most developing countries, over 20 percent of the development budget has been devoted to the power sector, a proportion that represents more than 60 percent of the budget for all energy activities. Moreover, because much of the capital invested in the power sector is borrowed from the international market, the government's ability to raise funds for other development activities has been drastically curtailed. In many countries, outstanding loans for the power sector represent over 40 percent of the national foreign debt.

The utilities in most developing countries have been facing increasing operational, financial, and technical difficulties. In many utilities, the availability factor -- defined as the fraction of time that a power system is capable of operation -- is less than 60 percent, compared with an average of over 85 percent in the United States and other industrialized countries. And the transmission and distribution losses in the power systems of most developing countries are over 20 percent, compared with under 8 percent in the United States. Finally, utilities in developing countries are unable to raise enough revenue to recover their operating expenses. As a result, they have become major sink holes of government subsidies. Under these circumstances, utilities can neither effectively expand their generating capacity nor keep pace with the growing demand for power.

Pirooz Sharafi, Alain Streicher

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The industrial sector in developing countries has been especially affected by power shortages. In some countries, industry receives only 20 percent of its power needs during the demand peak season. The loss of production because of power cuts, estimated at over one order of magnitude higher than the actual cost of power, has considerably slowed industrial growth in many countries. In many regions of developing countries, industrial expansion is delayed because new factories can rarely obtain a tie-in to the grid. To reduce the impact of power shortages, many firms are installing small, inefficient diesel generators that use expensive imported fuels. Such a practice only increases the country's dependence on imported petroleum products. Furthermore, to the extent that the generators are imported, they adversely affect the country's trade balance.

One way of alleviating power shortages in developing countries, and reducing the financial burden of power-sector expansion, is to involve the private sector in power generation. To begin with, the private sector has an incentive for such involvement: it is directly affected by the power shortage situation. In addition, the private sector has a greater ability to attract technical, managerial, and financial resources than the public sector. Third, the private sector is interested in power generation activities because of the large market and the potential for growth. Finally, the private sector can take advantage of some power generation opportunities that lie outside the traditional scope of electric utilities, e.g., industrial cogeneration and small-scale power generation facilities based on agro-industrial waste.

In addition to adding to the power supply capacity of a developing country, the involvement of the private sector in power generation activities can have far-reaching effects on the energy situation and the overall financial operation of the power sector. The more efficient use of energy resources and the exploitation of nonconventional indigenous energy sources can reduce a country's dependence on imported fuels. Furthermore, since the private sector is unlikely to undertake financially unjustified activities, it can achieve a higher operating efficiency, reducing the need for government subsidies. Finally, private-sector power generation will introduce long-missing competitive forces into the electric utility structure of developing countries and will act as a strong incentive for improved utility operation.

With this background, the AID Bureau for Asia and Near East (ANE) has initiated country-specific studies of the potential for, and impediments to, private-sector power generation. These studies are part of a broader AID effort to promote the privatization of energy systems in Asia and is supported by the Bureau of Science and Technology, Office of Energy. The objectives of these studies are:

(1) To identify the potential for private-sector power generation from cogeneration and power-only systems, with emphasis on renewable and indigenous energy sources

(2) To identify the technical, financial, and institutional impediments to private-sector power generation

(3) To develop recommendations and an action plan for addressing the impediments to private-sector power generation.

The results of these studies are expected to provide an impetus for further development of such power generation possibilities, not only by the governments of developing countries but by the international development organizations that have traditionally supported government-owned electric utility operations and by the manufacturers of power equipment.

REVIEW OF STUDY FINDINGS

Under the sponsorship of AID, studies on private-sector power generation in Pakistan, Thailand, and the Philippines have been completed to date and a study is under way in India. These studies concentrate on industrial cogeneration and power generation using domestic resources such as agricultural waste or locally available fossil fuels. However, during the early stages of these studies it was recognized that there is no reason to exclude the private sector from the installation and operation of large-scale power plants. In fact, negotiations on private-sector operation of large plants are under way in Pakistan, India, and Thailand.

For each study, a team of utility, industry, and energy experts visited the country, conducting interviews with representatives of the government, utilities, industry, financial institutions, and various private-sector entities to learn the views of the parties involved in the country's power sector. In addition, the study team collected information by reviewing existing literature and conducting interviews with members of energy research organizations in the country. To estimate the industrial cogeneration potential, the team used a proprietary computer model developed by Hagler, Bailly & Company. A detailed description of this model is presented in Appendix A.

To determine the relative attractiveness of the various private-sector power generation options, three sets of numbers were developed: the technical potential, the economic potential, and the financial potential. For each power generation option, the technical potential is the amount of generation capacity that can be developed given the current and expected state of the technology and the availability of the natural resource the technology uses. This potential is largely a resource-limited number. The economic potential is the portion of the technical potential that, when developed, will have electricity costs lower

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than the marginal production cost of electric utilities. In determining the production cost of electricity, this analysis uses only the true economic costs and benefits; it factors out transfer payments such as taxes, duties, and profits, which do not represent actual costs but rather shifts of resources from one sector to another. Similarly, the financial potential is the generation capacity that, when developed, has costs below the financial cost of power provided by utilities. The financial analysis looks at the project from the viewpoint of the investor. It determines the cash flows of a project using market values for capital costs, labor, and materials. It incorporates taxes, duties, profits, and other transfer payments explicitly, and determines the actual returns to the investor.

Pakistan*

Pakistan's economic and social development is currently constrained by an electric power deficit of 1,500 MW, or about 38 percent of the national firm capacity. This deficit is expected to grow to 3,000 MW by the end of the Seventh Five-Year Plan (1993) if drastic measures are not taken. As a result, the Government of Pakistan has placed high priority on programs aimed at reducing demand and increasing generation capacity.

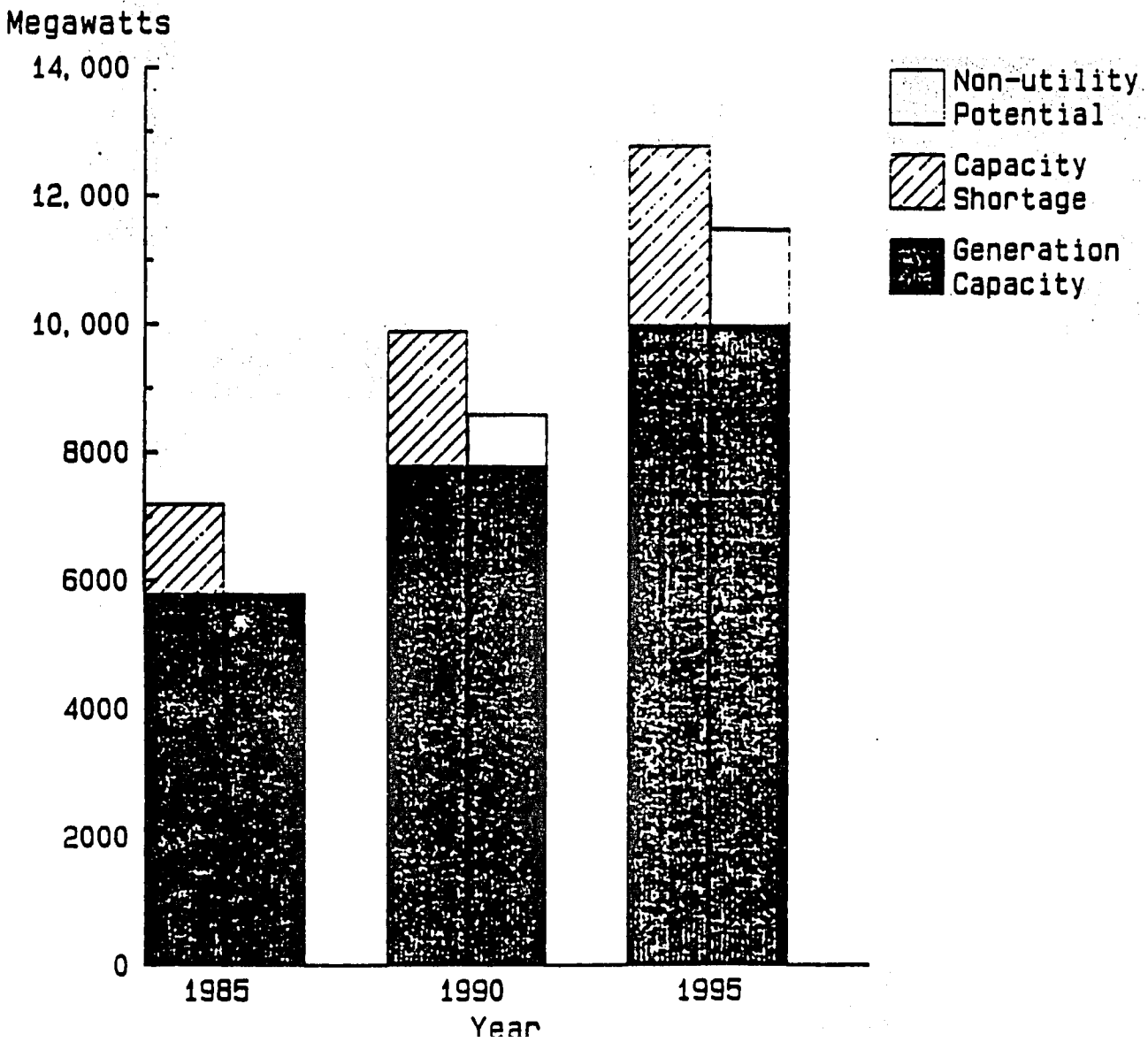
With respect to generation, the country's two utilities -- the Water and Power Development Authority (WAPDA) and the Karachi Electric Supply Corporation (KESC) -- expect to install a total of 500 MW of new generation capacity each year until 1990, which is the maximum they are likely to achieve given current financial and institutional constraints. However, the 5-year investment program of WAPDA, which controls over 80 percent of current generation and distribution in Pakistan, may be cut because of local currency shortages. If this reduction occurs, WAPDA may not be able to install more than 1,200-1,500 MW of new capacity before 1990, which would have the effect of increasing the generation deficit from its current level of 1,500 MW to more than 2,000 MW (see Exhibit 1).

Even if the demand reduction and generation facility improvement and construction programs are successful, a substantial power deficit for several months of each year is expected for the foreseeable future unless additional generation capacity is brought on line.

* The Pakistan study was carried out by a joint team from Hagler, Bailly & Company and Arthur D. Little.

Exhibit 1

Generation Capacity, Power Shortage, and Non-utility Generation Potential in Pakistan



Source: Hagler, Bailly & Company

23x

Potential

In Pakistan, the study team evaluated the potential for private-sector power generation from industrial cogeneration and from power-only facilities using natural gas and coal, as well as from small hydro plants and systems using renewable energy resources. The team found that the private sector could play a major role in reducing current and projected shortfalls in electric generating capacity. Cogeneration and small-scale power could potentially grow to approximately 2,500 MW over the next 10 years (see Exhibit 2). Of this potential, approximately 750 MW could be installed by 1990 and 1,600 MW could be in place by 1995 or 16 percent of the expected total utility installed capacity.

The industrial cogeneration potential is estimated at 425 MW in existing facilities and 765 MW in facilities that could come on line by 1995. On average, new plants account for almost all the potential, and privately owned plants account for 65 percent. Cogeneration systems that use natural gas as their fuel will offer the lowest cost approach for generating power, primarily because only one-third of the fuel cost is attributed to power generation, with the remainder attributed to process heat needs. The electricity from gas-fired cogeneration systems is estimated to cost 40-70 Ps./kWh* (2.5¢-4.4¢/kWh). In contrast, the cost of utility-supplied electricity to industry is about 95 Ps/kWh.

The potential from gas-fired turbines is estimated at 625 MW, with the electricity from such systems costing about 60 Ps./kWh (3.8¢/kWh). This estimate assumes that the gas used will be low-Btu gas from dormant (low-quality, non-pipeline) gas fields and associated gas from oil fields (see Exhibit 3).

The potential generating capacity of small-scale hydro plants is estimated at 550 MW, with electricity costing about 60 Ps./kWh (3.8¢/kWh). Policies that would give the private sector access to the barrages (small irrigation dams) would enhance the prospect of this option.

The generation potential of small-scale coal-fired systems is estimated at 35 MW, given the current low coal production level and the need to site such systems where there is a concentration of coal to keep transportation costs low. In addition to the domestic energy sources cited above, only bagasse and cotton waste are likely to make a substantial contribution to small-scale power generation.

Large-scale private power plants using imported oil or coal could add several hundred megawatts to the total potential, although it would be expensive in

* 1 U.S. dollar = 16.5 Rs and 1 Rs = 100 Ps. as of mid 1986.

Exhibit 2

Private Sector Power Generation: Preliminary Estimate of Financial Potential and Possible Development, Excluding Oil-Based Systems (MW)

A. INDUSTRIAL COGENERATION*	POTENTIAL	POSSIBLE DEVELOPMENT	
		by 1990	by 1995
- Existing Facilities	425	100 (25%)**	40 (50%)
- New Facilities	765	230 (30%)	500 (65%)
B. OFF-SITE			
- Gas	530-715	185-250 (35%)	370-500 (70%)
- Coal	25-50	13-25 (50%)	25-50 (100%)
- Hydro	400-700	120-210 (30%)	280-490 (70%)
- Other Renewable	50-100	12-25 (25%)	25-50 (50%)
TOTAL (rounded):	1,195-2,755	660-840	1,410-1,800
Average	2,500	750	1,600

*The cogeneration figures were generated from a market penetration model. The off-site estimates are based on more qualitative procedures.

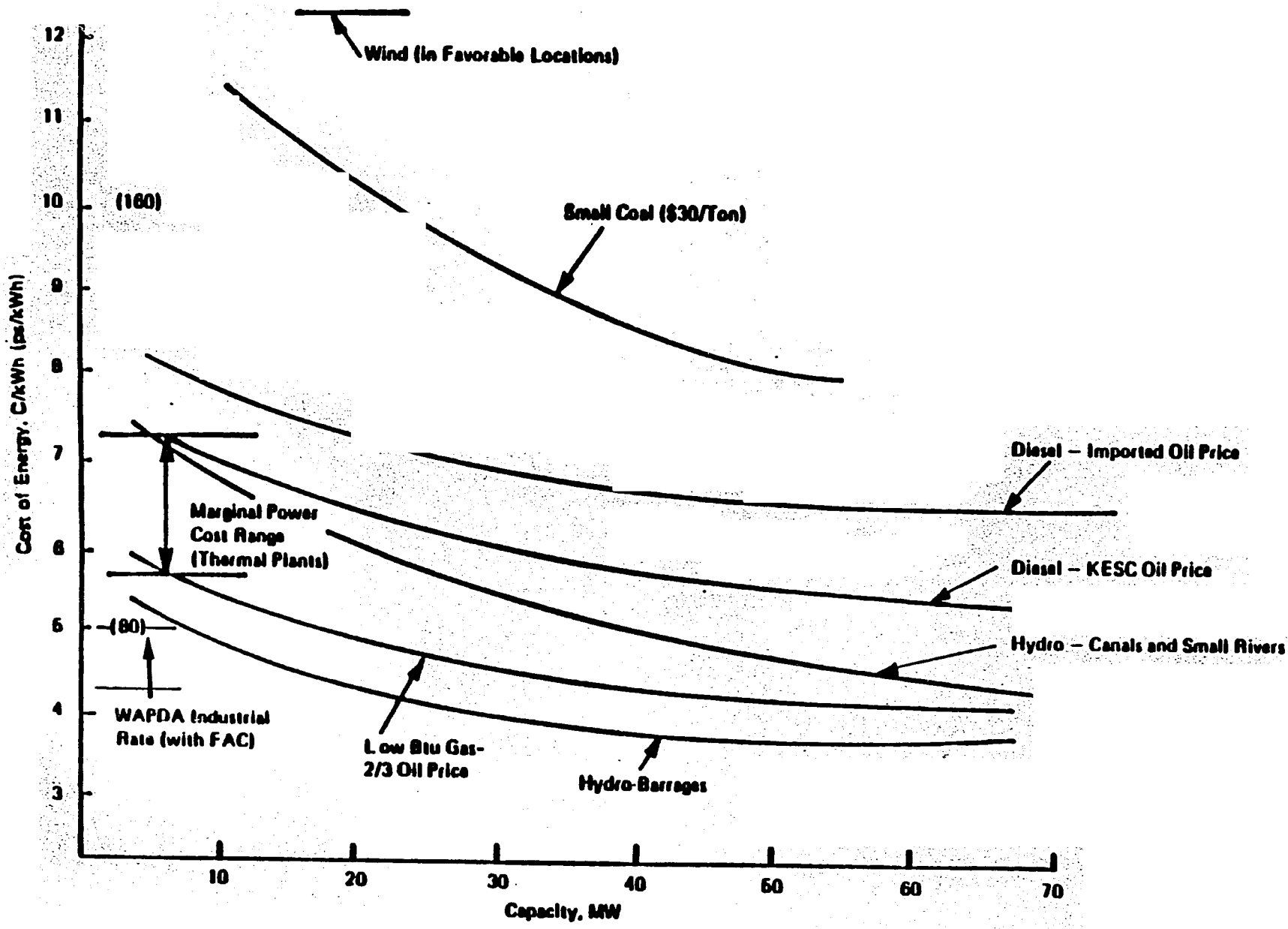
**Estimated market penetration rate.

Source: Hagler, Bailly & Company

25x

Exhibit 3

COST OF ELECTRICITY FROM PRIVATE SECTOR POWER GENERATION OPTIONS



Source: Arthur D. Little

terms of foreign exchange. Oil-fired generation systems using efficient diesel engines can range in capacity from five to several hundred megawatts. Private installation and operation of such systems would provide much needed operating capacity quickly, providing power that could be sold profitably at rates below or near the utility's own cost of new thermal power generation (see Exhibits 4 and 5).

Achieving the 1,600 MW potential of small-scale private-sector power generation in Pakistan by 1995 will require a total capital investment of $1.9-$2.5 billion, depending on the size and type of facilities installed. Of that investment, approximately 46 percent will be in domestic currency, and 54 percent in foreign currency.

Issues and Impediments

The key players in the development of private-sector power in Pakistan are the private sector, the utilities, and the government. In the following paragraphs, each group's views and perceptions of private-sector power generation are presented.

Representatives of the private sector in Pakistan said that there were sufficient private financial resources to develop the country's power generation potential as long as sufficient economic incentives are provided. The private sector has already demonstrated its ability to work with foreign interests and obtain favorable financing for similar projects using such mechanisms as vendor credits. Furthermore, the private sector is already active in power generation. It is in the process of installing an additional 50-100 MW of on-site power, including some cogeneration units, which will bring the total private industrial generation capacity to roughly 550 MW. The private sector is also interested in the development of large-scale power plants for the sale of electricity to the utilities. Recently, for example, over a dozen private-sector firms submitted proposals for a 120 MW power plant at Hub Chowki in Sind Province.

The private sector, however, feels that a large private power generation industry would be a dramatic departure from historical Pakistani and international practice. It thus seeks a demonstration of the government's commitment to such an industry. In addition, private-sector parties are concerned about the price that the utilities would pay for the electricity over the life of the power plant.

Staff from the electric utilities -- WAPDA and KESC-- have concerns of their own. First, on the basis of their experience, they expressed doubts about the technical ability of the private sector to operate and manage power units of any size. In addition, they think that the need for large profits will push private power prices too high to be acceptable. Finally, WAPDA and

27x

Exhibit 4

Estimates of Avoiaea Energy Costs for Selected WAPDA Thermal Plants

Plant Name	Fuel Type	Heat Rates Kcal/kWh	Fuel Cost Ps./kWh	O&M Cost Ps./kWh	Avoided Energy Cost Ps./kWh
Multan	Furnace oil	3000	46	3	49
Faisalabad ST	Furnace oil	2900	44	3	47
Faisalabad GT	High speed diesel	4000	152	5	157
Shadhra GT1	High speed diesel	4200	169	8	177
Guddu 2	Gas	2600	27	3	30
Hyderabad	Furnace oil	5000	83	6	89

Source: Hagler, Bailly & Company; based on data from WAPDA.

Exhibit 5

Summary of Capital Costs ($/kW) and Capacity Credit ($/kW/Yr) for Alternative Thermal Power Plant Additions

Plant Name	Capital Cost ($/kW)	Construction Time (Yrs)	Plant Life (Yrs)	Levelized Capital Cost ($/kW/Month)
Pipri (210 MW)	916.4	3.5	30	11.3 (178)*
Jamshoro #1 (300 MW)	1,522.4	5.0	30	23.93 (383)
Duki (100 MW)	1,230.0	5.0	30	19.33 (309)
Imported Coal (600 MW)	1,287.4	5.0	30	20.24 (324)
Imported Coal FGD (600 MW)	1,544.8	5.0	30	24.28 (388)
Combustion Turbine (100 MW)	571.1	2.0	25	6.34 (101)

*Numbers in parentheses are in Rs./kW/month.

Source: Hagler, Bailly & Company; based on data from Lakhra Power Feasibility Report, USAID, August 1985.

KESC are concerned that if industrial customers substantially increase on-site power generation, the loss of customers would exacerbate their financial problems. In reality, however, the equivalent amount of power could easily be sold by the utilities to other industrial customers awaiting connection to the grid.

In late 1985, the Government of Pakistan initiated a policy on private-sector participation in power generation that was designed to stimulate the development of large-scale coal- or oil-fired power generation plants. This policy stipulated that:

- The Ministry of Water and Power specify projects for private power generation as well as entertain power supply proposals from the private sector
- The Ministry of Water and Power calculate the power purchase price paid by the utility to the private firm, based on what power production would cost if the utility had made the investment (see Appendix B)
- A suitable return on equity be allowed and the purchase price and quantity of private power sold to the grid be guaranteed, but no fixed return be guaranteed.

This policy is one of the first of its kind to be formulated in a developing country.

Recommendations

The major recommendations of the Pakistan study deal with government policies on pricing, fuel availability, and cogeneration promotion.

There is currently a large potential for generating power from dormant gas as well as recently discovered associated gas. The government should attempt to make these resources available for power generation. In addition, the government should expand its policy on private-sector power generation to include resources other than oil and coal and technologies other than large-scale power facilities.

In addition, the government should undertake electric tariff studies that could lead to further rationalization of electricity tariff structure, thus improving the utilities' financial status and providing a more suitable pricing environment for private-sector power initiatives in the long term.

The Ministry of Planning, in particular, should initiate programs to familiarize both utility and industry decision-makers with cogeneration and independent

power production options. Such a program should consist of seminars, short courses, and tours of cogeneration facilities in Pakistan and abroad. In addition, since cogeneration is the most efficient use of natural gas, the government should permit the use of this fuel in cogeneration applications at those facilities meeting specific electrical and thermal efficiency requirements. The government should develop the details of such a policy and its application to specific technologies.

The government should also develop methodologies to calculate appropriate electricity purchase prices from private producers, taking into account such issues as:

(i) Seasonal variations in the value of power to the utilities and, particularly, the high value of power delivered during load shedding months

(ii) Costs of providing service to remote areas and associated premiums that might be considered for power generated in these regions

(iii) Special incentives for early entry of the private sector into power generation to accelerate the process.

Thailand

Thailand's economy is growing rapidly, as is the amount of electricity that it uses. Between 1961 and 1984, electricity demand grew from 464 GWh to over 18,500 GWh, or from 18 kWh to over 370 kWh per capita. Moreover, demand for electricity is expected to grow by over 6 percent per year between 1985 and 2000.

To meet this growing demand, Thailand's electric power sector has absorbed over 70 percent of total government investment in the energy sector in the past 20 years. The share of investment in the power sector, as a fraction of total government investment, was over 15 percent in the Fifth Development Plan (1982-1986). In absolute terms, government investment in power exceeded $3.4 billion in the Fifth Plan. The amount of government investment needed to meet electricity demand during the Sixth Plan (1987-1991) is estimated at over $3.8 billion. Total generation capacity is expected to increase from its current 6,155 MW (see Exhibit 6 for a breakdown by type) to 10,000-11,000 MW by 1995 (see Exhibit 7).

The growing public debt in Thailand, however, makes it extremely difficult for the government to undertake this high level of investment in the power sector. At the time of the study, the final budget allocation for power was not available but it was clear that large budget reductions were under way.

3/x

Exhibit 6

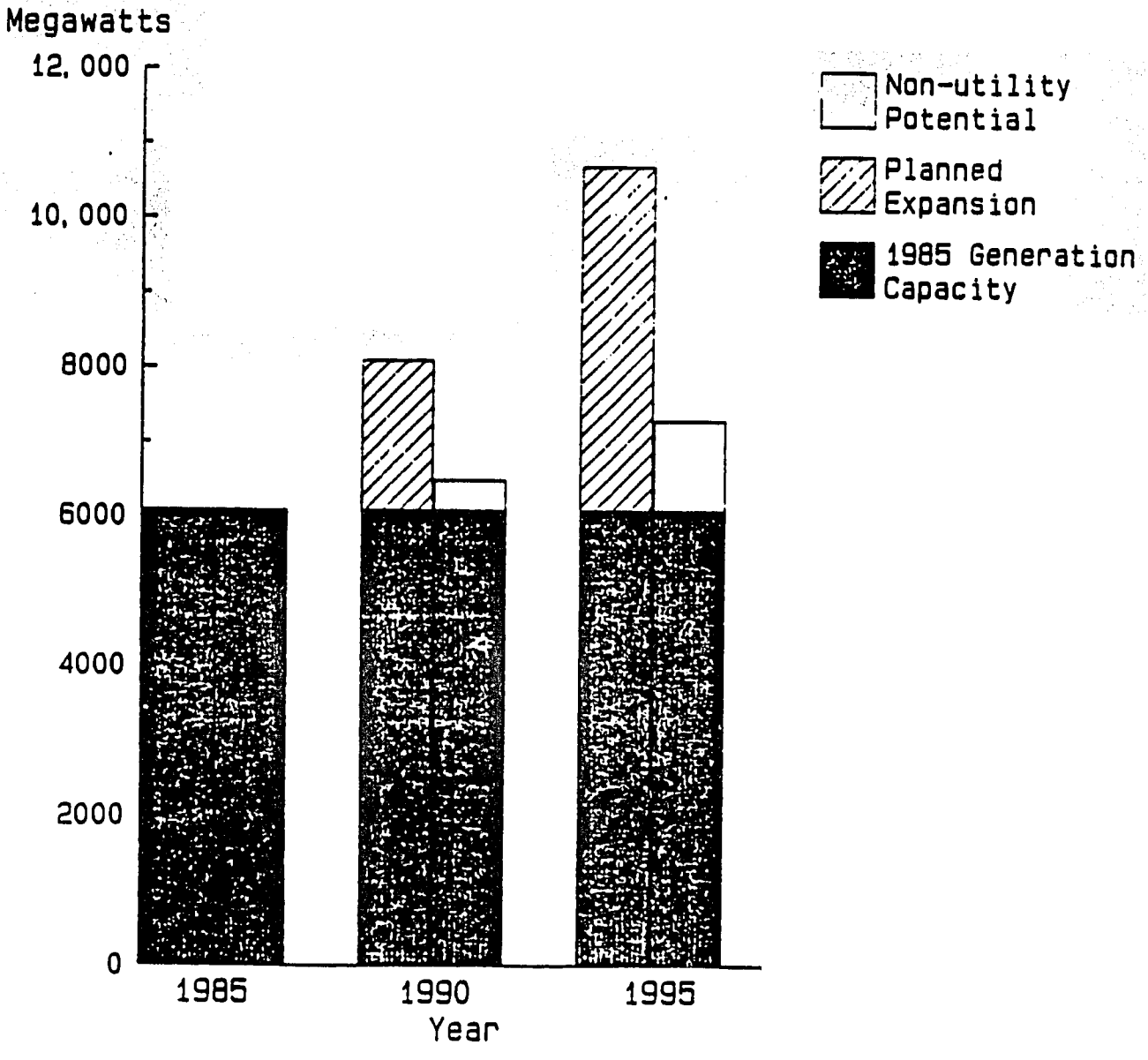
The Electricity Generation Mix of EGAT

Type	Fuel	Installed Capacity (MW)	Dependable Capacity (MW)
Hydro	Hydro	1,809.9	1,533.1
Thermal	Total	3,327.5	3,158.3
	Lignite	585.0	552.9
	Oil	742.5	705.4
	Gas Oil	2,000.0	1,900.0
Combined Cycle	Gas	740.0	684.0
Turbines	Total	265.0	218.5
	Gas	70.0	60.5
	Gas/Diesel	75.0	60.5
	Diesel	120.0	98.0
Internal Combustion	Diesel	33.6	26.9
Total		**6,155.0**	**5,260.8**

Source: EGAT

Exhibit 7

Generation Expansion Schedule and Non-utility Generation Potential in Thailand



Source: Hagler, Bailly & Company

The reasons for such reductions included lower demand growth, a comfortable reserve margin, and the need to reduce foreign borrowing.

In addition, while there are sizable reserves of natural gas, oil, coal, and lignite in Thailand, the expected high cost of exploiting these resources places a question mark over their availability. Thailand's current power generation expansion plan calls for an additional domestic natural gas- and lignite-based capacity of more than 5,000 MW between 1985 and 2005. If the domestic supply of fuels, especially natural gas, continues to be severely limited and costly, new generation capacity beyond the early 1990s would have to use imported fuels. Reliance on imports would substantially increase both capital investment for new generation units and the nation's fuel bill, pushing up electricity costs.

A government study, for example, projects a large increase in the long-run marginal cost of power in the mid-1990s. It estimates that the marginal energy cost will increase from under 1 Baht/kWh in 1990 to about 2 Baht/kWh in 1996, and the capacity cost will rise from less than 1,500 Baht per kW per year in 1990 to over 4,000 Baht per kW per year in 1996 (see Exhibit 8).

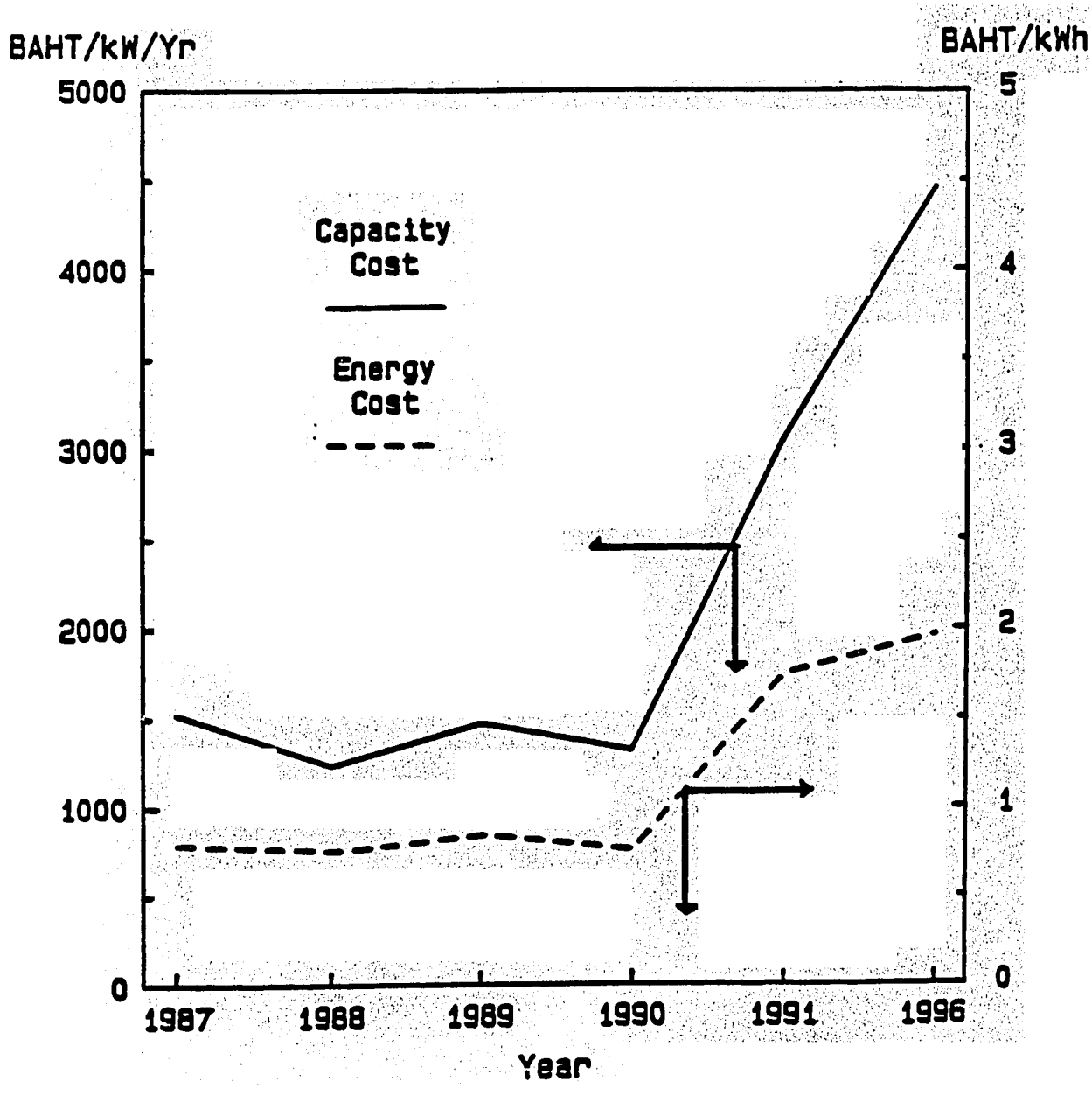
Potential

The results of the study indicate that the economically attractive potential for private-sector power production from cogeneration and small-scale generation systems (less than 50 MW) using indigenous energy resources over the next 10 years is about 1,035 MW, or roughly one-tenth of projected total installed capacity in 1995. Of this potential, about 725 MW could be developed by the private sector at costs competitive with utility electricity prices (see Exhibit 9). Over 300 MW of this financially attractive potential is provided by industrial cogeneration. The rest, over 400 MW, is provided by power generation systems using agricultural waste such as rice husks and bagasse. The study also looked at the potential for power generation using municipal waste and dendrothermal sources.

The study analysis focused only on the direct and obvious economic costs and benefits of each power generation option, ignoring socioeconomic factors such as employment and domestic energy self-sufficiency. Given this caveat, the production cost of power from municipal waste and dendrothermal sources was not competitive with utility-produced power. However, these two resources represent opportunities whose evaluation was beyond the scope of the study. For example, power generation from municipal waste could help resolve long-term waste disposal problems in large urban areas. Similarly, the development of dendrothermal plantations could bring employment opportunities to rural areas and reduce deforestation in the country.

Exhibit 8

MEA's Marginal Cost of Medium Voltage Distribution



Source: Hagler, Bailly & Company; based on data from NEA.

Exhibit 9

Potential Generating Capacity

	Technical (MW)	Economic (MW)	Financial (MW)
Small Power Systems			
Topping cogeneration	483	466	230
Bottoming cogeneration	125	78	78
Small fossil-fueled system	--	--	--
Municipal waste systems	40	20	--
Bagasse systems	980	260	260
Rice husk systems	300	155	155
Small hydropower systems	22,300	55	--
Dendrothermal systems	5,000	--	--
Total, small	29,228	1,034	723
Large Power Systems			
Large hydropower	951	*	*
Large lignite	3,075	*	*
Large natural gas	600	*	*
Total, large	4,626		
TOTAL (Rounded)	33,314	1,034 **	723 **

* The economic and financial potential of large utility-sized systems depends on government policies that have not been defined.

** Does not include the potential for large power plants.

Source: Hagler, Bailly & Company

The study also looked at the potential for private power generation from large plants (over 50 MW), which was estimated at 2,000-4,000 MW before 1996, or more than the generation capacity additions planned by the Electricity Generation Authority of Thailand (EGAT). A number of issues must be resolved, however, before this potential can be realized.

Issues and Impediments

The issues of private-sector power generation in Thailand are very different from those in Pakistan. For one thing, the power supply in Thailand is reliable and the existing power generation capacity is about 25 percent higher than demand. Therefore, availability of power is not an issue at this time. The incentives for private-sector investment in power generation facilities must thus focus on the profitability of such activities and not on the reliability of supply for an existing production activity. The private sector has not yet developed a strong interest in power generation, especially for sale to the utilities. It feels that it cannot generate power at a cost as low as that of EGAT, since it does not have the advantage of economies of scale or fuel availability.

In addition, the private sector will not consider investing in power generation activities unless there is a government policy on the purchase of power.

The electric utilities in Thailand are generally receptive to the idea of private power generation and are willing to purchase power from such units. In the absence of a precedent, however, they are not certain how such transactions should be handled. The utilities are also concerned about a few other issues. They tend to share the view that no independent generator will be able to provide electricity, even for its own use, at prices lower than existing utility prices. In interviews, utility representatives often pointed out that a large number of on-site generators in industry are used only for backup purposes. In addition, the utilities believe that because of the high reliability of power from the grid, no private-sector company will be interested in replacing this supply with its own generators.

The utilities also tend to believe that they account for all the power experts. They thus think that the private sector will be hard pressed to find enough experts to install, operate, and maintain generating systems. The utilities indicated, however, that they are willing to purchase power from anyone that can provide it to them at prices below their own generating cost. Although there are no explicit procedures for such transactions, the study team was told by utility representatives that purchase decisions can easily be made on an ad hoc basis.

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The Thai government, faced with a squeeze on capital, is genuinely interested in private investment in the energy sector. However, no policy for private-sector participation in power generation has yet been formulated.

Some government agencies, such as the National Energy Administration (NEA), have been experimenting with the idea of private-sector involvement in power generation. NEA, for instance, has been helping rural communities to develop hydro projects that will generate power for sale to the utilities. NEA acts as a shareholder in such ventures and provides capital and technical assistance. Over the long term, however, NEA will sell its shares to the community, which will be the sole owner and operator of the plant.

The government sees these projects not only as a means of generating power, but of bringing prosperity to rural areas by providing employment opportunities and using indigenous energy resources. For these reasons, the government appears willing to require utilities to purchase power from private generators at prices that reflect the high socio-economic value of these projects. The development of dendrothermal and waste-to-energy facilities, for example, is considered by some government agencies to be socio-economically important which qualifies such projects for special treatment.

With regard to private-sector involvement in large power projects, some government representatives indicated that the government is receptive to the introduction of measures to privatize the electric utilities, if such measures would improve utility operation and financial efficiency. These measures could include selling stocks or bonds to raise capital, or introducing private-sector management into utility operation. However, the government is satisfied with the performance of the electric utilities and does not feel a need for such measures at this time.

Recommendations

The major recommendations associated with the Thailand study focus on the need for a clear government policy on private-sector power generation. In particular, the government should develop a policy designed to promote the development of industrial cogeneration and waste fuel-based power generation. One important element of such a policy would be a definition of the purchase price paid by utilities. Although utilities' current generating costs are lower than those of most nonutility generating options, the power generated from future utility plants is expected to cost much more than utility power does now. These cost increases should be reflected in the price that the utilities are required to pay for power from private-sector generators. Assistance on such issues can be obtained from U.S. electric utilities, which have extensive experience in determining both short- and long-term marginal generating costs.

In addition, the government of Thailand should sponsor a demonstration project with the electric utilities for the purchase of power from sugar mills that have excess generating capacity. Such a project would provide data on the economic and technical characteristics of utility/private-sector power transactions.

The government should also assume a more active role in promoting cogeneration in industries with large steam demand. It should disseminate information to industry on the advantages of cogeneration and should provide technical assistance in designing and operating such systems if they are economically attractive. Under the current import policy, equal duties are charged on imported cogeneration and non-cogeneration systems. Given the potential of cogeneration systems for reducing industrial energy consumption, the government should provide preferential treatment for their importation.

Privately owned and operated large-scale power plants, which are considered a possible option by the government, should be studied as alternatives to traditional utility-owned power plants. Government agencies and committees directly involved in the generation and expansion review process should be provided with clear guidelines to analyze such options. In particular, the relative merits of government-owned versus privately owned plants should be evaluated under similar basic assumptions, including fuel and capital costs.

Philippines

The Philippine economy is highly dependent on petroleum for its energy requirements. In 1984, oil accounted for 60.1 percent of total energy requirements, with the power and industrial sectors accounting for 23.7 percent and 20.1 percent, respectively, of total oil consumption.

Despite the dependence on petroleum products, considerable progress has been made in energy conservation and fuel substitution. Of particular importance are the various initiatives taken by the Bureau of Energy Development (BED) and the Bureau of Energy Utilization (BEU) in cogeneration, including the feasibility study of an agricultural waste-fired cogeneration unit at a Proctor and Gamble plant (P&G-PMC) and a study of the country's cogeneration potential (and grid interconnection) prepared by Stanley Consultants for BED with USAID funding.

The electric utility system of the Philippines consists of the National Power Corporation (NPC), which is responsible for most of the generation, the Manila Electric Company (MERALCO), the major distribution company responsible with NPC for most of the sales to industry, and a number of smaller utilities and cooperatives. NPC has made significant progress in reducing the use of imported oil by shifting to hydro, coal, geothermal, and nuclear electric generation. Oil accounted for 46 percent of the generation mix in 1984,

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but that share is projected to fall to between 20 and 24 percent over the next few years.

NPC's installed generation capacity in 1984 was 5,196 MW, of which 1,798 MW (or 44 percent) were oil-based, 1,654 MW (32 percent) were hydro, 896 MW were geothermal, and 350 MW were coal-based (see Exhibit 10). In addition to the nuclear power station that came on line recently, the expansion program consists mainly of coal and hydro plants, with some oil-fired units (see Exhibit 11).

NPC has two categories or rates: "utilities" and "industries and nonutilities." Demand charges vary from P 13.20/kW to 24.20/kW per month and the energy charge is around P1/kWh (see Exhibit 12). In addition, a fuel adjustment charge is levied.

MERALCO's industrial rates consist of a large "generation charge" of about P 2/kWh (made up of P 1.22 for the basic charge and P 0.8 for losses, franchise tax, and a subsidy) and an "energy charge," including a currency exchange rate adjustment clause of about P 0.3/kWh (see Exhibit 13).

MERALCO's residential and commercial customers are receiving subsidized rates and industry is actually paying for this subsidy. The resulting high industrial rate provides a powerful incentive for the introduction of cogeneration projects to displace electricity purchases.

A recent survey conducted by BEU shows a grand total of 555 MW of industrial electric generating capacity. The survey excluded the coconut and vegetable oil sector, however, which may have sites with generating capacity, including industrial cogeneration capacity. There may also be significant generating capacity at military installations, which were not included in the survey.

According to the survey, current cogeneration capacity is 152 MW, or approximately 27 percent of total capacity. Much of the cogeneration capacity is in the petroleum, sugar, and wood sectors, although little of the capacity in the sugar and wood sectors is connected to an electric utility.

Potential

The study identified the steam topping turbine as the most applicable technology for cogeneration. Diesel engines and gas turbines use distillate or gaseous fuels and are appropriate for cogeneration only in special circumstances.

Exhibit 10

NPC INSTALLED CAPACITY AND GROSS GENERATION BY GRID AND PLANT TYPE, 1980-1984

	1980		1981		1982		1983		1984		
Grid	MW	GWH	MW	GWH	MW	GWH	MW	GWH	MW	GWH	% GWH
Luzon											
Oil-based	2,230	9,173	2,230	8,894	2,230	9,011	2,230	10,145	1,925 (1)	7,787	53
Hydro	556	1,873	556	2,033	856	1,832	1,126	1,274	1,216	2,519	17
Geothermal	440	2,069	495	2,739	550	3,555	550	3,875	660	4,125	28
Coal	---	---	---	---	---	---	---	---	300	224	2
Total	3,226	13,115	3,281	13,666	3,636	14,398	3,906	15,294	4,101	14,655	100
Visayas											
Oil-based	95	304	168	464	202	676	192	719	224	551	47
Hydro	2	9	2	8	2	10	2	9	2	12	1
Geothermal	6	8	6	31	9	31	234	218	234	415	35
Coal	---	---	50	---	50	60	50	111	59	199	17
Total	103	321	224	503	263	777	478	1,057	519	1,177	100
Mindanao											
Oil-based	105	30	141	136	141	329	181	650	149	198	7
Hydro	382	1,620	382	1,683	409	1,909	436	1,681	436	2,636	93
Total	487	1,650	523	1,819	550	2,238	617	2,331	585	2,834	100
Totals											
Oil-based	2,430	9,507	2,537	9,444	2,573	10,016	2,603	11,514	2,298 (1)	8,536	46
Hydro	940	3,502	940	3,724	1,267	3,751	1,564	2,964	1,654	5,167	28
Geothermal	446	2,077	501	2,770	559	3,586	784	4,093	894	4,540	24
Coal	---	---	50	---	50	60	50	111	350	423	2
Grand Total	3,816	15,086	4,028	15,938	4,449	17,413	5,001	18,682	5,196	18,666	100

(1) 305 MW Rockwell Plant decommissioned in 1984.

Source: NPC 1984 Annual Report

Exhibit 11

GENERATION MIX SUMMARY
LUZON AND MINDANAO GRIDS

Year	Luzon Grid, GWh						Mindanao Grid, GWh			
	Hydro	Geothermal	Coal	Nuclear	Oil	Total	Hydro	Coal	Oil	Total
1984	2,519	4,125	224	---	7,787	14,655	2,636	---	---	2,636
1985	2,589	4,325	1,946	856	4,876	14,592	3,070	---	---	3,070
1986	2,829	4,325	1,840	2,715	3,240	14,949	3,648	---	---	3,648
1987	2,834	4,325	1,840	3,001	3,568	15,568	3,847	---	---	3,847
1988	2,961	4,014	1,803	3,258	3,682	15,718	4,225	---	---	4,225
1989	2,961	4,014	1,847	3,530	4,269	16,621	4,526	---	---	4,526
1990	2,961	4,758	1,847	3,530	4,507	17,603	4,688	---	410	5,098
1991	2,961	4,758	1,860	3,530	5,508	18,617	4,688	506	219	5,413
1992	2,961	4,758	3,096	3,530	5,402	19,747	4,688	913	150	5,751
1993	3,116	4,758	3,717	3,530	5,804	20,925	5,799	317	4	6,120
1994	3,116	4,758	5,545	3,530	5,275	22,224	5,799	635	46	6,480
1995	3,116	4,758	5,577	3,530	6,530	23,511	5,799	939	146	6,884

Note: Electric cooperations and private generation not included.

Source: NPC

Exhibit 12

NPC ELECTRIC RATE SCHEDULES

NPC - Luzon Grid
Schedule Effective August 2, 1985

Utilities

Applicable to electric power and energy supplied to electric utilities in Luzon served by NPC.

Demand Charge		Per Month
First	500 kW of billing demand	P13.20 per kW
Next	19,500 kW of billing demand	17.60 per kW
Over	20,000 kW of billing demand	24.20 per kW

Energy Charge		
First	200 kWh per kW of billing demand	P0.9891 per kWh
Next	200 kWh per kW of billing demand	1.011 per kWh
Over	200 kWh per kW of billing demand	1.0353 per kWh

Industries and Nonutilities

Applicable to electric power and energy supplied to industries and nonutilities in Luzon served by NPC.

Demand Charge		Per Month
First	1,000 kW of billing demand	P19.80 per kW
Next	9,000 kW of billing demand	20.90 per kW
Over	10,000 kW of billing demand	22.11 per kW

Energy Charge		
First	1,000 kWh per kW of billing demand	P1.0716 per kWh
Next	9,000 kWh per kW of billing demand	1.0331 per kWh
Over	10,000 kWh per kW of billing demand	1.00001 per kWh

Exhibit 13

MERALCO INDUSTRIAL CUSTOMER SAMPLE BILL
August, 1985

Load (Typical)

Demand	1,000 kW
Energy	438,000 kWh

Energy Bill (per Schedule GP-11)

Generation Charge	
NPC Basic Charge	P 1.2255/kWh
Subsidy, Losses, and Franchise Tax	0.8295/kWh
Total Generation Rate	P 2.0550/kWh
Total Generation Charge	P 2.0550 x 438,000 kWh = P 900,090
Distribution Charge	
Demand Charge @ P 12.60/kW	P 12,600
Energy Charge	
First 200 hours use @ P 0.25/kWh	P 50,000
Next 200 hours use @ P 0.23/kWh	46,000
Next 100 hours use @ P 0.22/kWh	8,360
Next 100 hours use @ P 0.20/kWh	—
Excess kWh @ P 0.20/kWh	—
Total Energy Charge	P 104,360
Currency Exchange Rate Adjustment Clause (16.83%)	19,684
Total Distribution Charge	P 136,644
Total Charge	P 1,036,734
Average Charge	P 2.3670/kWh

The economic potential for oil- and waste-fired cogeneration systems is summarized below:

	Oil	Waste	Total
Cogenerated electricity GWh/yr	1,130	1,570	2,700
Generating capacity, MW	150-190	200-260	350-450
No. of cogenerators	30-40	50-100	80-145
Incremental investment, million $U.S.	180-270	550-825	730-1,100
Payback period, years			5.7-8.7
Annual fuel oil savings, kloe (thousand liters of oil equivalent)	550,000	530,000	1,080,000

Cogenerated electricity would constitute about 30 percent of all electricity purchased by industry. Thus, cogeneration could have a significant impact on energy savings in the Philippines.

With respect to economic feasibility, projects under 3,000 kW would have a higher investment cost per kW, seriously affecting their appeal. However, coal- or biomass-fueled projects of 3,000 kW or more would be economically attractive, assuming a displaced electricity cost of P 2.30/kWh in the MERALCO area. If the displaced electricity cost is as low as P 1.25/kWh (the typical rate for NPC Luzon), only large cogeneration projects would be feasible.

Cogeneration capacity may develop at between 80 and 145 locations, for a total capacity of 350 MW to 450 MW. Average capacity would range from 3.1 MW to 4.4 MW at each location. Over half the capacity would be waste-fired, with the remainder coal-fired.

Issues and Impediments

Although the Government of the Philippines provides incentives for energy conservation and fuel substitution projects (which include cogeneration), there are a number of impediments to their development, including:

- NPC is the only entity that may produce electric energy for public consumption via utility-established grids. Cooperatives and certain

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privately owned electric utilities and industries are permitted to generate electricity and build generation facilities (e.g., P&G-PMC), but are not permitted to produce electrical energy for sale to the public.

The NPC "Rules on the Sale of Electricity" also provide that:

- Interconnection equipment not deemed necessary by NPC for normal installations must be provided by the customer at its own expense.
- Customers cannot connect any equipment that would cause objectionable voltage fluctuations, harmonics, or other disturbances. All equipment must meet applicable safety codes and is subject to approval by NPC.

However, NPC has agreed to assist electric cooperatives and the National Irrigation Administration (NIA) by wheeling energy generated by dendrothermal or mini-hydro generating plants. The agreement reflects NPC's current policies on contracts that permit its customers to sell power to NPC as well as to purchase it from NPC.

During periods when generating capacity is not sufficient to supply all loads reliably, NPC initiates scheduled load shedding, or "rotating blackouts," to maintain service on as fair a basis as possible. Industrial customers' concern about such service interruptions has led NPC to give circuits with large industrial loads a higher priority in the load shedding sequence. Repeated outages may result in the construction of industrial electricity generating facilities, including cogeneration, but improvements in the generation situation would adversely affect such plans.

The effect of NPC's excess generating capacity, particularly in Luzon, is reflected in the latest tariff study (EDF). Since the marginal costs are developed by season and time-of-day, these data are useful in designing avoided cost rates for the utility purchase of surplus cogenerated electricity.

Cogeneration feasibility in the MERALCO area is affected by the rate structures:

- The NPC wholesale rate to MERALCO is based on the energy charge only. It does not include demand charges, which would reflect NPC's capacity cost. In turn, MERALCO's rate reflects only the energy cost, based on the purchase rate from NPC, and the transmission and distribution capacity cost of its system.
- MERALCO's relatively high industrial rates are in part the result of subsidizing the residential and small commercial sectors. The subsidy, which is currently P 0.80/kWh, has a substantial impact

on cogeneration feasibility analyses. An industry that bases its decision to cogenerate on electric savings at MERALCO's current industrial rate may risk future savings. Because the subsidy and resulting rates are not cost-based, they may be subject to arbitrary changes. The subsidy is supposed to be reduced over a 5-year period, but there are no plans to eliminate it.

Recommendations

Based on the data reviewed and the studies conducted, the following recommendations are made on cogeneration development in the Philippines:

1. The EDF study should be used as a source of utility cost data. The capacity and energy cost projections in that study should be updated as necessary for use in establishing utility cost levels and rates for electricity purchases from cogenerators (see Exhibit 14).

2. Government policies should be formulated to include cogeneration and small power production by private entities and small utilities, consistent with present policies on the reduction of fuel oil imports and the efficient use of fuels.

3. Government regulations should be promulgated on the qualifications of independent power producers, including cogenerators; the requirements of utilities regarding interconnection; and the extension of tax incentives on imported cogeneration equipment. Qualifications for an independent power producer should include the efficiency and operating standards of facilities and, in the case of petroleum-based fuel, should require documentation that oil consumption will be reduced.

4. Utilities should be required to offer parallel operation, if safety standards and other qualifications are met, and cost-based rates for the sale of supplemental, backup, and maintenance power to independent power producers, and be required to buy excess power at rates based on avoided costs.

5. The government, through the Board of Investments, should designate cogeneration, along with energy conservation, as a preferred investment, with appropriate incentives for its encouragement.

CONCLUSIONS

The three studies presented above are representative of the situation in most developing countries in the region. At one end of the spectrum is Pakistan, with chronic power deficits and little hope of quick relief from public

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Exhibit 14

NPC MARGINAL POWER COSTS IN REAL TERMS(1)

Grid	Annual Fixed (3) Charges P/kW (4)	Incremental Energy Costs, P/kWh(2) High Season Peak	High Season Off-Peak	Low Season Peak	Low Season Off-Peak
Luzon	1,550	1.1183	0.8958	0.9889	0.6267
Mindanao	1,168	0.6160	0.6160	0.4693	0.4693
Cebu	3,830	1.1416	1.1416	1.1416	1.1416
Negros and Panay	1,575	1.2784	0.6673	1.2784	0.6673
Leyte	1,678	1.1580	0.7006	1.1580	0.7006
Bohol	1,200	1.2936	1.2936	1.2936	1.2936

(1) 1985 used as base. All values shown are for the year 1990 except Mindanao, which is for 1995.

(2) Luzon - high season is February-August, low season is September-January. Peak is 0600-2300, Off-peak is 2300-0600. Mindanao - high season is 1800-2100, off-peak is 2100-1800. Leyte - peak is 1800-2200. Off-peak is 2200-1800.

(3) Does not include losses (2-14%) or diversity (0-20%).

(4) Generation cost only.

Source: EDF Study

utilities. At the other end is Thailand, with excess capacity for the next 4 years and an internationally recognized efficient utility system. Nonetheless, Pakistan, Thailand, and the Philippines all share a common interest in promoting private-sector involvement in power generation, either as a way of dealing with a deteriorating power situation or as a way of reducing public investment in the energy sector and reducing the national debt. In light of the results of the three studies, the following general conclusions can be drawn.

There is a sizable potential for private-sector power generation in developing countries. Industrial cogeneration and power production from waste fuels, e.g bagasse and rice husks, represent the most attractive options for small scale power systems. Since over 50 percent of demand for electricity in developing countries comes from the industrial sector, development of cogeneration opportunities could substantially reduce the overall growth in electricity demand. The potential for industrial cogeneration in most developing countries is 10-15 percent of current national electric capacity. About half of this potential is in plants that will be built in the next 10 years. Because of the importance of agro-industries, there is substantial potential for biomass-based power generation in almost all countries in the region.

With the exception of biomass and small hydro, the potential for renewable-based power generation is almost insignificant under current conditions. The potential for power generation from small fossil-fueled systems is also very small. Only in cases where fossil fuels are available at very low costs could such systems produce electricity at attractive rates. In some countries, however, these resources are available (e.g., dormant gas in Pakistan).

The potential for large scale private-sector power generation is much greater, but a number of issues need to be resolved before the private sector can actively participate in such projects.

So far, the only strong incentive for private sector investment in power systems has been the shortage and unreliability of supply from the existing utilities. Almost all nonutility generated power is used on site, with no sale to the grid or other customers. Only in a very few cases has the private sector constructed a power generation facility to supply power to the grid. The private sector, in general, views power projects as a new line of business and is very cautious about investing in such activities. Major issues of concern to the private sector include the acceptable rate of return on investment, the availability of fuel, and regulations on the financial and technical issues of interconnection to the grid. The private sector would like the government to implement explicit policies to reduce the uncertainty of investing in power projects.

Private-sector power facilities need to rely on utilities for transmission and distribution of power, control of load fluctuations, and back-up power during

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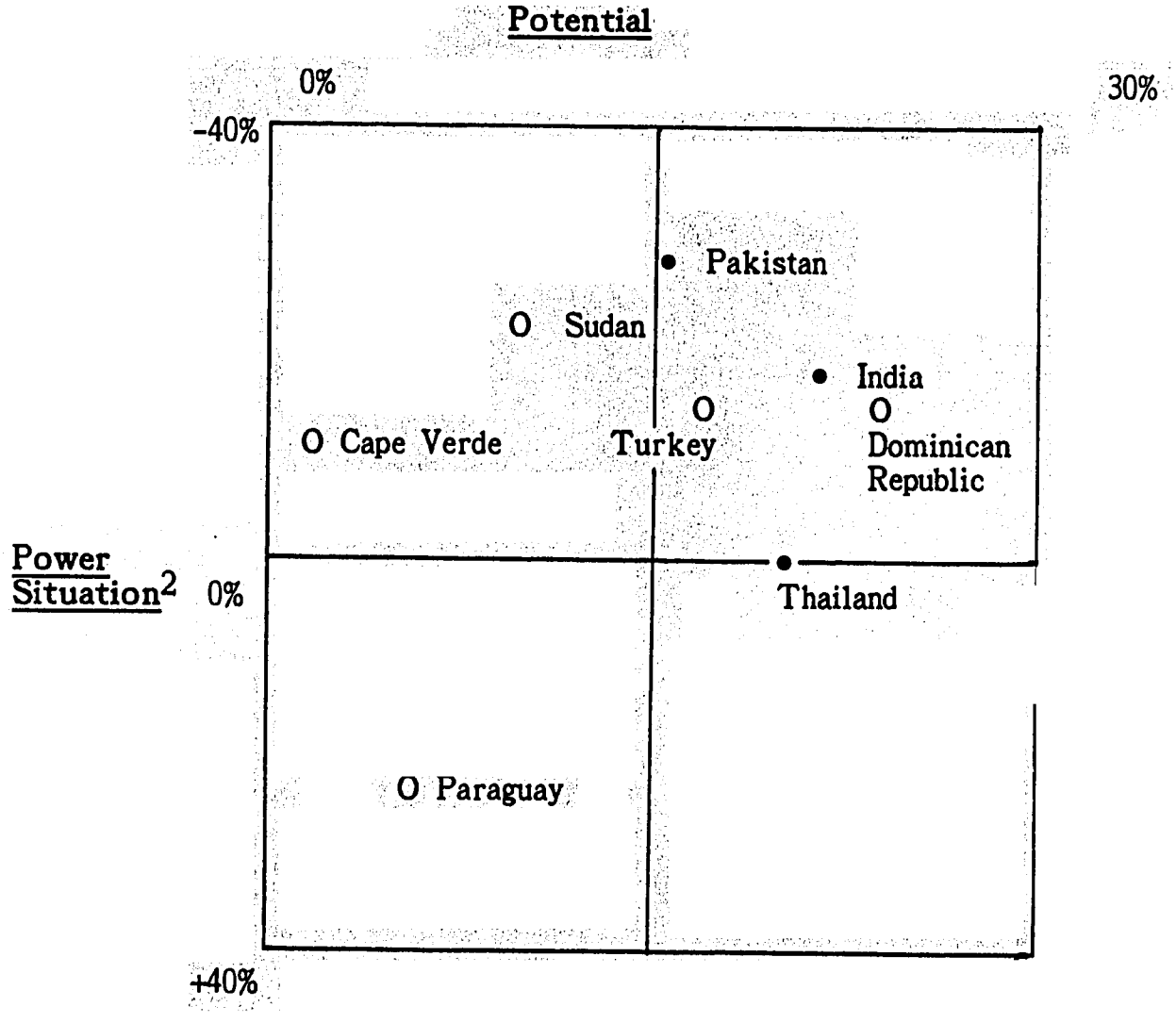
Exhibit 15

A TAXONOMY OF LDCS: EXPECTED 1990 SITUATION



1) Economic potential from cogeneration and small-scale power generation as a percenttage of expected utility installed capacity

2) Expected electricity deficit/surplus as a percentage of expected utility installed capacity (without non-utility options).

scheduled or unscheduled maintenance shut downs. Therefore, the utilities play a key role in the development of non-utility power projects. Many utilities believe that power from private-sector facilities will be more expensive than their own. In addition, utilities question whether there would be sufficient power experts for the private sector. They are also concerned about technical aspects of interconnection and dispatchability of dispersed power generation units. Finally, the utilities are concerned about the possibility of losing their industrial customers if nonutility power options are successfully developed.

Since private-sector power is in the very early stages of development in developing countries, it is difficult to predict the impact these issues may have on the development of private power options. However, three key factors indicate a need for nonutility power generation in many countries: (i) the existence of opportunities, (ii) a power deficit, and (iii) the lack of capital and managerial/technical capabilities within existing utilities (see Exhibit 15). Because of this need, while few countries even considered nonutility power generation 5 years ago, most countries are now either actively promoting it (e.g. Turkey, Pakistan, and the State of Gujarat in India), or are beginning to consider it (e.g., Thailand, the Philippines).

The approach to nonutility power options is different in each country. In countries with a severe power shortage, (e.g., Pakistan) governments are primarily interested in private-sector development of medium- or large-scale power plants that will burn imported oil (e.g. diesel engines), because these will have an immediate impact on power deficits. In these cases, governments tend to be less enthusiastic about cogeneration or renewable-based power options, which, in the long run, would help to alleviate power shortages and increase fuel use efficiency and utilization of domestic resources. In countries with no immediate power shortage (e.g., Thailand), the emphasis is on utilization of domestic resources and higher power generation efficiency through cogeneration. No matter what the approach, a clear government policy on fuel supply availability to private-sector generators, the purchase price for the nonutility power, and interconnection with the grid is needed to encourage such power options.

U.S. PURPA regulations are a useful reference, as most of the provisions could apply to developing countries as well (e.g., qualification, safety, operating conditions, purchase price, role of the utility in providing backup). The major point of debate between governments and the private sector is the appropriate basis for the purchase price. Many governments and electric utilities strongly question the applicability of the concept of "avoided cost" to their countries. Indeed, an "avoided cost-based" policy often appears too generous to the private sector, and the utilities argue that, if they were paid such rates, they too could provide the additional capacity. To prevent the debate from becoming too heated, governments appear to prefer a more

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traditional approach that bases the purchase price on a detailed analysis of the production cost, including a "fair return" to the investor. No windfall profit is politically acceptable in capital-constrained developing countries.

The above conclusions are preliminary, as the studies have not all been finalized. More research is needed to provide developing countries with practical answers to their questions, especially those concerning the methodology for defining the electricity purchase price from a variety of independent producers.

This paper has presented the initial findings of several country surveys and is intended to be used for discussion to improve understanding of the unresolved issues and to accelerate the search for acceptable solutions.

Pirooz Sharafi, Alain Streicher

Over the last few years, Hagler, Bailly & Company has developed a sophisticated computerized data base and set of market assessment models that offer a high degree of realism and flexibility in analyzing industrial cogeneration markets. These models simulate in detail the technology costs and performances, energy prices, and regulatory and tax environment faced by the industrial decision-maker, and the actual decision factors (such as the return on investment) that he uses. Because of this high degree of realism, our models have been used by numerous industrial and government clients.

Exhibit A.1 is a block diagram that depicts the overall model organization. The market assessment process entails four steps:

1. Segment the market
2. Compute life-cycle costs
3. Assess market shares
4. Determine total market size.

SEGMENT THE MARKET

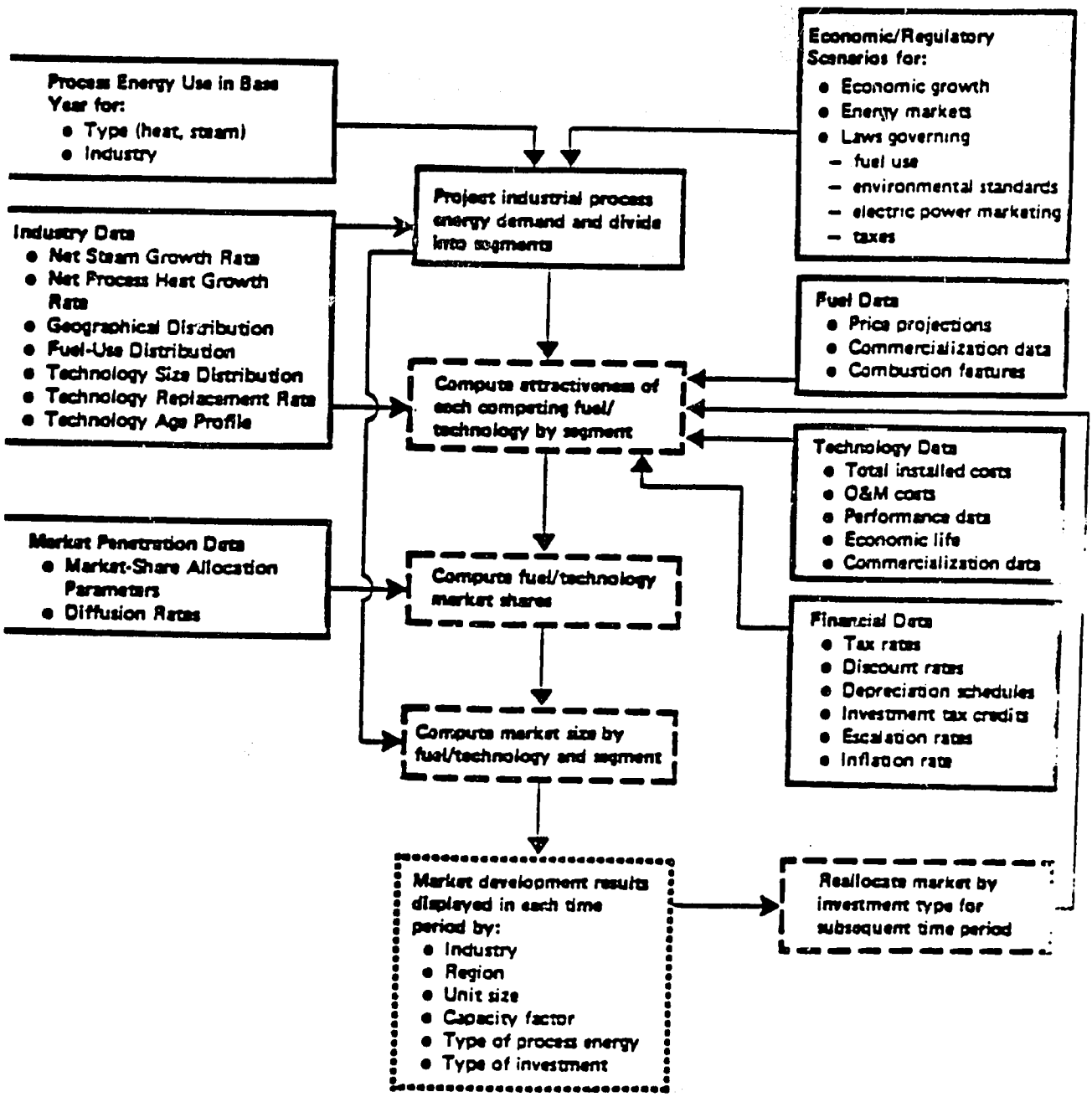
First, we divide the market for industrial steam-generating equipment into segments to examine more accurately the effect of various factors on the selection of steam-generating and cogenerating technology. The total market for industrial steam-generating equipment is disaggregated by the following categories:

- Geographical region
- Industry
- Class of fuel (i.e., purchased and waste)
- Electric-to-thermal ratio
- Boiler size
- Type of investment
- Type of fuel used in existing boilers
- Time period.

For each region, we obtain fuel and electricity prices and develop price projections. We also project steam

Exhibit A.1

Organization of Hagler, Bailly Market Models for Industrial Process Energy Applications



demand by industry and region over the length of the study period. For those industries that use waste fuels (or process residuals) that are not expected to have any significant commercial value, we disaggregate each industry's steam projections into the amount produced by purchased fuels and the amount produced by waste fuels. At this point, we treat the market segments using purchased fuels separately from those using waste fuels. That is, technologies using purchased fuels are allowed to compete only with one another, and technologies using waste fuels are allowed to compete only with one another.

In addition to its steam demand, we characterize each industry by its electric/thermal ratio (E/T) distribution. Such distributions are computed by first analyzing in detail the electric and steam requirements for the most energy-intensive processes within each industry over time, and then by integrating projected process mix changes over time.

We further categorize the projected process steam consumption for each industry/region segment by boiler size. We consider five steam-capacity size categories, e.g.:

1. 25-50 mmBtu/hr
2. 50-100 mmBtu/hr
3. 100-250 mmBtu/hr
4. 250-500 mmBtu/hr
5. Over 500 mmBtu/hr.

Size range is important because the cogeneration technologies considered have varying economies of scale; thus, some are economical only in a limited range of capacities. In addition, not all technologies are available in all size ranges. Finally, regulations such as the Clean Air Act or the Powerplant and Industrial Fuel Use Act affect each size range differently.

We also consider three types of investment for each industry/region segment:

1. New: industry growth in the market segment necessitates the addition of new steam-generating capacity.

2. Replacement: a certain percentage of the 1983 stock of steam boilers will be retired during

each year. This percentage is called the "phase-out ratio." We estimated phase-out ratios for each industry and applied them to the 1983 boiler inventory to estimate the replacement market in each industry/region segment.

3. **Retrofit:** some of the existing boilers that still have useful life may be, on a discretionary decision basis, retired early and replaced with new cogeneration or noncogeneration systems.

To facilitate computation and presentation of the results, the projection period is usually divided into 2-year increments, e.g., 1985-86, 1987-88, etc. The market sizes presented in the output represent sales. The actual installation is assumed to occur 1 to 3 years later, depending on technology, fuel, and system size.

COMPUTE LIFE-CYCLE COSTS

Within each of the segments, we calculate the life-cycle cost for each of the conventional technically feasible and legally allowed boiler and cogeneration technology/fuel options. To do this, the capital costs, annual operating and maintenance (O&M) costs, and performance parameters (e.g., efficiency) of each system are first calculated for each size range in which the system is available. We modify these costs on a regional basis to adjust for the coal types available and for environmental control requirements such as scrubbers.

Next, the after-tax cash flows are determined for the "book life" of the system (20 years). The cash flows are calculated assuming the installation takes 2 years. Investment tax credits and tax depreciation shields are explicitly included (if applicable) when the industrial party would actually benefit from them.

Sales or use of cogenerated electricity is assumed to be handled by the industrial operator in the most economically advantageous manner. For example, if the buyback rate is above the operator's retail rate, all power generated is sold to the utility at the buyback rate while the operator simultaneously purchases his requirements at the retail rate. If the buyback rate is less than the retail rate, the operator uses as much of the

power generated as possible to displace purchased power, and any excess is sold to the utility at the buyback rate.

Financing is assumed to be 100-percent equity. Most industrial firms make this assumption when evaluating cogeneration opportunities. The discount rate (expressed in real terms) usually used is 20 percent for new and replacement installations. A 30-percent discount rate is usually assumed for retrofit installations. These are mean values developed by Hagler, Bailly personnel based on hundreds of interviews with industry decision-makers as well as site-specific assessments of industrial cogeneration opportunities. Different values can, of course, be used.

Once the net annual after-tax cash flows are determined, they are discounted, using the real discount rate (or hurdle rate) to determine the net after-tax life cycle cost for each competing technology in each market segment.

ASSESS MARKET SHARES

Once the life-cycle costs are determined, we evaluate the market shares of the competing technologies for purchased fuels and waste fuels separately using a logistic curve. This curve ensures that technologies having equal life-cycle costs in a particular market segment had equal market shares in that segment, while technologies having lower life-cycle costs than their competitors would dominate that segment, although they would not usually capture the entire segment. This is a more accurate representation of actual market behavior than to assume that the lowest-cost technology captures the entire segment, because site-specific variations in energy prices, capital costs, and process requirements tend to blur the estimated economic differences between the competing technologies.

New technologies entering the market usually face a long diffusion period during which they capture a smaller market share than cost comparisons alone would indicate, because potential purchasers are uncertain of the new technology's operating costs, performance, and reliability. There is also a time lag in disseminating information about a new technology to potential buyers. Our research indicates that between 7 and 15 years are required, after a new capital-intensive energy

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technology is first demonstrated on a commercial scale, before that technology reaches the level of market penetration indicated by costs alone. We often assume a 10-year diffusion period in our cogeneration market studies.

In the retrofit market, each of the technologies must compete against an existing oil-, gas-, or coal-fired boiler. In evaluating the life-cycle cost, the boiler was assumed to have no capital cost, but to have annual O&M and fuel costs. This assumption includes the implicit assumption that the old boiler will be put on standby when the new one is installed, or will have a scrap value about equal to its removal cost.

The result of this step is a projection of the relative market shares of each of the competing technologies in each of the market segments.

DETERMINE TOTAL MARKET SIZE

Next the total market size is determined for each of the investment types: new, replacement, or retrofit. The new market results from additional steam demand that develops during the time period. It represents both new greenfield plants as well as expansions at existing facilities. The replacement market represents that portion of the 1983 boiler inventory that reaches the end of its useful life and must be replaced. It starts at approximately 2 percent of the inventory per year, and increases slightly over the time period of the study. This increase simulates the vintaging of the initial inventory.

The retrofit market is considered to be the existing inventory of distillate oil-, residual oil-, natural gas-, and coal-fired boilers (and waste-fueled boilers for those segments using waste-fuels). Our cogeneration market assessment models use a dynamic allocation between the retrofit and replacement markets during the time period of the study, since boilers retrofitted in one time period will not be available for replacement in subsequent periods (or vice-versa).

The demand for steam-generating equipment in each market segment is then multiplied by the market share for

each technology to project sales volume* for that technology in that segment. Projected sales are converted to installed megawatts and summed by region, industry, size, investment type, and time period.

*Sales volume measured in steam generating capacity.

DISCUSSION

Questions were directed to the author of the paper, Mr. Alain Streicher, Hagler, Bailly & Company:

QUESTION:

What fuel were you relying on to be available for your estimates? Could you also say a few words about the possible use of natural gas for cogeneration in Thailand and Pakistan? In the U.S. case, as you know, natural gas has been the major fuel used for expanding the cogeneration potential.

MR. STREICHER:

The cogeneration market we analyzed in India was looking at a number of fuels, both commercial fuels and non-commercial fuels. Commercial fuels included different types of oil (diesel and heavy oil), natural gas where available, coal, and lignite eventually. The non-commercial fuels included bagasse, waste in the pulp and paper industry, and so forth. As far as the natural gas is concerned, we broke down the availability of natural gas depending on the region and the industries. It's always site-specific and country-specific. For example in the case of India, in the State of Gujarat some natural gas would be available to some industries, such as fertilizers, but likely not to others. So we had to take that into account.

In the case of India again, we ran two different scenarios looking at the impact of having natural gas available versus not available. And of course, the results are drastically different. At today's costs and the performance of cogeneration technologies, gas turbines and combined cycle systems are the lowest cost solution, especially if natural gas is priced below its opportunity cost which is very often the case in developing countries.

COMMENT:

I would like to make a few observations on the Pakistan situation. One of the reasons for the high profit up front is the unfortunate history of expropriation and nationalization that took place in Pakistan in the 1970s. At that time many of the local, privately-run power distribution operations were

nationalized. So, it is a very understandable concern on the part of Pakistani entrepreneurs who want to get in to the power business to want to get as much out as soon as possible, especially given the high capital requirements.

Secondly, gas capacity in Pakistan is load shedded to industrial consumers during the December to February period.

Furthermore, it is current policy in Pakistan (which continues to endure for numerous reasons) that there is a flat-out embargo on the use of any good natural gas for power. They have shifted from using gas in the cement industry to oil. So, that's part of the problem.

Also in Pakistan there is an absolute embargo still (which is one of the problems we are going to face there), against such things as being able to sell net power across-the-fence or being able to wheel power from one producer down the line using the existing distribution and transmission system to another industrial consumer. These are some of the problems that in fact are not part and parcel of the policy which you mentioned but which continue to come up and indicate the concern of the utility over losing their prime industrial customers.

I would like to add that Pakistan has not only announced its policy but has gone out with a very firm solicitation for one project, the Hub Chowki project. On Hub Chowki we have so far gotten a very good response. There have been thirteen firm proposals submitted for that 120 megawatt gas-fired, diesel facility.

So, it looks so far in the case of Pakistan to be a very exciting and promising situation.

I am curious to what extent, when you went to Thailand or India, for instance, the issue ever came up of the need for power development boards. Did the idea ever come up to give special attention to stand-alone, non-utility applications where there is no problem with interconnection or technical problems in managing the overall system? To what extent were the public utilities concerned that if private sector gets going the public utilities will lose all of their best staff to the private sector?

MR. STREICHER:

In India each state has its own state electricity board which is basically responsible for the local electric activities in the state The state of Gujarat is facing a large power deficit, but they have been able to promote a policy, which is not really as official as that of Pakistan, but which allows the private sector to generate its own power. Not only private sector, by the

way, they are also allowing publicly-owned enterprises to group themselves to develop a power station from which they share the power produced.

Now, five very large industrial concerns in Gujarat are building a 120 megawatt power plant, and the local grid will be used to wheel this power to each one of the five owners of this power plant. Also a number of private entities have been coming forth to generate power and to sell it to the grid.

MR. V. RAGHURAMAN, NATIONAL PRODUCTIVITY COUNCIL, INDIA:

Thirteen years back, we made a quick study, and we identified a potential of 1500 megawatts. Today the estimate is closer to 6000 megawatts. The studies could be further refined.

The point is, however, that all the government asks (when you go for subsidies or some sort of concessions apart from the issue of paralleling or other technical problems) is what will the cost be per megawatt. One megawatt is costing now, let us say ten million rupees for generation per megawatt, and ten million rupees for transmission/distribution. The government will say even if you're working at fifty percent capacity, suppose it costs the government about forty million rupees, will you be able to generate this one megawatt out of cogeneration with this comparative investment?

There are two different problems. One is the problem of the energy crunch and the other is a resource crunch. If the private sector goes for large scale sets and efficiencies comparable to those of the utilities (even utilities working at fifty percent capacity) and if they are able to show the same kind of benefits from their investments, then of course this is not a problem for the government. But in most of the private power projects, what happens is that we are looking at small systems. We are looking at systems that are not going to operate throughout the year, as with sugar or others because the energy source is seasonal.

So the point is to make these numbers more realistic and to define the real investment opportunities. This will make it easier to define what the government can practically do to help.

CURRENT DEVELOPMENTS IN NON-UTILITY POWER GENERATION IN PAKISTAN, INDIA, AND THAILAND

The objective of this paper is to review the current activities in non-utility power generation in Pakistan, India, and Thailand.

PAKISTAN

Non-utility power generation in Pakistan is developing at a rapid pace. Following the government's policy to allow private power generation, in 1985, a large number of candidate projects have surfaced. In the following paragraphs, some of these projects will be briefly discussed.

Hub Chowki

In 1986, the Karachi Electric Service Company (KESC) of Pakistan requested for proposals from private parties to construct and operate a central station power plant at Hub Chowki. The proposed 120-MW power plant would consist of some six 20-MW medium speed diesel engines using furnace oil as fuel operating in a base load configuration, and providing all its electric power to KESC. The bids from over a dozen parties were received in late 1986 and were evaluated by March 1987. Four candidates have been selected for final negotiations. However, no contracts have been awarded as of May 1987.

Adamjee Paper Cogeneration Plant

The feasibility study for this project is completed. A number of U.S. firms have been contacted for equipment cost quotations. The study along with quotes will be presented to the World Bank for financing arrangements. Subsequently, request for bids will be issued. System specifications are as follows:

Plant steam requirements:

10 T/H, 110 Psig (sat)

13.6 T/H, 50 Psig (sat)

Power requirement: 3.9 MW at 440V

Boiler: 900 Psig, 650F super heat

Fuel: Natural gas

Steam throughput is estimated at 28 T/H with condensing load of 4.7 T/h in extraction condensing turbine.

Rafhn Maize Cogeneration Plant

The feasibility study for a cogeneration system at Rafhn Maize food processing plant is completed and will be presented to the World Bank for financing at the end of June 1987. A number of firms have been contacted for equipment cost quotations. Plant specifications are as follows.

Case 1

Plant steam demand: 15 T/H at 12 Bar (sat)

Boiler: 40 Bar, superheat at 335 C

Fuel: Natural gas

In this case a back pressure steam turbine is to be used to generate 0.8 to 1.0 MW of electricity at 440V.

Case 2

In this case a combustion turbine with waste heat recovery boiler will be used to meet full electricity load requirement of 2.6 MW and steam load of 15 T/H at 12 Bar (saturated). The waste heat boiler will use supplemental fuel.

Pakland Paper Cogeneration Plant

The feasibility study for this cogeneration system is also already completed and some quotes from U.S. firms have been received. The study will be presented to the World Bank in late June 1987 for financing arrangements. Subsequently, request for bids will be issued. Project specifications are presented below.

Plant steam requirement:

64.7 T/H at 3.3 Bar (saturated)

11 T/H at 8.0 Bar (saturated)

Plant power requirement: 13.0 MW

The feasibility study suggests the use of two turbines and three boilers. One boiler will be used as stand by.

Boilers: 3x45 T/H, 68 Bar, 470C superheat

Fuel: Natural gas

Turbines: with two stage extraction and one condensing

Nandpur Gas Field Plants

There are eight gas field in Northern parts of Pakistan referred to as "dormant gas fields" which were discovered in 1950s and not fully developed. These gas fields are currently held by the OGDC. Recently, the government has decided to allow private sector use of these fields for power generation with electricity sold to WAPDA (the electric utility company). The first field considered for this purpose is Nandpur located at Multan. It is estimated that this field can reach a production capacity of 60 mmcfd with 40 percent combustible content.

A number of joint US Pakistani firms are in the process of presenting a proposal to the Government of Pakistan to install a power plant at this site.

Proposed Barge Mounted Power Plant

A private US firm has presented an unsolicited proposal to build and operate an 80 MW barge-mounted plant in South of Pakistan. This plant will use imported coal. The prospect for this project are not promising since import of coal will require Cabinet approval. Apparently, the private parties involved in this proposal overlooked this issue.

Similar to Pakistan, in India there has been a considerable amount of discussion on prospects for private sector or non-utility power generation. However, there has been no explicit government policy on allowing private sector power generation for sale to the grid. A number of activities, however, are taking place on a regional level. The following are examples of such activities.

Faridabad Captive Power Generation

Faridabad, located in the Northern state of Haryana, contains over 2000 large, medium, and small industries. However, the area's prosperity and industrial growth have suffered in recent years, and in the past three years, especially, because of the insufficient and unreliable supply of electricity from the state utility.

In 1985, the Faridabad Industrial Association (FIA) formed an ad hoc committee to investigate the possibility of installing and operating a 100 MW power plant. Subsequently they performed a feasibility study of the project. The plant is expected to consist of about eight 13 MW medium speed diesel engines running on heavy petroleum fuel. The total project cost is estimated at $60 million. The required government permits for the plant are granted. However, no contracts have been awarded yet. Original commissioning date was estimated at mid 1988. However, with current delay in the project this dead line will not be met.

Gujarat Industrial Power Project

Similar to Haryana, the industries in Gujarat have been facing considerable power shortage in recent years. A number of large industries in this state -- Gujarat State Fertilizers Company, Gujarat Narmda Valley Fertilizer Company, Petrofils Cooperative Company, Gujarat Alkalies & Chemicals Company, the Heavy Water Project of Baroda -- have formed the Gujarat Industries Power Company to install and operate a 120 MW power plant to supply part of their power needs.

The proposed plant will use coal (available from West India) and will be able to burn natural gas if available. Total project cost is estimated at US$150 to 180 million. The state utility has already accepted to wheel the power at a flat cost of 0.4 cents per kWh. GIPC is in the process of obtaining financing for this project and construction is expected to start in 1988.

Other

In addition to the above projects a number of cogeneration plants are being installed in Indian industry. In fact, all new large industries are required to examine the possibility of cogeneration as a power supply option before they obtain construction permits from the government.

Finally, in the State of Tamil Nadu, the government has announced its willingness to allow private sector development of a 100 MW power plant. The electricity from this plant will be purchased by the state electric utility.

THAILAND

Because of the reliable supply of electricity in Thailand, there has been very little activities on non-utility power generation in this country. The government had considered allowing private sector development of a 70 MW barge-mounted power plant in the South. However, eventually it was decided to have the state utility (EGAT) own this plant. A team of American, Korean, and Canadian companies have been granted a contract to build this plant.

MOROCCO: PROSPECTS FOR PRIVATE POWER GENERATION

Background

Morocco is a middle income developing country with a 1984 GNP per capita of $670 and an estimated 1985 population of 22 million.

Morocco faces a double challenge of a large and growing dependence on oil imports and a capital shortage. Energy imports in 1986 accounted for 89 percent of all commercial energy used. In 1986, the country imported 4.7 million tonnes of oil and more than 900,000 tonnes of coal. Together, these imports represented over 5.2 million tonnes of oil equivalent. According to recent projections, oil imports are likely to be close to 6 million tonnes (Mtoe) by 1996, with total energy imports -- oil plus coal -- close to 8.2 Mtoe. At 1987 oil prices, the energy import bill would exceed US$ 1 billion. This import dependence will continue to constrain economic development and at the same time will contribute greatly to the growing scarcity of foreign exchange, which has its roots in the national debt. That debt now exceeds $14 billion, and in 1986, the debt service was equivalent to 71 percent of total export revenues.

Meeting national energy needs is also placing heavy pressure on the domestic budget. Energy sector investments in the 1981-1985 five-year plan accounted for about 10 percent of total investments. The scarcity of public domestic funds is illustrated by the country's budget deficit, which exceeded 6 percent of GDP in 1985.

Current Energy Balance

Total primary commercial energy demand was 5.14 Mtoe in 1985, of which 12.8 percent was for coal, 83.5 percent for oil, 1.3 percent for natural gas, and 2.4 percent for hydropower (see Exhibit 1). Electricity demand in 1985 was 6,502 GWh. Total energy demand is projected to grow at an annual average rate of 4.92 percent, reaching 8.72 Mtoe in 1996. This relatively high rate is mostly attributable to electricity demand, which is projected to grow at 7 percent per year, to 13,700 GWh in 1996.

Focus on the Power Sector

The Office National de l'Electricite (ONE), the National Electricity Authority, is the monopoly producer of electricity in Morocco. It is also responsible for the transmission of all electricity and for the distribution of approximately 44

percent of the electricity produced. The country's 10 regies are responsible for distributing the remaining 56 percent of electricity produced by ONE.

Electricity currently accounts for 30 percent of primary energy demand in Morocco. Total installed capacity in 1985 was 1861.8 MW, of which 32.8 percent was from hydropower and 67.2 percent from thermal plants (see Exhibit 2). However, due to drought conditions for several consecutive years, hydropower's share in total electricity production has fallen from about 25 percent in 1980 to 7.5 percent in 1986. Thus, thermal electricity production currently accounts for 92.5 percent of total power generation. Total installed power capacity is projected to increase to 3146.6 MW in 1996, of which hydropower will provide 30.8 percent and thermal, 69.2 percent. ONE's plans for the construction of future power plants are presented in Exhibit 3.

Prospects for Non-Utility Power Generation

In light of rapidly growing power demand, a crippling dependence on energy imports, and domestic investment budget problems, non-utility power generation would appear to offer an attractive option for Morocco.

Although ONE has the monopoly of generation and transmission of electricity, it currently purchases small amounts of power from several independent producers (e.g., phosphate, chemical, and sugar companies).

Most of the potential for non-utility power generation in Morocco is in industrial cogeneration, particularly in the sugar, phosphate, pulp and paper, and chemical industries. Cogeneration currently accounts for 12 percent of total electricity demand or over 200 MW of installed capacity (see Exhibit 4). A preliminary estimate of the potential for cogeneration by 1996 is 250 GWh in existing facilities and a new financial market of between 60 and 80 MW. Developing this potential would require policy changes (ONE generation monopoly) but would greatly benefit Morocco because most of this power (e.g., from sugar mills) can be generated in winter, when thermal central power generation is at its peak, and for a relatively low incremental capital cost (in the range of $600-800/kW) and a low operating cost, because of the low fuel value.

Although independent power generation in Morocco has not yet been studied in detail, it is clearly an option worth investigating.

Exhibit 1

Energy Demand in Morocco

		1985 1/		1996 2/
Coal	(toe)	657,100		2,500,334
Oil	(toe)	4,291,800		5,712,134
Natural Gas	(toe)	66,100		70,000
Hydropower	(toe)	126,300		442,000 3/
Total	(toe)	5,141,300		8,724,468
Annual Growth Rate (%)			4.92	
Elasticity (Energy/GNP)			1.17	
Electricity Demand (GWh)		5,502		13,700
Annual Growth Rate (%)			7.0	
Elasticity (Elec./GNP)			1.7	
Population (Millions)		23.2		32.8
Energy Demand (koe Per Capita)		221		266

1/ Source: MEM
2/ Source: Consultants' estimate
3/ Source: ONE, drought-year scenario

Source: Hagler, Bailly & Company

EXHIBIT 2" BREAKDOWN OF POWER GENERATION BY TYPE OF EQUIPMENT

BASE YEAR : 1985

TARGET YEAR 1996

	BASE YEAR		TARGET YEAR		
	Capacity MW	Productio GWh	Capacity MW	Productio drought GWh	Production normal GWh
Hydropower	610.15	485.9	970	1700	2700
Gas turbine	135.5	68.4	335.5	0.1	0
Steam turbine	1092	5936.2	1817	11959.9	10960
Diesel	24.146	11.8	24.146	40	40
Total	1861.796	6502.3	3146.646	13700	13700

Source: ONE

Exhibit 3

O.N.E. Future Power Plants

Expected Date of Completion	Type Of Power Plant	Name	Power Rate MW	Average Annual Energy Production GWh	Fuel Requirement t
1988	Diesel [1]	Laayonne	21		
1989	Hydro		67		
1989/1990	Gasturbine	N/A	180		
1990	Hydro	SIDI DRISS	3,1	17	4,250
1992	Hydro	MATMATA	224	265	6,000
1992/1993	Thermal (coal)	CORF LASFAR	600	42,000	900,000[2]
1994	Hydro	M'DEX	35	50	
1995	Hydro	DCHAR EL "QUED	92	200	
1994	Hydro	ABDEL MOUMEN	29	57	
1995	Hydro	EL MENLEL	148	320	
1996+	Hydro	MJAARA	240	390	

1/ Not connected to the grid.

2/ Equivalent to 14,750,000 tons of imported coal.

EXHIBIT 4: POTENTIAL FOR COGENERATION IN MOROCCO BY 1996

Existing cogeneration in 1987

- 12 percent of total electricity demand = 730 GWh/year
- Or over 200 MW of capacity

Projection for 1996

Existing Facilities:

Phosphate	200 GWh
Pulp and Paper	10 GWh
Sugar	25 GWh
Refineries	15 GWh
TOTAL	250 GWh

New Market (in MW):

	Technical Market	Financial Market
Topping System*	100	40
Bottoming system**	30-60	20-40
TOTAL	130-160	60-80

*Mostly in sugar and paper mills
**Sulfuric acid

Source: Hagler, Bailly & Co.

Indonesia Private Power Market Information

INTRODUCTION

Indonesia is one of the largest nations in the world, with a population of 165 million (ranking fifth in the world). It has a diversified economy, traditionally oriented toward agriculture and basic resources, but increasingly based on its large and diversified industrial and commercial sectors. For example, in 1984, industry accounted for 40 percent of GDP and agriculture provided 26 percent. Fuels, minerals, and metals accounted for 80 percent of merchandise exports in 1983 and other primary commodities accounted for 12 percent. Indonesia is trying to shift away from reliance on commodity exports, and from 1973 to 1984, industry as a whole grew at 8.3 percent while manufacturing grew at 14.9 percent.

Indonesia is one of the poorest nations in the world on a per-capita basis. Its 1984 GNP per capita was $540. Per capita GNP grew at 4.9 percent between 1965 and 1984. Indonesia's population is expected to grow at 1.9 percent from 1980 to 2000, placing a strain on its resources. Approximately 57 percent of the workforce was employed in agriculture in 1980, 13 percent in industry, and 30 percent in services.

Indonesia is the largest energy producer and consumer in Southeast Asia. Although it is an important exporter of energy products, mostly petroleum and liquefied natural gas, Indonesia is facing a rapidly growing domestic demand for all types of commercial and non-commercial energy sources. Indonesia's rapidly growing population and ambitious economic growth targets combine to produce a rapidly growing demand for energy. To maximize its energy export revenues, Indonesia has no alternative but to improve the energy efficiency of its economy.

In 1983, Indonesia produced 15,280 MWh of electricity from a net installed capacity of 5,084 MW. Self-producers generated 4,380 MWh from a net capacity of 2,449 MW. Indonesia produces its electricity predominantly from oil-fired thermal systems. In 1983, thermal systems generated 13,778 MWh of electricity, or 90 percent of the total. The remaining 1,502 MWh was produced from hydroelectric facilities.

On a per-capita basis, Indonesia's energy consumption is one of the lowest in the world, at 96 kWh per capita. The world average is 1,876 kWh. Asia's average is 558 kWh, and Africa's average is 405 kWh.

MARKET INFORMATION

Indonesia has an extensive industrial sector with a great potential for private power generation. The industrial sector uses approximately 35 percent of commercial energy supplies and could therefore achieve significant energy savings through conservation measures. Oil and gas are the major energy sources for industry, accounting for approximately 41 percent and 49 percent, respectively, of total commercial energy. The textiles, wood products, and plastic wares industries (1,833 companies) are the largest, however, the industrial sector is very diversified; these three industries account for approximately 22 percent of the number of establishments and 30 percent of employment (see Exhibit 1). Industry in Indonesia has both a substantial interest and extensive experience in power generation.

COGENERATION

- Several recent studies[1] have concluded that cogeneration is feasible in fertilizer, cement, aluminum, and sugar industries, plywood factories, and lumber mills, as well as in refineries, and methanol and petrochemicals production
- Major industries generate about 75% of their electricity requirements
- Prominent non-utility generators are found in textiles, food, chemical, cement, paper, aluminum, and iron and steel. The largest are: Krakatau Steel (400 MW steam power plant), Pursi Fertilizer (30 MW), Gresik Petrochemicals (25 MW) -- all steam plants and all government-owned. There are also 32.3 MW of diesel power plants operated by PN. Aneka Tambang, and a 90 MW diesel power plant operated by PT. Indocement Group
- Many of the existing plants in industry are not as energy efficient as the plants now being designed, thus there are substantial opportunities to increase energy efficiency by retrofitting new equipment
- The public utility (PLN) plans to phase out small diesel generating plants, except where cogeneration is feasible
- The private sector provides power to some rural areas. Some private industries provide power to a few households nearby, and some private entrepreneurs and/or cooperatives purchase portable diesel generators to provide power to small communities
- Of 57,000 villages, only 3,000 are electrified, or approximately 6 percent.

[1] UNDP/World Bank, Indonesia: Issues and Options in the Energy Sector, November 1981; Indonesia Activity Completion Report, September 1984; and Analysis on Policies and Regulations on Electricity Pricing, January 1986.

Exhibit

INDONESIAN INDUSTRIAL ENERGY CONSUMPTION AND ENERGY INTENSITY*

INDUSTRIAL SUBSECTOR		Number Establishments	Total Employment**	Total Energy Expenses (Billion Rupees)	Total Input Cost (Billion Rupees)	Share of Energy in Total Costs (%)	ENERGY CONSUMPTION				Total Commercial Energy Consumption (TOE)	ENERGY INTENSIVENESS RATIOS	
Code	Name						Electricity (MWh)	Oil (Liters)	Coal Coke (KG)	Gas (M3)		Energy Per Establishment (TOE)	Energy Per Employee (TOE)
31121	Condensed/Dried Milk	6	1,582	3.051	148.448	2.06%	27,854	6,944,135	0	19,057	8,294	1,382	5.2
31151	Coconut Oil	91	3,687	4.691	172.563	2.72%	20,172	18,071,384	343	750	17,355	191	4.7
31159	Other Vegetable & Animal Oil	34	2,148	6.162	122.378	5.04%	29,477	23,098,570	0	1,036	22,381	658	10.4
31164	Wheat Flour	3	1,358	6.038	170.957	3.53%	27,464	28,123,177	0	0	26,787	8,929	19.7
31181	Sugar Factories	60	43,914	33.298	445.966	7.47%	296,794	81,279,518	9,633,503	194,558	99,022	1,650	2.3
31230	Manufacture of Ice	136	2,998	8.599	11.113	77.38%	101,592	23,793,613	151	1,260	28,758	211	9.6
31270	Seasoning	12	3,474	17.111	63.030	27.15%	200,539	63,473,479	0	0	72,350	6,029	20.8
31280	Cattle Food	33	2,877	3.723	169.860	2.19%	40,614	11,383,581	0	0	13,157	399	4.6
31420	Clove Cigarettes	179	115,859	4.317	986.851	0.44%	40,748	14,186,935	0	20,498	15,450	86	0.1
32111	Yarn and Thread	70	44,977	50.966	357.012	14.28%	3,299,588	139,383,376	0	2,000	385,777	4,946	8.6
32112	Weaving Mills	907	114,599	82.323	548.976	15.00%	707,373	249,459,013	0	1,430,026	274,050	303	2.4
32113	Bleaching, Dyeing Fabrics	53	4,190	6.346	44.889	14.14%	40,918	26,020,669	0	929	25,922	489	6.2
32130	Knitting Mills	133	14,320	3.186	45.444	7.01%	45,936	8,450,128	0	42,962	11,030	83	0.8
33111	Saw Mills	334	29,270	15.219	175.192	8.69%	120,626	55,594,157	12,772	532	57,502	172	2.0
33113	Plywood	85	102,141	46.814	574.152	8.15%	694,890	226,674,941	0	0	251,743	2,962	2.5
34111	Paper	27	6,597	30.457	104.432	29.15%	256,506	81,104,990	0	21	91,222	3,379	13.8
34200	Printing, Publishing	297	16,719	5.186	85.922	6.04%	51,540	11,280,137	0	4,023	13,669	46	0.8
35110	Basic Chemicals	79	4,990	10.396	75.971	13.68%	163,011	32,941,283	86,473	3,670	41,795	529	8.4
35221	Drugs & Medicine	128	12,930	6.207			179,468	16,519,304	1,575	232,910	28,720	224	2.2
35231	Soap & Detergent	52	6,271	3.468			24,997	15,574,684	0	700	15,137	291	2.4
35510	Tyres and Tubes	29	9,269	9.941	103.292	9.62%	69,019	31,875,386	0	7,410,320	39,321	1,356	4.2
35523	Crumb Rubber	66	15,323	19.279	518.233	3.72%	2,089,145	73,901,331	9,407	5,140	231,676	3,510	15.1
35600	Plastic Wares	294	26,867	13.389	167.114	8.01%	197,407	39,300,275	0	500,479	50,316	171	1.9
36110	Ceramic & Porcelain	29	9,157	9.862	21.993	44.84%	39,006	41,267,056	0	3,024,155	41,334	1,425	4.5
36210	Glass & Glass Products	32	6,401	13.476	38.622	34.89%	139,261	52,992,663	424,432	5,177,627	61,647	1,926	9.6
36220	Sheet Glass	2	1,173	5.529	26.911	20.55%	13,797	23,920,002	0	0	22,142	11,071	18.9
36310	Cement	8	6,094	143.239	233.066	61.46%	950,788	219,058,068	249,500,264	84,473,670	477,000	59,725	78.4
37100	Iron and Steel	26	9,638	226.663	669.487	33.86%	1,253,675	100,729,907	29,243,784	372,024,785	517,859	19,910	53.7
38130	Structural Metal	84	10,966	12.492	298.009	4.18%	95,413	29,639,420	500,006	194,653	33,772	402	3.1
38140	Metal Containers	70	7,484	3.477	45.394	7.66%	23,859	9,070,527	186,000	91,751	9,760	140	1.3
38200	Machineries and Repair	131	9,166	3.184	77.735	4.10%	22,341	4,740,737	1,498,472	557,891	7,150	55	0.8
38330	Electrical Apparatus	55	11,660	9.026	253.495	3.56%	70,152	18,407,469	377,423	3,400,913	25,281	460	2.2
38430	Motor Vehicles	40	10,116	9.000	286.019	3.46%	73,509	21,526,957	9,410	47,597	24,410	610	2.4
	TOTAL	3,593	660,231	827	7,043	11.74%	11,424,199	1,799,796,492	291,500,895	470,961,529	3,043,404	847	4.6
	NATIONAL TOTAL	8,006	975,470	920	9,700	9.56%	12,765,231	2,045,221,323	292,613,904	404,170,300	3,366,632	421	3.5
	SAMPLE PERCENT OF TOTAL	44.80%	68.50%	89.00%			89.49%	88.00%	99.65%	98.92%	90.40%		

* Without Fertilizer
** Production workers

11-Mar-87

Source: Bureau of Statistics Annual Survey of Large and Medium Manufacturing Establishments, 1984

- Decentralized power for the island of Kalimantan is a prospect (a study has been completed with funding from the Asian Development Bank)
- Gasification of biomass for electric power generation has great potential.
- 1.2 million small-scale enterprises provide 80 percent of employment in manufacturing, productivity could be greatly enhanced by electrification. Less than 3 percent use electric power.

PRICES

- Electricity costs were adjusted to represent long-run marginal costs in 1980, including differentiation by voltage level and time-of-day and the elimination of decreasing blocks, [apparently only in Java, not in outlying islands]
- The long run marginal cost (LRMC) for Java has been applied to other grids since adequate data are not available to determine costs for each grid
- Demand charges for medium and high voltage users are still low but plans call for bringing them in line with the LRMC
- Petrol fuel prices were raised 50 percent a year in 1982 and 1983. As of January 1984 they approximated the opportunity cost except for industrial diesel oil (which was slightly below at 98 percent economic price), and kerosene (which was considerably below at 64 percent economic price)
- Electricity prices averaged Rp 98 per kWh (US$0.09) in February 1984, plans are in place to bring prices in line with LRMC.

CAPACITY

- Captive power capacity was 4000 MW in 1983/84 (see Exhibit 2) (captive power means non-utility power generation. Many captive power generators in Indonesia are government-owned companies.)
- The increase in captive power is expected to be about 5 percent/year
- Captive generation outside Java is expected to grow from 0 to 9,638 GWh in 2003
- PLN capacity was 3900 MW in 1983/84
- Public utility capacity will increase to 15,000 MW by 1993/94 according to PLN's projections in 1984
- The average growth of oil consumption for private generation ii industry (excluding kerosene) was 12.1 percent in 1970-77; it fell to 0.2 percent in 1981/82

- 85 percent, or 2158 MW, of PLN power is generated by oil and 15 percent by hydro. PLN's goal is to generate only 20 percent by oil by 1993/94, the remainder will come from coal, hydro, and geothermal
- According to PLN's plans, 21 percent of rural households will be electrified by 1994.

MISCELLANEOUS

- The private sector generates its own power primarily for three reasons: 1) PLN cannot meet demand; 2) PLN's network has been unreliable, generally caused by an excessive overload of the system; and 3) PLN imposes high connection charges
- There were 348 registered independent rural electrical cooperatives in 1984. Their experience has not been good. Problems were encountered with budget, procurement, lack of experience, and a shortage of technical and managerial capability. Some have been determined not to be more cost-effective than PLN
- Many large industries generate their own power and some sell extra power to nearby homes.

CAPTIVE POWER IN KALIMANTAN

Kalimantan provides an important example of the private power potential in Indonesia. Kalimantan has only 12.6 percent of the villages and 4.6 percent of the population, but it accounts for between one quarter and one fifth of the total national output, thanks to its oil, gas, and forest products industries. Several facts about its private power situation follow:

- In 1982, Kalimantan had 130.4 MW of non-utility installed capacity, or 35 W/person
- 75 percent of captive power is in the wood and wood products industry, 10 percent is in the commercial and public sector, and almost 8 percent is in the rubber, plastics, and chemicals industries (see Exhibit 3)
- Some of this captive power is connected to the utility grid, or will eventually be connected.
- With the exception of one hydroelectric facility, all of the 1984 installed capacity was in diesel units.
- Of the 7,944 villages in Kalimantan, 317 had been electrified by March 1984. The utility planned to electrify 737 villages by 1989 with small diesel generators (typically 3-5 KVA)
- In 1984, the government was electrifying villages for an average cost of $3,900/kWe
- 21.5 percent of the electrified villages receive power from private sources, 1.5 percent from cooperatives.

Exhibit 2

INDONESIA
INSTALLED CAPACITY OF CAPTIVE POWER
(MW)

Year	Connected to PLN	Not Connected to PLN	Total	Percent Increase
1975	498.2	1158.1	1656.2	18.0
1976	550.7	1279.0	1829.8	10.4
1977	585.2	1336.0	1921.2	5.0
1978	645.7	1412.6	2058.3	7.0
1979	679.0	1488.7	2167.8	5.0
1980	697.7	1929.2	2226.9	3.0
1981	702.6	1544.5	2247.1	0.9
1982	720.6	1659.1	2379.1	5.9
1983	703.8	1967.3	2671.0	12.3

Excluding:

Asahan Hydro PP	= 603 MW
Juanda Hydro PP	= 150 MW
Larona Hydro PP	= 165 MW
Krakatau Steel Steam Oil PP	= 400 MW
Aneka Tambang Diesel PP	= 32.3 MW

Source: World Bank, "Analysis on Policies and Regulations on Electricity Pricing," January 1986.

Exhibit 3

CAPTIVE PRODUCTION OF ELECTRICITY IN KALIMANTAN (1980, MWH)

Households		1,391
Industry		250,437
Food, beverages, & tobacco	1,110	
textiles, clothing & leather	0	
wood & wood products	214,504	
Paper writing & publishing	2340	
Rubber, plastics & chemicals	21,299	
Mineral products	6,572	
Basic metals	0	
Machinery & equipment	4,612	
other	0	
Commercial & Public		28,121
Total		**279,949**

Source: "Indonesia: Rural and Renewable Energy Development Study in Kalimantan," Interim Report, Asian Development Bank, June 1984.

BACKGROUND - POWER GENERATION IN JAMAICA

The Jamaica Public Service Company (JPS) has a monopoly on electricity sales in Jamaica. Power produced by other entities may be used only for their own use or sold to JPS. The utility is regulated by the Ministry of Public Utilities and Transport, which in no way operates as a public service commission in the US, although it does respond to consumer pressure on the political directorate.

Installed capacity in the JPS system amounts to about 455 MW. Peak JPS demand, which represents about half of the total electric demand on the island, is about 250 MW and is forecast to grow at an average of 3% per annum. The electric energy is generated by heavy fuel oil-fired steam and diesel units (90% of generated kWh), diesel fuel-fired gas turbine units (5%), and small hydroelectric units (5%).

A least cost expansion study was completed for JPS by Montreal Engineering Co. in 1985. This study recommended the further development of the system with three basic type of units - additional minihydro plants to the extent feasible, coal-fired steam units for baseload, and gas turbines for peaking. The study also showed that optional scenarios using coal conversion, cogeneration, and peat-fired plants offered about the same net present cost over the 20-year study period as the base alternative.

Power is generated by a number of private producers for their own use. Some use cogeneration cycles, while some use simple cycles. In addition, standby power plants (mainly high speed diesels) are maintained by nearly all industrial and large commercial enterprises. The need for these systems was much greater in the 1970's than at present, since the completion of the JPS rehabilitation program has substantially improved reliability.

Private power producers, not including standby plants, are found mainly in the alumina, bauxite, sugar, cement and ethanol industries, with one other example in a tourist hotel.

Alumina

The alumina industry is the largest export earner in Jamaica. Locally mined bauxite is refined in large plants using the Bayer process which requires major inputs of steam and electricity. At present there are three operational

plants in Jamaica. In addition, both the largest and smallest plants in the island are now closed. The smallest, Revere, will never be reopened due to economies of scale. The largest and also the least energy efficient plant, Alumina Partners (Reynolds, Kaiser, Anaconda), was closed in 1985 but may be reopened at some point, depending upon world alumina demand. Alcan operates two plants, Kirkvine and Ewarton, and Clarendon Alumina Producers (Government) operates, with Alcoa assistance, the plant at Halse Hall that Alcoa closed in 1985.

All alumina plants in Jamaica obtain their energy from heavy fuel oil, using steam cogeneration cycles. Steam is generated at about 600 psi, passed through a back-pressure turbine for generation of electric power, and exhaust steam at about 150 psi is sent to the process. Approximate power demands for the three active plants are on the order of 40-60 MW each.

Bauxite

Bauxite in Jamaica is a mining operation, with the material either being provided to alumina factories or exported in dedicated ships. The raw material, a red clay, is mined using diesel powered implements. The bauxite is transported primarily using diesel vehicles. At the port facilities, electric power is required for material handling (conveying and loading) and general utilities, such as lighting. At present, only one bauxite export facility, Kaiser at Trelawny/Discovery Bay, is in operation. Reynolds, at St. Ann/Ocho Rios, closed in 1984.

For its power needs, Kaiser operates high speed diesel generators. The peak demand is estimated to be about 5 MW.

Sugar

Sugar is the largest employer of Jamaican labor, and is grown in most parishes. The industry waned considerably from 1970 to 1983, with production dropping from about 450,000 tons per annum to only about 200,000. The industry has been restructured and many plants were closed. At present, only nine factories are in operation. Of these, five (including the three largest) are owned by the Government. Distilleries are installed in four facilities (two private) which manufacture rum from all molasses produced in Jamaica. A fifth distillery is being installed this year and one more has been proposed.

All sugar factories in Jamaica generate their own power using steam cogeneration cycles. Steam is generated at less than 200 psi and used to drive the mill and electric power back-pressure turbines. Exhaust steam at 15 psi is used in the boiling house and the distillery.

Bagasse fuel is used to the extent available, and is supplemented with heavy fuel oil. During the out-of-crop season, power needs are provided for most distilleries and estates by high-speed diesel generators or by the steam cogeneration facilities burning fuel oil if steam is needed for the distillery.

The factories and their approximate characteristics are listed below, in order of size.

Name	Ownership	Production ton/yr	Distillery	Demand MW
Frome	Govt	60,000	no	8
Monymusk	Govt	40,000	yes	7
Bernard Lodge	Govt	30,000	now being inst	5
New Yarmouth	Priv	25,000	yes	4
Hampden	Priv	15,000	no	3
Worthy Park	Priv	13,000	no	3
Long Pond	Govt	12,000	yes	3
Appleton	Priv	10,000	yes	3
Duckenfield	*	10,000	being consid	3

* Govt owned, leased to private company.

Cement

The Caribbean Cement Company manufactures Portland cement at Harbour Head near Kingston. The plant generates all of its own power using medium speed diesel engines, with a peak plant demand of about 15 MW. A major ($70 million) project is now underway, funded by IDB, to expand the plant converting to the dry manufacturing process with coal combustion in the kilns. As part of this conversion project, additional diesels will be installed, which will burn fuel oil to achive a capacity of about 25 MW. This project is being implemented by Kajima of Japan.

Ethanol

Tropicana International operates a fuel-grade ethanol dehydration facility at Rockfort for export to the US, where it generates its own power from high speed diesels. No cogeneration is used, and peak demand is less than 500 kW. In addition, Tropicana has leased the Duckenfield Sugar Factory, where it may install a distillery to feed its dehydration plant which is now supplied with European feedstock

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Hotels

The Government owns most of the large hotels in Jamaica. An announcement by the Prime Minister in April 1987 stated that these hotels are to be divested. Foreign investors are now invited to make proposals.

The Wyndham Rose Hall Beach Hotel (leased by Government to Wyndham) generates all of its own power using high-speed diesels in a cogeneration cycle. The plant includes four 550 kW Caterpillar genertor sets and meets a peak demand of about 800 kW. The cooling jacket water for the diesels passes through heat exchangers in which domestic hot water for the buildings is generated. A proposal has been made to add an exhaust gas heat exchanger which would provide waste heat to operate an absorption chiller for part of the building air conditioning, however funding has not been obtained.

The Holiday Inn Rose Hall Hôtel (leased by Government to Holiday Inn) nearby was also designed for cogeneration. However, as the building was being completed the JPS distribution grid in the area was upgraded, allowing the hotel load to be added. As a result, this plant operates only as stand-by power.

GOVERNMENT ENERGY POLICY

Government policy has been stated that development of electric power generation in Jamaica will follow the following priorities:

1) Hydroelectric;

2) Peat using locally available resources;

3) Coal (imported).

As regards private power generation, government policy is that it should be encouraged. However, no legislation (such as PURPA in US) has been drafted or enacted that guarantees a market or a price for this power. Deregulation of the economy with regard to foreign exchange transactions has been stated as an objective by the Government. Jamaican dollars are not now readily convertible to hard currency.

PROPOSED PRIVATE POWER PROJECTS

Three major private power generation projects have been proposed for Jamaica and studied to the feasibility level. All projects are now still under consideration. These projects are known as the coal-cogeneration. peat, and

cane energy projects. Other smaller projects are in various stages of development.

Coal-cogeneration

A consortium of US companies has proposed the construction of a privately-owned power plant. The plant would be sited at Clarendon Alumina Producers (CAP) and would use pulverized coal as principal fuel. The plant would sell both steam and power to CAP and power to JPS. The plant has been sized to provide up to 100 MW to the JPS grid.

This project has been the subject of months of proposals, negotiations and counterproposals. The basic concept of the project has received the approval of the political directorate, however conflicts have arisen over the need for a plant of this size, the price of power, and the repatriation of foreign exchange.

Peat

The Petroleum Corporation of Jamaica (PCJ) has proposed the construction of a 60 MW peat-fired power plant at Negril. This operation would mine wet peat at sea level, dry the peat, and burn it in solid-fuel boilers for power generation.

The project has been studied by JP Energy Oy of Finland. The problems with this project include the technical risks involved in the unproven wet peat operation, the price of power, and environmental considerations in this prime tourism area.

Cane Energy

A major power generation project has been studied in detail for Monymusk by Bechtel, under USAID sponsorship. This project would upgrade the cane production per acre by about 40%, would begin burning cane trash for fuel, and would upgrade the steam pressure to about 1000 psi in order to improve the thermodynamic efficiency of power generation. The bagasse and trash would be supplemented by fuel oil to achieve a 25-35 MW capacity, year round. Excess power would be sold to the JPS grid. Redesign of this project is now under way, to more fully integrate it with the factory and estate operations and to consider peat or coal as supplemental fuel.

PetroJam Refinery Cogeneration

A project has been proposed by PCJ to install power generation equipment at the 20,000 bbl/day PetroJam oil refinery. The fuel used would include gas now being flared. The project is now being designed by PCJ Engineering, with assistance from CIDA.

Industrial Chemicals Company

A 500 KVA back-pressure steam turbine generator set exists at ICC which uses steam from a waste heat boiler on the exothermic sulfuric acid manufacturing process. Due to balancing problems with this unit, it has been out of commission for several years. The repair or replacement of this unit represents a potential cogeneration project.

Export Free Zones

JIDC has established free zones in Kingston and Montego Bay to stimulate export manufacturing. These have been very successful in attracting investment, particularly in the garment assembly sector. These are being expanded. The establishment of integrated energy systems represents a potential project, although demands for heat are not great. Most buildings in the Free Zones are not air conditioned at present, but worker activism is strong and a cogeneration/absortion chiller system is feasible if it can be sold.

Others

Frequent proposals are made to the Government regarding other projects, including more exotic technologies such as wind and ocean thermal energy conversion. Most recently, a US company has proposed a 25 MW power plant. Their discussions received a more favorable response from JPS because the plant size is acceptable to the utility.

PRELIMINARY DISCUSSIONS REGARDING WORKSHOP

Preliminary contact has been made with three agencies, National Development Bank - Energy Credit Fund, Ministry of Mining, Energy and Tourism and USAID/Jamaica, regarding interest or support for the concept of a workshop in private power generation.

National Development Bank - Energy Credit Fund

Contact has been made with Mr. Larry Bailey, Manager of the ECF. The ECF exists to make concessionary loans to the private sector for energy conservation investments. Mr. Bailey supports the concept of the workshop and is willing to make all arrangements for a preliminary mission to Jamaica, including using his network of contacts to arrange attendance for a seminar or panel discussion on the subject. He suggests the use of luncheon and cocktail party/reception to encourage attendance. He is willing to prepare a budget estimate based on a draft agenda.

Ministry of Mining, Energy and Tourism

Contact has been made with Mr. Nigel Grant, Director of Economic Planning for the Energy Division. Mr. Grant fully supports the workshop concept. He feels that this is a key issue for both Jamaica and the region at this time. He and his Division are under constant pressure to evaluate proposals in this area, and are grappling with the problems listed above. He judges the issue as particularly important in light of recent Government policy shifts toward opening up the economy, which may address the repatriation problem.

Mr. Grant offers MMET official support for the concept. He suggests the use of the Jamaica Conference Centre on the Kingston waterfront for the workshop. This facility was built to house the Law of the Sea conferences and body. It provides complete UN-type translation, public address, individual microphone/headset, conference room, luncheon and banquet facilities. Its cost is reasonable, less than $400 per day not including catering. The facility is adjacent to a first class hotel.

USAID/Jamaica

Mr. Charles Mathews, Director of Energy and Engineering was contacted and also offered full support to the workshop concept. He believes that the legislative issue, to develop a PURPA-type law which will protect the investor, is a key problem which should be addressed.

Mr. Mathews feels that USAID/Jamaica may be unable to offer much in the way of financial assistance to the workshop because of present cash flow constraints at the mission. Essentially they are able to fund only existing projects. Their USAID/GOJ Energy Sector Assistance Project, which closes September 30, 1987, is now fully committed for works only in energy conservation engineering for the National water Commission.

DOMINICAN REPUBLIC

Power Generation by Private Sector

Opportunities:

- Complete Itabo II power plant project, run the power plant and sell Electricity to GODR - 125 MW - coal fired
- Provide Electric Power generation for 1-10 Industrial Parks and/or Free Zones - 20-40 MW units
- Retrofit Gas turbine generators to combined cycle units
- Provide Electric Power generation and/or cogeneration for groups of industries or single large industries such as Cement Plants, Steel Mills and/or sugar mills.

Pros:

- GODR is very motivated and is seriously considering breaking up CDE and opening door for Private Sector power generation. The President, Joaquin Balguer is behind this.
- Individual (non-GODR) industries have good credit ratings and some available capital resources.
- There is a current Electric Power crisis due to insufficient and unreliable supply by CDE
- World Bank has shown interest in helping CDE

Cons:

- GODR has very limited financial resources and a fair credit rating
- New concept, change from long history of non private sector power generation

DOMINICAN REPUBLIC

Population:	6.5 million
Principal City - Santo Domingo	2.4 million
Language:	Spanish
GDP per capita:	$873
Foreign Investment:	
U.S.	$235 million
Other	$35 million
Trade:	
U.S. exports to D.R. (FAS)	$500
U.S. % of Total D.R. imports	40%
U.S. imports from D.R. (CIF)	$574
U.S. % of Total D.R. exports	78%
Principal U.S. exports:	Food, textiles, machinery chemicals
Principal U.S. imports:	Sugar, coffee, gold, furniture, garments
Electric Power Installed:	1010 MW
Currency:	DR $2.88 = US $1.00

CARIBBEAN STUDY TOUR

As part of our work for the Office of Energy at AID, Hagler, Bailly is exploring the possibility of organizing a week to 10-day trip to Jamaica and the Dominican Republic for a group of TTT members to examine private power developments and opportunities in these countries.

We are tentatively looking at a trip in July starting and ending between July 8th and July 20th. The travel plans would be three days in Jamaica one week and three days in the Dominican Republic the next. Unfortunately, one has to fly via Miami to get between the two countries. This, however, would make it possible to be part of the trip for only one country.

The following agendas suggest some of the possible visits and contacts. At this point we would like to gather general expressions of interest. In the next week if there is sufficient interest in the trip (3 or 4 participants would be enough to justify the trip), we would firm-up the agenda with a more detailed schedule and proceed to get commitments form those we wish to visit in the two countries.

We think the trip will be valuable for a number of reasons:

- both countries are receptive to private power activities and open to U.S. business and investments
- furthermore private power projects are already either being designed or contemplated
- we can introduce those who go to key actors because some of our staff have recently held senior positions in the energy sector in these countries
- we as group will have an opportunity to promote the idea of private power.

As part of the trip (assuming those participating would help to share the cost), we would arrange a briefing/reception in each so that those who go could present their companies and interest in the visited countries.

Our contract with AID will cover the costs of our consultants and allow us to host and guide the trip. Cost to participants would be the time and travel expenses. We would also expect the briefing/reception and other out-of-pocket expenses to cost between $500 and $1000 per participant. As a start, please fill out and leave the attached questionnaire. We would also like to learn of your interest in the regional private power workshop

STUDY TOUR & WORKSHOP QUESTIONNAIRE

NAME _____

COMPANY _____

TELEPHONE _____

COUNTRIES/REGIONS OF PARTICULAR INTEREST: _____

_____

_____

MARKETS/TECHNOLOGIES OF PARTICULAR INTEREST: _____

_____

_____

TOUR

I am interested in joining the Caribbean tour:

Dominican Republic only. ___

Jamaica only ___

Both countries ___

I am not likely to join the tour but keep me informed. ___

I am not interested in the tour. ___

WORKSHOP

I am interested in participating in the planning for the workshop and would likely attend. ___

I am not interested in participating in the planning for the workshop but would likely attend. ___

I am not likely to attend the workshop but keep me informed. ___

I am not interested in the workshop. ___

PRIVATE POWER GENERATION
EXPLORATORY MISSION TO THE CARIBBEAN
JAMAICA: DRAFT AGENDA

DAY	TIME	VENUE / VISIT WITH	TOPICS
1	A.M.	**Ministry of Mining, Energy & Tourism** Minister (Hon. Hugh Hart) Permanent Secretary (Dr. Alan Kirton) Director of Energy (Mr. Perkins) Director of Economic Planning (Mr. Nigel Grant)	National energy policy, status of projects: coal cogeneration, cane energy
1	A.M.	**National Development Bank** Manager, Energy Credit Fund (Larry Bailey)	Financing for energy investments
1	P.M.	**Jamaica Public Service Company** Managing Director (Mr. Brian Picken) Director of Finance (Mr. Al Casserly) Director of Planning (Mr. Robert Miller)	Electric utility company policy, buyback rates
1	P.M.	**United States Embassy** Commercial Attache (Mr. John Bodson) Director, USAID Office of Energy (Mr. Charles Mathews)	Caribbean Basin Initiative, USAID activities
2	A.M.	**Petroleum Corporation of Jamaica** Managing Director (Mr. William Saunders) Director, PetroJam (Mr. Pete Fenton) Director, PCJ Engineering (Mr. Steven Marston)	Cogeneration plans for refinery & ethanol
2	A.M.	**Tropicana International** Managing Director (Mr. William Maloney)	Cogeneration in ethanol & sugar
2	P.M.	**Monymusk Sugar Factory** General Manager (Mr. Eddie Brown) Factory Manager (Mr. Robert Jumpp)	Cane Energy project
3	A.M.	**Free - prepare for seminar**	
3	P.M.	**Luncheon & Seminar: Private Power Generation** **Under Auspices of NDB/ECF** **Wyndham New Kingston Hotel** Invitations/arrangements by NDB/ECF Representatives from: JIDC, JNIP, PSOJ, JMA JTB, JHTA, NHP Private businessmen & hoteliers	Cogeneration in Energy-integrated industrial parks, factories & hotels
3	5-7	**Reception:** **Wyndham New Kingston Hotel** All people who were met Seminar attendees, others invited by NDB/ECF	Further contacts Drinks, hors d'oeuvres

MMET - Ministry of Mining, Energy & Tourism

NDB/ECF - National Development Bank Energy Credit Fund (loan facility for private sector investments in energy conservation)

JPS or JPSCO - Jamaica Public Service Company (state-owned electric utility, monopoly)

PCJ - Petroleum Corporation of Jamaica - holding company for PetroJam, PCJ Engineering, PCJ Ethanol-Bernard Lodge

PetroJam - 20,000 BBL/day grass-roots oil refinery, cogeneratior project design under way

Tropicana - US-owned fuel-grade ethanol and sugar manufacturer/exporter, self-generator of electric power

Monymusk - one of two large Jamaican sugar factories, produces about 40,000 tons/yr, has rum distillery, site of proposed Cane Energy project (Bechtel), formerly sold power to JPS grid

Free Zones - tax & duty free export-only manufacturing parks located in Kingston and Montego Bay

JIDC - Jamaica Industrial Development Commission - assists manufacturers, manages & develops free zones

JNIP - Jamaica National Investment Promotion - attracts investment capital to Jamaica

PSOJ - Private Sector Organisation of Jamaica - active association of private businessmen

JMA - Jamaica Manufacturers Association

JTB - Jamaica Tourist Board - promotes tourism

JHTA - Jamaica Hotel & Tourism Association - association of private hotel owners

NHP - National Hotels & Properties - Government company, owns most large hotels, most of which it has leased and now will sell

Recommended hotel and base of operations: Wyndham New Kingstor Hotel - Mr. Conal O'Sullivan, General Manager

Cost estimates: Luncheon $1,000 for 50, reception $2,000 for 100

DOMINICAN REPUBLIC
(DRAFT AGENDA)

		Subject
Day I	• USAID - Capital Development Projects & Energy Offices	Presentation of Mission's interest and activities related to Private Sector Power Generation and Cogeneration
	• U.S. Embassy - Commercial Section	Presentation on current activities related to assisting U.S. Companies who have an interest in providing services/goods for the D.R.
	• Foreign Investment Promotion Council (Consejo Promotor de Inversiones Extranjeras)	Presentation on current activities related to Foreign Investment in the D.R.
Day II	• GODR Cabinet Members and/or Govt. Officials i.e., Free Zone Council Finance - Technical Secretary Executive Secretary COENER	Presentation on GODR's position on CDE, Free Zones and Private Sector power generation
	(evening) • Reception with Private Sector D.R. Engineering firms and Manufacturer's reps. plus individuals visited during days I, II and III	
Day III	• Local Consulting/ Engineering Firms	Presentation on their activities
	D.R. Industries i.e., CDE power plant(s) steel mini-mill cement plant(s)	Presentation on their needs

ASIA/NEAR EAST WORKSHOP ON ENERGY CONSERVATION AND PRIVATE POWER GENERATION

Volume I: Energy Conservation

September 29 - October 3, 1986
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Bangkok, Thailand

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and

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National Energy Administration

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PREFACE

This report is the proceedings of the Asia/Near East Workshop on Energy Conservation and Private Power Generation, which was held from September 29 to October 3, 1986 at the Asian Institute of Technology, in Bangkok, Thailand. The Workshop was co-sponsored by the Office of Energy in the Bureau for Science and Technology and the Energy and Natural Resources Division in the Bureau for Asia and Near East, both in the United States Agency for International Development, and the National Energy Administration of the Royal Government of Thailand. The workshop was initiated as a project of the Energy Conservation Services Program (ECSP), a centrally-funded project of USAID's Office of Energy. Hagler, Bailly & Company, as the prime contractor for ECSP, organized and ran the Workshop.

These proceedings are presented in two volumes, the first covering energy conservation, the second private power generation. The proceedings contain papers presented at the Workshop, a summary of the information presented and conclusions reached, and summaries of the many discussions. Many papers were followed by a question and answer period and general discussion, summaries of these discussions can be found following each paper. The final agenda is included as Appendix A and a list of all attendees and their addresses is presented as Appendix B.

Questions about the Workshop should be addressed to one of the following:

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