DOE/ID/12850--5

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NATIONAL GEOTHERMAL ASSOCIATION
TRADE MISSION TO CENTRAL AMERICA

Topical Report

October 1992

DISCLAIMER

Work Performed Under Contract No. DE-FG07-89ID12850

For
U. S. Department of Energy
Office of Industrial Technologies
Washington, D.C.

By
National Geothermal Association
Davis, CA 95617-1350

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Prepared for the
U.S. Department of Energy
Under DOE Idaho Field Office
Sponsored by the Office of the Assistant Secretary
for Conservation and Renewable Energy
Office of Industrial Technologies
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NEW DIRECTIONS
FOR THE UNITED STATES GEOTHERMAL INDUSTRY

A Report of the National Geothermal Association
Central America Mission

EXECUTIVE SUMMARY

The United States (U.S.) geothermal industry, the world's most technically proficient, has been unable to achieve penetration into the markets of the developing nations. This report details the findings of an industry Trade Mission to Central America, tasked with determining the reasons for this shortfall and with developing a U.S. industry geothermal export strategy designed to achieve immediate and long-term export benefits.

The Trade Mission found that each visited country (Guatemala, El Salvador Honduras and Costa Rica), has substantial amounts both of proven geothermal reserves suitable for immediate development, and reserves with great potential. Each country visited is in financial difficulty, and in order to reduce reliance on external financing sources, each is tentatively receptive to private sector power development. Because U.S. firms are virtually never able to meet the concessionary tied-aid terms offered by other countries and their industries, an approach which would allow U.S. industry to export its project financing in a package with its technology is essential if the industry is to be competitive. Moreover, industry and U.S. government resources must be focused on developing within the Central America governments a greater receptivity to private sales of power to the public grid at a reasonable profit.

The Trade Mission concluded that a U.S. geothermal energy export strategy must contain two elements: (1) U.S. industry must organize to be a horizontally and vertically integrated export force; and (2) the U.S. government must add its political muscle and financial resources to industry's export efforts. To implement this strategy, industry and government, working in tandem, must develop technologically sound and economically viable export products and services which can be expeditiously financed by U.S. government and multinational financial institutions. A coordinated educational effort both as to the policy advantages of private power sales to the publicly owned Central American grids, and as to the technological and economic advantages offered by U.S. industry must be initiated. Information flow among industry, host governments and the U.S. government must be institutionalized, effective and current; and mechanisms for longer-term industry/host country relationships should be set in motion.

Government and industry must initiate a program now which will establish a strong U.S. geothermal presence in Central America if the industry is to establish itself as a significant export force in the region. *The key recommendation of the mission is that a field be targeted and a unified government - industry effort be launched to obtain a designated field for U.S. exploration, development and production as an export model for Central America and the other market countries of the developing world.*

This effort is in addition to, and would not preclude, individual industry efforts to develop other opportunities in the region and worldwide. Such efforts should include both prepositioning industry so that it may be responsive to host country RFP's, and developing a program to export small, modular, mobile units to the captive factory/mine/agricultural cooperative markets.

In order to effect the Trade Mission's recommendations and in order for the industry to survive in international competition, it is requested that the Secretary of Energy, acting through the Committee on Renewable Energy, Commerce and Trade (CORECT) establish a task force to work with industry to focus the financial assistance programs and the political influence of the U.S. government on implementing a geothermal export plan. Initially, focus can be given to develop 50-60 MW of production at the candidate sites of Tecuamborro (Guatemala), Platanares or San Ignacio (Honduras), Rincon de la Vieja, Tenorio or Miravalles III (Costa Rica). In addition, U.S. participation in the development of Amatitlán or Miravalles I or II is possible under Interamerican Development Bank financing.

The industry recognizes that political, economic, social and resource differences among the Central America countries are very real, and great care must be taken to avoid the trap of designing a universal model without also allowing for host-country uniqueness. Moreover, the industry recognizes that the problems it has experienced in developing an export market are symptomatic of the problems of U.S. industry in general and that industry — specific solutions are intertwined in the national debate over trade promotion policy. Nevertheless, industry export efforts may be given a quantum boost by focusing on a U.S. model project in one of the four countries.

The time is ripe for the U.S. geothermal industry to offer private sector energy to the developing nations, but success cannot be achieved without the whole-hearted support of the U.S. government.

INTRODUCTION

I. OVERVIEW

The United States (U.S.) geothermal industry is the most experienced and technically proficient explorer, developer and producer of geothermal energy in the world. Forty-five percent of the 5059 megawatts of power produced by geothermal power plants worldwide (1987) are in the United States. The world market for hydrothermal renewable energy resources is enormous -- an estimated 3.8 million megawatts over the next thirty years. Nevertheless, United States industry has not proven to be competitive in exporting its geothermal technology. It has been closed out in the European Economic Community and the developed countries in the Pacific Rim, and it has not been gaining ground in the developing countries. These industry-specific problems are symptomatic of the downslide of U.S. exports generally, and industry-specific solutions to these problems are intrinsically involved in the national trade promotion policy. Nevertheless, the United States geothermal industry is ideally poised to penetrate a relatively unexploited market and is thus capable of being developed into a successful model export industry -- a model with broad application to the alternative energy industry and, perhaps, to industry across a broader spectrum.

A National Geothermal Association (NGA) Trade Mission, co-sponsored by the Department of Energy and the United States Agency for International Development under the auspices of the Los Alamos National Laboratory was dispatched to Central America June 19 to July 1, 1989, to identify the issues attendant to penetrating the Central American market. The mission visited Guatemala, El Salvador, Honduras and Costa Rica. Panama and Nicaragua (with the second highest geothermal energy in Central America) were excluded from this visit, but should be included in future missions if political circumstances allow. This paper details the findings, conclusions, and recommendations of the mission in context of the Central American Model.

II. LESSONS LEARNED

1. The four-country market has a considerable geothermal potential of between 2,070 to 6,700 megawatts. Their combined present total installed electric power capacity is 2,776 MW.
2. Guatemala, El Salvador, Honduras and Costa Rica, have each identified substantial fields which are capable of rapid development and production.
3. All four countries suffer hard currency deficiencies which cause their energy development decisions to be based not on energy plannng and technolgy considerations, but also on the availability of soft loans.

4. U.S. government and U.S. industry are not coordinating efforts effectively. Consequently, the U.S. does not capture its fair share of multinational institutional aid and is frozen out when confronted with foreign government offers of soft bilateral loans. The U.S. geothermal industry faces especially strong competition from the Europeans, Mexicans and Japanese. This competition is not only technical but financial. Although the United States has made a number of prefeasiblity study grants (which have resulted in valuable work by the exploration sector of the industry), the development and production sectors of the industry have been unable to capitalize on the initial United States groundwork (as Italian industry has done). There are a number of reasons for this shortfall:

   - U.S. government commercial/diplomatic personnel are unable to advocate as strongly for U.S. industry as are the representatives of competing, single-industry governments, *i.e.*, govenments whose geothermal industry is consolidated for export purposes rather than competing internally for export opportunities;
   - Because foreign competitors are not subject to a Foreign Corrupt Practices Act, the playing field is unlevel for U.S. industry;
   - Foreign governments have marshalled low-interest-rate, long-grace-period loans in anticipation of (not in reaction to) energy development, and have done so in a manner linking their own industry without apparent violations of General Agreement on Tarriffs and Trade (GATT);
   - The United Nations Development Program (UNDP), who historically has taken the lead role in Central American geothermal assessments, prefeasibility studies, generally contracts with European firms for their technical assistance at no cost to the developing country (all costs are subsidized by the contracting nation). This is good for the recipient country but it very effectively prevents any prospective U.S. participants from bidding on these projects since the products and services are all part of subsidized grant/loan packages;
   - U.S. industry has not prepositioned itself in the host countries to respond to multinational institutional RFP's as successfully as its foreign competition.
   - Our competitors have subsidized, in-country representatives and export trade officers who are constantly promoting their geothermal products and technologies. Experience has shown that the competition, because they are well represented in the Central American countries and are presently working on Central American geothermal projects with the national utilities, have technical and financial packages prepared and are ready to negotiate field development with the host government shortly after the financial geothermal resource report is accepted or the wells are tested and proven. By comparison, it now typically takes the U.S. geothermal industry three to six months to develop and present a financial and technical proposal; more so if innovative financing is involved.

5. The four-country market appears ripe for a U.S. industry initiative to promote private sector development of power to the host country grid. All four countries have expressed receptivity to private sector ownership of independent power generating capacity; however, a legal structure conducive to private energy investment is not fully in place. Two preconditions are essential for private sector investment in geothermal power plants:

   (a) provision for the long-term leasing of geothermal resources;[1]

   (b) provision for sale of power to the public utility-owned or government-owned grid;[2]

   In addition, prospective private investors selling power to Central American public utilities must be mindful of the need to secure guarantees of hard currency in payment of profit or repayment of debt.

There is no requirement that comprehensive legislation covering geothermal concessions or power purchase be in place prior to private investment. Indeed, the same results may be achieved through a contract to which the government is a party. Nevertheless, the prospective private investor in geothermal resources must evaluate the risk of entering into concessional and power purchase agreements in host countries which have not enacted a specific legal framework.

III. ELEMENTS OF A U.S. GEOTHERMAL ENERGY EXPORT STRATEGY

Based on these lessons learned, it is appropriate for the U.S. geothermal industry, in cooperation with the U.S. government, to establish a geothermal energy export strategy for the Central American market. This strategy must be applied within the unique resource, social, environmental, and institutional situation of each country in Central America.

What are the overall objectives of the geothermal energy export strategy?

FIRST, to organize U.S. geothermal idustry members so that they may approach the Central American market as a cohesive export force. Such organization should result in an ability to create opportunities for U.S. export, to obtain information on government multinational RFP opportunities at the developmental stages, and to disseminate informaton on U.S. technological capabilities to host country decision makers.

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[1] Guatemala is the only country which has enacted legislation authorizng the private exploration and development of geothermal sites. Honduras has granted one private concession on the basis of its mining laws. Neither El Salvador nor Costa Rica has determined a legal approach, although both have tentatively concluded that a private concession is not prohibited.

[2] Costa Rica is alone in having enacted power purchase legislation but has expressed reservations about whether geothermal resources were contemplated under its legislation. Nevertheless, the other three countries have indicated receptivity to negotiating power purchase agreements on a case-by-case basis.

SECOND, to achieve U.S. government support for U.S. private sector initiatives to supply necessary energy services, technology, and capital in order that the Central American countries may achieve self-sustaining solutions to energy problems. Politically, the U.S. government, with the institutional conditions to maximize the opportunity for both host country governments and related multinational lending institutions to be receptive to U.S. private sector support of industry, would work to achieve financial packaging (suitable to geothermal energy exploration, development and production), which places the industry on a level playing field vis-a-vis competition — competition which is increasingly dependent upon the use of tied aid by official foreign lending institutions and is not subject to Corrupt Practices Act penalties.

IV. IMPLEMENTATION OF U.S. ENERGY STRATEGY

1. Organize the U.S. geothermal industry as a more effective export force.

   - Apply to the Commerce Department's Office of Export Trading Company Affairs for a certificate of review to protect cooperating companies from state and federal antitrust actions related to export trade.

   - Establish a mechanism for expedited two-way communications between the host countries and the U.S. geothermal industry. The industry should seek ways to institutionalize this communications flow, the components of which may include: regularized trade and reverse-trade missions, maximize use of existing U.S. government services already establishing host country private sector agents/facilitators responsive to U.S. industry export information requirements.

   - Develop an export model power system which maximizes U.S. equipment export, economies of scale, and return to the investor. Such a system may be established on modular approach, *e.g.*, a 50 MW system can be installed in 5 MW or 10 MW stages. The goal would be to bring the cost per kW average capital cost and the cost per kWh levelized energy cost of smaller (10 MW) projects, closer to the costs of larger (50 MW) projects.[3] The mobility of small scale plants should be an important selling factor in developing such a model. Similarly, export models may be developed by the exploration/development sectors of industry working in conjunction with the production sector.

[3] Based on figures supplied by some industry analysts, the goal would be to bring the $2,350 per kW average capital cost/6.6¢ per kWh levelized energy cost of the 10 MW project, closer to the $1,715 per kW average capital cost/4.1¢ per kWh levelized energy cost of a 60 MW project.

- Develop a detailed, current information base on the resource development and production opportunities in each host country.

- Develop a detailed information base allowing analysis of third country competition -- both as to methods of operation and financing.

- Develop a concrete, industry-wide business plan for institutionalizing export facilities services which may include the benefits of an Export Trading Company, Foreign Sales Corporations, computerized data banks, Foreign Trade Zones, and so forth.

- Reconcile internal industry competition among the vertical industry sectors — exploration, development and production. Producers advocate expedited exploration and development, and lobby to go directly to low megawatt production to prove feasibility; the exploration sector urges meticulous prefeasibility and feasblity assessments in order to assure rational resource allocation and conservation. This internal sector competition is healthy, but financially motivated advocacy by individual companies may affect technical judgement and delay export opportunities.

2. Establish host country policies conducive to U.S. private sector development of geothermal resources.

- Development of host country receptivity to U.S. private sector initiatives to supply power financed by the private sector is dependent upon host country receptivity to: (a) long-term leasing of geothermal resources; (b) private power sale to the government-owned utility/grid system; and (c) institutionalized host-country ability to interface between the public and private sectors (*e.g.*, PURPA-like authority). All four countries visited by the Trade Mission requested industry input on the power purchase concept. U.S. industry has the technical/legal resources to develop a model approach which can be tailored to the individual country, provided that the U.S. government will assist in funding such an undertaking and by interceding with host country governments.

- U.S. diplomatic efforts should be marshalled to identify and encourage the host country to designate a geothermal field for the exploration, development and production by U.S. industry with U.S. government grant, loan and guarantee assistance.

- AID missions should be educated by industry so that the missions may effectively incorporate geothermal energy considerations into project design and planning.

- Expressions of interest by the higher levels of the U.S. government would be beneficial in focusing host country resources and attention. U.S. government liaison at the higher levels of the host country is needed to minimize the effect of shifts in the lower bureaucracy which has proven problematic to U.S. industry — knowledge of

agreements in principle reached by lower level bureaucrats assigned to interface with U.S. industry have often times dematerialized overnight.

- Establish a long-term program for targeted countries to educate country and utility management planners in the advantages of geothermal power in general and the preeminence of U.S. industry in specific. For example, one-month exchange programs funded jointly by U.S. industry and government would provide contacts and shape allegiances for the future. This approach has served Italian industry well.

3. Establish U.S. government financial assistance packages conducive to commercial development of the Central American Market.

- For U.S. industry to be competitive, the U.S. government and industry must jointly develop innovative financing schemes to assist in the penetration of rural and urban energy markets. Obstacles to such financing must be identified and addressed. For example, energy investment is inherently an infracture investment and thus, unlike manufacturing or tourism investments, does not produce hard currency (other than by displacement of import oil). Thus, traditional international project financing could be precluded if the lead U.S. government agencies are not receptive to the additional degree of additional risk sharing created by energy projects' dependence on host country soft currency for income. CORECT is an appropriate vehicle to marshall a collective U.S. government list of the obstacles which the lending/grant institutions identify as a deterrent to geothermal project financing, and to coordinate a joint government-industry solution to overcoming or ameliorating those obstacles.

- CORECT, the industry's designated ally in the Executive Branch, has untapped potential to mobilize its interagency members in support of industry efforts; however, to this date, it has not fully realized the intended results of its mandate. Two actions which may serve to strengthen CORECT's ability to support the industry are suggested: (1) CORECT task forces should be given specific, task-oriented mandates, and an interagency staff should be assigned to this task force to implement this mandate, each of whom has clearly drawn authority and responsibility; (2) CORECT might consider ways to strengthen its policy/policital clout in order to achieve the interagency consideration required to achieve concrete results. For example, either higher level policy makers take a more direct role in CORECT, or CORECT or a specific CORECT task force be brought under the umbrella of the Executive Office of the President.

- Financing is key. Existing programs need to be reviewed with the geothermal export model in mind and inactive programs need to be revitalized. In this regard, special attention should be paid to revitalization of the geothermal loan guarantee program and

applying it internationally. *See* Geothermal Energy Research, Development and Demonstration Act of 1974, 30 U.S.C. et. sec., as amended (placed in abeyance in 1982). If existing programs or current policies prove inadequate to enable U.S. industry to compete, new, innovative thinking needs to be encouraged.

- The U.S. Congress needs to be educated and mobilized in support of industry objectives. If the U.S. Executive cannot be responsive, stronger Congressional lobbying needs to be initiated by the geothermal industry.

- U.S. lending institutions need to be convinced of the viabilty of smaller-scale financing.

- Expansion of risk-sharing via feasibility studies and other explicit support such as targeted use of AID programs currently not directly applied to geothermal energy (such as the AID commodity import system to facilitate U.S. private sector ventures to transfer, adopt and market cost-effective rural energy systems) may be coordinated through CORECT.

V. COUNTRY-SPECIFIC CONCLUSIONS AND RECOMMENDATIONS

1. *Guatemala*

The Guatemala government is under considerable pressure to expand power to the rural consumer and to decrease the country's dependence on one major hydro-electric power plant (Chixoy) for base load generation. These pressures, coupled with serious electric utility financial difficulties, have engendered government receptivity to private sector generation of power. Thus, the government and the national utility INDE appear receptive to the concept of a U.S. built, owned operated power generation facility. The geothermal fields at Tecuamburro and Amatitlán appear ripe for commercial development, provided that U.S. industry, in conjunction with the U.S. government, can come forward with a financing package and concomitantly negotiate a satisfactory geothermal lease/power purchase arrangement with the host government utility.

2. *El Salvador*

The current political turmoil in El Salvador has a chilling effect on U.S. private sector investment. Nevertheless, it is the most advanced geothermal producer in Central America — the only one of the four visited countries with an on-line geothermal base load. Consequently, the country's five-year development plans for the Chipilapa and Ahuachapan fields appear to offer concrete

opportunities for the development of small (3 to 5 MW) production projects and potentially larger scale development in both. Opportunities in Berlin and other potential areas are limited because of anti-U.S. guerrilla presence in those areas. United States industry opportunities in El Salvador may be dictated, almost exclusively, by the U.S. government's ability and desire to stregthen the country's infrastructure with U.S. private sector investment. Third country soft loans have already predetermined the country sourcing of many of these projects. Although the Central American Bank for Economic Integration indicated a host country private sector investment potential, political considerations preclude this alternative from being considered seriously at this time.

It appeared to the mission that U.S. industry's entrance into the El Salvador market depends on the U.S. government's political assessment of whether it is in the mutual interest of both governments to encourage energy infrastructure development by the U.S. geothermal industry.

3. *Honduras*

Unlike its sister countries, Honduras has no lead organization for the formulation of national energy policy. This situation fosters U.S. private sector opportunity while simultaneously creating less certainty in negotiating contracts. Nevertheless,-one can secure geothermal concessions from one agency and a power purchase agreement from another without engaging the entire breaucracy. The Platanares site is in many respects an ideal site for a U.S. geothermal demonstration project technically feasible, operationally manageable and with rural electrification potential. More exploration and resource evaluation assessments would probably be needed at Platanares or at prime sites at San Ignacio and Azacalpa before private investors would consider these sites as having proven potential for commercially viable generating plants. Thus, these sites are candidates for feasibility study grants from appropriate U.S. government agencies.

4. *Costa Rica*

Costa Rica's decisive policy to bring power to isolated areas has resulted in the installation of the most comprehensive grid system in Central America, reaching 82 percent of the households (in contrast to approximately one-third of the households in the neighboring countries). However, in order to reduce reliance on large-scale external financing sources for utility-based power generation expansion, Costa Rica has enacted the regions' first power purchase law. This law, however, does not expressly extend to geothermal development. Costa Rica has already issued IDB-financed RFPs for Miravalles I. The expected issuance of an RFP Miravalles II will result in the production of 110 MW. Nevertheless, a U.S. financed 55 MW power plant at Miravalles III, would be entertained by the government at acceptable terms, and a build/own/operate or build/own/operate transfer approach

may be viable if the financing can be developed. Other than Miravalles, fields at Rincon de la Vieja and Volcan de Tenorio, which are in earlier stages of development, are suitable candidates for U.S. industry development.

5. CONCLUSION

The time is ripe for a U.S. government and industry initiative to develop a 50-60 MW, modular production facility at the candidate sites of Tecuamburro (Guatemala), Platanares or San Ignacio (Honduras), Rincon de la Vieja (practically within a national park), Tenorio or Miravalles III (Costa Rica). In addition, U.S. participation in the development of Amatitlán or Miravalles I or II is possible under Interamerican Development Bank financing. Economic, political and technological resources of both government and industry must be focused in order for this concept to succeed.

It is hereby requested that the Secretary of Energy, acting through CORECT, organize an interagency task force with the express mandate of working with industry (through the National Geothermal Association) to implement the recommendations of this mission.

VI. GUATEMALA

A. GEOTHERMAL BACKGROUND

Electric generation and distribution throughout Guatemala is provided by the Instituto Nacional de Electricidad (INDE), except in Guatemala City. Guatemala City (some 300,000-plus customers) electricity distribution is supplied by the Empresa Electrica de Guatemala S.A. (EEGSA), a utility formerly owned by ITT and 92%-owned by INDE. INDE is a government-owned enterprise reporting to the Minister of Energy and Mines, but in effect operates autonomously because of its revenue-generating capability.

Guatemala's total installed generating capacity is 595 MW, of which 89% is hydro-generated. The remaining capacity is in fossil fuel thermal plants. With the completion of the Chixoy hydropower system in 1986, Guatemala's generation system was changed from one heavily dependent on fuel oils to one relying almost entirely on hydropower from one source. Chixoy supplies approximately 87% of the country's power demand. The nation's dependence on Chixoy is, however, a matter of considerable strategic, economic and political concern.[4]

INDE has serious financial problems, and deficits of Q.100 to Q.150 million (2.78 Guatemala Quetzals (Q.2.78) = US $1 at the official exchange rate) per year are projected through 1991. INDE/EEGSA estimate a Q.618 million deficit between 1989-1991. IDB and World Bank oversight authorities have been pressuring INDE to increase electricity tariffs 65% by 1991 in order to (i) enable INDE to service its debts, (ii) cover about 25% of the investment requirements from internally generated funds, and (iii) reduce government subsides to about Q.40 to Q.50 million during 1989-1991. Previous attempts to increase tariffs have triggered significant political reactions and street violence. A 1988 increase of 22% resulted in a political backlash which shook the government. As the Minister of Finance (Ministro de Finanzas Publicas) personally stated to the Mission, *if putting our utility company into the black costs us our democracy, the price is too high.*

As a consequence of these converging technological, economical and political pressures, INDE and the current Christian Democrat administration in Guatemala are evidencing heretofore unknown

[4]The technical integrity of the Chixoy system itself is in question. The system, according to newspaper reports, was to be shut down for 3 days between June 30 and July 2, 1989 to install pressure-monitoring devices. There was widespread news media speculation, however, that pressure drops along the 26-kilometer-long tunnel connecting the dam to the generating plant are the true motivating factor for the shutdown, and that massive repairs to stop the tunnel leaks will be required.

receptivity to working in concert with the private sector to cope with the electric power crisis. They are especially cooperative in the development of the country's considerable geothermal and co-generation resources.

Guatemala has the potential for hundreds of MW of geothermal electric-power generation. This resource potential has been the subject of considerable study since 1971. In part because of INDE's decision to concentrate on development of its hydropower sector, not one kilowatt of geothermal electricity is being generated in Guatemala as of this date, despite expenditures to date of the Quetzales equivalent of US $25 million in several studies over this 18 year period. Only Zunil I, a 15 MW plant being coordinated by the American firm Morrison-Knutson, is under active design and is scheduled to go on line in 1992 or 1993. A second geothermal facility of 55 MW is under consideration, pending prefeasibility studies of the geothermal areas of Amatitlán and Zunil II, scheduled to be completed in October 1989 and May 1990 respectively. The IDB-funded feasibility study comparing these two potential geothermal sites (to be completed by the end of 1991) will determine the location of the second geothermal plant.

Discussions with Andrés Caicedo, manager of geothermal projects for INDE, indicate his willingness to accept US participation in geothermal development in Guatemala. Because of anticipated growth in demand, the need to diversify away from one major hydro-electric power plant (Chixoy), and the financial weakness of INDE, power generating shortfalls and blackouts are expected during the coming decade. Caicedo said that INDE is planning the purchase of an oil-fired thermal plant to increase its generating capacity. This will further increase INDE's electric-power generation which in turn will place pressure on INDE to increase tariffs to pay for imported fuel oils. This could cause, serious political and economic problems, as noted above.

Subsequent conversations with Edgar Flores, INDE planning director, confirmed that INDE already has purchased a 100 MW bunker-fuel thermal plant scheduled to begin electric-power generation in 1993. Flores indicated that the anticipated cost per kWh represents a good purchase price for INDE at this time. He also stated that the 15 MW geothermal plant being designed for Zunil will be put for bid in early 1990.

With this background, the Trade Mission explored the potential for US private industry to participate in the development of geothermal resources, not only in the traditional pattern of selling goods and services to Guatemala, but also in exporting US project financing (in conjunction with the US government), in an effort to offset the successful Japanese, European and Mexican competition. The competition has enjoyed success in the Central American market

largely as a result of "tied aid" for resource development, grants, low-interest, long-term government loans, and the absence of inhibitions such as found under the US Foreign Corrupt Practices Act.

The Trade Mission understood the government's (and thus INDE's) strategic interests in ownership of its natural resources, especially their geothermal resource and in public-sector production of electricity. Within this context, however the Trade Mission expressed its belief that continued expansion and diversification of Guatemala's power generation is also of strategic importance. The Trade Mission thus explored the receptivity by the Government to 3 concepts: (i) build, own, operate (BOO); (ii) build, own, transfer (BOT); or (iii) build, own, operate, transfer (BOOT), by US private industry, not as a vehicle for imposing an American political presence in Guatemala, but as a vehicle for providing development capital at a time when alternative approaches are constrained. The Trade Mission also made it clear that while innovative approaches were being suggested, the US industry was equally interested in being allowed the opportunity to bid competitively for geothermal projects.

The Government response to the Mission's concepts was consistently positive. The Minister of Energy and Mines (whose ministry has historically expressed opposition to any private ownership) stated that a privately financed and owned operation would be given, *the most serious of consideration.* The Minister of Finance stated that the Ministry "and the National President" would support the private ownership of electrical generation facilities, and further stated that as long as the electricity was sold to the grid there would be no reason to transfer ownership to the State (*you have proposed a BOOT, I suggest you remove the T*). INDE stated that it had no institutional objections to private power generation and invited US industry to participate (within the Guatemala's regulatory framework) by submitting a generic model of how said agreements could be executed (for example, power purchase agreement, mineral lease agreement, etc.). The Ministry of Energy and Mines indicated that the geothermal industry was in a situation similar to the petroleum industry a few decades ago, with similar opportunities for development.

The private sector reaction was equally encouraging, as was the response of the international banking community. The Guatemalan Industrial Chamber of Commerce indicated the political wisdom of a US-Guatemalan private sector joint venture--a theme consistently echoed elsewhere, including the Ministry of Energy. In addition, it was suggested by the IDB that private sector generation of power might encourage INDE and the Government to deal more directly with public-private tariff issues.

Pursuant to Acuerdo Guvernativo (Government Agreement) Numero 967-86, the Ministry of Energy and Mines granted 5 major geothermal sites to INDE on December 23, 1986, as allowed by Guatemala Law Number 126-85, for INDE's exclusive development: Zunil, Amatitlán, San Marcos, Moyuta and Tecuamburro. The 5 sites presently represent the most attractive areas for geothermal power generation development in Guatemala.

From the perspective of the Ministry it would be relatively easy to redesignate, with INDE's approval, San Marcos, Moyuta or Tecuamburro for exclusive US geothermal industry development. Because INDE is actively developing Zunil and exploring Amatitlán, any development there would have to be established in conjunction with INDE. For its part, INDE stated that its primary objective was to get Zunil and Amatitlán on-line as soon as possible, to satisfy the growing demands for electricity.

The principal deterrent to the acceleration of geothermal development in Guatemala is financial. INDE would consider allowing US development of essentially any geothermal field in Guatemala if the financial and technical package were sufficiently attractive to INDE. Nevertheless, the potential loss of the IDB prefeasibility and feasibly study grants are a major consideration for INDE and would have to be worked out between IDB and INDE. IDB, for its part, stated that the sooner plants are on line, the better, and that it could conceive of no objection on its part of accelerating geothermal/electric-power production. Well-head generating units could be installed and producing needed electricity on those sites where production wells already exist within 9 to 24 months. The objection to this alternative appear more driven by short-term economics and politics than long-term electrical production benefits.

As to the 3 areas (San Marcos, Moyuta and Tecuamburro) that are not currently being developed by INDE, INDE indicated it would release its proprietary information only if a recovery of developmental costs were negotiated, even though most or all of this information came from international grants. This economic decision is not one conductive to promoting private sector acceptance of commercial investment cooperation; however, it was the consensus of the Trade Mission that the official government policy was uncertain.

B. TECHNICAL FINDINGS

An inventory of the major geothermal areas in Guatemala has been done throughout the years by various organizations, under various economic grants, in coordination with INDE. Copies of the studies were not provided to the Trade Mission by INDE. Six major geothermal areas were discussed with INDE and other agencies: Zunil, Tecuamburro, Amatitlán, Moyuta, San Marcos,

and Ipala. Three of the sites were visited by the Mission Team: Zunil, Tecuamburro, and Amatitlán. The several sites are in widely differing stages of exploration and/or development:

Zunil I:

Zunil I is about 12 kilometers from Quetzaltenango in the central highlands of Guatemala. The development site is about 2 by 2 kilometers square. Six wells have been drilled to depths of 800 to 1,300 meters. Four of the wells are probably producible. Definitive well tests are now being conducted. Locations are on hillsides (similar to The Geysers geothermal field in northern California). Accessibility is reasonably good, with some additional road work required. All wells are drilled as straight holes. No directional drilling was considered. Studies need to be done to determine the economic savings of drilling more than 1 well from a single pad.

Morrison-Knutson, as stated above, is coordinating the design and engineering of a geothermal plant of approximately 15 MW based on the results of the current resource evaluation being conducted by GeothermEx, Inc., another American firm and the results of 3 additional wells to be drilled starting about January 1990. The resource appears suitable for a condensing flash plant. A binary system probably could be used to increase output, by utilizing surplus hot water from a single-flash plant. The Mission Team was not given data on the fluid chemistry for Zunil. That information and the concentration and composition of gases will be needed for the detailed plant design. Los Alamos and GeothermEx have been working at Zunil, and have access to this data.

The RFP for the drilling of up to 3 development wells will be put out for bid in late 1989. A Request for Quotation (RFQ)for the turbine manufacture and installation will be issued in early 1990. Both are funded by the IDB.

Zunil II:

This is a larger area surrounding Zunil I, in which are found a multitude of thermal springs and fumaroles. Western Japan Engineering Consultants, Inc. (WEST JEC), is conducting the prefeasibility study with IDB financing. This work includes geology, geochemistry and some geophysics. One or two slim holes (to about 500 meters) will be drilled in late 1989 or early 1990, using an IDB financed rig.

It is not yet decided where the slim holes will be located. Improvement to mountain roads may be needed especially if the locations are near the Banos Georgino hot springs. Transportation of the drilling rig, wellhead equipment, and any future power plant would be expensive, because of the terrain.

The Zunil II prefeasibility study is to be completed by mid-1990. The results will be compared to these of the Amatitlán prefeasibility study. The geothermal site showing the best results will be chosen for a feasibility study, to be also done by WEST JEC with IDB funding.

Amatitlán:

The existence of a high-temperature geothermal field is indicated from the geochemical, temperature-gradient and other studies conducted to date. The field is approximately 20 miles from Guatemala City, with major arterial access roads and nearby electric-transmission lines. The field has the greatest logistic advantages of any Guatemala geothermal area, could be developed in a relatively short-time frame, and might have the lowest cost for an initial 20 to 25 MW plant. It might be possible to drill, test, construct and start a plant of up to 20 to 25 MW at Amatitlán within 2 to 3 years. This could be an excellent field in which to test an NGA model for low-cost power generation in the shortest time frame.

The prefeasibility study is being conducted at Amatitlán by Electroconsult, an Italian company, under Italian government and OPEC financing: work includes geology, geochemistry and geophysics. Six temperature-gradient slim holes have been drilled (the hottest being about 175°C). Five were drilled to 500 meters and one to 700 meters. The prefeasibility report is due late in 1989. WEST JEC has again been selected by INDE for the feasibility study (IDB financing). Completion of the feasibility study is expected in 1992. An alternative proposal by Italy for all-Italian-financed development has been presented to INDE and is being considered. (1.75% loan with a 4 year grace period). UNOCAL has also expressed an interest in developing Amatitlán and a power sales agreement is being discussed with INDE.

The drilling of 4 production diameter wells at Amatitlán is to be performed in 1990-1991. They will be included in the same drilling contract as the 3 production wells at Zunil. A short list of drilling contractors has been developed which includes two US firms, one Japanese, two Mexican, one French and one Belgian.

Tecuamburro:

The prefeasibility work was done by Los Alamos. Additional drilling may be done under an Italian grant by the end of 1991 or early 1992 by a consortium for two Italian firms, Aquater/DAL. Existing work includes geology, geochemistry and geophysics (see the list of Los Alamos publications in Appendix B). Plans are to drill one or more slim holes to about 700 meters in early 1990. Geochemical studies indicate a high-temperature reservoir of as much

as 300°C. A good access road is needed into parts of the area. Existing roads are poor, steep and rock strewn.

There is a high potential for a high-temperature geothermal resource at Tecuamburro. Transmission lines are about 5 to 6 kilometers from the main thermal area. No funding is yet available for deep drilling and well testing. UNOCAL has also expressed an interest in the Tecuamburro site development.

Moyuta:

This site was explored from 1972 to 1976 by the Italian group Electroconsult with Italian, Guatemalan, IDB and other financing. Geology, geochemistry and geophysical studies were performed. Twelve temperature-gradient holes (500 meters) were drilled, plus 2 deep holes 900 to 1,000 meters, the highest measured temperature was 114 °C. It is now believed that the holes were located in an outflow zone, and not in the major upflow zone. INDE is now interested in re-analysis of data, leading to new drilling. No funding is available. Interest has also been expressed by UNOCAL.

San Marcos:

Prefeasibility work may be completed under an Italian grant in late 1990 or early 1991 by Aquator/DAL. They are to carry out a program of additional geology, geochemistry and geophysics, and perhaps will drill one or more slim holes to about 500 meters. Plans are still preliminary. No funding is available for deep well drilling.

Ipala:

Preliminary geology and geochemistry is being done, apparently by INDE. No external funding is available. There are no detailed plans for drilling or development, although INDE hopes to continue its work.

C. THE POTENTIAL FOR PRIVATE POWER GENERATION

The law governing private geothermal development is the Geothermal Law, Decree No. 126-85 of December 11, 1985. In form and substance it is similar to the Guatemala hydrocarbon development law. It allows the Ministry of Energy and Mines to execute risk contracts for the private exploration of a geothermal site for a period up to 25 years in exchange for a royalty, provided that electric power is generated. The private contractor would sell the power to INDE.

There is no prohibition on the "sale" of the electricity to INDE, but the question was raised by

the Ministry as to the private generation of electricity which is not specifically addressed in the Law.

Although the lack of implementing regulations for the geothermal law is of concern, the opportunity to help participate in the formulation of those regulations in a cooperative initiation of a venture may prove, on balance, an asset to the NGA. The major issues to be resolved in a regulatory framework include:

- INDE's acceptance of a long-term commitment to purchase steam or private-generated power; and
- acceptance by INDE of avoided costs or marginal costs as the basis of pricing the purchase of power, as distinguished from nominal costs if the supplied power is peak load, or the establishment of a commercially reliable ratio if the power is base load, must be determined.

At present there is no institutional framework in place to promote a rapid, streamlined process for private power generation in Guatemala. Thus, one must anticipate a relatively lengthy bureaucratic process unless the Administration is interested in the expedition of geothermal electric power. Furthermore, the unicameral Congress is taking an increasingly active and independent role in government, thus making it difficult for the national President to make unilateral decisions. Therefore, although the principal committee chairmen (Energy, Economy, Finance) were not consulted by the Mission Team they should be consulted at the earliest opportunity to determine their attitude on private power generation which could affect the implementation of the Law.

D. FOREIGN COMPETITION

At the present, several of the major geothermal projects in Guatemala are funded for at least the next stage of activity. An Italian firm is conducting the OPEC-IDB funded Amatitlán prefeasibility study. The Japanese firm WEST JEC is conducting the Zunil II prefeasibility study with IDB funding, and will perform feasibility study comparing the Amatitlán and Zunil II for further development. An Italian grant offered for work at Tecuamburro and San Marcos probably will result in an Italian study of those fields (despite the Los Alamos/USAID-financed study currently underway at Tecuamburro). A number of RFPs for slim hole drilling in both Amatitlán and Zunil II have been issued under IDB regulations and short lists of bidders have been determined.

RFPs for all major geothermal contracts financed by IDB or other multinational institutions are

published in the local newspapers. Our major competitors have local representatives in-country, or are working on major projects and may even assist in developing individual RFP. These same RFPs are also mailed to all of the foreign embassies in the country. If mailed, the RFP may take up to two to three weeks to reach the appropriate US official at the American Embassy. The American Embassy than drafts a cable and notifies the Department of Commerce, who in turn publishes the notice in the Commerce Business Daily and notifies select industrial trade organizations. The Trade Mission estimates that, at times, this total process may take 4 to 5 weeks. By the time an individual potential US bidder is notified, it may be too late to respond effectively as most RFPs have a 60 to 90 day response period.

Therefore, it would be very beneficial for the NGA to establish close ties to the commercial attache's office in the US Embassy in each of the Central American countries, or to have some other procedure for rapid notification of up-coming RFPs. It is also vital to enlist the support of the Department of Commerce in Washington in arranging for special notification to the NGA of known or rumored commercial opportunities. If the opportunities exist, it may become necessary for NGA to retain a local in-country representative or agent. Country registration or legal representation is not a prerequisite for bidding, but it is for legal matters and contract award.

The next major open IDB-sponsored RFP will be for (i) the drilling of wells at Zunil I and Amatitlán (1990-1991) and (ii) a power plant up to 55 MW for either Amatitlán or Zunil II, in about two years.

UNOCAL has proposed an unknown dollar amount risk contract for the development of Amatitlán and the production and sale of steam to INDE. This proposal is under consideration and study by the Guatemalan government and INDE.

E. UNCERTAINTIES

Several uncertainties need to be resolved, in order for NGA to clearly identify opportunities for US commercial activities:

1. The geothermal resources at Zunil I are still not proven at 15 MW.

2. The total geothermal generating potential is unknown at Zunil II, Tecuamburro, and Amatitlán, although there is a high probability that geothermal resources exist, as indicated by on-going studies.

3. There is an uncertainty of the existence of adequate resources at Moyuta, San Marcos or elsewhere.

4. The degree of competitive interest from Italy, France, Japan, etc., is high. What commitments would the US need to match their potential offers?

5. There are unknown and unpublished commitments made by INDE, or commitments now being negotiated. How can NGA get this information?

6. There are questions of the strength of INDE's commitment to continue with geothermal development after Zunil I and Amatitlán/Zunil II, and the new upcoming administration's commitment to geothermal development is a total unknown.

7. Geothermal law regulations need to be written and implemented, to allow private investment of geothermal resource exploration and development. How should the NGA proceed?

8. Pricing structures for the sale of steam or electricity to INDE must be worked out. What steps should NGA take at this time?

F. REQUIREMENTS FOR FURTHER ACTION

1. Publication of the regulations by the Government to implement the geothermal privatization law.

2. Release to NGA of completed results and studies for Amatitlán, Tecuamburro, Moyuta exploration to date.

3. Better assumptions on which to base (a) development cost estimates for each field, and (b) private sale of steam and/or electric power to INDE.

4. The continuous supply of reliable and timely information from US Embassy/AID-ROCAP regarding political and economic conditions in Guatemala, and/or the establishment of a local agent or representative.

5. The identification of competitive sources of financing for US geothermal activities in Guatemala.

G. OBSERVATIONS,IMPRESSIONS AND ASSESSMENTS

1. Despite geothermal projects extending back to at least 1972, INDE:
   - does not appear to have had a deep commitment to geothermal development until recently;
   - is cautiously awaiting results of development at Zunil before making additional commitments; and
   - has developed a small technical group relative to the anticipated future development, further suggestion of a wait-and-see attitude.

2. INDE has enjoyed significant offers of financial and technical support for geothermal projects: IDB, Italy, Japan, OPEC Fund, USAID. Therefore, INDE:
   - has been able to rely on expatriate technical help rather than developing a significant technical group; and
   - believes that it is able to continue to pick and choose among potential future financial offers.

3. After over 10 years of work at Zunil, the status of development and calculation of reserves is not far advanced. It remains uncertain how large the reserves are at Zunil I, although probably 15 MW can be supported. The larger Zunil II area is an unknown quantity, although an attractive prospect.

4. Amatitlán looks attractive; exploratory wells should be drilled to perhaps 1.5 to 2 kilometers. The same is true for the smaller area of Tecuamburro. Moyuta is worth a re-evaluation of the earlier (1972-1976) exploration data. The original drilling at Moyuta appears to have been based on a possible misinterpretation of geophysical survey data.

5. Except for Zunil I, all geothermal resources remain exploration projects, no more. No reliable estimate can be made of reserves at Zunil II, Amatitlán, Tecuamburro, Moyuta or elsewhere at this time.

6. The INDE technical staff have been trained largely by the Italians, and still has close ties to them. Recent efforts by the US (Los Alamos/USAID studies, NGA reverse trade missions, NGA short courses, etc.) are beginning to make an impression on INDE. This should be continued, with additional attention given to longer-term training residencies in USA.

7. INDE appears to be especially in need of help in:
   - assessment of exploration data/results;
   - drilling of larger-diameter (>3 inch) holes;
   - reservoir engineering, including computer modeling; and
   - operation of geothermal production systems.

8. Any proposal should include:
   - training in the USA for selected INDE technical staff;
   - free assistance to reassess exploration data from other geothermal prospects;
   - strengthening of INDE's geothermal computer data-processing (hardware and software); and
   - offers to further strengthen the infra-structure (roads, field vehicles, field camps, test facilities) available to INDE. Some (all?) of these may be suitable for funding by US Aid or other US funding sources.

9. In the past, INDE has moved very slowly on project approvals, award of contracts, etc. This slow pace can be expected to continue, at least until Zunil I is proven commercially successful. Faster availability of grants or low-cost financing may increase after that.

H. CONCLUSIONS AND RECOMMENDATIONS

The time appears right for a US geothermal initiative in Guatemala.

1. An annual 10% increase in the demand for electric power places enormous pressure for the expansion in INDE's electric-generation system.

2. There has been an over-reliance on one large hydro-electric plant.

3. Geothermal power appears to be available in quantity. Although it has been studied for many years, it appears to be commercially exploitable now.

4. The political will to allow private development of electricity appears to have been reached. A serious proposal would nudge privatization into being.

5. An initial effort for a BOOT contract could be costly and time-consuming because the institutional framework for implementation is not in place.

6. To initiate serious discussions, INDE has requested the submission of an NGA generic model, including power purchase and related agreements which describe the concept. Dollar amounts and detailed implementation would come later.

7. Financing is the key to the successful development of the geothermal resources in Guatemala. There is virtually no public nor private capital for the financing of large infrastructure projects in Guatemala. Although Guatemala is up to date on its multinational institutional loans, has repaid some capital, and has legislation in place which insures continuity, its debt burden is critical. Thus, if the US geothermal industry, with government and/or private assistance, can provide long-term financing with delayed interest payments and simultaneously expedite the development of geothermal energy, the opportunity to capture this market is there.

8. On-site observation coupled with comments from INDE led the Mission to conclude that Amatitlán offers the most immediate potential to US industry for private power generation and direct heat industrial use. Both Zunil II and Tecuamburro are more remote, less advanced in exploration, afford difficult access, and would require considerable infrastructure expenditures. Moyuta appears to offer less immediate opportunities. Little is known about San Marcos. INDE believes that it has two options to create geothermal generating capacity:
   - Purchase the generating plants. US Industry will have to compete with foreign subsidized loans similar to the following proposed financing: (i) The Italians are offering US $150 million at 1.75% for 40 years, with a grace period of 4 years. (ii) The Swiss are offering a package that is 35% grant and 55% loan, with a 20-year period, and the loan portion at 1% over prime Swiss foreign rate (about 4-5%).
   - Purchase energy from other countries, or from private companies such as UNOCAL, who according to INDE have offered to invest up to $100 million in a geothermal development at a site of UNOCAL's choosing.

I. US GEOTHERMAL INDUSTRY OPPORTUNITIES

1. A drilling contract for 3 production wells at Zunil I and up to 4 holes at Amatitlán with IDB funding will be put out for bid by late 1989.

2. The Zunil I IDB-funded turbine/plant-construction contract for a nominal 15 MW will be let out for bid in early 1990.

3. An offer by an American firm has been made to install a mobile 3-5 MW wellhead turbine-generator to be placed at one Zunil well until that well is needed to supply Zunil I in 1993 (a maximum of 3 years operation). No financing is presently available for the offer.

4. INDE has discussed calling for competitive bids to drill and develop Amatitlán, either in small (3 to 15 MW) increments or as one larger plant. The plant size will be determined by prior drilling and testing. Competitive interest exists (Italy, IDB, Japan, and others). No funding is yet available for such development. If funding becomes available the first wellhead unit could be installed by the end of 1992 or early 1993.

5. The situation at Tecuamburro is similar to Amatitlán. Competitive interest has been demonstrated by Italy and UNOCAL, but no financing is presently available. It might be possible to install the first wellhead unit by 1993-1994.

6. Moyuta is similar to Amatitlán and Tecuamburro but would require larger lead time for development. There is a possible interest from UNOCAL.

VII. EL SALVADOR

A. GEOTHERMAL BACKGROUND

The Commission Ejecutiva Hydroelectrica del Rio Lempa (CEL) is the quasi-governmental electric power generator and distributor of El Salvador. They have an installed electrical generating capacity of over 600 MW. It is the most advanced geothermal industry in Central America, with 95 MW of installed geothermal generating capacity. This represents about 37% of the country's electric-power base load capacity--a figure projected by CEL to remain constant for the next decade.

El Salvador has several hundred MW of geothermal resource potential. It plans to put on-line an additional 225 MW by the year 2000. CEL's 10-year power development plan includes the development of 5 geothermal areas: Ahuachapán, Berlín, San Vicente, Chipilapa and Coatepeque. The Ahuachapán field was allowed to run down due to the lack of financial resources and the guerrilla activity. A renovation effort is now underway, and financial sources are being investigated. These include the Central American Bank for Economic Integration (CABEI) and the government of Japan. Small grants have been obtained for studies from Mexico and USAID. Belgian funding will be used to support a Belgian drilling contractor and turbine manufacturer in the development of the first stage of the Berlín site. France, in concert with the IDB is financing the first 2 phases of the drilling and well testing at Chipilapa. The Government of Italy is funding the first stage of exploration in Coatepeque. Subsequent stages of activities in all 5 areas are open for additional financing.

The June 1989 change in government hampered the Trade Mission's ability to evaluate CEL's reaction to our suggestions for private development of the geothermal resources. The new head of CEL's geothermal division took office the day we arrived, the new president of CEL was out of the country, the new executive director was uninformed about the visit, and no visits could be scheduled with the government ministers responsible for energy and natural resources because they had not been appointed. Nevertheless, the technical staff was well prepared for the visit and the quality of the geothermal operations, facilities and expertise bespoke a high degree of professionalism. The ability of the CEL staff was clearly very high during a time of great political and economic transitions. This indicated organizational stability and competence.

As in Guatemala, financing is the essential element in gaining access to the Salvadorian geothermal market. However, by law and by principle, CEL alone is responsible for geothermal

development and electric-power production and transmission. The Canadian-owned company that managed power transmission and distribution to the greater San Salvador metropolitan area was absorbed by CEL in 1981 after 50 years of operations. CEL officially advised that it was *difficult to think in terms of private production of geothermal electric generated power on a long term basis as CEL is the geothermal electrical production authority.* However, CEL stated its interest in the purchase of US services and equipment if financing could be arranged to CEL's best interest. CEL noted their perception that the lack of US geothermal industry presence in El Salvador was primarily the result of a lack of interest by American companies. The technical expertise of the United States was a known fact, and CEL expressed a receptivity to any proposal which makes financial sense to CEL.

CEL expressed concern about possible Salvadorian private-citizen participation. Whereas US private investment might be acceptable, local private participation might create political problems, unless CEL is to nominate the local investors. In contrast, the Central American Bank for Economic Integration (CABEI) indicated that private investors in the western departments of Santa Ana, Ahuachapán and Sonsonate, which encompass the Ahuachapán and Coatepeque geothermal fields, might be interested in joint ventures with US companies.

B. TECHNICAL FINDINGS

The security briefings provided by US embassy security officers indicated to the Trade Mission that a risk of guerilla activity exists almost everywhere in the country. However, the areas of Ahuachapán and Chipilapa, in the far western part of El Salvador, are relatively free from these problems. By contrast, the areas of Berlín and San Vicente are difficult to develop as they are considered dangerous zones by the Salvadorian government

GEOCEL (CEL's geothermal division) provided the Mission Team with considerable technical information concerning the Salvadorian geothermal resources and CEL's future development plans. CEL's geothermal development projects need an estimated US $860 million between now and the year 2000 to maintain CEL's projected 35% base load generated from geothermal resources.

The Mission Team visited 3 geothermal sites: Ahuachapán, Chipilapa and Coatepeque. As mentioned earlier,there is one producing field (Ahuachapán), two previously drilled prospects (Chipilapa and Berlín), and several attractive prospect areas in varying stages of exploration (including Coatepeque, San Vicente, Chinameca and at least 6 others).

Ahuachapán:

CEL has 95 MW of installed capacity in 3 power plants (built by Fuji and Mitsubishi). Of a total of 32 wells drilled in the 1/2 square kilometer field there are 14 producing wells, 2 injection wells and 4 monitoring wells. Severe pressure, temperature and water-level declines have occurred at Ahuachapán since the first 30 MW plant began operation, with the results being that the present electric-power output is now 57-60 MW. Various data indicate that the main up-flow area is to the south or southeast of the production field, with the present production wells located in an outflow zone. There is a probability of cool-water inflow into the field from the east or the southeast. Temperature, salinity (18,000-25,000 parts per million), and non-condensable gases (<0.8%) all increase east-to-west and north-to-south in the wells. Enthalpy and steam percentage vary from well to well, in part because of the pressure, temperature, and water-level declines and the cool-water intrusion. There is a need to expand exploration and production to the south. Three new wells are planned: two at 1,500-2,000 meters, and one at 3,000 meters depth. CEL's objective is to search for the southwest continuation of the existing field and for possible deeper reservoirs. CEL scientists have forecast temperatures to 260°C in the main up-flow zone (compared to the original 240°C in Ahuachapán wells, now down locally to 215°C). - No make-up drilling has been done in 1980's because guerrilla activity and the resulting economic problems. Serious efforts at revitalization are now underway: this include reservoir assessment studies by Los Alamos and Lawrence Berkeley Laboratory (LBL), and the Instituto de Investigaciones Electricas (IIE of Mexico).

CEL would like to add three 5 MW binary plants to be used both for continued reservoir evaluation and as additional generating capacity at Ahuachapán. These plants would use water at 150°C from the first steam flash, or at 110°C from the second flash or from hot water wells. There is abundant fresh make-up water for cooling. CEL also plans to stabilize the output from the 3 large existing generating plants and possibly increase the output by up to 10 MW as a result of the planned drilling of 3 new wells.

The Ahuachapán field and the planned well locations are easily accessible. All of the 32 wells were drilled vertically (only one well per pad). However GEOCEL has expressed an interest in obtaining information on multi-well pads and directional drilling, because of the potential for cost savings.

Chipilapa:

This may be a continuation of the Ahuachapán field. It is 3 kilometers to the east. One well had high temperature but a low flow rate. CEL is presently drilling into a geophysical anomaly, with French financial and technical assistance. The resource size is unknown, but may also extend to the south at greater depths. The French will finance two well-head 5 MW units (if drilling is successful) in 1990. CEL's plan is to drill to 1,500 meters to obtain suitable temperatures and permeability. They also plan to install a third 5 MW plant, with Belgian financing at a cost of US $8 million if drilling continues to be successful. CEL will finance up to US $4 million of the cost. The exploration, drilling and wells are estimated at US $600 per kW, and the plant at US $1400 per kW. Financing is at 7.4% interest. Chipilapa is still in the early stages of exploration. A Belgian rig is being employed with Salvadorian crews and a French drilling superintendent. Crews from the US would definitely increase the drilling performance, but at a greatly increased labor cost. The additional cost would be recovered by decreasing the drilling time of each well.

Berlín:

Three wells were drilled in 1968-75, with high reported temperatures (>240°C) but with only moderate hot-water flows from a moderate depth. Berlín is located in the eastern part of country, in the center of guerrilla activity. Exploration work is continuing with difficulty, with French financial and technical assistance. Two well-head 5 MW units (Belgian financed) are reportedly being installed. These plants are scheduled for February 1990 operation.

Coatepeque:

A prefeasibility study (geology, geochemistry, geophysics) has just been started by an Italian firm with partial Italian financing. The completion date is mid-1991.

Others:

Several other areas are identified on maps or in work lists: (i) San Vicente is a volcanic center, located between Berlín and San Salvador. Some reconnaissance studies have been conducted. It is in the zone of military activity. There is no known current work. (ii) Chinameca is another volcanic center in the eastern part of the country. Some reconnaissance studies have been done. It is in one of the zones of military activity. There is no known current work. (iii) San Lorenzo, Caluco, Chambala, Chilanguera, and Olomega are identified by name only. The status of past or current work is unknown.

CEL's Geothermal Development Plan:

CEL has proposed the following plan for geothermal development through the year 2,000 (see Appendix C):

Year	Field	Plant Size & Type	Financing	- MW - Project	Cumulative
'89	Berlín	Two 5 MW well-head, non-cond.	Belgium	10	10
	Chipilapa	Two 5 MW well-head, non-cond.	France	10	20
'91	Ahuachapán	One 3 MW binary, well-head	-	3	23
'92	Berlín	One 3 MW well-head, non-cond.	CABEI	10	33
'92	Ahuachapán	Additional steam supply, to stabilize field at 75 MW	CABEI (?)		
'93	Chipilapa	One 5 MW well-head, non-cond.	Belgium (?)	5	38
'94	Berlín	30 MW condensing	-	30	68
'95	San Vicente	Two 5 MW well-head, non-cond.	-	10	78
	Chipilapa	30 MW condensing	-	30	108
	Ahuachapán	10 MW (not stated)	-	10	118
'96	Coatepeque	Two 5 MW wellhead, non-cond.	-	10	128

If financing for the planned geothermal power development continues at the projected fast rate, CEL will not install fossil-fuel burning plants.

CEL's geothermal energy developmental plans are very ambitious. Geothermal power currently provides >25% of El Salvador's electricity. CEL intends to keep a similar or higher percentage throughout the rest of century. CEL's expansion plans call for the following:

Ahuachapán:

1. Three 5 MW binary well-head generators, using a blend of low-pressure, low-flow steam and 150-170°C water from existing wells currently not being used, will be installed. CEL plans to solicit bids with external financing.
2. CEL is working on the stabilization and revitalization of existing field by rearranging the steam flow lines and by drilling 3 new wells to the south in a higher-temperature area. This effort is being impacted by the reservoir engineering study that LBL is doing with Los Alamos/USAID funding. No new turbines are planned. CEL hopes this will increase output from the currently estimated 60 MW to 70 MW (of the original 95 MW capacity). Completion of this project is anticipated in 1992. CABEI is being asked to finance this project.

3. Additional well-head generating units, perhaps totaling 10 MW, are projected. No financing is yet available, because of the uncertainties regarding the reservoir production capacity. Production is hoped for by 1995.

Chipilapa:

Two well-head 5 MW units financed by France are to be installed in 1990 if the geothermal resource is sufficient. CEL will add a 5 MW well-head unit in 1993 (initial financing discussions are being held with the government of Belgium) and possibly a 30 MW plant in 1995 if the geothermal resources are available. There is no certainty on the resource availability nor the financing beyond the initial 10 MW.

Berlín:

Two well-head 5 MW units financed by Belgium are scheduled to be installed by February 1990. If the geothermal resource is sufficient, CEL will install two additional 5 MW well-head units in 1992 (possible Belgian or CABEI financing), and up to a 30 MW condensing plant in 1994. There is no financing for the 30 MW plant. This project depends greatly upon guerrilla activity in the area.

Coatepeque:

Development depend upon results of work just begun. The first two 5 MW well-head non-condensing units could possibly be installed (if the geothermal resource is adequate) in 1996.

San Vicente:

Development depends upon results of a proposed feasibility study (no financing yet available). If the resource is adequate CEL plans to install two 5 MW well-head units in 1995.

Well-head units would be moved from field to field as development proceeds. However, CEL still anticipates a maximum need for up to twelve 5 MW well-head units by 2000 at Berlín, San Vicente, Chipilapa and Coatepeque.

All future geothermal energy development in El Salvador is dependent on external, international financing for the projects. The following items must be considered when looking at El Salvador as a potential market:

1. CEL will remain in charge of all geothermal development in El Salvador. CEL will also continue to control all geothermal exploration and drilling activities. No one should attempt to by-pass CEL with separate offers of private development. Private development will be considered by CEL, but with great caution.

2. CEL is pursuing many lines of bilateral and multilateral financing, both as loans and grants. The NGA will have to compete with French, Belgian, Mexican, Japanese, and Italian offers as well as projects arranged through CABEI and IDB.

C. UNCERTAINTIES

1. The military-political situation remains difficult and problematical, especially regarding Berlín, San Vicente, and Chinameca.

2. The size of the resource at Berlín, and the size and quality of the resource at Chipilapa, Coatepeque, San Vicente and Chinameca are yet to be proven.

3. The degree of future competitive interest from Italy, Japan, Belgium, Mexico, France and possibly others could have a negative effect on American penetration of this market.

4. The willingness of CEL to accommodate private investment in field development and ownership of power plants is questionable.

5. The US geothermal industry's ability to interest American financial institutions and the US government to lend and/or donate to El Salvador's geothermal development must be determined.

D. CONSIDERATIONS FOR INCREASED EXPORTS

1. The results of exploration or drilling at Chipilapa, Berlín, San Vicente, Chinameca, and Coatepeque must be obtained and disseminated within the US geothermal industry for decisions regarding financing of like activities.

2. The results of reservoir analyses (Los Alamos/LBL and IIE/Mexico) for Ahuachapán must be released to the US geothermal industry for decisions regarding field renovation and/or expansion.

3. A continuous flow of reliable information on the economic, political, and military situation in El Salvador is needed from the US Embassy and AID/ROCAP.

4. A better and more rapid system of information and dissemination is needed (i) regarding calls for bids by CEL and, (ii) other-country offers of loans/grants to CEL. A local representative or agent may be needed.

5. Follow-up trade missions are needed to establish closer relationship with CEL. Special efforts are needed to establish closer contact with key CEL personnel who maintain close ties to Italy and New Zealand.

6. A better set of assumptions is needed, on which to base development cost estimates for each field.

7. Any US proposals to CEL should include:
   - long-and short-term training in the US for CEL staff;
   - US technical assistance in improving CEL's drilling operations;
   - US technical assistance in reservoir engineering (calculation of reserves and development potential) via the various US government-sponsored training programs;
   - training in the high-technology aspects of computer operations; and
   - a strong emphasis on the US lead in binary generation technology.

E. OBSERVATIONS, IMPRESSIONS AND ASSESSMENTS

CEL's engineering and operating personnel are probably are as good as any in the third world. GEOCEL provided the Mission Team members with very detailed information on their plans for each site, including financing and the current level of technical studies. This should greatly assist the NGA Consortium in their decision making.

CEL has made a major commitment to geothermal development. This probably will continue, despite geothermal reservoir problems at Ahuachapán, major military problems and limited internal financing. CEL's geothermal program is very ambitious, given the guerrilla activity, the bad economic situation, and the lack of specific data on reserves for Berlín, San Vicente, Chipilapa, Coatepeque, etc. They will require extensive external financial help. This offers both problems and opportunities.

CEL has a sophisticated, effective operation and staff. The staff are technically experienced and proud of their capabilities. Many of them have received training in Italy, New Zealand, Japan. Close ties to these countries exist, especially to Italy.

CEL prefers to own and operate all geothermal plants. Private investment would need government approval and changes in the law to allow the operation and sale of power to the CEL grid. There are too many pitfalls in the path of foreigners owning and operating geothermal plants in El Salvador, even for a period of only 2 to 5 years. It is preferable to sell plants and/or equipment to CEL, contract for the installation and let CEL perform the construction and operation. Contracts also should incorporate a training package with on-call technical assistance as needed. CEL would operate the plants and manage their fields with direct private investment.

Except for the AID/ROCAP funded Los Alamos/LBL geothermal reservoir study at Ahuachapán, there is no US geothermal industry presence in El Salvador. Currently the US private industry occasionally sells valves, wellheads, tools, etc. to CEL.

CEL has no major international bank financing for its geothermal operations. It relies on bilateral financing and grants: France (Chipilapa and Berlín); Italy (Coatepeque); Belgium (Berlín and perhaps Chipilapa); Mexico (Ahuachapán); and the US (Ahuachapán). Japan is in the wings, waiting and assessing. The technical assistance provided by Los Alamos and its subcontractors (LBL being one) may increase the market penetration of US goods and services to the region, but not as much as the industry might like.

F. US GEOTHERMAL INDUSTRY OPPORTUNITIES

1. CEL plans to contract for three 5 MW binary plant at Ahuachapán in 1990. External financing will be required.

2. A drilling contract for 3 production wells at Ahuachapán will be let out for bid by CEL in 1990. Financing is expected from CABEI, but may be supplemented from other external sources.

3. Two 5 MW well-head non-condensing unit for Chipilapa will be purchased by CEL in 1991. External financing will be needed.

4. A 30 MW condensing plant for Berlín may be let out for bid by CEL in 1991. This will greatly depend on the military situation and the results of the resource assessment and drilling. External financing will be required.

5. Further geothermal development bidding at Ahuachapán, San Vicente, Chipilapa, etc. may take place in 1992 or later. No financing is presently available for any of these potential projects. The NGA Consortium could propose on these projects if they can provide their own financing.

6. There may be opportunities to install flash-steam and/or binary wellhead units at individual wells, prior to their being put into use supplying power plants at any of these fields. Specific proposals (including self-financing) are needed.

VIII. HONDURAS

A. GEOTHERMAL BACKGROUND

The Empresa Nacional de Energia Electrica (ENEE) is the government-owned power company in Honduras. However, no single organization is responsible for the overall formulation of energy policy in Honduras. Government agencies with geothermal responsibilities include the Secretariat-Ministry of Planning, Coordination and Budgeting (SECPLAN) and the General Directorate of Mines and Hydrocarbons (DGMH). As an example of the independence of action, DGMH has supposedly granted two sequential mineral-exploitation concessions allowing geothermal development (with a 50-year exploitation right in the San Ignacio geothermal area). This concession was granted without review or approval either by ENEE or SECPLAN--each of which appears to hold veto powers over future development.

Among the Central American countries visited by the Mission Team, Honduras had the least developed geothermal resources. Honduras has serious economic problems which serve to reduce interest in geothermal development and financing of major projects.

The law creating ENEE does not give ENEE the exclusive right either to develop power or to exploit electrical power generating resources; nevertheless, ENEE would be the sole client of any private power producer under the current scenario. The Mission Team was given a copy of the energy expansion plan (see Appendix D) during the visit. Unfortunately, no mention is made of geothermal energy in this plan.

The geothermal potential in Honduras is estimated to be a few tens to a few hundred MW, of low to moderate temperature (160 to 205°C). Six geothermal sites have been investigated in detail: Platanares, San Ignacio, Azacualpa, Pavana, El Olivar and Sambo Creek. Detailed investigations by Los Alamos and others have led to the identification of Platanares as the site having the highest potential in the country. Platanares was the only site visited in Honduras.

B. TECHNICAL FINDINGS

Platanares is located in the extreme west-central part of Honduras, 16 kilometers west of Santa Rosa de Copan. It was the most remote area that the Mission Team visited. It is located along that takes one hour to travel by 4x4 vehicle from a paved highway. An improved road would be a requirement for any field development. The steep terrain may also be best suited to multiple-

well drilling pads, from which wells would be drilled directionally. Modular, small power plants could then be built on each pad.

At Platanares, exploration by Los Alamos is complete through the prefeasibility stage. Three slim holes were drilled, and a 160°C resource has been found at 600 to 700 meters. Well no. 3 will flow about 17 kilogram/second, which would generate 3 to 3.5 KW with a binary plant. Geochemically, there is the potential for a deeper resource (depth unknown) of 200 to 220°C. The shallow zone appears to be suitable for a binary geothermal project, the deeper zone may be suitable for a flash plant.

Transmission lines are to be built to within 8 kilometers of Platanares by 1991, thus providing relatively easy access to the transmission grid.

Platanares would be suitable for rapid development by binary-cycle generation. Further drilling of larger-diameter wells would be necessary. The existing wells need to be tested, if possible, and monitored for possible scale build-up. A calculation of reserves then needs to be made. Thereupon, the deeper hotter reservoir should be tested by deeper drilling (approximately 2 km). No current work is underway.

The Mission Team believes that the Platanares site is technically and economically feasible as a demonstration project for US geothermal technology. It should be possible to install 5 to 10 MW of binary generation by the 1991 date of completion of the transmission line being built in the area, if work can begin in 1989. Financing would need to be arranged. The UNDP has indicated an interest to co-finance the development at Platanares.

In addition to Platanares, 4 other thermal areas have been identified with temperatures probably >150°C: Azacualpa, San Ignacio, Sambo Creek, and Pavana/Nacaome. Azacualpa and San Ignacio have been explored in detail and one or more shallow holes have been drilled at each site. Each requires further exploratory drilling, and may ultimately prove suitable for binary-cycle power generation. The suitability of Sambo Creek and Pavana/Nacaome is unknown. No high-temperature (>220°C) volcanic sites have been identified in Honduras.

C. THE POTENTIAL FOR PRIVATE POWER GENERATION

A minerals and geothermal concession of unknown validity has been granted for the geothermal site of San Ignacio. Additional exploration and drilling is planned at San Ignacio, but insufficient financing is available. A representative of the San Ignacio concession discussed his problems

with the Trade Mission, and was advised to pursue a steam or power sales agreement with the national electric utility (ENEE), as a pre-requisite to arrange financing. It was also suggested that he discuss co-financing with the UNDP.

ENEE and the Honduran government realize that a comprehensive resource assessment is needed for Platanares (and,of course, at any of the other sites) before the private sector would consider financing a geothermal project. The problem is acquiring the up-front finances for studies of this nature without first being able to demonstrate that the geothermal resources have a promising potential for large generating plants.

D. FOREIGN COMPETITION

Platanares:

The UNDP has expressed a willingness to co-finance the Platanares geothermal development. A financial offer from the Government of Italy has been promised as a follow-up to the Italian co-financed exploration at Azacualpa, San Ignacio and elsewhere in 1987-88. The Japanese government has also expressed an interest in financing or co-financing development at Platanares. As mentioned earlier, Platanares probably could support up to 5 MW binary from the shallow (about 600 meters) zone, with generation beginning in 1992. The potential of the deeper zone is unknown. ENEE expressed an interest in receiving a technical and financial proposal from the NGA for the development of Platanares. If a proposal proved to be acceptable, ENEE would pursue all of the necessary approvals from SECPLAN, and Ministry of Natural Resources, Mines and Hydrocarbons, etc.

Azacualpa:

Exploration was conducted by Los Alamos and an Italian firm under AID and Italian-UNDP co-financing. Two slim holes were drilled by the Italians to about 600 meters, with measured temperatures to about 135°C. Reservoir permeability probably is adequate, but the resource needs significant further testing before it could be declared suitable for binary-cycle development. Azacualpa thus is about 6-12 months behind Platanares in assessment. Geochemistry at Azacualpa also indicates a deeper reservoir (unknown depth and permeability) with temperatures to 180-210°C. If Platanares is unavailable for development, Italy may offer to co-finance Azacualpa with UNDP.

San Ignacio:

Exploration was conducted by Los Alamos and an Italian firm under AID and Italian/UNDP co-financing. One slim hole was drilled by the Italians outside of the anomaly. Geochemistry

indicates temperatures up to 210-215°C at an unknown, but probably great depth. This site requires further exploration drilling prior to assessment of the resource.

Sambo Creek And Pavana/Nacaome:

Geochemistry indicates a temperature of >150°C at each, at unknown depth. Geological and geophysical exploration have been limited at each site; there are no current plans to continue exploration.

E. UNCERTAINTIES

Although ENEE has a geothermal group, and has worked for several years on Platanares and other projects, ENEE does not appear to have made a commitment to the utilization of geothermal energy. It remains unknown if the Platanares field will fit into ENEE's generation plans for the '90's.

Honduras looks promising for binary-cycle geothermal generation from a technical viewpoint; however, financing and the payment by ENEE for the imported goods and services are problems that must be resolved when deciding upon any future US industry involvement in geothermal development in Honduras.

ENEE's Presidente Ejecutivo, Ing. Jose Ramiro Zuniga, stated that Honduras presently has excess power from the El Cajon hydro plant, and sells electricity to Nicaragua, Costa Rica and Panama. According to ENEE's projections, the surplus will end in 1992. ENEE expects to be able to develop another large hydro project, but not before the year 2000. Honduras will only be able to meet its own demands or experience a shortage of electricity between about 1993 and 2000. Geothermal power could fill some of that generation gap. ENEE has been considering the installation of 100 MW of imported fuel-oil thermal generation capacity to fill the expected energy gap between 1993 and 2000, perhaps four 25 MW bunker turbines. Geothermal power could offset one or more of the proposed fuel oil turbines. Without incentives in the form of external financing, ENEE is likely to do nothing with its geothermal resources.

There are many uncertainties within the Honduran government regarding power development planning, privatization, etc. These uncertainties will need to be resolved. The Mission Team believes that ENEE would accept a small (5 MW?) development plan for Platanares if properly financed, planned and presented.

F. PREREQUISITES FOR US INVOLVEMENT

1. A determination should be made of the validity of the private concession for San Ignacio, and of the intentions to proceed with drilling.

2. An information-flow system regarding Italian, Japanese and UNDP geothermal intentions and activities in Honduras should be established.

3. Commitments should be sought from ENEE to build transmission lines and purchase electricity from. private developers at Platanares prior to commencing any further work at the site.

4. A commitment from the US government for co-financing should be obtained prior to additional development at any Honduran geothermal site.

G. OBSERVATIONS, IMPRESSIONS AND POTENTIAL

1. Platanares is essentially ready for development. A geothermal program to produce about 5 MW would cost less than US $10 million, and would consist of:
   - flow-testing the existing slim holes - $0.3 million (may or may not be possible);
   - drilling 2 large-diameter production wells and an injection well to about 700 meters - $1.5 million;
   - resource-assessment and field development planning. $0.3 million;
   - installation of pumps on the production wells - $0.5 million;
   - roads, water supply, other infrastructure, as required - $0.5 million;
   - design, manufacture, and erection of a 5 MW binary-power plant - $6 million;
   - training of ENEE engineers and scientists - $0.1 million; and
   - purchase of other equipment (vehicles, computers, tools, etc.) and consumables - $0.2 million.

   The Platanares project could be completed within 3 years after inception. It may be possible to get the UNDP or IDB to agree to the purchase of only US goods and services in return for US co-financing of Platanares with UNDP or IDB. This has been done previously by the government of Italy in Honduras and elsewhere.

2. Once the uncertainly regarding the validity of the private concession at San Ignacio has been clarified, and if a valid steam-sales agreement can be reached with ENEE, it may be attractive to help raise money from private investment sources for drilling, field assessment and development.

IX. COSTA RICA

A. GEOTHERMAL BACKGROUND

The Instituto Costarricense de Electricidad (ICE) was created in 1949 as the government owned institution responsible for electric-power generation and transmission, and overseeing of power-system planning. The power sector also includes the Compania Nacional de Fuerza y Luz (CNFL), a subsidiary of ICE; two municipal utilities, the Empresa de Servicios Publicos de Heredia (ESPH) and the Junta Administrativa del Servicio Electrico de Cartago (JASEC); and 4 rural electricity distribution cooperatives: Guanacaste, Santos, San Carlos and Alfaro-Ruiz.

In addition to CNFL, ICE also owns the Compania Radiografica Costarricense (RACSA), which provides data communication services for the country. ICE itself provides telecommunication services within the country pursuant to a 1963 law, and international telecommunication services by subsequent legislation. This combination of electrical and telecommunications services is somewhat unusual, since in most developing countries telecommunications is tied to postal services. This exception to the rule appears to work well in Costa Rica.

However, it appears that the highly profitable telecommunication services may be cross-subsidizing electricity consumers. As of the end of 1988, ICE's telecommunications operations has contributed about C/ 5,500 million (80.65 Costa Rican Colones (C/ 80.65) = US $1.00) to the investment plan of the ICE power sector. The ability of ICE to adjust telephone rates on the basis of economic criteria is much greater than its ability to raise electricity prices. Thus, through accounting transactions within a single company, ICE can raise telecommunication rates to finance some of the partial needs for electric utility expansion and development, and the required 25% investment required by the multinational lenders.

In addition to ICE, the key institutions in the energy sector are the Ministries of Energy, Mines and Natural Resources (MEMRN), the National Planning and Economic Policy Commission (CNPPE) and the Servicio Nacional de Electricidad (SNE). MEMRN is charged with the coordination of national energy planning and energy policies. SNE was created by law in 1941, and is an autonomous agency with broad regulatory jurisdiction, including the granting of concessions for the installation of generating plants and the authorizing of rate increases requested by the public service utilities. However, rate increases are authorized only after consultation with the Administration and Congress, who take political considerations into account. The prices charged to consumers for electricity have always been quite below economic

cost, the subsidy ranging from 4% to 66% (depending on the economic sector), thus reflecting political rather than economic reality or reasons. Average electrical rates are US$ .055 per kWh.

In 1988, Costa Rica had 866 MW of installed generating capacity, 84% of this capacity being hydroelectric and the remaining 14% fuel-oil thermal. Geothermal power is expected to supply approximately 5% of the nation's capacity by 1993. Electrical service in Costa Rica reaches about 82% of the households in the county, the highest in Central America (as compared with 37% in Guatemala and 36% in El Salvador). Electricity consumption per capita is about 1,160 kWh (as compared to about 186 kWh in Guatemala and 246 kWh in Honduras).

Since 1986 ICE has imported electricity from Honduras, via Nicaragua (in 1988, imports were 6% of total consumption); beginning in 1992 no electric power imports are foreseen, because neither Honduras nor its neighboring countries are expected to have energy surpluses. The only electricity exchange through the proposed Central American electrical-grid interconnection would be to cover national emergencies.

ICE has been one of the few electric power utilities in Latin America that has managed to finance its portion (25% internal investment required by multinational lenders) of the power system expansion investments without inter-governmental transfers (since ICE controls the highly profitable telecommunication system). This has been accomplished in spite of serious financial limitations, and currency devaluations that have affected the security of foreign loans.

This does not mean that ICE is not one of Costa Rica's largest contributors to their large external debt problems. As of 1989, ICE's commercial bank debt amounted to US $40 million plus US $12 million of pending interest payments. ICE's long-term external debt amounts to US $570 to US $673 million according to various estimates. Of this total, about US $190 of commercial debt needs to be renegotiated.

B. TECHNICAL FINDINGS

Miravalles (see Appendix E):

Geothermal exploration began in 1975 at Miravalles; development to date has been slow. The field is located in easily accessible terrain on the lower flanks of the Miravalles volcano. Eight production-diameter holes have been drilled from individual pads to depths of 272 to 2,268 meters. Six of the eight wells are producible, to a present capacity of about 30 MW. The remaining 2 wells may be usable as injection wells. Field temperatures reach as high as

245°C. Field temperature appears to increase to the north end of the field.

ICE's plans are to construct a 55 MW single-flash power plant at Miravelles, for operation by late 1992 or early 1993. Five or 6 new production wells will be needed in addition to the existing 6 producers. Well testing to date has indicated the field reserves are in excess of 110 MW. Therefore, ICE is planning a second 55 MW plant at Miravalles, for operation by about 1995, at which time additional electric power will be needed in Costa Rica.

To supply the 2 Miravalles power plants (Miravalles I and II), ICE will let a contract in 1989 for the drilling of 20 to 30 deep production holes. To minimize the pressure drops expected when the steam is moved in the pipelines across the field area, the drilling of direction wells from multi-well pads should be recommended to ICE. Drilling will begin in 1990.

A significant scaling problem ($CaCO_3$) is recognized at Miravalles, and extensive scale-control and scale-removal experiments have been run, are underway or being planned. Based on tests to-date, the injection of scale inhibitors appear promising. Corrosion has been identified in one deep well, and corrosion-mitigation tests are also being performed. Results were unavailable.

If reserves prove adequate, ICE will consider adding additional geothermal units at Miravalles in the middle 1990s. The size and type of these units is not decided.

The feasibility study for the Miravalles I field development was financed by the IDB, and awarded to an Italian firm under competitive bidding in 1981. A Japanese consortium has signed an agreement to finance and construct the initial 55 MW plant; however, the agreement allows ICE to accept a better financing/construction package if one is offered within some unspecified period. IDB plans to finance the second 55 MW plant, as well as the 20 to 30 well drilling program. A feasibility study is to be offered for competitive international bidding in 1990; this will involve management of well-testing operations and design of the power plant once reserves are confirmed. ICE will request bids for the power plant after feasibility has been demonstrated.

In addition to Miravalles, the Volcan de Tenorio geothermal area is being studied in detail: geology, geochemistry, and geophysics have been completed. Four shallow holes have been drilled: 2 more are being drilled and 3 others are planned using ICE core rigs. Anomalies indicate temperatures >220°C. System depths and permeability are unknown. All of this work is being performed by an Italian firm financed, in part, with an Italian grant. No results are

yet available but ICE remains encouraged.

ICE's classification of geothermal resource prospects, other than Miravalles and Volcan de Tenorio, is as follows:

Priority - Area

High - Rincon de la Vieja

Medium-high - Arenal-Poco Sol

Medium - Orosi-Cacao

Medium-low - Cerro Pelado, Poas, Barba, and Irazu-Turrialba

The other major potential geothermal areas are:

- Borinquen - located north of Rincon de la Vieja. Geochemistry has been completed and the first slim hole drilled to about 150 meters. This hole had a temperature of >100°C. Geochemistry indicates temperatures of >200°C. At the present no work is being done in this area.
- Las Pailas and Las Hornillas - These two sites are within Rincon de la Vieja National Park. The geochemistry indicates temperatures of >200°C; no work is underway.
- For the other sites, there is insufficient data; access is difficult; the sites are located within national parks; and/ or temperatures are indicated at <150°C.

Many of the other potential geothermal resource sites are located within national parks or wildlife refuges. At present it is very unlikely that the government, because of public opinion, will allow geothermal development in national parks and wildlife refuges.

C. THE POTENTIAL FOR PRIVATE POWER GENERATION

In order to reduce ICE's dependence on external financing for power generation facilities,the Government issued Executive Decree on Private Power production (No. 18947-MIRENEM) on May 2, 1989. The Decree states that the *purchase of electricity by the Costa Rican Electricity Institute (ICE) from those who establish new or rehabilitate established installations is .....in the public interest*, provided that such installations *do not currently form a part of the interconnected national system.* SNE has been designated to establish the purchase prices for

privately generated power.

ICE is interested in private sector investment in geothermal power-generation but Miravalles I and II are not open to the BOOT concept. Soft financing for these two projects is expected to be provided by Japan and/or Italy. ICE might be interested in having the participation of US geothermal industry in Miravalles III or IV, or other geothermal sites, assuming that suitable financial, and technical terms and conditions are provided. Perhaps 15% of all power generation in Costa Rica ultimately could be produced privately.

An amendment to the national utility law currently is under consideration by the Costa Rican Congress. At question is whether to allow each private electricity concession to produce up to 20 or 30 MW per development. This law aims to encourage small, private operators to restart operating their private power plants, which had stopped producing when they were connected to the national power grid which provided cheaper electricity because of the ICE subsidies. There are perhaps 50 small private power plants throughout the country.

The following items must be determined by the government:

- ICE should establish the nominal purchase prices and the number of years that they would purchase private generated electricity from any or all private producers.
- The 1989 electric power prices range according to time of day, amount of power used, capacity, and location. How the private producer will be paid must be determined and a fixed rate established.
- The ICE-SNE power purchase agreement would require an SNE concession and an ICE-private supplier supply purchase contract which is equitable to both the government and the private investor.

At this time private plant capacity is limited by law to 500 hp. (1/3 MW) per unit. The amendment now pending before the Congress would increase the limit to 20 MW for most hydroelectric plants, and up to 30 MW for electrical generating plants using other indigenous energy sources, including certain hydro plants. Although the existing Law for Private Power Generation and the pending implementing ICE guidelines, plus the present SNE regulations address the power-purchase concept in a manner generally applicable to geothermal electricity, the Costa Rican laws are not specific regarding the treatment of geothermal power. This issue must be addressed before geothermal development can proceed on a commercial basis.

As part of the overall development strategy for Costa Rica, the Government has determined to develop its indigenous energy resources, including geothermal power. The first geothermal unit

is expected to be installed at Miravalles (55 MW) in 1992 or 1993. A Miravalles II (55 MW) geothermal plant is projected for 1995. For the period 1995 to 1999 two more geothermal units (up to 110 MW) could be installed. It is very unlikely, for financial, technical, administrative and regulatory reasons, that the proposed investments which are substantially higher than in the past, can be achieved from traditional funding sources. In order to achieve the increase in electrical production proposed by ICE, increased private-sector investments in electrical generation seem requisite.

D. FOREIGN COMPETITION

The Minister of Energy, stated to the Trade Mission that *US geothermal industry is not among the best in the world.* He also pointed out that when Costa Rica issued an RFP for Miravalles I, Japan responded with a technological and economic bid, as did Italy. The United States industry did not respond principally because no financing was available to support such a bid.. The point is a variation of the theme heard in Guatemala, El Salvador and Honduras: Unless American technology is coupled with financial packages that will compete with other countries and with Central America's ability to pay, the US geothermal industry cannot be and will not be a viable competitor in Costa Rica and Central America.

Japan's bilateral loan agreement offers a 4.74%, 25-year loan with a 7 to 8 year grace period (note, however, that the Japanese loan was also reported to be a 4.5%, 25-year loan with a 4 to 5 year grace period). The Italians have also offered a mixed government/commercial loan package. The Italian government portion would be a 1% to 2%, 25 year loan, plus a grace period of unknown duration. The mix of the public/private funding has not been released, pending a formal bid on the Miravalles I power plant. Because the broad terms of the Japanese and Italian offers are known publicly, the two countries are expected to adjust either the prices of their goods and services, or the loan conditions in their respective packages to attempt to secure the award.

E. UNCERTAINTIES OF GEOTHERMAL DEVELOPMENT

The fate of the legislative amendment to allow private construction of 20 MW or 30 MW maximum production power plants is uncertain. There is also a question of the willingness of ICE to allow private financing of geothermal power plant(s) in the Miravalles field area versus elsewhere. A major question which can only be answered later is; can or will private concessions be granted by the various government agencies even if an enabling law is passed by the Costa Rican Congress. The price and conditions under which ICE will buy electricity from

the private sector will greatly influence private sector investment.

Because Costa Rica has the highest per capita external debt in Central America, there is a question of the willingness of the Costa Rican Congress to approve the IDB loan for a second 55 MW plant at Miravalles. In addition, environmental protection has a high priority in Costa Rica and may curtail or delay geothermal development in certain areas.

F. PREREQUISITES FOR PRIVATE INVESTMENT

1. ICE must provide the results of continued well testing and scale-control experiments at Miravalles.

2. ICE must provide the results of exploration/drilling at all geothermal prospects other than Miravalles.

3. A rapid, continuous flow of information on ICE calls for bids (drilling, wellhead units, feasibility study, etc.) must be provided, perhaps by the US Embassy, AID, the Department of Commerce or a private representative.

4. Embassy support (seminars, private meetings, etc.) for US geothermal bidders and vendors relative to Costa Rican government entities and their plans is essential.

5. Legal and technical representation in Costa Rica for the NGA and individual firms is necessary.

6. Rapid and accurate news on Costa Rican legislative actions on the pending IDB loans, bilateral country loans and agreements, private power plants, environmental actions, and any other matters related to geothermal opportunities can be provided by the US Embassy, AID and/or private representatives.

7. Continued discussions with ICE are vital regarding their plans for the purchase of electricity from private generating plants.

G. OBSERVATIONS, IMPRESSIONS AND ASSESSMENTS

1. Costa Rica will eventually allow the private construction and ownership of geothermal plants up to 20 to 30 MW per concession. ICE will buy power on a less-than-avoided-cost, interruptible basis. ICE probably will resist any private attempt to develop any parts of Miravalles.

2. IDB will remain a major financier of geothermal projects, and will shape some of ICE's financing attitudes. It is therefore important to maintain good communications with the IDB, especially with Gustavo Calderon.

3. ICE is a very professional organization, with good geothermal technology and experience, and will increasingly take on more and more of the geothermal development project work itself.

4. ICE (and all government agencies) are very legalistic in approach. This requires great attention to details (proposals, contracts, etc.) and caution in negotiations.

5. ICE and the Costa Ricans have a friendly regard for the US and American geothermal technology. This should be enhanced through: technical traineeships in the US, attendance at GRC meetings and courses, supply of computer software and published documents, and repeated technical and trade missions to Costa Rica.

6. Dissatisfaction was expressed by ICE with some of the technical work at Miravalles I. This could work in favor of a US proposal relative to any bid on the feasibility study for Miravalles II.

7. An informal belief exists that a Mexican driller may win the big drilling contract (20 to 30 wells). US firms might consider using lower-wage workers in order to win this major contract.

8. Environmental factors can both hinder and assist US efforts to penetrate the Costa Rican market. Geothermal development may be delayed or made more costly, but the US geothermal industry experience in geothermal environmental controls should give US firms an advantage in bidding and work performance.

H. CONCLUSIONS AND RECOMMENDATIONS

ICE has made a major commitment to geothermal energy development, despite financial difficulties, environmental uncertainties, and scaling in Miravalles wells. Although Costa Rica is the most advanced of the 4 Central American countries with respect to establishing a mechanism for private power production, its national goals for the private generation of electricity do not yet (explicitly) include geothermal development. The Miravalles geothermal field is a "world-class" field probably capable of up to 200 MW. The IDB funding will assure at least 100 MW is on-line within the near time frame. This, plus the privately owned 80 MW would relieve the near-term energy pressure on ICE, and create an environment for near-term geothermal development. Opportunities exist in the near-term for lease purchase agreements for wellhead generators, and in the long term for privately financed BOOT development of the Miravalles field outside of the present Miravalles I and II sites, or elsewhere. Two other geothermal prospects adjacent to Miravalles offer downstream development potential, although an Italian company operating under an Italian grant has already begun geothermal prefeasibility studies at Volcan de Tenorio.

It is not premature to establish the groundwork for a downstream project for the early to mid-1990s, assuming that the US resources and the government mechanisms are in place. A soft sale approach seems mandatory in this country. ICE is slow to decide on new approaches or new ideas and reacts cautiously to pressure. It is the policy of IDB and the Costa Rican government, after much deliberation, to accept the lowest bid submitted if the bid meets all of the criteria of a "properly" submitted bid. Attention to legalistic details, therefore, becomes very important.

In order to compete in the Costa Rican market, the NGA must get US government support for soft financing and for insurance from the Overseas Protection Insurance Corporation (OPIC). The initial marketing approach should be to offer to sell small flash and binary well-head plants, and thereby assist in the evaluation of the feasibility of the reservoir at Miravalles, and at other sites. This will also allow ICE to invest in generating facilities according to the Costa Rican growth demand. ICE would operate the facilities: Costa Rica does not have the internal legal tradition nor the economic capability to allow the private sector to use excess steam at the geothermal sites for other industrial uses, or to permit private industrial users of electricity to by-pass ICE.

The Costa Rican laws may be a major obstacle to our BOOT concept. However, the NGA concept of presenting a proposal for Miravalles I probably is too late, but for individual or private companies, the opportunities are still open to propose to supply smaller well-head units. An

individual company should secure the services of an agent or law firm to ensure that the proposals are properly documented and presented according to Costa Rican bidding procedures. The future of Miravalles II, III and IV will be determined by the success of Miravalles I, the results of the drilling at Miravalles in 1991-1992, the demand for electrical power, and the possibility of trade with other Central American countries.

I. MARKETING OPPORTUNITIES FOR US PRIVATE INDUSTRY

1. ICE issued an RFP for the drilling contract for 20 to 30 wells for both Miravalles I and II in August, 1989. Responses are due in October, 1989. IDB is financing the project, with competitive international bidding.

2. ICE might consider additional proposals to finance and construct the first 55 MW power plant at Miravalles, despite the existing Japanese agreement, because of yen exchange-rate problems. The proposal must be presented as soon as possible, and must provide project financing.

3. The feasibility contract for the second 55 MW Miravalles plant is expected to be offered for bid in mid-1990. If the Costa Rican Congress accepts the loan being offered, financing will come from the IDB.

4. ICE is considering the installation of three 5 MW well head noncondensing unit at Miravalles. No financing is presently available; ICE expects to call for bids in late 1989 or early 1990.

APPENDIX A: BIBLIOGRAPHY OF RELEVANT PUBLICATIONS RESULTING FROM LOS ALAMOS' CENTRAL AMERICA PROGRAM

A list of publications resulting from the USAID/ROCAP-funded Los Alamos project in Central America is presented in this appendix. Interested readers can request copies from Ed Van Eeckhout or Anne Tellier at Los Alamos National Laboratory at the following address:

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APPENDIX B. SUMMARY COMMENTS BY GARY SHULMAN, GEOTHERMAL POWER CO.

The alarm bells are ringing in Central America. Ringing for National Treasuries and National Utilities that are going broke. Ringing for power shortages and black-outs that are becoming routine. Ringing for political changes away from US influence, trade and cooperation. Ringing for lack of US export of expertise, goods and services in the electric energy sector, and its supply instead by European and Japanese firms, powerfully aided by their governments. Ringing for growing US Trade Deficits!

Before these alarm signals continue to a major loss of US influence and give and take marketing, there is still time for the White House to formulate, in a short time span, an aggressive policy to provide US expertise, goods and services to rescue the electric energy sector of Central America. This can be done by supplying the proposed Geothermal Consortia, formed by members of the National Geothermal Association, with the tools to develop the enormous Central American supply of indigenous geothermal energy so plentiful in this volcanic region. In a relatively short time frame, the generation of electric power can be doubled and delivered at a moderate cost to consumers with a major development of the geothermal energy potential that exists in Central America.

This lower cost power availability can greatly lessen the growing need to increase cost of power to the people to satisfy international banking debts for higher cost energy construction and fuel, thus provoking an overall background for political instability. The ready supply of this new geothermal technology will prevent an estimated 25% of agricultural products now rotting because of the lack of proper preparation and storage facilities, which now are seriously short of electric power supply.

Of all measures to upgrade the standard of living for most people of Central America, the supply of low-cost electric-power from their prolific geothermal resources will have the greatest impact to provide a flourishing economy from "world class" agricultural growing conditions and growth in the commercial and business sector resulting in increased import-export trade. This is all possible with US governmental assistance to US industry by making possible competitive low interest loans in the area of 7% and providing guarantees for debt payment. There is federal help available, I understand, through the Geothermal Loan Guarantee Program which is administered by the US Department of Energy. This program was administratively shut down several years ago after achieving notable success in promoting the development of domestic geothermal energy. It is now time to re-activate that program and authorize its availability for

Central American development.

To implement this geothermal program it is necessary for bi-lateral trade agreements be signed for each geographical zone between our present Administration, and State Heads in each of the Central American countries. Agreements reached at any lower level are not apt to be binding because of political interference, such as I have experienced in dealings in Guatemala.

In contrast to this recommended US policy, the most striking conclusion that I have drawn from the Central America Trade Mission, is the extent to which foreign geothermal suppliers are vigorously supported by their respective governments in Third World marketing, while the US industry is largely left to fend for itself. The inevitable results of this disparity of support is not only the near exclusion of US geothermal exports to Central America, but the serious lessening of US influence in these neighboring countries to European and Japanese powers

An innovative plan for modular development of geothermal power generation facilities of 25 MW in increments of $50,000,000 is presented in the following tables. These advance targets of 25 MW are easily attainable within two or three year periods, with careful coordination of exploration, well drilling, plant installation and operation on a fast track, and prudently planned schedule.

The result of a positive and rapid response by the Administration (State, Commerce, Energy, Treasury and AID) to this Central American Geothermal study and recommendations can result in an export of $1 billion in US goods and services, and the installation of 500 MW of badly needed electric power generation within the next five years, for the stabilization and upgrading of Central American economies and productivity resulting in increased trade and a warmer relationship with the US

A PLAN FOR US FUNDED $50,000,000 PROJECTS TO EXPEDITE CENTRAL AMERICAN GEOTHERMAL POWER DEVELOPMENT AT THE LOWEST COST AND THE SHORTEST TIME FRAME USING THE "BOOT" CONCEPT WITH A 5 YEAR DURATION

Estimated Financial Requirements for 25 MW Geothermal Power Plant Proposal

25,000 KW X $2,000 Per KW = $50,000,000

1. Exploration - Geological, Geophysical and Geochemical	$500,000	
2. Marshalling Drill Rig and Associated Equipment	1,500,000	
3. Drilling 4 Wells in 12 Months	4,000,000	
4. Operating Lease of 6 MW Monoblok (4) Years	4,000,000	
5. Turnkey Installation of 11 MW Flash Steam Plant to Include Foundations, Gathering System and Substation	8,500,000	
6. Drilling of 6 Wells	6,000,000	
7. Turnkey Installation of Second 11 MW Flash Steam Plant	8,500,000	
8. Turnkey Installation of 5 MW Binary Plant	5,000,000	
9. Reservoir Evaluation	1,000,000	
10. Planning, Engineering and Administration	2,500,000	
11. Legal and Financial Arrangement Costs	2,000,000	43,000,000
With 15% Contingency Cost	6,525,000	50,025,000
With 20% Contingency Cost	8,700,000	52,000,000

PROJECTED INCOME TO THE CONSORTIUM FROM THE SALE OF POWER TO THE UTILITY AT $.05/kWH DURING THE "BOOT" COMPLETION IN 5 YEARS.

1. Noncondensing 6 MW Monoblok Operating at 5 MW for 4 Years 5000 KW X 8,000 Hours X 4 Years = 160,000,000 KWH 160,000,000 KWH X $.05 = 8,000,000 $8,000,000

2. Condensing 11 MW Plant Operating with Net Output to the Utility of 10,500 KW for 3 Years 10,500 KW X 8,000 Hours X 3 Years = 252,000,000 KWH, 252,000,000 KWH X $.05/KWH = $12,600,000 12,600,000

3. Second Condensing 11 MW Plant Operating with Net Output to the Utility of 10,500 for 2 Years = 168,000,000 KWH, 168,000,000 KWH X $.05/KWH = $8,400,000 8,400,000

4. Binary Plant Operating with Net Output to the Utility of 5,000 KW for 2 years 5,000 KW X 8,000 Hours X 2 Years = 80,000,000 KWH, 80,000,000 KWH X $.05/KWH = $4,000,000 4,000,000

5. Total Earnings During a 5 Year "BOOT" Period $33,000,000

6. Estimated Financing Cost Over a 5 Year "BOOT" Period 10,000,000

7. Estimated Operation and Maintenance Cost for Period 4,000,000

8. Gross Income to the Consortium from Plant Operations 19,000,000

9. Assuming $.075/KWH Average Cost of Power to the Utility During the 5 Year "BOOT" Period, Then $.075 Less $.05/KWH Charge by the Consortium = $.025/KWH Savings $.025/KWH X 660,000,000 KWH = $16,500,000 Savings for the Utility $ 16,500,000

Submitted By: Gary Shulman, Central America Geothermal Trade Mission Member, President, Geothermal Power Co. Inc., Elmira, New York

NEW DIRECTIONS
FOR THE UNITED STATES GEOTHERMAL INDUSTRY

A Report of the National Geothermal Association
Central America Mission

EXECUTIVE SUMMARY

The United States (U.S.) geothermal industry, the world's most technically proficient, has been unable to achieve penetration into the markets of the developing nations. This report details the findings of an industry Trade Mission to Central America, tasked with determining the reasons for this shortfall and with developing a U.S. industry geothermal export strategy designed to achieve immediate and long-term export benefits.

The Trade Mission found that each visited country (Guatemala, El Salvador Honduras and Costa Rica), has substantial amounts both of proven geothermal reserves suitable for immediate development, and reserves with great potential. Each country visited is in financial difficulty, and in order to reduce reliance on external financing sources, each is tentatively receptive to private sector power development. Because U.S. firms are virtually never able to meet the concessionary tied-aid terms offered by other countries and their industries, an approach which would allow U.S. industry to export its project financing in a package with its technology is essential if the industry is to be competitive. Moreover, industry and U.S. government resources must be focused on developing within the Central America governments a greater receptivity to private sales of power to the public grid at a reasonable profit.

The Trade Mission concluded that a U.S. geothermal energy export strategy must contain two elements: (1) U.S. industry must organize to be a horizontally and vertically integrated export force; and (2) the U.S. government must add its political muscle and financial resources to industry's export efforts. To implement this strategy, industry and government, working in tandem, must develop technologically sound and economically viable export products and services which can be expeditiously financed by U.S. government and multinational financial institutions. A coordinated educational effort both as to the policy advantages of private power sales to the publicly owned Central American grids, and as to the technological and economic advantages offered by U.S. industry must be initiated. Information flow among industry, host governments and the U.S. government must be institutionalized, effective and current; and mechanisms for longer-term industry/host country relationships should be set in motion.