COSTA RICA:

IMPROVING THE EFFICIENCY OF THE POWER SECTOR

Prepared by
the
Office of Energy
Bureau for Science and Technology
U.S. Agency for International Development

Prepared for

Ministerio de Recursos Naturales, Energia y Minas
Costa Rica

and

U.S. Agency for International Development
San Jose, Costa Rica

February 1987

INTRODUCTION

With the highest foreign exchange debt per capita in the developing world, Costa Rica has made conservation of capital and physical resources one of its priorities. In order to improve the efficiency of its economy, it is also making major efforts to privatize formerly government-owned enterprises and to support the private sector. The newly established Ministry of Natural Resources, Energy and Mines (MNREM) is developing an action agenda that will support this broad government initiative. As part of this agenda, the Ministry is taking a leading role in spurring privatization in an area that has traditionally been entirely in the government realm: power generation.

The involvement of the private sector in power generation presents a number of advantages for Costa Rica. It capitalizes on the private sector's great ability to attract technical, managerial, and financial resources. The private sector is also best suited to take advantage of some power generation opportunities that lie outside the traditional scope of electric utilities, e.g., industrial cogeneration and small-scale power generation facilities based on agricultural or industrial waste. It will also introduce vital competitive forces into the electric utility sector and will act as a strong incentive for improved utility operation.

USAID has supported many similar activities in this area through the Energy Conservation Services Program (ECSP), a program of the Office of Energy in the Bureau for Science and Technology. ECSP has assisted the governments of the Dominican Republic, Pakistan, Thailand, and India in

assessing the potential for private power generation and in designing programs to encourage the involvement of the private sector in power generation, both for their own use and for sale to the national grid. These projects have been remarkably successful, indicating that a similar effort in Costa Rica stands an excellent chance of being equally successful in advancing the development of the private sector and improving the power generation situation.

At the request of MNREM and USAID/Costa Rica, Hagler, Bailly & Company, the Office of Energy contractor for ECSP, visited Costa Rica between June 26 and July 1, 1986 to identify possible areas for future USAID activities in this field. (See Appendix 1 for a list of persons/organizations interviewed during the visit). Based on the findings of the visit, a series of proposals entitled "Costa Rica: Improving Efficiency and Capital Utilization in the Energy Sector" was submitted to MNREM and USAID/Costa Rica in August, 1986. The following two proposals are derived from this document and have been updated and improved based on further discussions with MNREM in January, 1987 and on the basis of the studies recently completed in the Dominican Republic, Pakistan, Thailand, and India.

The first proposal, for promoting private sector power generation, complements work being done by the National Rural Electric Cooperation Association (NRECA) on rural electricity and institutional reforms and work conducted on the supply side under the Los Alamos initiative. This proposal seeks to address the problem of a capital shortage for investments in the energy sector by focusing on cost-effective means of delaying or supplanting government investments in the power sector. This initiative will be

coordinated very closely with other lending and donor organizations such as the Interamerican Development Bank, with which meetings have been held during the development of the proposal.

A second proposal, on load management, has also been included for the purpose of discussion.

PROMOTION OF INDEPENDENT POWER GENERATION

The United States and more recently, some Less Developed Countries (LDCs), e.g., the Dominican Republic, Turkey, Pakistan, India, have pursued an alternative to building large and expensive new power generation plants as a means of reducing public investment and foreign debt in the power sector. They have allowed the private sector to develop and operate power plants to generate electricity for its own needs or for sale to the grid. Policies to encourage such private investment have focused on industrial cogeneration -- the sequential production of power and process heat from one fuel source -- or systems using domestic energy resources, especially renewables. Since 1978, U.S. policies have resulted in 15,000 MW of additional private power generation, and Pakistan is expected to be able to generate in excess of 1,000 MW of private power (or 15 percent of its total needs) within 8 years. Such investments are not only technically feasible in most countries, but are economically justified and financially attractive when the requirements for fair purchase (or "buyback") rates* are stipulated for the utilities. In most countries, these private power policies have also sought to reduce future dependence on imported fossil fuels.

In Costa Rica, more than 95 percent of the electric energy is produced from hydroelectric systems and most of the future generating capacity will come from thermal and hydro sources. In only a few cases (e.g., excess electricity from sugar mills) could electricity production from private sources compete economically with utility-generated power at today's costs (about U.S.

*The price a utility will pay for electricity purchased from a private generator.

4 cents/kWh average cost in early 1986). However, such plants may well be competitive with new utility generation units if properly evaluated from both financial and economic standpoints. A number of options are likely to be cost-effective when compared with ICE's long-run marginal cost (LRMC), which is estimated at not less than U.S. 6 cents/kWh, with the cost of a new power plant at or above U.S. $2,000/kW. Among these options are small-scale hydro and excess power from sugar mills. The Ministry of Natural Resources Energy and Mines has designated as a priority item the identification of prerequisites for developing appropriate policies in Costa Rica. The following proposal outlines a study approach that is recommended for identifying such prerequisites based on the extensive experience by Hagler, Bailly & Company in conducting similar assignments in other AID-assisted countries over the last 16 months.

The study will examine the impediments to and potential for off-system private-sector power generation. The study team will visit with key power sector, private sector, and government policy officials to determine their views, collect and analyze data and information, and debrief the Mission on its preliminary findings and recommendations. A draft report will be prepared before departure and a final report will be prepared within 21 days after receipt of MNREM, Mission and AID/Washington comments.

STUDY OBJECTIVES

(1) Preliminary identification of the market and economic potential for cogeneration and private-sector small power production from

renewable and indigenous resources (particularly mini-hydro and agrowastes)

(2) Identification of the policy, regulatory, institutional, and other impediments to off-system private-sector electrical generation from cogeneration or renewable/indigenous resources for sale to the grid

(3) Development of recommendations and an action plan for addressing the impediments to off-system generation.

The study will be carried out in three tasks.

Task 1: Identify Market and Economic Potential

In carrying out this task, we will successively analyze the background, the situation of the current off-system generation and its costs and benefits, and describe the utility system and the existing power sector policies.

Background

- Country energy situation: Describe briefly, using existing data, the current energy situation and the factors influencing the introduction of private-sector off-system electrical generating systems. Such factors may be power sector constraints (e.g., capital availability, skilled manpower, inadequate generation capacity, system reliability) and the size and type of the industrial base and its capacity for cogeneration.

- U.S. experience: Briefly describe the Public Utility Regulatory Policies Act (PURPA) and the U.S. experience in fostering private-sector non-utility electrical generation.

Current Off-System Generation

Identify any current purchase arrangements between public utilities and non-utility electricity generators. Identify any projects under discussion or in the planning stage. Determine the extent of a trend toward private (captive) diesel or fuel oil-based generation.

Potential for Off-System Generation

Estimate the potential for non-utility renewable or indigenous energy based generation and cogeneration and assess the character of the generation, e.g., intermittent, seasonal, daily peaks.

Make preliminary estimates of the industrial cogeneration potential. Use existing industrial data and growth projections and identify the market for cogeneration by industry type, size of current and projected electricity/steam demands, applicable cogeneration technologies, and energy supply (coal, biomass, and/or oil). Indicate what the utility would have to pay for surplus electricity in order to make the system financially attractive. Provide an estimate (a range, if appropriate) of electricity that could be available for sale to the grid and an estimate of the capital investment needed.

Identify other decentralized private-sector generation options and, based on existing information, estimate the potential electricity that could be provided to the grid. Identify the energy resources, the energy conversion technology

options, and the institutional arrangements for generating the electricity. For example:

- bagasse; steam boilers; mill owners
- hydro; small scale turbines; industrialists

For the major generation options, indicate the financial viability of the systems and what the utility would have to pay for surplus electricity in order to make the system financially viable.

Costs and Benefits of Off-System Generation

Identify the costs and benefits of indigenous/renewable-based off-system electrical generation from the utility, user, and national perspective.

Utility System Description

Briefly describe the utility system, ownership, fuel use, marginal cost of generation, load projections, system expansion projects, and tariffs.

Determine the utility technical concerns about off-system generation such as system protection, metering, and reliability, and any related concerns about the purchase of off-system generation.

Identify the factors affecting the utility's marginal costs. Derive estimated "avoided costs" and the price a utility might reasonably be expected to pay for intermittent power during peak and off-peak periods.

Discuss the basis for the calculation, whether any fuel cost should be used in establishing the price to be paid by the utility for intermittent power, or whether some capacity cost should also be included in the price.

Power Sector Policies

Analyze the policy, legal, and regulatory framework governing the power sector, including:

- Government policy on non-utility generation of electricity for sale to the grid
- Legal and regulatory authority for generation of electricity
- Rate setting mechanisms and source of authority.

In carrying out this task, local consultants will be hired to gather basic market data, e.g., energy resource assessment, site specific project information, energy prices, taxes and electric utility costs.

Task 2: Identify Impediments to Off-System Generation

In this task, the team will analyze the policy, legal, regulatory, institutional, or other problems and impediments to off-system generation and determine the views of key institutions, industries, and individuals on the impediments to and potential for private sector off-system generation; these groups will include, but not be limited to, utilities, government ministries, banks and other financial institutions, commissions responsible for energy and utilities, key industrial and private sector entities, and policymakers and lawmakers.

Task 3: Develop Recommendations and an Action Plan for the GOCR

The consultants will provide policy, legal, regulatory, and other recommendations that will foster the introduction of private indigenous or renewable energy-based generation and cogeneration of electricity for sale to the grid, including the drafting of prototypical purchase contracts between private generators and ICE.

Schedule, Budget, and Staffing: The study will require three calendar months to produce a draft report to the GOCR, and 2.5 man-months of consultants' time, 1.5 of them in-country. The cost of the study will be $60,000, including provisions for using local consultants in Task 1.

Counterpart: The counterpart for this project will be DSE which should make one senior person available to the project on a full time basis during the three calendar months required for the study. Other key agencies to be involved on an ad hoc basis in the project include ICE and SNE (tariffs).

ELECTRIC LOAD MANAGEMENT

As new generating capacity is needed to meet constantly increasing peak demand, additions to the system become increasingly costly and less utilized. Peak demand rose by 35 percent between 1980 and 1985 to reach 558 MW, compared with a total installed capacity of 781 MW. As in many other developing countries, peak demand is growing sharply while base load demand is growing more slowly. As a result, there is a trend toward a decreasing load factor for the system as a whole and higher average production costs. Moreover, the problem is not limited to generation: proportional expansion of the transmission and distribution (T/D) systems is also needed. For social reasons, the GOCR has so far provided the electric industry with full support to make the related investment, but at great cost to the country in terms of local and foreign capital.

In contrast to most countries, there are two sharp peaks in Costa Rica, each one at meal time, because of the increasing popularity of electric cooking. Electricity rates for the domestic sector, which is responsible for 45 percent of peak demand are flat (i.e., only one rate; no time of day provision). Similarly, electric cooking represents most of the peak demand in the commercial sector because of the large contribution of hotels and hospitals to this sector. While higher electricity tariffs could be implemented to discourage use of electricity at peak time, this possibility is not likely to materialize in the next few years because of obvious social and technical difficulties.

One of the proven ways to alleviate this situation is to use load management techniques (LMT), which are aimed at flattening the peak by displacing some of its discretionary components (e.g., water heating) in time. (See Appendix 2 for a full definition of LMTs). LMTs cover a broad spectrum of measures, from simple thermostatic water heater devices that switch off electricity when demand in the house or the building exceeds a given level, to computerized and radio-controlled multibuilding systems that can cycle air conditioning units (or other types of appliances) as soon as total load exceeds a preset level, which can vary with the time of day.

Clearly, none of these techniques has been extensively used in developing countries. Clearly, too, the United States is a leader in their use and many electric utilities (e.g., Bonneville Power Authority in the Northwest) have experienced great and lasting success from LMTs. This proposal entails a phased approach to the transfer of know-how and technology from the United States to Costa Rica, with associated training of ICE operators. A phased approach is recommended because of the innovative aspect of the project, which can serve as a guide for other AID-assisted countries.

PROJECT OBJECTIVES

The project will seek to demonstrate that peak load can be reduced by 10 percent in a representative sample of medium-sized users (i.e., 20-100 kW) at a cost acceptable to both the users and the electric utility. To put this project in perspective, a 5 percent reduction in peak demand at the National level by 1990 would contribute as much to the system as the addition of one

55 MW geothermal unit. This would save roughly $15 million in foreign exchange by delaying construction of that power plant by about 2 years.

Three phases are proposed for the pilot project:

Phase 1: Design

Phase 2: Demonstration

Phase 3: Dissemination

Each phase is presented in detail below, with tasks to be performed, schedule, budget, and staffing.

Phase 1: Design

An analysis of the structure of current peaks indicates that they derive from two sectors, the domestic and the commercial sectors, and that cooking accounts for the major use of electricity. Because typical household demand is low by international standards of 400-500 W average peak* and 200 kWh/month, it is unlikely to be technically or economically practical to initiate the project in the domestic sector. The commercial sector is thus the most suitable candidate for the project, together with some medium-scale industries contributing to the peak. In both cases, typical loads are likely to be in the 20-100 kW range and can justify sizable investments. In addition, each participant in these groups, e.g., hotels, supermarkets, hospitals, medium-size industries, has a full-time trained technician that will be a great

* Which is about 10 times the average LDC figure (50 W).

asset for the project's day-to-day operation. Moreover, each establishment is -- or can easily be -- equipped with adequate metering systems.

This phase will consist of the following tasks:

Task 1: Finalize ICE and GOCR commitment to the project.

Task 2: Select, with ICE, the optimal sample of participating establishments to maximize chances of success for Phase 2 and replicability, probably around 40, of which 20 in the commercial sector (5 hotels, 5 hospitals, 5 office buildings, and 5 "other") and the other 20 in small/medium industries around San Jose.

Task 3: Define detailed organizational arrangements, i.e., role of DSE, ICE, participants, equipment suppliers, and consultants.

Task 4: Develop detailed budget for Phase 2.

Task 5: Conduct preliminary cost-benefit analysis for Phase 2. The goal should be not less than a 10-percent peak load reduction in Phase 2.

Task 6: Get final agreement and commitments from all parties involved in the project.

Schedule, Budget and Proposed Staffing

This phase will last 2 calendar months, consisting of 2 weeks of preparation in the United States, including a review of U.S. LMT experience and its transfer to developing countries, 3 weeks in-country to carry out on-site

work for Tasks 1-6, and 4 weeks to finalize the Phase 1 report. The cost of this phase is estimated at $35,000.

Phase 2: Demonstration

This phase, which will be defined in detail at the end of Phase 1, is likely to consist of the following tasks:

Task 1: Preparation.

In this task, the consultants and their counterparts will revisit the participating establishments to make arrangements (e.g., data, staff requirements) for installing the LMT equipment and associated metering instruments. At the time of writing this proposal it is difficult to anticipate exactly what type of "hardware" will be needed, but one can assume that there will be 2 categories of equipment: (1) direct load management devices and associated meters (at each participating location) and (2) the data transmissions and analysis (including software) components.

The consultants will also develop ICE's monitoring system, which will probably be computerized. For example, direct communication between ICE's counterpart team and the participating establishments may be required. Detailed hour-by-hour baseline load curves will need to be developed for not less than 1 month in each establishment to allow accurate measurement of peak reduction during the demonstration and after correcting for seasonal factors.* During this task, all training, e.g., for ICE and participating technicians, will be carried out. This step is likely to take about 2 months

* It may be best to conduct Task 2 during the dry season to make results more dramatic as gas turbines are used as peakers during that period.

for two consultants, one with direct experience of the U.S. electric utility programs.

Task 2: Demonstration.

This task will consist of the implementation of the LMTs during a period of not less than 3 months, with on-the-job training for the ICE team. During this period, no more than 2 man-months of consultant time are expected to be needed to oversee ICE activities.

Task 3: Evaluation and preparation of final report.

In this task, quantitative data collected during the previous task, together with a survey of reactions from participating establishments, will be analyzed to estimate project costs and benefits and recommend next tasks. This task is likely to require 3 man-months of consultant time, including report preparation.

Phase 3: Dissemination (Prepare Nationwide Implementation Program)

This phase can only be designed and costed after completion of Phase 2. However, it is likely to result in a multiyear, multimillion dollar program submitted to international lending organizations such as the World Bank and the Inter-American Development Bank for funding. Possible savings resulting from such a phase would be in the order of $10-20 million (rough estimate).

Schedule and Budget for Phases 2 and 3

The two phases are estimated to require 9 calendar months for completion and cost about $220,000 including purchase of equipment.

Counterpart

Two agencies would be involved as counterparts: ICE must be the implementing agency with day-to-day responsibility for all aspects, especially technical, of the project and to a lesser extent DSE, because of its overall energy planning responsibilities. The exact definition of the counterpart role, including personnel and equipment will be part of Phase I.

This program could delay large public investments by several years and has the potential to save considerable foreign exchange for Costa Rica in the future. And most importantly, the project will develop a local capability within ICE to expand and continue using more and more efficient load management techniques and thereby make ICE a leader in Central America in this field. This project must therefore be seen as an ambitious technology and know how transfer effort at the conclusion of which load management activities in Costa Rica will be handled mostly by local staff with minimum outside consultancy support.

APPENDIX 1: LIST OF CONTACTS

Wednesday, June 25

- Direccion Sectorial de la Energia (DSE)

  Dr. Jorge Blanco, Director

  Lic. Ana Lorena Leon

  Ing. Antony Araya

Thursday, June 26

- Instituto Costarricense de Electricidad (ICE)

  Ing Guillermo Emilio Alvarado U.

  Jefe Departamento Transmision de Energia

  Ing Manuel F. Corrales V

  Jefe de Direccion Planificacion Electrica

- Refinadora Costarricense de Petroleo S.A. (RECOPE)

  Ing Jose Ruben Naranjo Sanchez

  Jefe Departamento de Planificacion

- Ministerio de Recursos Naturales, Energia y Minas

  Dr. Alvaro Umana, Ministro

Friday, June 27

- Consorcio de Transportes Cooperativas R.L. (Cotracoop)

  Sr Oscar Zuniga Rojas, Gerente General

- Sol 2000 S.A.

  Ing Jose Chacon, Presidente

  Ing Juan Rafael Rojas, Gerente

- Camara de Transporte

  Luis Gonzales Herrera, Presidente

  Ing Eduardo Arigo, CONATRA

  Sr William Morales, GUADALUPE

  Lic Eduardo E. Mora V, POCO

- ICAITI

  Ing Felix del Barco

Monday, June 30

- USAID/San Jose

  Ing. Heriberto Rodriguez

  M. Kevin Kelly

- I.C.E.

  Ing Luis Alberto Soto

- GASH (Trucking Company)

  Ing Javier Reyna

  Vice Presidente Ejecutivo

- MRNEM

  Dr. Alvaro Umana, Ministro.

  Dr. Jorge Monge, Vice Ministro

  Dr. Jorge Blanco, director, DSE

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Thursday, July 1

- RECOPE

  Oldemar Ramirez

  Director Recursos Carboniferos

- BID

- DSE

  Ing Antony Araya

APPENDIX 2: ELECTRIC LOAD MANAGEMENT: DEFINITION AND KEY TECHNIQUES

DEFINITION

A load management technique means any technique (other than a time-of-day or seasonal rate) to reduce the maximum kilowatt demand on the electric utility, including ripple or radio control mechanisms and other types of interruptible electric service, energy storage devices, and load-limiting devices.

KEY TECHNIQUES

Direct Load Control

Singular or cyclical interruption of customer equipment and appliances in response to peak-load levels on the utility system.

- Remote utility control of:
  - -- Residential space heaters
  - -- Residential storage space heaters
  - -- Residential air conditioners
  - -- Residential water heaters
  - -- Commercial-customer water heaters and nonessential loads
- Communications systems for remote utility control:
  - -- Ripple control
  - -- Power line carriers
  - -- Sine wave alteration
  - -- Radio control
  - -- Telephone control
- Other means of control:
  - -- Local control
    - -- Site-specific activation
    - -- Time-specific activation
    - -- Direct utility activation
  - -- Customer control
  - -- Multiple building computer control

- Incentive programs for energy conservation
  - -- Reduced electricity rates for interruptible service
  - -- Subsidized insulation and other energy conservation retrofits sales and installation
  - -- Interest-free/reduced interest for energy conservation loans
  - -- Energy saving sweepstakes
  - -- Energy saving new or retrofited home awards
  - -- Conservation awards

- Conservation services:
  - -- Customer insulation programs
  - -- Free trippers for swimming pool
  - -- Free energy audits
  - -- Free energy conservation products

- Public appeals for conservation

Energy Storage

Thermal, mechanical, or electrical storage of energy during off-peak hours to reduce demand during peak hours.

- Storage Water heaters:
  - -- Clock timer control
  - -- Remote utility control
  - -- Ceramic heat storage
  - -- Pressurized water heat storage
  - -- Non-pressurized water heat storage
  - -- In-Ground heat storage
  - -- Eutectic salts heat storage

- Storage space heaters:
  - -- Clock timer control
  - -- Remote utility control
  - -- Ceramic heat storage
  - -- Pressurized water heat storage
  - -- Non-pressurized water heat storage
  - -- In-Ground heat storage
  - -- Eutectic salts heat storage

- Storage air conditioners:
  - -- Clock timer control
  - -- Remote utility control
  - -- Ice cool storage
  - -- Eutectic salts cool storage

- Combined heat and cool storage:
  -- Non-pressurized hot water/cool water/ice
- Compressed air storage
- Pumped hydro storage
- Battery storage
- Hydrogen from water storage

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