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FOREIGN TRIP REPORT
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DATE: April 10, 1990

SUBJECT: Report of Foreign Travel of Daniel B. Waddle, Research Staff
Member, Energy Division

TO: Alvin W. Trivelpiece

FROM: Daniel B. Waddle

PURPOSE: To assess the potential supply side efficiency measures that would result in significant cost and energy savings for the Instituto Costarricense de Electricidad, as part of an overall power sector efficiency analysis in Costa Rica.

SITES VISITED: 3/19-3/29/1990 San Jose, Costa Rica
3/22/1990 Quesada, Costa Rica

ABSTRACT: I travelled to San Jose, Costa Rica, to review the state of the electric power utility with a team of specialists, including a transmission and distribution specialist, a hydroelectric engineering specialist, and a thermal power plant specialist. The purpose of the mission was to determine the costs and benefits of efficiency improvements to supply side technologies employed by the Instituto Costarricense de Electricidad, the national power company in Costa Rica, and the potential contribution of these efficiency measures to the future electric power needs of Costa Rica.

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Background

In an effort sponsored jointly by the Office of Energy AID/Washington and USAID/Costa Rica, a comprehensive cross-sectoral analysis of cost effective energy efficiency measures has been undertaken by the Instituto Costarricense de Electricidad (ICE), the Direccion Sectorial de Energia (DSE), and the Ministry of Natural Resources, Energy and Mines (MIRENEM) in cooperation with other Costa Rican electric power utilities. A.I.D. requested Oak Ridge National Laboratory (ORNL) to provide technical and programmatic assistance through the Energy Policy and Planning Development Project for this project. The traveller was designated as the ORNL task manager for ORNL's participation in the Costa Rica study.

The concept is to introduce an integrated program of power sector efficiency measures in all sub-sectors of the electric power system, including energy conversion efficiency for utility prime movers (thermal, as well as hydroelectric facilities); to the extent possible, reduce transmission and distribution line losses and to introduce demand side management programs to improve energy use by electric energy consumers. The end product of the exercise will be two-fold. A document will be drafted outlining least cost options for the power system development with a summary of the costs and benefits of each respective option as well as a summary of the data and research needs for the utility to better define the plan's optimization in future years.

Costa Rica was selected as the first country in which A.I.D. wished to develop this integrated analysis and planning concept. The power sector is sufficiently small (825 installed MW; 3400 GWh/yr energy consumption) to make the initial analysis more manageable, with an abundance of data, in comparison to many other A.I.D.-assisted countries. Furthermore, close political ties improved the viability of completing the study with maximum cooperation from Costa Rican counterpart agencies.

In January the first field mission sent to Costa Rica was composed of the demand side management analysis team. This team gathered data from various government agencies, identifying energy savings potential of the relevant end uses and users. The mission, completed in March 1990, included members of a supply side analysis team working directly with electric power utilities. The traveller was the team leader of the supply side analysis team.

Summary of Activities and Findings

I arrived in Costa Rica on March 19, 1990. During the following morning, meetings were held with a number of ICE senior management staff, including the Technical Advisor to the Director, the Director of Generation, the Director of Transmission, the Sub-Director of Dispatch, and the Director of Distribution for Western Costa Rica. In these meetings, the team received an overview of ICE operations, dispatch protocol, maintenance issues, water and energy management and capacity expansion scenarios. A tentative schedule was planned for the rest of the week which included site visits to Arenal/Corobici, San Antonio, Colima, and Moin. Data requests for indicators of plant performance, maintenance schedules and other parameters pertaining to efficient operation and management were presented during these initial meetings.

During the ensuing eight days, the team toured all of the above mentioned plants, with the exception of Moin due to logistical problems. The data provided, together with interviews with ICE

personnel and data trends, indicate that ICE assets are closely monitored, maintained and managed. The review of the hydro facilities revealed that the Arenal/Corobici complex is meticulously monitored and maintained. However, it was noted that actual plant efficiency cannot be determined with the data presently monitored; actual flow data is not collected. Nonetheless, in the opinion of the hydro specialist, it is highly unlikely that improvements in operating efficiency could be effected at this plant.

Additional analyses of the plant data will be made in the coming weeks to determine if specific analyses are merited at one or more of the older hydro facilities (Rio Macho, Cachi, or La Garita). Real time flow and power output are measured to determine if obstructions exist in the intake structure, or perhaps if the turbine machinery is in need of inspection and repair. Without flow versus power output data, plant performance cannot be measured. The team will assess the relative cost of such measurements against possible benefits and provide recommendations to A.I.D. and ICE.

The thermal plant inspections illustrated several issues that will require further investigation and discussion. Plant performance data has not been analyzed in detail, but it appears that from a combination of over-cycling and infrequent usage, the gas turbines, steam, and internal combustion diesel sets have all experienced high outage rates. While the pending IDB loan should allow ICE to bring all equipment to a state of full availability in the next 18 months, the team will perform additional analyses to quantify the financial effects of frequent cycling versus increased use and the associated operating costs of such a strategy.

The team also held several discussions with various ICE personnel regarding the procurement of the 3 x 36 MW simple cycle gas turbines. The discussions revolved around the issue of the decision taken to purchase simple cycle machines versus combined cycle, or perhaps aero-derivative steam injected machines. A more detailed analysis will be performed to provide ICE staff with additional information regarding this issue from the perspective of a possible retrofit of combined cycle equipment for future system expansion. This will be accompanied by a sensitivity analysis of the effects of hourly operation and the number of starts per operating hour of the machines against expected maintenance and operating costs for various technologies which should be considered to augment thermal capacity in future years.

The transmission and distribution task involved reviewing the recent and planned changes in the ICE grid and their effect on losses. The transmission losses appear to be within acceptable limits; and while changes could be made to some selected geographic areas of the transmission system, investments in upgrades cannot be justified until more detailed data can be made available to determine actual transmission spur loads and losses subsequently calculated to determine real benefits of proposed upgrades. Distribution losses have been estimated to be 7.5%; but it was noted that these losses are calculated rather than measured; therefore, the actual value could vary from this figure. A more careful analysis of non-technical losses could reveal some low cost management improvements for distributing the utilities, but this is perhaps an activity that is best conducted by the utilities themselves. The analysis for this task will focus on reduction of technical losses. At present, the data will have to be reviewed in more detail to determine if any hardware changes will result in significant savings. The initial review indicates that the system, while not optimal, is being operated and maintained extremely well.

The team will prepare a draft report in the coming weeks with supporting analysis for the above tasks. This report will be integrated into a master draft report including the demand side management analysis which will be provided to ICE, DSE, MIRENEM and A.I.D. for review and comments. If additional field study is recommended (as may well be the case for the hydroelectric task), it is hoped that this can be completed prior to the first draft of the report. The first draft will be submitted for review on or about May 31, 1990.

On Thursday, March 29, 1990, the team returned to the United States. I flew to Washington to confer with A.I.D. management staff as well as support contractors for the Costa Rica mission. I returned to Oak Ridge Saturday, March 31.

Itinerary

<u>Date</u>	<u>Location</u>	<u>Topic Discussed</u>
3/19	San Jose	Arrival
3/20	San Jose	Overview with ICE
3/21	Quesada	Cooperatives participation in project
3/22	San Jose	Meetings with Engineering and Operations
3/23	San Jose	Meetings with Planning and Dispatch
3/26	San Jose	Power plant review
3/27	San Jose	Data Analysis
3/28	San Jose	Meeting with AID and ICE to debrief and set future agenda
3/29	Washington	Travel to Washington from San Jose
3/30	Washington	Discussions with AID sponsors
3/31	Oak Ridge	Return to Oak Ridge

List of Persons Contacted

Heriberto Rodriquez, USAID Energy Officer

Hernan Robles, Technical Assistant to the President, ICE

Rolando Rios, Chief, Department of Transmission, ICE

Carlos Bejarano, Department Energy Control, ICE

Carlos Runnebaum, Department of Distribution, ICE

Bernal Delgado, Chief of Operations, ICE

Alberto Ramirez, Chief of Maintenance, ICE

Jorge Zamora, Chief of Engineering, ICE

Luis Barquero, Chief of Energy Control, ICE

Hector Vargas, Department of Planning, ICE

Carlos Rodriquez, General Director COOPELESCA

Federico Baltodano, President of BEL Engineering

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1. John J. Easton, Jr., Assistant Secretary for International Affairs and Energy Emergencies (IE-1), DOE, Washington, DC 20585
2. J. A. Reafsnnyder, Deputy Assistant Manager, Energy Research and Development, DOE-ORO
3. D. J. Cook, Director, Safeguards and Security Division, DOE-ORO
4. A. W. Trivelpiece
5. D. B. Waddle
6. R. Chronowski, IRG Systems, 1400 Eye Street, N.W., Suite 700 Washington, DC 20005
7. P. Clark, NRECA, 1800 Massachusetts Avenue, N.W., Washington, DC 20036
8. G. E. Courville
9. S. J. Dale
10. S. B. Floyd
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12. L. J. Hill
13. E. L. Hillsman
14. D. J. Jhirad, Office of Energy, U.S. Agency for International Development, SA-18, Room 508, Washington, DC 20523
15. D. W. Jones
16. H. G. Jones, Oak Ridge Associated Universities, 1019 19th Street, N.W., Suite 700, Washington, DC 20036
17. R. D. Perlack
18. C. H. Petrich
19. R. Pumfrey, Office of Energy, U.S. Agency for International Development, SA-18, Room 508, Washington, DC 20523
20. A. J. Sabadell, Office of Energy, U.S. Agency for International Development, SA-18, Room 508, Washington, DC 20523
21. R. B. Shelton
22. P. Smith, Oak Ridge Associated Universities, 1019 19th Street, N.W., Suite 700, Washington, DC 20036
23. J. B. Sullivan, Director, Office of Energy, U.S. Agency for International Development, SA-18, Room 508, Washington, DC 20523
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