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BACKGROUND AND RECOMMENDATIONS

FOR

A REGIONAL ENERGY TECHNICAL ASSISTANCE PROJECT

by

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I. INTRODUCTION

Energy *per se* has taken a place in recent years alongside such traditional development targets as health, agriculture, and education. A January 1981 AID Energy Assistance Policy Paper and a worldwide cable from the Secretary of State in May 1981 underscore the urgency of applying AID resources and ideas to projects of energy assistance.

Energy projects now represent a significant share of AID's project budget. In Latin America and the Caribbean, for example, over 25 projects devoted entirely or in part to energy were active or in the planning stage as of September 1981. Funding in FY 1982 for these projects was projected at $27.4 million. An estimated 10-11% of the LAC Bureau's project budget was allocated to energy projects.

Most of these projects are bilateral. In Central America, Costa Rica has three active projects, Honduras has two active and two planned. At the regional level there is one active project, the Fuelwood and Alternative Energy Sources Project, as well as three others in the planning stage. These four are under the management of AID's Regional Office for Central American Projects (ROCAP), with headquarters in Guatemala City.

Regional approaches to common problems can provide economies of scale and other benefits, as the Fuelwood and Alternative Energy Sources Project is expected to demonstrate. ROCAP is building on the experience from that project in planning three new energy projects. One of these is the Energy Policy Support, Conservation, and Renewable Energy Development Project (or the Regional Energy Project, for short). This paper is intended to serve as background to the Project Identification Document (PID) and the subsequent Project Paper by assessing regional energy planning and policy-making, renewable energy technologies, and energy efficient technologies,

as well as the regional institutions that carry out these activities, their capabilities and requirements.

In order to identify institutional requirements, the paper first recommends a strategic approach and then ties requirements to that approach.

The organization of the paper has four parts. In this Introduction section are discussed Central America's energy problems, a set of suggested regional strategies for dealing with them, currently available resources (natural, institutional, and financial), proposed roles in the project for key regional institutions, and a proposed role for ROCAP.

Sections II and III deal at greater length with the matters of regional energy strategies and the regional institutions that can play key roles in the project, their known capabilities, proposed roles, and requirements if they are assigned those roles. Section IV summarizes recommendations alluded to elsewhere in the paper.

At a number of points, the discussion takes up the question of participation by the private sector in regional energy development. This is certainly an area of concern to private business, for the immediate impact that energy prices have on profit-making as well as for the vital stake that the private sector has in the overall economic health of the region. AID's current emphasis on bringing the private sector in as a participant in development projects is reflected in the strategy suggested for this one.

Developing energy sources without concern for possible adverse impacts on the environment or the social structure or the general economy would be sub-optimizing at its worst. Any detailed project plan should include assurances that diversion of a crop from food to fuel will not work to the net disadvantage

of a society, for example, or that government subsidies to encourage a new technology could not be applied more productively to another end. This paper does not reach that specific a level of detailed project planning, but if the reader begins to infer from these pages the message that energy development is an end unto itself, this disclaimer is intended to correct that impression.

A. Central America's Energy Problems

There are two very different major energy problems in the Central American countries. One is the cost and supply of imported oil to meet demands for electricity generation, transportation, and industrial use. The other is the cost and supply of fuelwood to meet primarily rural demands for cooking, light, and heat and for some industrial uses. Regional oil supplies are insufficient to meet regional needs, and the costs of imported oil are onerous. Regional fuelwood supplies are still abundant, but they are being used faster than they are being replenished, and prices are rising.

Even though the two fuels are used by distinct sectors of the economy, there are some inter-relationships. On the one hand, high prices for imported oil make it difficult to use it as a replacement for fuelwood, as has been the historic pattern in developing countries. On the other hand, high prices of fuelwood and the environmental problems attendant to deforestation make it difficult to substitute fuelwood, charcoal, or wood derived liquids for imported oil in industry or transportation. Some of the possible solutions for the imported oil and domestic fuelwood problems are similar, e.g., the use of biogas to replace imported oil in a factory or wood in a rural kitchen.

Although the scales, costs, and methods for attacking the two problems require separate strategies and separate projects, it is virtually impossible to consider either in isolation. So while this paper is concerned essentially with the imported oil problem, it will contain frequent references to the fuelwood problem.

1. Imported Oil

In 1960, one dollar out of every seventeen earned through exports from Central America went toward the cost of the region's imported oil. By 1985, one dollar out of every

four of export earnings will be needed to pay for Central America's oil imports.[1/] In dollar terms the payments for oil imports have soared from $77 million in 1971 to $950 million in 1979.[2/]

These numbers continue to rise because of increasing populations, escalating oil costs, and productivity losses from civil unrest in parts of Central America. Aggravating the problem is the inability of the region to produce its own oil. Except for Guatemala, none of the countries in Central America has any known petroleum resources.[3/]

In circumstances like these, economies respond in the long run by substituting available and cheaper goods for the scarce and costlier goods. But the response times can be very long. For example, ROCAP estimates that the results of the Fuelwood and Alternative Energy Sources Project, now in its third year, will take five to ten years.

Complete transitions from one major fuel source to another take even longer. In the United States, the replacement of wood by coal, and later of coal by petroleum, as principal fuels took about sixty years in both cases. Whether the constraints are lack of information or lack of capital for investment in the means for using new energy, these transitions are not accomplished quickly.

2. Rural Energy

An outsider is apt to be startled to learn that more than half of the energy consumed in Central America comes from wood and other biomass sources. In 1979, wood and charcoal accounted for 49% and other biomass (principally bagasse) for 6.5% of all energy used in the region. Most of the firewood and charcoal -- 89.4% -- went to domestic uses; the balance was consumed by industries.[4/]

Most of the homes in Central America burn wood or charcoal for cooking, light, and heating. The figure is 80%, according to one estimate.[5/] For the rural sector, where petroleum fuels and electicity have scarcely entered the market, the fraction of homes using wood as fuel goes even higher.

This sector of the economy faces its own set of energy-related problems as shrinking supplies and growing transport costs drive up wood prices. In addition, ecological problems arise. The cutting of trees for fuelwood and charcoal production and industrial uses has contributed to deforestation and resulting erosion, siltation, flooding, loss of natural habitat, and lower water infiltration.[6/]

Concern for the fuelwood crisis and the need for solutions prompted ROCAP's Fuelwood and Alternative Energy Sources Project, which is designed both to increase regional fuelwood supplies and to speed the adoption of more efficient woodstoves. This project was initiated in FY 1979 and will run for five years.

B. Regional Strategies for Dealing with the Problems

While the remedies for Central America's energy problems are neither quick nor cheap, some at least are clearly identifiable. The substitution of hydroelectric or geothermal electric power for electricity produced by oil-fired generators, for example, stands out as one way to reduce Central American oil consumption. In 1979, oil-fired generating plants consumed about 19% of all petroleum used in Central America.[7/] All five governments currently have hydroelectric and/or geothermal projects underway, and some of the post-1973 plants are already producing electricity.

As of 1979, the region was generating 47.7% of its electric power from petroleum fuels, and the rest from hydroenergy (27.4%), geothermal energy (19.0%) and biomass fuels (5.9%).[8/] Guatemala placed the greatest dependence on petroleum fuels, about 80% of generating capacity, which has been reduced with the inauguration of the Aguacapa hydroelectric system in November 1981.[9/] El Salvador, on the other hand, derived less than 1% of its electric energy from petroleum fuels in 1979; hydroenergy and geothermal energy provided the balance.[10/]

For the 80% or so of the oil that goes to uses other than electric power generation, and for all of the wood that currently goes to rural and industrial uses, no such substitution program has been undertaken by any of the governments, with the exception of one or two alcohol fuel projects. One reason is that the economic condition of the Central American countries places severe limits on the amounts that they can invest in developing new energy technologies.

Another reason is uncertainty concerning which of many interesting alternate paths to petroleum substitution and woodland conservation are the most attractive, economically. If a

coffee grower wants to dry a crop without burning oil, should he try burning coffee wastes, using a solar-powered system, or finding still another drying process? Should a potential manufacturer of ethanol choose sugar cane as a raw material, or sorghum, yucca, camote, guayaba, or banana wastes? Answers to such questions require elusive cost and benefit figures that take into account environmental and social externalities of varying sublety. The Central American governments lack ready answers.

Since many of the answers will help not just one but several or all of the Central American countries, ROCAP is considering a regional approach in which U.S. assistance is extended to regional institutions engaged in energy planning and policy-making, increased energy efficiency, and renewable energy technology development. Each of these three elements of strategy is discussed briefly in this section and at greater length later in the paper.

1. Coordinating Energy Planning and Policy Making

Regional energy policies for Central America are expressed in a succession of multilateral agreements, resolutions, and proceedings dating back to 1960. Through all of these documents runs the theme that joint efforts can be effective in solving certain energy-related problems common to all parts of the region.

To implement these policies with specific plans for regional energy programs, in 1975 the Central American governments created a regional body, the Comisión Centroamericana de Energía (COMENER). In addition to COMENER, many other institutions, at the super-regional, regional and national levels, contribute or can contribute to regional energy planning.

At the present time, the efforts of this complex of institutions are not well coordinated. Reasons include lack

of resources, intra-governmental jurisdictional questions, and -- a particularly acute problem -- inter-governmental political differences. The institution having a charter to coordinate regional energy planning activities, COMENER, has only met once in its six years of existence. Its Secretariat, SIECA/COMENER, having only a modest budget, nevertheless performs a number of useful services for the regional planning community.

The five-way lobbying effort that would be required to bring COMENER up to the level of effectivness that its creators intended goes well beyond the scope of ROCAP's regional energy project. Vitalizing COMENER, or replacing it with another organization, must be done by the five governments if it is going to be done.

Meanwhile, however, some measures can be suggested whereby ROCAP can support regional energy planning and policy-making by strengthening SIECA/COMENER. One such measure is to help build a regional energy project information system within SIECA/COMENER. There is a need for better sharing of information on project status and progress, as the difficulties encountered in the preparation of this paper well demonstrate. Technical assistance from ROCAP to SIECA/COMENER can take the form of two specialists, one in information and energy systems engineering and the other in energy planning and analysis, who would use SIECA's current manual system for tracking infrastructure projects as a foundation from which to develop an automated system for tracking all regional energy projects.

Another feature of the ROCAP support, using the same personnel, would be assistance to SIECA/COMENER in doing technical studies, forecasting, preparing regional energy policy proposals, and generating ideas for new projects. For these activities, current knowledge of regional energy projects is

seen as a prerequisite; hence the information system development should take first priority.

A requirement for equipment arises as the information system approaches operational status. The approach suggested in this paper is that ROCAP explore the possibilities of using the small, inexpensive, stand-alone "home" computers that have come onto the market in the past several years. With a regional complex of these microprocessors, a new kind of regional information system can be created at modest cost which will stimulate national-level interest in and support for regional energy planning.

2. Increasing Energy Efficiency

Conserving energy by increasing the efficiencies of devices that transform or use it has been shown to have a high benefit/cost ratio. Opportunities for cutting costs through increasing efficiency can be found in every sector -- agricultural, industrial, transportation, and commercial/residential. In Central America's agricultural sector, efficiency can be improved through the Fuelwood and Alternative Energy Sources Project and like projects designed to raise the currently low efficiency of woodstoves.

For the transportation sector, major projects such as electrifying mass transit systems could bring greater efficiency, but they would be long-term undertakings beyond the scope of the Regional Energy Project. In the commercial/residential sector, opportunities for increasing energy efficiency are less common in Central America than in areas with harsher climates.

The sector that offers the greatest potential for early improvements in the industrial sector, which used 24% of the region's energy in 1979. To acquaint industries with currently available devices and processes for increasing

efficiency, a program of technology transfer is needed. Because of the complexity of the sector, efficiency-increasing measures tend to be industry-specific and even plant-specific. What is recommended is an individual energy audit for any manufacturer or agribusiness that wants to join the program.

Under the Regional Energy Project, the energy audit concept can be supported in two ways. First, a regional auditing mechanism can be set up. Its personnel can be trained with technical assistance from ROCAP. Once the audit program has been publicized with the help of private industry associations, firms start using the service. At the outset, audits should be performed at no cost to the audited firms other than their agreement to allow dissemination of findings beneficial to other firms. Later on, the auditing institution should charge for its services.

The second form of support to the audit program is a loan fund set up for the benefit of plant operators in need of assistance in financing plant modifications.

Both measures are recommended. For the creation and development of an energy audit mechanism, ICAITI rates as the best qualified institution. To administer the loan fund, BCIE is the logical choice. To give the program the publicity it requires, FECAICA and the industry associations can play a useful role.

But before an energy audit program is put into effect, there is a need for a broad study of energy use in Central American industries. This "macro energy audit" would quantify energy use by fuel, by specific industry (and possibly some subsets of industries), and by country, for several years back. Purpose of the study would be to set priorities as well as baselines for the subsequent energy audit program. ICAITI

stands out as the regional institution best qualified to perform this macro energy audit.

3. Developing Renewable Energy Technologies

Except for large hydroelectric projects around the region and geothermal projects in El Salvador, most projects for developing and using Central America's renewable energy resources are still in the discussion stage. A notable exception is Costa Rica's sugar cane-to-ethanol distillery, which has been in operation since 1980.

The slow pace of development is not due to any shortages of natural resources, which abound in Central America, but to other factors. Those who might benefit from renewable energy technologies are either unaware of the possibilities, skeptical about returns on investments, or strapped for capital.

Nevertheless, opportunities exist. A paper prepared by SIECA/COMENER for the UN Conference on New and Renewable Energy Sources in Nairobi, Kenya in August 1981 described the current status of, and the potential for, development of small hydroelectric plants, solar energy, biomass, biogas, alcohol fuels, and wind energy in Central America. The contrast between the potentials and their exploitation to date was striking.

Some of them merit high-priority attention. Replenishment or more efficient use of fuelwood in particular is an urgent requirement for the region, if not for the rest of the world.

The desire to perfect and disseminate these technologies is shared by many institutions of regional or national scope, all of which can bring a useful set of capabilities to bear on regional problems. ICAITI stands out as having the experience and insight needed to develop and demonstrate several of the more promising technologies.

But which? The proponents of any one technology can argue convincingly for it, but any devil's advocate can counter with benefit/cost uncertainties, food vs. fuel arguments, environmental implications, or a host of other economic, social or political issues.

Rather than commit support now to any one technology, or begin a study to choose one, or hedge by supporting several, ROCAP should look for signals from the marketplace. The decision-makers in the private sector, given enough knowledge about the opportunities, and the risks involved, can be expected to make known their choices and their willingness, if any, to share in the costs of technology development. Only with some show of support from the private sector should ROCAP commit its own support.

Insistence on private sector commitment is a realistic measure only if there is some assurance that the decision-makers in that sector are fully informed. There is no way today that they could be expected to know all that is happening or that might be made to happen with renewable energy sources. In fact, no one regional energy planning institution has a full grasp of the subject. What is needed is a regional energy information collection and dissemination center.

The strategy suggested here is that such a center be set up, under SIECA/COMENER management, using key regional and national private sector institutions as conduits to regional industries and individual firms. This approach is an extension of the one already proposed for the regional energy planning element, which places emphasis on a regional energy project tracking system.

ROCAP is looking for ways to work with the private sector; the recommended strategy requires this sector to assume

part of the responsibility for determining which renewable energy technologies will be developed in Central America.

C. Currently Available Resources

Implementing these regional strategies will require resources of three kinds. One will be the natural resources with which the region is endowed. A second class of resources is made up of institutions that deal with regional energy matters in one form or another. The individual and organizational capabilities embodied in these institutions will be able to adapt the region's natural resources to new, energy producing forms only with the help of a third resource -- financial support. A brief discussion of these three resource types will serve as background to ROCAP's proposals for enhancing the regional institutions that play leading roles in this project.

1. Natural Resources

Next to Mexico's border, in the upper one-third of Guatemala, lie oil reserves that, according to estimates by Government officials, may run to two billion barrels,[11/] or 75 times the amount consumed in all of Central America in 1979. Guatemalan government officials now believe that the nation can displace all oil imports by the late 1980's.[12/] The rest of Central America, however, is devoid of petroleum deposits, as far as we know today.

Similarly, the only known natural gas reserves in the region are found in Guatemala, where gas was still being flared as of early 1980, although a Guatemalan consortium, FABRIGAS, had plans to convert some of it to commercial uses.[13/]

Coal is not to be found in Central America except for scattered deposits of lignite and some reserves of coal in Costa Rica. The Costa Rican Electricity Institute, estimating those reserves to be on the order of 100 million tons, was planning in early 1980 a three-year study of likely coal-bearing regions that would include topographic, photogeological, geophysical, and geochemical investigation.[14/]

In contrast to the dearth of fossil fuels in most of Central America, the region has an abundance of renewable energy resources. Except for El Salvador, all of the countries have hydro and/or geothermal resources far in excess of what they have converted to electric power generation to date or, for that matter, of what they will need by 2000 to satisfy projected electricity demand in that year.[15/] All of the countries are currently expanding their hydro and/or geothermal electricity generation capacities. In 1980, in fact, $364 million of new investment in energy projects went to hydro and geothermal projects out of a total of $435.5 million; see Table 1 for a breakdown.

TABLE 1

INVESTMENTS IN CENTRAL AMERICAN ENERGY PROJECTS
IN 1980
(In Millions of Dollars)

	G	ES	H	N	CR	TOTAL
Hydroelectric	129.7	81.5	82.0	-	55.0	348.2
Geothermal	4.1	6.1	0.3	2.6	2.7	15.8
Thermal Electric	0.4	-	3.6	-	-	4.0
Transmission Lines	3.8	0.8	-	0.5	6.0	11.1
Hydrocarbons	56.2	-	-	-	-	56.2
Non-Conventional Fuels	-	-	-	0.2	-	0.2
	194.2	88.4	85.9	3.3	63.7	435.5

(SOURCE: Décimo Informe sobre el Inventario de Proyectos Regionales de Infraestructura en Centroamérica through December 1980, SIECA 81/INF/PF/16, Published November 1981.)

As might be expected of a region that produces large quantities of agricultural products, Central America enjoys an abundance of solar energy. Insolation rates vary from one area to another, as well as seasonally, and they have not been recorded in the detail needed for solar energy project planning. The need for more accurate and complete solar energy data is noted frequently in analyses of Central America's solar energy potential. Similarly, wind power appears to have promise as a renewable energy source, particularly at certain high-elevation and coastal sites, but again the backup data are lacking.

The renewable resource that has historically provided the area with a major part of its energy is wood. About one half of Central America is forest land, although this fraction is decreasing at a rate that has energy planners and environmentalists worried. Massive tree-cutting for rural cooking and for commercial uses has far outstripped reforestation efforts in recent years, so the "renewability" of this resource is open to question.

Other forms of biomass are either available in quantity, e.g., bagasse, or could be introduced to the region on a broad scale, e.g., sorghum, because as one study notes, "Rich volcanic solids along the Pacific plains and slopes, together with moderate rainfall, provide the conditions for high agricultural yields."[16/]

A reliable inventory of Central America's natural resources, including data on solar radiation, wind velocities, and other phenomena that affect renewable energy project selection and planning, would fill an urgent need. Portions of such an inventory are in the preparation stage or are planned. For example, the Organization of American States intends to conduct a study of water, soils, and forests in Central America during

1982 and 1983.[17/] While this report will be welcomed by the institutions engaged in national or regional energy planning, the two-year time scale for its preparation suggests the degree of difficulty that the OAS expects to encounter. Other data collection and analysis tasks required for a comprehensive resource inventory also entail substantial investments of time.

2. Institutional Resources

The following list of institutions that have already contributed to the development of regional energy resources or that can be expected to make a contribution is a long list even though it is undoubtedly incomplete at this time. Like every other task involved in coordinating a regional approach, compiling a complete inventory of institutional resources will require further investigation, particularly at the national level. The following list, however, is at least suggestive of the number and variety of institutions that have some stake in one or more of the three strategic elements of the proposed ROCAP regional energy project.

In terms of their geographic scope of interest, these institutions range from the super-regional to the regional to the national level. The following super-regional institutions have done work of great value in such fields as statistical analysis and the promotion of national and regional energy planning:

- United Nations, Department of Technical Cooperation for Development, which started the Proyecto Energético del Istmo Centroamericano in 1976 and which continues to work with representatives of the Central American governments in energy planning, programming, and budgeting.
- The United Nations Comisión Económica para América Latina (CEPAL) investigates and analyzes trends and

problems of Latin American development, advises these governments in finding and applying solutions, and trains professionals in the socio-economic field. CEPAL's main office is in Santiago, Chile. A regional office in Mexico City provides useful statistical and analytical services related to energy, such as production of an annual report on energy statistics for Central America. CEPAL's Committee on Economic Cooperation, in Mexico, has done some detailed studies on an electric energy network for all of Central America.

- Organization of American States (OAS), which conducts hemispheric, Central American, and national energy studies and which provides funds for ICAITI's industrial information system.
- Organización Latinoamericana de Energía (OLADE), which supports the 25 Latin America countries that signed the Lima Agreement of 1973 through the "integration, protection, conservation, rational utilization, commercialization and defense of the energy resources of the region."[18/]
  Examples of OLADE publications of value to regional energy planners are recent studies of methane gas and geothermal energy, a Latin American and country-by-country energy balance report (issued in November 1981), and a summary of profiles of institutions operating in Latin America and having an interest in energy.
- Interamerican Institute of Cooperative Agriculture (IICA), San José, Costa Rica, which implements the Proyecto de Información Agropecuaria del Istmo

Centroamericano (PIADIC) and administers an Agricultural Research and Information System, parts of which are of value to energy planners.

- Centro Agronómico Tropical de Investigación y Enseñanza (CATIE), located in Turrialba, Costa Rica. Created in January 1973 by the IICA and the Government of Costa Rica to promote and carry out research in agriculture, forestry and animal husbandry, responding to tropical conditions, CATIE has been a major participant in ROCAP's Fuelwood and Alternative Energy Sources Project (596-0089) as well as three other projects of an agricultural nature.

At the regional level, many Central American institutions have a current or potential interest in regional energy development. A list of these regional institutions follows.

- Secretaría Permanente del Tratado General de Integración Económica Centroamericana (SIECA) and the component of SIECA designated to serve as Executive Secretariat of the Comisión Centroamericana de Energía (COMENER). SIECA/COMENER is described in greater detail in Section III.A.
- Instituto Centroamericano de Investigación y Tecnología Industrial (ICAITI), an institute set up in 1955 by the five governments to do research helpful to old and new regional industries. ICAITI has headquarters in Guatemala City and representatives in each of the five capitals, plus working relationships with many national institutions.
- Banco Centroamericano de Integración Económica (BCIE), established by agreements in 1960 and 1963 among all of the Central American governments as an institution for financing and promoting the integration and economic development of Central America. The Bank has

headquarters in Tegucigalpa and branches in the other four capitals.

- Escuela Superior de Administración Pública (ESAPAC), founded in 1954 and located in San José; ESAPAC gives short courses and seminars on subjects related to the integration of Central America.
- Federación de Cámaras y Asociaciones Industriales de Centroamérica (FECAICA), founded by the Cámaras de Industria and the Asociaciones de Industria of the five Central American countries in 1959 to promote and improve business and industry in Central America. The presidency and the seat of the institution are rotated among the five memeber countries.
- Instituto Estadístico de Centroamérica (IECA).
- Centro Mesoamericano de Estudios sobre Tecnología Apropiada (CEMAT), located in Guatemala City, which investigates non-traditional energy sources for rural areas, including solar energy systems, biogas, and Lorena stoves.
- Federación de Empresas Privadas de Centroamérica (FEDEPRICA).
- Federación de Ingenieros de Centroamérica, an organization established in November 1981 in Guatemala City by representatives of Central American engineering and architecture schools and associations to promote regional programs for solving engineering problems common to the region.
- Comité Regional de Recursos Hidráulicos (CRRH), based in Tegucigalpa.
- Consejo Superior de Universidades de Centroamérica (CSUCA).
- Federación de Universidades Privadas de Centroamérica (FUPAC).

- Instituto Centroamericano de Administración de Empresas (INCAE).

The remaining members of the regional energy development community are national institutions, of which a partial listing follows. There are doubtless other institutions that will be identified, particularly in countries other than Guatemala, that qualify for inclusion in this list.

Guatemala

- Secretaría de Minería, Hidrocarburos y Energía Nuclear
- Comisión Nacional Petrolera
- Dirección de Hidrocarburos
- Secretaría General del Consejo Nacional de Planificación Económica (SEGEPLAN)
- Dirección de Industria
- Dirección de Transportes
- Dirección General de Servicios Pecuarios (DIGESPE)
- Dirección General de Servicios Agrícolas, División de Riegos y Drenajes
- Instituto Nacional de Electrificación (INDE)
- Dirección de Caminos
- Choquí Experimental Station
- Solar Energy Association of Guatemala
- Instituto de Fomento Municipal (INFOM)
- Fundación del Centavo
- Desarrollo de la Comunidad
- Instituto Nacional Forestal (INAFOR)
- Comité de Reconstrucción Nacional
- Colegio de Ingenieros de Guatemala
- Destilería de Alcoholes y Rones (DARSA)
- Instituto Técnico de Capacitación y Productividad Industrial (INTECAP)
- Centro de Experimentación en Tecnología Apropiada, Universidad de San Carlos

- Facultad de Ingeniería, Universidad de San Carlos
- Banco Nacional de Desarrollo Agrícola (BANDESA)
- Instituto de Ciencia y Tecnología Agrícolas (ICTA)
- Instituto Nacional de Sismología, Vulcanología, Metrología e Hidrología (INSIVUMEH)
- Oficina Profesional de Ingeniería y Agronomía (OPINA)

El Salvador

- Ministerio de Economía
- Comisión Ejecutiva del Río Lempa (CEL)
- Dirección de Comercio Exterior
- Dirección de Industria
- Dirección de Transportes
- Municipalidad Dirección de Caminos
- Ministerio de Planificación
- Centro Nacional de Tecnología Agropecuaria (CENTO) Ministerio de Agricultura
- Universidad Centroamericana
- Universidad Nacional de El Salvador

Honduras

- Ministerio de Economía
- Ministerio de Recursos Naturales
- Consejo Superior de Planificación Económica (CONSUPLANE)
- Dirección de Hidrocarburos
- Gabinete Económico Comisión Asesora
- Dirección de Comercio Exterior
- Empresa Nacional de Energía Eléctrica (ENEE)
- Corporación Hondureña de Desarrollo Forestal (COHDEFOR)
- Universidad Nacional
- Dirección de Industria
- Instituto Nacional de Formación Profesional (INFOP)
- Ministerio de Transportes
- Dirección de Caminos
- Centro de Desarrollo Industrial (CDI)

- Ministerio de Planificación
- Consejo Hondureño de la Empresa Privada (COHEP)

Nicaragua

- Instituto Nicaraguense de Energía (INE)
- Dirección de Comercio Exterior
- Dirección de Comercio
- Ministerio de Transportes
- Ministerio de Planificación Nacional
- Ministerio de Industria
- AGROINRA
- Empresa Nicaraguense de Petróleo (PETRONIC)
- Instituto Nacional de Reforma Agraria (INRA)
- Instituto Nicaraguense de Energía (INE)

Costa Rica

- Sector de Energía, Ministerio de Energía
- Consejo Nacional Sectorial de Energía
- Dirección de Geología
- RECOPE
- Servicio Nacional Eléctrico
- Ministerio de Industria
- Ministerio de Transporte
- Ministerio de Planificación
- Corporación Costarricense de Desarrollo (CODEA)
- Instituto Costarricense de Electricidad (ICE)
- Instituto Tecnológico de Costa Rica (ITCR)
- Universidad de Costa Rica
- Universidad Nacional (Heredia)
- Consejo Nacional de Ciencia y Tecnología (CONICIT)

Exactly how great a contribution is likely to be made to regional energy planning, increased energy efficiency or renewable energy technology development by any one of these institutions is impossible to predict at this time. But a reasonable assumption is that putting them in touch with one another through some system

of information exchange can only serve to benefit the region. Recommendations for such a system will be set out later in this study.

3. Financial Resources

Every year SIECA publishes a detailed report on regional infrastructure projects in Central America, including large-scale energy projects. The following observations are based on the 1981 report, which provides historic data through the end of 1980 and projections through 1990.

From 1970 to 1980, 138 infrastructure projects were completed at a cost of $1,536.2 million. Of these, 16 were energy projects costing $495.2 million. For the decade beginning in 1980, 250 infrastructure projects were planned, of which 64 were energy projects. Total project costs for the period 1970 through 1990 were $11,840.5 million, and of this amount, $8,626.9 million, or 73.%, was to go to energy projects.

Funds had already been committed in the amount of $4,075.3 million when the SIECA report was published. Approximately 59%, or $2,385.9 million, was promised by international financial institutions, and the balance was committed by internal sources. Of the remaining $7,765.3 million in funds still to be sought, $4,928.7 million was being solicited from external sources.

Table 2 summarizes these funding figures. In Table 3 appears a breakdown of the funds obtained from external sources for the 1970-90 period. Of the institutions identified in the table, the Interamerican Development Bank will lend the largest share, $742.3 million, followed by the World Bank($464.4 million), the Banco Centroamericano de Integración Económica ($372.7 million), the Venezuelan Investment Fund ($185.7 million), and the Eximbank ($57.7 million). Other sources, including USAID, will provide $563.1 million. The SIECA report does not present in summary form the amounts specifically designated for energy projects

from these external funding sources, although that information could be extracted from the individual project descriptions.

The Organization of Petroleum Exporting Countries (OPEC) supported the UN-sponsored Programa Energético Centroamericano (PEC) with a grant of $1.5 million in 1977.[19/] The PEC and its role in regional energy planning are discussed in Section II.A.3.

TABLE 2

INFRASTRUCTURE PROJECT FUNDING
(1970 - 90)
(Funding Figures are in Millions of Dollars)

	1970-80	1980-90
Number of Infrastructure Projects	138	250
Energy Projects	16	64
Actual Funding, all Projects	1,536.2	
Energy Projects	495.2	
Non-energy Projects	1,041.0	
External Sources	1,029.4	
Internal Sources	506.8	

	1970-90
Estimated Costs, all Projects	11,840.5
Energy Projects	8,626.9
Non-energy Projects	3,213.6

(SOURCE: Décimo Informe Sobre el Inventario de Proyectos Regionales de Infraestructura en Centroamérica through December 1980, SIECA, November 1981.)

TABLE 3

External Financing for Central American Infrastructure Projects, Through 1990
(Figures are in Millions of Dollars)

Committed Funds		
Interamerican Development Bank	$742.3	
World Bank	464.4	
Banco Centroamericano de Integración Económica (BCIE)	372.7	
Venezuelan Investment Fund	185.7	
Eximbank		
U.S.	23.3	
Japan	34.4	
Others	563.1	
TOTAL COMMITTED		$2.385.9
Additional Funding Required from External Sources		4,928.7
TOTAL PROJECTED		$7,314.7

Source: Décimo Informe Sobre el Inventario de Proyectos Regionales de Infrastructura en Centroamérica con Datos a Diciembre de 1980, SIECA, November, 1981.

Another source of external financing has recently been established: the Mexico-Venezuela Oil Facility (MVOF). Details of the agreement that set up this funding mechanism in August 1980 are given in Section II.A of this paper. Energy-related projects are specifically designated in the agreement as meriting favorable consideration.

The amount of money available from this source for energy projects increases as Central America's imported oil bill increases. If the region's payments for petroleum in 1981 are in the neighborhood of $1.2 billion, as one expert predicts,[20/] the maximum that can be diverted to economic development projects will be $360 million. No comprehensive report is available on now the Central American countries are responding to this opportunity, but two examples have been noted. Costa Rica is using concessional funds from the MVOF to search for potential oil reserves, to expand refining capability and to build new oil ports and pipelines.[21/] The Honduran Ministry of Economy used MVOF funds to finance a feasibility study of an alcohol fuel plant in Búfalo, Department of Cortés, using cane juices and molasses as feedstocks.[22/]

While these sources of financing are appropriate for large infrastructure projects administered by a government or other entity within a single country, there are serious questions about their suitability for the regional energy activities contemplated for the ROCAP project. These activities involve support to regional institutions, e.g., SIECA and ICAITI, that are not themselves eligible for bank loans, depending instead on grants or contract revenues, respectively. The regional planning and policy assistance element of the ROCAP strategy will therefore require grant assistance. The fact that MVOF funds are in local currencies also restricts their use for projects depending in part on purchases of goods or services from abroad.

D. Proposed Roles for Regional Institutions

The number of institutions identified as having a current or potential role in the regional energy project, at the super-regional, regional, or national level, is already approaching 100 (see Section I.C.2).

To attempt to coordinate their activities through bilateral links from ROCAP to all of them or to any large subset would be impractical and surely non-productive. A better approach is to establish a radial network of organizations with no more than two or three at the center, and then to deal directly with those, indirectly with the others.

This is the approach to be recommended in this paper. The central institutions proposed as candidates for support are SIECA/COMENER, ICAITI and BCIE. All are well known to ROCAP. ICAITI has been a key counterpart institution in several ROCAP projects, notably the Fuelwood and Alternative Energy Sources Project (596-0089), which runs through the end of FY 1983. SIECA/COMENER, together with ICAITI, organized the Central American Energy Conference in Tegucigalpa, March 1981, which received ROCAP's financial support. BCIE has played a part in a number of ROCAP projects.

All three are official regional institutions, established by agreements among the five Central American governments. Their complementary capabilities are such that they fit readily into the regional energy project framework. A brief discussion of their proposed roles follows.

1. SIECA/COMENER

SIECA/COMENER acts under a five-country agreement as executive secretariat to COMENER, which has the charter (but not the needed national-level support) to coordinate regional energy planning and projects. Until COMENER develops that capability--and that may be a matter of many years--it is proposed that ROCAP assist SIECA/COMENER in performing at least a minimal coordination role by itself.

Under this concept, SIECA/COMENER monitors regional and national energy programs and projects, performs technical studies and forecasts, prepares policy proposals, and generates ideas for new projects.

SIECA/COMENER disseminates to the energy planning community of 90 or more institutions information on regional energy planning and energy efficiency technologies. To aid in this dissemination, SIECA/COMENER establishes working ties with key private sector institutions of a regional and national character.

2. ICAITI

ICAITI is proposed as the implementing institution for a program of industrial energy audits throughout the region. As an essential first step, ICAITI conducts a study of energy use in the major sub-sectors of the Central American industrial (including agri-business) sector. After doing this "macro energy audit," ICAITI creates a regional capability for energy auditing by training a nucleus within its staff, recruiting and training a corps of national energy auditors, working with private sector groups to publicize the program, and then entering the operational stage by performing actual energy audits.

During the operational stage, ICAITI maintains full records of audits performed, recommendations made, follow-up actions taken by plant managers, and lessons learned. With the

accumulation of experience, ICAITI applies it to program improvements.

A close working relationship with both SIECA/COMENER and private sector institutions will be required of ICAITI.

3. BCIE

BCIE is proposed as the institution that lends money through national counterpart financial institutions to enterprises that require financing for plant equipment modifications recommended in energy audits by the ICAITI auditing complex.

A means of coordinating the audits with the subsequent loans will have to be worked out among ICAITI, BCIE, and the national institutions involved.

E. ROCAP's Role

Under the approach recommended in this paper, ROCAP is responsible for (1) providing specific types of support to the participating institutions on a bilateral basis and (2) integrating the work of all of those institutions. (Alternatively, ROCAP might choose one of the counterpart organizations as a prime contractor and assign to it the integrating responsibility, but this would introduce jurisdictional and organizational questions that are better avoided at this stage of the project.)

Both of these ROCAP roles depend on how the project is organized and how responsibilities are assigned among the counterpart institutions. The following outline is recommended:

Project Component	Primary Responsibility
Energy Efficiency Technology Transfer	
Energy Audits	ICAITI
Implementation Financing	BCIE
Promotion	FECAICA
Energy Project Information Management	SIECA/COMENER

The transfer of energy efficiency technology to the industrial sector is seen as the largest project component, having three subcomponents. ICAITI is given the responsibility for developing and managing a regional capability for conducting energy audits of individual firms. BCIE creates a mechanism for making loans through national-level financial institutions to firms wishing to implement audit recommendations. FECAICA promotes the audit program within industry, using its national counterparts as communication channels.

At the same time, SIECA/COMENER develops an energy project information system which encompasses not only energy-efficiency projects within the industrial sector but all other regional

energy projects as well. These include the infrastructure projects that are already in SIECA's data base and those renewable energy technology projects that are not in the infrastructure category, e.g., ICAITI's past work on biogas systems and on the Ex-Ferm process for making ethanol from sugar cane.

1. Bilateral Support

ROCAP's support to ICAITI should include technical assistance in developing an energy auditing capability. This requires locating experienced energy auditors and assigning them to ICAITI to conduct training courses, prepare manuals, perform the first audits alongside ICAITI trainees, evaluate performance of the ICAITI personnel, and maintain project progress records. The number of energy auditors that ROCAP provides should be at least two, given the variety of engineering, economic, and business skills needed and the substantial travel requirements of the project.

One or more courses in energy auditing can probably be found in the United States and translated into Spanish for ICAITI's use. There may also be courses of instruction in the United States for engineers entering the energy audit field that would be appropriate for certain ICAITI personnel in the early stage of the project.

ROCAP's support to BCIE should be in the form of a loan that BCIE then makes available to appropriate banks in the region for the express purpose of financing plant modifications for increasing energy efficiency. The amount and the timing of this loan to BCIE should be determined after the project is far enough along -- six months or so -- to allow the need to be reasonably estimated.

ROCAP's support to FECAICA should include an advisor with experience in similar industry associations in the United States who can give technical assistance in publicizing the energy audit program and organizing campaigns by national

associations in support of it. Every effort should be made to have FECAICA and affiliated associations bear the costs of publications, trips, and workshops to promote the program, but some catalytic funding from ROCAP for these purposes may also be essential.

ROCAP's support to SIECA/COMENER should include technical assistance in creating an information system and applying it to regional energy planning by disseminating energy project newsletters, distributing copies of the project tracking data base to selected institutions, preparing analyses, forecasts, and policy proposals. Two specialists would be required, each working with SIECA/COMENER for a minimum of one year. One would be an information systems specialist, and the other a specialist in energy planning and analysis.

ROCAP should also provide equipment to give SIECA/COMENER the independent capability to create and maintain automated data bases, especially the project tracking data base. The most practical and inexpensive equipment to meet this requirement will be found in the rapidly expanding microprocessor marketplace, which supplies small businesses, individual users, and an increasing number of larger organizations that are learning how to apply this new technology to their diverse needs.

ROCAP should also consider making available identical hardware to the National Energy Committees or equivalent institutions in each of the five countries as they come into being. These entities can then make use of the data bases maintained by SIECA/COMENER and distributed via inexpensive magnetic diskettes.

2. Integration

With four regional institutions playing roles in the project, there are six two-way links that ROCAP, as the integrating organization, should guide and monitor. Good

management of these six interfaces will move the project forward; neglect of them can impede it. Examples of requirements or opportunities for effective cooperation follow.

ICAITI and BCIE. BCIE may be a valuable source of information on the industrial sector for ICAITI's initial macro-energy audit. Later, the two institutions will need to share the results of audits so that loan applications will accurately reflect audit recommendations.

ICAITI and FECAICA. FECAICA may be able to provide some industry-level or national-level data of use to ICAITI's macro-energy audit. ICAITI will furnish much of the information that FECAICA will use in its campaign to promote the energy audit program. ICAITI engineers can appear at FECAICA-sponsored workshops or conferences to explain technical aspects of the program.

ICAITI and SIECA/COMENER. ICAITI will be the source of some of the information in SIECA/COMENER's energy project tracking system. ICAITI might also provide programming assistance to SIECA/COMENER during the development of that system or other data base systems relevant to the project. SIECA/COMENER will use its regional and national institutional links to disseminate information about ICAITI's role in the audit program.

FECAICA and BCIE. BCIE will explain financing mechanisms and procedures in FECAICA's promotional materials and workshops.

FECAICA and SIECA/COMENER. These two institutions should coordinate their information dissemination activities. FECAICA's major concern is with the private sector, while SIECA/COMENER's is with public institutions. The contents of their information releases will be similar in some respects, so coordination to insure consistency is desirable.

SIECA/COMENER and BCIE. BCIE may have information on national policies with respect to energy-related investments that would be a useful input to a SIECA/COMENER study of that subject. BCIE is also one of the lending institutions that help SIECA with production of the annual inventory of regional infrastructure projects in Central America. Through BCIE's ties with the central banks, SIECA/COMENER may be able to identify additional energy projects for inclusion in SIECA/COMENER's energy project tracking system.

Other needs or opportunities for collaboration among two or more of these counterpart institutions will arise in the course of the project. ROCAP should look for and exploit them as one vital aspect of program management.

II. REGIONAL ENERGY STRATEGIES

In the short term, energy use can be diminished in Central America with the adoption of energy efficiency technologies that are already working or that can be shown in the next year or two to work. With little risk, private and public entities can adopt these technologies as appropriate to their needs.

In the more extended term, new energy sources can replace conventional sources. But for these new sources, the uncertainties and risks grow, and the likelihood of private investment in them diminishes.

Both energy efficiency and new sources have a place in a regional energy strategy, since they fill different time-slots in the future.

They can be developed regionally only if some form of regional decision-making mechanism is in place to give them the central direction and support that any technology requires. The following sections examine these three essential elements of a regional energy strategy, beginning with regional energy planning and policy making.

A. Regional Energy Planning and Policy-Making

In the formal sense, only the Central American governments, acting jointly, can make regional energy policy and develop regional energy plans. The major policy-setting documents affecting energy management for the region have been these:

- General Treaty of Central American Economic Integration; Managua, 13 December 1960. Chapter IX establishes the Consejo Económico Centroamericano (CECA) composed of the five Ministers of Economy, and authorizes the CECA to prescribe measures for carrying out the provisions of the treaty, to resolve problems arising from the application of those provisions, and to propose to the member governments any additional multilateral agreements necessary for the economic integration of Central America. The same chapter creates a Permanent Secretariat (SIECA) to monitor compliance with the resolutions of the CECA and to perform other treaty-prescribed functions.
- Resolution of the Central American Ministers of Economy; San Jose, November 1971. The Ministers agree to define a regional energy development policy and to organize and reinforce the national mechanisms responsible for studying and managing energy development.

  Treaty of Twenty-One Latin American Countries Creating the Latin American Energy Organization; Lima, 2 November 1973. This Agreement creates the Organización Latinoamericana de Energía (OLADE) and adopts as OLADE's fundamental purpose "the integration, protection, conservation, rationalization, commercialization and defense of the energy resources of the Region." Article 33 states that OLADE will cooperate with organizations, already existing or created in the future, that specialize in some field of energy, within the Latin American area. All of the Central American countries are signatories, as are all

of the other Latin American countries (including Cuba).

- Resolution of the Central American Ministers of Economy; Guatemala City, 20 February 1975. With this resolution, the five Ministers (no longer called CECA, but still acting under the General Treaty of 1960) create the Comisión Centroamericana de Energía (COMENER), to be comprised of one regular member and one alternate from each country. The resolution further assigns COMENER the responsibility for proposing to the ministers of economy a wide range of regional, energy-related actions (e.g., "intensify studies in the fields of hydroelectricity and geothermal energy that will identify viable projects for the production of electric energy," "inventory, exploit and conserve the natural energy resources of the region").
- Resolution of the Central American Ministers of Economy; Guatemala City, July 1976. Reaffirming the urgency of holding the first meeting of COMENER, the Ministers agree to push the activation of National Energy Committees in their respective countries. They also authorize SIECA to negotiate and administer a technical cooperation project with the United Nations Department of Technical Cooperation for Development to be called Proyecto Energético Centroamericano (PEC). The five governments sign the PEC Project Document later in the same year. With the help of a grant from OPEC of $1.5 million, the UNDTCD sets up a Dirección del Proyecto Energético Centroamericano in Guatemala City and begins to organize national Ad Hoc Energy Committees.
- Central American Energy Project Document; San José, May 1978. Representatives of the five governments meet to approve a draft of a project plan for Phase II of the Proyecto Energético Centroamericano (PEC). Later in the year, the member governments approve the plan.

- Proceedings of the First Meeting of COMENER; San Salvador, 19-20 June 1979. At its first meeting, attended by sub-ministerial representatives of the member government, COMENER agrees on many matters of substance and procedure, including ten conclusions regarding the energy situation in Central America, 25 recommendations to the Ministers of Economy for consideration at their next joint meeting, and eight recommendations to the member governments regarding positions to be taken at the forthcoming meeting of OLADE. The very number of these agreed-on points demonstrates the desire of this group of senior technologists for a regional energy policy. (COMENER has not met since, however, and none of its recommendations has been adopted in any binding agreement among the countries.) The significance of the meeting, as it affects the rest of this report, is that it establishes a quasi-official regional energy policy. None of the judgments or recommendations that follow will be found to conflict with the conclusions and recommendations produced by the COMENER meeting.
- Central American Energy Coooperation Agreement; San Jose, 3 August 1980. Actually a bilateral agreement signed by Mexico and Venezuela, this accord takes on the character of a regional agreement when all five of the Central American governments subsequently accept the invitation in the agreement to buy all of their imported oil from Venezuela and Mexico, in equal amounts, and to take advantage of the very favorable credit arrangements offered by the agreement. The terms allow a beneficiary country credits for up to thirty percent of oil bills for periods of five years with interest rates of four percent, with the additional provision that "if the funds made available by these credits are used for priority economic development projects, in particular those related to energy, these

credits can be extended into others with a period of up to twenty years and an annual interest rate of two percent."

These documents make up the existing policy framework within which regional energy planning can be carried out. They convey an implicit consensus among the policy-makers that regional planning will work to the benefit of the Central American countries. Some of the reasons for that consensus are made explicit in the following section.

1. How Can Regional Planning and Policy Assistance Help the Region?

The operative word in the title of this section is "regional". While awareness of the need for energy planning is evidenced by the national energy plans already published by the Central American Governments, some decision-makers might question the merits of a regional approach to energy planning. (Note: To keep things simple, the phrase "energy planning" in this discussion is intended to imply "and policy-making" as well.)

The case for regional energy planning rests on four basic arguments. The first of these is the critical mass argument. There are some undertakings of a national character that make sense only when the sponsoring nation's population, wealth, and other material and human resources are of sufficient magnitude to make it possible. Not every nation has a space program, for example. By combining forces, the Central American countries can achieve the critical mass necessary for some programs that no one of them alone might see fit to initiate. The five governments did this when they formed a single industrial research institute, ICAITI, in 1955 to serve the entire region.

Even when a program is within reach of any of the governments and the critical mass criterion is inapplicable, there will often be distinct advantages to collective actions to achieve economies of scale. This is the second argument. A good example might be the region's need for increased oil refining capacity.

Although each country has a refinery at the present time and could expand its capacity or build another, appreciable economies of scale could result from the constrution of a single super-refinery for the region.

A third argument can be termed the signal center argument. Ideally, a regional planning system that makes use of regional organizations automatically routes information from one sender to one or many receivers according to the known requirements of each member of the system. The kinds of information that can be of value to one government for its energy planning are quickly made available to that government under such a system. An energy project signal center in Central America would, for example, track these projects and disseminate information on their progress, problems, solutions, successes and failures, costs and benefits:

- ROCAP's Fuelwood and Alternative Energy Sources Project
- Geothermal Plant Project, Berlín, El Salvador
- Woodwaste-Fired Generator Project, La Venta, Honduras
- Anhydrous Alcohol from Sugar Cane Distillery Project, Guanacaste, Costa Rica
- Anaerobic Digestor Project, Siquinalá, Guatemala
- Geothermal Plant Project, Momotombo, Nicaragua.

The fourth argument is the station-keeping argument. Under a regional planning system, data relating to planning baselines, goals, and accomplishments can be used for comparison purposes by the member governments. There are enough similarities, physically and economically, among the Central American governments to make such comparison useful. Where a wide difference is brought to light with regard to, say, energy efficiency in the lumber industries of country "X" and country "Y", the difference itself can prompt an investigation into its causes and possibly the establishment of a new target for the

next cycle of the energy plan of the country that is second best in the comparison. The analog is a fleet of ships moving in the same direction, each effecting moves as are necessary to keep its station relative to the others.

Table 4 provides an example of how station-keeping might work.[23/] The table compares energy inputs per unit of output for cement plants in Peru and other countries. The least efficient —a plant in Peru— uses 70% more energy to produce a kilogram of cement than the most efficient —a German plant. Within Peru, the least efficient plant uses 60% more energy per kilo than the most efficient. The generation and publication of similar statistics for Central America should stimulate efforts by the laggers to catch up with the leaders.

The regional approach has moreover a sound basis in tradition. As early as 1964, ROCAP compiled a pamphlet describing 22 Central American institutions that "run the gamut of public and private affairs in the Isthmus."[24/]

An updated version of the 1964 pamphlet would have to be expanded to include many newer regional institutions, among them several that can play a part in a regional energy project.

Of all the regional institutions organized in this century, the one having the greatest potential for synergism is the Central American Common Market (CACM), which was established by the 1960 General Treaty of Central American Economic Integration. In 21 years of ups and downs, the CACM has been the target of criticism from some who would like to change or even do away with the institution. But these initiatives so far have been without effect, and the CACM survives.

A fifth argument might be made, therefore, that the regional approach to problem-solving is a Central American tradition that remains a tradition only because, in the long haul, it works.

TABLE 4

Comparative Energy Intensities in Cement Plants, Peru & Elsewhere

	Kiln Fuel K Cal/Kg. Cement	Electricity KWH/tonne clinker
Peru (1976) Plant A	900	115
Plant B	1,440	N/A
Plant C	1,215	137
Plant D	1,196	135
National Average	1,111	137
Germany (1974)	800 - 1,200	118
Italy (1974)	900	127
United Kingdom	886	127
United States (1974)	1,358	163
"Best Modern Technology"	850	110 - 120

Source: Phil Palmedo, Pamela Baldwin, et. al., The Contribution of Renewable Resources and Energy Conservation as Alternatives to Imported Oil in Developing Countries, E/DI, 1980.

2. What Institutions Take Part in Regional Energy Planning?

Among the institutions listed in Section I.C.2, Institutional Resources, the following are essentially planning organisms. (The others in Section I.C.2 are included there because they engage in energy research and development, provide links to the private sector, or have some other energy-related function.)

Super-Regional Institutions

- United Nations, Department of Technical Cooperation for Development
- United Nations Comisión Económica para América Latina (CEPAL)
- Organization of American States (OAS)
- Organización Latinoamericana de Energía (OLADE)

Regional Institutions

- Secretaría Permanente del Tratado General de Integración Económica Centroamericana (SIECA)
- Banco Centroamericano de Integración Económica (BCIE)

National Institutions

Guatemala

- Secretaría de Minería, Hidrocarburos y Energía Nuclear
- Comisión Nacional Petrolera
- Dirección de Hidrocarburos
- Instituto Nacional de Electrificación (INDE)
- Dirección de Industria
- Dirección de Transportes
- Municipalidad Dirección de Caminos
- Ministerio de Planificación

El Salvador

- Ministerio de Economía

- Comisión Ejecutiva del Río Lempa (CEL)
- Dirección de Comercio Exterior
- Dirección de Industria
- Dirección de Transportes
- Municipalidad Dirección de Caminos
- Ministerio de Planificación

Honduras

- Ministerio de Economía
- Dirección de Hidrocarburos
- Gabinete Económico Comisión Asesora
- Dirección de Comercio Exterior
- Dirección de Industria
- Ministerio de Transportes
- Dirección de Caminos
- Ministerio de Planificación
- Consejo Superior de Planificación Económica (CONSUPLANE)

Nicaragua

- Instituto Nicaraguense de Energía (INE)
- Dirección de Comercio Exterior
- Dirección de Comercio
- Ministerio de Transportes
- Ministerio de Planificación Nacional
- Ministerio de Industria

Costa Rica

- Sector de Energía, Ministerio de Energía
- Consejo Nacional Sectorial de Energía
- Consejo Nacional de Ciencia y Tecnología (CONICIT)
- Dirección de Geología
- RECOPE
- ICE
- Ministerio de Industria
- Ministerio de Transportes
- Ministerio de Planificación

The sheer number of these organizations can be expected to —and does— pose a problem for an institution having the responsibility for regional energy planning. Other factors that inhibit the process are described next.

3. What Obstacles Have Impeded Regional Energy Planning?

Heading the list of impediments to the development of a regional energy planning system is the current political situation in Central America. At few junctures in the region's history have mistrust and hostility between neighbors and within national boundaries reached the levels that they have reached in late 1981. Some speculation has appeared in the press that new political-military alignments will divide Central America into two Central Americas. This state of affairs, should it come about, would mark the end of "regional" energy planning.

Hence, one major assumption that must be and has been made throughout this paper is that these political differences will pass, that the countries can then get on harmoniously with their economic development. A questionable assumption, to be sure, but a sine qua non for this project.

There remains another obstacle to regional energy planning, and it has a structural nature. When they set up COMENER in 1975, the five governments vested in that institution the authority to do regional energy planning. But the resolution creating COMENER also specified that its members would represent "the entity or mechanism that in each of the Member States of the Central American Common Market is in charge of the management, coordination, or administration of the energy sector."[25/] The problem that then arose was that none of the governments had such a mechanism. Six years later, the problem persists.

There has been some progress. Nicaragua now has an Instituto Nacional de Energía (INE), and Costa Rica has a Ministry of Energy, but neither enjoys the full range of authority

over national energy planning that is specified by COMENER's charter. The other countries have not moved even that far. So what progress has been made has not been adequate.

The five two-member delegations to COMENER's only meeting, in 1979, represented nine separate national institutions. Not represented at the meeting were two dozen or so national institutions that have been identified by SIECA as sharing in the responsibility for energy planning at the national level. The defects of this situation are two-fold: COMENER delegates speak for only a part of their respective energy planning communities, and there is little hope for continuity between one COMENER meeting and the next.

Meanwhile, the Ministers of Economy agreed to support the UN's Programa Energético Centroamericano (PEC), and the initial project agreement was signed in 1976 (by the Salvadorean and Nicaraguan Ministers of Energy, the Guatemalan and Costa Rican Ministers of Foreign Relations, and the Honduran Secretary for Economic Planning). This led to the formation of national Ad Hoc committees who represented their governments at subsequent meetings dealing with the PEC. These Ad Hoc committees tended to be dominated by the National Ministries of Planning, bodies that have been involved historically in jurisdictional disputes with their Ministries of Economy. This added another layer of bureaucratic difficulty to the national energy committee problem.

Although the PEC Project Document designates COMENER as the "regional implementation organism," the real coordinating work has fallen by default to the UN's Dirección del Proyecto Energético Centroamericano, located in Guatemala City. The result is that the UN comes closer to being a de facto regional planning coordinator than any other institution, despite COMENER's de jure responsibility.

One recommendation that will not appear in this paper is that ROCAP should try to mediate. A wiser course of action is to wait for the PEC Ad Hoc committees to become the COMENER National Energy Committee, or viceversa, conceding that this assimilation may be long in coming.

A constructive approach that will be recommended is for ROCAP to help SIECA/COMENER to enhance its capability for supporting COMENER or any other institution or combination of institutions engaged in regional energy planning.

B. Increased Energy Efficiency

If one good way to cut down on oil imports is to substitute hydroelectric power for thermoelectric power, or to replace a fifth of each gallon of gasoline with ethanol from biomass, another good way is to cut down on the use of oil--period. The same is true for firewood; we deplete our forests more slowly if we burn less wood. Of course, if we have to sacrifice production, or convenience, or comfort by reducing the use of a fuel, we may be giving up more than we are gaining; the price may not be worth it.

But if we can maintain the original level of production, convenience, or comfort while at the same time cutting fuel use --and costs-- we have achieved a desirable state of affairs. We have increased the ratio of output to input, i.e. energy efficiency. (We have also conserved energy, but in this paper the use of the term "conservation" will be avoided because of the unusually incorrect but widespread association of that term with lowered output, deprivation, or discomfort.)

In recent years increasing attention has been drawn to new or rediscovered technologies for increasing energy efficiency. A recent study of 36 industries in the United States, for example, showed that 34 had reduced their energy use per unit of output, with a median 23.2% increase in energy efficiency.[26/]

Many of the technologies available for increasing efficiency have insignificant costs; others require capital investments but offer quick paybacks. They make use of "off-the-shelf" hardware and/or procedures of proved effectiveness, as a rule, although the dividing line between the technologies for increasing efficiency and those that produce new fuels from renewable sources can be fuzzy. For example, cutting wood, converting it to charcoal, and burning it in cookstoves may be a more efficient way of using wood than cutting it and burning it directly. But we may need more research to prove this. Even

if it has been proved for other parts of the world, we may want some assurance that a wood-to-charcoal process is more efficient than direct combustion, under Central American conditions. If a technology can be validated only through prolonged or expensive research, such as the construction of a demonstration plant, it is not yet ready for immediate use to increase energy efficiency. Its validation under the second strategic element--developing renewable energy technologies--should precede its inclusion in the set of "off-the-shelf" technologies available for increasing efficiency.

The importance of this caveat becomes more clear when we turn to a discussion of methods and mechanisms for transferring increased energy efficiency technologies. Leading up to that discussion is a brief assessment of the sectors that make up the Central American economy and the degree to which each can realize early benefits from the adoption of energy-efficient technologies.

1. Which Sectors Stand to Benefit the Most from Increased Energy Efficiency?

The benefits that begin to flow from the adoption of new or more efficient technologies are of two kinds. First, there is the general, societal benefit that comes from not having to lay out as great a fraction of national earnings for oil, from being able to use that saving for other goods. Every sector of the economy benefits, although for most consumers there is no obvious, immediate monetary gain. These benefits tend to be diffused and deferred.

For example, when the new Aguacapa and Chixoy hydroelectric systems are both in operation in Guatemala in 1982, savings in imported oil costs for Guatemala will be $90 million to $100 million per year, according to an official of Guatemala's national electrification institute.[27/] Whether or not this saving

is passed along immediately to the buyers of electric power, there is a clear benefit to the country.

The second kind of benefit does take the form of direct monetary gain to an individual or organization. This is the benefit enjoyed by a firm that adopts a more efficient industrial process, the farmer who acquires a more efficient woodstove, the motorist who buys a more fuel-efficient car, or the hotel that installs a solar water heater. If we divide the entire economy of a nation into industrial, commercial/residential, transportation, and agricultural sectors, there is no sector that cannot --at least in theory--realize some benefit of this second kind.

The theoretical benefits of this kind are easier to demonstrate for some sectors than for others. For example, experimenters with stoves of improved design for rural use under ROCAP's Fuelwood and Alternative Energy Sources Project estimate that the user will save 30% of the firewood needed for the stove of traditional design.[28/]

The agricultural sector (let's exclude the agri-business sub-sector and deal with it instead as a part of the industrial sector) certainly deserves a high priority, therefore. Paying 30% less for fuel, or spending 30% less time in gathering it, should have undoubted economic appeal to the rural fuelwood user.

In the commercial/residential sector, there are opportunities for saving energy in new buildings through greater attention to energy efficiency in the architectural stage. The recent II Congress of Guatemalan Architects, in fact, had energy as its major theme.[29/] There may also be opportunities for developing more efficient electrical appliances, such as hot water heaters, which currently account for as much as one-half of the high electricity bills that have Guatemalan customers fuming.[30/] Conditions throughout the rest of Central America are probably similar to those in Guatemala.

In the transportation sector, individual car-owners and truck-owners can replace old vehicles with newer ones of more efficient design. Entire transportation systems can be made more efficient, in theory, by such major infrastructure changes as the introduction of better mass-transit facilities, but the costs in capital investment are staggering and the public's acceptance questionable.

The most complex sector is the industrial. In 1979 this sector used 21.7% of the energy in Central America.[31] The industrial sector covers a broad range of industries from the well-known agricultural industries to some lesser-known but significant manufacturing industries. Much of their capital equipment is obsolete and/or designed before the days of energy consciousness. For some industries, energy-saving adaptations can be readily identified, e.g., co-generation of electricity from waste heat in sugar refineries. For others, more intensive energy audits will have to be conducted to identify efficiency-increasing opportunities.

But in any case there is good reason to believe that there are such opportunities in Central America just as there are in the United States. In Guatemala a major tobacco processing firm is realizing significant savings in fuel costs after instituting a number of energy efficiency measures over the past two years. The company began its efficiency program after discovering in 1979 that fuel costs as a fraction of total operating costs had jumped from 10% to 47% in ten years.[32]

In Costa Rica, a pilot project sponsored by the Ministry of Agriculture analyzed energy use in some 35 coffee-producing beneficios across the country. These sophisticated computer analyses resulted in operational and fuel-switching changes in several beneficios that have yielded energy cost savings of up to 40%.[33]

Of the four sectors, then, the agricultural sector invites and is receiving attention as a priority target for increased energy efficiency. The commercial/residential and transportation sectors also offer opportunities, but their exploitation will be the responsibility of architects, appliance manufacturers and sellers, and individual users of cars and trucks. The fourth, the industrial sector, has some known and some probable sub-sectors that can be profitably modified for greater energy efficiencies. Much work remains to be done to identify needs and methods applicable to this sector. For these reasons, the emphasis in the remainder of this section will be on the industrial sector.

2. What Methods Promote the Adoption of Energy-Efficient Technologies in Industry?

Neither the governments nor the national private sectors in Central America have devoted much thought to the opportunities for cutting energy costs by increasing energy efficiency in industry. The reasons for this indifference probably include preoccupation with the major infrastructure projects like hydroelectric plants and expanded electric power grids that offer relief from oil import costs in the long run, as well as a negative attitude toward energy "conservation" because of its negative connotations. Another likely reason is that there is as yet no effective mechanism for transferring energy-efficiency technologies to the hundreds or thousands of dispersed firms that make up the region's industrial sector.

The products and production systems of those firms are heterogeneous, and so, therefore, are their needs for energy-efficient technologies. Where one device, like a more efficient woodstove, can bring benefits to the entire sector of rural wood-burners, a far more varied set of devices and processes is needed to increase energy efficiency in the industrial sector.

Three levels of measures for increasing industrial energy efficiency are available: (1) housekeeping measures that cost little or nothing, (2) "off-the-shelf" technologies that involve capital outlays, and (3) new technologies that also involve capital outlays, probably requiring some outside subsidization to offset their higher risks to the firms willing to experiment with them.

Some examples of good housekeeping measures are these:[34/]

- Insulate bare steam lines and add appropriate levels to existing insulation.
- Eliminate steam leaks.
- Inspect and repair steam traps.
- Return steam condensate to boiler.
- Use turbo-expanders instead of throttle valves to let down steam pressures in process use.
- Operate standby at reduced temperature.
- Install traffic doors on frequently used openings.
- Tune-up boilers.
- Keep boiler tubes clean (water side).
- Reduce vapor losses from heated open vessels.
- Use refuse as fuel.
- Minimize boiler blowdown.
- Use dock seals to reduce heating and cooling expenses.

"Off-the-shelf" technologies that have been adopted with success in other parts of the world where industrial energy efficiency has become a priority goal include the following:[35/]

- Reduce maximum demand load through improved equipment demand control power factor correction.
- Recycle materials.
- Recover boiler flue gas heat for space heating, feedwater preheating, and air preheating.

- Use engine exhaust heat to generate steam.
- Recover heat from textile dryer exhaust streams.
- Convert to more efficient light sources.
- Flash high pressure condensate to produce low pressure stream.
- Reduce reflux ratios in distillation columns.
- Recover heat from boiler blowdown.
- Cogeneration.

New technologies that have a potential for increasing industrial energy efficiency include all of the renewable energy technologies described elsewhere in this paper. Examples are the substitution of biomass,e.g., coffee wastes, for petroleum-derived fuels in boilers, or the use of solar water heaters. Some of these technologies are known to be technically feasible and need further development to make them economically attractive. Others still need extensive work to determine their technical feasibility. For all of them, there is a degree of uncertainty that puts them for the time being outside the set of "off-the-shelf" technologies for increasing industrial energy efficiency. Hence the continued development of these new technologies will depend for the most part on non-industry sources of funding.

Energy Audits

Prescribing equipment or methods to increase energy efficiency for a single firm calls for a combination of economic and engineering skills that will not be found in all industrial organizations. Those firms large enough or fortunate enough to be able to do their own analyses will implement energy-efficient changes when they make good business sense. Many smaller firms cannot perform these energy audits in-house. If they want them, they must look outside for help.

A regional activity that will promote industrial energy efficiency thus suggests itself: Creation of a mechanism to

perform energy audits for small and medium-sized industrial firms. There should be a modest charge to each firm, although the provision of free energy audits to manufacturing organizations has a precedent in the United States. In the late 1970s, the Tennessee Valley Authority (TVA) began offering such audits at no cost to its customers, reasoning that the adoption of efficiency-increasing measures by individual consumers of electricity would permit the TVA to postpone costly expansions of generating capacity. If the cost of an energy audit in Central America is nominal, or even zero, a rationale could be developed similar to that used by the TVA in the U.S. More study is needed on this point.

An energy audit begins with an examination of a plant, its equipment and procedures, by a specialist in both energy efficiency engineering and economics. The second step is an analysis by the auditor of the plant's energy use and of the measures that could be taken to increase efficiency, and the life-cycle costs involved. The third step is preparation of a set of recommendations by the auditor.

At this point, the plant operator decides whether to follow the recommendations or not. If the decision is affirmative, the operator takes the fourth step--implementing the recommendations.

This final step in the process may be blocked by the high cost of money. Whether an energy-efficient plant modification is or is not attractive to a business depends in large part on what financing the firm can get. Here is another possibility for a regional energy activity: Establishment of a fund for low-cost loans to businesses for the installation of energy-efficient equipment.

By way of planning for such a low-interest loan fund, a study should be made of the tax policies of the Central

American governments with respect to investments in energy-efficient equipment. These policies may differ notably from one country to the next. A comparative analysis would be helpful in setting up loan procedures at national levels, and it might help to point the way to desirable changes in government tax policies to encourage this form of investment.

An energy audit program organized along these lines would probably need at least three years to run its course. As the auditing institution gained experience, the program would benefit both from improvements in audit methodology and better knowledge of endemic problems and their solutions.

The program should start with the highest priority industries and firms, i.e., those that use large amounts of energy and whose energy efficiency measures--units of energy input/units of output--appear to be sub-optimal. To determine these priorities, an essential preliminary step would be a regional study of energy use by country and by industry (or sub-sector of industry), preferably for a multi-year period. This "macro energy audit" would have some side-benefits. It would serve as a baseline for measuring program progress in the future. It would help to acquaint the private sector with the energy audit program to follow, and it would help to identify those firms that already have embarked on internal energy efficiency projects and are willing to share the results with others.

In summary, the methods that a regional energy project might adopt to promote increased industrial energy efficiency could reasonably include (1) a broad study of industrial energy use in Central America, (2) a mechanism for providing low-cost energy audits to medium and small businesses, and (3) a low-interest loan fund for financing energy efficient plant modifications for those firms. In addition, a means of publicizing these opportunities would be essential. The costs (to ROCAP) of

publicizing should be relatively modest, if a substantial portion were to be borne by regional and national industry associations.

3. What Institutions Can Carry Out Such Activities Regionally?

One institution having a background in regional technology transfer activities is ICAITI. The ROCAP-funded Technology Transfer Program, started in FY 1976 and due to end in FY 1982, has been administered by ICAITI's Division of Scientific and Technological Development, which currently has representatives in each of the Central American countries. With its industrial orientation, ICAITI is the ideal organization to manage a program of energy audits for firms in Central America.

A second institution that can play a key part in the transfer of industrial energy efficiency technologies is the Banco Centroamericano de Integración Económica (BCIE). As the preceding discussion of methods pointed out, some assistance will be needed for firms unable to implement energy-efficient plant modifications. Through BCIE and its national counterpart financial institutions, provisions could be made for low-cost loans, beginning with a loan from AID. While ROCAP's recommendation in the Annual Budget Submission for a credit mechanism of this nature was later deleted by AID/W, a reconsideration of this feature of the project appears to be more than justified at this time.

In addition to these key institutions, the Regional Energy Project can make good use of those regional and national industrial associations that are by their charters concerned with the efficient operation of their constituent business firms. At a minimum, these associations can be expected to publicize the opportunities presented by the Regional Energy Project to Central America's industrial complex. There is also a reasonable expectation that the associations could share in some of the financing, e.g., of an energy audit program.

C. Renewable Energy Technologies in Central America

In general, renewable energy technologies are still pies in the sky in Central America. For example, Guatemala's National Development Plan for 1979 to 1982 discusses the Energy Sector in two sections: Electric Energy Sub-Sector and Petroleum Sub-Sector.[36/] The plan contains only a passing reference to renewable energy souces, other than hydroelectric and geothermal. This implicit downgrading of those other renewable energy sources may well be representative of the attitudes of the other Central American governments. They stress those measures that promise to make the largest dents in oil import levels in the shortest time, principally through substitution of hydroelectric plants for plants that burn petroleum-derived fuels.

Yet in the longer run, energy from unconventional, renewable sources may come to play an increasingly important part in the region's economy. One or more of these may be the "sleepers" of today. Certainly there has been no dearth of studies and proposals relating to the exploitation of Central America's renewable resources in ways that can help. ROCAP's files bulge with an accumulation of such analyses dating back to the onset of the petroleum crisis eight years ago. In this section appear highlights of actual and proposed projects, related activities, a discussion of priorities and a list of regional institutions that promote these technologies.

1. Which Renewable Energy Technologies Can Benefit the Region?

As far as the raw materials for renewable energy production are concerned, Central America has them all -- sunshine, heat sources beneath the earth's surface, wind, and biomass in profusion. Any or all of them can be converted to usable forms through known technologies, so that the criteria for implementing them are economic criteria. The following sections discuss the

current states of these technologies in the region.[37]

a. Alcohol Fuels

Production of sugar cane in Central America is on the order of 10 million metric tons annually. The land area devoted to sugar cane production is 200 million hectares, or less than 5% of productive cropland in 1980. Through increased use of land for sugar cane or for other crops such as yucca, the region can produce appreciable quantities of alcohol fuels.

Costa Rica has a distillery for anhydrous alcohol from sugar cane that can produce up to 220,000 liters per day, located in Guanacaste. This plant, constructed with Brazilian technology, was inaugurated in 1980. It has encountered operating difficulties, however, for lack of raw materials, since the price of sugar on the international market attracts producers to that market first.

ICAITI has designed a plant to produce 120,000 liters daily with the objective of attaining regional economies by using a type of plant that can be adapted to the needs of any country in Central America.

ICAITI also conducted an experiment in which over fifty vehicles were operated on a mixture of 15% alcohol with gasoline. Results were good both in terms of vehicle operation and user acceptance. ICAITI plans larger-scale tests in which the gaschol is sold through gas stations to anyone who wants to try it.

The problem with gasohol development is purely economic, since under current market conditions, the price per ton of sugar cane can oscillate by as much as 100%. This has led some observers to the conclusion that sugar cane should not be diverted from its traditional destination to export markets. One Brazilian study suggests sorghum as an excellent raw material for alcohol fuels that approaches sugar cane in terms of energy

gain (i.e. ratio of energy produced per unit to energy used to produce one unit).[38] A Guatemalan scientist announced in 1980 the invention of "Alcomaya", an alcohol fuel derived from vegetable matter--corn, sunflowers, and other vegetable sources--that had been evaluated by U.S. and Israeli scientists as holding great promise.[39]

b. Biogas

Anaerobic digestion to produce methane gas has been used in Guatemala since 1956. A Guatemalan pioneer in the technology, Ing. Mario Penagos, began long before the 1973-74 energy crisis to produce biogas as a by-product of compost for coffee-growing. In recent years he has worked increasingly on improving the efficiency of his biogas digestors. His company has installed ten or twenty digestors in Guatemala and other Central American countries. He has served in the past as a consultant to OLADE on biogas technology.[40]

ICAITI is also performing biogas research in Guatemala under the Fuelwood and Alternative Energy Sources Project. ICAITI has built several model digestors in an effort to achieve the higher efficiencies needed to make biogas competitive with other fuels.

A current program supported by OLADE in Honduras is developing prototype plants of family size that can digest manures as well as vegetable wastes. In El Salvador a similar project is designed to build a prototype digestor that will use the manure from a 20-head herd of cattle for methane production. The gas will be used for combustion in a kitchen stove and lamps as well as running a small electric generator. Another project in Nicaragua will investigate the use of biogas in the home.

In a recent study of biogas technologies for ROCAP, a U.S. expert concluded that (1) Anaerobic digestion of bio-waste can be a source of energy in Guatemala and Honduras,

(2) Work needs to be done to determine the true value of digestor effluent in Central America, (3) the Miramar plant in Siquinalá, Escuintla has the potential to be an excellent example of an industrial size anaerobic digester, (4) the price of propane in Guatemala is $1.05 per gallon and in Honduras $2.25 per gallon; as these prices increase, alternative energy sources will become much more attractive than at present.[41/]

c. Biomass

Approximately 50% of the land area of Central America is covered by forests. Another estimated 38% is suitable for annual or permanent crop-growing. Thus nearly all of the region will support one or another form of biomass growth.

Wood and charcoal have been used traditionally in Central America as basic cooking fuels in rural areas and small communities as well as in such small industries as bakeries and lime kilns. An estimated 80% of the homes use wood or charcoal stoves, consuming the equivalent of 3 million tons of petroleum, or about 20 million barrels annually.

The uncontrolled use of these resources harms the environment and threatens irreparable depletion of the forests. Regional institutions are attempting to arrest the deforestation rate in two ways: reforestation projects and the dissemination of efficient woodstove technology.

The Fuelwood and Alternative Fuels Project, supported by ROCAP and implemented through ICAITI and CATIE, has had some success in demonstrating the Lorena stove, which increases substantially the efficiency--typically only 10%--with which traditional open-fire stoves in the region operate.

The government of Honduras is conducting a project to use forest residues from hardwood lumbering operations, along with sawdust and sawmillwastewood, to generate electricity.

Bagasse, or sugar cane residue, is another traditional fuel in rural parts of Central America. In 1979, the fractions of energy use in the region attributable to wood and bagasse, respectively, were 41.2% and 6.4%. Recent studies suggest that the direct combustion of bagasse in commercial applications may be economically attractive. A Nicaraguan study is looking into the use of fast-growing wild cane as a heat source for electricity generation.

Another unconventional fuel for direct combustion applications is coffee wastes. In May 1981, ROCAP proposed a pilot demonstration project, burning those wastes to dry coffee, citing an estimate that in Costa Rica alone, 80,000 barrels of oil went into the processing of that country's 1978/79 coffee harvest of 105,000 tons.[42/]

d. Solar Energy

Solar radiation in Central America averages approximately 20 megajoules per square meter per day, year-round, with more than 2200 hours of insolation annually. This insolation rate is one of the highest in the world, enough to satisfy 20,000 times the amount of petroleum-derived energy in Central America in 1979. Technologies for converting the energy at costs competitive with conventional fuels have not been perfected yet, however.

So far, little use is being made of solar energy in the region, beyond traditional solar drying of coffee, corn, cacao and lumber. Some solar water heaters for home use have been built and installed. ICAITI has constructed a water heater for a hospital near Guatemala City.

ICAITI is also developing prototype devices having higher efficiency for crop-drying than those currently in use.

The University of Costa Rica has also been developing new solar driers and water heaters. The University has

started work on a stove that concentrates solar heat through a water lens.

Some photovoltaic cells have been constructed and demonstrated at large haciendas, but at their current cost of $10,000 per kilowatt, they are merely scientific curiosities for the time being.

A recently completed study for ROCAP urges the prompt establishment of a regional network to collect solar radiation data, establish standards, and train technicians.

e. Wind

The potential for energy produced from Central America's steady winds is estimated to be as high as 300 kWh per square meter annually. The rate varies greatly by time of year and place, which is one disadvantage to its use. Another is the need for costly storage devices for the electric, mechanical, thermal, or chemical energy into which the wind is converted.

Wind-driven water pumps, used for years in Central America, were in fact until recently giving way to internal combustion pumps because of high replacement costs for the wind devices. Only now that petroleum prices are again rising are they being reconsidered.

At the University of Costa Rica work is in progress on an omni-directional wind turbine that has worked well in tests, even with winds of low velocity. Another wind-turbine design has been patented by a Guatemalan inventor.

A novel approach to the storage problem was presented at a symposium in Panama on renewable energy sources by a Central American scientist. His techniques involves conversion of wind energy to heat by agitating a liquid medium with rotating vanes, then storing the heat for later use in steam turbines.

f. Small Hydroelectric Plants

Large hydroelectric plants account for 80% of the 1979 investments in Central American energy projects. There remain many opportunities for small hydroelectric projects in remote areas. An estimate by SIECA/COMENER sets the regional potential for small hydroelectric plants (defined as those with a capacity under 5,000 kilowatts) at 4 million kilowatts, producing 10,000 gWh annually. The cost of building such a complex of plants is estimated to be $8 billion.

No figures are available on the extent to which small hydroelectric plants are currently planned or under construction in Central America.

g. Geothermal Energy

El Salvador was the first Central American country to use geothermal energy, converted to electricity via a 30-megawatt generator, connected to geothermal sources in Ahuachapán, that began operation in 1975. A year later a second generator in the same area started to produce power, and work began on a third in 1979. The three will have a combined capacity of 100 megawatts.[43/]

Guatemala's Instituto Nacional de Electrificación (INDE) has a geothermal project at Zunil in the Department of Quezaltenango. The project will produce a 20 megawatt generating plant driven by hot water from six wells. Cost of the project, which is due to become operational in 1987, is $8 million.[44/]

Nicaragua plans to install a 35 megawatt plant before the end of 1981 at a site in Momotombo, where 32 wells have been dug. Total cost of the plant will be $38.3 million.[45/]

Costa Rica has begun a $22.5 million study at the Miravalles site of its geological, geophysical, geochemical, and geohydrological characteristics. The study has a 1983 completion date.[46/]

2. What Institutions are Developing Renewable Energy Technologies?

A listing of institutions that perform research and development of renewable energy technologies or that promote the use of these technologies in some form follows.

Super Regional and Regional Institutions

- Instituto Centroamericano de Investigación y Tecnología Industrial (ICAITI)
- Banco Centroamericano de Integración Económica (CABEI)
- Centro Agronómico Tropical de Investigación y Enseñanza (CATIE)

National Institutions[47/]

Guatemala

- Centro Mesoamericano de Estudios sobre Tecnología Apropiada (CEMAT)
- Choquí-ICADA (Estación Experimental de Tecnología Apropiada)
- Instituto de Ciencia y Tecnología Agrícolas (ICTA)
- Instituto Nacional de Forestación (INAFOR)
- Instituto Nacional de Sismología, Vulcanología, Metereología, e Hidrología (INSIVUMEH)
- Junta Nacional de Educación Extraescolar (JNEE)
- Oficina Profesional de Ingeniería y Agronomía (OPINA)
- Universidad de San Carlos de Guatemala, Centro de Investigaciones de Energía

El Salvador

- Centro Nacional de Tecnología Agropecuaria (CENTO) Ministerio de Agricultura
- Universidad Centroamericana
- Universidad Nacional de El Salvador

Honduras

- Corporación Hondureña de Desarrollo Forestal (COHDEFOR)
- Universidad Nacional

Nicaragua

- AGROINRA
- Instituto Nacional de Reforma Agraria (INRA)
- Instituto Nicaraguense de Energía (INE)

Costa Rica

- Corporación Costarricense de Desarrollo (CODEA)
- Instituto Costarricense de Electricidad (ICE)
- Instituto Tecnológico de Costa Rica
- Universidad de Costa Rica
- Universidad Nacional (Heredia)

III. KEY REGIONAL INSTITUTIONS

The regional institutions having major roles under the approach suggested in this paper are SIECA/COMENER, ICAITI, and BCIE. The following sections deal with each in turn, discussing structures, demonstrated capabilities, proposed roles for this project, and the requirements entailed by those roles.

A. SIECA/COMENER

When the five governments signed the General Treaty of Central American Economic Integration in 1960, they created a Consejo Económico Centroamericano (CECA), to be made up of the five Ministers of Economy, and at the same time set up a secretariat to monitor compliance with the Consejo's resolutions and to perform other functions prescribed by the treaty. Fifsteen years later, in 1975, the five Ministers created a Comisión Centroamericana de Energía (COMENER) which was to include one regular member and one alternate from that government entity in each country which was responsible for the energy sector. The same resolution that created COMENER charged it with proposing to the Ministers of Economy a wide range of energy-related actions to be taken collectively for the joint benefit of the member countries.

The first meeting of COMENER did not take place until June 1979. At that meeting the delegates adopted some 43 conclusions and recommendations to their respective Ministers of Economy for future actions within Central America and in the broader arena of the Organización Latinoamericana de Energía (OLADE). From this promising start, however, nothing further has happened with COMENER. The group has not met since.

Meanwhile, the component of SIECA that was assigned responsibility for supporting COMENER -- referred to in this paper as SIECA/COMENER -- has continued to perform a number of valuable studies and other coordinating functions for the Central American energy planning community.

1. Structure

Within SIECA, the responsibility for serving as executive secretariat to COMENER has been assigned to the Department of Physical Integration, one of nine departments within SIECA whose directors report to three assistant general secretaries.

Only one person serves full-time in this SIECA/COMENER component. He is Ing. Julio E. Obiols. The Director of the Department of Physical Integration, Ing. Rafael Pérez Riera, devotes a part of his time to SIECA/COMENER matters.

These career SIECA staff members have encyclopedic knowledge of the geographic, economic, political and administrative factors that affect energy resource development, and their judgements on these matters are highly respected throughout the region.

2. Demonstrated Capabilities

Acting within its charter as the Executive Secretariat for COMENER, SIECA/COMENER has attempted to provide the continuity of function that the official members of COMENER itself, having met only once in six years, have been unable to provide. Among the recent activities carried out by SIECA/COMENER are the following:

- Preparing and presenting at the First National Energy Seminar, 23-31 August 1978, San Jose, "The Energy Situation in Central America and Future Prospects," SIECA 78/INF/14.
- Preparing the agenda for the First Meeting of COMENER, 19-20 June 1979, San Salvador, the proceedings for that meeting, and working papers used there:
  - "The Energy Situation in Central America and Future Prospects," SIECA/78/INF/14
  - "Evaluation of the Renewable Energy Resources Situation in Central America and Possible Technologies for Their Use," SIECA 78/INF/19
- Preparing the agenda for the Second Meeting of COMENER (which was cancelled) and a working paper for the meeting:
  - "Commercialization of Petroleum-Derived Fuels in Central America, SIECA 79/COMENER/II/D.T.3

- Assisting with preparation for the Central American Conference on Energy and Development in Tegucigalpa, 25-27 March, 1981 and presentation of a paper there:
  . "Nat nal and Regional Institutional Framework of the Energy Sector in Central America," SIECA 81/INF/4.
- Preparing the proceedings of the Tegucigalpa Conference.
- Preparing materials for presentation at the UN Conference on New and Renewable Energy, Nairobi, August 1981.
- Preparing the energy portions of the "Ninth Report on the Inventory of Regional Infrastructure Projects in Central America."
- Preparing the energy portions of the "Tenth Report on the Inventory of Regional Infrastructure Projects in Central America," to be published in late 1981.
- Preparing Perspectivas del Desarrollo de la Infraestructura en Centroamérica, to be published in 1982.
- Preparing "Consideraciones sobre Tecnología para Aprovechar Recursos Energéticos Renovables en Centroamérica," November 1981, a paper presented at the Second Congress of Guatemalan Architects, Guatemala City, 16-21 November 1981.

3. Proposed Role in the Regional Energy Project

Until closer coordination is achieved among the governments of the region, they will be denied the benefits that regional energy planning and policy formulation can bring. SIECA/COMENER (S/C) is the institution best suited to play the coordinating role.

This is the role that COMENER itself would take on if it were functioning in the manner intended when the Energy

Ministers created COMENER in 1975. But since the process of selecting or creating a single entity to speak on energy matters proved to be an unexpectedly difficult task for most of the countries, COMENER's development has been sluggish, to say the least. By default, whatever multilateral coordination has occurred has come about through the efforts of S/C, with the help of ICAITI and the working group of the UNDP-Sponsored Programa Energético Centroamericano (PEC).

S/C is thus caught in a vicious circle. With staff resources limited to something under two people, S/C cannot exert much influence on the member governments to create the National Energy Committees that can rejuvenate COMENER, which in turn can commit additional resources to its executive secretariat. Only with such additional resources can S/C assume the strong supporting role that its two staff members see as being essential to regional energy planning.

To break out of this vicious circle, S/C needs assistance. One form that that assistance might take was set out in a draft proposal from S/C to the Interamerican Development Bank in early 1980. (The draft did not reach the stage of a formal proposal.) In it, S/C suggested two lines of action. The first would accelerate the creation or strengthening of National Energy Committees by sending a planning specialist to each of the countries in turn to work with national counterpart institutions on organizational, procedural and financial matters. This expert would need one year, most of it on the road, to complete the task.

While this action, once completed, would certainly advance the cause of regional energy planning and policy-making, it does not fall within the scope of the ROCAP project. It requires a five-way lobbying effort, confronting five quite

different and undoubtedly touchy political situations, with the outcome many months down the road. For these reasons, ROCAP support is not recommended.

On the other hand, a second action proposed by S/C does fit in well with the aims and strategies of the ROCAP project concept. This action is designed to strengthen S/C itself. The proposal calls for technical assistance from two specialists, each working with S/C for one year. They would monitor the development of regional programs and projects, perform technical studies, prepare forecasts, generate ideas for new projects, and prepare policy proposals. The work would take place at the S/C office in Guatemala. In addition to the two specialists, there would be a requirement for an adequate system for collecting and processing statistics and other data.

With virtually no change, this statement of work can be applied to the Regional Energy Project, with S/C as the implementing institution. Emphasis should be placed on the information center tasks, i.e., creating and running a project monitoring system and a dissemination system, because there are tangible tasks that fill urgent needs.

The project tracking system is only one example of the types of data bases that could be created as part of this project or borrowed from other sources and incorporated into the S/C library. A more complete list of data bases useful to the Regional Energy Project is presented in Table 5.

Good information systems are prerequisites to good planning systems, or conversely, no planning system can be relied upon if it lacks comprehensive, accurate, and timely information bases. Right now, there is a lot of information scattered through the Central American energy planning community, but until it is systematically organized and maintained, regional energy planners are handicapped by many blind spots. A highly

TABLE 5

DATA BASES USEFUL TO A REGIONAL ENERGY PROJECT

Title	Source or Administrator	Contents
Energy Projects and Status	SIECA/COMENER	Country, technology, status, sponsor, cost, funding source, keywords.
Energy Resources	OLADE? OAS?	Solar, biomass, wind, hydro-geothermal resources, by country, sources of data and dates of information.
Energy Balances	OLADE	Balance data for all countries, updated annually.
Energy Use in Industry	ICAITI	Industry or sub-sector, energy inputs per unit of output, preferably over a span of years, by country. (ICAITI's macro energy audit will provide initial data.)
Energy Audit Log	ICAITI	Firm, location, principal officer, date of audit, auditing organization and auditor, recommendations made, follow-up actions planned, actions taken, costs.
Regional Energy Institutions	SIECA/COMENER	Name, address, director's name, type of institution (e.g., research, planning, government, private, regional, national), publications.

appropriate role for S/C in this project is to take on the task of organizing the information and making certain that the appropriate pieces of it get into the hands of the appropriate institutions.

In the performance of this service, S/C may also influence the member governments to move in the direction of forming the National Energy Committees that can bring COMENER back to life.

4. Requirements

The level of technical assistance that S/C suggested for strengthening the S/C itself appears reasonable. It calls for two specialists, each working for one year. One of them should be a specialist in information systems, preferably someone with an energy systems engineering background. The other should be a specialist in energy planning and analysis.

One of their first tasks would be to develop a system for tracking energy projects throughout the region. SIECA has in operation today a manual system for tracking regional infrastructure projects, which SIECA classifies under seven major headings: transportation, energy, communications, natural resources, water management, geo-economic zones, and mining. From this data base SIECA produces the annual inventory of regional infrastructure projects that has been used as a source for this paper. The expansion of the energy part of this data base to include all known energy projects in the region, whether of infrastructure proportions or not, would fill a need that both S/C and ROCAP recognize as having a high priority.

Just compiling a full list of such projects is a time-consuming task. As noted elsewhere, even the identification of all of the regional and national institutions conducting energy projects will require additional effort. Yet, there is a clear-cut need for those institutions to know what is happening, or being planned; without an information exchange they risk

duplication of effort and miss opportunities to build on one another's accomplishments.

At a minimum, the ninety-odd institutions listed in Section I.C.2 should receive periodic newsletters dealing with the status of energy projects around Central America. Not all of these institutions manage such projects, but all qualify in one way or another as members of the regional energy planning community.

To handle the logistics of putting out a newsletter, S/C might work out an arrangement with an organization like INFORPRESS Centroamericana in Guatemala, which publishes a weekly Spanish-language newsletter bearing the same name. This newsletter already carries some energy-related items among its economic and political news summaries. INFORPRESS is supported by subscriptions and fees for research. It should be a relatively simple matter to start up a quarterly energy project newsletter, either as a supplement to INFORPRESS Centroamericana or as an independent publication attributed solely to S/C but produced with INFORPRESS assistance. In either case the costs of editing, printing, and distributions to institutions listed in Section I.C.2 would be subsidized by ROCAP.

Some of these institutions will have a need to know more details than can be practically transmitted in the form of a newsletter. Ministries of Energy (e.g., Costa Rica's) or National Energy Committees (none yet in existence) will fall into this category. For them, access to the complete regional energy project data base will be desirable. The system already developed by SIECA can easily be converted to this purpose.

A great advantage of adopting the SIECA system for tracking projects is that it has been validated over a period of ten years. Moreover, it lends itself readily to storage and processing by computer. With some minor additions to the data

structure now used, the SIECA system could be converted to a dynamic, automated system capable of many forms of analysis impractical in the current manual mode.

Automation of the system would entail a requirement for some equipment. An attractive technology for use here is the rapidly developing microprocessor technology. At a relatively modest cost, one of the home or small business computers currently on the market could be applied to S/C's requirements, including but not limited to the project tracking system. Copies of the master energy project data base in the form of 5" magnetic diskettes could be made available periodically to key institutions. CATIE has been using the larger 8" diskettes as a data base exchange medium for some time, without problems, according to Dr. Julio Henao, Head of CATIE's Data Processing Department.

Provision might be made in this project for identical microprocessors to be issued to the five National Energy Committees as they are activated. The advantages of these small, inexpensive, but versatile and powerful computing devices go well beyond their use for the project tracking system.

Other institutions having an interest in the contents of the data base would have the option of acquiring their own microprocessors or of receiving printed versions of the same data.

B. ICAITI

The Instituto Centroamericano de Investigación y Tecnología Industrial (ICAITI) was set up in 1955 by the five Central American countries with assistance from the United Nations. Its headquarters is in Guatemala City, and it has representatives in the capitals of the other Central American countries. ICAITI's basic purpose is to contribute to the improvement and growth of industries in Central America through modernization of existing establishments and design of new industries. Its board of directors consists of the Ministers of Economy of the Central American countries and the Director of the Institute, who is chosen by the Board with the approval of the United Nations. There is also a Consulting Committee made up of one prominent industrialist from each of the member countries. As of October, 1981, ICAITI's staff numbered 154, including 76 professional and technical personnel.

A detailed institutional analysis of ICAITI appears as Appendix 1.

1. Structure

ICAITI is organized into an administrative and financial staff and nine Divisions, of which one, the Technology Transfer Division, is due for phasing out at the end of 1981. These Divisions are the following:

- Technical and Industrial Services
- Applied Investigation
- Analysis, Testing and Trials
- Norms
- Applied Geology
- Scientific Policy
- Documentation and Information
- Technical Publications
- Technology Transfer

The first three of these Divisions are the largest,

accounting for approximately one-half of ICAITI's personnel. The Technical and Industrial Services Division is the component that performs the major part of the work for ICAITI under ROCAP's Fuelwood and Alternative Energy Sources Project.

Among the disciplines represented by ICAITI's staff are the following:

- Law
- Economics
- Anthropology
- Biology
- Microbiology
- Bio-Chemistry
- Industrial Chemistry
- Pharmaceutical Chemistry
- Food Technology
- Agronomy
- Geology
- Chemical Engineering
- Mechanical Engineering
- Electromechanical Engineering
- Industrial Engineering
- Civil Engineering

2. Demonstrated Capabilities

Energy technologies have received increasing attention from ICAITI during recent years. The Institution's role in the Fuelwood and Alternative Energy Sources Project has already been mentioned. ICAITI's share of the ROCAP funding for that project will be $3,239,650, or 43%. ICAITI did a large part of the organizing work for the Regional Energy Conference in Tegucigalpa in March 1981. This Conference was funded by ROCAP.

ICAITI has also done work on energy-related contracts for other organizations, e.g.:

- On a $650,000 grant from the Interamerican Development Bank, ICAITI has conducted research and development into production of fuel from agricultural wastes, biogas from coffee wastes and solar grain dryers.
- Canada's IRDC made a grant to ICAITI to support a demonstration of a coffee waste-to-biogas production process.

Other activities cited by ICAITI (in Appendix 1 to this report) that deal with energy:

- Fuel production from agricultural wastes
- Use of solar dryers for grain preservation
- Alcohol fuel plant in Guatemala (feasibility study)
- Alcohol fuels (inter-American seminar preparation)

In a recent memorandum to ROCAP, an ICAITI working group described a number of projects that ICAITI was prepared to undertake as a part of the Regional Energy Project. The list included regional inventories of non-conventional energy sources (solar, hydro, wind and biomass), topographic and metereologic conditions, as well as the following projects for renewable energy sources and increased energy efficiency.

Renewable Energy Projects

- Review of the state of the art in energy technologies for wind, solar energy, charcoal manufacture and mini-hydroelectric plants;
- Design, construction and demonstration of gasification and carbonization units using agricultural residues or wastes to produce industrial energy;
- Design, construction and demonstration of photovoltaic units for institutional and industrial uses;
- Design, construction and demonstration of wind energy conversion units;
- Design, construction and demonstration of small

plants to produce ethanol for use in agricultural vehicles and small electric generating plants.

Increased Energy Efficiency Projects

- Diagnostic study of uses of mechanical, electric and thermal energy in small, medium, and large industries in the Central American countries based on representative samples from each industry;
- Recommendations (based on the diagnostic study) for energy-efficient demonstration units, as well as installation and operation of such units;
- Training at ICAITI and in the United States in energy efficiency technologies and their industrial applications, for key personnel of ICAITI, BCIE and engineers from national institutions;
- Seminars in these technologies for managers in industry and business;
- Organization of an energy data base with emphasis on renewable energy and energy efficiency.

3. Proposed Role in the Regional Energy Project

One goal of the Regional Energy Project should be to increase industrial energy efficiency in Central America by (1) establishing a regional mechanism capable of conducting energy audits for small and medium-sized industrial organizations, (2) through that mechanism, performing such audits for firms that request them, and (3) providing for low-interest loans to firms to help implement recommendations in the energy audits.

For activities (1) and (2), ICAITI is the appropriate implementing institution. ICAITI has a regional charter, a background of working with Central American industries, representatives in all five countries and a network of bilateral links with national institutions that can be used to advantage in the project. ICAITI's staff includes engineers and economists who can be qualified through technical assistance from ROCAP for the

specialized tasks involved in energy auditing. ICAITI also has in its top management the vitality and imagination required to run these parts of the project.

The following outline of steps required to accomplish measures (1) and (2) is suggested.

a) ICAITI does a diagnostic study of uses of mechanical, electric and thermal energy in small, medium and large industries in the Central American countries, based on representative samples from each industry. This is one of the studies recently proposed by ICAITI and included in the list in the preceding section. This study will pinpoint industry sub-sectors offering energy efficiency improvement possibilities and, as important by-products, will serve as a baseline for, and measure receptivity to, the subsequent energy audit program. The study itself will serve as a sort of "macro energy audit".

b) ROCAP and AID/W locate or develop an energy auditing course and a team to work with ICAITI to build up an institutional capability in energy auditing. The team conducts the training in Guatemala to the ICAITI project members.

c) ICAITI expands its regional capability for energy auditing either by direct hiring in the Central American countries or, preferably, by arranging for the assignment of candidates by selected national institutions.

d) The ICAITI nucleus, working with the ROCAP team, trains the national energy auditors. One readily apparent training technique will be pilot audits by ICAITI and national personnel working together.

e) ROCAP and ICAITI enlist the support of private institutions and associations in the region for purposes of publicizing the energy audit program, providing data and possibly putting up some of the operating funds.

f) The program enters its full operational stage. Firms request audits. Trained members of the ICAITI-managed regional

complex perform the audits and submit their findings to the firms, The latter then decide which of the auditors' recommendations they wish to follow. If implementation costs exceed their available investment reserves, they seek outside financing. (Provision for low-cost loans is covered elsewhere in this paper.)

g) Records of audits requested and performed, and their results, are kept by ICAITI for statistical and project modification purposes. Periodic project evaluations are performed by ROCAP and ICAITI.

These steps are not taken in strict sequence; there can and should be some overlaps.

A number of requirements for ICAITI are implicit in this outline of steps. The next section deals with them more explicitly.

4. Requirements

The proposed outline of steps imposes a requirement on AID/W and ROCAP for technical assistance in the development of an ICAITI institutional capability both to perform energy audits and to propagate the capability to other individuals or institutions at the national level. Such capabilities are assumed not to exist in this region at this stage. Energy auditing has become something of an engineering speciality in the United States. Lessons are still being learned, and mistakes doubtless still made. The skilled energy auditor must combine knowledge of industrial technologies actually in use in a given plant with those available from a variety of sources, some of quite recent development. The auditor must have engineering sophistication as well as the ability to do the benefit/cost analyses that take into account non-engineering factors. Where this uncommon mixture of skills cannot be found in one person, an audit team may be needed.

ICAITI's requirement for this kind of technical assistance can be met through the provision, by AID/W and ROCAP, of two or three people and a course of instruction. The people should be one experienced energy auditor (or two auditors whose qualifications complement one another to provide the full range necessary) and one planning/management/education specialist. Their services should be made available to ICAITI for at least eighteen months, preferably longer.

The course of instruction should deal in detail with the why's and how's of energy auditing in general, and the specifics of energy auditing in Central America. The course should be in Spanish. There probably is at least one such course at some institution in the U.S. that can be adapted to ICAITI's needs.

Other training methods, such as participation in English-language courses in the United States for selected candidates, can be applied to this project as well, but the basic course in Spanish in Central America will remain an essential requirement.

C. BCIE (or CABEI)

The Banco Centroamericano de Integración Económica (BCIE), often known as CABEI for its English-language acronym, is an institution dedicated to financing and promoting the integration and economic development of Central America. It was established by an agreement signed by the governments of Guatemala, El Salvador, Honduras and Nicaragua in December 1960. BCIE began operations in May 1961. In July 1963, Costa Rica adhered to the agreement. Headquarters of the bank is in Tegucigalpa, Honduras. Offices are in each of the other member countries.

A basic criterion used by BCIE in financing a project is "regionality," or the degree to which the project has an impact on the development and the economic integration of Central America. BCIE-funded projects thus fall into one of the following classes:

- Infrastructure projects that complete existing regional systems or correct local disparities in those systems.
- Long-term investment projects for regional industries.
- Coordinated agricultural projects aimed at improving or expanding operations that contribute to regional requirements.
- Private sector projects that expand operations, modernize processes, or make structural changes to increase efficiency and competitive position within the Central American Common Market.
- Projects for services that are "indispensable to the functioning of the Common Market."
- Social development projects in education, health, hygiene, housing, and other areas of social interest.
- Other productive projects that serve the cause of regional economic integration.

From its start in 1960 through the end of 1980, the Bank made loans totalling $1.3 billion. Energy-related loans, all of them for electric power projects, amounted to $169.4 million, or 12% of the total.

BCIE maintains four loan funds:

- Ordinary Fund, used principally for pre-investment and investment projects of an industrial, agricultural, or service nature, particularly in the private sector;
- Central American Economic Integration Fund, used exclusively for loans to member governments, regional institutions, local and municipal governments, official autonomous institutions and mixed (government and private) institutions, for infrastructure projects;
- Fund for Housing Financing, used for low-cost housing projects; and
- Social Development Fund, for projects in the fields of education and teacher training, health and hygiene, housing, and economic and social development,

1. Structure

The senior policy-making body in BCIE is the Assembly of Governors, comprised of the five Ministers of Economy and the five Central Bank presidents. They meet regularly once a year.

The senior executive organism is a Directorate made up of five members, one from each country. One member of the Directorate is elected President of the Bank by the Assembly. The President is chief executive officer of BCIE. An executive Vice President, proposed by the President and approved by the Directorate, has charge of administration and operations.

The Bank's four major divisions are Financial, Analysis and Supervision, Programming and Promotion, and Administration.

Under the Bank's operating procedures, the Programming and Promotion Division (PPD) does the initial studies dealing

with a new project concept. The PPD is broken down into branches for industry, infrastructure, agriculture, housing, and other economic sectors. The industry branch deals with renewable energy projects and the infrastructure branch with conventional energy projects (including geothermal).

After the project enters the detailed design stage, the Analysis and Supervision Division (ASD) takes over responsibility.

This division is organized in much the same manner as the PPD, i.e., with branches for industry, infrastructure, etc.

Both the PPD and the ASD have staff members who are familiar with energy technologies of many kinds.

2. Demonstrated Capabilities

BCIE has received very few project proposals for renewable energy, according to BCIE officials.

Those that the Bank has received are for alcohol fuel plants and other biomass projects, i.e.:

- Costa Rica is seeking $1.1 million for the operation of its 120,000 liter/day sugar cane distillery, Central Azucarera Tempisque, S.A. (CATSA).
- Nicaragua is preparing a proposal for a 240,000 liter/day distillery in León to be built at a cost of $60 million to cover agricultural and industrial investment; BCIE financed the feasibility study preparatory to the project proposal.
- Honduras is preparing a proposal for a woodwaste and forest residues-to-gas plant at La Venta, Province of Morazán. The biogas produced by the plant will power electric generators. Cost will be $40 million for equipment, construction, and transportation.
- El Salvador is in the earliest stages of drawing up a plan for 140,000 liter/day alcohol plant that will also produce charcoal.

BCIE and ROCAP have worked together on many projects. Titles and agreement dates of major loans by ROCAP to BCIE follow.

Feasibility Studies	1963
Home Loan Department	1963
Industrial Relending	1964
Economic Integration	1965
Economic Integration (2nd)	1967
Economic Integration (3rd)	1969
Export Industries and Tourism	1970
Tourism Infrastructure	1973
Highway Infrastructure	1973
Regional Rural Agribusiness	1977

3. Proposed Role in the Regional Energy Project

There will be a need for investment every time a business or other institution decides to adopt the measures prescribed by an energy auditor for achieving greater energy efficiency (Section III.B.3). Since many businesses will not have available the necessary capital, they will have to look elsewhere for financing. A need can be foreseen for an energy efficiency loan fund.

If such a fund can be provided under the Regional Energy Project, BCIE is the appropriate institution to administer it. The amounts of individual loans will be small by BCIE standards, but BCIE has a Financiamiento Intermediario system for using national banking institutions as lending channels. At least one ROCAP project uses this mechanism.

4. Requirements

There is not enough information at the present time to forecast the requirements for an energy efficiency loan fund. Much will depend on the outcome of the "macro energy audit" of the region's industrial sector by ICAITI (Section III.B.3.).

If the $9 million proposed by ROCAP in the FY 1982 Annual Budget Submission (ABS) were to be approved, it would not appear to be excessive. However, if the response to the industrial energy audit program is sluggish and funds are lying idle, there are other types of loans that the fund might make. These were noted in the ABS. They are loans to (1) municipalities, cooperatives, firms or individuals that wish to replicate successful ICAITI demonstrations, and (2) firms wishing to manufacture small-scale conservation or renewable energy equipment.

The creation of an energy efficiency loan fund will require BCIE to make some organization changes. In addition, some provision will have to be made for coordination between the energy-auditing institutions (ICAITI and/or national counterparts), and the (national) lending institutions. Such coordination will help the lending institutions to evaluate loan applications based on energy audits.

IV. RECOMMENDATIONS

When ROCAP set out in June of 1981 to define the scope of a Regional Energy Project, three lines of strategy appeared to be worth considering for inclusion in the project. These were (1) strengthening the regional energy planning and policy-making systems, (2) promoting energy conservation, i.e., increased energy efficiency, and (3) supporting the development of renewable energy technologies. By mid-December 1981, it is possible to synthesize the ideas of a great many people, whose names and affiliations appear in Appendix 2, and a great many documentary sources, listed in the Bibliography, into a few recommendations.

These recommendations do not represent a consensus among the people and the documentary sources consulted. Indeed, there is no consensus. Even among the ROCAP staff members, whose views have strongly influenced these closing paragraphs, there have emerged differences of opinion concerning emphasis on objectives and methods for achieving them. The differences have not been major ones, and they have diminished to insignificance during the preparation of five drafts of the Project Identification Document (PID) for what has come to bear the title of Regional Industrial Energy Efficiency Project.

So while these recommendations inevitably reflect the opinions expressed by the members of the PID preparation team (on which, incidentally, I was privileged to serve), they do not just echo the PID. They may go more deeply into detail on some points than the PID does, or they may in some cases argue for slight modifications to the strategies proposed in the PID. It is my hope that they will help in the next step, preparation of the Project Paper (PP), by calling attention to points that need discussion in the PP, whether or not those points are dealt with in the manner recommended here.

In any case, the recommendations are my own.

They appear in four sets. The first three sets cover specific project activities. Those recommendations have already appeared explicitly in the foregoing sections, or are now being converted from implicit to explicit form.

The fourth set of recommendations is more general in nature. These deal with the concept of the project as a whole and its management, rather than with any one project activity.

A. Recommendations Related to Regional Energy Planning

The recommendations related to regional energy planning are based on two premises. The first is that there are synergistic benefits to be derived from regional approaches to energy management. This premise is defended in Section II.A.1. The second premise is that the region's information-sharing mechanisms are woefully inadequate to support any regional planning effort. This is the inevitable conclusion that follows ten weeks of research on the topics covered in preceding sections of this paper. The number of promising leads encountered along the way suggests that not even the tips of all the icebergs have been sighted.

Recommendation 1: Build an effective regional energy information center. With SIECA/COMENER as the integrating institution, create and maintain a data base on regional energy projects. Include energy infrastructure projects already in the S/C project tracking system. Add all other energy projects in the region. These will include private sector and public sector projects, energy efficiency projects and renewable resource projects, of infrastructure proportions or smaller. Use other regional and national counterpart institutions as sources of project information. Section I.C.2 lists many of these.

Disseminate highlights to energy-oriented institutions throughout Central America by means of a quarterly (or monthly) newsletter. Once the system is automated, make the entire data base available to institutions requesting it.

Add other data bases, such as those suggested in Section III.A.3, Table 5, either by creating them or acquiring them from other institutions.

Build and maintain these data bases by active means, i.e., by periodic visits or inquiries to data sources, rather than by such passive means as questionnaires, which rarely elicit complete responses and even more rarely open up new avenues for investigation.

Recommendation 2: Make regional energy conferences annual events. Use as a model the Tegucigalpa conference of March, 1981. Invite contributions from national institutions engaged in energy planning or project management. Encourage a case study approach including critiques by sponsoring institutions. Invite private sector representatives. Transcribe informal discussion periods, which are often the most informative segments of a conference. Publish proceedings.

Recommendation 3: Take advantage of low-cost microprocessor technology to support data base management and other regional energy planning activities. Develop systems for tracking energy projects and other purposes. Upgrade them after a year or so of use; costs and difficulties of revisions are small for these low-budget systems. Provide national energy committees (or their equivalents) with hardware and software identical to those used by S/C to create and maintain data bases. Share information, using magnetic diskettes bearing programs and/or data as the exchange medium. Encourage national-level users to use standardized data formats and to develop compatible sub-systems for use by other members of the regional planning complex.

Recommendation 4: Provide two specialists to SIECA/COMENER to develop the preceding capabilities. Assign one specialist to lead the information system design and automation effort; the other, to assist with energy planning and analysis tasks, e.g., technical studies, forecasts, policy proposals, project outlines. Assign both for one to two years. Give them the additional responsibility of training S/C personnel, thereby enhancing the institution's long-term capabilities.

B. Recommendations for Increasing Energy Efficiency

This project activity is the one that warrants the major share of ROCAP's material support. The recommended measures are labor-intensive, so costs are relatively high, but the benefits are higher still and they are more immediate than those foreseen for the remaining activity, renewable energy technology development.

Recommendation 5: Concentrate on the Industrial Sector. Many opportunities for reducing energy use in the short term will be found in the industrial sector. Receptivity within that essentially private sector should be excellent, once the costs and benefits of energy-efficient technologies are made known. Opportunities for saving energy in the transportation and residential/commercial sectors also exist, but they are not as readily exploitable as those in the industrial sector.

Recommendation 6: Conduct an Energy Audit Program. With ICAITI as the implementing institution, establish a mechanism for conducting energy audits of industrial organizations in the region. Start with a study of energy use in the major industrial sub-sectors of the region. Use this as a baseline for the program and also as a guide to which sub-sectors rate priority attention. Next, create within ICAITI the capability to conduct audits. Furnish technical assistance for this step. Use on-site instruction, short training courses in the U.S., and demonstration audits, as appropriate.

For ICAITI: Conduct audits of those firms that request them; furnish each such firm with a report of findings and recommendations for energy-efficient modifications to plant equipment and procedures; maintain records of audits performed, findings, recommendations, follow-up actions taken by firms audited, and (after 6-12 months) results reported by those firms; analyze and publish periodic summary reports on the program.

Recommendation 7: Use regional and national private institutions to promote the audit program. With FECAICA as the coordinator, organize national-level campaigns within the private sector to disseminate information on the program. For FECAICA: Use national counterparts as information channels; encourage firms to ask ICAITI to perform audits; help ICAITI to determine appropriate charges for audits; assist with information-collection tasks; assist in locating sources of financing plant modifications.

Recommendation 8: Facilitate energy-efficiency investments through a loan fund. Through BCIE, make available low-cost loans to individual firms that intend to invest in energy-efficient equipment or other plant modifications as the result of either an energy audit under this program or an equivalent study by qualified engineers.

Recommendation 9: Encourage Central American governments to adopt tax policies favoring energy-efficiency investments. Do a country-by-country study of existing tax policies as they relate to energy-efficiency investments. Then through USAID Missions, SIECA/COMENER, FECAICA, or other channels, acquaint appropriate government officials with the opportunities for reducing balance of payments deficits by promoting industrial energy efficiency, including possible uses of tax policies to encourage investment by industry in energy-efficient technologies.

Recommendation 10: Provide technical assistance to ICAITI and FECAICA to build up the required institutional capabilities. Assign one or two specialists in energy auditing and one in planning/management/education to ICAITI for at least 18 months. Develop a Spanish-language course in energy auditing for use by ICAITI. Assist ICAITI in recruiting and training additional energy auditors in member countries. Assign to FECAICA an advisor who is expert in managing programs for industry associations conducting industry-wide surveys, and raising funds for programs beneficial to industry generally.

C. Recommendations for Developing Renewable Energy Technologies

The tenor of this set of recommendations is one of caution. Scaling up an experimental technology from the laboratory to a size where it can conclusively demonstrate its economic feasibility tends to be costly. In the absence of some sign that the technology will subsequently be adopted by a sector of the economy, the benefits of the demonstration are indeterminate; in the worst case, they are zero. Rather than recommend that ROCAP undertake such risks unilaterally, this paper recommends an approach that involves some risk-sharing by the private sector.

Recommendation 11: Disseminate to the private sector information on progress of renewable energy technology development projects. As one function of the regional energy information center (Recommendation 1), keep the private sector informed about the status of renewable energy technologies in the region and elsewhere, their potential for the region, their costs and the risks entailed. At the same time, through the same media, suggest projects which industry associations might sponsor to prove the feasibility of some of these technologies.

Recommendation 12: Support renewable energy demonstration projects only if industry assumes part of costs. When an industry group sees a need to develop a technology through the demonstration plant stage and is willing to bear a part of the costs, give serious consideration to providing ROCAP support for the project. Make industry cost-sharing a requisite in order to increase the likelihood that the technology will be adopted by industry.

D. General Recommendations

These recommendations have to do with project management and other general considerations that ROCAP may wish to touch on in the Project Paper.

Recommendation 13: Build into the project plan an effective procedure for evaluating progress. Set quantified objectives wherever possible, particularly with respect to an energy audit program. Schedule periodic evaluations, and budget for them. Choose a neutral evaluator, and if possible, allow that evaluator to participate in setting up the original project objectives. Only when these objectives and their attainment schedule are clearly set out in the original plan can a true evaluation take place at a later date.

Recommendation 14: Look for ways to simplify management responsibilities. With as many as four counterpart institutions —ICAITI, SIECA/COMENER, FECAICA and BCIE— taking part, and none of them acting as "prime contractor," there are numerous opportunities for productive bilateral and multilateral collaboration. There are equally many opportunities for misunderstandings, duplications of effort or working at cross-purposes. ROCAP, in effect the prime contractor, should spell out responsibilities clearly in the plan and should strive to keep the management interfaces simple. Section I.E discusses this matter in more detail.

Recommendation 15: Use this project to strengthen ties among regional energy-oriented institutions. Give SIECA/COMENER the major information management role. Consider ways of augmenting S/C staff with a representative from one member country, rotating each year. Conduct lobbying efforts with Central American governments to form National Energy Committees (as they agreed to do in July 1976) and to get COMENER back on the track.

This project will not be the first example of regional cooperation in the field of energy, nor need it be the last. By way of precedent, we can cite the Central American electric power grid, now well along in its development. By way of successor projects, we might speculate on the possibilities of a regional gasohol production and distribution system based on the Brazilian and/or Costa Rican models. If such regional energy projects are to have a future in Central America, they will require a solid institutional framework. This project, by strengthening institutional ties, can only improve the prospects for future regional cooperation on energy matters.

NOTES

1. Letter of September 25, 1980, from Francisco Aguirre B., Director, ICAITI, Guatemala City, to Richard S. Desik, World Bank, Washington, D. C.

2. Leonor Blum, "Tras la Energía en Centroamérica," Américas, August 1981, 3-8.

3. The situation may be changing, however. In Costa Rica, technicians from the Mexican state oil enterprise, PEMEX, recently reported the likelihood that in the Talamanca region lie deposits of oil on the order of 35 to 90 million barrels. If the first wells, to be drilled by PEMEX in late 1981 or 1982, bear out this prediction, Costa Rica can cut imported oil payments from current levels (e.g., $250 million in 1981) to near zero. "Costa Rica: There's Oil in Talamanca," Central America Report, 21 November 1981, p. 362.

4. "Istmo Centroamericano: Estadísticas sobre Energía, 1979," Mexico City: CEPAL (E/CEPAL/CCE/SC.5/140), 17 July 1981, pp. 12 and 22.

5. "Situación y Aprovechamiento de las Fuentes Renovables de Energía en Centroamérica," Guatemala City: SIECA (SIECA/INFRA/81/3), March 1981.

6. "ROCAP Project Paper: Fuelwood and Alternative Energy Sources, Annex IV, Initial Environmental Examination," August 16, 1979, ROCAP, Guatemala City.

7. CEPAL, op. cit.

8. Ibid., P. 31.

9. Ibid., p. 67.

10. Ibid., p. 53.

11. "Presencia de petróleo sería una bendición para Guatemala," Prensa Libre, Guatemala City, November 7, 1981.

12. "Evaluation of the Potential of Developing an Alcohol Fuel Industry in Central America, Including Optimum Plant Sizes" (draft), submitted by Solar America in September 1981 to ROCAP.

13. Wayne Park, et al., El Desarrollo de la Energía en América Central, Vol. II, Diagnóstico por Países, McLean, VA: The Mitre Corporation, March 1980 (hereafter referred to as MITRE II), p. 12.

14. Ibid., p. 206. Ing. Rafael Pérez Riera of SIECA, however, in conversation November 13, 1981, questioned the existence of any coal in Costa Rica, describing the reserves instead as bituminous shale.

15. Wayne Park, et al., El Desarrollo de la Energía en América Central, Vol. 1, Diagnóstico Regional, McLean, VA: The MITRE Corporation, March 1980 (hereafter referred to as MITRE I), pp. 41 and 48. This study shows hydro- and geothermal potentials for the region at 30,967 megawatts and 9,240 megawatts respectively as of 1980. Projected electricity generation for 2000 is 35,209 gigawatt-hours, requiring a capacity of around 10,000 megawatts.

16. MITRE I, p. 11.

17. "Conferencia Centroamericana sobre Energía y Desarrollo, Tegucigalpa, Honduras," 25-26 March 1981 (proceedings), undated and unattributed, p. 21.

18. System of Inter-Agency Information of Energy: Summary of the Institutional Profiles, Quito, Ecuador: OLADE, September 1981.

19. "Programa Energético Centroamericano, Fase II," 19 July 1978, a project planning document prepared by the United Nations Development Program staff in Guatemala City.

20. Victoria A. de Diaz, "Perspectivas Financieras para el Desarrollo de Proyectos Energéticos en Centroamérica," presentation at the Central American Conference on Energy and Development, Tegucigalpa, 25-27 March 1981. The author is Financial Manager, BCIE.

21. "Costa Rica Project Paper: Energy Policy Development," USAID, Costa Rica, September 28, 1981, p. 19.

22. José Dalmiro Caballero, Coordinator of the Advisory Group on Energy Matters, Ministry of Economy, Honduras, in conversation 20 October 1981 in Tegucigalpa.

23. This table is used in MITRE I, p. 48, and in the English version of the same report, p. 65.

24. "Organizaciones Centroamericanas Impulsando la Integración Económica y el Desarrollo del Istmo," Guatemala City: ROCAP, October 1964.

25. "Resolución Aprobada por la Decimotercera Reunión de Ministros de Economía que Crea la Comisión Centroamericana de Energía, 27 February 1975," Guatemala City: SIECA, undated.

26. David E. Jones, "Alternatives for Cutting Electricity Costa," Battelle Today, November 1981.

27. "Ajustes por combustible desaparecerán al funcionar la hidroeléctrica Chixoy," Prensa Libre, Guatemala City, November 3, 1981.

28. Mr. Justin Whipple of ICAITI, in conversation 9 October 1981.

29. "La energía: preocupación del Segundo Congreso de Arquitectos," Prensa Libre, Guatemala City, November 16, 1981.

30. Estimate by Ing. Victor Dardón of ROCAP's staff.

31. Exclusive of energy lost through conversion and petroleum exported outside of the region, industrial consumption accounted for 21.7%, transportation for 20.3% and residential/commercial/public for 58.0% of all of the energy used in Central America in 1979. CEPAL, op. cit., pp. 29 and 115.

32. John Davies, Production Manager, Tabacalera Nacional, S. A., Guatemala City, in conversation December 2, 1981.

33. "Costa Rica Project Paper: Energy Policy Development," USAID, Costa Rica, September 28, 1981, p. 31.

34. TRW Energy Engineering Division, McLean, VA, in letter to ROCAP dated November 20, 1981.

35. Ibid.

36. Plan Nacional de Desarrollo 1979/1982, Sector Energía (Resumen), Guatemala City: Secretaría General del Consejo Nacional de Planificación Económica, December 1978.

37. SIECA, March 1981, op. cit., is the source for the remainder of this section, except where noted. This paper was presented by SIECA/COMENER at a meeting of Central American energy planners in preparation for the UN Conference on New and Renewable Energy Sources, Nairobi, August 1981.

38. "A Biomassa: Alternativa Energética Brasileira," Carta Mensal da Confederacao Nacional do Comercio, Rio de Janeiro, February 1980, p. 27.

39. "Científicos norteamericanos reconocen un combustible producido en Guatemala," Prensa Libre, Guatemala City, November 15, 1980.

40. Ludwig Ingram of ICAITI and G. L. Mauldin of New Mexico Solar Energy Institute, in conversations December 11, 1981.

41. Edward Fulton, "Evaluation of Feasibility of Bio-Gas Production" (first draft), submitted to ROCAP in June 1981.

42. ROCAP cable (GUATEMALA 3250) dated May 20, 1981, subject: Energy Use in Coffee Processing - Response to Hazen Research Proposal.

43. Leonor Blum, op. cit.

44. "El proyecto geotérmico de Zunil," Prensa Libre, Guatemala, October 15, 1981.

45. Décimo Informe sobre el Inventario de Proyectos de Infraestructura en Centroamérica con Datos a Diciembre de 1980, SIECA, November 1981.

46. Ibid.

47. The national institutions listed here are all described in MITRE II.

Appendix 1

ICAITI, INSTITUTIONAL ANALYSIS

i. Background and Functions

The Instituto Centroamericano de Investigación y Tecnología Industrial (ICAITI), officially known in English as the Central American Research Institute for Industry, is a non-profit regional organization founded in July 1955 by the five Central American Republics to advise and provide technical services to the region's industrial sector and to conduct appropriate technical research on products and processes utilizing raw materials and natural resources. It has been in its present Guatemala facilities, donated and maintained by the Government of Guatemala, since March 1957.

ICAITI's fundamental objectives are:

- To advise the private sector in all phases of industrial feasibility studies and their execution;
- To advise and assist private firms in solving any production problems that they might encounter;
- To undertake technical experiments using regional raw materials, develop production methods, design new projects and adapt modern production techniques;
- To promote the adaptation and adoption of modern technology to improve Central American industrial productivity;
- To advise public and private industrial development institutes and investment institutions;
- To develop Central American standards for raw materials, intermediate and finished goods;
- To conduct quality control analyses, tests and trials for raw materials and products;
- To cooperate with the various offices of the governments of the Central American Isthmus, universities, technical organizations and other entities.

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ii. Organization

ICAITI's management is headed by a Board of Directors composed of the five Central American Ministers of Economy. The Institution's director is nominated by the Board of Directors and is responsible for among other things, the direction, organization and administration of the Institute.

The Executive Committee consists of the Director, Assistant Technical Director, Financial and Administrative Manager and the Assistant Director for Planning and Institutional Development. It is responsible for providing advisory services to the Director and assisting in policy making.

ICAITI's facilities cover 6 485 square meters where the staff of 154 employees, including 54 professionals, are employed as of 10-30-81. Professional personnel cover such fields as chemical, industrial and mechanical engineering, other technical fields. For details of personnel by Division, type, and profession, see Exhibit A.

ICAITI's facilities include:

- An organic chemistry laboratory;
- An inorganic chemistry laboratory;
- A leather technology laboratory;
- A laboratory and pulp and paper pilot plant;
- A laboratory and textile pilot plant;
- A food technology laboratory;
- An industrial microbiology laboratory;
- A special analysis laboratory equipped with an atomic absorption spectrophotometer, an ultraviolet and visible spectrophotometer, an infrared spectrophotometer, a mass spectrophotometer and various gas chromascopes.
- An up-to-date reference center and research service.

ICAITI is organized into the following divisions. For additional detail see ICAITI's Organizational Chart in Exhibit B.

Applied Investigation. This division conducts food technology work and studies processes designed to exploit regional, especially agricultural, natural resources.

Technical and Industrial Services. Marketing, technical and economic feasibility studies, cost control, process expansion, raw material availability, productivity and other economic and industrial engineering activities are conducted by this division. Use of alcohol produced from sugar as a partial gasoline substitute is under current investigation here.

Norms. ICAITI has developed regionwide standards for a variety of manufactured industrial products. It also acts as a reference laboratory to help maintain standards for a variety of exports which have to meet foreign standards.

Applied Geology. This division assists and advises on ecological resorces and potential for mineral exploitation in the region.

Analysis, Testing and Trials. A variety of work in food, textiles, leather, paper and cartons, synthetic industrial resins, use and control of insecticides and pesticides and environmental contamination tests are carried out by this division.

Scientific Policy. This division conducts applied studies and special training programs using resources of other divisions in applied science and technology.

Documentation and Information. Information storage, research and retrieval are provided by this division using ICAITI's own library and a variety of other information resources.

Technical Publications. This division publishes popular, technical and research studies for the general public, industrial sectors and specific industries or other clients.

iii. Technical Activities

As of October 31, 1981, ICAITI had a total of 60 projects contracted for a total cost of $ 2.5 million. At the beginning of that year, 16 projects were completed for a contracted value of $ 700 000; most of these projects were started in previous years.

The types of activities ICAITI is involved in are listed in Exhibit C.

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ICAITI is presently involved in research activities related to the proposed Project, including: 1) the development of solar grain dryers, and 2) the production of biogas from coffee and agricultural wastes. This research experience in alternative energy technologies, as well as ICAITI's research in GASOHOL, is the foundation on which the Project will build upon. ICAITI's existing Technical-Industrial Services Division staff will be greatly increased under the Project to widen its scope in a variety of applications and technical solutions of rural energy problems. Basic research will not be conducted by ICAITI; rather, ICAITI will apply existing knowledge, adopt technology as necessary and develop new approaches to meet immediate and short-term energy needs of fuelwood users. In addition, ICAITI staff will conduct studies in small hydro development and assist the region in beginning to standardize solar data collection systems.

ICAITI personnel will attende short-term training courses, visit appropriate technical experts and consultants in order to increase their technical knowledge base in the variety of technologies to be introduced and demonstrated under the Project. This will insure a cadre of leadership in the region to focus on solutions to the energy problems of the poor. ICAITI's contacts with government and private groups will be used to increase attention given to and skills employed in this problem area in the region. ICAITI will employ local training, seminars, workshops and information services to disseminate the results of its work under the Project in order to develop regional competence in the proven technologies.

National Cooperators and In-Country Organizations

Throughout the five year project period, various national and international counterpart organizations will collaborate with ICAITI in carrying out the project tasks. Their effort is expected to cover the following:

- Continuous liaison for information and planning
- Work directly with ICAITI line personnel in field investigations
- Provide assistance in the selection of specific sites for demonstration units and obtain official permits as required
- Take direct responsibility, with ICAITI's technical supervision, for the construction and operation of all demonstration units.
- Joint sponsoring with ICAITI of regional seminars
- Provide personnel and pay all costs for their participation in regional seminars and in ICAITI workshop sessions.

- Undertake wide-scale dissemination of proven new technologies after completing the demonstration projects.

The following institutions capable of participating in some or all of the above tasks, are being considered for this collaboration:

Guatemala	University of San Carlos, Peace Corps, VITA, United Nations Central American Energy Program, Mesoamerican Center of Appropriate Technology Studies (CEMAT), Choquí Experimental Station, Solar Energy Association of Guatemala, Instituto de Fomento Municipal (INFOM), Fundación del Centavo, Desarrollo de la Comunidad, INAFOR, Oficina de Planificación Económica.
El Salvador	University of El Salvador, Catholic University, Río Lempa Energy Commission (CEL), United Nations Central American Energy Program, CENAP, Peace Corps, VITA, Solar Energy Association of El Salvador, Banco de Fomento Agropecuario, CENTA
Honduras	Corporación Hondureña de Desarrollo Forestal (COHDEFOR), National University, United Nations Central American Energy Program, Peace Corps, VITA, Centro de Desarrollo Industrial (CDI)
Nicaragua	National University, INVIERNO, Fundación Nacional de Desarrollo (FUNDE), United Nations Central American Energy Program, Peace Corps, VITA
Costa Rica	National University of Costa Rica, University of Costa Rica, National Board of Scientific and Technological Investigation (CONOCIT), Centro de Investigación de Tecnología de Alimentos (CITA), Instituto Costarricense de Electrificación (ICRE), United Nations Central American Energy Program, Peace Corps, VITA
Panamá	Hydraulic Resorce and Electrification Institute (IRHE), Panamanian Institute for Agricultural Research (IDIAP)

Although ICAITI will contact directly all of the above organizations, their assistance for each specific application will be requested through the offices of the national coordinators of the United Nations Central American Energy Program, who are thoroughly familiar with regional energy problems and with the relative capabilities of the local organizations presently active in this field. The criteria for selection of the field counterparts will be that they are extension oriented, are able to provide personnel to receive training in the technologies or systems to be introduced, assist in construction of the demonstration, and follow-up in monitoring the demonstrations.

The coordinators in four countries who already have expressed their willingness to cooperate with ICAITI in this Project, are the following:

Guatemala	Oficina de Planificación Económica Comité de Reconstrucción Nacional
El Salvador	Comisión Ejecutiva Hidroeléctrica del Río Lempa (CEL)
Honduras	Ministerio de Energía Oficina de Planificación Económica
Nicaragua	Instituto Nicaraguense de Energía (INE)
Costa Rica	Ministerio de Energía

Project Staffing

The present staffing of the ICAITI Technical-Industrial Services Division, the Applied Research Division and the Analysis and Tests Division, are as follows:

- Technical-Industrial Services Division

Justin H. Whipple	Deputy Head, Mechanical Engineer
Oscar Gil Girón	Chemical Engineer
Raúl Pingarrón B.	Electro-Mechanical Engineer
José Manuel Recinos	Economist
Luis F. Cifuentes	Economist
Bertha E. Barrios	Economist
Carlos Alfredo González	Industrial Engineer
José Antonio Silva	Chemical-Industrial Engineer
Miguel A. Zetina	Mechanical Engineer
Oscar Maldonado	Chemical Engineer
Víctor Manuel Burgos	Chemical Engineer
Reynaldo Rodríguez	Chemical-Industrial Engineer
Carlos Heberto Alegre	Civil Engineer
Clara Arenas	Economist and Anthropologist
Otto R. De León	Chemical Engineer
Julia A. de Ortíz	Economist
César A. Ramírez	Economist
Marco A. Recinos	Chemical Engineer

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Alfredo Paz y Paz	Technician
Carlos Ixcaraguá	Technician
Alfredo Diéguez	Technician
Marco Antonio Castañeda	Technician
Silvia Silva	Technician
Rodolfo Osorio	Technician
Sergio Mazariegos	Technician
Ariel Paiz	Technician
Juan Carlos Morales	Technician
Otto Santizo	Technician
Edwin Castro	Draftsman
Flor González	Secretary
Estela González	Secretary
María del Carmen Parada	Secretary
Lidia Hrstka de Valladares	Secretary

Applied Research Division

Carlos Rolz	Chemical Engineer
Juan Francisco Menchú	Chemical Engineer
Sheryl de Cabrera	Microbiologist
Roberto De León	Bio-Chemist
Elizabeth de Porres	Food Technologist
Edna Isabel Morales	Bio-Chemist
Ricardo García	Chemical Engineer
Francisco Calzada	Chemical Engineer
Jaime Valladares	Industrial Chemist, PHD
Carlos Porres	Chemical Engineer
María del Carmen de Arriola	Bio-Chemist
Fabiola de Micheo	Pharmaceutical Chemist
Carlos Segura	Technician
Federico Chavarría	Technician
Jesús de María Silva	Laboratory Technician
Rafael Ramírez	Laboratory Technician
Norberto González	Laboratory Technician
Carlos Eduardo Rodríguez	Laboratory Technician
Carlos Humberto Arias	Laboratory Technician
Cecilio Antonio Coronado	Laboratory Technician
César Enrique Gámez	Laboratory Technician
María Eugenia Ayala	Secretary
Janina de Godoy	Secretary

Analysis and Tests Division

José Fernando Mazariegos	Chemical Pharmaceutical
Julia Alicia de Zeissig	Chemical Pharmaceutical
Tomás Prieto P.	Chemical Pharmaceutical
Enrique Hernández	Chemical Pharmaceutical
Aura Noemí de Archila	Chemical Pharmaceutical
Erwin Francisco Vásquez	Agronomist
Antonio Guzman	Technician
Adriana Grimaldi	Technician
Juan Luis Yuc	Laboratory Technician
Rubén Alberto Fiorini	Laboratory Technician
Julio César Escobar	Laboratory Technician
Víctor Hugo Orellana	Laboratory Technician
Edwin Enrique Oliva	Laboratory Technician
Oscar Augusto Castro	Laboratory Technician
Manuel de Jesús Cuyán	Laboratory Technician
Luz Alicia de Ordóñez	Secretary

Exhibit A

ICAITI

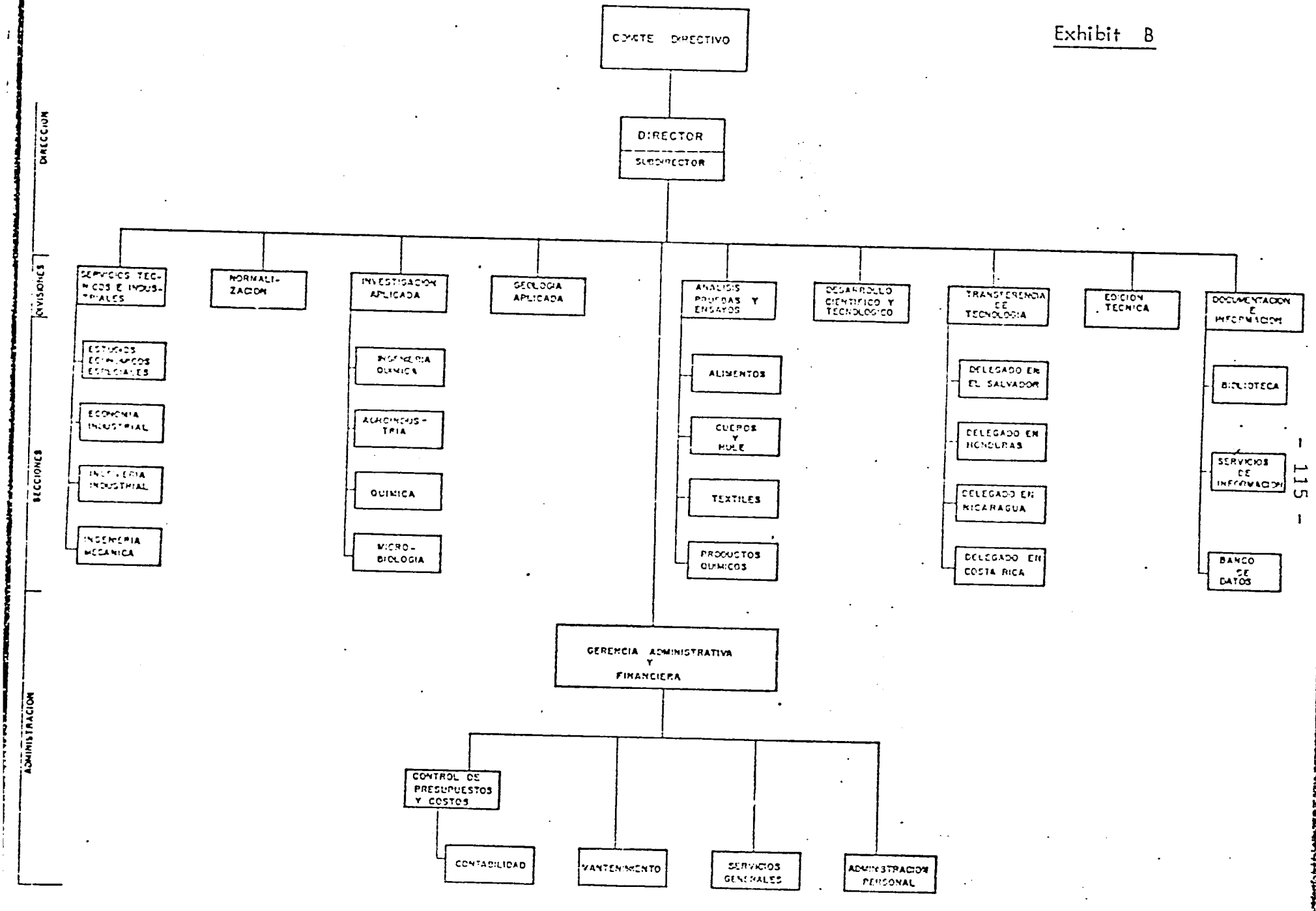
LABOR FORCE AS OF 10-30-81

Description	Professional Pers.	Technical Pers.	Admin. Pers.	General Services Person.	Secretary Person.	Other (2)	Total
Director's Office (1)	8	1	2	-	1	-	12
Technical Editor	1	-	-	-	1	-	2
Documentation & Information	2	2	3	-	2	-	9
Deputy Director	1	-	-	-	-	-	1
Tech. & Industrial Services Division	18	11	-	-	4	-	33
Applied Geology Division	1	-	-	-	-	-	1
Analysis & Testing Division	6	2	7	-	1	-	16
Applied Research Division	12	2	7	-	2	5	28
Norms & Standards Division	3	1	-	-	2	-	6
Financial & Admin. Mgt. Div.	1	3	6	22	3	-	35
Cost & Budget Control Division	1	-	8	-	2	-	11
TOTAL	54 (3)	22	33	22	18	5	154

(1) Includes consultants for Special Projects
(2) Includes University of San Carlos participants and other
(3)

Engineer				Licenciados (BA)			
Agronomist	3	Civil	1	Auditor CPAs	2	Lawyer	1
Chemical	16	Geologist	1	Biologist	5	Economist	7
Electromechanical	1	Industrial	2	Microbiologist	1	Nutrition	3
Chemical-Indus.	3	Mechanical	3	Pharmaceutical	5		
Total	30			Total	24		

Exhibit B


DIRECCION
DIVISIONES
SECCIONES
ADMINISTRACION
COMITE DIRECTIVO
DIRECTOR
SUBDIRECTOR
SERVICIOS TECNICOS E INDUSTRIALES
NORMALIZACION
INVESTIGACION APLICADA
GEOLOGIA APLICADA
ANALISIS PRUEBAS Y ENSAYOS
DESARROLLO CIENTIFICO Y TECNOLOGICO
TRANSFERENCIA DE TECNOLOGIA
EDICION TECNICA
DOCUMENTACION E INFORMACION
ESTUDIOS ECONOMICOS ESPECIALES
ECONOMIA INDUSTRIAL
INGENIERIA INDUSTRIAL
INGENIERIA MECANICA
INGENIERIA QUIMICA
AGROINDUSTRIA
QUIMICA
MICROBIOLOGIA
ALIMENTOS
CUEROS Y HULE
TEXTILES
PRODUCTOS QUIMICOS
DELEGADO EN EL SALVADOR
DELEGADO EN HONDURAS
DELEGADO EN NICARAGUA
DELEGADO EN COSTA RICA
BIBLIOTECA
SERVICIOS DE INFORMACION
BANCO DE DATOS
GERENCIA ADMINISTRATIVA Y FINANCIERA
CONTROL DE PRESUPUESTOS Y COSTOS
CONTABILIDAD
MANTENIMIENTO
SERVICIOS GENERALES
ADMINISTRACION PERSONAL

ICAITI Activities

Producción combustibles a partir de desechos agrícolas

Utilización de secadores solares para preservación de granos

Aprovechamiento de pulpa de café para forraje y/o abono químico

Purificación de agua para consumo humano, utilizando pequeños filtros

Miniplanta de cemento de horno vertical

Ladrillos, techos y otros elemenios de construcción en base de desperdicios vegetales

Producción de carburo de calcio para uso en pequeños talleres del área rural

Miniplanta de pasta celulósica en base de desperdicios agrícolas

Segunda Fase de los Proyectos Anteriores

Programa de capacitación servicios de información a la industria (II)

Asesoría en normalización, control de calidad y metrología

Evaluación de yacimientos de mármol

Adiestramiento y capacitación personal

Estudio mercado varios productos

Curso sobre principios de control de procesos términos y evaluación cierres de envases

Seminario sobre uso y manejo plaguicida

Asistencia en Ingeniería Mecánica

Reparación de emergencia-planta

Programa de capacitación, clasificación, almacenamiento y recuperación de información

Asistencia en el sistema regional de laboratorios aduaneros

ICAITI

Capacitación análisis microbiológicos

Utilización energía solar para secado cosechas

Seminario para Directores de Institutos Latinoamericanos de Investigación Tecnológica

Servicios de consultoría en sistemas de información financiera y procedimientos administrativos

Capacitación análisis microbiológicos

Seminario sobre preparación y promoción proyectos de pequeña empresa

Estudio de factibilidad para la producción de alcohol como carburante (Planta para Guatemala)

Preparación de seminario interamericano sobre alcohol como carburante

Appendix 2

CONTRIBUTORS TO THIS STUDY

Each person in the following list has contributed in one way or another to this study. To all of them I am most grateful.

Guatemala

ROCAP

Edward Nadeau	Division Chief, General Development Office
Kevin Kelly	Division Chief, Project Development Office
Peter Lapera	Assistant Project Development Officer
Victor Dardón	Engineer, General Development Office
Clark Joel	Regional Economist
Frank Zadroga	Regional Specialist for Natural Resources and Environment
Rafael Franco	Assistant Capital Development Officer
Gustavo Ruiz	Assistant General Development Officer

SIECA/COMENER

Rafael Pérez Riera	Director, Department of Physical Integration
Julio E. Obiols	Department of Physical Integration

ICAITI

W. Ludwig Ingram, Jr.	Sub-Director
Elias Hill	Regional Coordinator, Technology Transfer
Justin H. Whipple	Technical-Industrial Services Division

BCIE

Constantino Bernasconi	Director

U.S. Embassy

David B. Timmins	Chief, Economic-Commercial Section

Brazilian Embassy

Fernando Hugo Castro	Scientific Attaché

United Nations Department of Technical Cooperation

Micheline Morel	Energy Project Coordinator

Peace Corps

Ronald P. Arms	Director

Save the Children Fund

David H. Collins	Director

Tabacalera Nacional, S. A.

Ian F. B. Stewart	President
John H. Barwick	Manager, Agricultural Department
John Davies	Production Manager

Productos de Kenaf, S.A.

Fred H. Sherwood	Manager

Solar America

Leon Cooper	Technical Director

MITRE Corporation

Wayne R. Park	Group Leader, Energy Planning and Analysis

New Mexico Solar Energy Institute

G. L. Mauldin	Acting Head, Bioenergy Division

Honduras

USAID

Peter Deinken	
Russell W. Hawkins, Jr.	Environmental Protection Advisor
Albert Merkel	Forester
Edgardo Raúl Derbes	

BCIE

Guillermo E. Valle	Chief, Infrastructure Branch
Miguel Leyva Peña	Promoter of Industrial Projects
Roger Arteaga Cano	Promoter of Industrial Projects

Consejo Superior de Planificación Económica

Rafael A. Ochoa	Chief, Energy Department

Ministry of Economy

José Dalmiro Caballero	Coordinator, Energy Advisory Group

Costa Rica

ROCAP

Robert McColaugh	Deputy Regional Rural Development Officer

USAID

Bill Phelps	
Heriberto Rodríguez	Energy Officer
Mary June	

Ministry of Energy

Gloria Villa	Director, Planning Staff

Centro Agronómico Tropical de Investigación y Enseñanza (CATIE)

Gilberto Páez	Director
Julio Henao	Director, Data Processing Department
Jeff Jones	Anthropologist
Luis Ugalde	Forester

Inter-American Institute for Cooperation on Agriculture (IICA)

Finn Damtoft	Director, Centro Interamericano de Documentación, Información y Comunicación Agrícola (CIDIA)

Washington

USAID

Carl Duisberg	Energy Advisor, Latin America and Caribbean

State

Charles Ries	Office of Energy Consuming Countries

TRW Energy Engineering Division

Laura Hoehne	Energy Economist
Mani Balasubramaniam	Manager, Energy Analysis Office

BIBLIOGRAPHY

" A Biomassa: Alternativa Energética Brasileira." Carta Mensal da Confederacao Nacional do Comercio, Rio de Janeiro, February 1980.

Blum, Leonor. "Tras la Energía en Centroamérica." Américas, August 1981.

"Científicos norteamericanos reconocen un combustible producido en Guatemala." Prensa Libre, Guatemala City, November 15, 1980.

"Costa Rica Project Paper: Energy Policy Development." San José: USAID, September 28, 1981.

"Costa Rica: There's Oil in Talamanca." Central America Report, November 21, 1981.

Décimo Informe sobre el Inventario de Proyectos de Infraestructura en Centroamérica con Datos a Diciembre de 1980. Guatemala City: SIECA, November 1981. (SIECA/81/INF/PF/16)

Diaz, Victoria A. de. "Perspectivas Financieras para el Desarrollo de Proyectos Energéticos en Centroamérica." Presentation at the Central American Conference on Energy and Development, Tegucigalpa, Honduras, March 25-27, 1981.

"El proyecto geotérmino de Zunil." Prensa Libre, Guatemala City, October 15, 1981.

"Evaluation of the Potential of Developing an Alcohol Fuel Industry in Central America, Including Optimum Plant Sizes" (draft). Submitted by Solar America to ROCAP in September 1981.

Fulton, Edward. "Evaluation of Feasibility of Bio-Gas Production" (first draft). Submitted to ROCAP in June 1981.

"Istmo Centroamericano: Estadísticas sobre Energía, 1979," Mexico City: CEPAL, July 17, 1981. (E/CEPAL/CCE/SC.5/140)

Jones, David E. "Alternatives for Cutting Electricity Costs." Battelle Today, November 1981.

"La energía: preocupación del Segundo Congreso de Arquitectos." Prensa Libre, Guatemala City, November 16, 1981.

"Organizaciones Centroamericanas Impulsando la Integración Económica y el Desarrollo del Istmo." Guatemala City: ROCAP, October 1964.

Park, Wayne, et al. El Desarrollo de la Energía en América Central, Vol. I, Diagnóstico Regional. McLean, VA: The MITRE Corporation, March 1980.

———. El Desarrollo de la Energía en América Central, Vol. II, Diagnóstico por Países. McLean, VA: The MITRE Corporation, March 1980.

Plan Nacional de Desarrollo 1979/1982, Sector Energía (Resumen). Guatemala City: Secretaría General del Consejo Nacional de Planificación Económica, December 1978.

"Presencia de petróleo sería un bendición para Guatemala." Prensa Libre, Guatemala City, November 7, 1981.

"Resolución Aprobada por la Decimotercera Reunión de Ministros de Economía que Crea la Comisión Centroamericana de Energía, 27 February 1975." Guatemala City: SIECA, undated.

"ROCAP Project Paper: Fuelwood and Alternative Energy Sources, Annex IV, Initial Environmental Examination." Guatemala City: ROCAP, August 16, 1979.

"Situación y Aprovechamiento de las Fuentes Renovables de Energía en Centroamérica." Guatemala City: SIECA, March 1981. (SIECA/INFRA/81/3)

System of Inter-Agency Information of Energy: Summary of the Institutional Profiles. Quito, Ecuador: OLADE, September 1981.