MID-TERM EVALUATION OF USAID

PROJECT NO. 518-0029

ALTERNATIVE ENERGY SOURCES

Prepared For:

USAID Mission to Ecuador
Ecuadorian National Energy Institute (INE)

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I. GENERAL SUMMARY

The purpose of the Alternative Energy Sources Project (AESP) is to increase the capability of the National Energy Institute (INE) to influence energy policy and to promote non-conventional energy alternatives appropriate for Ecuador.

INE was created with the mandate to conduct energy planning and the research and policy of dissemination of non-conventional (NCE) technologies. The project purports to strengthen INE's capacity to fulfill this mandate through four interrelated components:

1. Energy Studies and Research to help INE complete the inventory of energy resources required by the National Development Plan, to enhance INE's institutional capabilities, and to promote the involvement of qualified public and private entities in analyses and investigations of energy issues and concerns considered of priority interest by the GOE.

2. Energy Technology Transfer and Information Network to facilitate the exchange of data and research on NCE among a wide range of public and private institutions in Ecuador, as well as between Ecuador and other countries. This component includes financing of a long-term resident advisor.

3. Alternative Energy Technology Demonstrations and Dissemination to test NCE technologies that Ecuador may be able to develop to supplement traditional fuel sources. INE will carry out alternative energy demonstrations directly and by entering into subproject agreements with Ecuadorian public and private entities. Initial subprojects included micro-hydro and solar hot water heaters as well as biogas plants and fuel-efficient stoves. Geothermal is an important new area of investigation/demonstration, as are passive solar, photovoltaics, direct combustion, gasification, use of agricultural resources, energy plantations.

4. Promotion of Energy Conservation through media campaigns and other methods to discourage wasteful uses of energy by government, business, and the general public, and through the expansion of INE's service capacity to advise and assist in the adoption of energy saving measures within the Ecuadorian public and private sectors.

Even though project funding was first obligated in September 1981, the true operational starting date is actually June 1982 when AID authorization for actual disbursements was given. Therefore, while the project has really been in operation for about two years to the time of this report, no project evaluation has ever been done. The present effort, therefore, constitutes in effect a mid-term evaluation with about 1.5 years remaining until the original project completion date (December 1985).

The evaluation effort was conducted within an atmosphere of concern expressed by AID/Washington and AID/Ecuador why seemingly so little has been accomplished in terms of expending obligated funds to date. The evaluation, especially section V.3, outlines reasons for delays and/or difficulties in spending funds, most of which are related to administrative/structural problems within INE. Until late 1983, INE functioned with a very autonomous substructure within which each operational team reported directly to the executive director (see Section V, Figure III), termed "stage one." This allowed the technical teams in particular to develop good technical skills, but did not emphasize integration of project components into a systematic, implementable operational plan. "Stage Two" was initiated with the arrival of a new execu-director in late 1983 who reorganized the institution into a more efficient and coord'nated structure from a programmatic point of view (Figure II) as well as adopting a comprehensive two-year operational plan approved by AID/Ecua'or. The evaluators believe that the possibility for eventual project success is intimately linked to these two important developments.

In terms of institution-building, the AESP is already a qualified success in the eyes of the evaluators. While it is true that INE has used other resources available to it as well as those through the AESP, the effect has been to develop considerable technical and planning expertise within a single organization. This is an unusual situation in Latin America.

It is true that conservation, planning, and NCE development have not previously enjoyed a high priority at a national level given Ecuador's position as a petroleum exporter and its heavily-subsidized petroleum-derived fuel prices at home. Nevertheless, INE activities have been critical in beginning to develop a consciousness in these areas. There would be no national voice for these important concerns were it not for INE and the AESP.

It is the opinion of the evaluators that in spite of many difficulties, INE has already made important contributions to the national energy picture through the AESP and the project should therefore be continued and extended at least through December 1986. A long-term goal already partially achieved is for INE to acquire the credibility to advise and influence energy policy in the country, in particular the energy sector institutions such as CEPE (the state-owned petroleum consortium) and INECEL (the national electrical utility). By law it has the responsibility for developing the national energy plan involving these two organizations. For this reason and also to improve its ability to disseminate useful project information at the field level, INE must concentrate among other important tasks, on developing an information center and information transfer capability. An effort in this direction has been initiated and needs more emphasis. Even in this area, an important first step has recently occurred in the formation of a "technology transfer" group with a full-time coordinator. This group will also consolidate the

emphasis already being given to working through the dissemination capabilities of other organizations.

While the ultimate success of the project will be judged in terms of the project's ability to get useful information out to a variety of users/audiences and that INE's ability to do this effectively is as yet uncertain, the evaluation team believes that there is sufficient evidence to suggest that the AESP is at a "take-off point." Barring any drastically negative action by the new democratic government taking office in August, there is reason to believe that the "second half" of the project's life will be more vigorous than the first, particularly in the planning component. The evaluators therefore recommend the continued support of the AESP by AID and the GOE.

FIGURE I

INE'S POSITION IN THE GOE

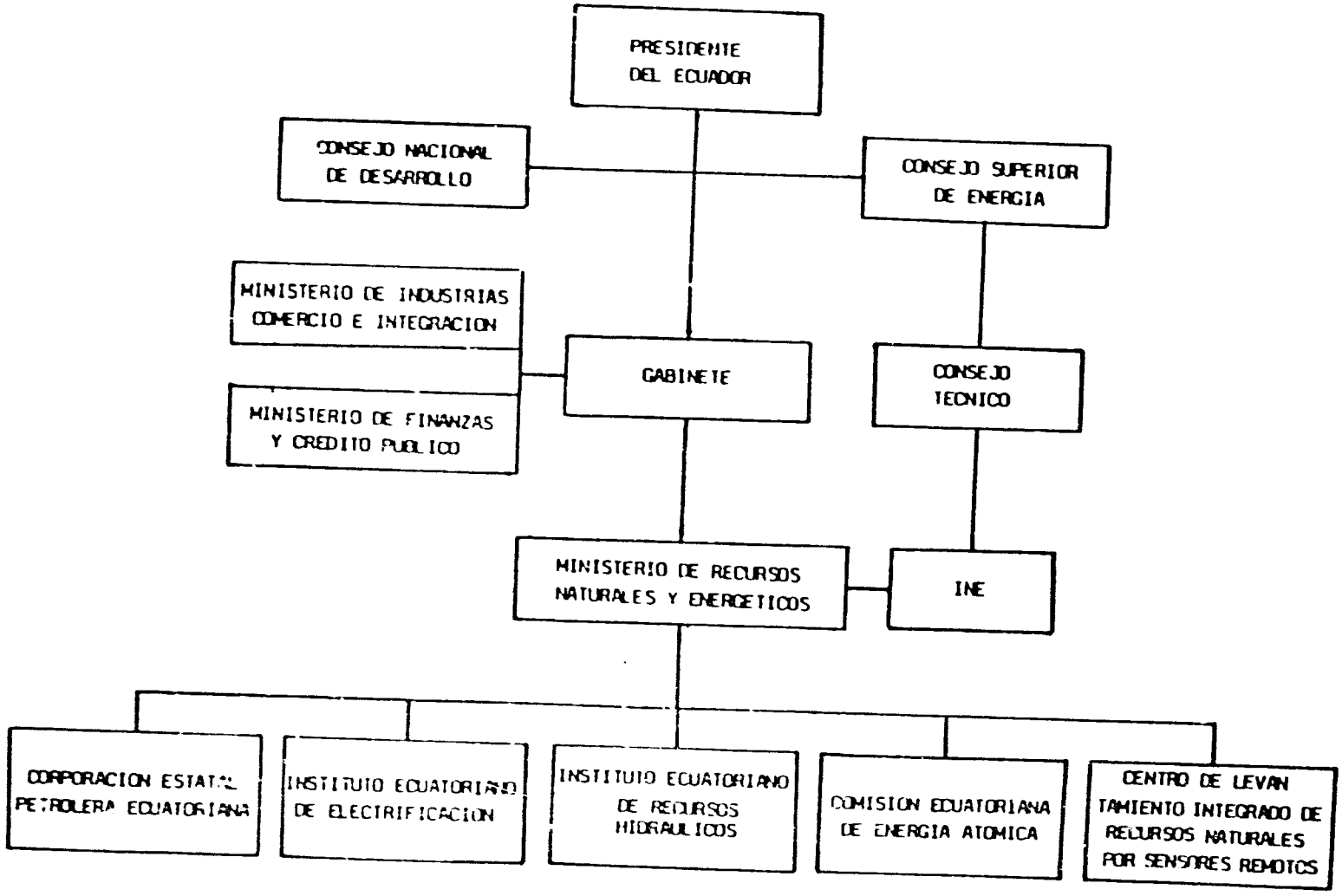


FIGURE I

Consejo Nacional de Desarrollo (CONADE): National Development Council

Consejo Superior de Energía: Superior Energy Council, composed of relevant members of the Cabinet of Ministers (Gabinete).

Ministerio de Industrias, Comercio y Integración: Ministry of Industry and Commerce.

Ministerio de Finanzas y Crédito Público: Ministry of Finance

Ministerio de Recursos Naturales y Energéticos (MNRE): Ministry of Natural Resources and Energy

Corporación Estatal Petrolica Ecuatoriano (CEPE): State Petroleum Company

Instituto Ecuatoriano de Electrificación (INECEL): State Electricity Company

Instituto Ecuatoriano de Recursos Hidraúlicos: State water utility

Comisión Ecuatoriana de Energía Atómica: Atomic Energy Commission

Centro de Levantamiento Integrado de Recursos Naturales por Sensores Remotos: Earth Satellite Station

Consejo Técnico: INE's Board of Directors, consisting of the subsecretary of MNRE (chair); representatives of the Ministry of Finance, Ministry of Industry and Commerce, CONADE, CEPE, INECEL, Water Utility, and Atomic Energy Commission; the Executive Director of the Earth Satellite Station; and the Executive Director of INE (secretary).

FIGURE II

Asesoría Jurdíca: Legal counsel

Comité Técnico - Administrative de Coordinación: Executive Director, Directors of the Planning (DPRE) and Development (DDE) Programs, and Heads of the Administration and Information Divisions

Division Administrativo - Financiero: Documentation and computation

Division de Informatica: Documentation and computation

Dirección de Planificación y Recursos Energéticos (DPRE): The Planning Program, under which are (a) the Energy Planning Division, responsible for energy balances, modeling, evaluation of projections, and policy recommendation; and (b) the Energy Resources Division, responsible for supply and demand-data collection and other resource studies to serve planning.

Dirección de Desarrollo Energético (DDE): The NCE Development Program, under which are (a) the Division of Energy Diffusion, responsible for dissemination of technologies; (b) the NCE Division, responsible for solar, minihydro, biomass, and geothermal projects; and (c) the Conservation Division, responsible for energy auditing and conservation projects.

FIGURE II

INE'S INTERNAL STRUCTURE

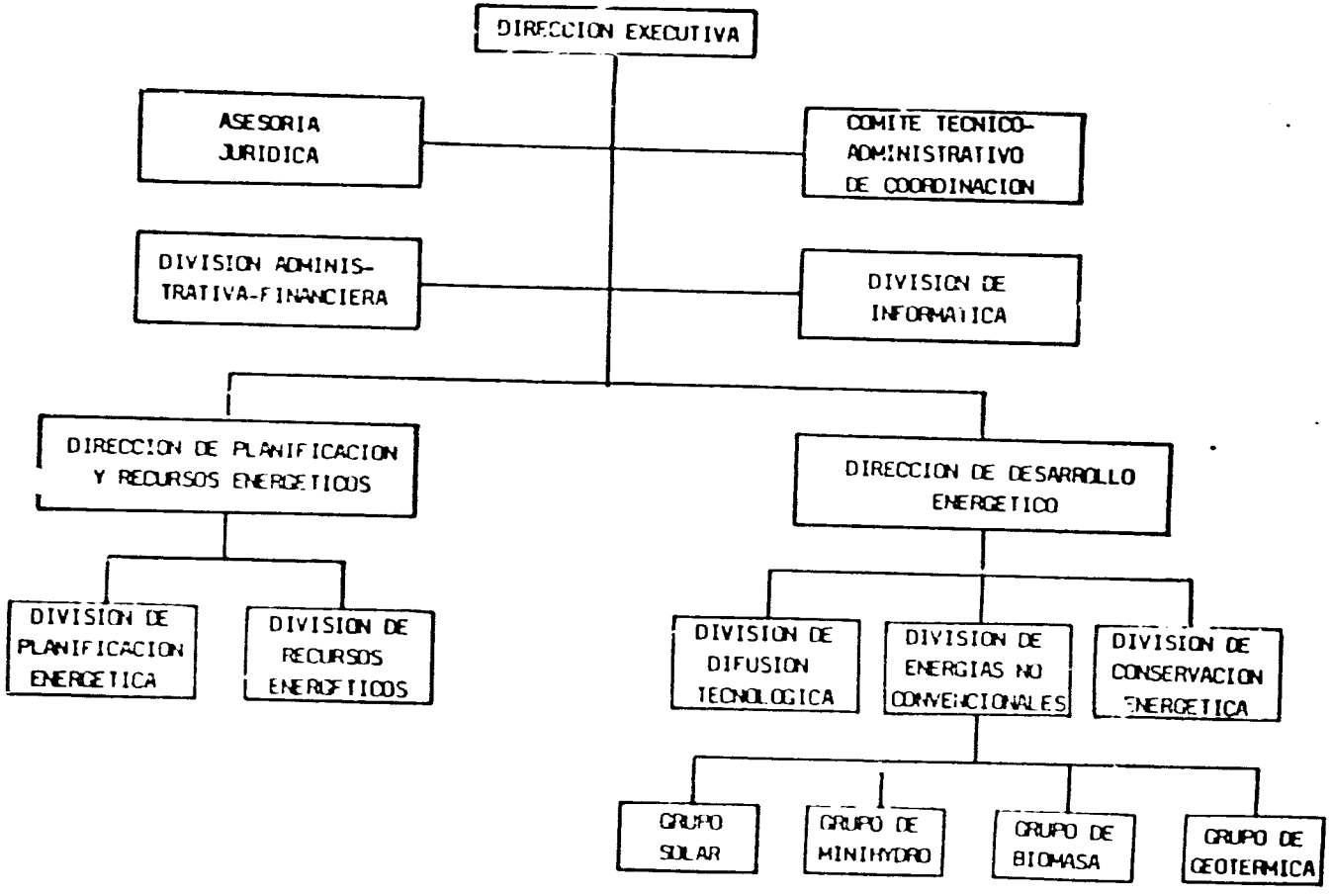


FIGURE III

INE'S INTERNAL STRUCTURE, NOVEMBER 1979-OCTOBER 1983

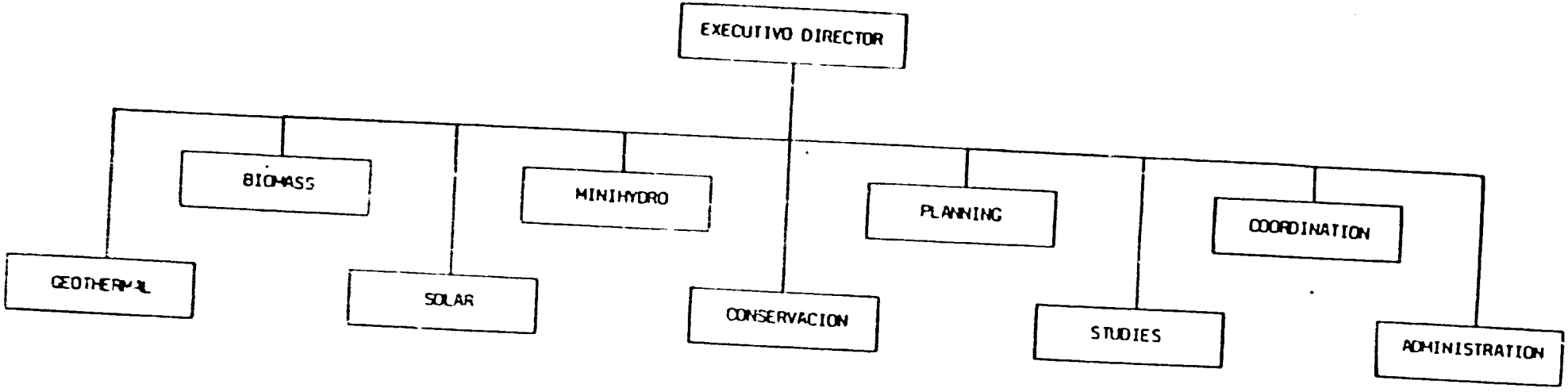
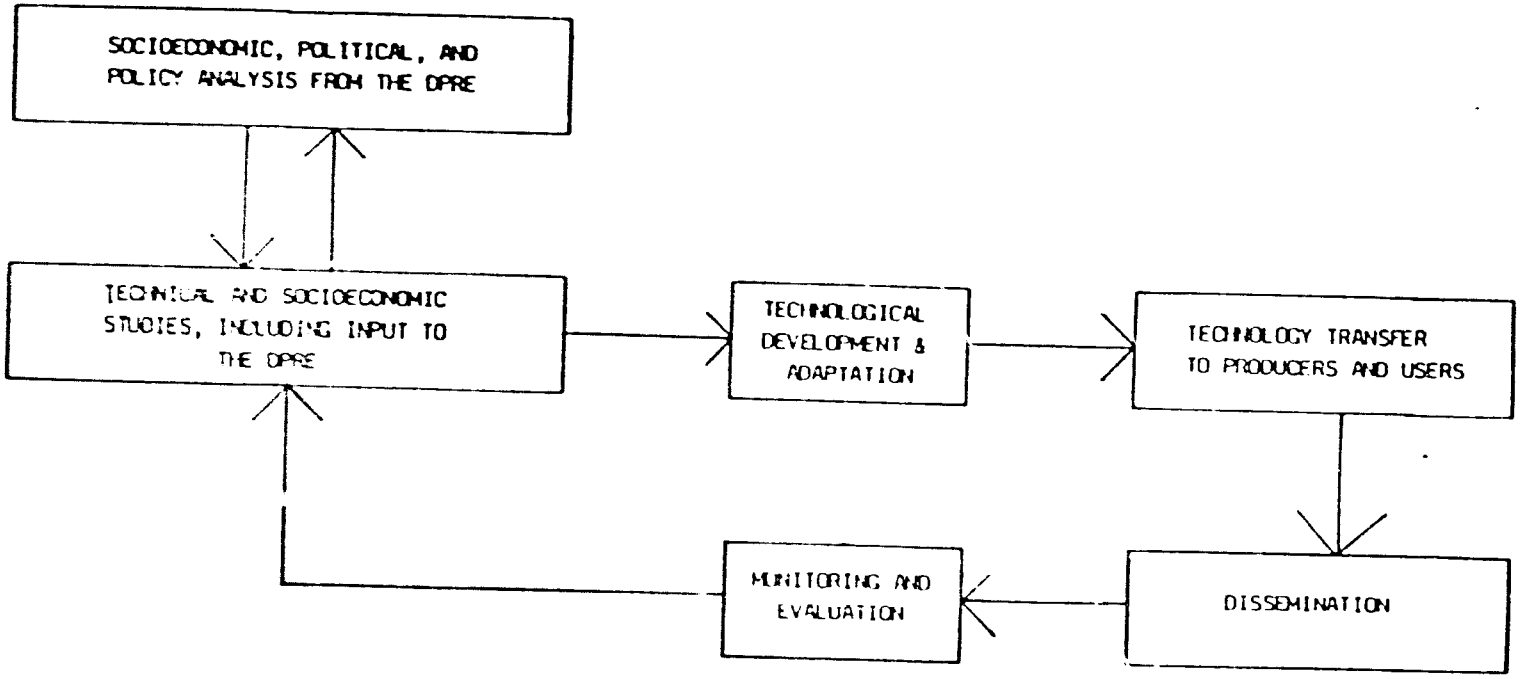


FIGURE IV

DDE FUNCTIONS AS RELATED TO THE DPRE



II. PREFACE

The evaluation took place over a three-week period during April and May 1984. While short site visits to INE projects outside Quito were made, most of the information was gathered through interviews with INE and AID representatives and others in Quito. Two informal presentations on preliminary findings were made to AID and INE officials at the conclusion of the evaluation visit. A preliminary draft of the report was provided to AID/Ecuador and INE whose comments are incorporated in this final draft. The evaluation itself and report were in general organized according to major categories given in the statement of work.

Evaluation team members consisted of the following individuals:

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The team wishes to express its thanks and appreciation to all who participated in the evaluation effort and especially acknowledges the administrative assistance, guidance, and logistical support of the following individuals: Carl Duisberg, USAID/Ecuador Regional Energy Officer; Ing. Pablo Maldonado,

Executive Director, INE; Ing. Eduardo Moran, Director of the Division of Energy Development, INE; Ing. Fernando Gonzales, Acting Director, Department of Technology Transfer, INE; Dr. Hugh Pearson, Energy Advisor, INE/AID..

III. LIST OF ACRONYMS, APPENDICES, TABLES

AESP	INE-AID Alternative Energy Source Project
AID	United States Agency for International Development
CEDRI	Integrated Rural Development Secretariat
CEPE	State Petroleum Company
CONADE	National Development Council
CREA	Regional Development Organization (Azvay Region)
DDE	Direction of Energy Development
DPRE	Direction of Planning and Energy Resources
EEC	European Economic Community
EPN	Polytechnical School (Quito Region)
ESPOCH	Polytechnical School (Chimborazo Region)
ESPOL	Polytechnical School (Guayaquil Region)
FED	Ecuadorian Development Foundation
GOE	Government of the State of Ecuador
GTZ	German Development Assistance Agency
IEOS	Ecuadorian Institute for Sanitary Works
INE	National Energy Institute
INECEL	State Electrical Utility
JNV	National Housing Board
MOA	Ministry of Agriculture
MRNE	Ministry of National Resources and Energy
NCE	Non-conventional Energy
OLADE	Latin American Energy Organization
PRONAF	Forestry Service of the Ministry of Agriculture

SECAP	Ecuadorian Professional Training Service
TORs	Terms of Reference
VITA	Volunteers in Technical Assistance
4F	4H Clubs of Ecuador

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IV. INTRODUCTION

1. The National Energy Institute (INE)

INE was created in May 1978 as a semiautonomous agency under the Ministry of Natural Resources and Energy (MRNE) to serve two functions:

- To serve as the energy planning body for the Government of the State of Ecuador (GOE), and
- To promote nonconventional energy (NCE) development in accordance with GOE policy.

Figure I shows how INE stands relative to other parts of the GOE--relevant because they contribute members to INE's Board of Directors. Figure II shows INE's internal organization.

2. The INE-AID Alternative Energy Source Project (AESP)

To support both of INE's functions, the GOE and the USA agreed to finance the AESP, a project for "(1) enhancement of INE's energy sector planning and analytic capabilities; (2) development of information network and technology transfer mechanism for the energy sector; (3) demonstration of and dissemination of successful non-conventional energy applications appropriate to Ecuadorian needs, and (4) promotion of energy conservation."

The 1981 AESP Loan and Grant Agreement specified that the United States Agency for International Development (AID) would appropriate, for INE, grant monies of no more than US $800,000 and loan monies of no more than US $1,900,000, both to be disbursed incrementally over the life of the project. The Agreement further specified that the Project Assistance Completion Date would be December 31, 1985, "or such other date as the parties may agree to in writing."

3. Summary of the AESP Loan and Grant Agreement

The 1981 Agreement divides the AESP into four components for which it provides detailed descriptions. Following these descriptions, the functional aspects of the Agreement can be summarized as follows:

(a) Energy Studies and Research. This component calls for INE to undertake energy demand studies, especially for the rural sector, and studies to assess Ecuador's potential for using NCE sources to supply future demand. Four studies of resource availabilities, one study of rural energy demand, and up to ten studies of the energy sector and special analysis are called for. This component also calls for establishment of an INE-administered small-grants fund to finance NCE research activities of individuals and institutions. Between twenty and thirty grants are called for by the end of the AESP.

(b) Energy Technology Transfer and Information Network. This component calls for INE to sponsor short-term training and atten-

dance at technical conferences and demonstrations outside Ecuador, and seminars, courses, workshops, and other training within Ecuador, for specialized Ecuadorian institutions and entities. At least twenty separate training activities outside Ecuador and ten within Ecuador are called for. This component also calls for establishment of a reference and information center in INE, expected to be the most complete center on NCE and energy planning in Ecuador, with close connections with other Ecuadorian information centers, and with an outreach program including a periodic publication. This component provides for a long-term (two year) resident advisor to assist INE in project implementation.

(c) Alternative Energy Demonstration and Dissemination. This component deals with field demonstration, to be followed by national dissemination, of NCE technologies of the following types:

--Minihydroelectricity. Collaboration between INE and INECEL is described in order to carry out a national minihydroelectric assessment, construct a minihydro plant and distribution system, and assist localities in maintenance and operation.

--Cookstoves and Woodlots. Collaboration with rural development organizations, such as the Ecuadorian Development Foundation (FED), is called for to demonstrate improved cookstoves, to train fifty local craftsmen to construct 1000 stoves throughout Ecuador, and to disseminate knowledge in use and maintenance. In addition, collaboration with the Ministry of Agriculture (MOA)

is called for to demonstrate and disseminate fuel woodlot technology.

--Solar Water Heating. Collaboration with the National Housing Board (JNV) and the Ecuadorian Institute for Sanitary Works (IEOS) is specified to demonstrate solar water heaters in public housing projects and public showers, and provide training in operation and maintenance. Construction of 360 collectors, locally operated and maintained, is prescribed.

--Other NCE. Collaboration with other institutions for pilot projects, demonstration and dissemination of biogas, micro-hydro, solar distillation and drying, windmills, photovoltaics, charcoaling, energy-use of agricultural and municipal wastes, etc., is encouraged.

(d) Energy Conservation. Use of specialized consultants is called for to develop, test, and disseminate energy-conservation materials and to establish, in INE, an energy-audit service for public and private enterprises.

Besides these activities, the Agreement calls for quarterly review and planning meetings between INE and AID, an overall evaluation plan, and an annual, joint review of progress and problems.

4. Summary of Progress to Date

At the time of writing, the AESP is in its thirty-second month; that is, from the time of the signing of the Agreement and the

tentative completion date of December 31, 1985, almost 63% of the life of the project has elapsed. However, the most recent project accounting (February 29, 1984) indicates that, of the maximum assistance budget of US $2,700,000, only 7.1% had been disbursed: US $142,100 in grant funds (18%) and US $49,200 in loan funds (2.6%).

In terms of the components of the Agreement summarized above, the breakdown is as follows:

(a) Energy Studies and Research. Four studies have been carried out, three small grants awarded, and instruments for measurement have been purchased. Of the assistance budget for this component, 15% has been disbursed, US $2,300 from the grant and US $49,100 from the loan.

(b) Energy Technology Transfer and Information Network. Twelve training activities outside Ecuador and two in Ecuador were undertaken, all for INE personnel. A small documentation center based on the Volunteers in Technical Assistance (VITA) model was set up for internal use, but it is not computerized, there are only informal links with other Ecuadorian information centers, and there is no associated outreach program or periodic publication. An agressive acquisitions program for additional materials and references has been initiated. A two-year resident advisor was retained in May 1982. Of the assistance budget for this component, 22% has been disbursed, US $134,100 from the grant and US $50 from the loan. Almost none of this went to the

information center; about 21% went for training activities and the rest for the resident advisor.

(c) Alternative Energy Demonstration and Dissemination. Nothing from the assistance budget, grant or loan was expended in this component. (The original budget contained no grant funds for this component.)

(d) Energy Conservation. US $5,700 has been expended from the grant for equipment intended for a public campaign for conservation. This is 2.3% of the component budget.

While formal quarterly and annual review and planning meetings between INE and AID have not been held, there has been a continuing informal review activity. There is no overall project evaluation plan.

5. Parameters for Evaluation

Although it has used very little of the AESP assistance to date, INE is convinced that it can complete the project, and has presented to AID a two-year plan (December 1983) for doing so during 1984 and 1985. In the light of this, to evaluate the AESP only in terms of the number and quality of subprojects undertaken--as suggested by the Agreement--seems inappropriate. What appears to be the key questions for the evaluators are:

--Why has INE used so little AESP funding to date?

--Is the two-year plan well formulated?

--Can INE carry it out?

This evaluation consists of a best attempt to answer these questions on the basis of documents examined (Appendix A), meetings held (Appendix B), and field trips undertaken (Appendix C) in Ecuador during the period of April 25 through May 11, 1984. At the same time, it has been guided by the specific injunctions of the Scope of Work provided by AID (Appendix D).

V. ANALYSIS OF INE'S CONCEPT OF ROLE

1. Evolution of the Planning Function: Stage I

As stated in the Introduction, INE's mandate upon its creation was dual: to act as the energy planning body for the GOE, and to promote NCE development in accordance with GOE policy. However, this duality of role was not always reflected in practice.

INE's first executive director promoted both planning and NCE development functions and initiated Ecuador's first energy balances (finished and published in 1980 under INE's second director). At this time, the EEC began to provide substantial technical assistance in terms of consultants/advisors assigned to INE, particularly for the planning function (see Sections VI and VII). Partly for this reason, INE's second executive director naturally emphasized NCE development. Since it was during the tenure of the second executive director (1979-83) that the AESP Agreement was signed, this may explain why only one part of the AESP touches directly on planning the "Energy Studies and Research" component.

Now, energy planning consists of the following, <u>at least</u>:

--Development of historical energy balances, that is, quantified descriptions of energy demand for various sectors, over a specified period, together with quantified descriptions of supply sources.

--Selection and use of appropriate models for demand and supply projections under various development scenarios, for some future period.

--Analysis and evaluation of projections, and presentation of policy recommendations.

--Preparation of a national energy-development plan to realize the policies that emerge.

In principle, energy planning and NCE development are related. The results of planning dictate development activities, and experience with development informs future planning. Although the AESP is designed especially to support INE's development function, because of the planning/development relationship, it promises ultimately to serve both.

This is so in principle. In practice, planning and development activities will be mutually reinforcing only if they are deliberately coordinated. Figure II shows the current internal structure of INE. Its structure between November 1979 and October 1983, was very different as illustrated in Figure III.

This flat structure tended to compartmentalize each subfunction; made all coordination the responsibility of the executive director, to whom every subfunction reported directly; made no distinction between function and subfunction, or between program and operational support; and in particular, put national energy planning on a par with INE administration. Given EEC assistance to planning, this structure deliberately emphasized NCE development.

2. Evolution of the Development Function: Stage I

In July 1982, the two-year consultant provided by the AESP component "Energy Technology Transfer and Information Network," arrived at INE. Even though this component paid for the advisor, his actual contract reflected a relatively small amount of projected time specifically dedicated to that effort:

NCE Demonstrations--estimated 40% of time

Conservation Promotion--estimated 20% of time

Information Center--estimated 15% of time

Research and Development Fund--estimated 10% of time

Energy Studies--estimated 10% of time

Progress Report and Evaluation--estimated 5% of time

This is a further indication of the priority placed on NCE development which at the time seems justified.

NCE development activities can be analyzed roughly into three categories:

--Development of Sources. In Ecuador, the likely NCE sources are sunshine, biomass (especially wood), moving water, and terrestrial heat. Development of these sources involve a number of engineering issues: solar collection, afforestation, electrical conversion, drilling of sites, and so forth. But it also involves a number of associated issues: socioeconomic analysis, project management, development of personnel, information collection and analysis, interinstitutional coordination, and others.

--Provision for End Users. When the focus of attention is not the source, but the development of technologies (devices or procedures) to apply the source efficiently to specific end uses (transportation, irrigation, cooking, etc.), the development effort falls into this category. Again, both engineering and associated, nontechnological issues arise: development of new solar heaters, stoves, etc., but also all the management, political, economic, informational, and training issues listed under the first category of NCE development. Even though INE is primarily a technical organization, it has developed considerable sensitivity to these non-technical factors over the years and now could be characterized as promoting an integrated approach.

--Realization of Development Benefits. This is sometimes called "disseminations." NCE sources and technologies are disseminated when the people for whom they are intended begin to use them, and continue to use them in enlightened preference to whatever they used before. Only through dissemination is the payoff for the first two categories above realized. The dissemination issues are almost all political, informational, educational, managerial--in short, nontechnological.

The importance of the nontechnological NCE-development issues is not immediately reflected in the INE-AID decision on the terms of reference for the long-term advisor. Naturally, dissemination and other issues were not of great initial concern. With little overall coordination, each technical group was individually responsible for building dissemination considerations into its projects and each was responsible for deciding on training activities. INE became primarily an experimenter with technical NCE projects.

3. OTHER STAGE I FACTORS

The preceding is only a partial explanation of why so little of the AESP assistance was spent during 1981-83. Several other factors were also operating.

INE was a very new organization when the AESP was signed. Its professional staff were young--mostly recent graduates--and none was experienced in energy planning or NCE development. Most were

engineers with enthusiasm for, but little direct knowledge of, NCE technologies. Their most urgent need, at the beginning of the AESP, was for hands-on experience of the sort that the second executive director provided.

The AESP Agreement, on the other hand, reflects an awareness of the complexity of NCE development probably imported by the expert consultants to AID who developed the project, but perhaps not entirely shared by all INE personnel in 1981 even though certain INE individuals had important inputs into the process. INE had to acquire its own appreciation of the importance of nontechnological development factors slowly and through experience--which it did, as is shown in later parts of this evaluation. However, the initial result was that it simply could not make strong progress during the first two years of the AESP on its own.

Almost coincident with the signing of the AESP, Ecuador went into a sharp economic crisis. The result for INE was that its budget was cut and frozen just as its workload began to increase. In 1981, it had a professional staff of 33 and a budget of 43 million sucres of which only 21 million were appropriated because of GOE austerity and anti-inflation measures. In 1982 and 1983, INE had 55 professionals and annual appropriations of 22 and 25 million sucres, respectively. For 1984 and 1985, the Consejo Tecnico submitted a two-year budget of 65 million sucres, of

which only 28.7 million have been appropriated for 1984; the Consejo is currently appealing for an additional 1.3 million.

National economic difficulties have had two kinds of effects on INE relevant to the AESP. First, it has caused an acute shortage of personnel, and especially support personnel. For example, there have never been more than three or four secretaries for the entire institution. As a result, administrative practices and project management procedures were poorly developed except in the accounting office, so that it took INE nine months to satisfy the "Conditions Precedent to the AESP" sufficiently for the first disbursal of AID funds. The operational starting date for the AESP should be taken as June 16, 1982, when " AID Implementation Letter No. 4" authorized disbursements for technical assistance, measuring instruments, and vehicles. (Project tracking capability will be improved once proposed computerized systems are functional.)

Second, the balance of payments emergency in Ecuador--an oil exporter--coupled with World Bank predictions (data provided by INE!) that petroleum reserves were being exhausted at such a rate that Ecuador would become a net oil importer within ten years, instilled in INE a sense of frugality and caution about incurring foreign debt. While the loan portion of the AESP represents a dept incurred by the GOE, the evaluators believe that INE has been trying to be conscientious and responsible in its use of

these monies. Indeed, INE has expressed concern that AID quickly set billing dates for payment of the interest already accruing--as called for by the Agreement--lest the GOE be penalized for being in arrears. It has also been suggested by an INE staff member that INE itself will be held responsible for its AESP loan by the GOE and that interest--and eventually principal--payments will be reflected in future budget cuts. This has been contradicted by more senior INE officials and by the MNRE, yet some doubt remains.

What does seem incontrovertible is that INE has been very loath to use its loan--more than 70% of the AESP assistance--unwisely. Feeling itself inexperienced in contracting for foreign consultants it has tended to hire, with its own budget, Ecuadorian consultants at a fraction of the cost, or to use free European technical assistance, while it discovers where American expertise really is required. Moreover, INE learned fairly quickly that to successfully disseminate the NCE and conservation technologies with which it has been experimenting would take great care and planning. It has carried out its experiments with its own budget; its reluctance to use the AESP funds for the third and fourth Agreement components (alternative energy demonstration/dissemination and conservation) appears not to be a disinclination for American assistance, but a disinclination to waste it.

An additional reason for implementation delays was the result of a political dispute between the current Minister of the MNRE and the previous Director of INE, the effective result of which was a hiatus in all significant activity for a six-month period during 1983. This occured because MNRE's subsecretary, who is president of the Consejo Tecnico (see Figure I), could not convene that body and the approval of convenios and programs/major activities did not occur. Finally, the lack of an operating plan (until late 1983) discouraged timely project implementation.

4. Evolution of Both Functions: Stage II

In October 1982, a new Minister was appointed to the MNRE. Strongly influenced by such advocates of national energy planning as the Organization Latinoamericano de Energia (OLADE), he pressed for the revival of the planning function in INE. In October 1983, INE's Executive Director left for the Instituto Politecnico and his predecessor (the original executive director) was named to replace him.

This change came roughly at the same time as it was becoming clear to the technical teams that INE no longer had comparative advantage for either NCE research or project execution, and that its preoccupation with these activities was impeding other development objectives including technology and information transfer and dissemination. In November 1983, it was jointly decided with the MRNE that INE would no longer direct its energies to research

and project execution, but would instead construe its NCE development function as follows:

--To promote NCE research, conducive to GOE policy, in suitable R&D institutions.

--To promote dissemination of technologies through executing agents capable of the extension activities entailed.

--To act as an agent for transfer of nationally developed and foreign technology and information.

--To act as a communicator to the public.

Thus, INE has been directed to carry out its NCE development function essentially as a project identifier and contract manager, although some design work continues. Its research and participation in projects are limited to support roles, including support to its planning function.

In response to this evolution of mandate, INE discarded the flat organization scheme given in Figure III and adopted the scheme of Figure II. This corresponds with the promotion of planning to a program with analytic and empirical divisions, and to the construal of NCE development as a management and dissemination process. The relevance to INE of the AESP then became apparent.

In December 1983, INE presented to AID "Two-year Plans" (plan operativo) for carrying out the AESP during 1984-85. Every area of the Agreement is covered. The remainder of this report consists of an analysis and evaluation of the plan operativo and an

evaluation of INE's ability to carry them out, based on assessments of its technical capability and of its progress between the beginning of 1984 and this time of writing. Recommendations are provided in Section XI.

5. Conclusions of This Section

The chief reasons why the AESP proceeded slowly during 1981-83 seem to be:

1. Stage I institutional structure under which national energy planning was de-emphasized in favor of NCE development so that only a few of the studies called for by the first component of the AESP Agreement were carried out.

2. INE's relative inexperience with NCE development which obliged it to delay dissemination attempts while it acquired familiarity with technologies that might be transferable. (This delay which explains why funds for the third part of the Agreement were not used, seems appropriate. Both that such a delay was not anticipated by AID, and that the Agreement sets specific dissemination goals in advance of prefeasibility and feasibility studies, indicate flaws in initial project development.)

3. Lack of administrative structure adequate to management and control of the AESP.

4. Fear of misspending the AESP loan monies exacerbated by national attention on Ecuador's balance-of-payments problems, and by misgivings about the value, given the prices quoted, of

American consultations for the first (planning) and the fourth (conservation) components of the AESP.

5. Severe political problems between the director of INE and the Minister of MNRE (1983) that resulted in very little new or previously planned activities actually being implemented.

6. Lack of an operating plan.

Of these six reasons, the third and sixth are no longer relevant and the rest have partially been removed. INE has developed its own training coordination in the past two months, but there is still no significant development of the information center; the general restructuring that followed upon the return of the original executive director has rationalized operations significantly, but there is still no formal project management system (although project control has improved); work related to planning is being conducted with U.S. support but less related to conservation.

However, some changes in the AESP could remedy the problems that remain. Specifically:

1. A budget adaptation to permit retension of another long-term advisor to assist development of the information center could have useful results. Since a computerized center is envisaged and since INE is already using computer functions, a rationalization of the entire computer system would seem to be called for. This rationalization might encompass the information center, various computation and linkage functions, and both cen-

tral and projects administration. Central administration at INE is well-developed and could easily be computerized. Project administration, on the other hand, is only recently being developed, as has been noted; here is an opportunity to introduce a system of project control and to integrate it into a general up-grading of institutional efficiency.

2. Another budget adaptation to permit INE to investigate thoroughly the world consultancy market, especially for technical assistance on conservation efforts, might have equally far-reaching effects. It would allow the most rational selection of consultants, which is certainly in AID's interest and which is critical to INE, given its determination not to misspend money Ecuador will have to repay.

In sum, the evaluators have concluded that INE's slow progress with the AESP during 1981-83 is not a barometer for the future. What are more relevant to the successful outcome of this project are the quality of INE's plans for completing it and the likelihood that INE can carry out these plans. These are the issues to which this evaluation now turns.

VI. EVALUATION OF PLANNING

1. The DPRE Master Plan, 1984-85

What is here called "the DPRE Master Plan" is an informal, two-year projection of all of the activities of the INE program for national energy planning, including those to be funded by the AESP. Prepared in November 1983, it calls for six steps, some taken concurrently:

--Elaboration of Formal Terms of Reference (TORs). Being only an informal instrument (that is, an instrument proposed by the DPRE, but not ratified by the Consejo Tecnico, INE's Board of Directors), the DPRE Master Plan calls, first of all, for the construction of a Formal Master Plan (one that is ratified by the Consejo Tecnico). The TORs for the Formal Master Plan were to be drafted and refined through consultation with all GOE bodies impinging on the energy sector, and presented to the Consejo Tecnico for official adoption by April 30. This elaboration of Formal TORs is earmarked for funding under the AESP grant.

--Inventory of National Energy Resources. The DPRE Master Plan anticipates that the formal TORs, to be elaborated in the previous step, will call for construction of an operational plan for making an inventory of all national energy resources, including sources of NCE. Development of the operational plan is scheduled for May 31, 1984, and is earmarked for joint AESP (grant)-INE funding. It is further anticipated by the DPRE Master Plan

that the inventory of renewable, hydroelectrical, and nonrenewable resources will be carried out through cooperative efforts of all relevant GOE bodies by March 31, 1985, and that the resulting report will be completed by May 31, 1985.

--Construction of Energy Balances. The DPRE Master Plan calls for revision of the historical energy balances of 1969-82 by August 31, 1984, construction of the 1983 balance by September 30, 1984, and projections of balances for 1984-85 and 1985-86 by November 30, 1984, and November 30, 1985, respectively. Support for this is to come from the AESP (grant) and the EEC (technical assistance).

--Supply Studies. The DPRE Master Plan calls for a methodological description of a supply study, to be completed by April 30, 1984. Three sets of studies are to be carried out: (a) production studies of hydrocarbons, electricity, minerals (coal and fissionable materials), and renewables; (b) sectoral studies of distribution of petroleum and petroleum products, natural gas, electricity, coal and renewables; and (c) analysis and evaluation of the national supply system. These sets of studies, the first two of which will also feed into construction of energy balances, are to be completed by February 22, 1985, October 31, 1985, and December 1985, respectively. Joint AESP (grant)-INE funding is called for.

--Demand Studies. The DPRE Master Plan calls for a series of sectoral demand studies to be completed by June 30, 1985, and to be followed by various forms of analysis of demand, to be completed by December 31, 1985. The demand studies, like the supply

studies, will inform the construction of energy balances. All will be financed by INE, and technical assistance will be provided by the EEC.

--Medium Term Studies. Finally, the DPRE Master Plan calls for study of the effects of patterns of energy use for the medium term, and possibilities for new energy-development focuses. This is to be completed by March 31, 1985 with joint AESP (grant)-INE financing.

2. Scheduling Problems

The DPRE Master Plan was apparently constructed with the December 31, 1985 deadline for the AESP in mind. In the opinion of the evaluators, the work entailed could not be carried out well by that date under the best of circumstances.

However, circumstances are not the best. At present, the DPRE has a permanent staff of four (two more are returning from studies in France), which cannot be increased because of budget constraints. Two planners from INECEL and two from CEPE are consulting on the electricity and petroleum sectors, respectively; a part-time planning advisor has been provided by OLADE; there are two consultants for modeling and projections provided by the EEC; and three additional, one-year, Ecuadorian consultants are about to be retained with AESP funding. This represents excellent leveraging of assistance to make up for lack of exper-

tise and manpower, but it will do little to ease the operational burden the DPRE faces on other accounts.

At this time of the evaluation, the entire DPRE had only one secretary, the computer terminal that gave it access to INECEL data has had to be returned for lack of a dedicated telephone line, it has no direct computer access to CEPE data, and its internal organization is in disarray. This last problem is especially poignant. As Figure II shows, the DPRE is supposed to include an analytic unit ("Division de Planificacion Energetica") and an empirical unit ("Division de Recursos Energeticos"). At this time of writing, there is no Director of the DPRE and no chiefs of the component divisions. This is partly explained by the fact that there are only four permanent staff members.

Also, it is most expected that the current Minister of the MRNE and Executive Director of INE will remain after the government changes in August (1984).

These were the officials responsible for the revival of national energy planning as a matter of GOE policy and for the strengthening of INE to carry out this function. To try, as far as possible, to influence the next government to adopt a policy of energy planning, it was decided to divert INE's efforts away from the DPRE Master Plan and toward production of an executive summary of what could be expected to be the results of carrying out such a

plan, together with an analysis of the import of such results for national policy. This is useful for educating and persuading the next government in maintaining a strong planning role for INE.

Since January therefore, the DPRE has had to set aside the Master Plan to work on what will have be called "The Tactical Plan." A coordinator has been named for this effort, but he has not been named director of the DPRE, and as has been noted, the divisions within the DPRE have not been formally staffed. This is because the planned structuring of the DPRE is intended for carrying out the Master Plan which has temporarily been shelved. All of the efforts of the DPRE and its collaborators are going into the Tactical Plan which is, nevertheless, part of the master plan (subject to future revision).

The report of the Tactical Plan is to be presented for approval to the Consejo Tecnico by June 15, and to the Consejo Superior de Energia for transmission to the new government by July 15. To meet these deadlines is a herculean task and it is to the credit of the DPRE that it is moving on schedule. However, if the Tactical Plan is successful, so that the new government sanctions INE's planning function and the DPRE can return to its Master Plan, that Master Plan, already too tightly scheduled, will be behind by six to nine months.

3. Problems of Political Effectiveness

Apart from its schedule, the Master Plan is essential a good one. Yet even if the new government (which was elected May 6 and will take office in August) endorses energy planning in the manner of the old one, and despite the DPRE's dedication and ingenuity in marshalling assistance, it may be very difficult for INE to carry out the Plan or to present policy recommendations with authority.

INE is like many planning bodies, small, new, and hence a politically weak organization compared with the other parts of the GOE whose planning it has been charged with coordinating. It is also understaffed, underpaid relative to CEPE and INCEL personnel, and its infrastructure is wanting. It is dependent for electrification and petroleum data on the powerful INECEL ard CEPE, respectively. If pertinent data were not collected by the collaborating institutions, or if they were not collected in usable form, or if they were withheld, INE would be helpless and its work would, of necessity, be flawed. Thus, INE may not have political support adequate to its planning mandate.

On the other hand INE's political and infrastructural weakness may be related to official oversight. If so, that oversight may continue in the next government, even if it advocates energy planning. In this eventuality, it will be critical for INE to advertise its existence better than it has in the past, to make its value felt, and to be sure its functional needs are met. To

protect its planning function, INE may have to strengthen its lobbying stance with the GOE. INE has some experience in this regard, having played an integral role in the passage of the 1982 law which promotes development of NCE technology through exoneration of import duties and reduction in other taxes.

4. Coordination Between Planning and NRE Development

The DPRE stands to CEPE, INECEL, and so forth as the national energy planner to the specialized energy developers. This is also the relationship in which it stands to its sister Direccion in INE, the DDE. Figure IV shows how DDE functions relate to those of the DPRE.

Interestingly, the scheme given in Figure IV does indeed seem to represent the actual working relationship between the DPRE and the DDE--this despite the DPRE's difficulties in entrenching itself as the national energy planner, its obscure past, and its uncertain future. Thus, INE as a whole seems genuinely committed to national planning. The DDE supports planning in theory and in practice--for it, like all the energy development agencies, must supply the DPRE with data--and the DPRE has managed to squeeze out results of use in directing the DDE program.

Credit for this largely belongs to the director of the DDE, who seems to provide the interface between INE's planning and NCE-development functions. However, in the opinion of the evaluators,

a more formal interface might be required in the future. The DPRE and the DDE are housed on separate floors in INE. They represent different disciplines (broadly, economics and engineering respectively), and they have no mechanism for coordinating efforts on a timely basis or for informing each other regularly of their progress and problems. Special efforts to facilitate and improve communication may be required. It should be noted that future energy demand studies will be done jointly and results shared.

5. Implications for the AESP

If the Tactical Plan succeeds, support for planning-related studies from other donors is in the form of technical assistance only. If the new government endorses national planning so that the Master Plan can go forward, those parts to be carried out with AESP funding will not be possible without it. However, as has been noted, the schedule for the Master Plan seems unrealistic in its original form, and given the delay occasioned by the Tactical Plan, it is now probably out of the question. In other words, it is unlikely that the DPRE could spend its share of AESP assistance by December 31, 1985, in which case financing for the parts of the Master Plan left outstanding will be very uncertain. It is therefore recommended that if the Master Plan is implemented, the deadline for the AESP be put back at least until December 31, 1986.

Even if the Tactical Plan does not win substantial government backing, AESP support for planning studies will still be important. How the DPRE will function in this eventuality is not of course known. But planning-related studies will still be required by the DDE, as Figure IV shows; resource-assessment, supply, and demand data will be necessary for short-term NCE development even if the analysis of that data for longer term NCE development and rationalization within a comprehensive energy development context should be unavailable. Again, INE has no assistance for data gathering of this sort other than from the AESP.

It should be noted that the use the DDE would make of the AESP planning funding might be closer to what is called for by the AESP Agreement than the use indicated in the DPRE Master Plan. AID has, of course, already accepted the DPRE Master Plan, as it has all of INE's "Two Year Plans" (plan operativo). This indicates an appropriate flexibility which, it is hoped, will operate again should the Master Plan have to be set aside.

VII. PERFORMANCE OF PROJECT COMPONENT ACTIVITIES IN COMPARISON WITH OBJECTIVES

1. Introduction

As noted in Section I.4, an area of considerable concern for AID has been the apparent slow progress of the project to date. Moreover, activities outlined by the project agreement have been followed only in a general sense; many changes have occurred in kinds of implementation actually carried out. While it is beyond the scope of this report to enumerate the specific kinds of changes in each of the project components, these were discussed at great length with all of the appropriate INE and AID personnel. The team is satisfied that in general the changes in direction were made for sound reasons that make sense from a programmatic standpoint. For example, the agreement calls for the construction and installation of 360 solar hot water heaters in GOE housing projects, while in reality only a small number have been installed on a pilot basis, although more are planned. The rationale for this approach is that a single massive unreplicable demonstration is likely to have less impact than a smaller one that is properly planned, including making arrangements for credit, training, and maintenance, etc., all part of a successful demonstration.

In addition, as further described in Section V.3, there exists a major reluctance to spend project monies, especially the loan

portion, when other resources can be used for the same purpose, thus saving the project funds for other needs. As a governmental institution, INE can tap a number of other resources, particularly the technical assistance and expertise offered by the EEC which is without cost to INE.

2. Energy Studies and Research

Appendix F is a listing of all the studies published by INE to date. While a systematic evaluation of their content was not an obligation of the evaluation, a cursory review of a selected sample indicated high technical quality and competence. Unfortunately, it was not possible to determine which of the studies conducted were completed using AID funds. The team generally did encounter difficulties in tracing activities funded under the AID project. A computerized project management information system would assist greatly in this respect and is being readied. Appendix F does indicate seven activities supported under this component as of 29 February 1984; however, this could not be confirmed by INE. The agreement calls for a national inventory of renewable energy resources. INE has worked with other national institutions in an attempt to carry out this mandate. For example, in a preliminary analysis of solar and wind resources in the Sierra and the coast was carried out in 1981 in conjunction with the Escuela Politecnica de Chimborazo. However, data gathering was difficult given the scarcity of instrumentation and the general inaccessibility of much of the country . While it is

still desirable to cohtinue to assess Ecuador's solar potential, it is more likely this will be an outcome of the demcnstration activities currently underway, rather than as a national inventory based on reliable data. The same appears to be true of biomass resources. Small hydropower resources are based on a national study done by INECEL. The evaluation of low-temperature geothermal reources has not yet been carried out, but is planned for 1984. In short, while the planning division of INE is charged with the responsibility of preparing a "Master Energy Plan" for the country, which should in theory be based on a complete resource inventory, the data are only partially available. Even these data may not be completely reliable. Under the circumstances, it is clear that best estimates will have to be made in order to complete the planning task immediately at hand. It is also expected that preparation of the Master Plan will provide feedback to INE on how and whether the energy development division will re-order its priorities to emphasize more data collection/analysis activities, promote implementation of demonstration projects through cooperating institutions, or maintain the current mix of both.

Appendix C is a preliminary compilation of data compiled in 1981-82 with assistance from the Ministry of Agriculture, for an analysis of rural energy demand and use, also called for by the AESP agreement. Due to a number of factors it has not been analyzed previously, but will now provide an input into the

Master Plan. While the report was not available during the team's visit, likely conclusions are that improvement of the rural distribution system for kerosene and the development of efficient and inexpensive kerosene stoves may suggest a significant additional level of activity in Ecuador, given the continuing government subsidy for kerosene.

3. Energy Technology Transfer and Information Network

This is the weakest part of the entire project to date. A technical library based on the VITA classification system exists with about 900 books, 2000 documents and subscriptions to 27 periodicals. VITA has trained two individuals from INE in how to implement and maintain a documentation center. INE wants to expand and computerize its collection and information retrieval system as well as add microfiche equipment, but requires technical assistance in order to accomplish this. INE is also responsible for establishing the "National Energy Information System" (SIEN) which will be built around its own internal system. In addition, INE has been named as the Ecuadorian node for the "Latin American Energy Information System" (SIELA) being established by OLADE. However, not even OLADE can articulate exactly what kind of configuration it wants, so it is INE's responsibility to determine its own needs first within the general context of both the Ecuadorian and Latin American systems.

In addition, it is becoming clear to INE that both its energy development and planning departments must improve their capability to disseminate information to various audiences in the broadest sense so that the stage is set for effective technology transfer outside the organization. All sub-projects now have "technology transfer" components within them and a acting director for coordinating all these activities has been named. Specific recommendations are given in Section XI.2.b. Here it is sufficient to state that the information needs of both INE departments should be analyzed in depth and how the information center can meet those needs. Simultaneously, the broad objectives of both SIEN and SIELA must be assessed so that the information center can meet their requirements as well. The computerized management information system must in particular be designed with a clear idea of what the internal information inputs and outputs should be.

"Technology transfer" under the project has meant basically training INE personnel through attendance and participation in overseas workshops and short-term training courses; Appendix F itemizes activities financed under the project as of 29 February 1984 (fifteen). In the future, these activities will be broadened to include training by non-INE personnel as well as local seminars and workshops. The preparation of technical information currently found in INE reports in formats useful to other government planners, field implementation agencies (such as

nongovernmental organizations--"NGOs") as well as public relations materials will constitute new activities under this component. If the current long-term U.S. advisor who is scheduled to leave the project in August 1984 is replaced, it will be important that much more emphasis be given to this component, especially since a systemmatic implementation plan has not existed previously. As INE completes its shift from project implementation to policy recommendation/ research coordination/project design/technology dissemination/information, it will be increasingly important that efficient use and diffusion of information, both internally and externally, be developed and maintained. On the latter point, INE has already used seminars to good advantage. Two examples are the "Politicas y Estrategias Energeticas del Ecuador" seminar and the "Primer Encuentro Nacional Sobre Investigacion y Desarrollo de Energias No Convencionales" held with apparent success during the first quarter of 1984. Other seminars during 1984 include solar (June), microhydro and biomass.

4. Alternative Energy Demonstrations

a. Microhydro power - The original concept of the work for the microhydro group was to develop an institutional capability "within INE/INECEL" to design, construct, operate and maintain small hydro plants via construction of a 200 KW plant at a site previously identified and to conduct a national microhydro assessment. This approach has proven unworkable. First, INE

does not have enough staff to conduct site surveys, resource feasibility studies, plant design, and supervise construction/ operation. Much of this capability has existed within INECEL itself over the years, howbeit in an ad hoc fashion. (INECEL has itself recently institutionalized this capability into its Rural Electrification Program). Further, it did not make sense for INE to give INECEL--one of Ecuador's "richest" governmental institutions--the money required to build the demonstration hydro plant. Thus the mandate has changed during the past two years to emphasize the development of a national technological capability in small turbine and electronic load control design and construction which would then be used by INECEL and its satellite regional utilities in future projects. An additional objective is to promote the use of small hydroelectric schemes as a national policy where it can be shown to be practical.

While time has been lost due to the change in direction, recent accomplishments should improve the productivity record of the team. Perhaps the most important effort in the Quevedo Administration has been the refurbishing of a 50 KW hydro plant in the sierran community of Apuela with the assistance of the regional electrical utility EMELNORTE. An INE-adapted design of a Michel-Banki (cross-flow) turbine has been installed as well as a transistorized load control mechanism and is functioning in an acceptable manner. Based on this experience, INE is expanding its turbine testing and development program to include more cross-flow designs and production plans for national fabrication

as well as Peltons. SECAP (Servicio Ecuatoriano de Capacitacion Profesional) is supposed to build and deliver to INE a Swiss "SKAT" prototype used with success in Nepal and two additional Peltons will be cast during 1984 (an initial prototype developed problems during construction and was never used). An improved version of the electronic regulator using triacs circuitry has been developed through a private firm and is ready for acceptance testing. A third generation regulator device using microprocessors has also been prototyped with a fourth generation in the works. Another private company will be involved in the design and construction of an oil pressure regulator for the improved Pelton near the end of 1984 with a second generation unit planned for 1985. The group also plans to study additional cross-flow and Pelton designs that will be imported from the US and possibly Canada during 1984. They hope to develop turbine transmission systems that will be used for mechanical (non-electrical) applications during 1984, though this has been delayed due to the press of other activities.

All of the turbine and electronic control testing will be done at a site near Quito (Guangopolo) that INE constructed on land leased from the Empresa Electrica de Quito. This is the only facility of its kind in Ecuador and though it is behind schedule in terms of functionality, the delays seem to lie beyond INE's control. For example, a hydraulic brake was recently purchased with AID project funds but was not installed as of the evalua-

tion because accompanying manuals and documentation had not yet arrived. The effects of dirty water which would pit turbines undergoing extensive testing requires installation of a special filter that had not yet happened. Progress on both counts occurred during the team's visit. And as experienced by other technical teams, convenios as the basis for a formal relationship with other organizations are slow in coming (sometimes precedent to signing contracts). For example, the contract with SECAP had not yet been signed, as was also the case with INECEL.

The experience of the hydro group shows that technological development is a process that really never ends. The hydro group needs to orient its future work around the dissemination of information regarding its experience to date as well as maintain technological progress, probably by relying even more heavily on collaboration with other institutions and private firms which is already happening. As the notion of technological progress matures at INE, it is expected that a general reorientation along these lines will occur throughout the DDE. Signs of this are already present.

b. Biomass - The project agreement calls for an activity component in the area of "cookstoves and woodlots demonstration and dissemination." This has been folded under a more general level of biomass activities shared by the biomass team which also

includes research/implementation of bio-gas/fertilizer, use of wood waste (and other agricultural and industrial wastes), and processing of sewage. While the technical competence of the biomass team appears to be at the same high level as the other technological groups, there is some concern whether this wide area of activity can be adequately serviced by only three full-time professionals. Like the solar team, the biomass group does not have a team leader. Unlike the solar team where this does not appear to negatively affect coordination of activities, efficient integration of biomass activities may be more problemmatic.

A major emphasis is being given at the present time to the development of model fuelwood plantations, presently using eucalyptus as the preferred species. INE has not had much success in dealing with the forestry service (PRONAF) of the Ministry of Agriculture which, like many forestry services, is more concerned with the development of commercial woodlots than with rural fuelwood supply. (In fairness, it should be mentioned that PRONAF has apparently developed a fuelwood plantation design and some inter-institutional jealousy may be keeping the two organizations from cooperating fully.) Instead, it is working through private and/or regional development agencies. The team visited the first such effort sponsored by the Fundacion Ecuatoriana de Desarrollo (FED) near Riobamba (Guamote). About 18,000 trees have been planted in two communities through the assistance of the local FED office and an American forestry Ph.D. candidate. The hope is

that a successful pilot project will motivate other organizations to develop similar collaborative relationships with INE. Since this first field experimental planting has only occurred within the past few months, it is too early to predict how successful the effort will be in terms of arousing sustained interest on the part of campesinos, but initial results in Guamote are very encouraging. An inquiry into native fuelwood species other than eucalyptus is also planned, with a special seminar on the subject planned during 1984. Even with this promising activity, it is doubtful that fuelwood plantation promotion will meet with widespread acceptance as long as heavy government subsidies on kerosene and bottled gas are maintained.

Prototype development of fuel efficient woodstoves, particularly ceramic models, is also just now getting underway. During the team's visit, contacts were made with groups experienced both in ceramic design and community outreach near Quito (Latacunga) who will be constructing models for testing in nearby small towns. Appendix H is an illustration of one of the models (there are five designs in all, including at least one non-ceramic design of simple construction. It is worth mentioning at this point that INE correctly predicted the unsuitability of many of the massive stove designs (such as the Lorena) several years before general disenchantment with these designs was apparent. VITA's own extensive experience with woodstoves programs clearly suggests that light-weight ceramic and metal stoves which can build on the

existing skills of local craftsmen hold much greater promise for local dissemination and use (see Appendix I). INE is working through a group at the Central University to test the new ceramic designs. The new provisional testing standards developed by VITA in cooperation with other worldwide groups will be used.

Biogas plant design and construction was one of the first real projects implemented by INE, working primarily through Peace Corps Volunteers assigned to construct seven plants throughout the country (all Indian designs). In fact, VITA financed this first such project during 1981-82. Except for a short visit to one of the plants at the experimental farm at the Escuela Politecnica de Chimborazo (ESPOCH) which is still functional, knowledge of the current operating status of the plants was obtained only through conversations. Reportedly, nearly all of the plants have been operating except for those damaged or affected by the heavy rains and bad weather associated with the "El Nino" phenomenon, especially in the coastal areas. However, a comprehensive evaluation of the experience to date has not been carried out and it was generally agreed that this would constitute a valuable information source, especially since there are few reported biogas success stories in Latin America. Also, while two studies of spent slurry as fertilizer have been done (one published) by INE, there is no comprehensive understanding of how, when, and under what conditions to apply the slurry as fertilizer and/or soil conditioners to fields. On both counts, the biomass team recog-

nizes that these require action in order to make the biogas experience useful. The biomass team, in conjunction with the planning division and external data processing facilities, also intends to conduct a factorial analysis of all the factors that influence the development of rural energy demand in Ecuador. While this appears to be a worthwhile activity, the evaluation team was not presented with documentation that would allow a review of this proposed effort. In addition to the implementation activities, a comprehensive study of Ecuador's biomass resources is planned during 1984-85. While this has not yet begun, an adaptation of an OLADE methodology is being prepared and will be discussed with the planning group. With the next two months, a conference will be held on native Andean fuelwood species.

In general, the evaluators believes that the biomass group has an enormous range of proposed activity which needs to be managed carefully. This is especially true since team staffing is not stable at the present time. As with the other groups, real dissemination of results achieved will depend on the team's ability to translate its technical work and reports into language suitable for non-engineering groups. This is particularly the case with the efficient cookstoves experimentation and requires a close working relationship with the "technology transfer" group.

c. Solar - The project agreement calls for a major effort in "solar hot water heating demonstration and dissemination." The

actual activities of the solar team include not only the solar hot water component, but also work in passive solar design, solar drying, and photovoltaics. The first major effort of the group--even before the AID contract was signed--was to design a demonstration solar house using Trombe wall construction in the community of El Carmen several hours travel from Quito. Community solar showers are also installed at an adjacent school. The evaluation team visited the site (see Appendix C) and while the site is not a true demonstration in the sense that the facility is not being used as originally planned and data are not being presently collected, it nevertheless did provide valuable design/construction experience for the solar team. The improved solar hot water design has been or will be installed on a pilot basis in other projects, notably the Solanda housing project near Quito. For about a year, approximately six houses adjacent to the project have been using the INE solar hot water design. A visit to the site indicated those that had been installed correctly were functioning well. The Solanda project, under the direction of the Junta Nacional de Vivienda, (JNV) plans to have as many as 5000 housing units ready for occupancy by low-income people by the end of the year. The idea is that the INE design would be used in many of these, based on the ability to pay of the individual occupant. The evaluation team also saw the same design at the FED building in Guamote and while it obviously functions from a technical vantagepoint, much concern was expressed about the cost (approximately S/. 30000.00) which would

make it difficult for low-income families to afford the system. There may be ways that this high initial cost could be financed through favorable credit arrangements, but this has not been fully investigated. The evaluation team received the impression after discussions with some of the JNV staff that the alternative would be for people to purchase low-cost electrical heating devices (S/. 1-2000.00), although lifetime and reliability is limited. INE must make a case for the economic advantages of the solar option as well as resume work on other lower- cost alternatives. Here again, having a well-designed presentation using simple pictures, diagrams, and charts would be very useful in describing the system to potential users, although, as before, the educational level of the potential audience must be carefully considered. Good data collection on the existing Solanda prototypes do not exist as yet, although this activity is to be initiated this year (it is nevertheless not specifically spelled out in the plan operativo).

The passive solar design effort is primarily a detailed study of local construction materials available in each area which will include thermal conductivities and other technical data. The goal is to recommend materials on a site-specific basis which can be used both to lower the cost of housing as well as to make them more energy efficient. This seems like a worthwhile effort; however, a detailed implementation plan for conducting this study and disseminating its results was not available. Its general

outline is known, but a clear plan to achieve the desired results is yet to be fully developed. None of the resident advisor reports mention the construction materials study, so its position in the hierarchy of priorities is not clear (although it was contracted 6-7 months ago). INE has participated in a NASA-AID project to test photovoltaic systems for refrigeration and lighting purposes in rural health clinics. The team visited one of two sites in Ecuador (near Riobamba) where such a system appears to be functioning well, albeit at a very high initial cost. The second site (Pedro Vicente Maldonado, on the coast) is about to be connected into the national electrical grid, making the equipment available for another installation (there were also technical problems with this installation including insufficient insulation; however, the responsible party--IEOS--apparently did not contact INE for some time after the problems surfaced). INE has made initial contact with entities in the Galapagos Islands that would be interested in photovoltaic installations, particularly involving telecommunications applications. A reconnaisance mission there is possible later in 1984. There is also the possibility of acquiring donations of solar panels and other equipment through the EEC which would allow for as many as 18 separate installations.

Based on conversations with INE personnel and others, the solar application with the greatest potential for Ecuador is perhaps solar drying (grains, fish, wood). An INE design for drying

coffee and built by SEDRI/Jipijapa is being tested on the coast. Based on initial good results, as many as 12 additional units may be built in that immediate area for various agricultural products. Technical assistance has also been requested by SEDRI/ Quininde which may build an additional 8. INE is proud of this set of events as an example of possible "spontaneous diffusion" of technology. While no written information on these efforts exist as yet, a report will be prepared following the completion of a testing period. INE is also working with Quito 4-H chapter ("4-F") to design and build grain dryers. The advantage in working through this type of organization is that training is also part of its function so that prototype design/construction/ testing can immediately be translated into training opportunities. Large scale wood drying designs have also been prepared and INE is waiting for the relevant convenios to be signed with PRONAF to move this project along. In addition,INE is working with CREA in Cuenca on a large-scale grain dryer and is studying solar fish drying processes useful in the Galapagos. Again, a means to let external audiences know of these efforts is important and at the time of the evaluation did not exist. Future seminars using videotape technology are a possibility.

The solar team has been sensitive to the existence of a small private sector component in solar hot water technology and is hosting a seminar in June 1984 which will, among other things, allow interchange among the local dealers of commercial technolo-

gy on ideas and technical problems that INE might help to support. A chat with one of the companies located in Quito revealed that most of the units available in Ecuador for residential hot water needs are not imported into the country; most materials are imported, assembly is done locally. INE's general strategy of supporting import substitution might make an important contribution in the solar marketplace if its current designs (as well as future models) can be commercialized.

Like the biomass team, the solar group does not have an official coordinator; however, integration of activities does not appear problemmatic. The solar team has had greater success in keeping to its schedule as outlined in the plan operativo than most of the other technical groups.

d. Geothermal - The geothermal group is the only technical team currently assisted by a French consultant. The development of geothermal energy in Ecuador is a new activity for which a large body of research and data does not exist. Investigation of high enthalpy (high temperature) resources is the responsibility of INECEL since they may be used for generation of electricity, while INE has been given the responsibility for studying low and medium temperature resources. These would be used for supplying process heat to various industrial processes.

The geothermal project has been plagued by a number of unexpected delays and, from what the evaluation team could gather, undeserved criticism for the difficulty it has experienced in implementing a pilot project near Quito in the Valle de los Chillos (only one aspect of the the project component). The Valle project hopes to provide process heat to a number of industries in the region, including a beer plant and textile mill. During 1982-83 the necessary preliminary studies in geology, geochemistry, and hydrogeology as well as marketing were completed by INE and the Escuela Politecnica Nacional. None of these activities required expenditure of AID project funds. The next important step, for which AID funds will be spent, involves exploration over a period of about six months. This involves the use and interpretation of data from ground resistivity measurements which is just about to get underway. The sequence of events being followed is outlined in a report by US consultants completed last year. The equipment to be used is being loaned by the Direccion de Geologia y Minas, which unfortunately had to undergo repair in Canada before being made available to the INE project. Payment problems complicated the situation, but these have been solved. Experts from the University of Utah were to arrive shortly after the visit of the evaluation team to supervise the operation and interpret data from the resistivity measurements. It was also pointed out that the original request to the AID mission to support this activity was made in March 1983, but was not approved until August of that year. This was a general problem

experienced by the project during the time that each major activity had to be approved by the mission in advance of expenditures. The new plan operativo permits entire programs to be approved in advance, thus speeding up the approval/disbursement procedures and eliminating these delays. The political problems between INE and the MNRE (mentioned in section V.3) during 1983 also slowed down operation of this project component in particular. The only major difference between what the US consultants recommended and what the team wishes to avoid if possible is the drilling of a test well after the resisitivity measurements have been completed. The group believes that a test well would only create undue speculation and possibly damage the project politically if the resource found is not adequate. While it was not clear to the evaluation team the extent to which such a test well is or is not required, this is obviously an issue to be further discussed.

The group also plans to work on a national survey of low-temperature geothermal resources. The proposed strategy taken makes eminent good sense to the team. That is, zones of economic demand near possible geothermal resources will be identified first, to be followed by the resource evaluation itself. Convenios necessary to conduct this work with the politechnical schools in Quito and Guayaquil are in progress. The group is also working with CEPE and ESPOL in an attempt to introduce aspects of geothermal engineering on a project basis, since the

specialty as an academic field of study does not now exist in Ecuador. The team reported a mixed working relationship with INECEL, perhaps as a result of perceived competition with INECEL's high enthalpy projects. OLADE has traditionally only supported the high enthalpy possibilities, but has recently shown interest in low enthalpy as well and invited INE to participate in a seminar in Brazil early this year. The evaluation team does not feel that the relative inexperience of INE with this technology inhibits project progress in any significant way, since good working relationships appear functional with various other organizations. Rather, bureaucratic/political difficulties in acquiring technical asistance have been more important to the lack of progress to date. These all appear to be on the road to solution.

5. CONSERVATION - Based on the experience gained by the United States and other industrialized countries, energy conservation has at the present time made a greater contribution to the total energy picture than the advent of renewables. Conservation is therefore a component of the AESP. According to the project agreement, INE would develop and test publicity and instructional materials encouraging public conservation as well as establish a service to conduct energy audits in both public and private enterprises. Success in this effort would be measured "by a decrease in per capita gasoline and electricity consumption in major urban areas." Unfortunately, this strategy does not take

into account the basic motivation for conservation in the first place, which is cost. For political reasons--obstensibly to keep the rate of inflation down--Ecuador has for many years heavily subsidized the prices of all petroleum derivatives. At the present time, for example, gasoline is approximately 25% of the international market price. This fact colors the conservation efforts. In spite of this disincentive, the conservation group has energetically embarked on a number of activities that are important to the long-term future of Ecuador and should be maintained, even though the "payoff" is not easily discernible. Appendix J is a summary of the various areas of study that are in the process of implementation. Those that have been completed are included in the list given in Appendix E. As observable, the transportation sector has received a great deal of attention followed by means of saving energy in industry, an example of the former proposing conversion of heavy transport from gasoline to diesel and of the latter introducing more efficient processes in sugar, textiles and ceramic mills. A cursory review of studies completed to date indicated high technical quality. Table 1 lists briefly the projects currently being undertaken by the conservation group as well as those already executed. Noteworthy is the desire to develop conservation studies in the politechnical schools (EPN and ESPOL) which is the only way that future generations of engineers will be exposed to conservation practices such as how to conduct energy audits. The conservation group is closely allied to the planning division of INE since

many topics are of direct impact on the planning process. As such, it has used European expertise extensively. For example, the Polish expert provided by the UN was the first major consultant to the group, was replaced in early 1982 with a German consultant, supported by the EEC, who is now working on the Plan Maestro. Other studies have been executed jointly by INE and other European technical assistance groups, such as GTZ. Using AID funds, the group conducted a five week campaign on radio and television urging motorists to save energy. Thousands of brochures were distributed in major Ecuadorian cities during automobile registration periods. Both were professionally produced and of high quality, even though the utility of the project, given the low price of gasoline, was questionable. The Minister of the MNRE directed that the campaign be conducted, however (during late 1983). A similar domestic energy savings campaign on the use of bottled gas and electricity is to be held during 1984. A campaign to promote energy savings in the industrial sector is likewise planned. AID funds will also be used to support a one man-year effort to provide technical/academic assistance to EPN and ESPOL and industry (three months in Guayaquil, nine months in Quito). In this regard, a search for the right individual has been going on for nearly two years. While someone has been tentatively identified, VITA will conduct a volunteer search to determine if any additional candidates from its expert roster can be identified.

In spite of the difficult environment for energy conservation in Ecuador, INE-supported activities are the only ones going and the evaluation team feels that AID should continue to support this component. The most difficult aspect of the conservation group's ability to meet its stated goals is staffing; there is presently only one full-time professional which is clearly insufficient. During the evaluation team's visit, requests were being made to the AID mission to support additional staff on a short- to medium-term basis. It is also possible that with the new government installed in August a movement from campaigns toward more technical assistance for industry will be possible.

A national level seminar was to be held shortly after the evaluation team's visit treating specific technical and economic aspects of energy conservation in the sugar industry. Ecuador's eight sugar mills represent about 7% of the energy consumption of the entire country, but for which as much as 30% of current consumption could be saved. Informative seminars of this kind are important to the national conservation effort.

VIII. INSTITUTIONAL CAPABILITY THROUGH TRAINING OPPORTUNITIES

Until quite recently, all use of AESP funds for training was the responsibility of the individual groups, as given in Figure 3. This meant that there was no overall training plan; decisions about who went where seem to have been more or less ad hoc. However, a new training coordinator has been named (who also heads all "transfer of technology" activities) which will provide an overall coordination and organizational perspective to future training opportunities.

To date, all training activities funded by AID have involved foreign travel, the majority for INE personnel, and almost all dealt with technical studies and meetings (see Appendix E). Few have dealt with planning or nontechnological aspects of energy development/dissemination. All of this is consistent with the earlier INE (called "Stage I" elsewhere in this report) and was not without merit. Opinion was nearly unanimous among other Ecuadorians, Europeans, and Americans affiliated with or knowledgeable about the project that, generally speaking, the technical competence of INE in development and adaptation of NCEs is high and a match for similar institutions anywhere in the world. It is clear that the various training exercises have contributed to this reputation (doubt was expressed only about a trip taken to the US by members of the microhydro team in 1983). Given all

the problems associated with the project (see Section V), it is noteworthy that technical competence is one area in which there appears to be universal agreement, especially given the age, lack of prior experience, and little formal technical study in NCEs by most of the technical team members before joining INE. It is also clear that the possibility of acquiring scholarships for short or extended periods of study overseas is an incentive for young engineers and architects to come to work for INE in the first place (salaries simply are not competitive with other institutions in the Ecuadorian energy sector).

Now, however, as INE continues to move from being an implementation body itself to providing coordination for other organizations, it should consider training opportunities for personnel from its sister organizations as needs dictate. Future training possibilities should probably be investigated and recommended on the basis of specific planning and NCE development issues, rather than broad-stroke staff development programs. This is a natural progression as needs become more technical and specific.

This component should be part of a comprehensive two-year training plan which is under development now. Consideration should also be given to internal mechanisms, such as staff seminars, where information exchange between the two divisions could occur. It is appropriate for the DDE to have a more in-depth understanding of planning functions so that both divisions can learn from each other.

IX. COORDINATION/PROMOTION OF PROJECT ACTIVITIES WITH COOPERATING INSTITUTIONS--EXTERNAL/INTERNAL LINKAGES

The evaluators were impressed with the extent to which INE is trying to work with other institutions, especially the universities and technical schools and private voluntary organizations. Since INE cannot itself implement projects, this approach must be followed in any case in order for it to fulfill its mandate. However, given the legalistic environment within which INE must carry out its functions, formal agreements or convenios are usually signed before any real interaction takes place. These are generally broad agreements of understanding under which specific activities are further spelled out in subsequent contracts. The process leading to a convenio is lengthy and may take 4-6 months or in some cases even longer. During the evaluation visit, there were a large number of convenios that were in process, although it was not possible to get a complete list of those that were already completed or near completion (this should be an additional task for a future computerized project management system). While it is understood that the process of arriving at an understanding with another Ecuadorian organization is frequently delicate and not easily definable, the evaluators believe that tighter control over the convenio process itself--that is, keeping track of whether copies of it have actually been received by interested parties, immediate follow-up, etc., would be useful in

speeding up the process. Initially at least, this is probably best accomplished by the technical groups themselves.

Relationships with governmental institutions, such as INECEL or MNRE, are of a complex nature and INE must necessarily be deliberate in the way it deals with these organizations. While the evaluation team hesitates to make any concrete recommendations based on such a brief exposure, it believes that INE could provide a more systemmatic and professional approach to making its presence known to other elements of the Ecuadorian government, perhaps through the use of audio-visual materials. INE has developed a good relationship with a major Quito newspaper and excerpts of INE-sponsored studies and activities have appeared in prominently-placed articles since early 1984 (and on almost a daily basis during the evaluation visit). INE has also maintained contact with international PVOs, such as VITA, and is aware of recent technological developments. An example is the tentative testing standards for efficient woodstoves developed by an international conference hosted by VITA late in 1983. The relationship with the AID mission has been inconsistent, probably due largely to the lack of an operational plan, and it is not clear that the present liaison function of the resident advisor adequately fulfills the role. It was, however, uniformly reported by all INE personnel that the interest demonstrated by the new AESP project officer within the mission has notably improved the INE-AID relationship.

It was noted that at least with the microhydro and solar groups, contact with the private sector is beginning to be made. The evaluation team believes that this is an important aspect of future promotional activities since it is ultimately through the commercial/light manufacturing sector that nationally-developed technologies will be made available for widespread dissemination.

As far as the evaluators could determine, the only real drawback to working with other organizations is that INE must depend on other groups to give it an accurate picture of what is going on at any given time. INE should strengthen its means to insure that problems that occur are followed up in time and that regular procedures for learning from project experience are in place. The most difficult, and yet most important, aspect of documenting project progress is to capture the real project experience as lived by those in the field. The evaluation team strongly believes that the real value of the AESP will lie in how well project experience is communicated, since INE from a technical point of view has or is demonstrating itself capable of creating and adapting useful technology. This responsibility primarily falls to the technology transfer and information center component which, as previously stated, is the weakest link in the overall structure at the present time.

X. IDENTIFICATION OF FACTORS INHIBITING PROJECT IMPLEMENTATION

Scattered throughout this report are reasons given for the delays in implementation experienced by the project to date. These are summarized below:

During 1981-83, INE construed its role in such ways that it tended to preclude significant project expenditures:

1. All groups were autonomous units with no effective overall coordination or operational plan since NCE development was being emphasized.

2. The relative inexperience of the organization in terms of NCE planning and development gave rise to a "go-slow" approach until sufficient fiscal capacity and technical expertise was acquired to efficiently and responsibly expend project funds.

3. Time was required for INE to fully appreciate the nature of non-technological factors of development, especially information dissemination and "technology transfer," which is always a long learning process.

In addition, a number of additional factors over which INE had little or no control intervened during the early life of the project. These included:

1. A national economic crisis requiring INE's non-AID budget to be frozen, just when its work load was increasing. This has particularly affected INE's ability to hire support personnel (only three or four secretaries across the entire organization). Also, the falling prices for Ecuador's most important export--petroleum--means that the debt acquired during the 1970's is becoming a serious burden (while exact figures were not acquired, the evaluation team was told on several occasions that the Ecuadorian external debt was the highest in Latin America on a per capita basis). A sense of prudence in indebting Ecuador even more is pervasive throughout INE personnel, especially since it is believed by some personnel that drawing down on the loan portion of the project would result in a concomitant decrease in the national budget assigned to INE.

2. Disputes of a political nature between the Minister of MNRE and the previous INE director not directly involving INE programs that resulted in a virtual hiatus of activity for a six-month period during 1983. The current director took charge during the last quarter and this crucial relationship has notably improved.

3. Delays within the AID bureaucracy which resulted in long waiting times for approving and executing important project expenditures (it took nearly a year to acquire the two vehicles assigned to the project). The INE-project-officer-in-charge at the mission has changed at least three times during the project.

Until the most recent project officer, the AESP has been only one of a large number of activities assigned to that officer's project portfolio, which, according to several INE officials, hampered effectiveness in the past.

Within INE's purview, additional factors are relevant:

1. Justifiably to some extent, de-emphasizing information and technology transfer components until recently.

2. Lack of an administrative structure and project management capability that would provide oversight to project execution/ timely problem solution.

It should be emphasized again that solutions to these latter problems are at least partially being implemented at the present time. The reader is urged to turn to Section XI ("Assessment Summary") for a more complete look at why certain of the sub-projects have encountered implementation delays. Generally, reasons have not been of a technical nature; rather, INE is part of and must deal with the general Ecuadorian milieu of following prescribed legal conventions (convenios) and is subject to the same difficulties of organizing work as any other governmental institution in the country.

XI. ASSESSMENT SUMMARY

1. Introduction

Late in 1983 INE submitted a two-year plan of activities, the plan operativo, which will spend $659,646 of the grant portion and $1,057,000 of the loan portion of the AESP project monies. When added to those respective amounts already spent, 100% of the total grant and 66% of the total loan will have been used by the project completion date. The evaluation team arrived in Quito some months after the plan operativo had been approved by the mission. Thus, an in-depth analysis of the plan operativo itself was not a function of the team's visit. It might have been worthwhile for the mission to have conducted an evaluation before the plan was actually approved; however, this did not occur. In this regard the team would make the observation that the narrative section of each component of the plan (energy demonstrations, energy technology transfer and information network, energy conservation, planning) does not in every case correspond to explicit activities outlined in the time-lines from the activity plan. That is, it is sometimes difficult to interpret discrete implementation activities based on the narrative alone. While this is partially compensated for by the resident advisor's quarterly reports, the difficulty encountered in "pinning down" the actual state of affairs is worth addressing. While the evaluators do not feel this to be an area for major concern, greater ease in identifying points of progress/problems to be

solved would be of benefit both to INE and to AID, as well as to the governmental institutions to which INE looks for both support and cooperation. In addition, copies of the plan operativo that were made available by the mission to the evaluators turned out to be only the draft versions; the final versions, with significant changes in time-lines for completion in some cases, were acquired from INE itself.

Taking into account the fact that most project components are already 2-4 months behind in their implementation plans and the fact that a new government will take over in August 1984 (implying a new director of INE), it is highly uncertain whether INE can maintain its current implementation schedule. In addition, the studies called for by the AESP-funded part of the DPRE Master Plan are behind schedule by 4-6 months due to the intense effort currently underway to complete the Master Plan before the current government leaves office. Additional time has been lost due to INE's recent move to new offices which was still being accommodated during the evaluation visit. The mission project officer has already requested a new project completion date of 31 December 1986 (one additional year) with which the evaluation team concurs. The team further recommends that all implementation schedules be re-evaluated on a quarterly basis throughout 1984 and 1985 so that a further extension of the project can be requested if necessary. A regular review procedure would also

assist in identifying any major problem areas well before any required reprogramming becomes impossible.

Recommendations that follow are not technical in nature. Even though this was not an important part of the scope of work, the evaluation team is convinced that technical work is in general excellent and technical aspects at this point in the project do not require a great deal of attention from an evaluation standpoint.

2. Specific Recommendations--Summary

a. IPE-WIDE

1) The evaluators believe the project should be continued and supported by AID. While it is true that use of project monies has not been substantial in the past, it appears now that conditions are such that major activities can and will be mounted using AID funds. The project should be extended through the end of 1986, with a further extension based on quarterly programmatic reviews through 1984 and 1985.

2) The interpretation of which activities should be actually undertaken should continue to be made loosely and on a case-by-case basis, without a great deal of concern whether the specific tasks as called for by the Project Agreement are being followed to the letter. The mission has already indicated great flexibility on this point.

3) Since elections were held during the evaluation visit and the new government does not actually take office until August, it is not yet clear what specific planning functions will be assigned by the new leadership. If INE is indeed supported as a planning body, a Director to the DPRE should be named immediately. Consideration could also be given to dividing the DPRE into three, not two, functional parts, either adding to the Division de Planificacion and the Division de Recursos Energeticos a separate "Division of Planning Design," or alternatively, putting "Planning Design" into the Division de Planificacion. The purpose of this new function would be to study and recommend to the DPRE ways to custom-fit INE planning into the Ecuadorian milieu.

4) Create closer connections between the DPRE and the DDE through establishment of occasional interdepartmental meetings and internal seminars both for the DPRE in development and for the DDE in planning with such costs as might be incurred covered by the AE[illegible]. A weekend retreat environment might be an ideal way to develop deeper professional appreciation of each other's perspectives such that any tendency toward organizational schizophrenia is diminished.

5) While INE has developed good working relationships with many of its sister institutions, both in and out of the government, it still appears to be struggling for recognition and legitimacy. It should consider developing a sophisticated public

relations approach in its dealings with national and international organizations which could include audio-visual materials as well as microcomputer-based presentations (graphs, charts, pictorials). Wherever possible, the logistical constraints to preparing convenios and contracts should be eliminated or diminished. For example, the efficiency of the few secretaries INE has could be improved greatly if word processing were employed. When major papers (including convenios) are prepared at the present time, they appear as if in final form and revisions--however small--require re-typing the entire document. It was estimated by one employee that at least a week per document is lost due to this circumstance alone.

6) Salary levels compared with other national and parastatal organizations in the Ecuadorian energy sector are very low (only one-third to one-half that of CEPE or INECEL). Hopefully the new government will be able to recognize the potential contribution of INE to the present and future energy picture in Ecuador and make appropriate adjustments. If this is not feasible or possible, INE could consider making stronger efforts to acquire international consultancies on the behalf of its technical employees. For this to be successful, it is essential to capture project experience in a palatable way which again points out the need for a professional-level effort to translate technical information into publicly-accessible forms.

7) The INE-AID relationship should be strengthened. Because of the dynamics involved, the key person in providing relevant information between the two is the resident advisor. The mission should also keep the advisor appraised of reactions/remarks bearing on the project that are generated at the mission and Washington levels so that responses are based on fact and events as they occur rather than conjecture and misinformation. INE could consider scheduling the inauguration of an important project while simultaneously honoring its benefactors, including AID, on a future "Dia del INE" (in May).

8) A two-year training program should be created which will address the concerns given in 4) above as well as provide INE and non-INE personnel with training opportunities. Such a plan would naturally include the schedule of seminars that INE has already used to good advantage, but which has not previously been centrally planned and coordinated.

9) It was reported that a possible deterrent to using the loan portion of project monies was that the Ministerio de Finanzas might charge off the amount used against INE's budget. The opposite opinion was also voiced that the ministry would actually add the amount used plus interest to INE's budget effectively meaning that general revenues of the GOE would be used to repay the obligation. While the latter approach seems most plausible, the fact is that the Project Agreement does not specifically

identify INE's responsibility in the matter. Also, according to the Agreement, interest begins accruing on the loan portion six months after the first disbursement and repayment to begin on a date to be specified by AID. As far as the evaluation team could determine, this date has not been set as yet. If interest is due and payable whether the loan is used in its entirety or not, clarification would be worthwhile since standard rules for foreign loans surely apply.

b. Project Components

--Technology Transfer and Information Network--

1) While this has been a weak part of the project to date, the appointment of a full-time director with an assistant (hired during the evaluation visit) is an important step. Within the context of the AESP, "technology transfer" has meant basically holding meetings and seminars within formal settings. INE has already held several of these, apparently with good results. The concept needs now to be broadened, since the AESP is acquiring project experience/technical results that can be of value to a number of audiences. These audiences include: other technical professionals, national/international officials with a focus on planning/policy, Ecuadorian intermediary development/implementation groups semi-skilled from a technical standpoint, lay workers at the village level. It is important to package information delivery differently for each group in order for it to used effectively. Since what is really being talked about here is

"information transfer" which can ultimately lead to transfer of technology, this new division should begin by identifying the near-term audiences for each of the sub-projects; they may be different for each. After these have been clearly identified, then it should seek whatever expertise is required to produce materials appropriate to that audience. For example, the micro-hydro group produces excellent technical papers on its work, but alone they are not sufficient to convey the progress made in developing national import-substitutable technology to those who could be in a position to stimulate a demand for it. It might be necessary to contract special instructional consultants for such purposes, and INE is encouraged to pursue this as required. Quite naturally, this effort could include public relations elements as well.

The information center is a related concern. A computerized system that would automatically record and update acquisitions and loans of materials as well as generate cross-referenced searches and bibliographies on hard copy will become enormously useful as the library approaches 8000 volumes (its goal during the life of the AESP) as well as becoming the chief Ecuadorian depository for energy information. INE presently owns a Data General computer (Eclipse) which is currently programmable only in FORTRAN with a 10 megabyte hard disk. This configuration is not suitable for an management information system. The team recommends that a late-model microcomputer with larger disk storage capacity and a good relational database manager be employed

to produce the kind of flexible system that could continously adapt itself to INE's requirements. When not being used for information manmagement, the microcomputer could be employed for technical programming by the technical teams as well as a myriad of other applications. VITA has developed such a system, based on the Apple II series microcomputer (which is widely available and supported in Quito) and would be interested in making its experience available to INE. The information center is also interested in adapting other technologies, such as microfiche and on-line database searching, although a realistic analysis on how these and other technologies would assist the overall information dissemination effort has not yet been completed.

As noted in Section VII.2, the difficulty that the evaluators had in getting up-to-date information on subprojects funded under the AESP suggests that a computerized project management system (possibly using the same hardware/software as given above) would perform an immense service to INE in keeping relevant information in an organized and quickly retrievable fashion. As part of such a system, "flags" could be inserted into the programming so that, for example, upon entering "today's date," the computer would immediately tell the operator what actions on which projects need to be completed by that date. This could be of assistance in keeping track of convenio progress, for example, as well as other actions that might otherwise be forgotten or

delayed as well as giving instant snapshots of where all efforts are.

It was originally envisioned that technical assistance for the above functions would be performed by the resident advisor; however, implementation of these would have been difficult or inappropriate earlier in the project. The situation, for all the reasons given in section V, is different now. The resident advisor position should therefore be extended through to the new proposed project completion date of December 1986 with specific emphasis on the information center/information transfer component.

--Energy Studies and Research--

This item is not a specific sub-project under the plan operativo and is therefore not discussed in terms of recommendations, except to note that plans do exist from the DDE side to develop a comprehensive factorial analysis of rural energy demand and distribution that will assist in understanding rural energy demand, supply, and use related to other factors. During the evaluation visit, arrangements were being made with the computer center of the National Politechnical School to carry out the computer analysis. Unfortunately, no documentation was available to enable the evaluators to gain a more in-depth appreciation of what was being proposed and how it fits into the broader planning picture. It was not clear whether this study would be financed

with AID funds. It is suggested that technical description of the proposed activity be made available at an early opportunity.

--Alternative Energy Demonstrations/Conservation--

1) While delays have plagued efforts by the microhydro team to date, potentially significant work (described in section VII.3.a) is underway with results likely in the near to medium-term future. While maintaining technological progress by collaborating even more closely with private firms and other organizations, the team needs to make the results of its work to date and its turbine and electronic controller development plans more accessible to those who will ultimately use the technology, particularly INECEL.

2) As outlined in Section VII.3.b, staffing of the biomass team is not presently stable and may influence its ability to work effectively in the wide area of activities it has undertaken. When the staffing situation does stabilize, activities should be consolidated so that only those that have the greatest possibility for widespread impact are emphasized. At the present time, these would include the efficient cookstoves experimentation, fuelwood plantations, evaluation of past biogas projects and slurry utilization, and use of agricultural wastes. Since technologies being investigated/developed by the biomass group and its constituents are those most likely to be used by the rural poor, it will especially require a close working relation-

ship with the technology transfer group to ensure that information and project experience are disseminated effectively.

3) The solar team is making good progress in its efforts to develop and implement projects in solar hot water heating, passive solar construction techniques, solar drying, and photovoltaics as described in Section VIII3.c. It has indicated sensitivity to the existence of a private market in solar technologies, particularly hot water heating, and will improve its efforts to ensure that all of the technologies with which it is involved are ultimately economically viable and acceptable to the marketplace. It is expected that technologies which cannot be demonstrated to be viable on a commercial basis will be dropped from the program after initial experimentation is completed. Since many of the technologies that the solar team is involved with have been or will soon be implemented on an experimental/demonstration basis, it will be important to maintain an active program of follow-up so that problems encountered/project experience is available. No such plan now exists.

4) The acquisition of technical assistance is critical to achieving desired results from the geothermal team efforts. Such acquisition has been hampered in the past by bureaucratic difficulties described in Section VII.3.d, but is now very close to resolution. The present work plan seems adequate, given the constraints. The geothermal team and AID should perhaps endeavor

to more frequently communicate the nature of progress/difficulties with each other, ideally through the resident advisor.

5) Given the difficult environment in which conservation efforts are carried out (low incentive to save because of subsidized prices), they are nevertheless useful and important to Ecuador's long-term energy future. It appears that the greatest constraint to implementation of the plan operativo is the lack of adequate staff. During the evaluation visit, consideration was being given to hiring two professionals on a temporary basis. Commendably, AID has shown great flexibility in assisting with such efforts and is encouraged to do in the future.

3. General Recommendations

The evaluation team believes that the project should be continued and extended. While there has been an understandable tendency throughout the lifetime of the project (indeed, beginning with the project design phase itself) to promote technologies in search of problems to be solved instead of the other way around, this approach is really no different than other renewable energy projects studied by the evaluators. The evaluators believe, pending any "surprises" by the new government, that the AESP is indeed at a "take-off" point and that past implementation problems are not an indication of its present accomplishments and future potential. The evaluators further believe that elements of the revised implementation plan proposed by the mission in

accord with the plan operativo, especially the reprogrammed increase in the "Energy Planning and Assessments" component (historically described as "Energy Studies and Research") by about US $150,000, are reasonable and appropriate (see Appendix K).

In the view of the evaluators, INE's ability to generate and disseminate useful project and planning information to a variety of audiences is absolutely critical to the success of the project. While the AESP might still be termed "high-risk, high-gain" in terms of AID's criteria for success, the evaluators believe that the project should be given the full support of both AID and the GOE for its remaining life.

TABLE 1

PROJECTS UNDERTAKEN BY CONSERVATION GROUP

CONSERVACION ENERGETICA EN EL INE: marco general de acciones

Sector \ Acciones	Estudios Globales	Establecim. Medidas	Estudios Prefactibil.	Promocion	Fomento	Asistencia Técnica
Oferta	EE	EE	OI	NI	NI	OI
Consumo final						
Transporte	EP	EP	EP	EP	PL	PL
Industria	EP-EE*	EP	EP	EE	PL	PL
Residencial	EE*	EP	PL	EE	PL	NI
Comercial	EE*	PL	OI	PL	OI	NI
Publico	EE*	PL	OI	PL	OI	NI
Agropecuario y pesca	EE*	PL	NI	NI	OI	NI

EP: ejecutada parcialmente

EE: en ejecucion

PL: planeada

OI: a cargo de otras instituciones

NI: acciones aun no identificadas

*: dentro de elaboracion Plan Maestro

APPENDIX A

DOCUMENTS CONSULTED

Instituto Nacional de Engía, Balances Energéticos, 1969-1978 (Quito: Instituto Panamericano de Geografía e Historia, 1980)

_____. "Envío de Programas 1984-1985 del Covenio INE-AID) December 1983.

_____. "Inventario de Recursos Energéticos No Renovables: Potencial Técnico y Económico," November 1982.

_____. "Plan Mactro de Energía, "October 1982.

_____. "Plan Nacional de Conservación Energética, February 1984.

_____. "Plan Nacional de Energía de la Biomasa," undated.

_____. "Plan Nacional de Energía Solar," undated.

_____. "Planes Nacionales de Energías No Convencionales," undated.

_____. "Plan Operativo de Grupo de Planificación, 1984-1985," November 1983.

_____. "Reglamento Orgánico-Funcional del Instituto Nacional de Energía," 1984.

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_____. Untitled, undated report on geothermal resources.

Eduardo Morán and Pierre Vernet." Industrial Energy Consumption in a Developing Country: The Ecuadorian Case," Resources for the Future Discussion Paper D-73D, March 1982.

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Unión de la Comunidad del Este de los Angeles (TELACO), "Directorio de Organizaciones Privadas de Desarrollo en el Ecuador," report to AID/Ecuador, July 1982.

United States Agency for International Development,"Ecuador Project Paper: Alternative Energy Sources," June 1981.

_____. "Implementation Letters, Alternative Energy Sources Project, No. 518-0029, Loan 518-W-039, "No. 1, 4 December 1981; No. 2, 5 January 1982; No. 3, 2 April 1982; No. 4, 8 July 1982; No.5, 30 March 1983; No. 6, 16 August 1983; No. 7, 1 September 1983; No.8, 20 January 1984.

_____. "Project Loan and Grant Agreement between the State of Ecuador and the United States of America: Alternative Energy Sources," 29 September 1981.

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_____. "Status Report on USAID Grants, Loans and HGs as of December 31, 1984 sic ," 13 February 1984.

Volunteers in Technical Assistance, "Evaluation of ROCAP Project No. 596-0089, Fielwood and Alternative Energy Sources," report to USAID Regional Office for Central America and Panama, 2[illegible] July 1982.

APPENDIX B

FORMAL MEETINGS - INE PERSONNEL WITH OTHERS

25 April - Mr. Carl Duisberg, Regional Energy Officer, AID/Ecuador
Mr. Leopoldo Garza, General Development Officer, AID/Ecuador

26 April - Mr. Carl Duisberg, Regional Energy Officer, AID/Ecuador
Mr. Orlando Llinza, Mission Director, AID/Ecuador
Mr. Leopoldo Garza, General Development Officer, AID/Ecuador
Ing. Fernando González, Chief, Division of Technical Diffusion, INE
Ing. Franklin Carrasco, Chief, Division of NCE, INE
Ing. Eduardo Morán, Director, DDE, INE
Dr. Hugh Pearson, AESP Coordinator, INE consultant (AID)

27 April - Ing. Raul Maldanado, Executive Director, INE
Dr. Hugh Pearson, AESP Coordinator, INE consultant (AID)
Ing. Fernando González, Chief, Division of Technological Diffusion, INE
Ing. Eduardo Morán, Director, DDE, INE

28 April - Ing. Eduardo Yánez, Biogas Group, INE
Ing. Marco Jácome, Member of the Consejo Técnico CONADE

2 May - Ing. Winston Gómez, Coordinator for the Master Plan, DPRE, INE
Ing. Martin Ehrlich, Consultant to DPRE, INE, (EEC)

3 May - Ing. Eduardo Morán, Director, DDE, INE
Ing. Winston Gómez, Coordinator for the Master Plan, DPRE, INE
Ing. Eduardo Morán, Director, DDE, INE

4 May - Ing. Eduardo Morán, Director, DDE, INE
Econ. Ramón Flores, Chief, Economic Studies, OLADE

7 May - Ing. German Ormaza, Rural Electrification Program
Ing. Povida, Rural Electrification Program, INECEL
Ing. Hernán Murqueytio, Chief Project Unity for the Master Plan, INECEL

8 May - Dr. Jorge Ringul, Technical Administration Subsecretary, MNRE
Dr. Alfonso Jurado, CHief, Dept. of Economic Studies & Project, MNRE.
Sr. Moacyr Aranjo, Head of Energy Information, OLADE
Sr. Enrique Rodriguez, Energy Information Consultant-SIELA, OLADE
Ing. Abel Tobar, Executive Director, Dept. of Forestry, MDA
Ing. Surgio Guevara, Executive Director, FED

10 May - Ing. Gonzalo García, Chief, Division of Administration, INE
Ing. Raul Maldonado, Executive Director, INE

Additional Frequent Interactions with INE Technical Teams:

Ing. Michel Lopoukhine, Geothermal Group
Ing. Victor Castellancs, Solar Group
Ing. Noemi Flores, Solar Group
Ing. Letron Gilles, Solar Group
Ing. Fernando Barriga, Small Hydro Group
Ing. Julio Hidalgo, Small Hydro Group
Ing. Alfonso Mejia, Small Hydro Group
Ing. Jan Tauber, Small Hydro Group
Ing. Miguel Acuña, Biomass Group
Ing. Amilcar Salazar, Biomass Group
Ing. Eduardo Yanez, Biomass Group
Ing. Juan Zak, Conservation

APPENDIX C

FIELD SITES VISITED

A. Solar House and Solar Showers Project - El Carmen

B. Commercial Solar Wood - Drying Project - Quito

C. Solar Beeswax Purification Project - Quito

D. Minihydro Turbine Testing Facility - Guangopolo

E. Solar Water Heater/Housing Project - Solanda

F. Solar Refrigeration/Health Clinic - Cobos

G. Biogas Plant/ESPOCH Experimental Farm - Riobamba

H. Fuelwood Plantation Project - Guamote

Statement of Work

A. Purpose - To conduct an in depth mid-term evaluation of Project 518-0029, Alternative Energy Sources.

B. Focus - The proposed evaluation will concentrate on a detailed review of the administrative, organizational, technical, planning and operational aspects of the project to determine whether original project objectives can be achieved on schedule. This review will examine the effectiveness of the exchange of data and cooperation between INE and other national and regional institutions, and the effects on Ecuador's energy situation. The evaluation will assess INE's capacity as an energy planning/energy development institution and indicate how obstacles to project implementation might be reduced and/or useful consequences of the project augmented.

C. Scope of Work

The project, as originally designed, has 4 major components:

Energy Studies and Research, Energy Technology Transfer and Information Network, Alternative Energy Demonstrations, and Energy Conservation. Where applicable, the evaluation team will review each of these components with regard to the following principle concerns for the evaluation:

1. Assess the organization and operation of INE's technical teams within INE's overall management structure in terms of their effectiveness in carrying out planned development and demonstration of various renewable energy technologies, conservation and energy planning activities.

2. Review the appropriateness of past and current operating plans in terms of relationship to overall energy planning and priorities set by INE, staffing, comparative advantage of INE, and implementation record.

3. Examine whether planning, selection and assignment of responsibilities have been adequately coordinated with potential cooperating institutions. Has INE's promotion of subproject activities with various executing entities been sufficient?

(V)

4. Look at linkages both within INE and between INE and other institutions to determine the extent to which INE's energy planning work has been usefully applied to energy-related progress in the country.

5. Assess the success of INE's efforts to involve other national institutions, and the private sector in their work, including local PVO's and Peace Corps. Have the experiences of other appropriate technology groups in Ecuador been successfully incorporated into INE's planning and activities?

6. Review INE's experience in building institutional capability through training (both technical and administrative) for its own staff and those of other institutions. This implies both the use of INE conducted training and seminars plus international opportunities.

7. Discuss the validity of project activities to date in relationship to achieving original project purpose. Specifically, with regard to the major project components the evaluation team will:

7.a. (Energy Studies and Research). Review the effectiveness of studies and assessments to date, perhaps making suggestions for future data collection and analysis.

7.b. (Technology Transfer and Information Network). Evaluate progress in the INE's data generation and reporting system. Review the utility and progress of the information system, possibly making recommendations for increased transfer and improved access and dissemination.

7.c. (Alternative Energy Demonstrations). Conduct technical reviews of specific demonstrations noting the adequacy of methodology for site identification, impact on users, data collection for future analysis.

7.d. (Energy Conservation). Review INE's plan for a conservation program including efforts to date in the initial public awareness campaign.

8. Identify the major factors that have inhibited project implementation, both globally and in the four components. Recommend possible reorientation of operational procedures and reprogramming of project funds to facilitate implementation and the achievement of project objectives.

D. Team Composition

The team should be composed of two members. A team leader, with Spanish S-3 / R-3, will be responsible for completion of a final report and an initial debriefing in country.
Team skills should include:

- Technical experience with renewable energy technologies (project includes: hydro, biomass, solar and geothermal).

- Administrative/operational understanding of national/ regional energy institutions.

- Economic and social evaluation of renewable energy technologies and the interaction of the natural resource base and human settlements.

Team members with broad background and generalized experience in non-conventional energy, fuel efficiency, information systems and energy planning will be most useful.

USAID/Quito and INE will concur on team composition before services are initiated. If available, ST/EY or LAC/DR participation would be advantageous.

E. Timing

The estimated schedule for the evaluation would be starting mid April for about three weeks in country. At the end of stay in country including visits to field sites, and other agencies concerned with energy, the team will debrief INE and USAID leaving a draft outline/report of the evaluation.

F. Ten copies of a final report, prepared in English, will be submitted to USAID within six weeks after completion of the evaluation. Secretarial assistance will be provided by USAID while in country.

INSTITUTO
NACIONAL
DE ENERGIA

APPENDIX E

PUBLICACIONES EDITADAS POR EL INSTITUTO NACIONAL DE ENERGIA I.N.E.

1. ESTUDIO INE Nº 1 : Producción Preliminar sobre la Producción de Alcohol de Caña de Azúcar para el Empleo como Energético./ Mayo de 1980.
Por: Bruno Lapillone y Eduardo Morán

2. ESTUDIO INE Nº 2 : Estudio de un Modelo de la Demanda de Combustibles./ Enero de 1980.
Por: Jaime Andrade y Arturo Villavicencio

3. ESTUDIO INE Nº 3 : Balance Energético / Mayo de 1980
I Parte : Análisis del Consumo Final
Por: Pierre Vernet y Arturo Villavicencio

4. ESTUDIO INE Nº 4 : Balance Energético / Junio de 1980.
II Parte : Análisis del Subsector Eléctrico
Por: Wilson Pástor y Pierre Vernet

5. ESTUDIO INE Nº 5 : Balance Energético Septiembre de 1980
III Parte: Estadísticas Básicas sobre el Sector Hidrocarburífero (Fases Aprovisionamiento y Transformación) 1969 - 1978
Por: Hernán López, Rodrigo Tirado y Byron Aguirre

6. ESTUDIO INE Nº 6 : Estudio sobre el Consumo Energético de la Leña en el Area Rural del Ecuador./Enero 1981.
Por: Jaime Andrade y Eduardo Morán

7. ESTUDIO INE Nº 7 : Balances Energéticos / Agosto de 1980
IV Parte: Balances Consolidados 69-78
Por: Equipo de Trabajo INE

8. ESTUDIO INE Nº 8 : Estudio en Proceso de Elaboración

9. ESTUDIO INE Nº 9 : Posibilidades de Aplicación de la Geotermia de Baja Entalpia en la Zona de Cuenca /Septbre. 1
Por: Michel Lopoukhine y Henri Ojeda

10. NOTAS TECNICAS DEL INE Nº 1 : Energía Solar, Conservación de la Energía una Ilustración. /Noviembre 19
Por: Franklin Carrasco y Pierre Vernet

11. NOTAS TECNICAS DEL INE Nº 2 : Estudio para Duchas Públicas Municipales con Energía Solar. / 1981. (Factibilidad)

12. NOTAS TECNICAS DEL INE Nº 3 : Estudio del Potencial Solar y Eólico del Ecuador. / 1981.
Por: Franklin Carrasco, Jean P. Durand y F. Gonzalez

13. ESTUDIO: INE-INECEL-CEPE Nº4: Oferta y Demanda a Corto Plazo
Por: Grupo de Trabajo Interinstitucional. Enero de 1981

14. Lineamientos de la Política y Estrategias Energéticas
Por: Consejo Superior de Energía. /Abril, 27 de 1981.

15. Conservación de Energía en Plantas Industriales. , Ibarra, Mayo-1981
Por: Jan Jastewicz

16. Report on Energy Conservation in Ecuadorian Industry. /1981.
Por: Jan Jastewicz

17. Industrial Energy Consumption in a Developing Country The Ecuadorian Case. / Junio 1981.
Por: Eduardo Marín y Pierre Vernet

18. Balances Energéticos 1969 - 1978
Por: Instituto Nacional de Energía, bajo el auspicio de la Sección Ecuatoriana del Instituto Panamericano de Geografía e Historia. / 1982.

19. Pruebas de Colectores Solares Prototipo I - SOL - 200 - 82
Por: Franklin Carrasco, Jean P. Durand, Fernando González /82-05.

20. Estudio Previo de Medidas Tendientes a disminuir el Consumo de Carburantes en el País. /Julio 1982.

21. La Estufa Eficiente MCP-INE. /Enero de 1981.
Por: Eduardo Morán

22. Bio-Abono-Gas Estudio Técnico Socio-Económico. /Agosto de 1982.

23. Geología Areas Referencial y Prioritarias. Proyecto Sectór mico Cuenca. / Febrero de 1982.
Por: Patricio Romero, en colaboración Bolívar Peza y Alejandro Urresta

24. Contribuciones de la Cooperación Técnica Financiera a la Política Energética, en el Contexto del Desarrollo Económico de los Países de América Latina: Un punto de vista Ecuatoriano. /Abril de 1982.
Por: Carlos E. Quevedo

25. Estudio Hidrológico para el Proyecto Maldonado. /Julio 1981.
Por: Fernando Barriga

26. Aprovechamiento del Gas Natural en el Ecuador 1969 - 1978
Por: Rodrigo Tirado

27. Aprovechamiento del Gas Natural Campos: Shushufindi-Aguarico
Por: Rodrigo Tirado. / Abril de 1982.

28. Plan Maestro de Energía Análisis del Consumo de Energía en el Sector Transporte en el Ecuador. / Septiembre de 1982.
Por: Peter Kublank

29. Natural Gas Utilization for the National Energy Institute of Ecuador Project ECU 79 003 with the United Nations Department of Technical Cooperation for Development. / An Examination of the Possibilities of a Rational Utilization of Natural Gas in Ecuador. /Octubre de 1980.
Por: Helen Bentz

30. Estimación de la Oferta Energética en el Ecuador al Año 2000 (Según Reducción del Modelo de Leontief) Diciembre 1981
Por: Iván Pazmiño

31. El Petróleo en el Ecuador. /Diciembre de 1981.
Por: Santiago Ordóñez C.

32. Termes de Referencias Generales Sur les Programmes Nationaux d' Alcool dans les Pays en Voie de Developpement
Por: Eduardo Morán (Grenoble - Septiembre 1982)

33. Propuesta para el Uso de Técnicas Isotópicas en el Proyecto Geotérmico "Valle de los Chillos". / 83 - 01 - 20.
Por: Patricio Romero y Michel Lopoukhine

34. La Previsión a Largo Plazo de la Demanda de Energía: La Metodología MEDEE
Por: Bruno Lapillone

35. Recursos No Renovables y Modelos de Crecimiento Económico, 1982
Por: Arturo Villavicencio

36. Primer Estudio sobre la Demanda Final de Energía a Largo Plazo
Por: Iván Pazmiño y Pierre Vernet. / Febrero - Abril 1981.

37. Revisión de Literatura del Bio-Abono. /Marzo 1983.
Por: Amílcar Salazar

38. Report on Energy Rationalization in Ecuadorian Transport Sector (Urban Passenger Transport in Quito) June, 1981
Por: Jan Jasiewicz

39. Requerimientos de Calentamiento de Agua para Piscinas
SOL - 001 - 82 82 -12
Por: Franklin Carrasco, Fernando González y J.P. Durand

40. Colectores Solares Planos Prototipo INE
01 - 83 - 202

41. Nociones Básicas sobre Generadores Fotovoltáicos
I - SOL - 002 - 83 83 - 02
Por: Franklin Carrasco, Fernando González y Gilles Le Tron

42. Estudio de un Secador Experimental de Granos Usando Energía Solar
I - SOL - 204 - 83 83 - 03
Por: Franklin Carrasco, Fernando Gonzáles y J.P. Durand

43. Guía para la Instalación de Sistemas de Calentamiento de Agua con Energía Solar
SOL - 205 - 83 83 - 04
Por: Franklin Carrasco, Fernando González y Gilles Le Tron

44. Aprovechamiento de la Energía Solar en las Técnicas de Secamiento de Productos Agrícolas
SOL - 206 - 83 83 - 04
Por: Franklin Carrasco, Fernando González

45. Generalidades sobre posibles aplicaciones de Técnicas Pasivas de Ecodiseño para Viviendas de Interés Social en el Ecuador
I - SOL - 208 - 83 83 - 05
Por: Noemy Flores y Fernando González

46. Fuel wood as an Energy Alternative in Ecuador (Informe Final del Seminario "La Madera como Energético", Parna, Mayo 1983)
Por: Oswaldo Mantilla-INE; Mauricio Terán-Aglomerados Cotopaxi

47. Costos Marginales en la Producción de la Madera como Energético
Por: Oswaldo Mantilla 1983

48. Microcentrales Hidroeléctricas de 50 KW "Apuela". 83-08
Por: Alfonso Mejía

48 A. Proyecto Hidroeléctrico Apuela, diseño de las Obras Hidráulicas (Adjunto planos, 48 A-1) MCH-3C1-83 83-04
Por: Fernando Barrica A.

48 B. Proyecto Hidroeléctrico Apuela, Evaluación técnica de las Obras Hidráulicas / MCH - 3C1 - 83 83 - 09
Por: Fernando Barrica A.

49. Principales aspectos Técnico-Económicos y organizaciones de los Planes Nacionales de Microhidrogeneración de Energía MCH
Por: Eliardo Marín P. Julio 1983

50. El consumo de Energía en la Provincia de Galápagos. Mayo 1983
Por: Byron Arroyo

51. Lineamientos para una Política Energética en el Sector Transporte. /Diciembre 1982
Por: Peter Kublank

52. Proyecto Geotérmico Valle de los Chillos, Perspectivas de Ahorro de Hidrocarburos en el Sector Industrial. GTE/404/83
Por: Michel Lopoukhine y Patricio Romero

53. Sugerencias para mejorar Confort Térmico en las Casas del Grupo Experimental "Solanda", mediante Métodos Pasivos de Aprovechamiento de la Energía Solar. SOL - 209 - 83
Por: Noemy Flores

54. Ensayo de Bio-Abono Guamaní. /Octubre de 1982
Por: Amilcar Salazar

55. Comparación Económica de Sistemas Energéticos
(Informe Interno) I - SOL - 210 - 83 83 - 08
Por: Franklin Carrasco, Fernando González, Gilles Le Tron

56. Plan Maestro de Energía, Previsiones del Sistema Energético Económico del Ecuador: 1980 - 2000, Cinco Escenarios.
Por: Grupo de Planificación Energética del INE y Gernot Ruths (Comunidad Económica Europea) Abril 1983

56 A. Anexos

57. Criterios Generales para la Elaboración del Proyecto de Construcción del Sistema de Almacenamiento de Derivados del Petróleo en Galápagos. "Plan Maestro Galápagos"
Por: Eduardo Morañ y Byron Arroyo. Septiembre de 1983.

58. Balances Energéticos del Ecuador: Serie Histórica 1979- 1982
Proyecto: Actualización de los Balances Energéticos del Ecuador. Octubre, 1983
Por: Peter Kublank y Hernán López

59. Análisis Preliminar de las Relaciones entre Economía-Consumo Primario y Final de Energía. 1983
Por: Santiago Ordóñez

60. Definición de un Modelo de Cálculo para Calentamiento de Agua
I- SOL- 212- 83 83- 12
Por: Franklin Carrasco, Fernando Gonazález y Gilles Le Tron

FORM A.2

ESTADO DEL ESTADO FINANCIERO No. 2/29/84
(En miles de dólares)

APPENDIX F

NOMBRE DEL PROYECTO: Fuentes Alternas de Energía
NÚMERO DEL PROYECTO: 518-0029 (516-W-039)
FECHA DEL CONVENIO: 29 de Septiembre de 1981
PACD: 31 de Diciembre de 1985

FONDOS DURANTE LA VIDA DEL PROYECTO - PRESTADO: US$ 1.960.000
FONDOS NO REEMBOLSABLES: US$ 800.000
FONDOS AUTORIZADOS A ESTA FECHA - PRESTADO: US$ 1.960.000
FONDOS NO REEMBOLSABLES: US$ 800.000

	FONDOS NO REEMBOLSABLES					PRESTAMO					CONTRAPARTIDA		
	PRESU-PUESTO (1)	RESER-VADO (2)	COMPRO-METIDO (3)	DESEM-BOLSOS (4)	SALDOS (5=1-4)	PRESU-PUESTO (1)	RESER-VADO (2)	COMPRO-METIDO (3)	DESEM-BOLSOS (4)	SALDOS (5=1-4)	PRESU-PUESTO (1)	DESEM-BOLSOS (2)	SALDOS (3=1-2)
I. ESTUDIOS E INVESTIGACIONES DIRECTAS	100.0	3.2	3.2	2.3	97.7	250.0	91.1	91.1	49.1	200.9	350.0		
A. Estudios	100.0	3.2	3.2	2.3	97.7	20.0	16.9	18.9	18.9	1.1	200.0		
B. Instrumentos de Medición	—	--	--	--	--	80.0	60.2	60.2	18.7	61.3	--		
C. Fondos para Investigación y desarrollo	—	--	--	--	--	150.0	12.0	12.0	11.5	138.5	150.0		
II. TRANSFERENCIA DE TECNOLOGIA, CAPACITACION Y ASESORIA DE LARGO PLAZO	400.0	218.3	218.8	134.1	265.8	200.0	0.05	0.05	0.05	199.95	200.0		
A. Transferencia de Tecnología	200.0	38.3	38.3	28.3	172.9	120.0	0.05	0.05	0.05	199.95	90.0		
B. Centro de Información	--	--	--	--	--	80.0	0.0	0.0	0.0	80.0	80.0		
C. Asesor Residente	200.0	180.0	180.0	105.8	94.2	--	--	--	--	--	30.0		

FORM A.2

RESUMEN DEL ESTADO FINANCIERO AL 2/29/84
(En miles de dólares)

PROYECTO: Fuentes Alternas de Energía

COMPONENTES Y SUBPROYECTOS	FONDOS NO REEMBOLSABLES					PRESTAMO					CONTRAPARTIDA		
	PRESUPUESTO (1)	RESERVADO (2)	COMPROMETIDO (3)	DESEMBOLSOS (4)	SALDOS (5=1-4)	PRESUPUESTO (1)	RESERVADO (2)	COMPROMETIDO (3)	DESEMBOLSOS (4)	SALDOS (5=1-4)	PRESUPUESTO (1)	DESEMBOLSOS (2)	SALDOS (3=1-2)
III. DEMOSTRACION Y DIFUSION DE ENERGIA ALTERNA	--	--	--	--	--	1,200.0	0.0	0.0	0.0	1,200.0	600.0		
A. Minicentrales Hidroeléctricas	--	--	--	--	--	500.0	0.0	0.0	0.0	500.0	300.0		
B. Fogones y bosques para leña	--	--	--	--	--	90.0	0.0	0.0	0.0	90.0	110.0		
C. Calentadores solares de agua	--	--	--	--	--	110.0	0.0	0.0	0.0	110.0	60.0		
D. Otros	--	--	--	--	--	500.0	0.0	0.0	0.0	500.0	130.0		
IV. PROMOCION DE AHORRO DE ENERGIA	150.0	5.7	5.7	5.7	144.3	100.0	0.0	0.0	0.0	100.0	100.0		
A. Campaña de ahorro	100.0	5.7	5.7	5.7	94.3	--	--	--	--	--	50.0		
B. Servicios de conservación	50.0	0.0	0.0	0.0	50.0	100.0	0.0	0.0	0.0	100.0	50.0		
INFLACION E IMPREVISTOS	150.0	0.0	0.0	0.0	150.0	150.0	0.0	0.0	0.0	150.0	250.0		
TOTALES	800.0					1,900.0					1,500.0		
OBLIGACIONES Y SALDOS A LA FECHA	800.0	227.2	227.2	142.1	657.9	1,900.0	91.2	91.2	49.2	1,700.8	1,500.00		
ANTICIPOS A LA FECHA				10.6					36.7				

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FONDOS NO REEMBOLSABLES

FORM-A.1

PROYECTO: Fuentes Alternas de Energía
NUMERO DEL PROYECTO: 518-0029 (518-W-039)

INFORME FINANCIERO AL 2/29/84 Página 1 de 11

COMPONENTE: I. ESTUDIOS E INVESTIGACIONES ENERGETICAS

VALOR DESEMBOLSADO A LA FECHA PARA EL COMPONENTE: US$ 2,306.23

FECHA (1)	DESCRIPCION (COMPONENTE Y No. VOUCHER) (2)	VALORES RESERVADOS (3)	VALORES COMPROMET. (4)	TIPO DESB. (5)	VALORES DESEMBOLSADOS POR A.I.D: DESEMB. US$ (6)	EQUIV. EN S/. (7)	T/CAMBIO (8)	LIQUIDACION ANTICIPOS $ (9)	SALDO NO COMPROMET. (10)=(3)-(4)	SALDO NO DESEMBOLS. (11)=(4)-(6)
	Saldo Anticipo F-W-R									
11/12/82	Vou R-83-262 Anticipo							10,597.58		
9/12/83	Vou R-83-1906 - Anticipo			A		400,000.00	59.45	+6,728.34		
				A		110,000.00	96.32	+4,256.64		
	I. ESTUDIOS E INVESTIGACION ENERGETICA	3,240.97	3,240.97		2,306.23				0.00	934.74
	A. Estudios	3,240.97	3,240.97		2,306.23				0.00	934.74
	Análisis de agua	249.00	249.00		249.00				--	--
11/29/82	P/O 518-83-003	249.00	249.00							
11/29/82	Vou R-83-190			D	249.00				--	--
	Paul Tinari (Energía Solar)	595.90	595.90		595.90				--	--
1/27/83	Contrato INE/P.Tinari	S/48,000.00	S/48,000.00							
2/18/83	Vou R-83-735 (50% anticipo)			L		24,000.00	59.45	-403.70	--	--
4/8/83	Vou R-83-1025 (50% saldo)			L		24,000.00	59.45	-403.70		
5/11/83	Vou R-83-1193			R	595.90	48,000.00	80.55			
	Estud. de Energía Rural (ERE)	220.61	220.61						--	220.61
5/27/83	Carta GDO-83-080 a INE	S/19,800.00	S/19,800.00							
	Proyecto de Microcentrales	415.40	415.40		415.40				--	--
9/6/83	Vou R-83-1886 (Proy. Aguela)			R	415.40	40,011.10	96.32			
	Asoc. Técnica Electrónica (TECNAS)	1,337.05	1,337.05		622.92				--	714.13
9/6/83	Vou R-83-1886 (50% inicial)	S/120,000.00	S/120,000.00	R	622.92	60,000.00	96.32			(S/60,000.00)
	Diseño Regulador Electrico	384.15	384.15		384.15					
1/11/83	Vou R-84-748	384.15	384.15	R	384.15	35,000.00	91.11			
	Turbinas	38.86	38.86		38.86					
1/11/83	Vou R-84-748			R	38.86	3,540.00	91.11			

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FONDOS NO REEMBOLSABLES

FORM A.1

PROYECTO: Fuentes Alternas de Energía
NUMERO DEL PROYECTO: 518-0029 (518-W-039)

INFORME FINANCIERO AL 2/29/84 Página 2 de 11

COMPONENTE: II. TRANSFERENCIA DE TECNOLOGIA ENERGETICA Y RED DE INFORMACION

VALOR DESEMBOLSADO A LA FECHA PARA EL COMPONENTE: US$ 134,164.10

FECHA (1)	DESCRIPCION (COMPONENTE Y No. VOUCHER) (2)	VALORES RESERVADOS (3)	VALORES COMPROMET. (4)	TIPO DESB. (5)	VALORES DESEMBOLSADOS POR A.I.D. DESEMB. US$ (6)	EQUIV. EN S/. (7)	T/CAMBIO (8)	LIQUIDACION ANTICIPOS $ (9)	SALDO NO COMPROMET. (10)=(3)-(4)	SALDO NO DESEMBOLS. (11)=(4)-(6)
	II. TRANSFER. TECNOLOGIA ENERG. Y RED DE INFORM.	218,336.27	218,336.27		134,164.10				0.00	84,172.17
	A. Transferencia de tecnología	38,336.27	38,336.27		28,335.06				0.00	10,001.21
	Alfonso Mejía	1,730.00	1,730.00		924.00					
6/17/82	TA 518-2-244 (curso sobre técnicas fotovoltaicas en Cleveland, Ohio)								0.00	806.00
12/29/82	Vou T-83-023 (pasaje)	1,730.00	1,730.00	D	924.00					
	Fernando González	1,656.00	1,656.00		1,106.00					
8/13/82	TA 518-2-300 (conf. sobre energía solar: Un.Tennesse)								0.00	550.00
8/19/83	TA 518-2-300-A1	1,606.00	1,606.00							
8/19/82	Vou R-82-1230 (inscripción)	50.00	50.00							
12/29/82	Vou T-83-023 (pasaje)			D	250.00					
				D	816.00					
	Ivan Pozniño	3,920.00	3,920.00		3,712.00					
9/9/82	T.A. 518-2-344 (curso sobre computación en Data General)								0.00	208.00
9/24/82	Enmienda 1 al TA 518-2-344	2,120.00	2,120.00							
9/24/82	Vou R-82-1322 (inscripción)	1,800.00	1,800.00							
12/29/82	Vou T-83-017 (pasaje aéreo)			D	1,800.00					
7/18/83	Vou R-83-1444 - viáticos			D	909.00					
				D	1,003.00					
	Patricio Romero	2,117.58	2,117.58		2,117.58					
9/28/82	T.A. 518-2-375 (reunión anual de Geothermal Energy Res. C.)								0.00	0.00
10/5/82	Vou R-83-031 (inscripción)	2,025.00	2,025.00							
12/29/82	Vou T-83-025 (pasaje a S.Fco)			D	325.00					
5/27/83	Vou R-83-1089 (liquid. viaje)			D	909.00					
5/26/83	Incremento para liq. difer.	92.50	92.58	D	883.58					
	Carlos Quevedo Terán	2,237.03	2,237.03		1,482.82					
8/13/82	PROY 2026 (Planning Workshop)	2,400.00	2,400.00						0.00	754.21
12/29/82	Vou T-027 (pasaje a Los Angel.)			D	909.00					
2/24/83	Vou R-83-761 (viáticos)			D	572.57					
7/21/83	Vou R-83-1463 (ingresos)			D	1.25					
7/21/83	Transferido para cubrir dif. viaje A. Villavicencio	-162.97	-162.97							

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FORMA.1

FONDOS NO REEMBOLSABLES

PROYECTO: Fuentes Alternas de Energía
NUMERO DEL PROYECTO: 518-0029 (518-H-039)

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COMPONENTE: II. TRANSFERENCIA DE TECNOLOGIA (continuación)

VALOR DESEMBOLSADO A LA FECHA PARA EL COMPONENTE: (ver pág. anterior)

FECHA (1)	DESCRIPCION (COMPONENTE Y NO. VOUCHER) (2)	VALORES RESERVADOS (3)	VALORES COMPROMET. (4)	TIPO DESB. (5)	VALORES DESEMBOLSADOS POR A.I.D. DESEMB. US$ (6)	EQUIV. EN S/. (7)	T/CAMBIO (8)	LIQUIDACION ANTICIPOS $ (9)	SALDO NO COMPROMET. (10)=(3)-(4)	SALDO NO DESEMBOLS. (11)=(4)-(6)
(sigue)	A. Transf. de Tecnología									
	Miguel Acuña									
6/14/83	Vou R-83-1389 (dev. a INE del valor del pasaje a Brasil)	877.14	877.14		877.14					
8/19/83	Vou R-83-1770 (dev. a INE por anticipo)			R	438.57				0.00	0.00
8/19/83	Vou R-83-1771 (gastos del viaje)			R	308.00					
				D	130.57					
	Arturo Villavicencio									
6/3/82	T.A. 518-2-243 (confer. de FAO sobre Fuentes Alternas de Energía, en Italia)	3,062.97	3,062.97		3,062.97				0.00	0.00
9/20/82	Vou R-82-1237 (pasaje Amst-Roma-Francfurt)	2,900.00	2,900.00							
4/15/83	Vou R-83-1405 (viáticos)			D	1,916.97					
7/21/83	Transf. de PIO/P 20026	162.97	162.97	D	1,146.00					
	Oswaldo Mantilla									
6/20/83	Vou R-83-1437 (dev. a INE por pasaje a Estocolmo)	1,331.86	1,331.86		1,331.86				0.00	0.00
				R	1,331.86	126,927.00	95.30			
	Eduardo Morán									
6/21/83	TA 518-3-405 (seminario de OLADE en Brasil y Lima)	1,070.00	1,070.00							1,070.00
		1,070.00	1,070.00							
	Mairico Tirado									
8/12/83	Vou R-83-1738 (dev. a INE por pasaje a Miami)	1,167.30	1,167.30		1,167.30				0.00	0.00
1/9/84	Vou R-84-734			R	779.20					
				R	388.10					
	Rosa Maldonado Gómez									
9/27/83	TA 515-3-549 (curso sobre Inf. Estadísticas en Virginia)	3,925.00	3,925.00		1,707.00					2,218.00
12/23/83	Vou R-83-1816 (inscripción)	3,250.00	3,250.00							
12/9/83	TA. 515-3-549-A1			D	850.00					
12/17/83	Vou T-84-34	675.00	675.00							
				R	857.00					
	Curso de Bibliotecología									
9/6/83	Vou R-83-1836 (inscripción)	31.15	31.15		31.15					
				R	31.15	3,000.00	96.32		0.00	0.00
	Viáticos locales									
1/11/83	Vou R-83-1193	159.70	159.70		159.70					
1/11/84	Vou R-84-749			R	52.14	4,200.00	80.55		0.00	0.00
				R	107.56	9,800.00	91.11			

FONDOS NO REEMBOLSABLES

FORM A.1

PROYECTO: Fuentes Alternas de Energía
NUMERO DEL PROYECTO: 518-0029 (518-W-039)

INFORME FINANCIERO AL 2/29/84 Página 4 de 11

COMPONENTE: II. TRANSFERENCIA DE TECNOLOGIA (continuación)

VALOR DESEMBOLSADO A LA FECHA PARA EL COMPONENTE: (ver pág. anterior)

FECHA (1)	DESCRIPCION (COMPONENTE Y No. VOUCHER) (2)	VALORES RESERVADOS (3)	VALORES COMPROMET. (4)	TIPO DESB. (5)	VALORES DESEMBOLSADOS POR A.I.D. DESEMB. US$ (6)	EQUIV. EN S/. (7)	T/CAMBIO (8)	LIQUIDACION ANTICIPOS $ (9)	SALDO NO COMPROMET. (10)=(3)-(4)	SALDO NO DESEMBOLS. (11)=(4)-(6)
(sigue)	A. Transf. de Tecnología									
	NRECA-(Grupo de Microcentr.)	13,850.54	13,850.54		10,605.54					
12/9/83	Vou R-84-546 (pasajes)			R	5,236.00				0.00	0.00
12/9/83	Vou R-84-545 - J.Hidalgo			R	312.00					
12/21/83	Vou R-84-711			A				0.00		
12/22/83	Vou R-84-713 - J.Hidalgo			L	1,278.37			+4,896.00		
11/18/83	Vou R-84-714 - A.Hojía			L	1,296.94			-1,224.00		
11/18/83	Vou R-84-712 - P.Barriga			L	1,248.68			-1,224.00		
12/21/83	Vou R-84-795 - P.Arévalo			L	1,158.55			-1,224.00		
2/10/84	Vou R-84-1083 - P.Arévalo			R/L	75.00			-1,158.55		
								-65.45		
	Fernando Barriga	1,200.00	1,200.00		50.00					
12/1/83	TA SIB-4-110	1,200.00	1,200.00							1,150.00
12/15/83	Anticipo			A						
12/15/83	Vou R-84-561 (inscripción)			D	50.00			+520.00		
	Ing.P. Ramiro (Cap. Brasil)	3,245.00	3,245.00		0.00					
2/26/84	PASEP 518-0029-1-20067	3,245.00	3,245.00							3,245.00
	C. Asesor Residente	180,000.00	180,000.00		105,829.04				0.00	74,170.96
	Hugh Pierson	180,000.00	180,000.00		105,829.04					
5/20/82	PASEP 20018	180,000.00								74,170.96
7/15/82	Contr. 518-0029-C-002031-00		180,000.00							
2/29/84	Pagos hasta esta fecha			D	105,829.04					

Actividad B. sólo fondos de préstamo

FONDOS NO REEMBOLSABLES

FORM-A.1

PROYECTO: Fuentes Alternas de Energía
NUMERO DEL PROYECTO: 518-0029 (518-W-039)

INFORME FINANCIERO AL 2/29/84 Página 5 de 11

COMPONENTE: III. DEMOSTRACION Y DIFUSION DE ENERGIA ALTERNA

VALOR DESEMBOLSADO A LA FECHA PARA EL COMPONENTE:

FECHA (1)	DESCRIPCION (COMPONENTE Y No. VOUCHER) (2)	VALORES RESERVADOS (3)	VALORES COMPROMET. (4)	TIPO DESB. (5)	VALORES DESEMBOLSADOS POR A.I.D. DESEMB. US$ (6)	EQUIV. EN S/. (7)	T/CAMBIO (8)	LIQUIDACION ANTICIPOS $ (9)	SALDO NO COMPROMET. (10)=(3)-(4)	SALDO NO DESEMBOLS. (11)=(4)-(6)

Este componente es financiado sólamente con fondos de préstamo

FONDOS NO REEMBOLSABLES

FORM A.1

PROYECTO: Fuentes Alternas de Energía
NUMERO DEL PROYECTO: 518-0029 (518-0-039)

INFORME FINANCIERO AL 2/29/84 Página 6 de 11

COMPONENTE: IV. PROMOCION DE AHORRO DE ENERGIA

VALOR DESEMBOLSADO A LA FECHA PARA EL COMPONENTE: US$ 5,737.90

FECHA (1)	DESCRIPCION (COMPONENTE Y No. VOUCHER) (2)	VALORES RESERVADOS (3)	VALORES COMPROMET. (4)	TIPO DESB. (5)	VALORES DESEMBOLSADOS POR A.I.D. DESEMB. US$ (6)	EQUIV. EN $/. (7)	T/CAMBIO (8)	LIQUIDACION ANTICIPOS $ (9)	SALDO NO COMPROMET. (10)=(3)-(4)	SALDO NO DESEMBOLS. (11)=(4)-(6)
	IV. PROMOCION DE AHORRO DE ENERGIA	5,737.90	5,737.90		5,737.90				0.00	0.00
	A. Campaña de ahorro	5,737.90	5,737.90		5,737.90				0.00	0.00
5/12/83	Video-cassettes Vou R-83-1207	1,671.92	1,671.92	R	1,671.92 1,671.92	134,673.00	80.55		0.00	0.00
6/15/83	Adquisición de materiales Vou R-83-1391	4,065.98	4,065.98		4,065.98 3,890.11	340,268.00	87.47		0.00	0.00
9/6/83	Vou R-83-1886			R	175.87	16,940.00	96.32			
	B. Servicio de Conservación				00.0				0.00	0.00

FONDOS DE PRESTAMO

FORM A.1

PROYECTO: Fuentes Alternas de Energía
NUMERO DEL PROYECTO: 518-0029 (518-W-039)

INFORME FINANCIERO AL 2/29/84 — Página 7 de 11

COMPONENTE: I. ESTUDIOS E INVESTIGACIONES ENERGETICAS

VALOR DESEMBOLSADO A LA FECHA PARA EL COMPONENTE: US$ 49.136.16

FECHA (1)	DESCRIPCION (COMPONENTE Y No. VOUCHER) (2)	VALORES RESERVADOS (3)	VALORES COMPROMET. (4)	TIPO DESB. (5)	VALORES DESEMBOLSADOS POR A.I.D. DESEMB. US$ (6)	EQUIV. EN B/. (7)	T/CAMBIO (8)	LIQUIDACION ANTICIPOS $ (9)	SALDO NO COMPROMET. (10)=(3)-(4)	SALDO NO DESEMBOLS. (11)=(4)-(6)
	Saldo Anticipos Préstamo							36,685.06		
10/11/82	Vou L-83-003 Anticipo			A		26,000.00	63.41	+410.00		
11/12/82	Vou L-83-008 Anticipo			A		543,000.00	33.00	+16,454.55		
9/12/83	Vou L-83-085 Anticipo			A		330,000.00	48.60	+5,790.12		
	I. ESTUDIOS E INVEST. ENERGETICAS	91,108.54	91,108.54		49,136.16				0.00	41,972.38
	A. Estudios	18,851.91	18,851.91		18,851.91				0.00	0.00
	Analisis de agua (ANTEL)	2,241.25	2,241.25		2,241.25					
5/1/83	Vou L-83-037 transporte			R	197.30	8,346.84	43.32		0.00	0.00
5/17/83	Vou L-83-039			R	2,043.95					
	1 Ford F250 (Champion Autom.)	12,335.82	12,335.82		12,335.82					
5/9/83	L/Cta. 518-W-03904	12,335.82	12,335.82						0.00	0.00
7/26/83	Vou L-83-061			D	12,335.82					
	Materiales varios	4,274.84	4,274.84		4,274.84					
2/12/84	Vou L-84-028			R	4,274.84	233,620.20	54.65			
	B. Instrumentos de Medición	60,243.82	60,243.82		18,783.57				0.00	41,460.25
	Inst. medición microcentr.	758.40	758.40		758.40					
11/8/82	Vou L-83-003A			R	758.40	25,027.27	33.00		0.00	0.00
	Inst. de laborat. y material.	12,286.70	12,286.70		12,286.70					
1/5/83	Vou L-83-017			R	4,267.16	184,853.17	43.32		0.00	0.00
10/31/83	Vou L-84-011			R	8,015.54	408,792.50	51.00			
	Dinamómetro	40,575.00	40,575.00							
8/31/83	L/C 518-W-03906	40,575.00	40,575.00						0.00	40,575.00
	Dinamómetro (Heisler Instr.Co.)	353.00	353.00							
10/14/83	P/O 518-84-011	353.00	353.00						0.00	353.00
	Extensiometro (Herman Stight Co)	532.25	532.25							
10/26/83	P/O 518-84-010	532.25	532.25						0.00	532.25
	Tablero de control	5,738.47	5,738.47		5,738.47					
1/12/84	Vou L-84-029			R	5,738.47	297,212.16	54.65			

FONDOS DE PRESTAMO

FORM A.1

PROYECTO: Fuentes Alternas de Energía
NUMERO DEL PROYECTO: 518-0029 (518-W-039)

INFORME FINANCIERO AL 3/29/84 Página 8 de 11

COMPONENTE: I. ESTUDIOS E INVESTIGACIONES ENERGETICAS

VALOR DESEMBOLSADO A LA FECHA PARA EL COMPONENTE: US$ 49.136.16

FECHA (1)	DESCRIPCION (COMPONENTE Y No. VOUCHER) (2)	VALORES RESERVADOS (3)	VALORES COMPROMET. (4)	TIPO DESB. (5)	VALORES DESEMBOLSADOS POR A.I.D. DESEMB. US$ (6)	EQUIV. EN S/. (7)	T/CAMBIO (8)	LIQUIDACION ANTICIPOS $ (9)	SALDO NO COMPROMET. (10)=(3)-(4)	SALDO NO DESEMBOLS. (11)=(4)-(6)
(sigue Componente I)										
	C. Fondos para investigación y desarrollo	12,012.81	12,012.81		11,500.68				0.00	512.13
	1 Jeep Cherokee (American M.)	11,760.00	11,760.00		11,247.87					
5/9/83	L/C 518-W-03903	11,760.00	11,760.00							
8/3/83	Vou L-83-066			D	11,247.87				0.00	512.13
	CEFA: mater. secador solar	252.81	252.81		252.81					
9/2/83	Vou L-83-079			R	252.81	12,160.00	48.10		0.00	0.00

FORM A.1

PROYECTO: Fuentes Alternas de Energía
NUMERO DEL PROYECTO: 518-0029 (518-H-039)

INFORME FINANCIERO AL 2/29/84 Página 9 de 11

COMPONENTE: II. TRANSFERENCIA DE TECNOLOGIA ENERGETICA Y RED DE INFORMACION

VALOR DESEMBOLSADO A LA FECHA PARA EL COMPONENTE: US$ 50.78

FECHA (1)	DESCRIPCION (COMPONENTE Y No. VOUCHER) (2)	VALORES RESERVADOS (3)	VALORES COMPROMET. (4)	TIPO DESB. (5)	VALORES DESEMBOLSADOS POR A.I.D. DESEMB. US$ (6)	EQUIV. EN S/. (7)	T/CAMBIO (8)	LIQUIDACION ANTICIPOS $ (9)	SALDO NO COMPROMET. (10)=(3)-(4)	SALDO NO DESEMBOLS. (11)=(4)-(6)
	II. TRANSF. DE TECNOLOGIA ENERG. Y RED DE INFORM.	50.78	50.78		50.78				0.00	0.00
	A. Transferencia de tecnología	50.78	50.78		50.78				0.00	0.00
5/1/83	Viáticos locales Vou L-83-037	50.78	50.78	R	50.78 50.78	2,200.00	43.32		0.00	0.00
	B. Centro de información	0.00	0.00		0.00				0.00	0.00
11/30/82	Vou L-83-011 - Anticipo			A		400,000.00	33.00	+12,121.21		

Actividad C, se financia con fondos no reembolsables

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FORM A.1

FONDOS DE PRESTAMO

PROYECTO: Fuentes Alternas de Energía
NUMERO DEL PROYECTO: 518-0029 (518-66-039)

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COMPONENTE: III. INVESTIGACION Y DIFUSION DE FUENTES ALTERNAS

VALOR EQUIVALENTE A LA FECHA PARA EL COMPONENTE: US$ 3.69

FECHA (1)	DESCRIPCION (COMPONENTE Y No. VOUCHER) (2)	VALORES RESERVADOS (3)	VALORES COMPROMET. (4)	TIPO DESB. (5)	VALORES DESEMBOLSADOS POR A.I.D. DESEMB. US$ (6)	EQUIV. EN S/. (7)	T/CAMBIO (8)	LIQUIDACION ANTICIPOS $ (9)	SALDO DE COMPROMET. (10)=(3)-(4)	SALDO DE DESEMBOLS. (11)=(4)-(6)
	III. INVESTIG. Y DIFUSION DE FUENTES ALTERNAS	3.69	3.69		3.69				0.00	0.00
	A. Minicentrales hidroelectricas	0.00	0.00		00.00					
	B. Fogones y hornos para leña	0.00	0.00		00.00					
	C. Calentadores solares de agua	0.00	0.00		00.00					
11/30/82	Vou L-83-011 Anticipo			A		30,000.00	33.00	+909.09		
	D. Otros				3.69					
5/1/83	Material de oficina Vou L-83-013	3.69	3.69	R	3.69 3.69	160.00	43.32		0.00	0.00

FORM A.1

PROYECTO: Fuentes Alternas de Energía
NUMERO DEL PROYECTO: 519-0029 (516-11-039)

COMPONENTE: IV. PREVENCION DE SUELO DE TIERRA

ESTADO DE PRESTAMO

IMPORTE FINANCIERO AL 2/29/91

VALOR DESEMBOLSADO A LA FECHA PARA EL COMPONENTE: US$ 00.00

FECHA (1)	DESCRIPCION (COMPONENTE Y No. VOUCHER) (2)	VALORES RESERVADOS (3)	VALORES COMPROMET. (4)	TIPO DESB. (5)	VALORES DESEMBOLSADOS POR A.I.D. DESEMB. US$ (6)	EQUIV. EN S/. (7)	T/CAMBIO (8)	LIQUIDACION ANTICIPOS $ (9)	SALDO NO COMPROMET. (10)=(3)-(4)	SALDO NO DESEMBOLS. (11)=(4)-(6)
	B. Servicio de Conservación				00.00					

La actividad A se financia con F-N-R

APPENDIX G

PRELIMINARY RURAL ENERGY DEMAND/USE PROFILE

CUADRO 2 : POBLACIÓN RURAL POR PROVINCIA 1982

PROVINCIA	TOTAL POBLACIÓN RURAL	% POBLACIÓN RURAL	POSICIÓN	DENSIDAD POBLACIÓN RURAL HA/KM^2	CAMBIO DE 1974 A 1982 %
CARCHI	75496	60.2	15	18.2	-3.5
IMBABURA	152768	62.2	12	27.9	+4.2
PICHINCHA	405165	29.4	19	24.5	+18.7
COTOPAXI	236236	84.4	1	46.3	+13.7
TUNGURAHUA	200608	61.9	13	52.1	+7.1
BOLIVAR	119274	84.3	2	20.5	-5.3
CHIMBORAZO	232455	72.6	7	71.5	+2.7
CAÑAR	146308	83.8	3	26.6	+13.4
AZUAY	271713	61.3	14	31.5	+8.0
LOJA	238744	66.3	10	24.0	-11.7
ESMERALDAS	126142	51.0	16	8.4	-3.8
MANABI	542145	62.1	11	28.8	-10.6
LOS RIOS	308155	67.4	9	40.3	-7.2
GUAYAS	623243	30.4	18	30.7	+10.8
EL ORO	119956	35.5	17	20.2	-13.5
NAPO	95099	62.6	4	1.9	+29.1
PASTAZA	21452	67.5	8	0.6	+15.6
MORONA SANTIAGO	53579	76.3	6	2.0	+15.3
ZAMORA CHINCHIPE	36096	77.3	5	1.6	-15.1
GALAPAGOS	1626	26.6	20	0.2	-
TOTAL	4048466	50.3			+6.1

REF: CENSOS 1974 Y 1982

CUADRO 3 FACTORES DE CONVERSION ENERGETICA

LEÑA (SECA)	0.300 TEP/TON.	3333 Kg/TEP
KEREX	0.1329 TEP/BL 1.153 TEP/TON	316 GAL/TEP
GASOLINA	0.1221 TEP/BL 0.936 TEP/TON	344 GAL/TEP
G L P	0.0966 TEP/BL 1.14 TEP/TON	887 KG/TEP

TEP: TONELADAS EQUIVALENTES DE PETROLEO.

REF: BALANCES ENERGETICOS 1969-1978
INE
CHEMICAL ENGINEERING HANDBOOK 1963

CUADRO 1: CAMBIO DE LA POBLACION RURAL Y URBANA
(REF. CENSO 1982 Y GEOGRAFIA DEL ECUADOR)

AÑO	POBLACION TOTAL	POBLACION RURAL	%	POBLACION URBANA (1)	%
1950	3202757	2289972	71.5	912785	28.5
1962	4558107	2949096	64.7	1609011	35.3
1974	6830967	4098581	60.0	2732386	40.0
1982	8050630	4048466	50.3	4002164	49.7

(1) POBLACION URBANA EN CIUDADES CAPITALES DE PROVINCIA Y LAS PARROQUIAS CANTONALES

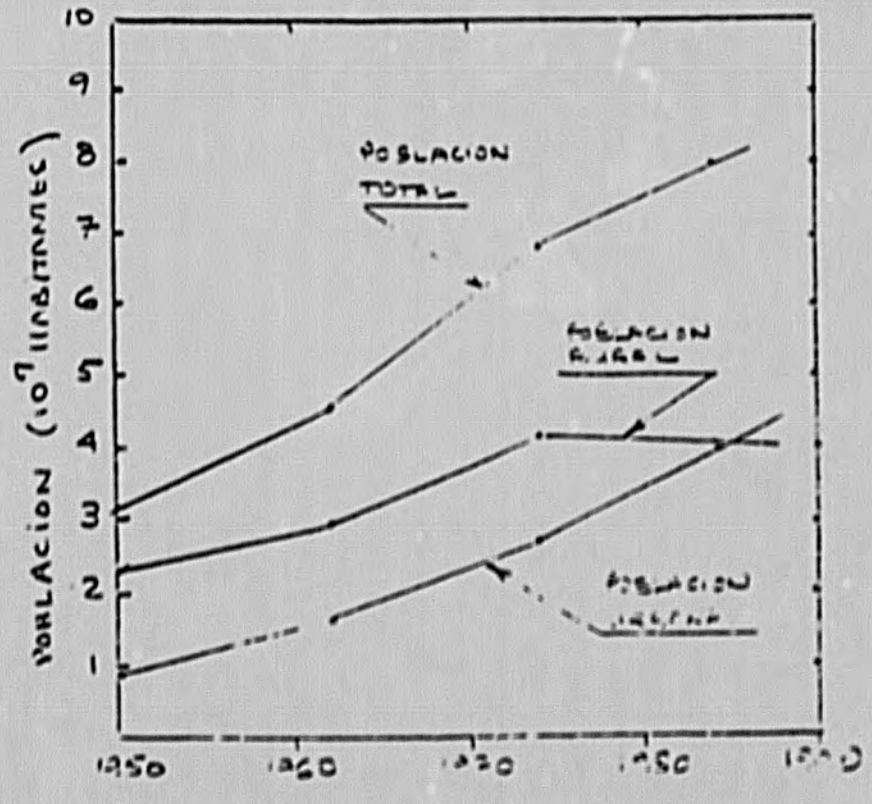


GRAFICO 1 CAMBIO DE LA POBLACION RURAL Y URBANA

CUADRO 4: CONSUMO Y COSTOS ANUALES POR FAMILIA RURAL. FUENTE: ENCUESTAS DEL INE

COMBUSTIBLE	COSTOS (1984)	CONSUMO ANUAL	CONSUMO ANUAL TEP	COSTO ANUAL POR FAMILIA
LEÑA (SECA)	S/3.5 / KG	3985 KG (1)	1.196 TEP	S/13950 (2)
KEREX	S/12 / GAL	120 GAL	0.380	S/1440
GASOLINA	S/20 / GAL	120 GAL	0.349	S/2400
GLP	S/10 / KG	180 KG	0.203	S/1800

(1) PROMEDIO 5.2 HAB/FAMILIA
USO PROMEDIO DIARIO 2.1 KG/HAB

(2) SE ESTIMA QUE MAS DE 50% DE LAS FAMILIAS RURALES RECOGEN LA LEÑA DIRECTAMENTE FUERA DE LA ECONOMIA MONETARIA

(3) LA MAYORIA DE LAS FAMILIAS RURALES QUE USAN KEREX, GASOLINA O GLP USAN TAMBIEN LEÑA.

CUADRO 6: CONSUMO RESIDENCIAL RURAL 1982.

		LEÑA	KEREX	GASOLINA	GLP	TOTAL
CONSUMO RESIDENCIAL TOTAL 1000 TEP		771	60	30	128	989
% CONSUMO TOTAL		79.0	6.1	3.0	12.9	100
% DE FAMILIAS USANDO CADA COMBUSTIBLE	RURAL	84.9	29.6 (1)		18.1	
	URBANO	15.1	70.4		81.9	
CONSUMO RURAL 1000 TEP (2)		655	18	9	23	705
% CONSUMO RURAL		92.9	2.5	1.3	3.3	100
NUMERO DE FAMILIAS RURALES USANDO CADA COMBUSTIBLE		576478	52692 (1)		97328	
CONSUMO RURAL (3) POR FAMILIA		1.153 TEP 3844 KG	0.326 TEP 107 GAL		0.236 TEP 209 KG	

(1) EL CENSO DE 1982 NO DISTINGUE ENTRE KEREX Y GASOLINA

(2) ASUMIENDO EL MISMO CONSUMO DE FAMILIA RURAL Y URBANA

(3) ASUMIENDO UN RENDIMIENTO DE 33 KG/GAL PARA EL KEREX

(4) NO SE INCLUYE LA ENERGIA ELECTRICA (0.15% DEL TOTAL)

FUENTE: CENSO DE 1982 Y BALANCE ENERGETICO

CUADRO 5 DEMANDA DE LA ENERGIA RESIDENCIAL TOTAL DE 1980 A 1982 Y PORCENTAJE DE CADA COMBUSTIBLE

COMBUSTIBLE	1980		1981		1982	
	TOTAL	%	TOTAL	%	TOTAL	%
LEÑA	785	81.2	779	79.6	771	79.0
KEREX	60	6.2	60	6.1	60	6.1
GASOLINA	30	3.1	30	3.0	30	3.0
GLP	92	9.5	110	11.3	128	12.9
TOTAL	967	100	979	100	989	100

(1) NO SE INCLUYE LA ENERGIA ELECTRICA

(2) CIFRAS ESTIMADAS EN 1000 TEP

(3) NO SE INCLUYE LA ENERGÍA ELECTRICA

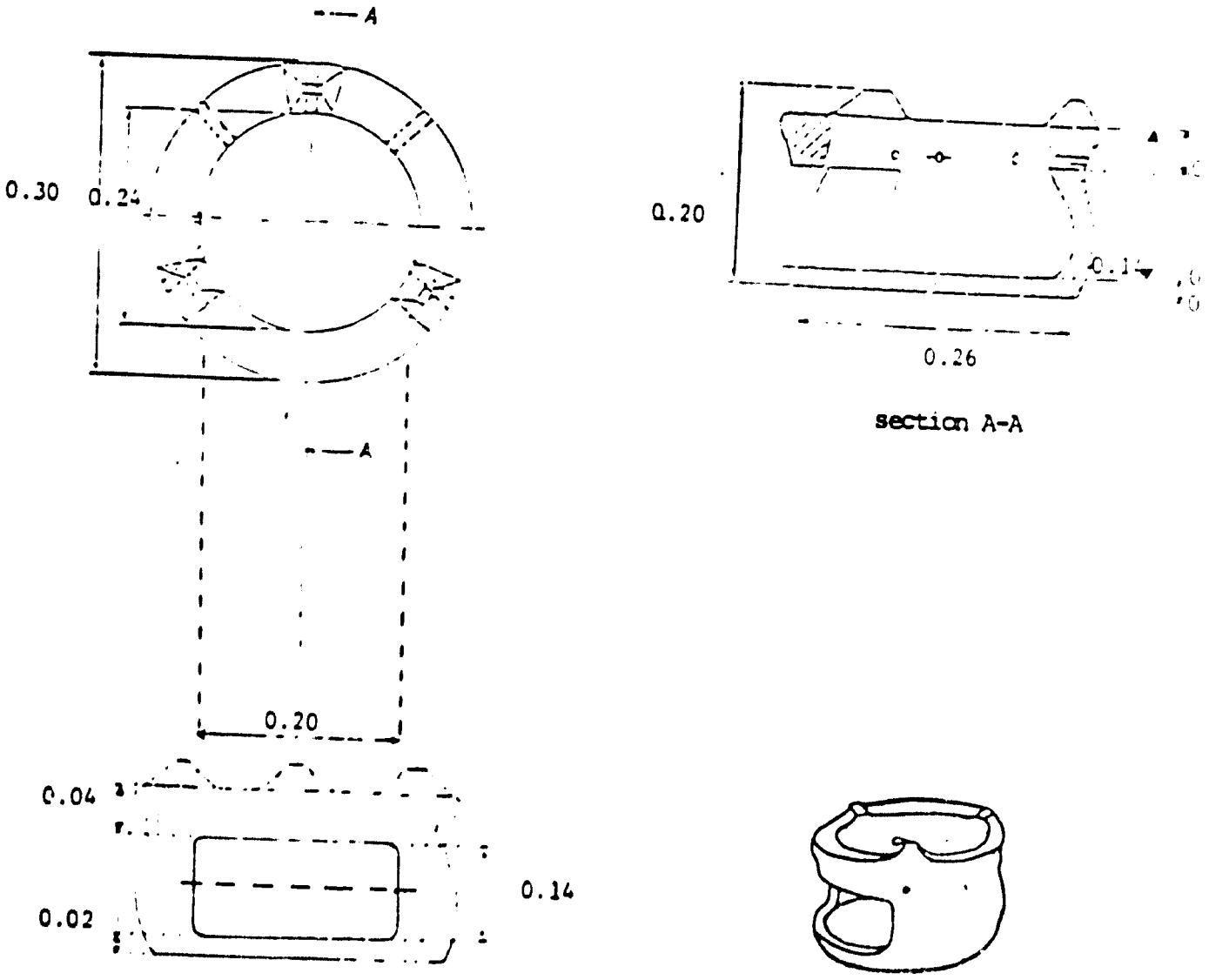
CUADRO 7. CONSUMO RESIDENCIAL RURAL POR PROVINCIA.
% VIVIENDAS USANDO LOS SIGUIENTES COMBUSTIBLES

PROVINCIA	LEÑA (1)	KEREX O GASOLINA	GLP
CARCHI	91.2	4.4	4.4
IMBABURA	79.7	9.9	10.4
PICHINCHA	57.0	6.2	36.8
COTOPAXI	89.5	3.1	7.4
TUNGURAHUA	87.2	3.8	9.0
BOLIVAR	89.9	4.3	5.8
CHIMBORAZO	85.6	9.2	5.2
CAÑAR	73.7	15.4	10.9
AZUAY	79.9	9.0	11.1
LOJA	92.3	3.1	4.6
ESMERALDAS	85.3	7.2	7.5
MANABI	88.4	3.4	8.2
LOS RIOS	73.0	17.5	9.5
GUAYAS	56.4	25.4	18.2
EL ORO	46.4	43.5	10.1
NAPO	84.6	4.7	10.7
PASTAZA	75.5	3.7	17.8
MORONA SANTIAGO	91.5	1.6	6.6
ZAMORA CHINCHIPE	90.3	3.3	5.8
GALAPAGOS.	560	50	29.0

(1) INCLUYE CARBON VEGETAL Y OTROS (CENSO 1982)

(2) NO SE INCLUYE LA ENERGIA ELECTRICA (0.15%)

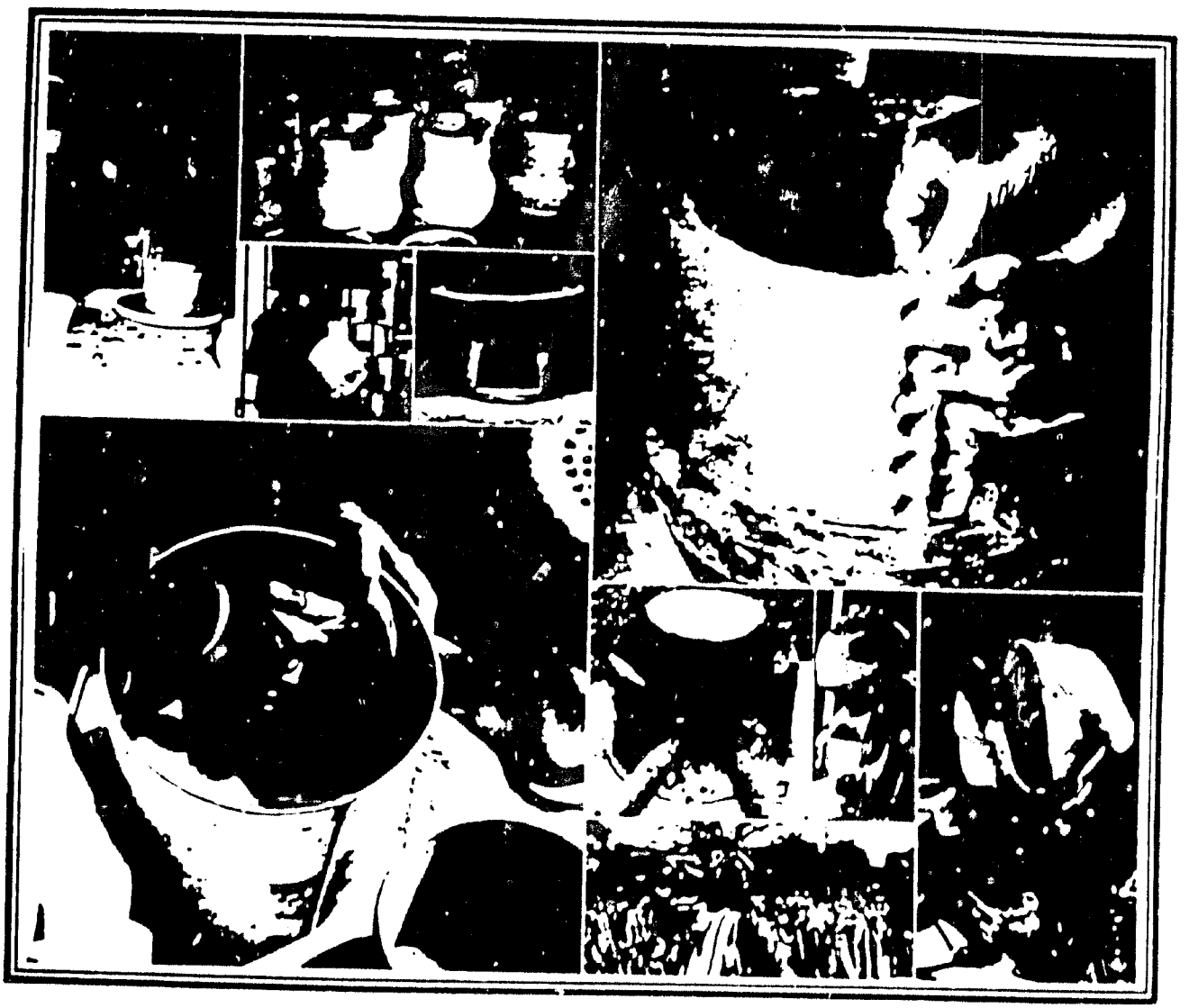
FOGON DE CERAMICA #1



APPENDIX I

VITA NEWS

JANUARY 1984



Report from Upper Volta:

New directions in woodstoves

New Directions in Woodstove Development

by Dr. Sam Baldwin

The ability of improved stoves to slow deforestation, erosion, and desertification, and to improve the lives and living conditions of half the world's population has approached mythical proportions. Thousands of people around the world are working for more than a hundred national and international organizations to develop and disseminate improved stoves to accomplish all this and more. *VITA News* presents here an in-depth look at some of that research.

Photos and drawings by Dr. Sam Baldwin

Despite years of effort, the potential of improved stoves remains unrealized, the technology remains unproven, and its future remains uncertain.

Dr. Sam Baldwin recently completed an 18-month tour designing and testing improved stoves in a project initiated by IBM Europe with follow-up funding from the U.S. Agency for International Development. Dr. Baldwin, a physicist, followed Dr. Timothy Wood, an environmental scientist, as the director of the Upper Volta-based project, which was managed jointly by VITA and CILSS, the Comité Inter-Etats de Lutte contre la Sécheresse dans le Sahel.

In this series of articles, Dr. Baldwin takes a fresh look at some of the myths and facts of woodstoves. Briefly, the points he makes are these. First, improved stoves alone will not significantly slow deforestation, but they do show enormous potential to reduce the expense of cooking fuel for the world's urban poor and the burden of collecting fuel for the world's rural poor. Better stoves may also aid in maintaining long term soil productivity by reducing the need to burn crop residues and dung.

Second, massive stoves, particularly the multipot ones promoted by various groups around the world, do not and cannot reduce wood use sufficiently to be of more than marginal interest. In addition, such stoves cannot be readily disseminated.

Finally, alternative stove designs emphasizing lightweight construction and artisanal mass production can achieve the necessary high performance, rapid production, and low cost desired. With such designs, the potential of improved stoves generally to aid the world's poor may yet be realized.

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Deforestation

Loss of forest cover is a serious problem around the world, particularly in developing countries. In Nepal, for example, forested acreage has decreased from 60 percent to 19 percent in just 20 years. In Thailand, it is expected that there will be no significant forests remaining by the period 1987-1993. When Haiti won independence from France in 1804, more than 70 percent of its surface was forested. Today it is seven percent.

The environmental consequences of this deforestation are devastating. They range from the erosion of watersheds and flooding to the destruction of farmlands and desertification. And when the forests are gone, so is the firewood they supply--the primary fuel of up to 90 percent of the people in some developing countries. For the world's poor, it is becoming increasingly difficult simply to cook their food.

The FAO has estimated that, worldwide, the number of people affected by the fuelwood shortage will increase from the current one billion to nearly 2.8 billion by the year 2000. Those suffering an acute scarcity of wood fuel will increase from 100 million to over 350 million over that same period. And by the year 2000, there will be an estimated annual shortfall of 860 million cubic meters of fuelwood, more than half of the demand. Already, 150 to 400 million tons of dung are being burned annually, and for every ton of dung burned, some 50 kg of food grain production is lost.

Worldwide, over one billion cubic meters of wood are now used annually for fuel, or the energy equivalent of some two billion barrels of oil. Eighty percent of this is used for cooking, and represents most of the energy used by the world's poor.

> "More than a billion cubic meters of wood are burned for cooking fuel each year . . . when the forests are gone, so is the firewood they supply . . ."

Improved woodstoves have been widely heralded as a way to reduce the pressures on the world's forests. However, in the face of the rapid population growth in less developed countries, even a stove that reduces wood consumption by 50 percent is unlikely to slow deforestation significantly. Consider a stove that reduces wood consumption by half and that can be produced and disseminated rapidly in large quantities. If half a given population used such a stove half the time, the overall household wood savings would be just 12.5 percent. For a static population that consumes slightly more wood than can be renewably produced, this might make an important difference; but for a population with a growth rate of 2.5 percent, such savings would be overtaken in less than five years. Even if everyone used such a stove all the time--a highly unrealistic scenario--a breathing spell of only 20 years would be provided. At least in West Africa, agricultural intrusion, animal browsing, and brush fires are likely to be more important factors in deforestation than is fuelwood collection. (See related story on computer modeling of fuelwood needs, p. 19).

Although the overall impact of improved stoves on deforestation will be small, they still have several other important roles to play. Returning to the soil even part of the 150 to 400 million tons of dung now burned annually would help maintain soil quality and productivity. As deforestation progresses, such savings of biomass and dung will become even more important. In rural areas, improved stoves will also shorten the ever longer search for fuelwood. Finally, improved stoves can rapidly and cost-effectively reduce an urban family's expense for cooking fuel, which in some areas is as much as one third of the family's income. For the foreseeable future, better stoves are potentially the most important energy project going for the poor of the world.

Improved Stoves

Given the potential of improved stoves and the tremendous time, effort, and money so far invested, why has there been so little success in disseminating them? How might the process be speeded up? Along with groups such as the Institut Voltaïque de l'Energie (IVE) in Upper Volta, the Laboratoire d'Energie Solaire (LESO) in Mali, the Centre d'Etudes et de Recherches sur les Energies Renouvelables (CERER) in Senegal, Association pour le Développement des Energies Renouvelables en Mauritanie (ADEREM) in Mauritania

and Church World Service (CWS) in Niger, VITA and CILSS have been able to answer these questions during the last 18 months.

First, our research proved that traditional cooking technologies perform much better than was previously believed. Second, the so-called "improved" stoves that many groups promoted in fact often burned more wood to cook a meal than the traditional methods. Thus, it is not surprising that groups have been unable to disseminate them widely. Finally, by applying the principles of heat transfer to stove design, we developed new stoves that show high performance and which we believe will demonstrate the tremendous potential of improved stoves.

In stove literature, the three-stone fire and traditional stoves are claimed to be very inefficient, often as low as 2 to 3 percent or 6 to 8 percent. Research done by the Voltaic Institute of Energy (IVE) found three-stone fires to have actual efficiencies ranging from 10 to 22 percent, with an average at about 17 percent. In addition, traditional stoves have the advantages of low costs (less than US$ 1), lifetimes of two years and more, and portability. They can also be adapted to any pot size or shape, their performance is not very sensitive to errors in construction, and they can be produced rapidly by traditional artisans (as many as 15 to 20 per person/day) and sold through the existing market system. Improvements can be made in their efficiency, but only at the expense of some of their other advantages such as their cost, adaptability to any pot size and shape, or the sensitivity of their performance to construction errors.

In contrast, the massive multipot stoves that most groups have promoted suffer a number of serious disadvantages. At best, the energy efficiency of such stoves is only slightly better than that of an open fire protected from the wind; many of these stoves, in fact, use more wood. Of the nine models of massive stoves being disseminated in Upper Volta, six were found to use as much or more wood to cook a meal than the open fire. Two of these used over 50 percent more wood.

> "Our research proved that traditional cooking technologies perform better than was previously believed."

In addition, site-constructed stoves are expensive as well as difficult and time-consuming to build. They often have lifetimes of a year or less.

Because of the slow production rate, a large number of people must be trained--further complicating quality control. Armed with often limited training, the trainees may make numerous errors in building the stoves, such as incorrectly placing the baffles or making the baffles, pot holes, or chimneys the wrong size. Finally, completely new systems for the construction, marketing, and quality control of these stoves must be put into place to assure their dissemination.

Leocadie Samandoulougou tests a metal stove in the IVE stove testing center, Ouagadougou, Upper Volta.

Nouna stoves in Ouagadougou have direct costs alone of US$ 20.00. Other projects in West Africa have reported that when training and overhead costs are factored in, even owner-built stoves can cost as much as $20-$60 each.

Construction of this type of stove typically takes a day for a single person. Although a team of two skilled masons can construct a concrete stove in two to four hours, preparatory work such as making bricks and chimney pipes or purchasing materials slows this down considerably. For stoves of sand and clay, preparatory work such as hauling, pounding, and sifting will itself usually require an entire day or more.

The lifetime of massive stoves can vary from one or two months to two years. Clay-sand stoves typically last no longer than one dry season if unprotected, and even less if of poor quality clay. Concrete stoves and protected sand-clay stoves built of high quality clay will generally survive one to two years.

Since the performance of massive stoves is sensitive to

Clay stove production

Producing fired clay stoves came easily to Frederic Yerbanga. Living in Guilongou, a village 35 km from Ouagadougou, Frederic had already distinguished himself as the area's most skilled and innovative potter. After helping a French volunteer build a downdraft kiln and a potter's wheel, with financial assistance from VITA, he was able to build one of each for himself. The kiln lowered the cost of fuel to fire his wares and improved the quality of the products. The potter's wheel allowed him to establish a whole new line of goods, including plates, bowls, cups, vases, pitchers, and other items in addition to his main product line of 3000 chicken waterers per year for the national center for chicken production. Working first with Tim Wood and later with Sam Baldwin, Frederic tried one stove design after another until a form was developed that gave high efficiency, was durable, and was easily produced. Although field tests to determine lifetime and wood savings are not yet complete, and molding and materials problems remain, he is selling his fired clay stoves as fast as he can produce them without interfering with his other products.

His stoves sell for 600 CFA (about US$ 1.50) with production costs broken down as follows:

Labor	50 CFA
Firing	25
Metal grate	100
Transport	50
Total production costs	225 CFA
Profit	375
Sale price	600 CFA

Frederic cuts a sheet of clay for the base of the stove, and forms a bowl for the top. The two pieces are fired together, stacked to air dry, and then fired in the kiln.

construction errors, follow-up and quality control are both essential and difficult.

Thus, massive multipot stove programs--at least those in the Sahel--have so far seen little success. This is likely not because of unknown cultural factors, but simply because the stoves do not work well. By contrast, "improved" traditional stoves that do show acceptable performance, low cost, and easy production and distribution have gained fairly wide use in some areas, cultural factors notwithstanding. (Examples of such "improved" stoves are the traditional malgache or singo stoves for wood.) Whether or not cultural factors will slow stove programs has awaited the development of a high performance stove to be tested.

However, excessive and frequently contradicting demands have often been placed on the production and performance of proposed improved stoves. Among others, some of these demands are that they cost little or nothing, be built of local materials, and be easy to construct, yet have a reasonably long lifetime. They must have a simple, foolproof design, yet be energy efficient; provide light to cook by or for social functions, yet be enclosed to prevent burns. They must provide space heating in the winter or in cold climates, yet reduce the amount of heat in the kitchen during the warm season; and finally, they must evacuate smoke from the kitchen, yet leave smoke in to repel termites and mosquitoes and preserve food in the rafters or waterproof the thatch. Clearly, such excessive demands preclude a rational design process. In trying to meet this impossible range of demands, stove designers have often forgotten their original purpose.

Stove Design

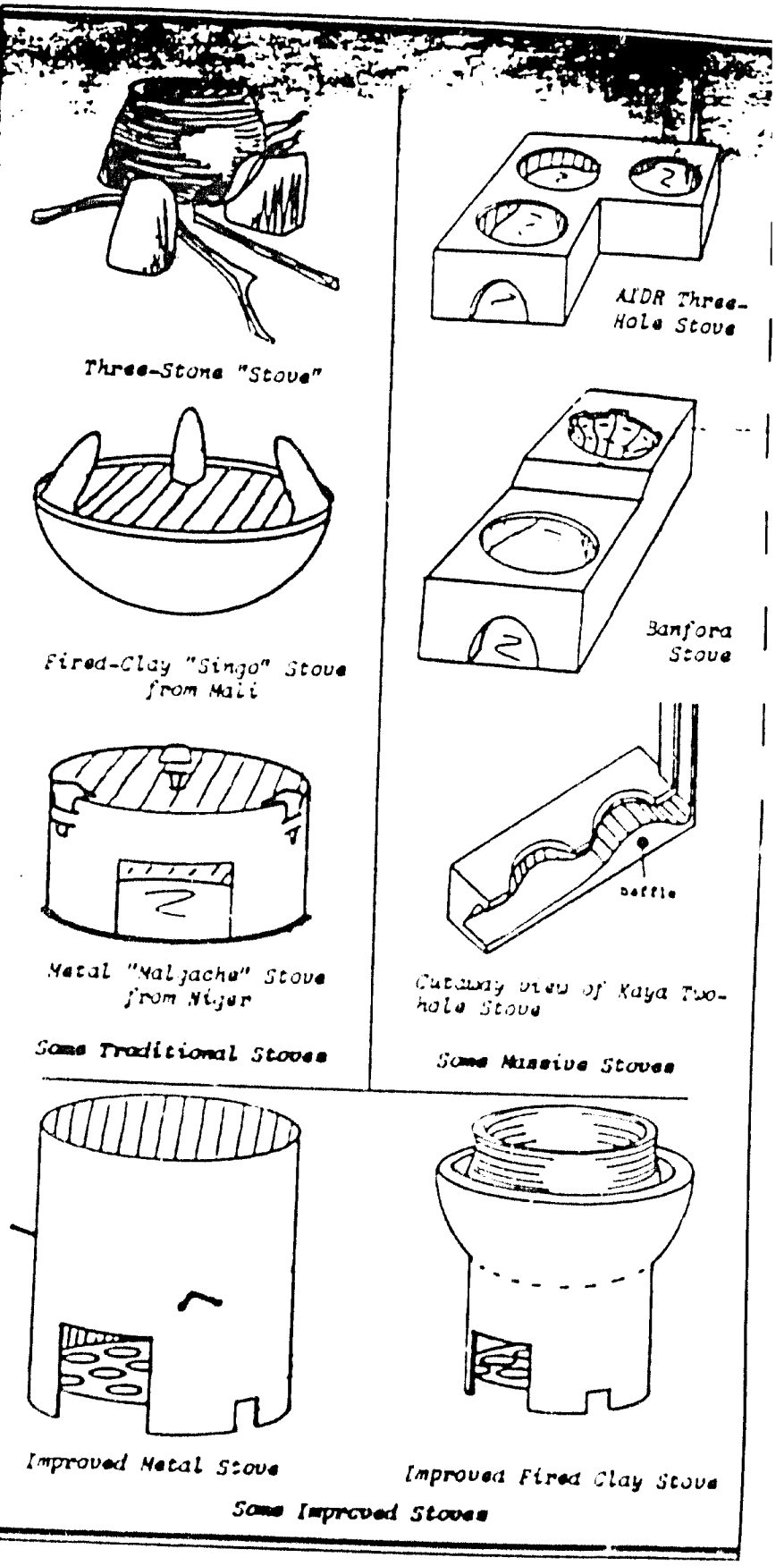
After reviewing stove programs generally, and seeing their lack of success and their contradictory requirements, we decided it was necessary first to ask what it was we were trying to accomplish. The answer, quite simply, was to reduce wood consumption.

With energy efficiency as the basic principal we then returned to the fundamentals of combustion and heat transfer--conduction, convection, radiation--to design a stove that would give high performance. In doing this, we discovered that massive multipot stoves combined many of the worst possible design features and had very strict intrinsic limits on their performance. We were then led to a considerably different design, which proved to be rather simple improvements to traditional forms.

Conduction

Conductive heat transfer in a stove is the process that carries heat through the pot to its contents or through the stove wall to the outside. High conductivity aluminum pots can save energy by conducting heat easily to the contents, and they are not likely to break like clay pots. In a very few years both the production and the use of aluminum pots have spread rapidly throughout West Africa.

To reduce heat loss it is necessary to minimize heat conduction into and through stove walls. Many stove builders had previously believed that the thicker the wall the better insulated a stove would be. This was, in part, the motivation behind massive stove



Three-Stone "Stove"

Fired-Clay "Singo" Stove from Mali

Metal "Maljacha" Stove from Niger

Some Traditional Stoves

AIDR Three-Hole Stove

Banfora Stove

Cutaway view of Kaya Two-hole Stove

Some Massive Stoves

Improved Metal Stove

Improved Fired Clay Stove

Some Improved Stoves

Conductive heat transfer

Reducing heat loss through the walls of a stove is one way to increase radiant heat transfer to the pot, assist convective heat transfer, and improve combustion.

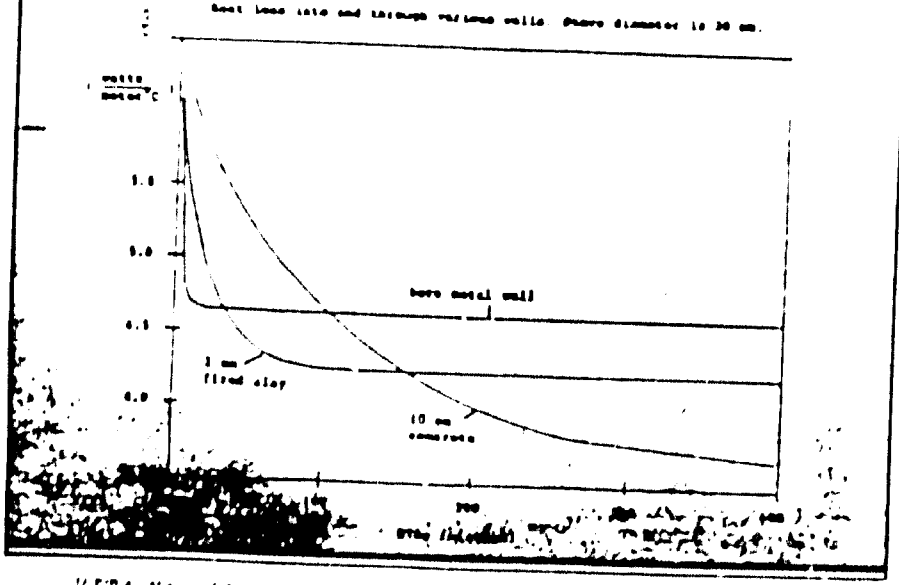
The wall of the stove is cold at first. During cooking, the wall warms up at a rate that depends primarily on its mass and the type of material it is made of. As it warms, the total heat absorbed by the wall or transmitted to the outside decreases to a constant, steady state value. Lightweight metal walls warm quickly. Fired clay walls 2 cm thick warm more slowly. Massive walls, such as 10 cm thick concrete, warm more slowly still.

As seen in the graph, the heat loss by even a bare metal wall is less than that of a concrete wall for cooking times of less than 100 minutes, and the integrated heat loss is less for the bare metal stove for a little over 200 minutes. Thus, only for the longest of cooking times can the concrete wall compete with a bare metal wall and it can never compete with a metal wall that has a one cm layer of fiberglass insulation over it.

If we compare the total energy absorbed to warm these various walls, the advantage of the lightweight wall becomes even more obvious. The table below shows assumed average values of mass (M), temperature change (T), and specific heat (Cp), and the resulting energy (E) absorbed to warm the wall compared to that needed to warm the pot of water.

	M	Cp	T	E
Metal Stove	3.0 kg	0.45×10^3 J/kg°C	200°C	270 kJ
Massive Stove	100.0	0.88×10^3	100	8800
Water	7.0	4.18×10^3	80	2340

Thus, we note the tremendous amount of energy needed to warm a concrete stove to its steady state value.



design. However, as discussed in the box at left, quite the opposite is true. For cooking times of a couple of hours or less, massive walls actually absorb more heat than even a bare metal wall loses to the outside. Instead of massive walls, stove walls should be made as light as possible and be covered with lightweight insulants such as fiberglass where economic.

Abandoning the assumption that massive walls are good insulators and switching to lightweight materials have particularly important implications: stoves of these lightweight materials will be portable, making centralized mass production possible with all the attendant advantages of rapid production, low cost, and good quality control. Being commercially produced, such stoves can have the additional market advantage of a professional finish.

Convection

In a stove it is the convective heat transfer process by which heat is transferred from the hot gases leaving the fire to the pot. To maximize convective heat transfer, it is necessary to pass the hot gases over as much of the surface of the pot and through as narrow a channel as possible. Here again are two of the serious deficiencies of massive multipot stoves.

Typically, only a fraction of the pot is exposed to the hot gases, with the pot closing off the pot hole to prevent the escape of smoke. As the hot gases are directed toward the chimney they have large spaces through which to pass by the pots, lowering the amount of heat transferred. Baffles to force the hot gases close to the pots are usually built into massive stoves, but they are rarely built correctly. It is extremely difficult

to control the dimensions to a few millimeters in mud or cement, particularly when each stove is individually hand crafted on site--even by a mason who has been adequately trained.

Narrower channels give higher convective heat transfer efficiencies. They also decrease the maximum size of the fire and can reduce the overall heating rate. If the channel is too narrow, the fire will be completely choked off. As discussed in the box at right, a channel width must be chosen that finds a compromise between high efficiency and rapid heating.

This compromise must be made carefully, however, because convective heat transfer to the pot is perhaps the single most important process by which stove performance can be improved. It is also extremely sensitive. For example, the efficiency of convective heat transfer itself can increase by a factor of four to five simply by increasing the pot-to-wall gap (or channel width) from 5 mm to 10 mm. In tests at LESO, increasing the pot-to-wall gap from 4 mm to 10 mm alone reduced the potential wood savings from nearly 50 percent to 25 percent.

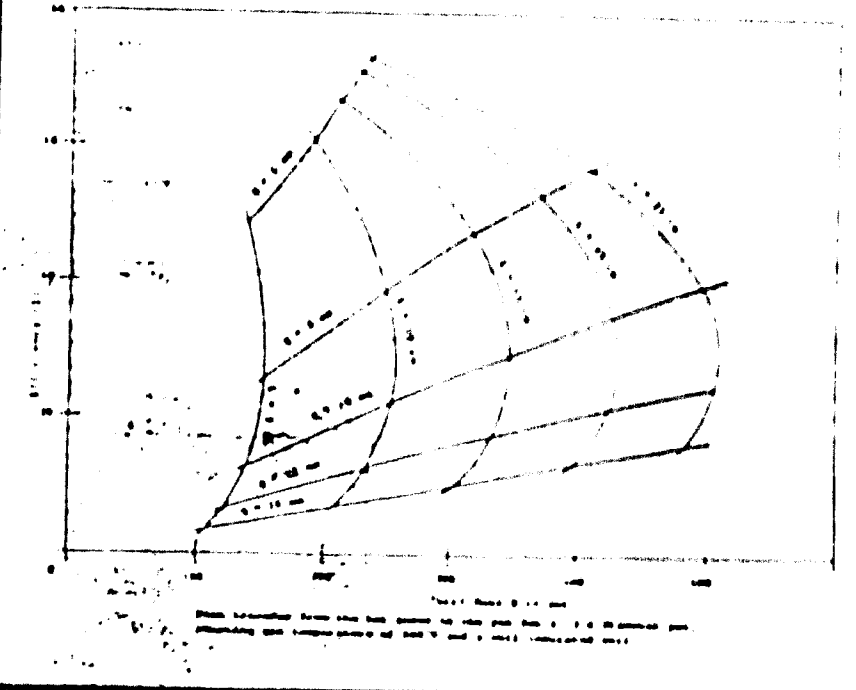
This sensitivity of convective heat transfer has two very important implications. First, mass production of stoves (and matching pots) to ensure precise dimensional control is virtually essential. Except for possibly the simplest designs such as the one pot chimneyless stove, assuring proper dimensional control in site-built stoves becomes extremely difficult if not impossible. Second, each stove and each pot must be matched dimensionally and, thus, one must abandon the flexibility of the traditional

See page 12. Also see related story on page 10.

Convective Heat Transfer

Increasing convective heat transfer from the hot gases to the pot is the single most important way to improve a stove's performance. An open fire exposed to the wind can be extremely wasteful. As soon as the fire is put inside a kitchen or a protected area, its efficiency increases dramatically, to around 17 percent. To increase efficiency further, it is necessary to expose the entire surface of the pot to the hot gases, forcing the gases against the sides of the pot. If walls are built around the pot we ask how close they must be to improve stove performance significantly--10 cm? 1 cm? 1 mm? At 10 cm, there is no appreciable forcing of hot gases against the wall. At 1 mm, there is not enough room for the smoke to pass, and the fire dies. Experiments and calculations indicate an optimum value in the range of 4 to 6 mm, depending on the size and shape of the pot. It is preferable to keep this gap as small as possible without choking the fire or having too much smoke escape out the door.

In the graph below we see that the efficiency of convective heat transfer increases very rapidly with the pot to wall gap g and only slowly with the channel length L. It is also important to note that one may often have a trade-off between the efficiency and the heating rate. Long narrow gaps can have very high efficiencies but low heating rates compared to wider gaps. This means that a compromise must sometimes be made between fuel consumption and the patience of the user in bringing a pot to a boil. In addition, the sensitivity of the efficiency on the pot to wall gap requires precise control of dimensions--possible only through mass production--and the careful matching of stoves to pots.



Using a template for

Use of a template or pattern when cutting stove parts helps ensure dimensional accuracy and speeds production. The template can be drawn on paper at first. A more permanent copy can be cut out of sheet metal. To prevent its loss through use as a stove itself, weld metal bars to it lengthwise. For a spherical or cylindrical pot, template design is straightforward. Prepare such a template following the steps below:

1. The length of the template is given by

$$L = C + G + S + T$$

C is determined by the measurement of the pot around its widest circumference. G is determined by the desired pot-to-wall gap, G = 2π(gap). For a gap of 4 mm, G = 2.5 cm; for 6 mm, G = 3.8 cm; for 8 mm, G = 5.0 cm. A gap of four to six mm is recommended. Increase it only if excessive smoke comes out the door or the heating rate is too slow. S is determined by the amount of overlap in the seam. It is preferable to weld the stove together end to end (thus S = 0) to prevent the creation of a small vertical channel by which the heat can bypass the pot. If the seam is crosswelded or folded, typical values for S will be 1 cm. T is determined by the thickness of the metal used. One typically uses 1 mm (T = 0.1 cm) or 1.5 mm (T = 0.47 cm) thick metal. Thus, for a 90 cm circumference pot, a 4 mm gap, an end to end welded seam, and 1 mm thick metal we find:

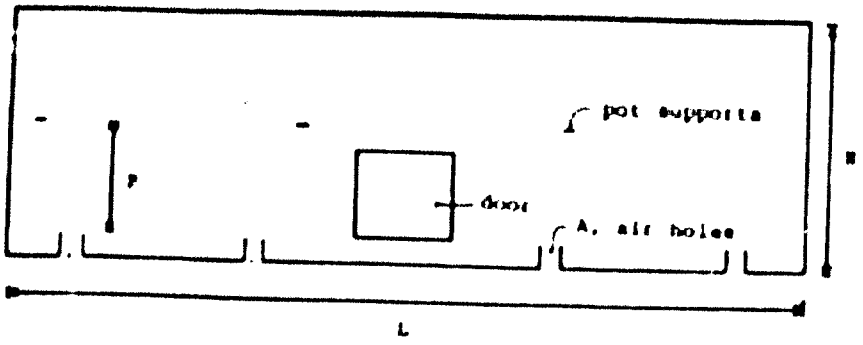
$$L = 90 + 2.5 + 0.1 = 92.6 \text{ cm}$$

2. For spherical pots, template height H is determined by the sum of the airhole height (A), the grate-to-pot height (P), and the amount necessary to extend a few centimeters above the pot's maximum circumference when in place on the stove (T).

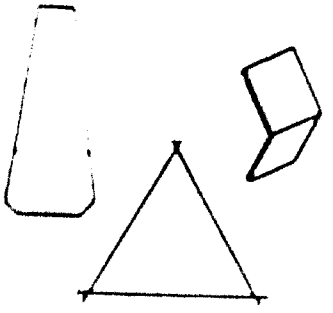
$$H = A + P + T$$

Typical values for A are 3 cm and for P, 0.4 of the pot diameter. For cylindrical pots the height T is typically 5 to 10 cm. The best height T is determined more precisely by comparing the increased efficiency and reduced fuel use caused by the additional height versus the increased cost of the extra metal. Additional height can also be provided at the top and bottom of the template, typically 1 cm each, to allow the edge to be folded over to protect against sharp edges and increase the stove's rigidity and strength.

3. Stoves usually have four airholes, about 1 cm by 3 cm each (A = 3 cm). Space them symmetrically, but far enough away from the door and the seams to avoid weakening the stove. Cut the airholes on two sides only



Template for a cylindrical metal stove shell.



Templates for a folded pot support, a welded L-bracket, and a complete triangular support of ½-in rod. Supports should be kept small to minimize their shielding the pot.

quantity production

so that when bent upward and inward they can act as supports for the grate. For larger pots or soft soil where the stove will sink in, larger airholes may be necessary. Alternatively, for soft soil conditions a ring-shaped platform can be cut and attached to the stove.

4. Space pot supports evenly around the stove, but offset from the door and edges so as not to weaken them. The height P for the pot supports above the top of the airholes (where the grate will rest) is given roughly by

$$P = 0.4C/\pi \text{ or } 0.4D$$

where D is the pot diameter. The best distance will vary somewhat with the size of wood used locally, its moisture content, and other factors.

5. The door size is somewhat arbitrary and is determined by the locally available wood size. Typical sizes for a 90 cm circumference pot are 12 cm wide by 9 cm high. Place the bottom of the door at the grate position--the top of the airholes. Make the top of the door several centimeters below the bottom of the pot so that the hot gases are guided up around the pot rather than out the door. If necessary, decrease the door height to ensure that it is below the bottom of the pot.

6. The grate is a circle of sheet metal cut to fit snugly into the finished cylinder. Punch the center diameter with a 30 percent hole density of 1 cm holes.

To produce stoves in quantity:

1. Trace the template on a sheet of metal as many times as desired or as space permits.

2. Cut each form out in outline. Cut the door, pot support holes, and strips for the airholes.

3. Roll the metal into a cylinder. The cylinder should be as straight and smooth as possible.

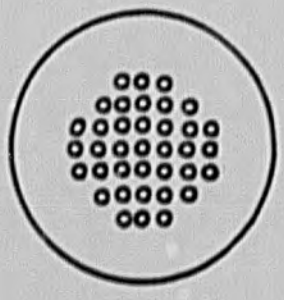
4. Cut out other components such as pot supports and stabilizers and put them in place.

5. Cut the grate and punch the holes in it.

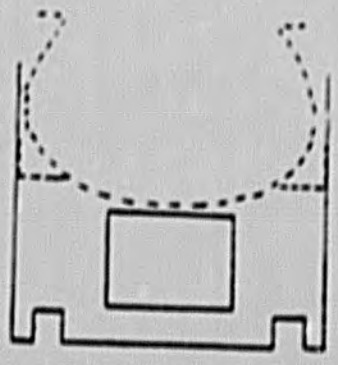
6. Weld the stove together. Weld pot support into place. Alternatively, fold all the seams together.

7. Place the grate in the stove, fold the tab from the airholes inward and upward.

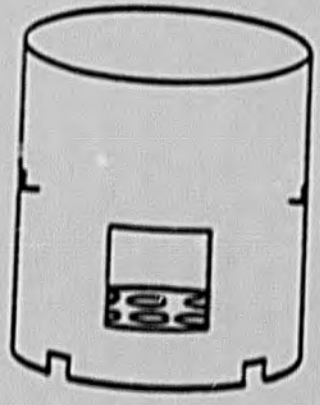
8. Paint it with heat resistant paint when available.



Template for a grate. Grate holes are not to scale.



Cross-section of the metal stove showing how the pot fits down inside.



Perspective view.

STOVE DESIGN From page 9

stove to adapt to a wide variety of pots.

Although the convective heating requirement of exposing the entire surface of the pot to the hot gases and forcing them through a narrow gap is easiest to achieve with simple chimneyless designs, high performance stoves with chimneys are possible. The problem posed by such a stove is the need to re-design the pot in order to expose its entire surface and still seal off the top of the stove.

Radiation

Radiant heat transfer is direct transfer of heat to the pot by radiation. The warmth you feel on your face when near a fire is due to radiant heat. In stoves, radiant heat transfer is optimized by placing the pot as close to the fire as possible without unduly disturbing the combustion. Radiant heat transfer is also improved by use of well insulated, lightweight walls that heat rapidly and thereafter re-emit radiant heat toward the pot.

Combustion

Combustion in stoves is the process of burning the wood to form carbon dioxide, water vapor, and other by-products. The efficiency of combustion is improved somewhat by using lightweight well insulated walls that heat rapidly and thereafter raise the average combustion chamber temperature. Also important is the use of a grate to improve fuel-air mixing. When wood burns it gives off volatile organic compounds that mix with oxygen and burn above the wood with the characteristic yellow flame. If the pot is too close to the fire, it will cool these volatiles before they have a chance to burn and cause them to be released as thick, black soot. A grate, compared to a solid floor under the fire, allows more complete and rapid mixing of these volatiles with oxygen which improves the overall quality of combustion as well as allows placement of the pot closer to the fire without excessively interfering with the combustion.

Thus, in considering the principles of combustion and heat transfer we are led to a design that:

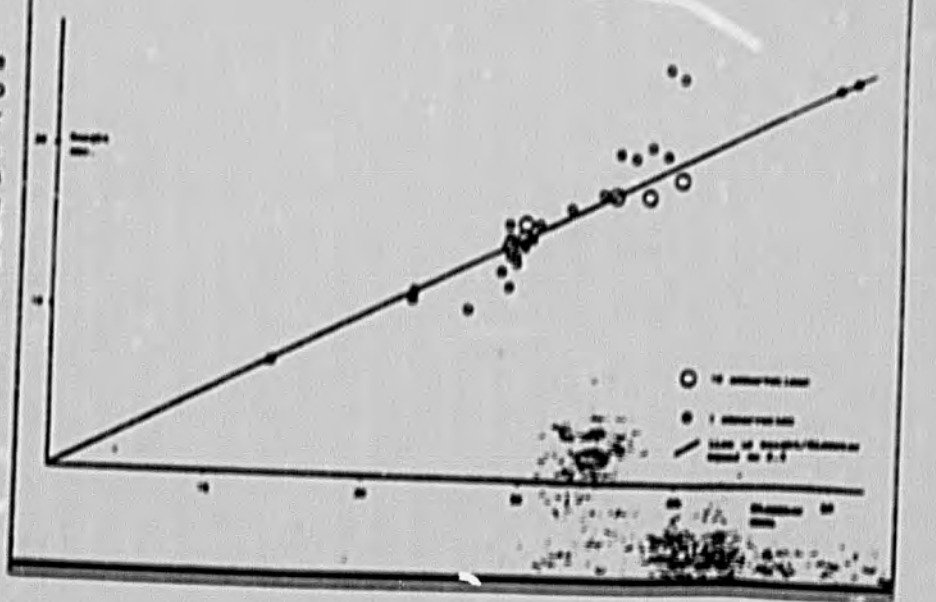
- is lightweight to minimize absorption and conductive losses;
- exposes the entire surface of the pot to the hot gases to increase convective heat transfer, whether or not it has a chimney;
- has specific, fixed dimensions for the pot-to-wall gap for optimum convective heat transfer and the pot-to-grate height for optimum radiant transfer;
- uses a grate to improve combustion;
- is mass produced to ensure dimensional accuracy and to speed production.

Combustion and traditional stoves

Calculations of radiant heat transfer versus combustion quality indicate that in stoves without grates, the best distance for the pot height above the firebed equals one-half the diameter of the firebed (or pot).

In measuring the dimensions of over a hundred traditional metal malgache woodstoves in Niger, Upper Volta, and Mali, it was found that traditional artisans had already learned this and put it into practice.

The graph below shows the ratio of stove height to stove diameter for a wide range of traditional stoves. The larger dots represent ten stoves each. The straight line is the value H/D=1/2, which is theoretically the best position based on calculations done to date.



APPENDIX J

CONSERVATION GROUP ACTIVITIES

Conservación Energética

Convenio USAID-INE

A. Proyecto(s) ejecutado(s)

A1. Campaña de ahorros energético (gasolina) destinada a automobilistas, a nivel nacional

Fecha: Octubre-Noviembre 1983 (5 semanas)

Descripción: difusion de consejos de manejo y mantenimiento; mediante anuncios un radio y television y distribución de folletos durante matriculación vehicular. Se difundió 5 anuncios diferentes (uno por semana) y distribuyó 400.000 folletos.

Financiamiento: US$ 10.000 para materiales, fondos no reembolsables IVa
US$ 75.000 para radio-TV, GOE (CEPE)

Contrapartes: CEPE, SENDIP

B. Proyectos en ejecución (durante 1984)

B1. Campaña de ahorro energético en hogares (gas y electricidad).

Duracion: 5 semanas.

Descripción: difusión consejos y prácticas de ahorro, mediante radio-televisión y distribución folletos, a nivel nacional. 5 anuncios diferentes durante 5 semanas (1 cada semana).

Financiamiento: US$ 25,000 para realizacion anuncios, fondos no reimbolsables IVa

US$ 75,000 para radio-TV, GOE (INECEL)

Contrapartes: INECEL, SENDIP

B2. **Asesoramiento a industrias y escuela politecuicas en area conservacion energetica industria**

Duracioñ: 12 meses
Descripcion:
- asesoramiento academico a ESPOL y practica a industrias (guayaquil), 3 meses
- asesoramiento academico a EPN (Guito) a industria (nivel nacional), 9 meses

Financiamiento: USS 80,000 para 12 meses hombre de consultoria especializada internacional,

(50,000 no reimbolsables, 30,000 prestamo componente IVb

Contraparte: ESPOL, EPN, Cdmaras de Industriales

B3. <u>Promocion en el sector industrial</u>

Descripcioñ: distribucioñ de folleto sobre metodos de racionalizaciñ energetica en plantas industriales.

Financiamiento: USS 4,000 para impresion 10,000 folletos fondos no reimbolsables IVa

Contraparte: Edmaras Industriales

APPENDIX K

Revised Implementation Plan for

ALTERNATIVE ENERGY SOURCES

Project. No. 518-0029

The following is a summary revised financial plan which demonstrates the reprogramming of project funds for CY-84, CY-85 and CY-86 of INE - AID project. Despite a current PACD of 31 December 1985 we anticipate the need for extending the project for at least one year. INE's recently submitted revised operating plan indicates a rapid increase in the disbursement rate. However, due to the uncertainties of the current government which will pass the reins to a new administration in August 1984 (implying another new Director of INE) it is uncertain whether INE can maintain the implementation pace shown in its operating plan. It is, therefore, expected that the project whould be continued through CY-86 in order to achieve the project purpose in a rational manner. The project evaluation to be conducted during May 1984 should reinforce and better define certain aspects of the reprogramming herein presented.

Notes on proposed reprogramming.

I. Energy Planning and Assessments

The major increase in the emphasis on energy planning has recently occurred. The reprogrammed budget increases funding for this component by almost US$150,000. The shift is justified by the increased GOE concern for more careful management of the country's energy sources, in light of a growing appreciation of trends in domestic oil production and consumption. It is anticipated, that after the preliminary energy plan is presented to the new government in August, it will want INE to conduct more detailed studies on which to base specific decisions in the energy sector.

II. Technology Transfer and Information Center

The apparent decrease in funding for this component reflects the fact that a number of promotional and training activities related to specific technologies have been included under those headings in NCE Demonstrations.

ALTERNATIVE ENERGY SOURCES PROJECT No. 518-0029
PROPOSED REPROGRAMMING OF A.I.D. FUNDS

US$ x 000

	Original Proj. Paper Plan		Total Disbursements as of 3/31/84	GRANT				Total Disbursements as of 3/31/84	LOAN			
	Grant	Loan		Rest of CY 84	Reprogrammed CY 85	CY 86	Total		Rest of CY 84	Reprogrammed CY 85	CY 86	Total
I. Energy Planning and Assessments	100	250	2.8	24.5	35.0	35.0	97.3	94.6	84.5	120.0	100.0	399.1
II. Technical Transfer & Information Center	400	200	139.3	26.1	54.0	40.0	259.4	0.3	40.7	70.8	60.0	171.8
A. Technical Transfer & Asesor				31.3	54.0	40.0	125.3		0	0		0
B. Information Center				0	0	0	0	0.3	40.7	70.8	60.0	171.8
III. NCE Demonstrations	0	1.200	0	113.6	109.0	75.0	297.6	0	398.0	474.5	330.0	1202.5
A. Mini Hydro				25.0	20.0	10.0	55.0		185.0	107.0	80.0	372.0
B. Biomass				23.0	24.0	20.0	67.0		70.0	117.0	70.0	257.0
C. Solar				29.0	28.0	20.0	77.0		50.0	103.5	65.0	218.5
D. Energy Plantations				15.0	17.0	10.0	42.0		24.0	62.0	60.0	146.0
E. Geothermal				21.6	20.0	15.0	56.6		69.0	85.0	55.0	209.0
IV. Energy Conservation	150	100	5.7	39.0	51.0	50.0	145.7	0	30.0	56.6	40.0	126.6
V. Contingencies	150	150										
TOTAL	800	1.900	147.8	203.2	249.0	200.0	800.0	98.9	553.2	721.9	530.0	1900.0

III. NCE Demonstrations

As a result of intensive efforts by INE during the last six months, this project component now has the best definition in INE's plans. If INE can increase its coordination with other implementing entities, there is hope that these programmed demonstrations will begin to be realized and will have a constructive impact on future renewables developments.

IV. Energy Conservation

This component has generated considerable interest and is receiving slightly more attention. The major obstacle to effective utilization of funds remains the acquisition of qualified and capable long-term technical assistance.