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FEASIBILITY REASSESSMENT OF THE PHILIPPINES RURAL ENERGY DEVELOPMENT PROJECT
(Project Numbe: 492-0375)

Prepared for:

U. S. Agency for International Development
1680 Roxas Boulevard
Magsaysay Center
Malate, Manila
Philippines

Prepared by:

Associates in Rural Development, Inc.
72 Hungerford Terrace
Burlington, VT 05401
U. S. A.
Under AID contract PDC-1406-I-10-2167-00.

Date: April 2, 1985

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ACRONYMS

A&E	architectural and engineering
ADB	Asian Development Bank
AID	Agency for International Development
ARD	Associates in Rural Development, Inc.
BFD	Bureau of Forest Development
BOE	barrels of oil equivalent
Btu	British thermal unit
CPA	Charcoal Producers Association
DTDO	Dendro Thermal Development Office
EPA	Environmental Protection Agency
ESF	Economic Support Fund
FSDC	Farm Systems Development Corporation
GDP	gross domestic product
GEMCOR	Gasifier and Equipment Manufacturing Corporation
GIT	Georgia Institute of Technology
GOP	government of the Philippines
GWH	gigawatt-hours
IEM	Information, Education and Motivation
ISA	Integrated Service Association
ITP	Industrial Tree Plantations
KAISA	Kalipunan ng mga ISA
kw	kilowatt
kwh	kilowatt-hour
LPG	liquified petroleum gas
MBOE	million barrels of oil equivalent
MHS	Ministry of Human Settlements
MNR	Ministry of Natural Resources
MOE	Ministry of Energy
MT	metric tons
MW	megawatt
NEA	National Electrification Administration
NEDA	National Economic Development Authority
NIA	National Irrigation Administration
NPC	National Power Corporation
NRDC	Natural Resources Development Corporation
OBM	Office of Budget and Management
PCA	Philippine Coconut Authority
PNOC	Philippine National Oil Company
PVO	private voluntary organization
REC	Rural Electric Cooerative
TFA	Tree Farmers Association
TPS	Tree Project Supervisor
TREE	Tree Resources for Energy and Enterprise
UP	University of the Philippines
UPLB	University of the Philippines at Los Banos

I. EXECUTIVE SUMMARY

Following a discussion of the relevant energy markets in the Philippines, this report presents an analysis of each of the three subprojects--dendro thermal power plants, gasifiers for irrigation and charcoal production, followed by suggested options for each subproject based on that analysis. Despite the current economic situation and institutional and administrative problems being experienced by the agencies involved, there are feasible options for continued activity for each subproject. However, in all cases, changes in approach are required, and the participating agencies will have to take important steps and institute major changes in their courses of action before the Philippines rural energy development project can proceed. Otherwise, the project will make no progress toward the achievement of its goals.

Given the current situation in the Philippines, there are no readily available options for working with other agencies to achieve the project's goals and objectives. If the energy problems the project seeks to alleviate are to be addressed using the technologies and approaches suggested in the project paper, the analysis of potential options leads to those summarized below. Detailed discussions of the assessment team's findings as well as the potential options for each subproject are contained in Sections IV, V and VI.

Dendro Thermal Power Plants

Two of the three sites visited by the ARD assessment team--Bohol and Masbate--have the potential for the construction and operation of economically attractive power plants. In both cases, the wood supply must be assured for the plantation sites, for although the potential yields are satisfactory, they have yet to be actually achieved. Thus, plantation yields and sufficient institutional support must be assured before the power plants are designed. Also in each instance, there are current unknowns about electricity demand that should, and easily can, be resolved prior to proceeding with the project. In addition, project funds will have to be utilized to augment the staff and technical expertise of both the NEA and RECs.

There is a lack of coordinated planning and project execution regarding electrical power supply in the Philippines. Without an overall planning effort and assessment of power supply options, the future attractiveness and magnitude of benefits from the dendro thermal program as a whole are unknown. Regional electricity demand, other supply options and the availability of suitable land for fuelwood plantations have yet to be fully assessed. It may well be that a primary project objective and

activity should be to address these planning and coordination issues before proceeding with the plants on Bohol and Masbate.

Gasifiers for Irrigation

The current charcoal-burning gasifier is not economically viable, given present charcoal and diesel fuel prices. Sensitivity analyses indicate that even with much more favorable assumptions about costs and benefits, it does not appear likely that the basic results of the assessment team's analysis will change. However, a wood chip-burning gasifier does seem to be economically and technically feasible. To develop and market such a gasifier will require a research and develompent program, and if GEMCOR conducts this research and development, it must have better technical capability than in the past.

Moreover, a successful gasifier program will require that FSDC operations be improved in terms of both technical capability and management competence. This can only be accomplished using project funds and with outside technical assistance. Without a firm commitment from FSDC to make major changes in gasifier design and their management approach, this subproject cannot succeed. Finally, securing a supply of wood chips for gasifiers does not appear to pose any major technical obstacles, although the institutional and woodlot management models have yet to be adequately developed by FSDC.

Charcoal Production

The assessment team's economic analysis indicates that this subproject is very attractive. The kilns perform well, and the charcoal market is strong. However, institutional and management issues must be dealt with before the project can improve its performance. This, in turn, should help resolve the key technical issues of low plantation yields. Better plantation sites must be found, technical forestry capability in the field greatly augmented, and new approaches to cooperative formation and tree production tried and assessed.

Although FSDC is not the most appropriate organization to carry out wood production and conversion activities, readily acceptable alternatives are difficult to identify at this time. However, FSDC will have to increase its coordination with the Bureau of Forest Development (BFD), perhaps with some outside assistance. FSDC will also have to greatly increase its technical support of field personnel, and project funds should be utilized for this purpose. Finally, given the lack of data and analysis concerning fuelwood and charcoal markets in the Philippines, a comprehensive national study of these markets would be extremely helpful to project implementation.

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II. INTRODUCTION

The Philippines Rural Energy Development Project (number 492-0375) was authorized by the U. S. Agency for International Development (AID) in August, 1982. The main purpose of this project is to assist the government of the Philippines (GOP) in reducing the consumption of imported petroleum by increasing the supply and use of indigenous biomass fuels. This goal is to be accomplished by developing the production and use of biomass energy resources and conversion technologies in three subproject areas:

- dendro thermal power plants,
- gasifiers for irrigation, and
- charcoal production.

In addition to the direct economic and financial benefits that will accrue from fuel substitution, it is expected that project activities will also generate both employment and income, increase income transfer to rural areas and have a positive effect on the environment. The components of the project are summarized in the following subsection.

A. Project Components

The dendro thermal power plants subproject is being executed by the National Electrification Administration (NEA) and is funded at $10,000,000. In this project component:

- AID is financing all the foreign exchange costs of three five-megawatt (MW) power plants as well as the services of an architectural and engineering (A&E) firm to develop plant specifications and assist in procurement; and
- under a separate technical assistance project, AID is providing the technical services and training associated with tree production, farm management and other wood production processes.

The Farm Systems Development Corporation (FSDC) is handling the gasifiers for irrigation subproject, which is funded at $3,380,000. Under this project component, AID is financing:

- the conversion of 495 diesel-driven irrigation pump systems to hybrid systems which incorporate wood-fed gasifiers that yield producer gas in order to partially substitute for diesel fuel; and

- the development of woodlots to produce wood chips for the gasifiers.

FSDC is also executing the charcoal production subproject, funded at $11,370,000. For this project component, AID is financing:

- the construction of kilns for converting wood to charcoal, and

- the development of tree farms to supply wood for the kilns.

Finally, AID is providing additional technical assistance using $2,000,000 from the Project Design Fund. This assistance is in the form of research and advisory services to help develop the technical capabilities of both the NEA and FSDC.

B. Scope of Work for the Reassessment

The present economic crisis in the Philippines has left the GOP's implementing agencies unable to meet their counterpart funding obligations for project operations. These agencies have requested a major realignment or augmentation of AID project budgets, thus prompting the mission to reassess the project's continued feasibility, particularly in light of problems and delays encountered during the initial implementation phase and significant changes in fuelwood markets during that time. Consequently, all project activities are currently at a standstill.

The GOP and AID agreed to undertake an assessment of the present technical, economic, financial and institutional viability of the project, and Associates in Rural Development, Inc. (ARD) was engaged by AID to carry out this assessment. This report is the end result of the assessment and is intended to provide the information and analysis needed to permit a decision on the restructuring or augmentation of the project and its budget. The scope of work for this assessment (presented in full in Appendix A) consisted of objectives in three general categories:

- technical feasibility--to assess the technical feasibility of dendrothermal, gasification and charcoal production technologies, recommend any necessary modifications to those technologies, and provide technical guidelines for continued project implementation;

- institutional/administrative feasibility--to assess the resources of the NEA and FSDC (including their

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organization, procedures and staff) needed to support their respective rural energy subprojects, as well as the capabilities of their associated organizations, such Rural Electric Cooperatives (RECs), Integrated Service Associations (ISAs) and Charcoal Producers Associations (CPAs), to implement the subprojects, and then to draw up institutional/ administrative guidelines for continued implementation of the project; and

- economic/financial feasibility--to reassess the economic and financial feasibility of the three subprojects, in view of significant increases in fuelwood production costs, yields below previous projections, and present and projected trends in the oil and biomass fuel markets.

Thus, this effort is intended to constitute a rapid update of the original project paper analyses with respect to altered economic conditions and accumulated technical and administrative experience. It is assumed that readers are familiar with the original project documents, specifically the summary project paper and three annexes organized as distinct project papers on the separate subprojects. This report provides an analysis of each of the three subprojects as well as a summary of the options available to AID and the implementing agencies regarding whether and how to proceed with each project component. The team was explicitly directed to outline possible alternative courses of action and their implications, rather than preparing final recommendations.

The assessment team found an enormous amount of information related to the project. This volume of information, in combination with the widely dispersed geographical settings of project activity and the short time frame for the fieldwork, placed severe constraints on the time and resources available to accomplish the proposed work. For example, all of the engineering data were gathered and analyzed in two weeks. Thus, an assessment of the current situation and assembling relevant data for review by AID were emphasized. A complete, detailed development of the available options can only be done by working with the relevant agencies for a longer period of time. In any case, this is probably best undertaken only after key decisions have been made about which options to exercise.

C. The Assessment Team

Given the available time and resources, the assessment team was directed to utilize, "to the extent possible, existing data and Philippine professionals knowledgeable of the pertinent fields." All of the field data was collected in the Philippines

between February 11 and March 7, 1985. Members of the assessment team were in the field for different lengths of time and expended varying levels of effort. They included:

- Dr. George Burrill--team leader and institutional analyst,
- Dr. Marcelino Dalmacio--forester/woodlot production specialist,
- Dr. Virgil Flanigan--gasifier/charcoal production technology engineer,
- Mr. Donald Pingrey--dendrothermal plant engineer,
- Mr. Roberto Rapera--fuelwood/charcoal market analyst,
- Dr. Adolfo Revilla--forester/fuelwood production and marketing analyst,
- Dr. Jayant Sathaye--economist and electricity demand analyst,
- Dr. Robert Siy--institutional analyst, and
- Mr. Eulogio Tagudar--forester/harvesting specialist.

Ms. Lisa Beale Powlison of ARD was responsible for editing the report.

III. RELEVANT ENERGY MARKET ANALYSIS

A. Introduction

Economic growth in the Philippines, as in many other developing countries, has been fueled largely by imported oil. Prior to 1973, oil was inexpensive, convenient to use and readily available on the world market, which led to its widespread use in all sectors of the economy. This heavy dependence on a single imported fuel exposed the economy to severe disruptions during and after the two oil price increases. Growth in the real gross domestic product (GDP) declined in 1974, compared to 1973, and again in 1980, compared to 1979. Due to the oil price increase, worldwide recession and large burden of debt in the Philippines, this growth rate continued to decline after 1980 and was negative in 1984. Economic projections made by the National Economic Development Authority (NEDA) and private consulting companies call for zero to one percent growth in 1985.

The effect of the oil price increases is readily seen in the increased import burden. The total oil bill doubled from 1973 to 1974 and again from 1977 to 1980. Payments for oil as a fraction of export proceeds increased fourfold from 9.9 percent in 1973 to 38.5 percent in 1980. Since exports declined faster then oil imports after 1980, the fraction increased further to 43 percent by 1983.

Recognizing the burden placed on the country by imported oil, the GOP made a concerted effort to substantially reduce oil imports. By 1983, imported oil accounted for only 76 percent of commercial energy consumption compared to 95 percent in 1973. These figures include some traditional fuels, such as bagasse and agricultural waste products, but not fuelwood and charcoal used in households. (The accounting of industrial energy use is not clear.) As a result, these statistics understate the amount of energy used in the country and mask not only the substitution of petroleum fuels by fuelwood and charcoal, but the increasing use of these traditional fuels in households as well.

Oil imports were displaced through fuel substitution and energy conservation, with substitutes from both domestic and imported energy sources. The domestic sources included coal, oil, hydro, geothermal and traditional fuels, such as fuelwood and charcoal. The domestic sources were supplemented with imported coal, and starting in 1985, imported nuclear fuel.

The Philippines has proven reserves of coal amounting to 312 million metric tons (MT), of which it is estimated that 210 million can be mined (Ministry of Energy, 1983). The quality of coal varies among the islands. Production in 1983 displaced

about four million barrels of oil equivalent (MBOE). Oil production has decreased from 7.2 million barrels in 1979 to 4.7 million barrels in 1983.

There were no dendro thermal plants operating in 1983, but dendro thermal capacity was approximately five MW in early 1985, with four plants in operation at partial load. The first plant in Bolinao, rated at three MW, began continuous operation in January, 1985. In addition, 17 plants ordered by the National Electrification Administration (NEA) are yet to be installed. The equipment for most of the plants is in the Philippines, but installation is contingent on the ability of NEA to secure sufficient funds from the government to cover local costs. Existing dendro thermal capacity and generation are discussed in greater detail in Section IV.

In 1983, geothermal capacity was 784 MW, and cumulative proven steam capacity reached 1,573 MW. Geothermal electricity supplied 7.9 MBOE or 7.1 percent of the country's total commercial energy consumption. Hydroelectric capacity was 1,654 MW in 1983, and contributed 5.7 MBOE or 5.2 percent of the total energy needs.

Imported coal, which has a higher calorific value and was used primarily in cement plants, supplied one MBOE of energy in 1983. Generation from the 620-MW nuclear plant is expected to begin in 1985. At a 60 percent capacity factor, the plant will generate 3,260 gigawatt-hours (GWH) of electricity beginning in 1986.

Evidence of energy conservation, induced by higher fuel prices and non-price policies, is apparent in the declining intensity of energy use in industry and transportation. The intensity of oil use per unit of value added in industry declined from 830 BOE per million pesos in 1979 to 498 in 1983. Combined with an increase in intensity of coal use from 15 BOE per million pesos in 1979 to 72 in 1983, the intensity of commercial energy use declined from 845 in 1979 to 570 in 1983. Intensity of oil use per vehicle in the transportation sector declined from 14 BOE per vehicle to 11 during the same period. Combined with trends in energy use in other sectors, the intensity of energy use per unit of GDP declined from 1,250 BOE per million pesos in 1979 to 984 in 1983.

B. Electricity Demand and Supply

The Philippines' power generating capacity expanded from 2,997 MW in 1973 to 4,957 MW in 1983 at an annual rate of 5.2 percent, well in excess of the annual GDP growth rate of 3.1 percent for this period. This high growth rate signalled not only a period of more intensive electricity use, but also the

expansion of distribution networks to rural areas that were previously unsupplied.

Since 1978, the government has focused on reducing oil-fired capacity, primarily through the installation of power plants that tap domestic energy resources, such as geothermal, hydro, coal and dendro thermal. Indeed, the share of oil-fired capacity has declined from 73 percent in 1978 to 52 percent in 1983. By 1987, total capacity is projected to be 6,886 MW of which only 40 percent will be oil-fired, and by 1992, 7,782 MW with only 35 percent oil-fired. The fraction of generation from oil is expected to be even smaller, 17 percent in 1987 and 19 percent in 1992, since it is assumed that the displaced oil-fired plants will be maintained as part of the reserve supply.

These projections do not explicitly take into account power generation from dendro thermal or mini-hydro plants operated for the NEA. Compared to the capacity and generation from National Power Corporation (NPC) plants, that of NEA plants can be considered marginal. However, the NPC operates on only eight of the hundreds of islands that make up the Philippines. Thus, the NEA is in a position to provide small amounts of much needed power on many of the other islands.

The displacement of oil by the construction of non-oil fired power plants will lead to excess capacity on each of three grids operated by the NPC--Luzon, Visayas and Mindanao. In 1983, the reserve margin on these grids was 34, 63 and 27 percent, respectively. The high margin for the Visayas is slightly misleading since all the islands are not connnected. Because each island has a different supply and demand configuration, they need to be evaluated separately. Reserve margins are projected to remain high for the next decade.

The reserve margins are based on demand and supply plans provided by NPC. The annual growth of electricity sales is projected to be 12 percent in the Visayas and 11 percent in Mindanao. Industrial expansion and addition of new customers (suppressed demand) is assumed to ensure rapid growth of electricity sales, but there has been no study to substantiate such claims with analyses of industrial, residential and commercial demand. The ARD assessment team examined the growth of demand and consequent need for supply options on two of the islands in the Visayas (Cebu and Bohol) and Masbate. The team's findings are reported in detail in a subsequent section, but the conclusions regarding the nature of electricity demand and supply in a largely rural setting are discussed here.

The high growth rates projected by NPC for Mindanao and the Visayas are based on historically high rates of growth for electricity demand on these islands, which stemmed from both industrial growth and rural electrification. However, industry

has been hurt by the economic depression of the last few years, as have rural areas. Consequently, growth rates are likely to be far lower than suggested, which belies the notion that there is always suppressed demand waiting for power in developing countries. It is more likely that, assuming favorable electricity prices, suppressed demand will exist only if households can afford appliances and industries have access to all production factors with an assured demand for their output.

Industrial demand for electricity often tends to be lumpy. A single industry, such as a large mine, can easily swamp the total household demand for electricity. Consequently, the shutdown of such an industry can leave the power supplier with an excess of unutilized power, and thus, unproductive capacity and a loss of revenue that may be sufficiently large to jeopardize the supplier's operation.

The demand for electricity in rural households is primarily for lighting and peaks in the evening around seven p.m. If industrial demand is nonexistent or very small, demand during the rest of the day can be small, often only 25 percent of the peak evening demand. This pattern of daily demand can create problems for the efficient operation of a dendro thermal power plant, which is designed to generate electricity on a continuous basis, 24 hours a day. Likewise, for a mini-hydro plant, if no dam is built, stream flow cannot be controlled to match hourly demand changes, which results in power production that is less than optimum.

Connecting dendro thermal plants to a large grid can improve their economic viability. If peak demand on other parts of the grid occurs at a time that offsets the rural cooperative's low demand during the day, the plant can be operated at a higher capacity factor to provide a steady supply of electricity. In planning a dendro thermal plant, due consideration should be given to other facilities being planned to supply the same demand. For instance, NEA has planned a five-MW mini-hydro plant in Bohol along with a five-MW dendro thermal plant, both of which would be connected to the grid. The current peak demand on the grid is only eight MW, and the base demand about two MW. Both plants are expected to provide base-load power, which will clearly be far in excess of demand.

1. Electricity Rates

The average power rate charged by the NPC was 0.579 pesos per kilowatt-hour (kwh) in 1983. The rate increased rapidly after 1979, primarily due to increased fuel costs (see Figure III.1). Increases were particularly sharp in 1979 to 1980 and again in 1982 to 1983. The second increase was caused by gradual devaluation of the peso, which continued in 1984, and the

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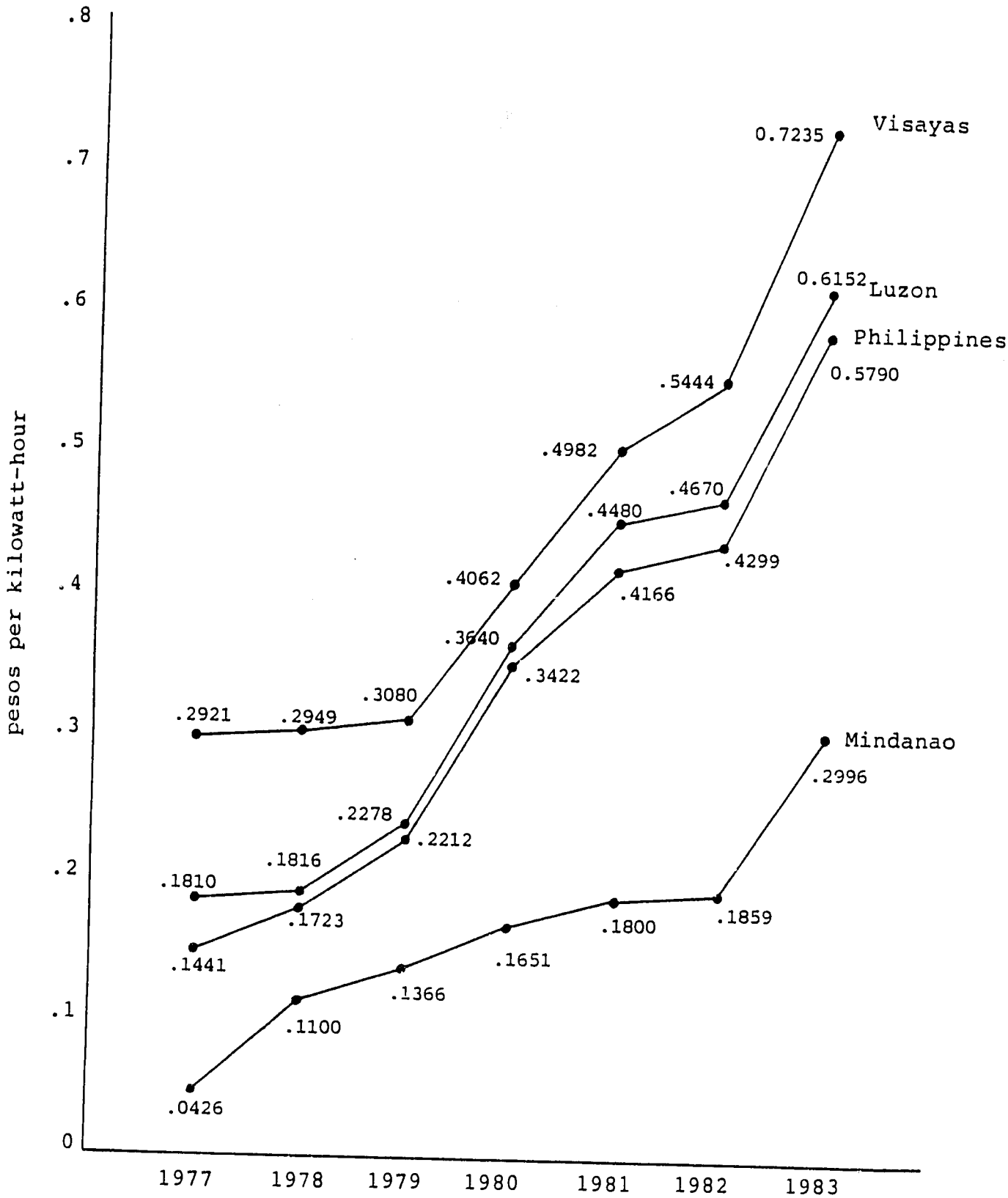
Figure III.1. Average Power Rates for 1977 to 1983



required increase in NPC's rate of return to at least eight percent, which was stipulated in NPC's loan agreement with the World Bank and Asian Development Bank (ADB) in order to enable NPC to generate funds from its operations to finance an increasing proportion of its capital investment.

To raise peso funds for financing the construction of on-going projects, NPC's basic rate was raised by 10 percent in February, 1983. Furthermore, the two successive devaluations in 1983 raised the peso cost of debt service payments as well as the foreign exchange portion of other operating expenses. The power rate structure was changed by adding a foreign exchange adjustment clause. Devaluation of the peso also increased the cost of fuel oil and geothermal steam, which increased electricity rates further yet. If, as expected, the peso is again devalued, power rates will increase faster than can be justified by domestic price increases.

The average power rate masks the wide disparity in rates among the three major grids. Rates on Mindanao have been traditionally lower than those on the other grids because of the large amount of inexpensive hydro generation. On the other hand, rates in the Visayas have been traditionally higher. Generation there has relied on fuel oil until recently, when geothermal and coal power plants were introduced. In 1983, the Visayas' power rate was 25 percent above the average for the Philippines. However, even the rates within the Visayas vary since not all the islands are connected--Negros has a rate of 0.56 pesos per kwh since it depends on geothermal power, compared to 1.16 on Panay which uses oil.

Despite the fact that rates are highest in the Visayas, they do not cover the generation costs on each island. For instance, in 1984, the average power rate on Bohol was 0.96 pesos per kwh, compared to an average cost of generation of 1.46 pesos, which reached 2.01 pesos by December, 1984. With future devaluation of the peso, this figure could increase rapidly since most of the generation on Bohol is oil-fired, and devaluation of the peso could easily offset a decline in the dollar price of oil.

2. Rural Cooperatives' Rates

The electricity rates of rural cooperatives are dictated by two objectives that are often in conflict. One is to keep power rates within the reach of rural people, in line with the area coverage concept. The second is to maintain rates at a high enough level to recover the cooperative's annual expenses incurred in the generation, purchase, transmission and distribution of power. This conflict has caused cooperatives to operate at a loss for many years.

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The area coverage concept calls for supplying electricity to every household within a cooperative's territory, regardless of the site's remoteness. This can lead to the extension of distribution lines into areas of low population density, which results in costs that cannot necessarily be justified by the revenue that will be collected from these customers. Furthermore, the extension of lines can lead to very high system losses. The average system loss for electric cooperatives deteriorated from 20 percent in 1981 to 22 percent in 1983, with losses varying from three to 46 percent across cooperatives.

Power expenses--the costs of purchasing and/or generating power--account for about three-fourths of electric cooperatives' total power rates. Cooperatives pass on increases in NPC power costs after adding a surcharge of 40 percent to cover the high system loss of 23 percent as well as a 10 percent provision for inflation. However, in 1983, markups ranged from seven to 208 percent.

C. Fuelwood/Charcoal

Traditional fuel sources, such as firewood, charcoal, wood wastes, and plant and animal residues are widely bought and sold in the Philippines, although formal market channels are scattered and unorganized. The heating values of firewood and charcoal differ, even when they came from the same species, with charcoal having the higher value. For example, giant ipil-ipil firewood has a heating value of 4,000 Btu per pound, while its charcoal has a value of 11,800 Btu per pound. Of course, more than just one pound of firewood is required to produce one pound of charcoal. Under actual field conditions in the Philippines, the production of one ton of charcoal requires five tons of green wood or four tons of dry wood.

Although firewood and charcoal have been produced and used in the Philippines for a very long time, no comprehensive historical records about marketing or supply and demand for these products exist. Limited studies of these commodities (some of which are referred to in this section) have been conducted only in recent years, but in general, the lack of reliable data, if any, on supply and demand for these products is a great hindrance to the formation of meaningful conclusions. This section presents the fragmented information that the ARD assessment team was able to gather from the few island-specific studies that have been conducted, team members' own observations in the field and recent figures developed by the Ministry of Energy (MOE). In 1982, MOE published the results of its energy sector survey for 1979. That report contains helpful data and several interesting observations regarding the demand for firewood and charcoal.

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1. Demand

Household Sector

The 1979 MOE survey of Philippine households found that energy use nationwide was 38,726 thousand barrels of oil equivalent (BOE) (see Table III.1). Traditional fuels--primarily fuelwood, coconut shells and charcoal--accounted for 22,864 thousand BOE or 59 percent of total energy use; fuelwood acccounted for 54 percent of traditional fuel use.

Households use energy for cooking, transportation, ironing, lighting and entertainment. By far, energy used for cooking accounts for the largest fraction (66 percent) in both urban and rural households. Transportation is the next largest use, and as expected, urban households account for a larger share (28 percent) of this total than rural households (14 percent).

Most traditional fuels are used for cooking. Suprisingly, only 20 percent of the charcoal is used for this purpose, with the remainder being used for ironing, and the fuel used for ironing constitutes a significant fraction (11 percent) of total household energy use. The amount of charcoal consumed per household increases with income, although it is used primarily for ironing in both urban and rural settings. The small amount of charcoal used for cooking may be explained by the disproportionately high price of charcoal compared to fuelwood per Btu of energy. In Table III.2, the figures for Region 4 showing the use of 80 percent of the charcoal for ironing are not easily explained. Electricity is readily available and subsidized up to 200 kwh a month, so charcoal use for ironing should comprise only a small part of total charcoal consumption. If the survey data are accurate, one possible explanation is that all the charcoal used for cooking is found in Region 4.

The 1979 survey also reported some findings on fuel substitution. Eighty percent of urban households have switched cooking fuels at one time or another, perhaps due to higher incomes and the greater availability of more convenient fuels in urban areas compared to rural locations.

Other noteworthy findings of the 1979 MOE survey were as follows. First, rural households consume fuelwood even when their standard of living improves, perhaps because of a lack of available alternative cooking fuels. Second, household consumption of firewood and charcoal has a very low, negative correlation with the extent of forestation in the area. This is surprising, but it may be that the extent of forestation is correlated with the availability of other fuels. Third, the consumption of firewood and charcoal in rural households has a

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Table III.1. MOE Estimates of Total Energy Use by Philippine Households in MBOE

Source	Cooking	Ironing	Lighting	Motive Power	Space Heating	Entertainment
Firewood	12,301.54					
Coconut shells	2,426.16					
Other Noncommercial Energy	2,888.14					
Charcoal	1,049.83	4,199.34				
Electricity		150.94	254.71		264.15	273.58
LPG	1,204.58					
Kerosene	3,353.08		2,743.43			
Other Commercial Energy				7,618.02		
Totals	23,223.33	4,350.28	2,998.14	7,618.02	264.15	273.58

Table III.2. Regional Percentages for 1977 Fuelwood and Charcoal in Philippine Households

	Region											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Firewood	12.59	2.33	8.44	14.46	2.84	16.61	6.55	6.18	17.48	3.55	2.45	6.52
Charcoal	8.58	2.94	11.72	38.52	6.91	5.85	4.97	5.10	5.16	4.56	1.65	4.04

high correlation with the number of markets in the area selling these commodities. As shown in Table III.2, the bulk of the charcoal (39 percent) is consumed in Region 4, while fuelwood use is more evenly distributed with the largest share (17 percent) in Region 9. This fact may be partly explained by the higher income of residents in Region 4, which includes Metro Manila.

Using the MOE estimates of fuelwood consumption in Table III.2 and assuming a ratio of 25 urban to 75 rural households, fuelwood consumption per household is estimated at 2.78 cubic meters per year. This figure already includes coconut shells and wood wastes and is the weighted average of 2.30 and 4.22 cubic meters for each rural and urban household per year, respectively.

On the other hand, Heyde in 1979 and Wiersum in 1977 showed that per capita fuelwood consumption in Indonesia and the Philippines ranges from 0.53 to 0.93 cubic meters per year. This translates to 3.2 cubic meters per family per year, if firewood is a supplementary fuel, and 5.5 if it is the household's only fuel, for an average value of 4.8 cubic meters per family per year.

While it is difficult to specify all the possible explanations for the disparity between these two derived values for average fuelwood consumption per household per year, it seems likely that both 2.78 and 4.8 cubic meters are very close approximations of the true average annual household consumption of fuelwood. The higher estimate was derived from a small sample of Philippine households and probably reflects all the energy sources used for cooking by the sampled households in an equivalent volume of fuelwood. The MOE estimate, on the other hand, is lower because it includes only the volume of fuelwood equivalent to the firewood, coconut shells and wood wastes used for cooking in the sampled households.

Since fuelwood is used primarily for cooking, demand is tied directly to the number of persons relying on it. Furthermore, the demand for fuelwood for cooking will depend on both the availability of other fuels, such as liquified petroleum gas (LPG), and consumers' ability to afford such fuels, which will be determined by household income and fuel prices.

It is clear that the population of the Philippines is expected to increase. If the factors mentioned above did not change, fuelwood demand would increase at a rate equal to the population growth rate (see Table III.3), but expected changes in most of the other factors will increase the demand for fuelwood. For instance, per capita income is not expected to reach the levels predicted for 1983 until 1995,* and according to some

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*AID internal memorandum, 1985.

Table III.3. Firewood Demand Projections for Household Sector (in '000 cubic meters)

Region	1985		1990		2000	
	(2.78) Low	(4.8) High	Low	High	Low	High
1	1,895.1	3,272.2	2,154.5	3,720.0	2,688.2	4,641.2
2	1,186.2	2,048.2	1,348.3	2.328.0	1,715.3	2,961.6
3	2,562.3	4,424.2	2.909.8	5,024.2	3,661.3	6,321.6
4	3,271.2	5,648.2	3,711.3	6,408.0	4,678.7	8,078.4
5	1,853.4	3,200.2	2,108.1	3,639.8	2,641.0	4,560.0
6	2,423.3	4,184.2	2,752.2	4,752.0	3,475.0	6,000.0
7	2,024.7	3,495.8	2,301.8	3,974.4	2,871.7	4,958.4
8	1,505.9	2,600.2	1,709.7	2.952.0	2,132.3	3,681.6
9	1,311.3	2,264.2	1,487.3	2,568.0	1,854.3	3,201.6
10	1,468.7	2,535.8	1,668.0	2,880.0	2,085.0	3,600.0
11	1,770.0	3,056.2	2,009.9	3,470.4	2,502.0	4,320.0
12	1,181.5	2.040.0	1,342.7	2,318.4	1,715.3	2,961.6
Metro Manila	3,169.2	5,472.0	3,594.5	6,206.4	4,495.3	7,761.6
Philippines	25,622.8	44,241.4	29,098.1	50,241.6	36,515.6	63,047.6

reports,* income distribution worsened during the 1970s and will continue to do so with economic stagnation. As a result, a larger fraction of the population will have lower incomes and a consequent propensity to consume more fuelwood.

Furthermore, the rapid increase in oil prices has made LPG more expensive, and LPG consumption in both absolute and per capita terms has declined since 1981. Even if international oil prices decline through the 1980s, domestic LPG prices may continue to increase if the peso is devalued further, as expected.** Thus, under present economic conditions, it is unlikely that households will be able to readily afford to switch to LPG. At least through 1995, fuelwood consumption may increase at a rate faster than the population growth rate, while after 1995, with stable economic growth and greater availability and affordability of other fuels, its increse may slow to a rate below the population growth rate.

Two projections were made, based on different assumptions about household fuelwood consumption, although both assume that demand will increase at the same rate as population growth. Due to time constraints, the factors discussed above were not incorporated in these projections. Hence, these figures will likely be a lower bound for the years up to 1995 and an upper limit after that time. For 1977, it was estimated that the household sector consumed 5,286.9 MBOE in charcoal, which is eqivalent to 1,184.3 MT. If it is assumed that demand increases only as a result of population growth at an annual rate of 2.5 percent, household demand for charcoal is projected as shown in Table III.4. The large amount of charcoal used for ironing noted earlier is not easily explained. The assessment was unable to determine the validity of the surveys reporting this use or to readily reconcile the large fraction of charcoal use in Region 4 for ironing. Thus, the projections of charcoal demand are tenative at best.

Commercial Sector

Commercial establishments, such as hotels, restaurants and bakeries, need firewood and charcoal for specific uses, and those located outside Metro Manila use more of both for any given use. In 1977, MOE estimated that this sector consumed 11,556 MBOE of energy. Approximately six percent (693,360 BOE) and two percent (231,120 BOE) of that total were supplied by firewood and charcoal, respectively. In volumetric terms, commercial

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*University of the Philippines, "An Analysis of the Phlippine Economic Crisis: A Workshop Report," 1984.

**AID internal memorandum, 1985.

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Table III.4. Charcoal Demand Projections for Household Sector (in '000 MT)

Region	1985	1990	2000
1	124.0	140.1	179.3
2	42.5	47.3	61.4
3	169.3	191.3	245.0
4	556.5	628.9	805.0
5	99.8	112.8	144.4
6	84.5	95.5	122.2
7	71.8	81.1	103.9
8	73.7	83.3	106.6
9	74.6	84.2	107.8
10	65.9	74.4	95.3
11	23.8	26.9	34.5
12	58.4	66.0	84.4
Total	1,444.8	1,631.8	2,089.8
	6,441.6 MBOE	7,288.5 MBOE	9,329.3 MBOE

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consumption amounted to 459,004 MT of firewood and 51,770 MT of charcoal.

The MOE survey also showed that wood and charcoal are the predominant substitute cooking fuels, regardless of the type or location of business establishment. Because of current economic difficulties, almost all survey respondents (99 percent) were considering switching to cheaper fuels, if the price of commercial energy sources, especially LPG, continued to increase. The survey results suggest that in this sector, the primary demand for firewood and charcoal is for cooking. Hence, the market share of both commodities will increase if the price of LPG increases, given the past readiness of commercial establishments to switch cooking fuels.

Allowing for an annual growth rate of five percent in this sector, the relative contributions of both firewood and charcoal to total commercial energy requirements can safely be assumed to at least remain constant. Projected demand for firewood and charcoal in the commercial sector is shown in Table III.5.

Industrial Sector

Energy consumption in the industrial sector grew by an average 4.4 percent annually from 1974 to 1979. Petroleum products made up a major portion (59 percent) of the total energy inputs for the sector, while coal contributed three percent and firewood, in the form of wood wastes, seven percent. However, because of recent economic developments and government directives aimed at lowering costs and the country's dependence on imported energy, charcoal and firewood are expected to constitute a larger share of the energy source mix for the industrial sector.

In the cement, mining and metal processing industries, charcoal has a very large potential market. AID estimates of charcoal demand for the industrial sector are shown in Table III.6. This sector does not have a demand for firewood per se; rather, wood wastes are used as an energy input to solve waste disposal problems.

Charcoal Exports

Firewood from "bakawan" is exported, but there are no estimates of this volume. Obviously, it is insignificant compared to exports of primary wood products. On the other hand, charcoal is exported to the Republic of Korea, Hong Kong, Japan, Guam, Taiwan, United States and France. Japan and the United States are the major buyers of Philippine charcoal, particularly that made from coconut shells.

Table III.5. Projected Demand for Firewood and Charcoal in the Commercial Sector.*

Fuel Type	1985	1990	2000
fuelwood ('000 cubic meters)	1,180.9	1,511.6	2,463.9
charcoal (MT)	69,372.0	88,796.0	144,737.0

*These projections do not include plans for gasifiers, which could have a very significant effect. If they can reduce this sector's dependence on purchased electricity, even just for lighting, the proportion of charcoal in the energy source mix will increase.

Table III.6. AID Demand Projections for Charcoal in the Industrial Sector (in '000 MT)

Industry	1985	1990	2000
smelter plants	307.35	392.26	639.39
cement industry	6.69	21.87	29.30
sugar industry	168.0	205.0	303.4
others -- tobacco, ceramics, etc.	204.1	249.0	368.5
Total	536.14	868.13	1,340.59

Table III.7. Summary of Philippine Charcoal Exports (in MT)*

Year	Wood Charcoal	Coconut-Shell Charcoal	Total
1978	8.1	20,863.3	20,871.4
1979	1.8	33,092.4	33,094.2
1980	112.0	48,394.5	48,506.5
1981	110.3	32,861.2	32,971.5
1982	-	23,074.9	23,074.9
1983	163.5	16,942.3	17,105.8

*Taken from Foreign Trade Statistics of the Philippines.

The percentage share of Philippine charcoal exports to world market imports doubled from 1978 to 1980, but dropped in 1981 and 1982, with exports in the latter year equivalent to 6.6 percent of world imports. Philippines' charcoal exports for 1978 to 1983 are shown in Table III.7. Although the country's exports have decreased, worldwide imports continue to increase, which means that with improved marketing strategies, it should be possible to maintain Philippine charcoal exports at the 1983 level of 17,106 MT.

Overall Projections

Overall projections of demand for fuelwood and charcoal are shown in Tables III.8, III.9 and III.10. Tables III.8 and III.9 give aggregate estimated demand volumes for fuelwood, while Table III.10 presents the total projected demand for charcoal. The projected demand estimates for fuelood in the two scenarios differ by 68 percent, and the figures for charcoal are tentative at best. Clearly, relevant surveys and demand projections must be analyzed carefully before proceeding with a program of fuelwood plantations.

2. Supply

Firewood

Quantitative data on current firewood supplies are quite inadequate, primarily due to the fact that fuelwood production and distribution systems in most areas of the Philippines are unorganized and widely dispersed. Consumers and producers of firewood transact business in a variety of ways and places. In fact, a 1980 MOE report found that only about one-third of total firewood consumption is actually traded in the marketplace.

Measuring fuelwood supplies is a serious problem, as firewood sold in the markets of various localities is measured in a variety of units. When purchased in small quantities, it is measured in kilos, bundles, carloads, sacks, tin cans and plastic bags of varying size, while in large quantities, it comes in tons or cubic meters.

The supply of firewood comes from private lands and public forests, where collection is allowed by law after paying minimal forest charges. Additional fuelwood supplies also come from coconut plantations (fronds and shells), tree branches from backyards, wood fences, wood wastes and rice hulls. In the near future, tree plantations established as part of the industrial plantations program will also be a source of firewood.

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Table III.8. Low Estimate of Total Projected Demand for Firewood
(in '000 cubic meters)

Sector	1985	1990	2000
Household	25,622.8	29,098.1	36,515.4
Commercial	1,180.9	1,511.6	2,463.9
Total	26,803.7	30,609.7	38,979.3

Table III.9. High Estimate of Total Projected Demand for Firewood
(in '000 cubic meters)

Sector	1985	1990	2000
Household	44,241.4	50,241.6	63.047.6
Commercial	1,180.9	1,511.6	2,463.9
Total	45,422.3	51,753.2	65,511.5

Table III.10. Total Projected Demand for Charcoal
(in '000 MT)

Sector	1985	1990	2000
Household	1,444.8	1,631.8	2,089.8
Commercial	69.4	88.8	144.8
Industrial	536.14	868.13	1,340.59
Subtotal*	2,050.34	2,588.73	3,574.39
Charcoal exports	17.0	17.0	17.0
Total	2,067.34	2,605.73	3,591.39

*Estimates based on historical consumption data.

In 1982, BFD reported firewood production of 69,262 cubic meters from the uplands and 14,362 cubic meters from the mangrove areas for a total of 83,624 cubic meters. However, this only represents fuelwood gathered legally with the necessary permit. It is highly likely that more was gathered illegally (i.e., without a permit). In the same year, BFD also reported about 2.3 million hectares of reproductive brush throughout the country, but some of these areas are inaccessible and are public forest land as well, where no cutting is allowed. Still, assuming that firewood can be gathered from these areas at the rate of two cubic meters per hectare per year, production for these areas would amount to 4.6 million cubic meters. Another potential source of fuelwood is the ipil-ipil plantations established by various agencies and programs. As of 1982, Maligalig reported about 15,875 hectares of such plantations. Given an annual increment of 20 cubic meters per hectare, these areas are capable of producing about 317,500 cubic meters of fuelwood.

Coconut plantations are also a potential source of firewood. In 1982, the Philippine Coconut Authority (PCA) reported a total production of 13.98 billion coconut shell pairs. These shells have various uses as copra fuel, for charcoaling, as dessicated copra fuel and for household fuelwood. Historically, 17 percent of coconut shell production is used as household fuelwood. Given that proportion, it is estimated that coconut shells contribute an equivalent of 1,020 cubic meters of firewood to the supply of fuelwood. Moreover, assuming the volume of coconut fronds contributes the same amount, coconut plantations are capable of producing the equivalent of roughly 2,040 cubic meters of firewood.

Table III.11 summarizes contributions from the various sources of firewood, and shows that on a yearly basis, these sources are capable of producing only about five million cubic meters of firewood. This means that the bulk of the demand for firewood is being met by production on other private lands and tree farms as well as with wood wastes and rice hulls. It is clear that the data are inadequate to arrive at any reliable estimates of firewood supply.

Charcoal

Charcoal is produced from wood and coconut shells. The former is produced from wood gathered on public forest land and private farms and land as well as wood wastes and production from tree farms. Because of insufficient information, wood charcoal production from public forest land and private farms and land is rather difficult to assess. However, for 1982, BFD reported that a total of 2,239 cubic meters of charcoal was produced from public forests, which, of course, only represents charcoal produced legally after payment of a small fee. Charcoal is also

produced from wood grown on tree plantations established through FSDC's Tree Resources for Energy and Enterprise (TREE) program.

Charcoal is also produced from coconut shells. For the period from 1982 to 1983, the average annual growth rate of coconut shell production was 5.8 percent, but out of the total produced, only about 34 percent on average are available for charcoal production. PCA's market development department reports that 114,183 metric tons of coconut shell charcoal was produced in 1982. Since the total production of shell pairs is expected to continue to grow at an annual rate of 5.8 percent, it is also expected that the amount of charcoal produced from coconut shells will increase at the same rate.

3. Market Prices

Firewood/Fuelwood

Several studies have collected data on fuelwood prices in the Philippines, but comparisons of these prices are hindered by differences in measurement units as well as the survey's base year and location. For instance, MOE estimated that the average price in 1980 was 0.63 pesos per kilogram in urban areas and 0.67 pesos in rural locations. The price in rural areas is higher because it was derived through shadow pricing, such that ₱0.67 actually represents the value of the effort required to collect a kilogram of fuelwood in rural areas. Another estimate of fuelwood prices in various parts of the country is shown in Table III.12. As can be seen, prices depend on whether wood is picked up or delivered, and retail or wholesale as well as with location.

Recently, the price of fuelwood in areas visited by the ARD assessment team has gone up considerably. Table III.13 shows fuelwood prices for various parts of the country. Except for Panay Island, these figures are the price of fuelwood in bundles sold in the marketplace and along roadsides. Compared to 1981 prices, the cost of fuelwood in 1985 is up significantly. For example, in Cebu, the same amount of fuelwood cost ₱119 per cubic meter in 1981, but ₱183 in 1985. This represents an increase of ₱64--54 percent over a three-year period or 16 percent annually. Partly, the rise in fuelwood prices can be attributed to inflation and increases in the price of LPG. It can also be explained by the increasing scarcity of fuelwood. Over time, collecting firewood becomes more costly because the areas where it is available become less accessible. This increases the cost of gathering the wood and hence, the market price of fuelwood.

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Table III.11. Contribution to Firewood Supply from Various Sources

	Estimated Annual Contribution (cubic meters)
legal gathering	83,624
reproduction/brush	4,600,000
tree plantations	317,500
coconut plantations	2,040
Total	5,003,524

Table III.12. Price of Ipil-Ipil Firewood Per Cubic Meter at Selected Locations in the Philippines.*

	Buying Price		Selling Price		
			Retail	Wholesale	
	Picked up	Delivered	Picked up	Picked up	Delivered
Cebu	39.00	115.00	157.00	119.00	142.00
Davao	40.00	50.00	-	32.00	40.00
Ilocos	81.00	88.00	127.00	95.00	95.00
Iloilo	30.00	119.00	135.00	90.00	129.00
Laguna	117.00	150.00	204.00	198.00	247.00
Negros	36.00	93.00	120.00	44.00	102.00
Average	57.00	102.00	149.00	96.00	126.00

*Taken from Novero, et al, 1981 survey.

Table III.13. 1985 Fuelwood Prices in Selected Areas of the Philippines

	Price (₱/cubic meter)
Ilocos	150 (retail, roadside) 100 (wholesale, farm gate)
Bohol	110 (retail, roadside)
Cebu	183 (retail, market)
Masbate	192 (retail, market; 7 ₱/bundle from farm and 11 ₱/bundle at market)
Panay Island	180-220 (stump site)

Charcoal

In general, there are no standards for charcoal quality or bag sizes, but often, charcoal is sold by the kilo or sack (12 to 16 kilos), particularly in urban centers. Charcoal is more economical to transport than firewood because it has a higher value-to-bulk ratio. Thus, it gains a relative economic advantage over wood as the distance between production and consumption centers increases, and unlike fuelwood, charcoal from areas with surpluses could find its way to locations with deficits, even though they are widely separated.

In the past, several studies have attempted to determine a national price for charcoal. Wood, et al (1979) reported that the average price of charcoal in the Philippines in 1969 was ₱0.09 per kilogram and ₱2.85 in 1977, which represents an annual increase of about 54 percent. On the other hand, Estudillo, Amio and Tamolang (1980) reported a retail price of ₱1.55 per kilogram. A sample of 1976 charcoal prices for various parts of the Philippines is given by Ang Bange and Curran (see Table III.14).

Table III.15 shows charcoal prices for various locations from another study conducted by Novero, et al in 1981. The prices vary depending on the season and whether the charcoal is picked up or delivered. Higher prices during the rainy season can be attributed to the relative scarcity of charcoal at this time. This is due to the fact that farmers normally work in their fields at this time of year and hence, fewer persons are available for charcoal-making. Moreover, gathering wood and charcoal-making are both more difficult during the rainy season, particularly for backyard operations.

Still, more recent data obtained by the ARD assessment team for selected areas of the Philippines is shown in Table III.16. The national average price for 1985 is about 2.40 pesos per kilogram, compared to 1.34 in 1984 and 0.86 in 1983. A closer examination of the figures reveals that since 1983, the average price of charcoal has gone up at a rate of 67 percent a year. The magnitude of the annual increases can be attributable to crises that began in 1983. Inflation was estimated at about 50 percent per year during the period, and the peso was devalued several times, from about 10 to one U. S. dollar to about 18 per dollar. The prices of both LPG and charcoal increased by about 50 percent.

The annual increases of 67 percent in charcoal prices for 1983 to 1985 are not expected to continue for the next two to three years. As prices for other energy sources stabilize, the annual rate of increase for charcoal prices should decrease. For instance, the peso-to-dollar ratio has remained relatively constant over the past few months, which should have some

Table III.14. Sample 1976 Charcoal Prices for the Philippines

	Price (P/kg)
Iligan	0.45
Negros Oriental (wholesale)	0.43
Bo. Puray, Montalban, Rizal	0.45
San Juan	0.90
Los Banos	1.58
Manila (delivered)	0.80 - 1.00
Rural Areas	0.20
Average Urban	0.98

Table III.15. Market Prices per Kilo of Charcoal for Selected Areas*

	Dry Season				Rainy Season			
	Buying		Selling		Buying		Selling	
	Picked up	Delivered	Picked up	Delivered	Picked up	Delivered	Picked up	Delivered
Batangas	0.49	0.69	0.69	0.89	0.67	0.82	0.80	1.00
Cebu	0.53	0.58	0.62	0.63	-	-	-	-
Iligan	0.40	0.44	-	-	-	-	-	-
Iloilo	0.28	0	0.31	-	0.39	-	0.44	-
Negros	-	0.47	0.57	0.84	-	-	0.80	1.18
Average	0.42	0.54	0.55	0.78	0.53	0.87	0.68	1.09

*Taken from Novero, et al, 1981.

Table III.16. 1983 to 1985 Prices for Some Areas of the Philippines (in P/kg)

	1983	1984	1985
Roxas City	0.80	1.60	2.10
	-	1.50	2.00
Iloilo	1.00	1.20	2.85
Cagayan	-	1.20	-
Ilocos	-	-	3.75 (Ret.)
	-	-	2.50 (FOB Laoag)
Pangasinan	0.80	1.20	1.80
Pampanga	-	-	2.50 (FOB kiln)
Average	0.86	1.34	2.40

Table III.17. Costs of Converting Wood to Charcoal in 1982

Items*	Cost (P/kg)
hauling	0.14
cutting/preparation	0.06
kiln operation	0.20
kiln depreciation	0.02
overhead	0.04
Total	0.46

*The cost of hauling refers to transportation from the stump site to the kiln, while cutting refers to bucking and preparation done prior to firing. Kiln operation is solely labor costs, while depreciation is the cost of using the kiln, based on an assumed kiln life of five years.

stabilizing effect since the prices of gasoline, oil and related commodities are tied to the U. S. dollar and thus, should also stabilize. However, it is expected that the current price of charcoal will increase, although at a much slower rate than was observed in 1983 to 1985.

The assessment team also observed that most of the charcoal sold in Laoag actually comes from Region 2, the Cagayan Valley, which is more than 100 kilometers away. This explains why the price of charcoal in Laoag is higher than the national average. Higher prices are also likely in areas where commercial establishments and industries have sizable charcoal requirements. These businesses can easily outbid household users, thus causing price increases.

Comparison of Firewood and Charcoal Prices

Wood used as firewood can also be converted to charcoal. Hence, given a certain volume of firewood, the producer actually has a choice of selling it as firewood or converting it to charcoal first. If the price of charcoal is high relative to that of firewood, producers would naturally convert the wood to charcoal, thus reducing the supply of firewood and increasing the supply of charcoal. Eventually, because of its "scarcity," the price of firewood will rise until producers are indifferent about whether they produce firewood or charcoal.

To perform a numerical comparison, the cost of converting firewood to charcoal was assumed to be the same as for the Pantabangan charcoaling operation. On the basis of 1982 figures, the cost of charcoaling using a 10-cubic meter, beehive-type kiln operated on a seven-day cycle is ₱0.46 kilogram (see Table III.17). Given this cost, the relative prices of firewood and charcoal for Cebu, Iloilo and Negros were compared using 1981/1982 prices (see Table III.18). All of these locations have a relatively low price for charcoal compared to firewood, such that the price of the wood plus the cost of converting it to charcoal exceeded the price of charcoal. In these cases, wood producers would be better off to sell the wood directly as firewood instead of converting it to charcoal.

Adjusted 1984 costs for charcoaling are shown in Table III.19, with all of the same components as shown previously for 1982. Using these figures, the price at which wood producers would be indifferent to whether they sell the wood as charcoal or firewood can be determined. For example, if the price of charcoal at FOB kiln is ₱2.40 (the average price for February, 1985) and the producer wants a profit margin of at least 20 percent for charcoaling, the corresponding price of wood should be about ₱120 per cubic meter for the producer to sell it as

Table III.18. Comparison of Firewood and Charcoal Prices for 1981 to 1982

	Fuelwood Cost (₱/cubic meter)	Conversion Cost (₱/cubic meter)	Total Cost (₱/cubic meter)	Price When Offered as Charcoal (equivalent to one cubic meter of wood)
Cebu	39	35.20	74.00	58.3
Iloilo	30	35.20	65.20	30.8
Negros*	93	35.20	128.20	51.7

*Delivered prices

Table III.19. 1984 Charcoaling Costs for a 10-Cubic Meter Kiln*

	Cost (₱/kg)
hauling	0.29
cutting/preparation	0.13
kiln operation	0.39
kiln depreciation	0.05
overhead	0.05
Total	0.91

*Adjusted costs from NIA, Pantabangan.

fuelwood. On the other hand, if the price for fuelwood is lower, the producer would be better off converting the wood to charcoal.

4. Consumption

The present and projected demand for firewood exceeds the estimated supply, which is only about five million cubic meters. Firewood requirements for the household sector alone are estimated at 44 million cubic meters for 1985. However, fuelwood prices have not increased at a rate high enough to justify this difference in demand and supply, which means that in order to satisfy the demand, a bulk of the requirement is probably being met with wood from private lands and backyards, wood fences and driftwood. Table III.20 shows the relative scarcity of firewood.

Likewise, the present and projected consumption of charcoal exceeds the projected supply. As indicated previously, fuelwood sources for charcoal production can include coconut shells as well as wood from TREE plantations, public forests and private lands.

Coconut-shell charcoal production from 1973 to 1982 is shown in Table III.21. Based on PCA estimates, coconut shell production has actually increased at an annual rate of 5.8 percent, but from 1980 to 1982, it decreased, which caused a consequent reduction in coconut-shell charcoal production. There are no reliable estimates of the production of charcoal from wood, but assuming that production from coconut shells continues at its present level, the relative scarcity of charcoal is shown in Table III.22. As a result, most of the consumption requirements will have to be met from wood grown in public forests and on private lands.

The locations of the 12 charcoal production projects are given in Table III.23. Clearly, the projects in Ilocos Norte, Capiz, Iloilo and Antique are located in areas with deficits in both charcoal and firewood. Nothing definitive can be concluded about the rest of the projects. However, considering the huge gap between supply and demand for both firewood and charcoal, it is likely that they too will soon be experiencing deficits in both commodities, if they are not already.

5. Marketing Practices

Firewood and charcoal markets are still poorly developed in the Philippines. There are no standards for either product quality or measures of quantity. In the public markets, both charcoal and firewood are sold in nonstandard measures, such as bags, cans and sacks, and firewood is offered in bundles as well.

Table III.20. Supply and Demand Projections for Firewood (in '000 cubic meters)

Year	Supply*	Demand	
		Low Estimate	High Estimate
1985	5,003.5	26,803.9	45,422.3
1990	5,003.5	30,609.7	51,753.2
2000	5,003.5	38,979.3	65,511.5

*Does not include supplies from backyards, private lands, wood fences and driftwood.

Table III.21. Coconut-Shell Charcoal Production (in MT)

Year	Quantity
1973	36,907
1974	54,718
1975	28,341
1976	35,032
1977	44,828
1978	65,518
1979	100,746
1980	153,686
1981	138,060
1982	114,183

Taken from Market Development Department of PCA, 1983.

Table III.22. Supply and Consumption of Charcoal (in '000 MT)

Year	Supply*	Demand
1985	164.14	4,822.3
1990	846.17	9,895.7
2000	1,014.18	12,591.4

*Includes only TREE-farm and coconut-shell charcoal production.

Table III.23. Location of Charcoal Production Projects

Project	Region
Sarrat, Ilocos Norte	1
Iguig, Cagayan	2
Capiz	6
Iloilo	6
Antique	6
Davao Sur	11
Agusan Sur	10
Maguidanao	12
Surigao Norte	10
Naawan, Mis. Or.	10
Torong-Torong I & II	12

The 1982 MOE report found that only about 33 percent of total firewood consumption is traded in public markets, which means that about two-thirds is traded elsewhere. This implies that the bulk of firewood requirements are met by households gathering wood from their backyards or other areas. On the other hand, two-thirds of consumption requirements are either bartered or produced by households.

Firewood and charcoal producers and sellers frequently operate on a seasonal basis. Usually, more volume is traded during the dry season and less, if any, during the rainy season. Partly because of this, firewood and charcoal sold during the rainy season normally has a higher price than that traded during the dry season.

In transactions involving traders/exporters, especially for coconut-shell charcoal, traders generally provide the drums and plastic bags used by producers free of charge. Some traders also give producers cash advances that can be liquidated according to the prevailing selling price of charcoal at the time of the transaction. When there is competition, producers usually sell to the highest bidder(s) that can pay cash immediately. Some traders set up buying stations in strategic locations.

Charcoal as well as firewood may be sold directly to wholesalers or commercial establishments and industries. In this case, charcoal is normally packed in sacks. Wholesalers then pass the charcoal on to retailers on a per kilo basis in paper or plastic bags or sacks, or tin cans. Firewood sold wholesale is usually measured in MT or cubic meters, and then sold to retailers in bundles.

Charcoal sold on the export market, particularly coconut-shell charcoal, is commonly graded as metallurgical grade A (metalgrade A), commercial grade A (comgrade A) or commercial grade B (comgrade B). Before coconut-shell charcoal can be exported, it has to pass quality standards enforced by the PCA.

6. Conclusions

On the basis of the data and analysis presented, the following conclusions and recommendations can be made.

First, there appears to be a good market for charcoal and firewood in the Philippines. Although the amount needed to satisfy consumption cannot be ascertained exactly, available data indicate that current as well as future demand far exceeds the projected supply. Supply shortages are particularly serious in areas like Ilocos, Capiz, Iloilo, Antique and Cebu, which have inadequate forest cover and hence, fewer alternative sources of noncommercial energy. Moreover, in other areas, the demand for

firewood and charcoal is quite heavy because establishments besides households use these fuels. Market availability also offers a partial explanation for increases in the price of these commodities over the past few years. Still, for about the past five years, apparent consumption has increased despite rising prices. In contrast, household consumption of commercial energy--e.g., LPG and gasoline--has gone down as a result of price increases.

Second, with regard to the charcoal production subproject for rural energy development initiated through ESF, it appears that the market will not be a constraint in the development of projects in Ilocos Norte, Capiz, Iloilo and Antique. Indications are that these areas are deficient in terms of firewood and charcoal supplies. In the case of Ilocos, for instance, the bulk of its supply now comes from Region 2. In these areas, the market can readily absorb the proposed projects' production of either firewood or charcoal. On the other hand, due to the availability of forest cover and/or tree plantations in such areas as Cagayan, Davao Sur, Agusan Sur, Surigao Norte, Lanao del Norte and Misamis Oriental, this assessment cannot say whether or not the firewood/charcoal market will limit the development of ESF-supported projects in these areas. A more intensive study is required to determine if the market would constrain these projects.

Third, there is a need to augment the firewood or charcoal supply, particularly in areas that have already been identified as having deficient supplies of these fuels--Ilocos, Capiz, Iloilo, Antique and Cebu. Strategies for increasing available firewood/charcoal supplies in these areas can be implemented through either plantation establishment or improving the marketing and delivery systems for both commodities. The latter strategy could actually be carried out alone or in combination with the former. By improving the delivery system for these commodities, interaction between areas with surpluses and deficits could be enhanced to increase available supplies in deficit locations. Moreover, the results of the MOE study show that only about 35 and 65 percent of the total consumption of firewood and charcoal, respectively, are traded on the public market. Improvement of the marketing system could also possibly increase available supplies.

Fourth, unplanned effects of new projects that will require firewood or charcoal need to be carefully examined. The effect of primary concern is related to sources for the firewood and charcoal needed to meet a new project's raw material requirements. This effect could be particularly serious in areas with deficient supplies of these commodities, as consumption requirements in these areas already far exceed available supplies. Any new project requiring firewood or charcoal could put additional pressure on the available supply if, during

implementation, there are problems with finding the planned sources of raw materials. Unfortunately, the most common alternative source of firewood/charcoal is adjacent forest areas. Meeting project requirements for raw materials from this source would increase the rate of forest denudation. An example of this, discussed in Section IV, concerns the Ilocos Norte dendro thermal plant. Therefore, in light of the supply shortages for both firewood and charcoal, it is extremely important that any proposed project which will require these commodities as raw materials should undergo a comprehensive analysis in terms of sources for those materials.

Fifth, the measurement units used in trading firewood and charcoal need to be standardized. Present practices indicate there are a variety of measures for these two commodities, ranging from kilos, plastic bags of different sizes, sacks, bundles, "karitons"/carts, cubic meters, metric tons and truckloads. This fact makes any assessment of supply and demand more difficult. Moreover, it complicates the comparison of prices with alternative fuels (e.g., LPG, kerosene and electricity). Implementing this recommendation may pose difficulties in terms of consumer preferences for a particular fuel source.

Sixth, an improved information system about the fuelwood market needs to be established. Unlike the agricultural sector, firewood and charcoal producers (especially farmers) are not well-informed about the relative prices of fuels and available markets. Thus, in most cases, a greater portion of their profit goes to a middleman.

IV. DENDRO THERMAL POWER PLANTS

A. Introduction

The GOP is committed to reducing the country's dependence on imported oil. A key element in its plan to accomplish this goal is the generation of electricity using indigenous energy sources--wood/biomass, hydro, geothermal and coal. The use of wood is particularly appealing since this option has the potential to accomplish rural development objectives in addition to the generation of electricity at dendro thermal power plants.

Generating electricity from wood entails two distinct activities:

- wood production, and
- generation of electricity from harvested wood.

The production of wood on marginal land promotes reforestation while providing employment and income for rural people, and saving precious imported fuel and foreign exchange.

Furthermore, rural electrification (similar to the program implemented in the United States 50 years ago) would presumably promote the development of rural areas and provide a convenience that would improve the quality of life for residents. However, a crucial issue is the speed and extent of the implementation of a rural electrification program. Two factors to be considered are the level of development in rural areas prior to electrification and ability of consumers to afford electricity. Until these and other issues are resolved, this type of program can operate only with large government subsidies.

While the objectives of the Philippine dendro thermal program are indisputable, its operation at all levels remains questionable. Primary concerns include the ability of some of the tree farmer associations (TFAs) to manage dendro plantations, lack of skilled personnel at RECs, dual role of the NEA as both banker and supervisor of RECs, temporary lack of counterpart funds due to the economic crisis in the Philippines, and relationship between the NEA and NPC in project planning and the exchange/sale of electricity.

Apart from these concerns, the economic viability of the proposed dendro thermal power plants is reduced by their small size and remote locations. The NEA is limited to plants less than five MW in size. In addition, the three plant sites suggested by NEA for AID funding are located several miles from any paved road. The costs of site development appear to be prohibitively expensive for a small power plant to support. In

this analysis, road development costs were excluded since roads would serve many other purposes than solely providing access to the power plants.

The remoteness of the proposed plant sites is clearly illustrated by the fact the ARD assessment team was unable to visit the Cebu site because REC counterparts did not know the road to the site. As a result, the team could not analyze the power plant proposed for Cebu. Thus, this assessment focuses in detail on the other two sites--Bohol and Masbate.

This section of the report addresses the institutionally issues involved in management of the TFAs and rural cooperatives as well as NEA-NPC relations. It also comments on the demand for electricity on each island, dendro thermal power plants that could be built at the proposed sites, and their costs. It then discusses the status of plantations and changes which should be implemented to ensure a reliable wood supply, as well as the costs of generating electricity, the rate of return and discounted benefit-cost ratio for the proposed Bohol and Masbate plants.

B. Institutional Capability

Power supply in the Philippines is the responsibility of a number of government and private institutions, including the NPC, NEA, RECs and several private utility companies. Distribution of power is handled by NPC, rural co-ops and private utility companies.

NPC is a stock corporation fully owned by the GOP and run by a board of seven members who are all appointed by the President. Prior to 1972, NPC's role was limited to the construction and operation of hydroelectric plants. Since then, its responsibility has been expanded to include all large-scale generation of electric power. NPC has also taken over the generating stations owned and operated by the Manila Electric Company (MERALCO). Since 1978 to 1979, it is responsible only for power distribution in Metro Manila, which includes seven cities and 50 municipalities. NPC generates and provides electricity on eight of the many islands in the Philippines, including Luzon and Mindanao, by far the two largest islands as well as six of the larger islands in the Visayas, of which only Samar and Leyte are connected. Plans for connecting Panay and Negros are being implemented with loans from the Asian Development Bank (ADB), and once this is accomplished, geothermal power from Negros will be supplied to Panay.

In 1979, the NEA's role was expanded under Presidential Decree Number 1645, which charged it with organizing, financing and regulating electric cooperatives throughout the country.

Among other things, it also recognized a distinct need to provide the NEA with additional authority to take measures to safeguard government inputs in electric cooperatives and other entities that are or will be related to the total electrification effort. Total electrification of all municipalities is to be achieved by 1987.

This extension of NEA's authority over the cooperatives has given it a dual role, being the source of loans for power plants, lines and associated equipment as well as the supervisor and controller of cooperatives. In a way, the decree blurs the distinction between the NEA and rural cooperatives--with the power to supervise cooperative operations, the NEA is simply operating as its extension. This can have advantages--more efficient use of resources, less duplication of effort and others that come with centralization of power, provided the decree can be successfully implemented. Judging from the lack of coordination in the dendro thermal construction program, the potential benefits of a closer relationship between rural co-ops and NEA may not be realized.

1. Program Status

As of December, 1984, the NEA dendro thermal development program reported that equipment for 17 British and French wood-fired power plants had been acquired. Of the 17 projects approved for implementation, four were completed and operational, four were still under construction, five had been temporarily suspended and four had received the equipment, but construction of facilities had not begun.

Tree plantation development had been initiated at 37 sites by RECs, but 11 were reported abandoned, leaving only 26 with any visible development activities. NEA also noted that 338 Tree Farmer Associations (TFAs) had been registered with a total membership of 3,820 families. Although a total of 40 sites had been identified for tree plantations to cover an area of 63,059 hectares, only 8,017 hectares were reported as having surviving plantations.

Since 1983, project implementation has been constrained by the NEA's financial difficulties. A major source of funds--equity contributions from the GOP--has been significantly reduced. From approximately ₱300 million in 1981, equity contributions dropped to ₱200 million in 1982, ₱100 million in 1983 and roughly ₱90 million in 1984. Because of this drop in equity contributions, NEA has had to make substantial cuts in releases to RECs for project implementation. The current 1985 budget for dendro thermal projects has been reduced to roughly ₱26.6 million from over ₱75 million in 1984. Moreover, delays in the release of funds from the GOP have reverberated all the way

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down to the level of the RECs and TFAs. As a result, all project sites have been unable to meet accomplishment targets and staff morale at most of the sites has suffered.

At present, NEA dendro thermal project management has responded to the tight financial situation by setting strict priorities on the allocation of funds. Funding priority is now being given to the four sites where construction is going on in order to make them operational as soon as possible. Funds for tree plantation development are also being funneled to these four sites as well as locations where power plants are already in operation. During the next two to three years, funding priority will be given to the remaining plant sites that have equipment, but are still not operational. Thus, the projects proposed for funding by AID/ESF are being accorded a much lower priority unless full funding is made available to NEA for these projects.

2. Program Management

The dendro thermal projects are being monitored and coordinated by the NEA's Dendro Thermal Development Office (DTDO), which is composed of six divisions under the executive director and DTDO project manager--the Program Control and Information Center and Administrative, Engineering, Agro-Forestry, Finance and Institutional Development Divisions. The establishment of dendro thermal power plants and tree plantations to support those plants are the responsibility of individual RECs. Each REC is required to establish a dendro thermal project unit within its organization, headed by a dendro thermal program coordinator.

In the development of tree plantations, RECs are expected to first organize TFAs that will be directly involved in growing and harvesting trees. Each TFA is composed of 10 to 15 members, who are responsible for developing an area of 100 hectares. TFAs are provided with loans of up to ₱3,500 per hectare to cover plantation development costs--seeds, fertilizer and labor. Loans are released on the basis of work accomplished and become the obligation of the TFA. Once the plantations can provide wood for the power plant, TFAs are required to sell all their output to the REC at a recommended price of ₱65 per ton. A portion of the proceeds is deducted by the REC to cover loan amortization and the remainder paid to the TFA.

The major constraint on timely project implementation is a lack of funding for REC activities. At most sites, funds were not released for either plant construction or tree plantation development during the past year. As a result, farmers were forced to leave project sites to seek work elsewhere and the staffs of the REC dendro thermal units were temporarily laid off. In some cases, dendro thermal project coordinators assumed other

positions and responsibilities at the RECs. In general, RECs were unable to advance their own funds to continue project implementation. Given this situation, DTDO personnel were likewise unable to provide the intended assistance to RECs. For example, training of REC staffs and TFA members was suspended, and project monitoring was restricted to sites where construction and tree plantation activities were fairly advanced.

At present, DTDO personnel are concentrating on the project's technical aspects--yields and survival rates for the tree plantations and activities surrounding power plant construction--with the aim of making the plants operational as soon as possible. As a result, the monitoring of field activities consists entirely of requesting and processing technical information. Although DTDO offers RECs training on the organization of TFAs, the cooperatives are expected to handle institutional development activities for the TFAs without further assistance from DTDO, under the assumption that RECs have the experience required for working in rural communities.

However, it is clear that the long-term viability of the dendro thermal plants is dependent on management of the tree plantations. This, in turn, is directly related to the organizational maturity and cohesiveness of the TFAs, a fact which may be overlooked by DTDO and RECs in their attempt to achieve immediate accomplishment targets. A number of issues were identified by the ARD assessment team for consideration by TFAs, RECs and DTDO--membership selection and management, labor subcontracting, assignment of loan obligations, allocation of profits, output pricing, and development of a sense of communal ownership and management.

Although NEA has reported that 338 TFAs have been organized and registered, many of these have not remained intact. Delays in the release of funds have forced many TFA members to leave plantation sites to seek work elsewhere, while those who have remained continue to maintain farms in nearby lowland areas. The main issue is how RECs can reorganize or rehabilitate TFAs that have disintegrated or suffered membership losses. Related issues include the selection of new members and whether new or continuing members should absorb the loan obligations of members who have left the association. Thus far, DTDO has left the resolution of these issues up to the RECs in order to permit flexible, responsive project implementation. However, these questions are serious and common enough to merit attention, assistance and guidance from DTDO. The experiences of various RECs could perhaps already provide guidelines for handling similar situations in the field.

At several sites, farmers were reported to have engaged in labor subcontracting. That is, TFA members passed on their work to nonmembers, who were paid for their labor. In some cases,

members were paying nonmembers less than the stipulated wage and earning money by merely subcontracting the work. This situation was common among TFA members who also cultivated lowland farms and were unavailable to work on the plantations for certain periods of the year. There were also instances in which nonmembers complained to REC dendro thermal project personnel and demanded additional compensation. If unaddressed, these cases could undermine the project's equity objectives and create conflict between local community members.

Another issue which may affect the long-term viability of TFAs relates to the assignment of loan obligations. In some TFAs, the loans are considered a collective obligation of the group, regardless of the amount of money received by each member. In others, loans are apportioned internally, with each member assigned an obligation in proportion to payments received. These arrangements could become a source of conflict within the TFAs, particularly in cases where some members leave the association and others are admitted later on. This issue is also related to the division of profits, i.e., whether income from plantation modules should be divided equally among TFA members or proportionally according to each member's work in either the development or harvesting stage. The point is that to the greatest extent possible, these issues need to be addressed by TFA members in the early organizational stages of the assocation. They also need to be raised by the dendro thermal staff, and TFAs should be aware of the long-term implications of alternative schemes for dividing obligations and profits. At present, these concerns are being set aside to pursue short-term targets and goals. TFA members are concerned with the payments they receive for work accomplished, while RECs are attending to plant construction and plantation development. As a result, there appears to be little monitoring of TFAs' organizational development.

Pricing the output from plantations is another issue concerning farmers. The project paper established a ceiling price of ₱65 per ton of fuelwood, and once the power plants are operational, farmers will be obliged to sell their entire production to RECs. At certain sites, the ceiling price is far below the market price for fuelwood. This price gap may motivate farmers to smuggle wood out of the sites to sell at local markets. Although RECs make the final decision on the price offered TFAs, the cooperatives must ensure that their costs for power plant operation are below those of NPC power supplied from the grid. As a result, RECs must maintain a balance between satisfying farmers' demands for higher wood prices and keeping costs within acceptable limits.

Even when prices are acceptable to TFAs, there remains a tendency for farmers to sacrifice the long-term viability of the plantations for short-term gains. They may harvest a larger

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volume or area than recommended in order to maximize their incomes in the short run. This situation has already occured in Bolinao, where farmers have complained that the amount deducted by the REC to cover loan amortization does not leave them with sufficient income. The farmers have proposed that they be allowed to harvest an additional volume of wood to cover the loan amortization so that proceeds from the recommended harvest volume can be given to them intact.

Short of policing plantations wtih armed patrols, it would be very difficult to control wood smuggling, as TFAs which are loosely organized and poorly managed could easily find a means of over-harvesting and selling the wood on outside markets. The attractiveness of this scheme to TFAs underscores the need to build a sense of collective, communal ownership and responsibility among the members as well as for a conscious process of developing the required skills in self-management, coordination and control.

As yet, these institutional issues are still far from being concerns at the levels of both NEA program management and the RECs. However, they will eventually become more prominent as plantation operations come on-stream.

Another serious issue is BFD support of the dendro thermal projects. Under the current model for tree plantation development, NEA remains dependent on BFD for the assignment of sites and issue of tree plantation leases. In both cases, NEA regards BFD as unsupportive and uncooperative. DTDO staff complain that sites offered to RECs are often technically unsuitable and marginal, even for the recommended species. Moreover, despite memoranda from the BFD director requiring field offices to cooperate fully, BFD staff appear to be reluctant to grant ITP leases. Although 36 RECs have applied for leases, thus far, only one has been approved for Bolinao. In that case, the application was submitted as early as 1979, but was not approved until 1983. Other applications have been pending now for over a year without a single definitive reponse from BFD.

In order to secure BFD support for the dendro thermal project, coordination should be developed at higher management levels. One option would be to invite the BFD director to serve on NEA's Board of Adminsitrators. Another would be for AID or ESF to use its leverage to pressure BFD into responding in a more timely and efficient manner to ITP lease applications.

Given that the scale of project implementation has been substantially reduced, NEA now has the opportunity to focus more attention on institutional issues, particularly those related to the establishment and management of TFAs. Close monitoring of institutional issues at the priroity development sites will provide DTDO with valuable experience, which it can then share

with RECs in future projects. In the event that AID/ESF should choose to postpone funding of the three power plants, one option would be funding of a "learning-process" component for the dendro thermal projects. This component would concentrate on addressing institutional development issues at the tree plantations. Activities could consist of pilot testing of alternative approaches for organizing TFAs and processes for developing necessary skills within them.

At the REC level, the staffs of the dendro thermal project units consist primarily of technicians. The project coordinator is responsible for TFA organization, but supervision of plant construction could easily take up most of the coordinator's time, thus leaving the TFA component neglected. RECs should consider employing persons with expertise in community organizing. Another option would be to team up with a private voluntary organization (PVO) with prior experience in social forestry projects and compensate the PVO out of a loan to the REC.

In areas where available tree plantation sites are inappropriate or inadequate for power plant requirements, RECs should consider the option of attracting private landowners to grow fuelwood. This option may be feasible for many former sugar lands that are now uncultivated because of low sugar prices. Although this might sacrifice the project's equity objectives, there may be no other realistic alternatives, as the failure to develop sufficient renewable sources of fuelwood for the dendro thermal plants will only result in more rapid deforestation. Already, the Iloilo REC has begun to encourage small landowners to band together for fuelwood production. This "experiment" should be monitored closely to see if the model can be applied to other sites.

The site selection and feasibility analysis of projects should be more rigorous and comprehensive. This will require further development of both the technical and institutional capabilities of DTDO and the RECs.

3. NEA-NPC Relations

Electricity sales in the Philippines amounted to 17,089 million kilowatt-hours (kwh) in 1983.* Luzon accounted for 13,908 kwh or 81 percent of total sales, while the Visayas had the smallest sales of the three grids at 933 million kwh. Some 2,500 million kwh were distributed through the REC rural

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*NPC Annual Report, Manila, 1984.

network.* The NEA plans to establish both dendro thermal and mini-hydro power plants, and these plans currently call for eventual establishment of 200 MW of dendro and 300 MW of mini-hydro capacity. However, this work has been delayed because of inadequate local funds for matching equipment grants. Furthermore, many of the plants were bought on supplier credits. The shortage of peso funds has placed the NEA in a difficult position in terms of meeting its planned targets for dendro and mini-hydro capacity. Overall, RECs will have to continue to rely on the NPC for much of their power requirements.

The generation of electricity from dendro and mini-hydro power plants has placed RECs in a new position as a seller of power to NPC. These plants often generate excess power during the day when there is insufficient demand in the rural cooperative. RECs can then sell this excess to either NPC or neighboring cooperatives. In an Interchange Agreement (see Appendix B), NPC has offered to "wheel" the power to neighboring cooperatives. The agreement provides for wheeling power through the NPC system from the interchange to receiving points, with the aim of avoiding any duplication of transmission facilities. A mutually acceptable wheeling charge has yet to be determined.

The daily load pattern on an REC grid is dictated primarily by the large number of residential customers, which has led to very low load factors on many of the grids. To improve their load factors, RECs have sought industrial customers. Unfortunately, industries prefer to be connected to the NPC grid since it has a better record for providing reliable power. Further, an agreement between the Board of Investments and NPC currently allows NPC the first right to provide power to all large industrial customers (2,000 kw or more at a transmission voltage of 69 kv and above). Smaller industrial customers are required to pay a small charge to the REC, but are still served by the NPC. This agreement puts RECs at a disadvantage.

Overall, the coordination between NEA, REC and NPC personnel in planning and operating their systems is inadequate. This stems partly from the fact that they report to different government agencies and also from the fact that these agencies are competing for the same load in many instances. Other grievances also exist. For instance, NEA claims that RECs are the first to lose power in the event of a forced shutdown of the power supply. This has been confirmed by the NPC for Luzon where RECs have their own source of power. On the other hand, the NPC claims that RECs are delinquent in paying their bills-- as of the

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*Georgia Institute of Technology (GIT), Dendrothermal Power Generation Program Evaluation Study, Summary, Volume 1. October, 1984.

end of November, 1984, electric cooperatives owed the NPC 312 million pesos.*

C. Electricity Demand

1. Bohol

Bohol has two electrical cooperatives--BOHECO I and II, which are responsible for distributing power to their customers. In addition, the major city on the island, Tagbilaran, has its own electricity distribution system. Power is supplied to the three systems by two 5.5-MW diesel units and three 0.4-MW hydro units (1984 NPC Annual Report). The total 12.2-MW capacity is owned and operated by NPC which, in turn, sells electricity to the rural cooperatives. NPC sales during 1984 amounted to 24.7 million kwh--net generation was 26.3 million kwh with a consequent system loss of eight percent.

The proposed dendro thermal plant site on Bohol is located in the municipality of Inabanga (see Figure IV.1), an area serviced by BOHECO I. Electricity generated by this plant would be available to BOHECO I customers with any excess sold to NPC or wheeled to BOHECO II through a single grid connecting the two cooperatives. Thus, transmission of electricity will not be constrained by a lack of lines, except in the immediate vicinity of the power plant.

Demand

The BOHECO I rural cooperative was incorporated in 1971. It covers 26 municipalities with 63,365 potential household connections (see Table IV.1). Of these, 25,711 households (41 percent) have been energized. This is above the regional average of 36 percent for Region VII (the Central Visayas, which includes Bohol, Cebu and other islands), but below the national average of 52 percent.

In 1983, the cooperative purchased or generated 7.6 million kwh, while it sold 6.1 million kwh with a system loss of 19 percent. Since the system's peak load, which occurred at 7 p.m., was 3,127 kw, the load factor was only 23 percent. Electricity demand increased rapidly from 1976 to 1983 at an annual rate of 23.2 percent (see Table IV.2). Data on peak load show that it increased at a rate of 27.8 percent from 1977 to 1983.

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*Batasang Pambansa, "Report of the Special Committee on Power Rates to the Committee on Energy," Quezon City, Metro Manila, February, 1985.

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Figure IV.1. Map of the Province of Bohol

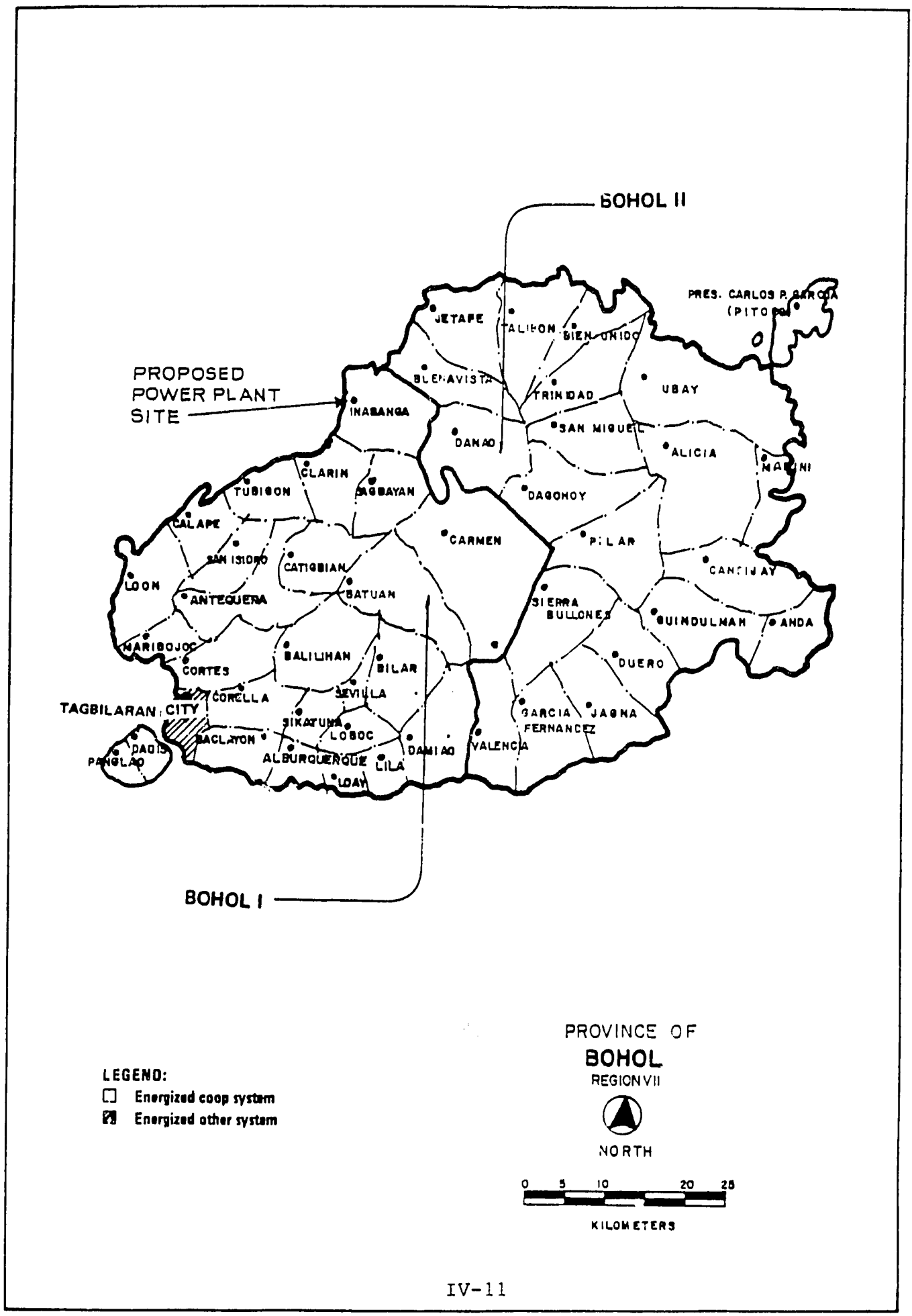

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Table IV. 1. Bohol I Electric Cooperative

Date of Incorporation and Registration: August 11, 1971

Total Amount of Loan: P42.0 M

Total Releases: P29.0 M

Status of Energization:

Municipalities	Barangays Covered	Barangays Energized	House Connections Potential	House Connections Actual	%
1. Tubigon	34	24	4,999	2,629	53
2. San Isidro	11	6	1,228	284	23
3. Sagbayan	24	12	2,117	549	26
4. Catigbian	21	11	2,603	458	18
5. Loon	67	48	5,941	2,402	40
6. Balilihan	31	16	2,321	447	19
7. Calape	33	28	3,748	2,110	56
8. Antequera	21	16	1,940	978	50
9. Clarin	24	18	2,287	986	43
10. Maribojoc	22	18	2,335	1,369	59
11. Inabanga	50	32	5,486	1,577	29
12. Dauis	11	11	3,043	1,881	62
13. Baturan	15	6	1,639	282	17
14. Carmen	29	15	4,393	796	18
15. Panglao	11	10	2,425	1,206	50
16. Bilar	19	13	2,119	569	27
17. Sevilla	13	7	1,512	249	16
18. Cortes	14	14	1,558	973	62
19. Sikatuna	10	7	874	276	32
20. Corella	8	8	866	461	53
21. Loboc	28	12	1,963	719	37
22. Baclayon	17	8	1,796	842	47
23. Loay	24	20	1,807	1,453	80
24. Dimiao	35	17	1,808	783	43
25. Alburquerque	11	7	1,177	370	31
26. Lila	18	17	1,380	1,062	77
Sub-Total	601	401	63,365	25,711	41
Other System:					
1. Tagbilaran City	Provincial Gov't. of Bohol		7,114	5,132	72
GRAND TOTAL			70,479	30,843	44

General Statistics for 1983:

		Monthly Average (Est.)
KWH Generated/Purchased	('000)	634
KWH Sold	('000)	511
Systems Loss (%)		19
Gross Revenue ('000)		P614
Peak Load (Kw)		3,127
Load Factor (%)		23

Membership: 25,908

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Table IV.2. Bohol I Electric Cooperative -- Energy/Load and Financial Statistics

Energy and Load:	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
KWH Purchased	457,252	1,720,031	1,754,893	1,433,981	2,585,765	3,458,930	5,678,070	6,803,047	7,60 ,082	6,987,384
KWH Sold	357,767	1,435,2 2	1,337,028	1,236,615	2,203,017	2,926,611	4,884,296	5,581,199	6,201,436	5,558,671
Systems Loss	100,485	284,769	417,865	197,366	382,748	532,319	793,774	1,221,848	1,404,646	1,428,713
Percent S.L.	21.97%	16.55%	23.81%	13.76%	14.80%	15.38%	13.97%	17.96%	18.46%	20.44%
Peak Load			700	885	1,401	1,564	3,118	3,201	3,127	3,242
Financial:										
Operating Revenue	₱182,773	₱581,504	₱783,379	₱800,939	₱1,715,639	₱2,381,245	₱4,234,625	₱6,211,005	₱7,371,864	₱10,191,009
Power Cost	314,239	770,604	727,546	749,511	1,042,248	1,221,640	2,119,529	3,135,896	4,513,213	6,805,812
Man-Power Cost	83,689	194,046	284,412	276,927	530,874	746,286	951,349	1,399,771	1,385,068	2,509,999
Depreciation and Interest	162,898	98,424	307,809	398,199	380,983	965,660	1,200,125	2,010,020	1,832,437	1,995,750
Profit (Loss)	(₱378,053)	(₱ 481,570)	(₱ 536,388)	(₱ 623,698)	(₱ 238,466)	(₱ 101,741)	(₱ 136,378)	(₱ 334,682)	(₱ 358,854)	(₱1,120,552)

This rapid growth in demand occurred in two phases. During the first phase, demand increased as houses in major townships close to generation or supply centers were energized. The resulting higher density of customers led to lower line loss. In the second phase after 1981, growth occurred primarily in distant areas which cooperatives were required to supply in accord with the area coverage concept. Consequently, line loss increased from 14.0 percent in 1981 to 20.4 percent in 1984. The number of new customers declined each year after 1981 as low-density areas were energized and electricity became more expensive.* The number of new house connections dropped from a peak of 8,269 in 1981 to 1,563 in 1984 (see Table IV.3).

Demand for electricity declined by about eight percent from 7.6 megawatt-hours (MWh) in 1983 to 7.0 MWh in 1984. This decline may be attributed to generally poor economic conditions in the country, higher electricity rates and a typhoon which knocked out transmission lines in September. Annual demand, based on the average for the remaining 10 months, was still lower in 1984 than 1983 by about three percent.

Residential sales accounted for 64 percent of total sales in 1984, but these customers represent a much larger fraction of the total population of customers (see Table IV.4). As a result, they have the lowest average consumption, 144 kwh, compared to 13,765 kwh for industrial customers. A residential customer's consumption is equivalent to a single 80-watt bulb lit for five hours a day all year.

Growth in peak load also occurred in two phases. The first phase reflected the rapid growth in demand up to 1981. However, after 1981, peak load did not increase very much (see Table IV.2). Since demand continued to increase the load factor increase from 18 percent in 1981 to 23 percent in 1983, the new load probably represents commercial or industrial activity occuring during the day.

The cooperative's financial statistics indicate that it has operated at a loss since 1975. Losses reached a low of 101,700 pesos in 1980 (see Table IV.2), but subsequently increased to 1,120,550 pesos in 1984. An analysis done by the cooperative indicates, not surprisingly, that it incurs more financial loss in supplying power to distant, less dense areas within its jurisdiction--99 centavos of loss per kwh of sales compared to

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*Average revenue (a measure of average rates) for BOHECO I increased from 0.97 pesos per kwh in 1983 to 1.45 pesos in 1984. Electricity rates for rural cooperatives are set by NEA (Annual Report, BOHECO I, 1985), and for every centavo increase in NPC power costs, BOHECO I is allowed to raise its rate by a multiplier of 1.4.

Table IV.4. Electricity Sales for Bohol I and Gasbate

	Bohol I (As of December, 1984)			Masbate (As of September, 1984)		
Demand:	3,242 kw			680 kw		
Power Source:	NPC			Diesel, 1,500 kw capacity		
Type of Consumer:	November	kwh Sales ('000)	Average kwh Consumption	November	kwh Sales ('000)	Average kwh Consumption
Residential	24,648	3,552	144.11	3,537	273	77.18
Commercial	1,271	562	442.17	258	118	457.36
Industrial	47	647	13,765.96	-	-	-
Irrigation	22	9	409.09	-	42	-
Public Buildings	370	271	732.43	56	14	250.0
Street Lights	874	326	372.77	17	-	-
Others	-	192	-	-	32	-
Total kwh Sales	27,232	5,559	204.13	3,868	479	123.84

Table IV.3. Bohol I Electric Cooperative-Institutional Statistics

	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
No. of Paid-Up Members (incremental)	1671	1828	1023	587	2983	4438	6095	3734	3552	1970
No. of House Connections					* 6851	4327 incremental	8269 inctl.	3483 inctl.	2781 inctl.	1563 inctl.
No. of Barangays Energized (incremental)	59	21	15	5	40	76	114	36	29	5

* As of December, 1979

eight in Tubigon, where BOHECO I headquarters is located (see Appendix C). Continuing the policy of area coverage would mean higher financial losses for the cooperative until industrial loads increase. Thus, this rural cooperative must choose between temporarily abandoning the area coverage concept or increasing its rates so as to avoid further financial losses.

NPC sales increased rapidly after 1978, when more supply became available and rural cooperatives were able to construct transmission and distribution lines to absorb the increased supply (see Table IV.5). Increased sales to cooperatives were primarily responsible for the more than three-fold increase in sales between 1978 and 1983. Because of the typhoon in 1984, poor economic performance and sharp rate increase, electricity demand declined. The daily load curve for the grid exhibits a pattern very similar to that observed for BOHECO I (see Figure IV.2). Daily load peaks at 7 p.m., and the low load factor of 23 percent corresponds to an average load of 1.8 MW.

Projections

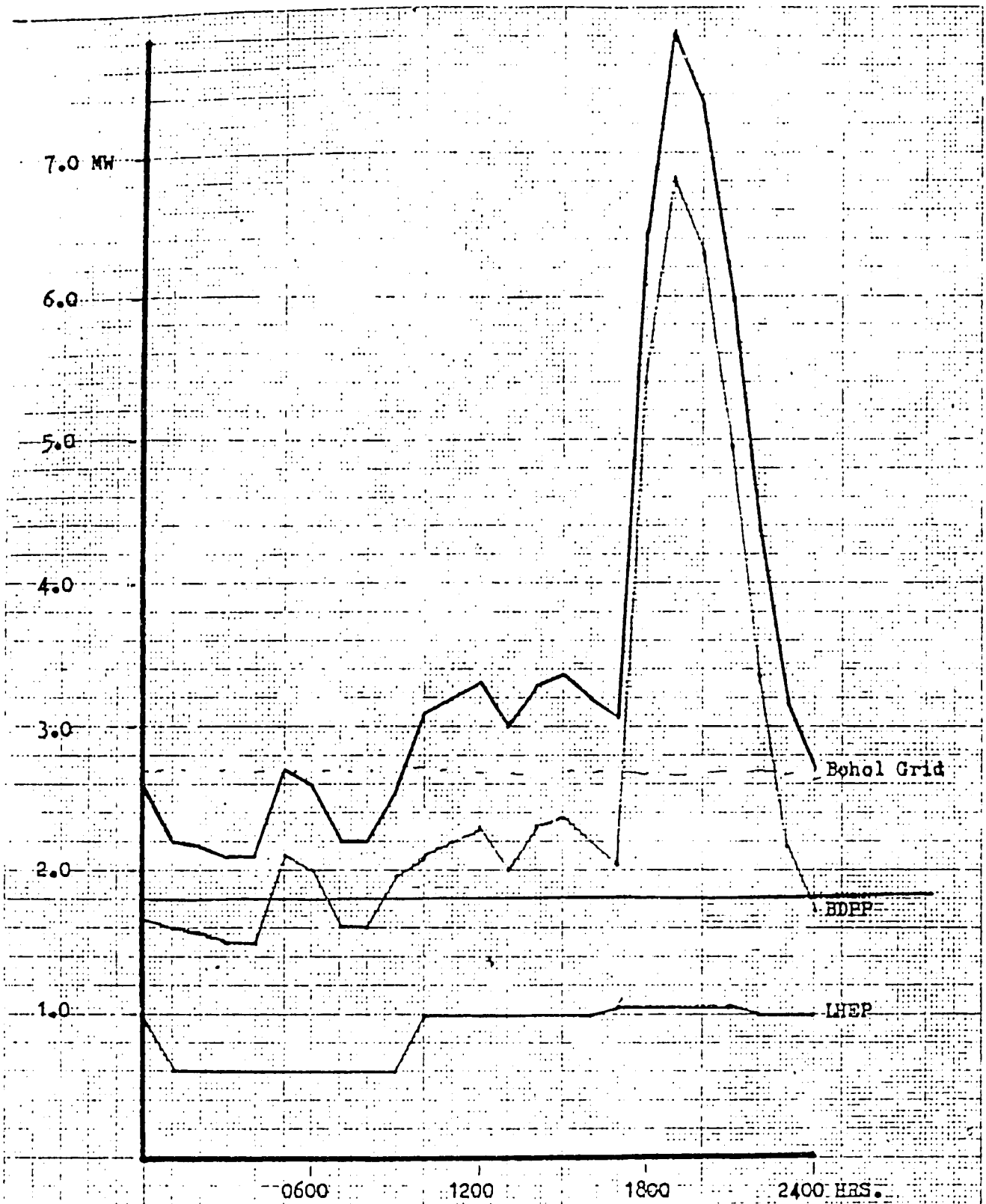
Future demand for electricity in Bohol will depend on the ability of cooperatives to provide new connections, the rates of population and income growth, and potential for attracting new industry. In the BOHECO I service area, only 41 percent of potential customers were connected at the end of 1983, leaving 37,654 houses yet to be connected. While this potential appears large, the number of new customers has declined each year since 1981 despite an increase in both the population and number of households. This decline may be attributed to the difficulty of extending new lines to less dense areas, lack of local funds to purchase equipment and lines, and a sharp increase in the price of electricity.

Population projections to the year 2020 for Bohol provided call for a relatively low annual growth rate of about 0.8 percent (NEDA, 1985). Unfortunatley, no regional projections of economic growth are available, but historical data show that growth in the Central Visayas (Region VII), which includes Bohol, has kept pace with national economic growth. Since 1978, this region has accounted for seven percent of the national gross domestic product (NEDA, 1984). A projection of national economic growth (prepared by AID mission staff members) calls for no growth in 1985 and one percent in 1986. A long-term forecast to 2010 calls for an annual growth rate of 3.5 percent. Historically, electricity sales have increased much faster than GDP in Bohol--sales in Bohol per unit of GDP in Region VII increased from 1.19 kwh per thousand peso in 1978 to 3.60 in 1983. This ratio did not change in 1984.

Table IV.5. NPC Sales by Customer Type for 1957-1984 in GWh

	Cebu				Bohol				Visayas			
	Util.	Ind.	Misc.	Total	Util.	Ind.	Misc.	Total	Util.	Ind.	Misc.	Total
1957	-	-	-	-	.46	-	-	.46	.46	-	-	
1958	-	-	-	-	.84	-	-	.84	.84	-	-	
1959	-	-	-	-	1.08	-	.04	1.12	1.08	-	.04	
1960	-	-	-	-	1.35	-	.18	1.53	1.35	-	.18	
1961	-	-	-	-	1.58	-	.53	2.11	1.58	-	.53	
1962	-	-	-	-	1.97	-	.81	2.78	1.98	-	.81	
1963	-	-	-	-	2.34	-	1.07	3.41	2.59	-	1.10	
1964	-	-	-	-	2.68	-	.40	3.08	3.60	-	.70	
1965	-	-	-	-	2.79	-	.35	3.14	6.12	-	.79	
1966	-	-	-	-	3.05	-	.53	3.58	5.22	-	.99	
1967	-	-	-	-	3.28	-	.50	3.78	6.00	-	1.01	
1968	-	-	-	-	3.39	-	.39	3.78	5.78	-	.90	
1969	-	-	-	-	3.94	-	.44	4.38	5.93	-	.96	
1970	-	-	-	-	4.12	-	.27	4.39	6.49	-	.77	
1971	-	-	-	-	4.90	-	.46	5.36	8.22	-	.71	
1972	-	-	-	-	5.35	-	.44	5.79	7.38	-	1.03	
1973	-	-	-	-	4.65	-	.32	4.97	6.09	-	.81	
1974	-	-	-	-	4.89	-	.34	5.23	8.57	-	1.10	
1975	-	-	-	-	5.28	-	.48	5.76	6.06	-	.72	
1976	-	-	-	-	5.82	-	.57	6.39	8.39	-	1.37	
1977	-	39.25	-	39.25	6.78	-	.52	7.30	10.75	39.25	1.31	
1978	38.36	145.31	-	183.67	6.56	-	.49	7.05	1.32	145.31	1.69	
1979	100.73	79.63	.34	180.70	10.385	.15	.62	11.16	144.51	79.78	2.19	
1980	118.13	45.41	.51	164.05	15.21	1.71	.62	17.54	242.61	47.12	3.52	
1981	147.20	86.60	.80	234.60	17.71	1.11	.38	19.20	355.81	87.71	3.52	
1982	217.87	172.99	3.19	394.05	21.63	.81	.50	22.94	514.99	175.64	6.55	
1983	284.87	175.08	2.10	462.05	24.17	.89	.47	25.53	657.87	270.31	5.94	
1984	294.26	165.44	2.15	461.85	22.530	1.27	.35	24.15	662.83	347.11	4.11	

Figure IV.2. Typical Daily Load Curve for BOHECO I



TYPICAL LOAD CURVE (WEEKDAY 1983)

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Future electricity demand may be projected in two phases. The first phase lasts through 1988, during which time GDP growth is expected to recover from the negative growth experienced in 1984. By 1988, NEDA projects a growth rate of 3.5 percent. Electricity demand on Bohol should grow at about the same or a slightly higher rate during this period. Demand will be partially constrained by a lack of funds for new lines as well as the high price of electricity. NPC rates will increase if the peso is devalued, and these increases will be passed on to rural cooperatives, thus forcing them to raise their rates.

Peak load on the NPC grid, along with the load factor, has increased steadily over the last five years. Continued improvement in the load factor is expected as the number of new customers declines and the income of existing customers increases, albeit at a slow rate. This additional income will lead to the purchase of appliances, such as refrigerators, which should produce a more evenly distributed daily load. Peak load will therefore increase at a rate slower than the growth of demand for electricity. Table IV.6 shows the projected growth rates for both electricity demand and peak load (these rates represent lower bounds).

Table IV.6. Lower Bound on Projected Electricity Sales for Bohol

	1984		1990		2010
Sales (GWH)	24.15		29.69		78.78
rate of increase		3.5%		5.0%	
Peak Load (MW)	8.2		9.8		15.0
rate of increase		3.0%		2.2%	
Load Factor (percent)	34		35		60

Assuming stable long-term economic growth and electricity rates as well as available funds for new lines, in the second phase after 1988, demand should increase at a faster rate than the GDP. While it is difficult to determine an exact figure, an annual growth rate of five percent would not be an unrealistic lower bound.

Power Requirements

Power is supplied by NPC's diesel and hydro plants. In addition, a five-MW mini-hydro unit is planned by BOHECO I using equipment granted by the Norwegian government and ADB loan

funds.* The viability of this mini-hydro plant is being evaluated by ADB.

The size of the proposed dendro thermal unit depends primarily on the demand for electricity, availability of wood and size of the mini-hydro unit. By 1990, electricity demand is projected to grow to about 9.8 MW, and the current base load of roughly 2.5 MW should increase to about three MW. The base load is of greater concern since the dendro thermal plant would operate most cost effectively as a base load unit. By 2010, assuming that peak demand reaches 15 MW, the base load should be in excess of 4.6 MW. Since the load factor is assumed to increase to 60 percent, the base load would increase faster than the peak load.

If the mini-hydro unit is not built, then on the basis of the load profile, a unit of at least three MW can be justified, provided the cost of generation is below that of fuel oil. On the other hand, if a mini-hydro unit is constructed, it is not clear how much electricity will be generated by the dendro thermal plant since seasonal and daily generation curves for the competing mini-hydro unit are not available.** However, there is no doubt that less electricity would be needed, so only a smaller dendro plant could be justified. Finally, the governor of Bohol had suggested a 35-MW hydro unit, but conversations with NPC planners revealed that such a plant is not under serious consideration at this time.

2. Masbate

Masbate province has a single rural cooperative (MASELCO), incorporated in 1977, which is responsible for generating and distributing electricity. It is the only public power entity since NPC does not operate on Masbate. MASELCO uses diesel engines with a total capacity of 1.5 MW to generate electricity, but unfortunately, these engines are old and have not been in operation since October, 1984. Thus, there has been no public power supply on Masbate since that time. The proposed dendro thermal plant would be located in the municipality of Uson (see Figure IV.3), but there is no transmission line or road connecting the site to the main coastal road. A further description of the site is provided in subsequent sections.

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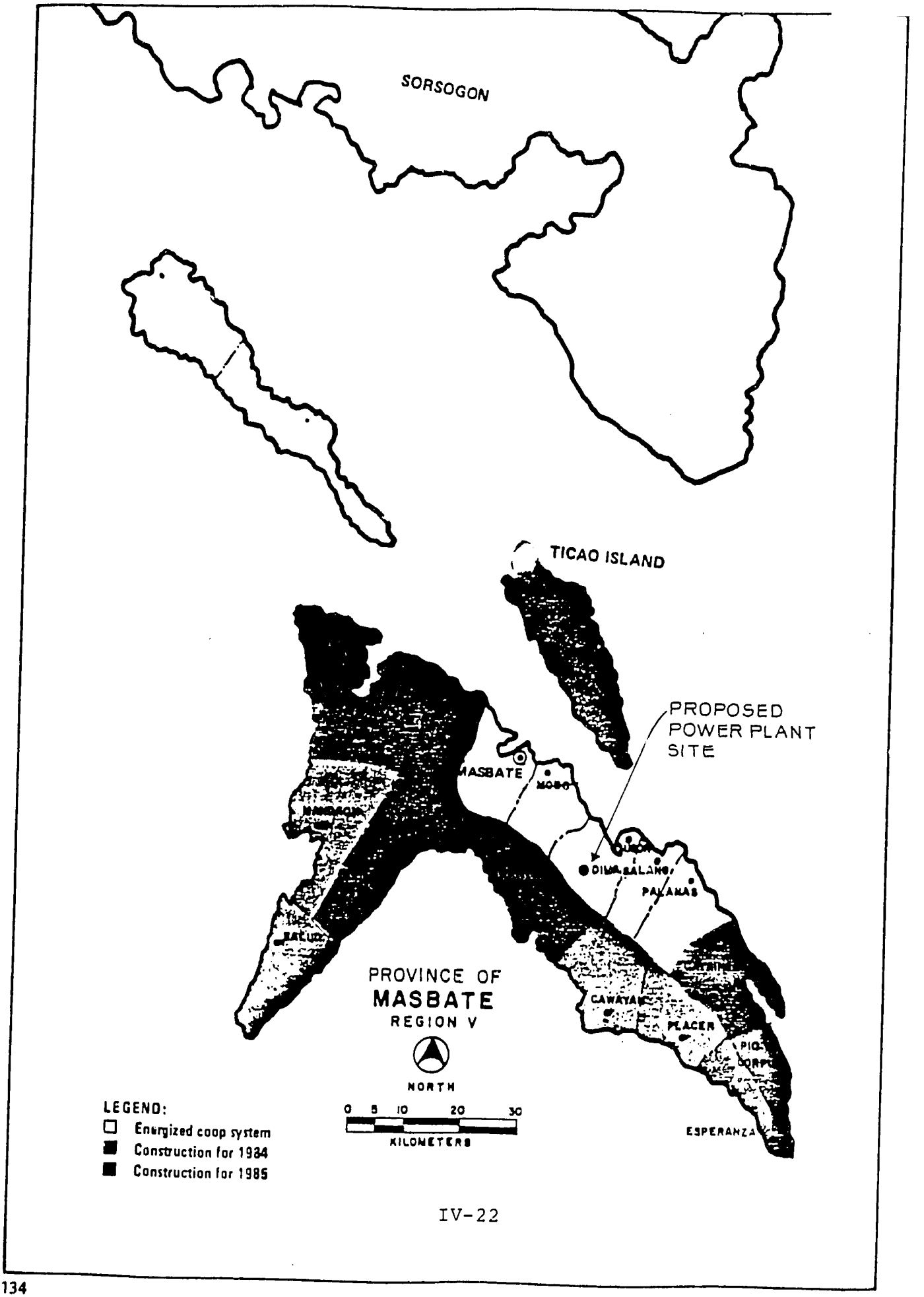
*Norconsult, "Bohol Hydropower Study--The Janepol Feasibility Study," submitted to NEA, June, 1981.

**Data from the mini-hydro study had not arrived as of the writing of this report, but it is assumed that generation costs for the mini-hydro unit will be less than those for the dendro thermal plant.

Figure IV.3. Map of the Province of Masbate



Provincial Demand

Masbate has 15 municipalities with 72,546 potential house connections (see Table IV.7). Only four of these were energized by 1983, thus providing power for four percent of the households--this is well below the regional average of 41 percent. During 1983, the cooperative generated 732,000 kwh of electricity, and sold 564,000 kwh with a consequent system loss of 18 percent. Since peak load on the island was only 600 kw, the load factor was low, 11 percent.

As in many other cooperatives, most of the customers (91 percent) are residential, but they account for a much smaller fraction (54 percent) of sales (see Table IV.4). Again, average residential sales are very small--about 77 kwh a year, the equivalent of one 40-watt light bulb used five hours a day all year. There is no industrial load, but the average commercial load is relatively high, about 457 kwh a year per customer.

In the absence of power from the rural cooperative, diesel and gasoline generators are being used by many of the large commercial customers, including local theaters, hospitals, schools, a college, gasoline stations and an ice plant. In addition, smaller generators are operated by about 30 households.

Mine Demand

Gold is mined on Masbate by the Atlas Mining Company and coal by the Hercules Mining Company. The gold mine processes 3,500 tons of ore per day and has a life of at least five years. Exploration is underway to find new gold deposits that would extend the life of this mine. Both mines are only a few hundred meters from the planned extension of MASELCO distribution lines.

Both mines have captive power plants which use diesel engines. The gold mine has a power generation capacity of 10 MW, although its present power requirement is only six MW.* The daily load profile is steady, and Atlas expects an additional load of possibly 1.5 MW by 1988. The coal mine has a generation capacity of 1.5 MW, but details on its load profile were unavailable at the time this report was written.

Power Requirements

The combined power demand of the mining companies and MASELCO customers approaches eight MW, and the potential for

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*Pablo Ong, Atlas Mining Company, memorandum, March, 1985.

Table IV. 7. Masbate Electric Cooperative

Date of Incorporation and Registration: November 23, 1977

Total Amount of Loan: P27.7 M

Total Releases: P23.2 M

Status of Energization:

Municipalities	Barangays Covered	Barangays Energized	House Connections Potential	House Connections Actual	%
1. Masbate	30	11	8,824	2,414	27
2. Mobo	29	8	3,768	298	8
3. Uson	35	9	6,134	244	4
4. Dimasalang	19	5	3,209	203	6
5. Palanas	24	2	4,228	65	2
6. Milagros	27		4,749		
7. Aroroy	41		6,436		
8. Baleno	24		3,186		
9. Cataingan	36		6,563		
10. Pio V. Corpuz	18		3,504		
11. Placer	35		5,952		
12. Cawayan	29		5,283		
13. Mandaon	25		4,253		
14. Balud	32		4,092		
15. Esperanza	10		2,365		
TOTAL	424	35	72,546	3,224	4

General Statistics for 1983:

	Monthly Average (Est.)
KWH Generated/Purchased ('000)	61
KWH Sold ('000)	47
Systems Loss (%)	18
Gross Revenue ('000)	P111
Peak Load (Kw)	600
Load Factor (%)	11

Membership: 5,073

61.

expansion of residential demand on the MASELCO grid is large. Thus, the peak load could easily approach a few megawatts.

The mining companies use fuel oil to operate their power plants, and it is likely that generation costs for the dendro thermal plant would be less than the price of oil. If this were the case, MASELCO could approach the mining companies with a contract to supply power until its own demand increases to absorb the supply from the dendro thermal plant. Such an arrangement would ensure adequate demand for power (six-MW base load) from the dendro thermal unit. Even without demand from the mining companies, if funds were made available to extend power lines, the new demand (at least one-MW base) would be large enough to absorb the electricity generated by the dendro thermal plant.

3. Cebu

Cebu has three rural electrical cooperatives--CEBECO I, II and III, which are responsible for distributing power to their customers. In addition, the major city on the island, Cebu City, has its own power plant and distribution system, as does Atlas Mining Company. All of the systems are connected by a single grid. Power is generated on the island by NPC, VECO and Atlas Mining Company, but NPC is by far the largest supplier of electricity.

The proposed dendro thermal plant site is located in Tubuelan, which is part of the area serviced by CEBECO II (see Figure IV.4). Electricity generated by this plant would be available to customers of other rural cooperatives through the NPC grid. Electricity transmission will not be constrained by a lack of lines, except in the immediate vicinity of the power plant.

Demand

CEBECO II was incorporated in 1977 and covers nine municipalities. Of 44,416 potential household connections (see Table IV.8), 10,153 households or 23 percent have been connected. This is below the regional average of 36 percent. During 1983, the cooperative purchased 4.32 million kwh and sold 3.98 million kwh of electricity, with a consequent system loss of seven percent. Peak load on the system was 1,248 kw, and compared to BOHECO I and MASELCO, CEBECO II has a high load factor, 37 percent.

NPC electricity sales have increased rapidly over the last few years, and sales to both industry and utility companies increased during this period (see Table IV.5). The displacement of industry and utility power plants by NPC units that generate

Figure IV.4. Map of the Province of Cebu

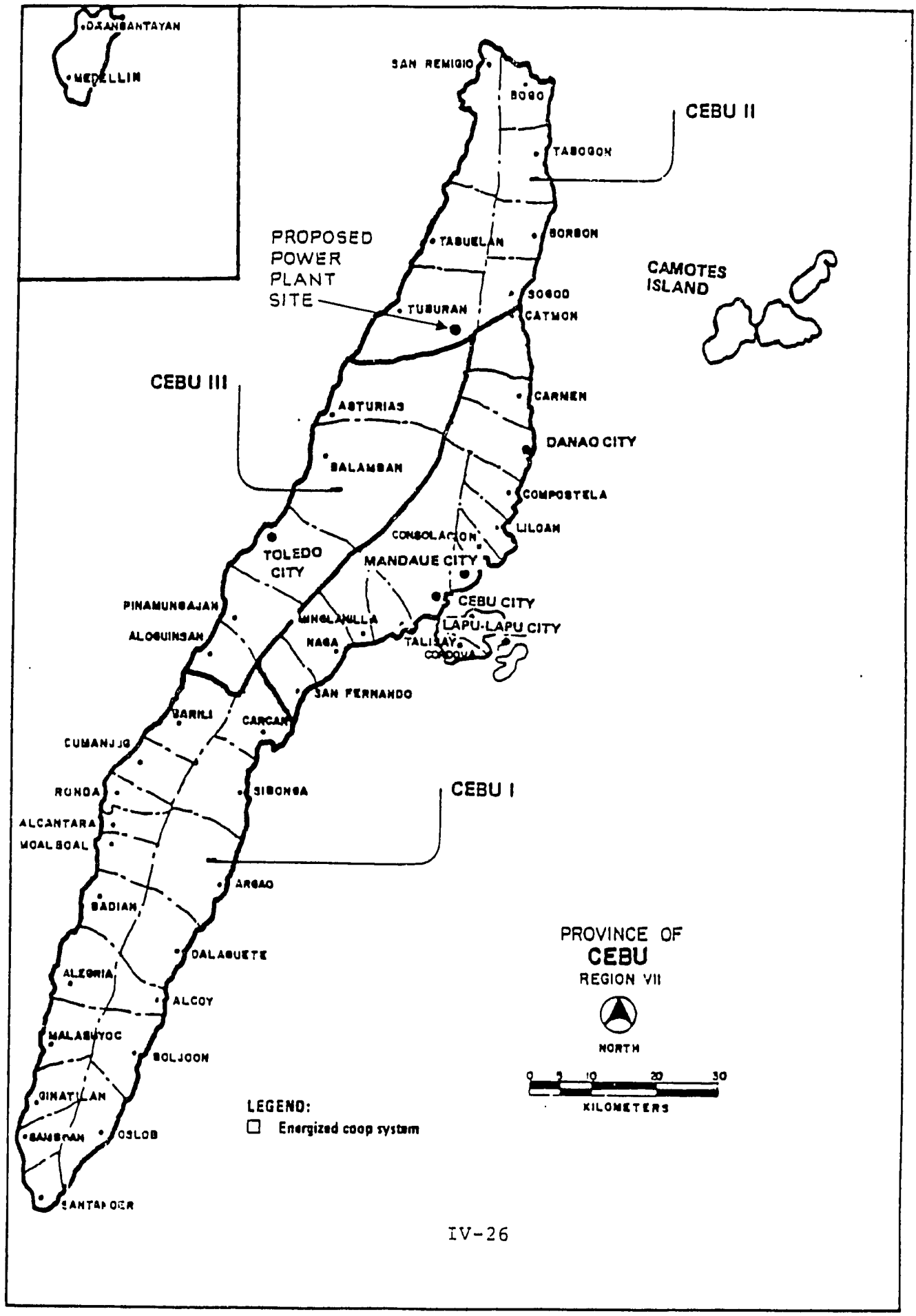

Table IV. 8. Cebu II Electric Cooperative

Date of Incorporation and Registration: December 28, 1977

Total Amount of Loan: P24.0 M

Total Releases: P21.7 M

Status of Energization:

Municipalities	Barangays Covered	Barangays Energized	House Connections Potential	House Connections Actual	%
1. Bogo	29	27	7,074	2,448	35
2. Tabuelan	12	11	2,417	305	13
3. Daan-Bantayan	20	16	7,654	2,183	29
4. Tabogon	25	16	3,640	729	20
5. Sogod	17	13	3,438	636	18
6. Mede-lin	16	16	4,774	1,500	31
7. San Remegio	27	16	4,902	851	17
8. Borbon	19	10	3,356	559	17
9. Tuburan	54	15	7,161	942	13
TOTAL	219	140	44,416	10,153	23

General Statistics for 1983:	Monthly Average (Est.)
KWH Generated/Purchased ('000)	360
KWH Sold ('000)	332
Systems Loss (%)	7
Gross Revenue ('000)	P452
Peak Load (Kw)	1,248
Load Factor (%)	37

Membership: 9,824

less expensive electricity was partly responsible for increased sales. For instance, NPC contracted to supply about 40 MW of power to Atlas Mining Company and about 20 MW to VECO.

Sales also increased as the cooperatives built more transmission and distribution lines and income increased in the region, but demand for electricity stagnated in 1984. However, unlike Bohol, supply was not affected by a typhoon. The daily load curve for the grid exhibits a very flat pattern with a correspondingly high load factor of 60 percent (see Figure IV.5). The daily load peak occurs between 10 a.m. and 2 p.m.

Electricity demand on Cebu was 610.3 million kwh in 1984, while the peak load was 89.8 MW and does not show significant seasonal change. In addition, VECO and Atlas had peak loads of 23 and 81.4 MW, respectively, with a combined coincident load of 194.2 MW.

Demand projections for Cebu are shown in Table IV.9, and they assume that by 1990, the VECO load will be supplied entirely by NPC. Atlas Mining would continue to fulfill its own requirements at the current level. Future projections are based on growth rates provided by NPC (Manzo, 1985). They show electricity demand growing at 2.7 percent to 1990 and then at 1.76 percent to 2015. The load growth rate is 2.16 percent to 1990 and 1.47 percent thereafter.

Power Requirements

The determination of Cebu's power requirements is more complicated since the system is larger and there are both oil and coal plants on-line. Power from a dendro thermal plant will have to be competitive with the cost of coal and fuel oil, unless demand clearly exceeds the capacity of the coal and oil plants. Unfortunately, there is excess capacity on the island, which is expected to continue through the year 2000. Therefore, a dendro thermal plant will have to compete with the annual costs of coal and oil generation.

To estimate the size and generation requirements for a dendro thermal unit, the assessment team relied on a generation planning model used by NPC's System Planning Department in Manila. The model's output in Appendix C shows the dispatch of a five-MW plant on the NPC grid for 1990, 2000, 2010 and 2015. During the earlier years, generation from the plant is low, about 13.9 million kwh, which amounts to a capacity factor of only 31 percent. However, generation from the plant increases as the demand for power increases, such that by 2015, the capacity factor reaches 60 percent. In order to better utilize the capacity, it is important that the plant be built in two stages. The first stage would lead to construction of a three-MW power

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Figure IV.5. Typical Weekday Load Curve for Cebu Grid

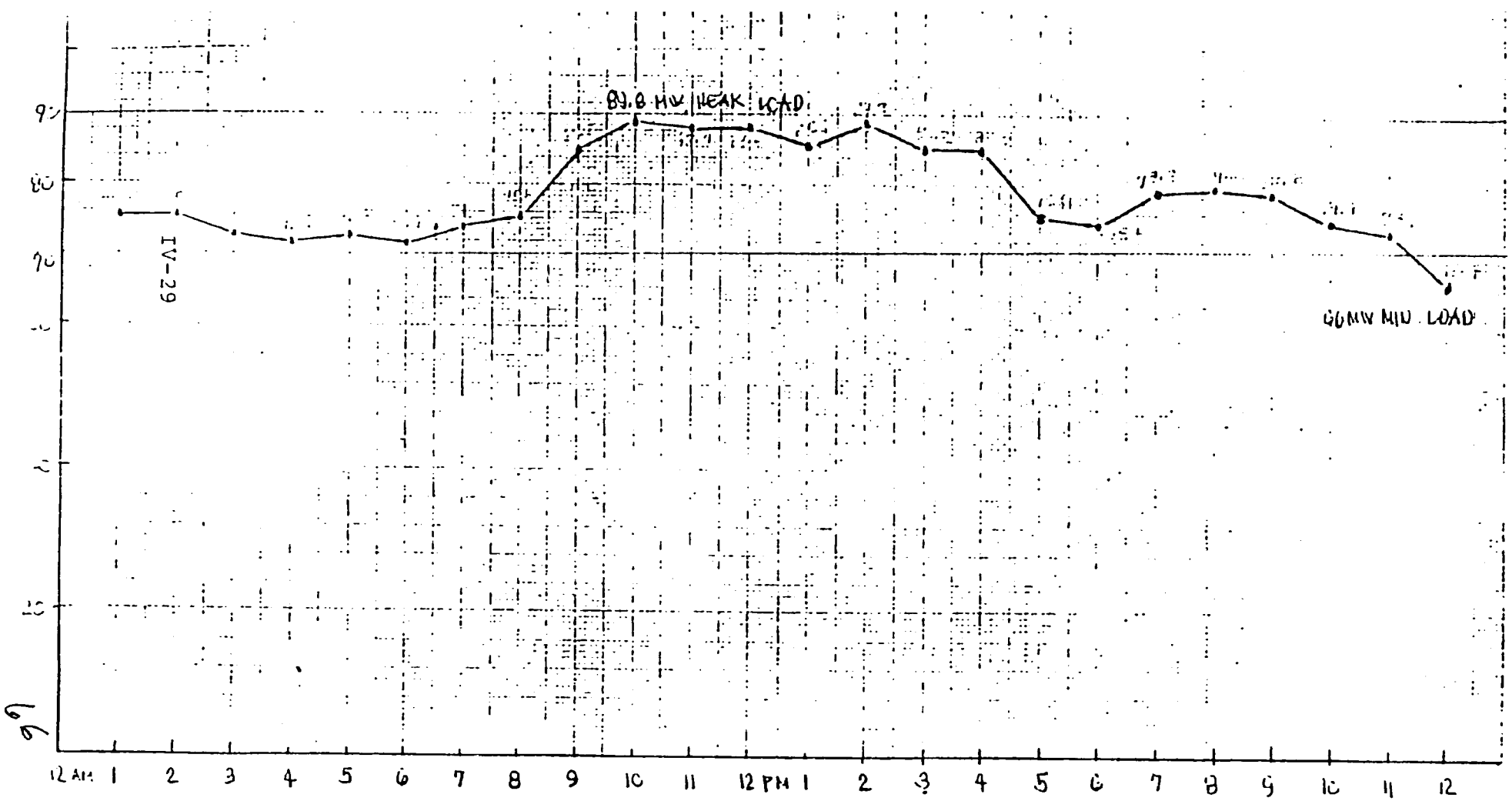

Table IV.9. Demand Projections for Cebu

Capacity (MW)

	Actual 1984	1990	2000	2010	2015
Utilities					
VECO[1]	23.0 MW				
NPC[2]	89.8 MW				
Sub-Total	112.8 MW	128.22 MW	148.3 MW	171.6 MW	184.6 MW
Rate of Increase		2.16%	1.47%	1.47%	1.47%
ACMDC (Atlas)[3]	81.4 MW				
TOTAL	194.2 MW				

Generation (GWH)

Utility	294.4 (GWh)				
Non-Utility	2.1				
Industry	165.5				
Sub-Total	462.0				
Additional Utility[4]	148.3				
TOTAL	610.3	719.35	851.7	1,014.0	1,107.9
Rate of Increase		2.7%	1.76%	1.76%	1.76%

1) VECO own load peak (in addition to that supplied by NPC) on July 17, 1984.
2) NPC peak load includes contracted amount of 30 MW with ACMDC (Atlas) and with VECO.
3) Load supplied by ACMDC power plants in addition to contracted amount with NPC. Non-coincident peak was 84.8 MW.
4) Net actual estimated additional VECO generation from NPC CORPLAN dated November 5, 1984.

plant in 1990 and the second, in the year 2000, to an additional two-MW plant.

D. Power Plants

1. Background

Historically, wood has been used as a fuel at power plants wherever wood and wood waste were plentiful. While using wood as a fuel for steam-electric power plants is not technically difficult, it does present challenges in terms of designing efficient, reliable, low-maintenance faclities. Past plants have often ignored fuel conservation and reliability because of plentiful wood supplies and the ease with which this energy source could be replaced by using gasoline or oil generators. This is not the case for the Philippine Dendro Thermal Development Program. Adequate quantities of wood must be grown to supply power plant needs since no other substitute fuels can be used.

Steam-electric power plants fueled by wood have been in operation throughout the world starting at the turn of the 20th century. Since World War II, forest product industries (including pulp and paper mills) have installed manufacturing facilities in heavily forested areas adjacent to their feed stock supplies. A number of these facilities have been installed in Brazil, Western Samoa, Japan, Canada, the United States, Sweden, Denmark, Norway, Finland, Mexico, Africa, etc, with approximately 100 in the United States. There are many different basic designs for such plants, ranging from hand-fired, wood slab-feed systems with manual controls to plants that are completely automated from the input of raw materials to the final output of electricity.

Plants in Brazil, Indonesia and Western Samoa are located in remote areas and hence, are operated entirely by local people who have been trained in power plant operation and maintenance. There is no reason that similar facilities cannot be satisfactorily operated and maintained at the proposed sites in the Philippines, given the obvious requirements of an adequate supply of fuelwood and proper plant design.

2. Dendro Thermal Plants in the Philippines

Project Status

As of June, 1984, there were 29 dendro thermal plants in various stages of planning or construction with a potential

generating capacity of 92.3 MW. The Georgia Institute of Technology (GIT) completed an evaluation in October, 1984 for the Asian Development Bank (ADB) that details the status of the program as of July, 1984. The power plants being started up or already in service are described in their report as follows.

"Five 3.1-MW steam plants are of British design. Those five are either in operation or in the final stages of construction. They are basically the same design. Fuelwood in log form is fed into the furnace/boiler by a converyor. The boiler is a standard marine-type, horizontal-drum, water-tube model, and the turbine is a seven-stage, single-extraction condensing unit. The units are rated to have a net power output of 2.97 MW and an efficiency rating of 16 percent.

Seven 3.4-MW and two 1.2-MW plants are of French design. They have all been manufactured; two are in the final stages of construction, and seven are in various storage locations. Design details of the 1.2-MW, French-designed steam plants were not available. The 3.4-MW French design utilizes a fuelwood crusher, wood dryer, covered storage building with automatic loading and retrieval, and pneumatic conveyor. The furnace/boiler input is a two-drum, water-tube boiler with super-heater, economizer and air heater. The turbine is a three-stage, single-extraction condensing unit. The units are rated to have a net power output of 2.91 MW and an efficiency rating of 15.6 percent.

Two 0.96-MW gasifier plants are of French design. Both are in final stages of construction. Both consist of a 600-KVA gasifier-engine-generator system. The gasifier converts wood fuel to a gas which is used as fuel in a reciprocating diesel engine. The fuelwood is chipped, dried and fed into the gasifier by a semiautomatic loader. The units are rated to have a new power output of 0.66 MW and an efficiency rating of 20 percent."

Table IV.10 lists the proposed 29 plants as of June, 1984, while Table IV.11 is a status report, as of December 31, 1984, which provides additional information on the 29 plants, such as probable date of commissioning. Construction contracts awarded in 1982 and their status as of December 31, 1984 are presented in Table IV.12. Finally, Table IV.13 gives the present status of plants on which construction has started and progress on them as of February 28, 1985.

French and British Plants

Both French and British dendro thermal plants are now in operation in the Philippines, and the lessons learned during the construction of these plants should be of considerable assistance in the design of additional plants. Improvements continue to be

Table IV.10. Proposed 29 Dendro Thermal Power Plants as of June, 1984

Plant No.	Site Name	Province	Town	Equipment Supplier	Capacity (MW)	Status
1	PANELCO I	Pangasinan	Bolinao	Alsthom-Atlantique	3.40	C
2	INEC	Ilocos Morte	Solsona	Balfour Beatty	3.10	BI
3	ANTECO	Antique	Ilamtic	Monteurs Duvant	0.96	96%
4	ISECO	Ilocos Sur	Burgos	Alsthom-Atlantique	3.40	80%
5	ISELCO II	Isabela	Ilagan	Balfour Beatty	3.10	BI
6	ZAMECO	Zambales	Palauig	Balfour Beatty	3.10	95%
7	CASURECO IV-A	Camarines Sur	Caramoan	Balfour Beatty	3.10	80%
8	ISELCO I	Isabela	Jones	Balfour Beatty	3.10	75%
9	OMECO	Occidental-Mindoro	Magsaysay	Monteurs Duvant	0.96	88%
10	ABRECO	Abra	San Juan	Alsthom-Atlantique	3.40	S
11	NUVELCO	Nueva Vizcaya	Dupax del Morte	Balfour Beatty	3.10	T
12	PALECO (A)	Palawan	Aborlan	Alsthom-Atlantique	1.20	S
13	MARELCO	Marinduque	Buenavista	Alsthom-Atlantique	3.40	S
14	AKELCO	Aklan	Nabas	Alsthom-Atlantique	3.40	T
15	FICELCO	Catanduanes	Virac	Alsthom-Atlantique	1.20	S
16	PALECO (A)	Palawan	Puerto Princesa	Alsthom-Atlantique	3.40	S
17	ILECO II-A	Iloilo	Lambunao (A)	Alsthom-Atlantique	3.40	T
18	CAPELCO	Capiz	Tapaz	WEST JEC	3.40	ND
19	BOHECO I	Bohol	Inabanga	Stone and Webster	5.00	NN
20	ILECO I	Iloilo	Miaq-ao	WEST JEC	3.40	ND
21	LUELCO	La Union	Arningay	WEST JEC	3.40	ND
22	CASURECO III	Camarines Sur	Balatan	WEST JEC	3.40	ND
23	CAGELCO II	Caqayan	Lallo/Lasam	WEST JEC	3.40	ND
24	CASURECO II	Camarines Sur	Pili	WEST JEC	3.40	ND
25	CASURECO IV-B	Camarines Sur	Garchitorena	WEST JEC	3.40	ND
26	CENECO	Negros Occidental	Murlia	Stone and Webster	5.00	NN
27	QUEZELCO	Quezon	Macalolon	WEST JEC	3.40	ND
28	MASELCO	Masbate	Mabo	WEST JEC	3.40	ND
29	ILECO II-B	Iloilo	Lambuanao (B)	Stone and Webster	5.00	NN

C - Complete
BI - Break In
T - Terminated
S - Suspended

% - Percent Complete
ND - Not Designed
NN - Contract Not Negotiated
X - Indicates Inspection Made

Table IV.11. Status of Dendro Thermal Power Plant Facilities

AS OF 31 December 1984

PROJECT	CAPACITY	EQPT SUPPLIER	A&E	CONTRACTOR	CONSTRUCTION STARTED	COMPLETION TIME (days)	DATE OF COMMISSIONING
REGION I							
1. ABRECO	3.4	FR-AA	AWIA	S.D.Flores	23 Apr'82	575	*
2. CENPELCO	3		MIESCOR				1988
3. INEC	3.1	UK-BBEL	DCCD	PACORP	18 Jan'82	550	Commissioned
4. ISECO	3.4	FR-AA	DCCD	BALUYOT CONST.	17 Jan'83	529	1985
5. LUELCO	3	J	EDCOP				1987
6. PANELCO I	3.4	FR-AA	MIESCOR	ECCO-ASIA	28 Jan'82	343	Commissioned
REGION II							
7. ISELCO I	3.1	UK-BBEL	AWIA	ECCO-ASIA	24 FEB'82	970	1985
8. ISELCO II	3.1	UK-BBEL	AWIA	ECCO-ASIA	28 Jan '82	626	Commissioned
9. CAGELCO II	3	J	MIESCOR				1987
10. NUVELCO	3.1	UK-BBEL	AWIA	WGS Const.	15 Jun.'82	300	**
REGION III							
11. BATELCO	3		MIESCOR				1988
12. NEECO II	3		TAP				1988
13. ZAMECO	3.1	UK-BBEL	MIESCOR	REMCO	18 May'82	690	*
REGION IV							
14. MARELCO	3.4	FR-AA	MIESCOR	PCCC	11 Aug.'83	321	*
15. OMECO	.96	FR-MD	DCCD	POWER CONSULTANTS, INC	2 Aug'82	699	1985
16. PALECO (PP)	3.4	FR-AA	DCCD				1986
17. PALECO (A)	1.2	FR-AA					1986
18. QUEZELCO I	3	J	MIESCOR				1987
REGION V							
19. CANORECO	3		MIESCOR				1988
20. CASURECO I	3		MIESCOR				1988
21. CASURECO II	3	J	MIESCOR				1987
22. CASURECO III	3	J	MIESCOR				1987
23. CASURECO IV-A	3.1	UK-BBEL	AWIA	[illegible] WORKS	9 Jul.'82	609	Commissioned
24. CASURECO IV-B	3	J	MIESCOR				1987
25. FICELCO	1.2	FR-AA	TAP				1986
26. MASELCO	3	J	MIESCOR				1987

DTDO/1/8/85

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Table IV.11. Status of Dendro Thermal Power Plant Facilities (continued

AS OF 31 December 1984

PROJECT	CAPACITY	EQPT SUPPLIER	A&E	CONTRACTOR	CONSTRUCTION STARTED	COMPLETION TIME (days)	DATE OF COMMISSIONING
REGION VI							
27. ANTECO	.96	FR-MD	AWIA	FIL SYSTEMS INC.	17 Feb.'82	604	1985
28. AKELCO	3.4	FR-AA	AWIA	ECCO-ASIA	2 Sept.'82	510	**
29. CAPELCO	3	J	MIESOOR				1987
30. CENECO	5	USA					1986
31. ILECO I	3	J	MIESCOR				1987
32. ILECO II-A	3.4	FR-AA	DCCD	EEI	25 Oct.'82	390	**
33. ILECO II-B	5	USA					1986
34. NOCECO	3	DCCD					1988
REGION VII							
35. BOHECO I	5	USA					1986
REGION IX							
36. TAWELCO	1						1988

* Termination of contract in process
** Contract terminated

Table IV.12. Status of Construction Contracts as of Dec. 31, 1984

PROJECT	CONTRACTOR	CONTRACT AMOUNT (INCLUDING CAR)	AWARDED	COMPLETION TIME(DAYS)	% OF COMPLETION
1. INEC Solsona	Pacific Asia Builders and Development, Inc.	₱ 7 777 099	21 Jan. 1982	550	Power Plant already operational. Minor modifications/ adjustments in progress.
2. PANELCO I Bolinao	Eng'g. Construction Corp.-Asia	14 834 734	05 Feb. 1982	343	Power Plant already operational. Minor modifications/ adjustments in progress.
3. ISELCO II Ilagan	Engineering Equipment, Inc.	8 246 209	28 Jan. 1982	626	Operational.
4. ANTECO Hamtic	FF Cruz and Co.	10 110 252	17 Feb. 1982	604	96.41
5. ISELCO I Jones	Eng'g. Construction Corpo.-Asia	9 560 000	24 Feb. 1982	970	73.23
6. ABRECO San Juan	SD Flores Construction	11 111 111	23 Apr.1 982	575	Termination of contract in process.
7. ZAMECO Palauig	RIMCO Construction	13 309 926	18 May 1982	690	Termination of contract in process.
8. AKELCO Nabas	Eng'g. Construction Corp.-Asia	11 751 000	02 Sept. 1982	510	Contract terminated.
9. NUVELCO Dupax del Norte	WCS Construction Specialists	10 507 603	11 June 1982	300	Contract terminated.
10. CASURECO IV Caramoan	Bicol Woodworks Industries, Co.	12 849 660	08 July 1982	609	Operational
11. OMECO Magsaysay	Power Consultants, Inc./ Isabelo Ong Construction Co., Inc.	4 061 287	13 July 1982	699	88.411
12. ILECO II Lambunao	Engineering Equipment, Inc.	14 700 000	25 Oct. 1982	390	Contract terminated.
13. ISECO Burgos	CR Baluyot Construction	13 718 730	03 Nov. 1982	529	80.85
14. MARELCO Buenavista	Phil. Const. Consortium Corp.	11 200 000	11 July 1982	321	Termination of contract in process.

Table IV.13. Present Status of Power Plants under Construction

Republic of the Philippines
Ministry of Human Settlements
NATIONAL ELECTRIFICATION ADMINISTRATION
Quezon City

Table IV-12

06 March 1985

MEMORANDUM FOR THE EXECUTIVE DIRECTOR

SUBJECT: Status of Dendro Power Project as of 28 February 1985

* *

1. Submitted is the project status as of 28 February 1985

a. Operational Power Plant

Solsona	- 3.1 MW	-	Latest operation - 26 Feb. 85
Caramoan	- 3.1 MW	-	Latest operation - 18 Feb. 85
Ilagan	- 3.1 MW	-	Operational. Latest date of resumption - 6 Feb - 28 Feb. 85)
Bolinao	- 3.4 MW	-	Operational
	12.7 MW		

b. For Test/Commissioning

Pilauig	- 3.1 MW	-	Test/commissioning start on 6 March 85

2. In progress and construction activities to continue for 1985:

Burgos	- 3.1 MW	-	80.15%
Jones	- 3.1 MW	-	73.21% (remobilization under discussion with ECCO-ASIA
Hamtik	- 1.0 MW	-	96.41%
Magsaysay	- 1.0 MW	-	88.41% (Remobilized - 14 Mar. 85)
	8.2 MW		

3. Project Terminated

San Juan	- 3.4 MW	-	50.24%
Dupax	- 3.1 MW	-	1.80%
Nabas	- 3.4 MW	-	44.03%
Lambunao	- 3.4 MW	-	17.43%
Marinduque	- 3.4 MW		
Palawan	- 3.4 MW		
	20.1 MW		

4. Equipment for allocation/no definite sites

Dupax units	- 3.1 MW
Small Dendro	- 1.225 MW
	1.225 MW
	5.550 MW

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made to the original installations that have significantly enhanced the overall operation of the plants.

While it is beyond the scope of this assessment to provide detailed recommendations or suggested improvements for the British or French designs, it is worthy of note that the operation and performance of the French design seem superior. Furthermore, because of its manual fuel-feeding operation, unprepared fuel and sizing, and lack of automation in the entire control system, the present British design appears to be unsatisfactory for consideration or modification by AID as an alternative to procuring equipment designed in the United States. The French design is similar to some U. S. designs except that the latter do not recycle dry fuel back into wet-fuel storage as well as some other minor differences. Figure IV.6 shows a typical U. S. design for a dried-wood suspension burning system that starts with wet fuel. Equipment costs for French- and British-designed plants, reported by the NEA in December 31, 1984, show that a French plant costs considerably less than a British one of similar size.

It is beyond the scope of the present assessment to recommend whether or not U. S. funds should be used to install units that are not currently in place, with some modifications. If the British units were used, very extensive modifications at a considerable cost would be needed to achieve the performance standards required of U. S. designs, and the French units would need some modification as well. The cost of a U. S.-designed power plant would be similar to that of a French design, but possibly 10 to 20 percent more to produce an equivalent net output of steam and electricity for the same amount of fuel. However, a U. S.-designed facility would not include a dryer, thus reducing maintenance expenses and increasing the plant's available time on-line, which should make it more cost-effective. The design differences between a typical wet-wood handling and boiler feed system and a dried-wood system can be seen by comparing Figures IV.6 and IV.7.

3. U. S.-Supplied Power Plants

Technical Description

In general, the proposed U. S. plants would be configured in a manner similar to the diagrams in Figures IV.8 and IV.9. A simplified heat balance (also presented in Figure IV.9) was determined for plants with three different sizes of electrical output--1.5, two and three MW. The size of the boiler is only an estimate since the steam turbine generator's actual heat rate will vary depending on the manufacturer and model selected. In addition, the heat input into the boiler will vary according to

Figure IV.6. Typical Wet-Wood Handling and Boiler Feed System

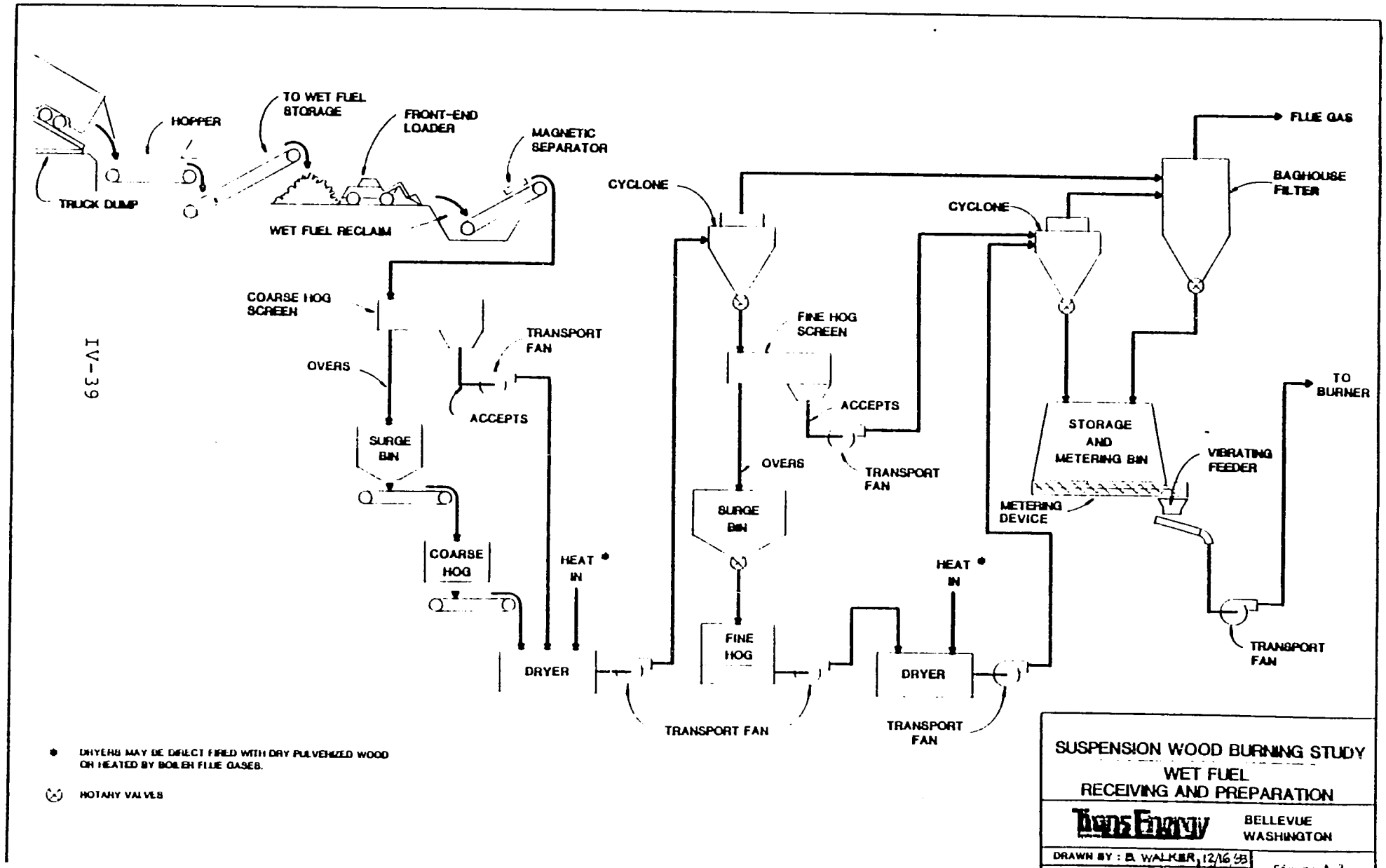


Figure IV.7. Simplified Process Diagram for Typical Dried-Wood System

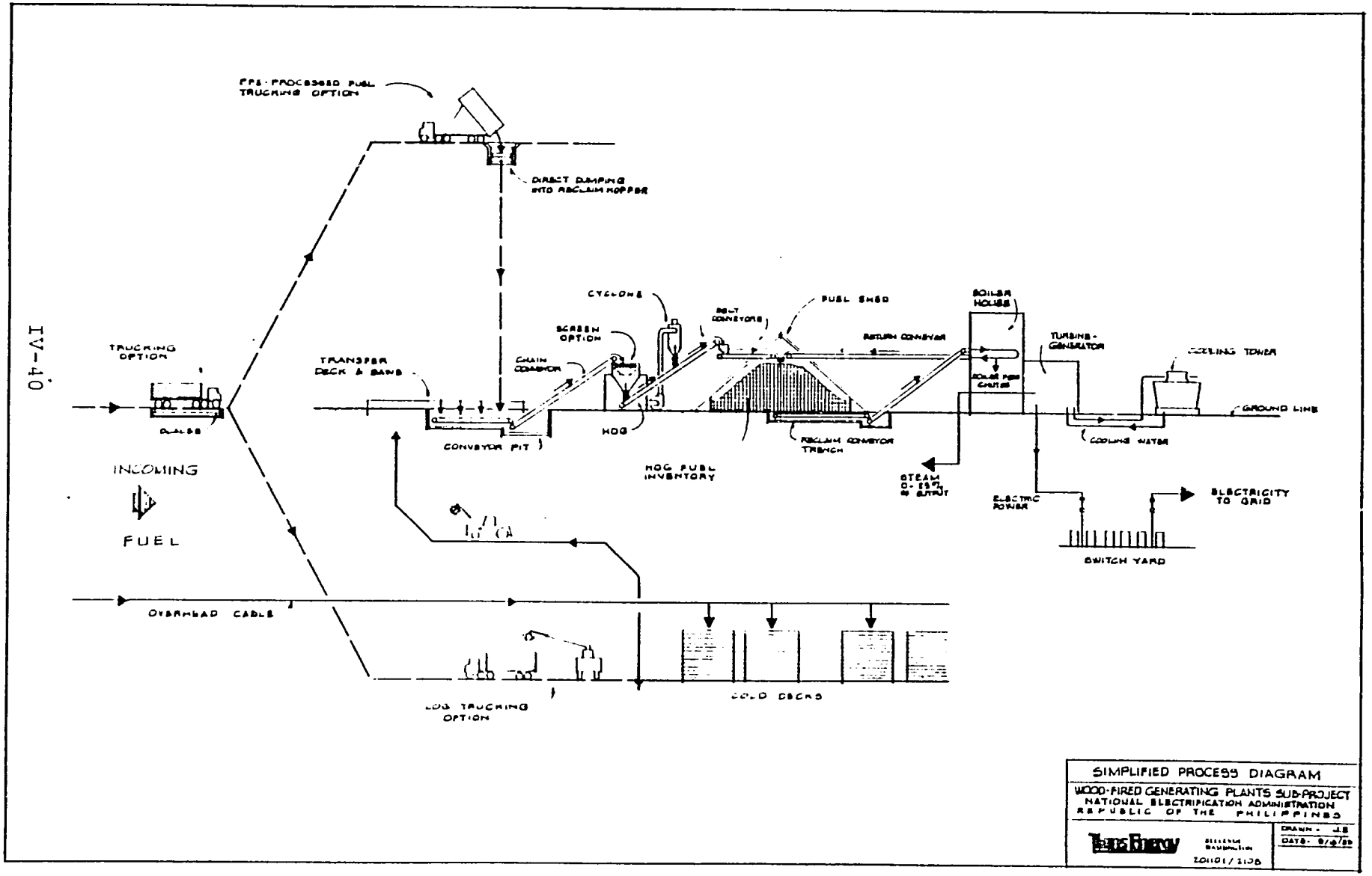


FIGURE 4-3

Figure IV.8. Typical Configuration of Boiler with Emissions Control Equipment

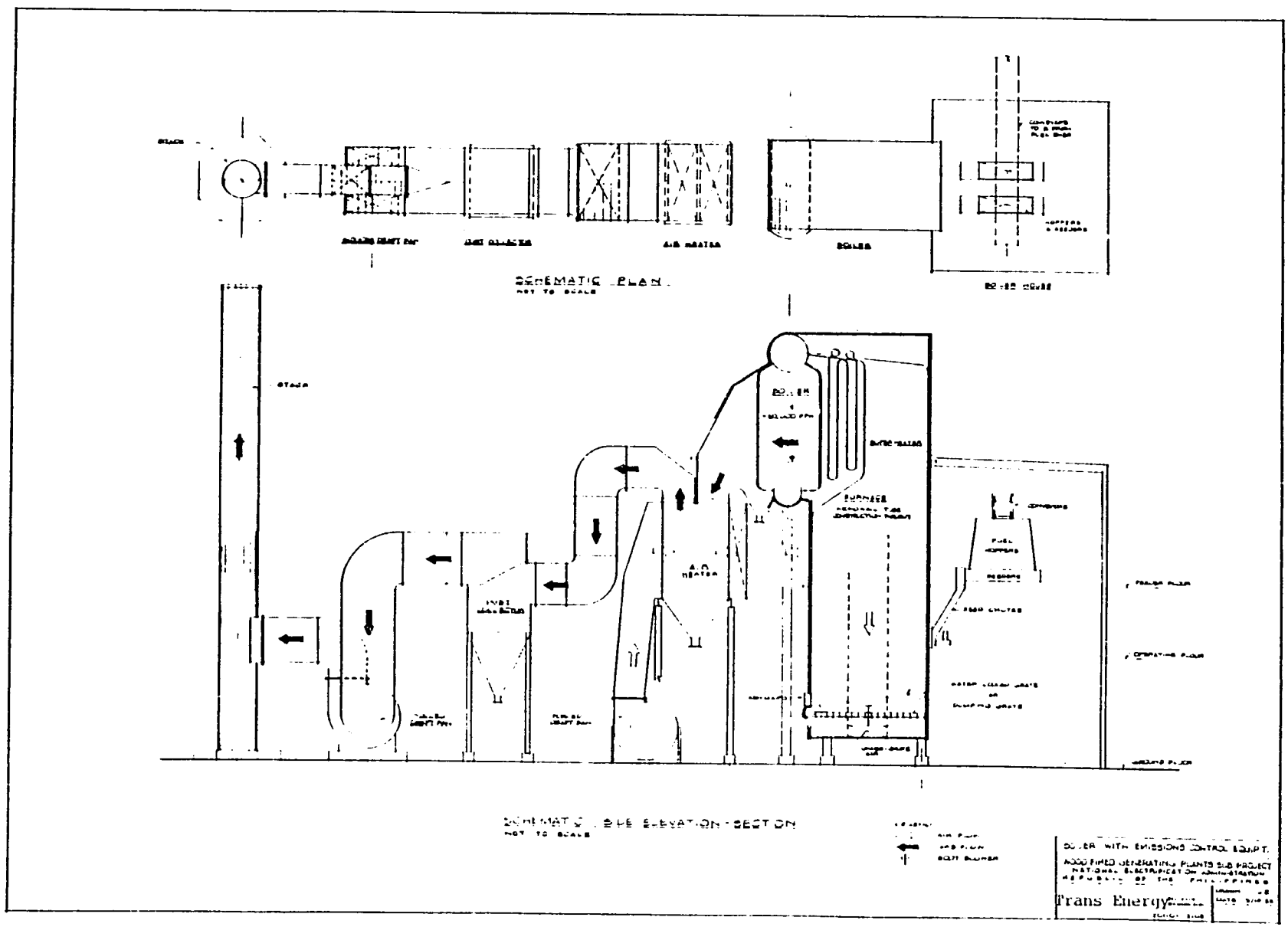
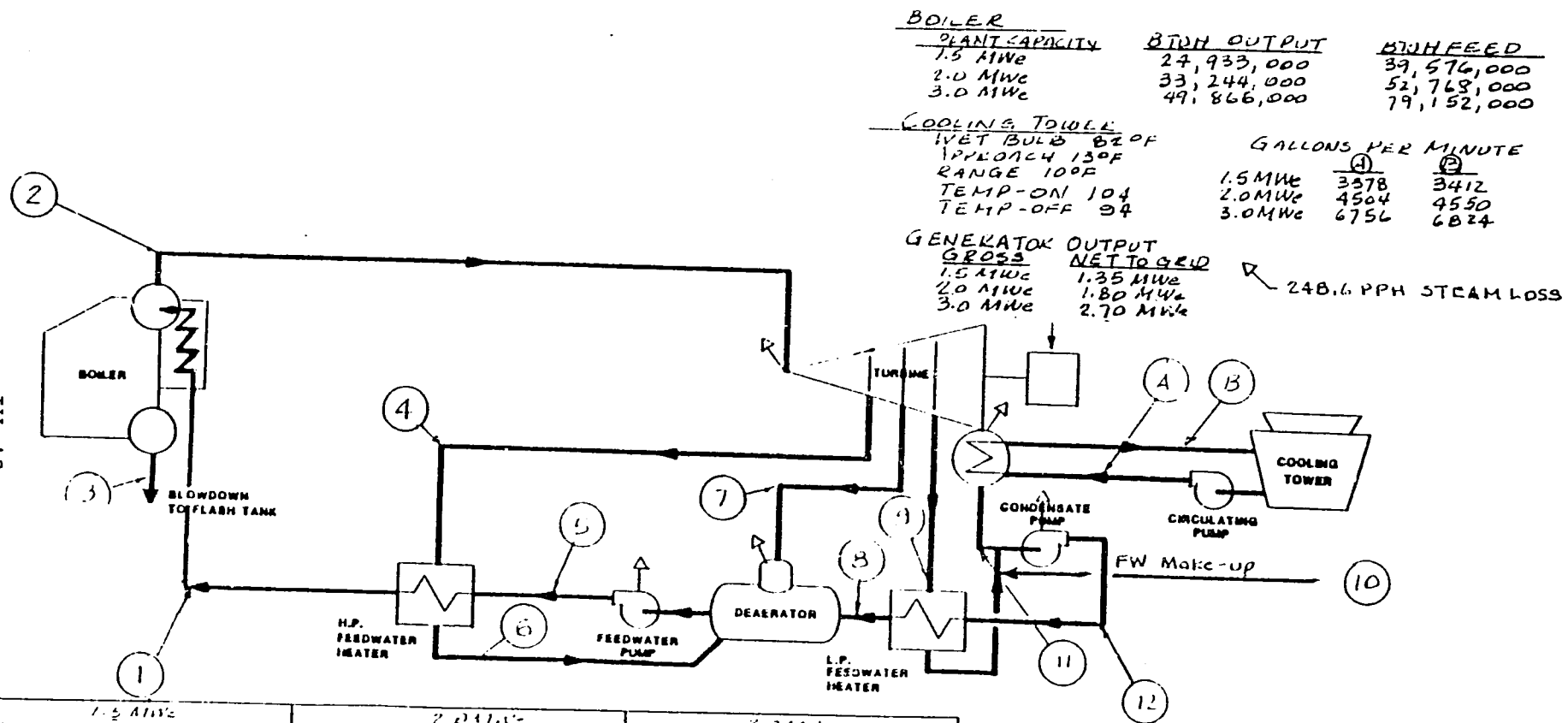


Figure IV.9. Diagram of Typical Wood-Fired Power Plant Steam Cycle



BOILER

PLANT CAPACITY	BTUH OUTPUT	BTUH FEED
1.5 MWe	27,933,000	39,576,000
2.0 MWe	33,244,000	52,768,000
3.0 MWe	49,866,000	79,152,000

COOLING TOWER

WET BULB 82°F
APPROACH 13°F
RANGE 10°F
TEMP-ON 104
TEMP-OFF 94

	GALLONS PER MINUTE (A)	(B)
1.5 MWe	3378	3412
2.0 MWe	4504	4550
3.0 MWe	6756	6824

GENERATOR OUTPUT

GROSS	NET TO GRID
1.5 MWe	1.35 MWe
2.0 MWe	1.80 MWe
3.0 MWe	2.70 MWe

248.6 PPH STEAM LOSS

	1.5 MWe				2.0 MWe				3.0 MWe			
	PSIG	°F	PPH	h	PSIG	°F	PPH	h	PSIG	°F	PPH	h
(1)	750	300	18645	269.7	750	300	24860	269.7	750	300	37290	269.7
(2)	600	750	18086	1378.6	600	750	24114	1378.6	600	750	36171	1378.6
(3)	600	750	559	1378.6	600	750	746	1378.6	600	750	1119	1378.6
(4)	200	381.8	263	1199.3	200	381.8	351	1199.3	200	381.8	526	1199.3
(5)	750	287.1	18894	256.4	750	287.1	25109	256.4	750	287.1	37539	256.4
(6)	40	287.1	263	256.4	40	287.1	351	256.4	40	287.1	526	256.4
(7)	40	287.1	26459	1175.9	40	287.1	35410	1175.9	40	287.1	53178	1175.9
(8)	40	140	16469	108.0	40	140	21959	108.0	40	140	32938	108.0
(9)	0	212	180	1150.6	0	212	647	1150.6	0	212	973	1150.6
(10)	0	80	2424	48	0	80	3231	48	0	80	4848	48
(11)	2½ Hg	109	13932	71	2½ Hg	109	18575	77	2½ Hg	109	27863	77
(12)	40	111	16468	79	40	111	21958	79	40	111	32937	79

the boiler's configuration and manufacturer. Efficiency across the boiler (Btus in to Btus out) was assumed to be 63 percent, and the steam turbine was assumed to be 73 percent efficient. While electric output is shown at the three levels mentioned, the plant's use of electricity is deducted from this amount before it is distributed into the network grid. The net amount of potential electricity output to the grid for each case is also given in Figure IV.9. The power plants would normally have a nominal pressure and temperature of 600 psig and 750°F, with 4,160 volt-60 Hertz operation. This is normal for plants of this size. Overall, from fuel input to net electricity output, a U. S. plant would have an efficiency of 12 percent.

U. S.-supplied plants would have duplicate pumps and wood chippers as well as controls with back-up electrical power and function cards for dependable operation. Controls would be solid state microprocessors with pneumatic damper and valve operators. A feed-water demineralizing system would be needed to control feed-water quality. Additional details about power plant equipment are given in the next section on cost estimates.

Microprocessor control systems with standard module replacement units would be used, and the power plant automated to a degree sufficient to permit only minor operator control. Alarms would be incorporated in the system along with trouble annunciator panel readout windows. Because modern electrical control equipment requires a dust-free, temperature-controlled environment, controls for the plant boiler, turbine and switch panel would be located in a central control room with air conditioning. Isolation from plant noise will also allow the shift supervisor to operate in an environment free from distraction. Communication links would be located in the control room as well.

Cooling towers should be used on all plants. Due to the intense summer rains, silt would be a major problem if river water were used for condenser cooling.

The use of wood fuel dryers on U. S.-designed plants should be carefully analyzed before they are even considered for installation. The value of such dryers may be marginal in view of the difficulties encountered in operating them, including the procurement of spare parts and maintenance, particularly in remote locations, and the added capital costs.

Cost Estimates

Costs were estimated for a generic type of wood-fuel, steam-electric generating plant. Such a plant would be equipped with a water-cooled, grate-type burning system that uses both under-grate combustion and over-fire air (dumping grates are also

frequently used). The boiler would normally be a balanced-draft type with water-wall construction and flue-gas heat exchangers for heating both combustion air and feed water. The control system would include microprocessors to operate air controllers on both dampers and valves. Wood fuel would be chipped to a uniform size by a knife or hammer hog before going into covered storage, which would have a conveyor out-feed system into surge hoppers. The fuel would then be fed automatically from the hoppers by SCR drives operating according to the steam demand of the boiler. Chemical feeders would be provided for treatment of make-up feed water and the cooling tower. Water softeners and demineralizers would also be installed for all make-up water.

The control room would be the only part of the plant that is air conditioned, but minimal shelters would be provided to protect the equipment from the weather. These buildings would be of light-gauge metal construction and well-ventilated, as is necessary for any tropical installation. Sanitation facilities would be included along with lockers for shift personnel. Concrete foundations would be poured, as necessary.

Pumps and water intake structures would be located in rivers adjacent to the power plant. High-efficiency, mechanical, flue-gas scrubbers with a low draft loss requirement would handle particulate clean-up, and synchronizing equipment for paralleling the generator with the grid along with transformers and switch gear would also be provided. A battery room with the necessary switches would be included with the steam turbine generator and cooling tower.

The cost of such a plant in the Philippines would be similar to one in the United States. Even though the cost of hiring expatriate supervisors to direct the erection, start-up and testing of the new facility would be high and the number of person-hours required for installation considerably greater because of local laborers' unfamiliarity with this type of construction, these factors would be offset by the low hourly cost of labor.

The cost estimates presented in Table IV.14 assume that for a facility with a capacity of 1.5 MW, the steam generator (including tubes and drums) will be fully assembled before shipping. This assembly does not appear to be too large or heavy for trucking to the site once new access roads are constructed. The steam generator sections for a power plant of any other size would have to be shipped in pieces and assembled in the field because of their size and weight.

These estimates also include allowances for local conditions, to the extent they could be determined from old topographical maps, since (with the exception of the Bohol site) the routing of proposed roads was not observed in the field.

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Table IV.14. Dendro Thermal Plant Cost Estimates

Plant Size	Description	US ₱ (1,000)	US ₱ (1,000)	Total ₱ (1,000)
1½ MW	Generation Plant (CIF) & Erection Superv.	15,000		
	US A&E	1,350		
	Philip. A&E		1,900	
	Philip. Erection		12,000	
	O&M/Year (without fuel)		1,600	
2 MW	Generation Plant (CIF) & Erection Superv.	26,000		
	US A&E	2,000		
	Philip. A&E		2,800	
	Philip. Erection		14,000	
	O&M/Year (without fuel)		1,800	
3 MW	Generation Plant (CIF) & Erection Superv.	39,000		
	US A&E	3,000		
	Philip. A&E		4,000	
	Philip. Erection		21,000	
	O&M/Year (without fuel)		2,200	
5 MW	Generation Plant (CIF) & Erection Superv.	51,300		
	US A&E	4,200		
	Philip. A&E		5,800	
	Philip. Erection		32,500	
	O&M/Year (without fuel)		2,500	

Site Location	₱ Access Road (1,000)	₱ Electric Tie Line (1,000)	₱ Site Improvements (1,000)	₱ Total (1,000)
Cebu I (Exact Location Unknown)	44,000 (22KM)	7,560 (21KM)	3,240 Allowance	54,800
Masbate	52,800 (22KM)	7,560 (21KM)	3,460 (96,000CY)	63,820
Bohol I	27,200 (17KM)	4,320 (12KM)	1,800 (50,000CY)	33,320

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Accurate information on routings for both roads and power lines will be needed along with better cost estimates before final site budget costs can be approved. The routings chosen for this analysis attempted to follow contours that would maintain reasonable grades and minimize river crossings, as bridges are costly. The final routings selected should avoid these types of expensive road construction.

4. Sites

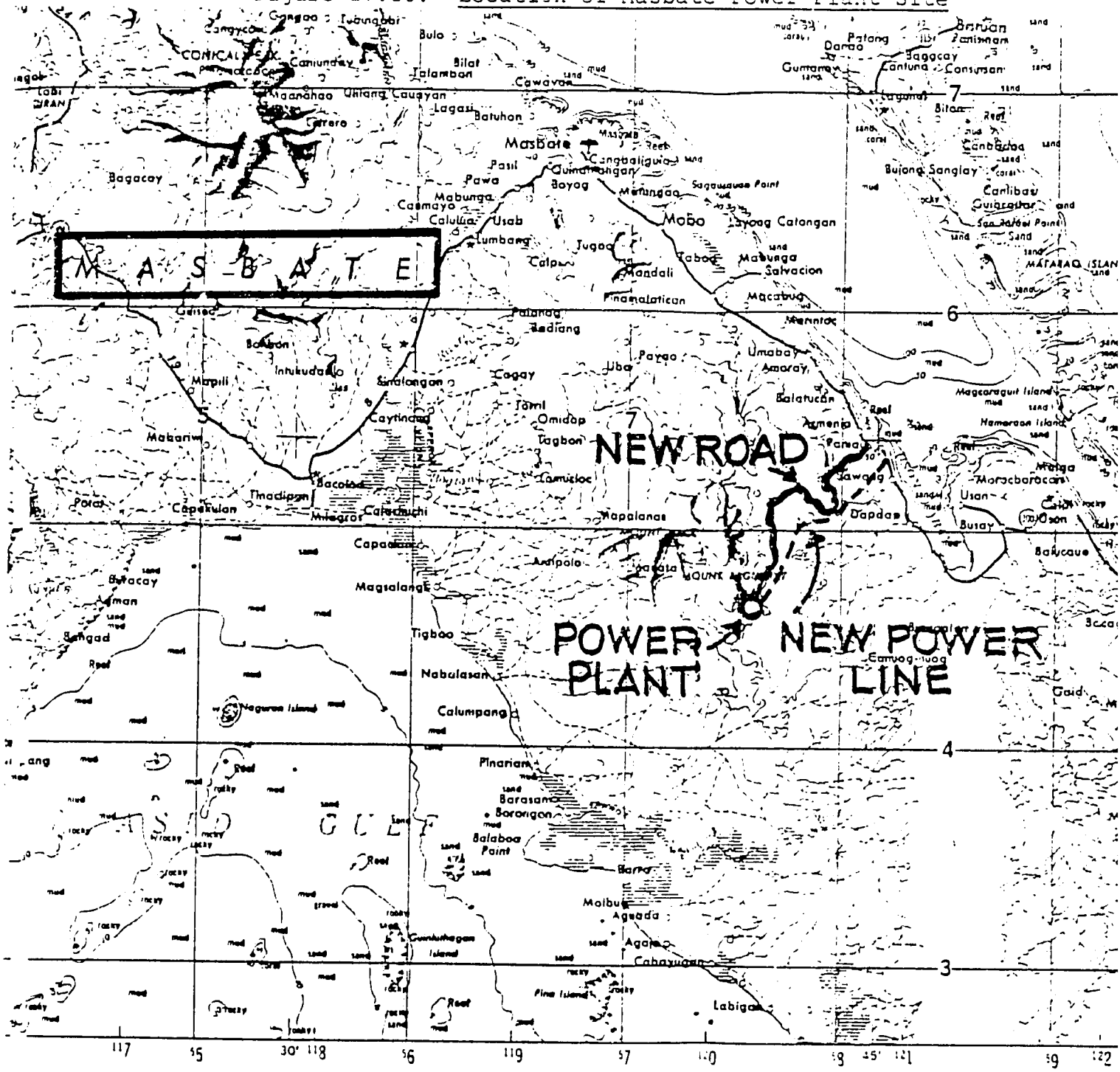
Due to the remote location of the Masbate site (see Figure IV.10), a costly access road will be needed to get heavy construction and power plant equipment to the site. This will be an all-weather road, and the proposed route goes through the villages of Central and San Jose. It is reported that there is already a road for four-wheel drive vehicles from Dapdap to the site, but this was not verified. Furthermore, the province governor stated that the route through Central and San Jose was preferable. The new roadway may cause environmental concerns because of hilside cuts and the displacement of farm land. The final route must be carefully planed to avoid erosion caused by the road's location.

Because of the rugged and hilly terrain between the currently maintained province road and the Masbate site, both the electric intertie and access road would traverse private land. The right-of-way for these facilities was not determined nor were the costs of obtaining a right-of-way. In addition, approximately six hectares will be developed for this power plant, and the site will require considerable leveling, the cost of which was not evaluated and so is not included in the estimates given here.

There is already an access road to within three kilometers of the BOHECO site (see Figure IV.11), and clearing has been completed to extend the road to within one kilometer of the proposed power plant location. A large gravel bed adjacent to the river is available for plant construction, and completion of the present access road will have very little environmental impact. Still, the site must be leveled, which was neither evaluated nor included in the cost estimates given here.

The BOHECO site is located near the city of Inabanga on the Inabanga River. The nearest 69-kv Visayas grid connection would be at Carmen, which is a proposed location for a 69-kv substation, although the 69-kv system has not been completed to this location as of the date of this report. If this substation and connection point are not installed when the proposed power plant is completed, an alternative connecting line will have to be run. The access right-of-way for the power line intertie was not determined, evaluated or costed.

Figure IV.10. Location of Masbate Power Plant Site



Scale 1:250,000

0 5 10 15 20 Statute Miles

0 5 10 15 20 25 Meters

0 5 Nautical Miles

INTERVAL OF APPROXIMATE CONTOURS 100 METERS
RELIEF PARTIALLY SHOWN BY FORM LINES

TRANSVERSE MERCATOR PROJECTION

ED LINES INDICATE THE 10 000 METER UNIVERSAL TRANSVERSE MERCATOR GRID ZONE 51 CLARKE 1866 SPHEROID
GRAY NUMBERED TICKS ... LINE INDICATE THE 10 000 YARD PHILIPPINE POLYCONIC GRID
THE LAST FOUR DIGITS OF THE GRID NUMBERS ARE OMITTED

MAGNETIC DECLINATION FOR CENTER OF THE SHEET IS 0°45' EASTERLY MEAN ANNUAL CHANGE IS 0°02' WESTERLY

USERS NOTING ERRORS OR OMISSIONS ON THIS MAP ARE URGED TO MARK HEREON AND FORWARD DIRECTLY TO COMMANDING OFFICER ARMY MAP SERVICE, WASHINGTON D C MAPS SO FORWARDED WILL BE RETURNED OR REPLACED IF DESIRED.

ENG MAP & INTEL SECT USARPAC 8 55

LOCATION DIAGRAM FOR ND 51-1

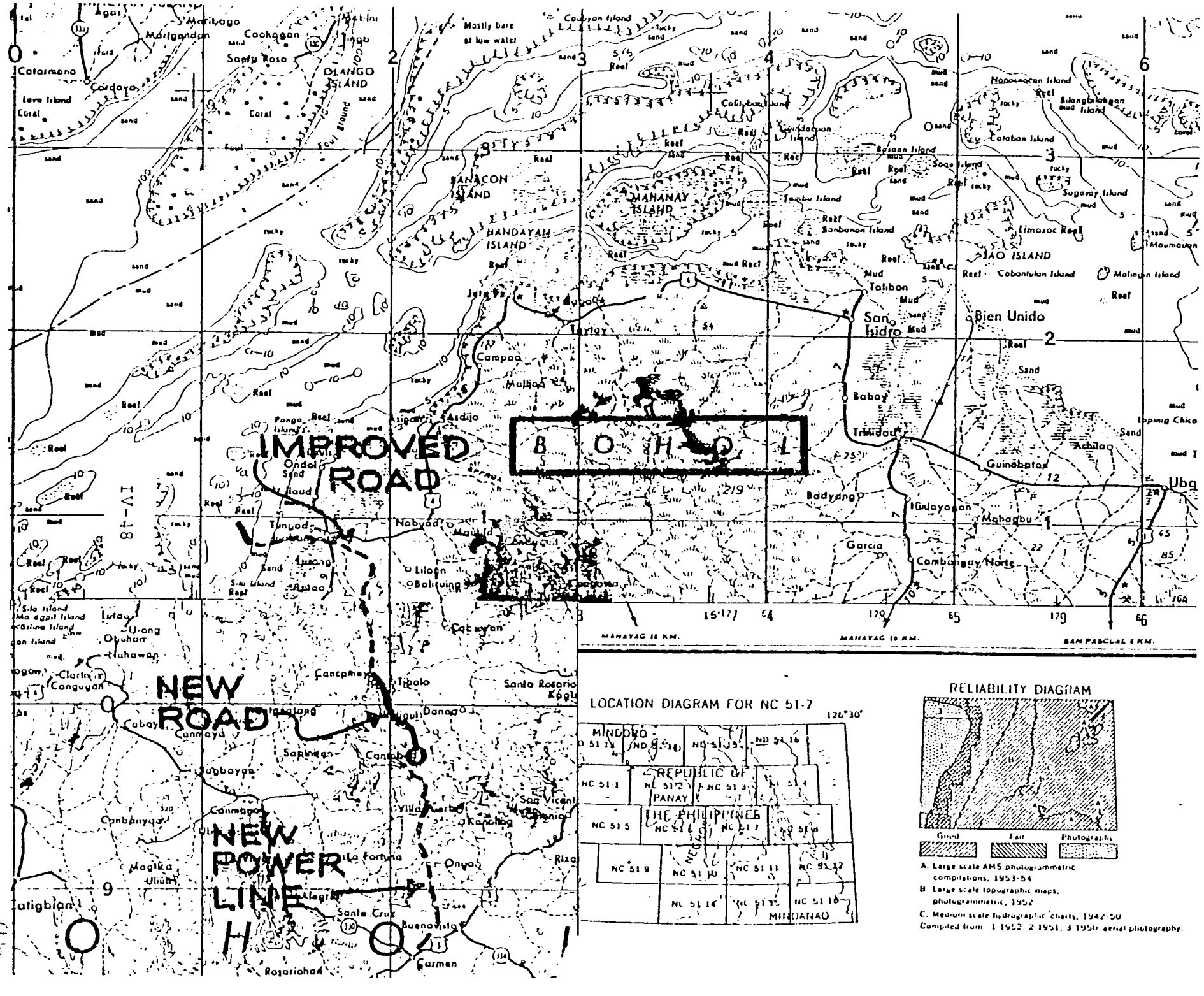


Figure IV.11. Location of BOHECO Power Plant Site

The Cebu site is located near Marmol, east of the city of Tuburan in Cebu Province (see Figure IV.12). The nearest 69-kv Visayas grid connection is Borbon on Cebu's east coast. However, there is a lower voltage connection at Tuburan, which is approximately 25 to 30 kilometers closer and should be used. Basically, the available options are routing the power line from the plant site to a grid at Tuburan and sizing the plant to supply this interconnection to the grid. Available information indicates that a 69-kv connection at Tuburan will soon be energized, thus making this connection a tie into the 69-kv grid.

Because the Cebu site is remote, it will require an extensive road to the provincial highway. The rights-of-way for the access road and power line intertie were neither investigated nor costed as part of this assessment, but each route will require much hillside cutting and will thus have a considerable impact on the environment, although no in-depth evaluation of environmental effects has yet been made. In addition, no member of the assessment team visited the actual plant site, so its suitability for a power plant is unknown.

5. Environmental Considerations

The location, design and operation of any dendro thermal plant installed under U. S. standards must comply with U. S. environmental regulations. Appendix D contains the environmental analysis included in the GIT evaluation study, dated October, 1984, as part of volume II, "Consultants Report." This analysis provides an excellent overview of existing dendro thermal plants in the Philippines and their environmental impact. However, it does fail to mention two important U. S. Environmental Protection Agency (EPA) particulate emission requirements:

- particulate emissions from a biomass-fired plant cannot exceed 0.10 grains per dry standard cubic feet of fuel gas emitted corrected to 12 percent carbon dioxide; and

- stack gas emission color cannot exceed a ratio of 20 percent opacity.

Neither British nor French units currently meet these requirements.

Also, an addition to current EPA regulations has been proposed (see Appendix E), and the agency's Washington, DC office advises that these new emission rules will be adopted in May, 1986.

The effect of the proposed rules will be to further reduce the amount of particulate that can be emitted into the atmosphere.

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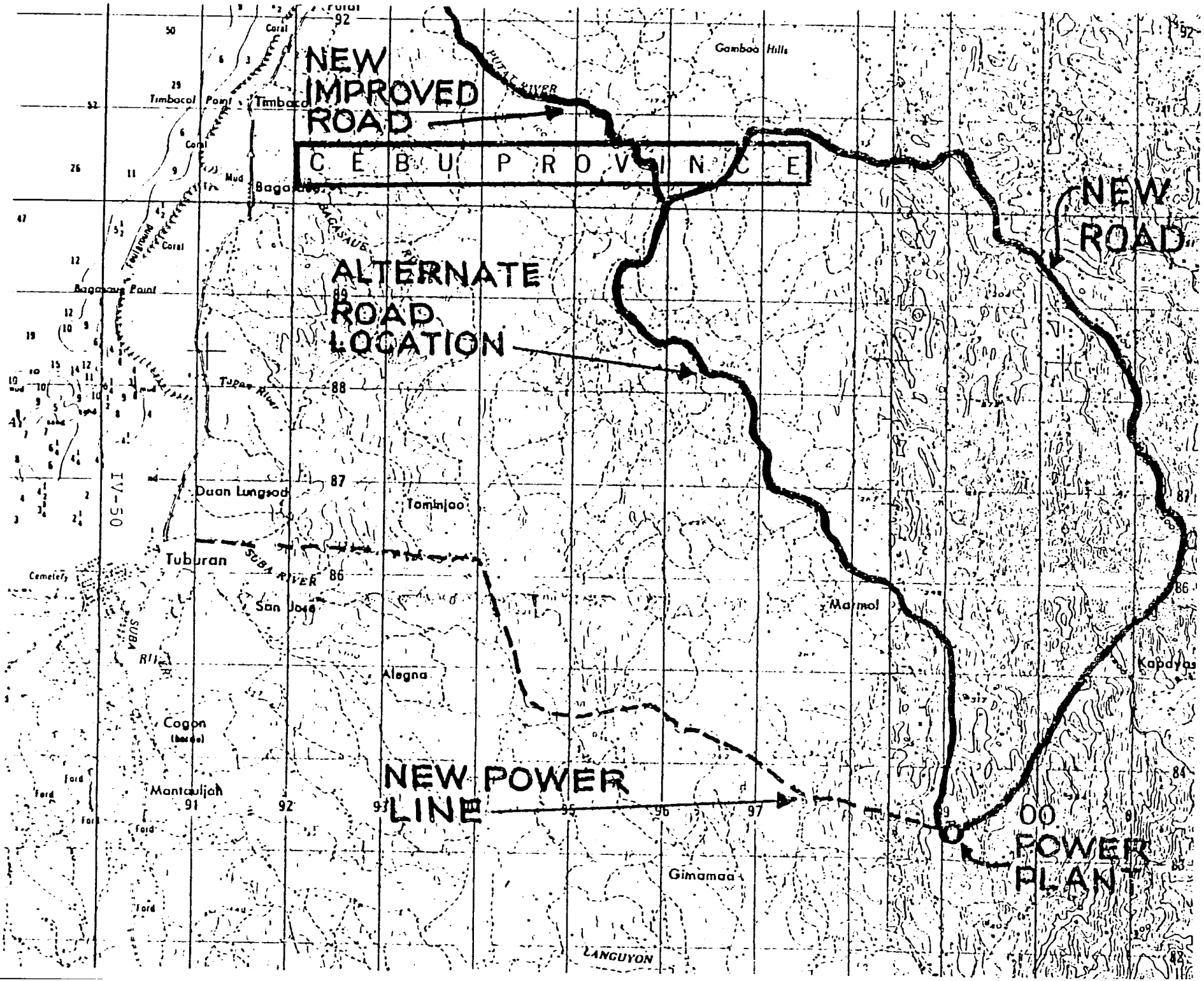

Figure IV.12. Location of Cebu Power Plant Site

The proposed locations for dendro thermal plants in Cebu, Bohol and Masbate do not have dependable, adequate supplies of clean water for water condensers. Since all the sites will use cooling towers, there is no concern about thermal pollution of river water. However, the chemical used to control the pH of water in the cooling tower will concentrate in the tower's basin and must be disposed of periodically in an environmentally acceptable way, such as burial at an appropriately designed waste site.

The make-up water supply at each of the three proposed sites was reviewed and local residents queried about the lowest level of flow for each water source. This information along with actual observations made at the beginning of the dry season indicate that there is ample water available at each site.

Collected particulate and ash can be disposed of at a landfill in the vicinity of each site, and there is sufficient land available for this purpose for the life of the power plants. Piles of disposed ash should be covered with earth to prevent rapid run-off of ash residues or severe dusting problems. Appendix D includes a further discussion of waste disposal methods.

All of the blow-down from the boiler would be piped into the cooling water basin and used to assist in water conditioning of cooling tower water.

6. Staffing and Training

An analysis of present NEA technical assistance to RECs indicates that an individual with extensive experience in wood-fired electric generation plants should be hired along with a basic staff of specialists to train personnel and monitor all REC dendro thermal plants. This staff should be capable of giving RECs all the technical assistance needed to correct malfunctions, prescribe modifications and provide training.

Training is a key factor in the proper operation and maintenance of a dendro thermal facility. Any U. S.-designed plant should be required to have two qualified U. S. technicians as part of the program to train personnel in plant operation and maintenance. These technicians should work at the plant for approximately one year, including the start-up period, but this type of expatriate training program should be needed only once as they will train local individuals who, in turn, can serve as trainers for other U. S.-designed plants. It is important to recognize that funds must be allocated for local training sessions. The technicians selected should be experienced operators of wood-fired power plants, who are knowledgeable about the control circuits and systems found at this type of facility.

Because several different wood-fired systems satisfy the U. S. design requirement, the technicians should also have worked on the exact type of plant selected for installation.

7. Conclusions

U. S.-designed plants can be adapted for use at all of the proposed sites. Philippine workers and technicians can be recruited on each island with a proposed site and trained, but the selection of supervisory and training staff by the NEA is essential to the operation, maintenance, reliability and longevity of the proposed power plants. Furthermore, the RECs must be monitored and assisted in order to maintain the proficiency of their staff members and hence, the serviceability of the plants.

Maintaining an adequate supply of spare and replacement parts is a necessity, as is an adequate distribution system for those parts. Good communication links between the power plants and network grid power controllers is also essential.

The interface between the wood fuel delivery system from the forest to the power plant can be crucial to plant operation. A uniform, mechanically controlled, wood feed to the boiler is essential for reliable steam control.

The location of access roads and powerline interties must be carefully reviewed to avoid negative environmental impacts and costly bridges or other construction. A study should be made of line-carrying capacity and the most favorable lcoation for the interconnecton into the existing electric network grid system on each island with a proposed power plant site.

Given a need for the power as well as its utilization and economic feasibility, a U. S. engineering firm with the required knowledge and a proven record in the installation of small wood-fired electric generating plants should be engaged. The firm should also be experienced with the operation of plants of similar size in tropical areas, preferably southeast Asia.

Information from several responsible parties in the Philippines indicates that it would be expensive to rehabilitate and modify the stored French and British units in the country to meet U. S. standards. Proposals for construction and materials should permit several different system designs while clearly stating the necessary performance requirements, guarantees and reliability. One year of needed spare parts should be included with each equipment order.

The location of the power plant sites on Masbate and Cebu should be reassessed in view of locating these plants closer to

main highways and the electric power grid in order to reduce capital costs and assure better maintenance. Such relocation would also likely improve the quality of personnel performance, as the present remote sites do not have acceptable living accommodations for workers nearby.

E. Plantations/Fuelwood Supply

The purpose of this section is to determine the feasibility of the woodlot component of the dendro thermal subproject of the rural energy development project at three sites--Bohol, Masbate and Cebu. Primary consideration was given to the following key issues:

- yields that may be expected from the plantation areas;
- silvicultural systems needed to attain those yields, based on soil samples and secondary data;
- technical capabilities of RECs to implement the woodlot program;
- socioeconomic conditions affecting wood production; and
- financial costs and returns of operating the tree farms.

The ARD team visited plantation sites at BOHECO I in Inabanga, Bohol and MASELCO in Uson, Masbate. Discussions with project staff and farmers proved to be very fruitful, particularly in bringing socioeconomic issues that affect wood production to light. Before discussing the sites, it is important to realize the type of problems that have already arisen when wood production for the dendro thermal program has not materialized.

Fuelwood plantations for the dendro thermal program used only giant ipil-ipil during the first three or four years of plantation development efforts. Because acidic soils prevail at most of the proposed sites, the plantations either did not develop or actual yields have been way below expectations.

The Solsona project (Ilocos Norte Dendro Thermal) is one such case--the power plant was built and commissioned in September, 1984, although no fuelwood has come out of the plantations. In the absence of a wood supply from its plantations, the electric co-op has tried to get a permit from BFD to cut wood on neighboring public forest areas, but so far,

BFD has resisted this idea. Thus, the co-op has chosen to buy wood, which is either picked up by co-op personnel or delivered to the power plant. The purchase price is only about half that of the current market price for fuelwood, so it can be inferred that the plant is getting wood mostly from "quick deal"-type sellers who have very little costs other than wood handling and transportation. This wood can range from scraps or driftwood to wood cut illegally in the forests. Consequently, in addition to a number of technical problems, the power plant has not operated on a continuous basis due to an inability to accumulate enough fuelwood. Accordingly, the power plant has operated for a stretch of 17 days at the longest before it was commissioned and only 20 afterwards, and at half its rated capacity in both cases.

This experience points to the need to establish plantations with appropriate wood species and ascertain their growth rates before building a power plant. Although this problem is beyond the scope of this report, its consideration points to a larger issue concerning the entire attractiveness of the whole dendro thermal program. The issue is whether or not the rising population and concomitant increasing pressures on available land for food production and other related needs lead to the eventual conclusion that the availability of adequate land to produce wood at a cost-effective rate is questionable. The ARD assessment team neither observed nor became aware of any analysis on an island-by-island basis of overall land-use projections. Without some sort of overview of such patterns and trends, it is difficult to determine the future feasibility of dendro thermal systems.

1. BOHECO I

Of the 2,000 hectares of currently available, 20 to 30 percent may not be suitable for ipil-ipil fuelwood production because of poor soil conditions and/or a steep grade. However, according to Mr. Virgilio Fortich, adjacent areas have expansion potential for tree plantations, so it appears that size is not a constraint. At present, the area is divided into 20 modules, of which only one is being run by the cooperative.

The soil can be categorized as annam clay loam, the characteristics of which are shown in Table IV.15. Acidity, measured by pH, is within a favorable range for ipil-ipil growth. However, an analysis of soil samples indicated that in some areas the pH can be as low as 5.0 or less (4.80), particularly in badly eroded and compacted spots vegetated by amorseco. Ipil-ipil would have difficulty growing in these areas.

Table IV.15. Soil Characteristics at BOHECO I Plantation Site

	Minimum	Maximum
pH	5.5	7.9
OM (percentage)	0.36	3.95
Total N (percentage)	0.03	0.27
P (parts per million)	nil	27.8
K (parts per million)	0.1	202.5
Ca (me per 100 grams)	13.0	26.0
Mg. (me per 100 grams)	2.42	5.70
Fe (me per 100 grams)	4.0	7.02
Mn (me per 100 grams)	8.0	62.0

Nitrogen, phosphorus and potassium levels are variable, though mostly deficient, such that complete fertilizer application would be beneficial. It is expected that only 60 percent of the 500 hectares planted (i.e., 300 hectares) will survive owing to potential drought, rat infestation, lack of maintenance and poor site conditions. The present average yield is 11 tons (wet) per hectare per year, or 44 tons per hectare at age four. At poor sites, such as on steep or badly eroded slopes, on top of ridges or in amorseco areas, the yield would be much less. On good sites--the lower portions of gently rolling or moderate slopes with deep, fertile soils, the yield could go up to 20 tons per hectare per year. If this can be obtained, only about 1,520 hectares would be required to support a two-MW plant.

With current silvicultural operations, the density of trees is unproductively high, one meter x one meter or 10,000 trees per hectare. More than half the trees are very small, which contribute very little to volume, and make handling during harvesting and transportation expensive. As for site preparation, vegetation has been removed completely by cultivation with pickmattocks. This is both expensive and unnecessary, as it accelerates soil erosion. Direct seeding of three to five seeds per hill is occurring, and the seeds should have high germination capacity of at least 80 percent, provided they are soaked in cold water for 24 hours before sowing. Fertilizer is being applied at the rate of one bag of 14-14-14 fertilizer per hectare or approximately five grams per hill, but

this amount is too little to have any significant effect on growth. Replanting blank spots should be done within a month of seeding and weeding generally twice--at two months after planting and again, three months later.

In terms of socioeconomics, 16 TFAs have been organized and 10 registered, each with 15 members. Loans are released to TFAs based on the level of planting, which is good, but no funds have been released since September, 1983, so no new plantings have been undertaken. This does not seem not to have dampened the enthusiasm of the farmers in the project, and they remain hopeful that the dendro thermal plant will finally be built.

The land allocated by BFD for wood plantations is marginal, at best. The TFA in Bohol started planting trees in anticipation of the plant, well in advance of plant construction. The TFA has no plans to sell the wood, yet it has to repay its loans. This puts an uncalled-for burden on TFA members. Hence, the issue is why should the cost of planting permanent trees be charged to the farmers.

From an institutional perspective, the Special Projects Director, who also takes care of the mini-hydro project, appears to be well-motivated and very capable. One agriculturist and three agricultural aides, who have bachelor of science degrees in agriculture, directly supervise the tree plantation program. Their main experience is in establishing ipil-ipil plantations and was gained on the job; their exposure to other species is very limited. The present salaries of the director at 1,500 pesos per month and the agriculturist at 963 pesos per month are below average for good, experienced foresters. For this reason, the co-op may have difficulty hiring a forester.

Recommendations

First, regarding site evaluation and classification, the following surveys should be undertaken before any planting is done:

- topographic survey and construction of a topographic map, at a maximum contour interval of five meters;
- vegetative survey; and
- soil survey of about 10 soil samples per module.

The results of these surveys should provide a basis for classifying sites according to their capability to grow ipil-ipil. Better sites should be identified and scheduled for first plantings. The surveys should also be used in planning road and harvesting systems.

Second, once the better sites have been determined, planting should begin. Generally, the best sites are the lower portions of level to gently rolling slopes with deep, black soils. The nature of vegetation often indicates soil fertility. For example, amorseco-vegetated areas generally have very poor, low-pH, compacted soil, while locations with shrubs and trees are still relatively fertile.

Third, silvicultural operations should adhere to specific guidelines for planting density, site preparation, fertilization, weeding schedules and regeneration. Trees should be planted to achieve a density of one meter x two meters, or 5,000 trees per hectare. After germination, seedlings should be thinned to one per hill. Planting sites should have grass cut flush to the ground in alternate strips that are one-meter wide and follow the contour, while grass in the uncut strips should be pressed down. In the cleared strips, planting holes should be dug that are 20 centimeters in diameter and 30 centimeters deep, and the soil replaced with topsoil scraped from surrounding areas. As a general rule, which may be modified by soil conditions, fertilizer should be applied at 20 grams per hill with simultaneous direct feeding about one centimeter away from the seeds. Three weedings should occur at two, five and eight months after planting. Grass in the strips should be cut and the soil cultivated 30 centimeters around the seedlings. The cut grass can be used to mulch the base of the seedlings. In harvesting, a clean, slanting cut should be made with a bow saw, leaving a stump about 20 to 30 centimeters high. One month later, the sprouts should be thinned to two per stump at the most.

Fourth, kakawate (*Gliricidia sepium*) and/or *Acacia auriculiformis* should be planted on acidic sites. Kakawate cuttings or seeds can be planted directly, but for *Acacia*, it is best to plant potted seedlings.

Fifth, socioeconomic considerations should include agro-forestry practices and their financial implications. Ten to 15 percent of a farmer's steep but fertile land, which may now be devoted to agricultural crops, such as coffee, cacao, black pepper or fruit trees, should be planted in permanent trees--not interplanted with fuelwood species. This would be benefit the farmer by serving an alternative source of stable income, reduce the risks associated with dependence on a single crop and provide permanent but productive cover for erosion-prone areas while optimizing the benefits of the project. By harvesting and selling mature trees during plant construction, farmers can earn income, gain experience in harvesting and managing second-rotation ipil-ipil, and provide data on the growth and yield of second-rotation trees. Finally, loans made to farmers should be restructured because of delays in building the plant. If possible, loans made for plantations that failed due to poor site

conditions, drought and other factors beyond the farmers' control should be written off.

Sixth, institutional development should ideally include hiring a professional forester with the specific training needed for this job, although the unattractive salary may make this impossible. An alternative would be to hire a forestry consultant to advise on project management and other aspects of plantation development, management and harvesting, as well as agro-forestry, site classification, growth and yield measurement and prediction. Further, the co-op should maintain complete control, ownership and management of at least four modules (400 hectares), not only to serve as a demonstration site for fuelwood management techniques, but to ensure a continuous wood supply in case of problems with the main source (the TFA). It should be emphasized that this would in no way put the TFA at any disadvantage with respect to harvesting and selling wood to the co-op. At least one of the agriculturists on the staff should double as an extension agent to assist families in finding practical ways to improve their health and sanitation, and develop home industries, such as raising small livestock, growing vegetables or keeping honeybees.

Seventh, the recommended area for a two-MW plant is 1,250 hectares. The area for agro-forestry should be 180 hectares.

Impacts

The project is expected to have significant socioeconomic, ecological, political and financial impacts. A successful project would benefit TFA members and their families. It is expected that 330 farmers will be gainfully employed, and it is most likely that 25 to 50 more will be partially employed. Project failure would have the reverse effect. To reduce the risk of failure, plans for strict monitoring and evaluation as well as alternative sources of income are integrated into the project. In terms of the ecological impact, the dendro thermal plant should encourage people to plant trees not only on public land, but their own as well. Problems with soil erosion will be minimized by applying soil conservation measures, such as contour planting, in the plantation development program. Politically speaking, the direct and active participation of people in the dendro thermal project will enhance their political awareness. Good, strong leaders may rise from the TFA membership, farmers who gain valuable leadership training from the project and hence, will be better prepared for larger political roles in the community.

The financial flow for a 1,000-hectare tree plantation is shown in the Appendix F, with a total development cost of 6,926,000 pesos. Gross income from wood sales amounts to

4,000,000 pesos annually, starting in year five. If there are 20 modules, each would produce an annual gross income of 200,000 pesos. Agro-forestry appears to be a viable alternative source of income for farmers. Developing only 120 hectares (six hectares per module) at a total investment of 2,447,860 pesos, the TFAs are bound to realize an income of 1,170,940 pesos in the sixth year to 5,408,240 in the tenth year and so on.

2. MASELCO

The ITP lease granted to MASELCO covers 1,500 hectares located in Brgy. San Jose, Madao, Simawa, Municipality of Uson and Masbate. The estimated area available for the tree plantation is 1,000 hectares, after deducting about 300 hectares for farmland, areas that are too steep or rocky, roads, and the plant and housing sites. The elevation ranges from 160 to 505 meters, with a relatively moderate topography. About 70 percent of the area is covered by cogon and talahib (*Sacharrum sp.*), 15 percent by wild bananas and shrubs, and the remaining 15 percent by farmland.

The soil is clay, belonging to the Sevilla clay. Soil pH could be acidic, below 5.0, as indicated by the results of an analysis of two samples collected in the area (the pH of the samples collected ranged from 4.2 to 5.4). If this is a general condition, ipil-ipil growth would be limited.

Social factors appear to be the most important consideration in plantation development and management, other than the problem of accessibility, for the following reasons:

- there are reportedly 96 families inside the area, who actually cultivate or occupy about 245 hectares (according to a 1982 census conducted by BFD), and most of them are migrants from Cebu, who settled the area as early as 1952;

- the families are not enthusiastic about joining tree farmers' organizations, rather, they want to participate as individuals;

- they demand that the lands they claim be titled in their names and have, in fact, filed a petition with the president toward this end;

- the Provincial Board has passed a resolution petitioning MNR not to approve the application of FSDC for an ITP on the adjacent land, but instead, to convert the area into a social forestry project, with stewardship certificates issued to individual occupants.

- Mr. Feliciano Merioles claims 180 hectares inside the co-op module and an alleged settlement unfavorable to MASELCO; and

- the presence of NPA in the area.

MASELCO currently lacks the technical capability to implement the tree plantation program. (The Acting Coordinator has a bachelor of science degree in criminology.) The proposed salary of 600 pesos per month for a forester and agriculturist is too low to attract capable professionals.

Recommendations

First, the character of the site should be established by conducting the following site evaluation surveys:

- topographic surveys and preparation of a five-meter contour interval topographic map, which should include creeks, farmlands, trails, rock, valleys, etc.; and

- a soil survey, with each module of 100 hectares represented by at least six to 10 samples, which should be analyzed for such characteristics as the depth of topsoil and subsoil, texture, pH, OM N, P, K, Ca, Mg, Al, CEC and percentage base saturation.

Site classes should then be delineated based on the topography and soil characteristics.

Second, the species should be selected and the yield calculated. If the pH is acidic (5.0 or lower), ipil-ipil may not be appropriate. *Acacia auriculiformis* and yemane, which tolerate acidic conditions, would be a better choice. Whether ipil-ipil should be planted at all would depend on the results of the soil tests. Meanwhile, the two species mentioned are recommended, with yemane to be planted on the lower, moist slopes and *Acacia* on the upper ones.

Third, the wood supply for the power plant must be assured. In this regard, a number of options need further study:

- MASELCO could own and manage the 1,000-hectare tree plantation, while the co-op would have complete control of wood production and the availability of wood would be limited only by plantation growth--the co-op could employ farmers in plantation activities, but to get better cooperation and support, the co-op might consider a profit-sharing scheme--this option may require a full complement of plantation

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personnel along with the necessary support facilities, housing, etc., so overhead costs would be high, and farmers may not realize the full benefits of the project, even if a profit-sharing plan is used.

- tree plantations could be owned and managed by the farmers, but the co-op would have very limited control of the wood supply;

- MASELCO could own and manage half the plantation, leaving the other half under the control of the farmers--this may be a good compromise, which would allow the co-op to have complete control of at least 50 percent of the wood supply, while permitting the farmers to manage the other half and providing them with the opportunity to gain more benefits from the project.

- MASELCO could consider buying wood from outside its ITP on the open market for up to 25 percent of its needs, and towards this end, it should conduct a vigorous information campaign to promote tree planting--it could offer several incentives, including a guaranteed market, financing and technical assistance in wood production; and

- MASELCO could enter into a joint wood production venture with the farmers, both within and outside the ITP on private lands--among the possible arrangements, MASELCO could provide seedlings, fertilizer, tools and equipment, plus possibly a portion of the labor costs, while cooperators would put up labor and land, and both parties could share in the profits.

Whatever option MASELCO finally chooses, its wood supply may have to come from all possible sources (its own plantations, farmers' plantations and the open market), and the co-op must ensure that a supply of wood will flow continuously to the plant.

Fourth, in terms of socioeconomic recommendations, MASELCO should initiate a move to provide security of land tenure to occupants for the land they actually cultivate. With joint action from BFD, these areas can be excluded from the ITP lease and corresponding stewardship certificates issued. The co-op should assist residents in improving their farming systems through the introduction of appropriate agro-forestry technology, which should provide for a maximum sustainable production that is acceptable to the farmers and within their capability to implement. This move should be preceded by a socioeconomic survey of the occupants.

An intensive information campaign should be launched to make use of local leaders who can speak about the potential benefits of the project for families and the community. Furthermore, the co-op should show its sincerity by fulfilling its promises and commitments, and paying hired laborers on time.

In institutional terms, MASELCO needs to strengthen its technical capability by hiring a professional forester who could double as an agro-forestry specialist, an agricultrist who could also act as an extension agent and community organizer, and two agricultural aides or forest rangers. These staff members should be stationed in the field where they will be available to interact fully with residents. A forestry consultant would be valuable during the initial stages of plantation development to help MASELCO identify and select alternatives to effectively implement the tree plantation program. This individual should have a tree plantation and agro-forestry background.

Impacts

The socioeconomic impact would be that at least 100 farmers, mostly occupants, would be gainfully employed, with about 20 to 25 more from outside the project area engaged in tree farming and benefiting from it.

The plantation site and surrounding areas are already devoid of cover. Thus, ecologically, the dendro thermal plant should provide the motivation needed for tree planting activities that would result in revegetation of denuded slopes.

The financial flow of plantation development and management, excluding harvesting and transportation costs, for a 1,000-hectare tree plantation is shown in the Appendix F. For a total investment of 9,241,500 pesos, which includes administrative costs, a net annual income of 3,070,500 pesos is realized.

3. CEBECO

The proposed dendro thermal plant site and plantation area are only tentative, so there are little available data. However, before a decision to locate a power plant in the area is made, a comprehensive feasibility study should be undertaken that covers the technical, economic, institutional and social aspects of the proposal. Furthermore, prior to the feasibility study, the site boundaries should be identified and other relevant information gathered. Given these data, the following recommendations are made:

- in consultation and coordination with BFD, NEA and CEBECO should select at least two possible sites

from the latest forestry maps, which are usually prepared by BFD's land classification team;

- next, they should conduct surveys of the selected areas, emphasizing accessibility (roads and trails), presence of rivers/springs, topography and elevation, occupancy, and soil conditions; and

- finally, one site should be selected.

Once the site has been identified, a detailed assessment of the area should be conducted. (This work could be contracted out to a consulting firm). The information needed is as follows:

- climate, including data on rainfall, number of days of rain, duration of wet and dry months, wind, occurrence of typhoons, temperature and relative humidity--often, such information can be extrapolated from the nearest PAGASA station, but it must be verified by the residents;

- vegetative cover and land use, including information on dominant species, areas covered and their location indicated on the map;

- elevation and topography, including preparation of a topographic map;

- land ownership, occupancy and locations;

- accessibility, including roads and transportation possibilities, etc.;

- river systems; and

- soils, including information on types, depth of topsoil and subsoil, and physical and chemical characteristics, all of which should be indicated on the map.

With this information, it will be possible to select species most suitable for the area, establish the silvicultural operation and management strategies needed to produce the wood, estimate yields, identify alternative wood sources (if plantation yields will be insufficient), and determine the project's financial and economic viability.

Initially, CEBECO should employ a professional forester to handle the activities described above, but manpower can be increased as activities expand during project implementation. The CEBECO tree plantation program should have a complement of at least four technical staff, one or two of whom are professional

foresters, and the others, agriculturists or forest ranger graduates.

4. Conclusions

BOHECO I

The average yield of the tree plantation is estimated at 20 tons (wet) per hectare per year or 80 tons per hectare in four years. The available area of 1,520 hectares is enough to fuel a two-MW power plant. As additional protection against shutdowns due to lack of wood, the co-op should have complete control of at least four modules, or 400 hectares. To attain the expected yields, improved management practices have to be followed, including planting on better sites, reducing planting density to 5,000 trees per hectare, performing better site preparation that combines good soil conservation practices with improved root growth conditions, more intensive weeding, and a higher and more timely fertilization program.

In spite of plantation failures and the nonavailability of loan money for the past one and a half years, the farmers have remained enthusiastic about the project. Agro-forestry should be integrated as a small (10 to 15 percent of the total project area), but necessary, project component to provide farmers with an alternative long-term source of income. Meanwhile, it is recommended that the current loans be restructured because of the delay in construction of the power plant. It might be wise to write off some of the loans due to plantation failures beyond the farmers' control.

To strengthen BOHECO's technical capability for implementing the tree plantation program, it must acquire the services of a professional forester. An alternative is hiring a forestry consultant.

Projected cash income from the project (both the tree plantation and agro-forestry) shows that increased income will accrue to TFA members. Their active involvement in the project, as members of the organization, will enhance their political awareness and improve their leadership and management skills.

The project is expected to bolster reforestation efforts as more barren grasslands are replaced with trees.

MASELCO

The estimated effective plantation area for MASELCO is 1,000 hectares out of a 1,500-hectare ITP lease. While the topography

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is relatively moderate, indications are that the soil is acidic (pH 5 and below), which is unfavorable for good ipil-ipil growth. Assuming this, yemane and Acacia auriculiformis are recommended instead. The projected yield for these species is only 10 tons (wet) per hectare per year, with a rotation of five years. At this rate, the annual harvest is expected to reach 10,000 (wet) tons per year, enough to satisfy the requirements of a 700-kw power plant.

Limited land area, low yields and formidable social conditions necessitate that the co-op get fuelwood from three sources--its own plantation, farmers' plantations and the open market. Several options were presented above for MASELCO'S consideration to assure a steady and sufficient supply of wood, once the plant is operational.

The choice of species and plantation management strategies appropriate for the area will depend on the site's quality. It is strongly recommended that a more comprehensive site evaluation survey be conducted in the area, consisting of topographic, vegetation and soil surveys and analysis.

The presence of 96 families in the area, who are opposed to joining organizations, and the NPA as well as a strong desire on the part of residents to own the land they occupy, among other reasons, make the socioeconomic aspects of this project a serious concern. For the tree plantation program to succeed, MASELCO must get the support and cooperation of the people. Possible strategies include assistance in the processing and issuance of stewardship certificates for lands actually occupied, help in improving farming systems by introducing appropriate agro-forestry technology, and an intensive information campaign.

There is a need to have at least one professional forester, one agriculturist and two technicians fully assigned to the area, in order to be able to effectively undertake the tree plantation program. It would be helpful if the services of a forestry consultant could also be engaged during the first year of program implementation.

The tree plantation program will boost reforestation efforts on Masbate, where most of the forest land has been denuded of trees. It will provide a steady source of income for 100 farmers, who will join in the tree planting, and up to about 25 more, who will be employed by the co-op/farmers in their plantation activities.

CEBECO

A decision to put a dendro thermal power plant on Cebu should be based on an intensive feasibility study. As yet, the

boundaries of the plantation area boundaries are not even known. Therefore, it is strongly recommended that a possible power plant site and tree plantation areas be selected and identified by NEA and CEBECO in consultation and coordination with BFD. A thorough evaluation of site suitability for a fuelwood plantation to supply a power plant must then be conducted. (A consulting firm could be contracted to perform this study.) Finally, it is recommended that a professional forester provide technical support to CEBECO.

F. Economic/Financial Analysis

1. Introduction

This section discusses the economic and financial feasibility of wood-fired power plants and plantations operated by tree farm associations (TFAs). The costs of generating electricity at wood-fired power plants were estimated and compared with the cost of operating diesel engines. In addition benefit-cost ratios and internal rates of return were computed. The socioeconomic aspects of plantation management and operation are covered in the preceding section on fuelwood supply.

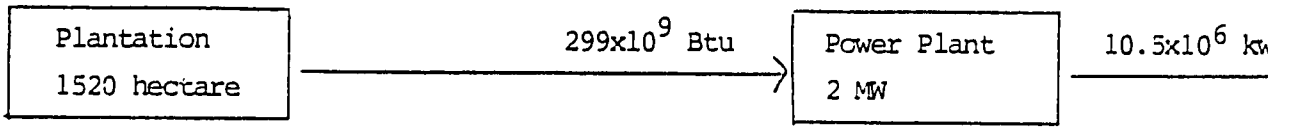
Wood-fired power plants have been proposed for three islands--Bohol, Masbate and Cebu. The ARD assessment team was only able to visit the sites on Bohol and Masbate. Thus, detailed economic and financial analyses were only done for plants at these sites.

The dendro thermal fuel cycle has three major components. The first is wood plantations where fuelwood is produced on tree farms operated by TFAs. Each association may have up to 100 or more members with an average lot of 10 hectares, sites for which are determined by the availability of land and the demand for wood. Farmers can raise additional revenues by growing crops. The second component is harvesting, gathering and transporting the wood to the plant site, which is to be accomplished by using "carabous" (work animals) and a polyethylene pipe system. The third and final component is the steam power plant itself, where wood is burned to generate electricity. Each of these components has already been described in detail earlier in this report. It is assumed that TFAs will be responsible for producing wood, and the rural co-ops for harvesting it and generating electricity. Plantation size, yields and annual production, and corresponding power plant size are shown in Figure IV.13. Since plant efficiency is only 12 percent, plantation size is extremely sensitive to slight improvements in efficiency.

The projects proposed for Bohol and Masbate will include all three components. The two-MW plant on Bohol will be about three

Figure IV.13. Dendro Thermal Plantation and Power Plant Characteristics

Bohol



Species: Ipil-Ipil

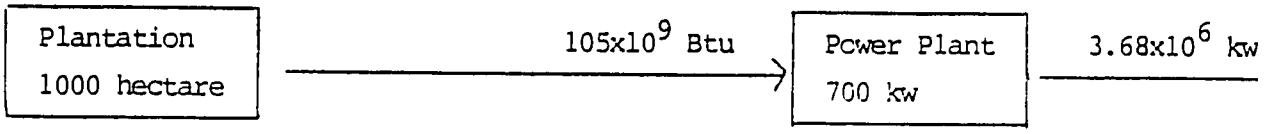
Calorific Value: 2483 kcal/kg,wet

Production: 30,400 wet tons/year

Yield: 20 wet tons/year/hectare

Efficiency: 12%

Masbate



Species: Gmelina
Acacia

Calorific Value: 2,650 kcal/kg,wet

Production: 10,000 wet tons/year

Yield: 10 wet tons/year/hectare

Efficiency: 12%

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times bigger than the one on Masbate, and the size of its plantation will be correspondingly larger. Ipil-ipil can be grown at the Bohol site, while the poorer soil conditions at the Masbate site can only support the Gmelina and Acacia species, which grow more slowly. This fact in combination with difficult accessibility reduces the economic viability of the Masbate site. All of the capital investment costs for the dendro thermal power plants on Bohol and Masbate are shown in Table IV.16. These investment costs will be borne by AID during the first four years for Bohol and the first five for Masbate with no matching counterpart funds. For the two sites, total capital investment costs amount to 5.6 million dollars, well within the amount proposed in the project paper.

Table IV.16. Capital Investment Costs for Dendro Thermal Plants

	Pesos	Dollars*
Bohol:**		
plantations	10,528,000	585,000
harvesting	2,231,000	124,000
power plant	50,920,000	2,829,000
crops	1,448,000	80,000
Total	65,127,000	3,618,000
Masbate:**		
plantations	8,422,000	468,000
harvesting	1,386,000	77,000
power plant	25,137,000	1,297,000
crops	1,448,000	80,000
Total	36,392,000	2,022,000

*Pesos converted to dollars at the rate of 18 pesos per dollar.

**It is assumed that all investment costs will be borne by AID with no matching counterpart funds during the first four years for Bohol and the first five for Masbate.

2. Generation Costs

The costs of generating electricity at the Bohol and Masbate sites were estimated and compared with the cost of using diesel power plants (see Table IV.17). These annual costs include fuel, operations and maintenance as well as amortized capital.

Table IV.17. Dendro Thermal Generation Costs

	Bohol		Masbate	
Plantation Size:	1520 hectares		1000 hectares	
Plant Size:	2.0 MW		0.7 MW	
Generation:	10.5 10^6kwh		3.68 10^6kwh	
	Economic	Financial	Economic	Financial
Capital Cost Annualized (₱10^3):	@20%	@12%	@20%	@12%
Plant	5660	3570	1540	970
Site Location[1]	1220	730	2230	1320
Other A&E	3400	2140	1310	830
	10280	6440	5080	3120
Harvesting Cost (Annualized):	680	442	460	299
Annual Costs:				
Fuel	1476[3]	6080[4]	1330[3]	3500[4]
Plant O&M	1800	1800	750	750
Harvesting O&M	1000	1000	675	675
TOTAL	15236	15800	8295	8340
Generation Cost (₱/kwh)[2]	1.45	1.50	2.25	2.27
Diesel Generation Cost (₱/kwh)		2.04		2.48

[1]Site Location includes transmission line and site improvement costs, subject to confirmation in a feasibility study.

[2]Depreciating plant costs and harvesting equipment will add another eight percent to the costs of generation.

[3]Annualized costs include plantation development and maintenance costs.

[4]Cost of fuelwood at market price, as borne by RECs is 200 pesos per kilowatt-hour for Bohol and 350 pesos per kilowatt-hour on Masbate.

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The analysis assumed that the rural cooperatives will pay the TFAs a price for their wood that is competitive with the market price. The market price for fuelwood on Masbate is P350 per ton, while on Bohol, it is P200 per ton, which reflects the relative scarcity of wood on these islands. This arrangement will substantially benefit the TFAs. The Bohol analysis indicates that the internal rate of return for just the farming operation will be 41.1 percent, such that the TFA will have a positive cash flow throughout the 25 years of power plant operation. The lowest cash flow will occur in the fifth year since loan repayment begins that year, while income from intercropping (coffee) is still small, though increasing. Assuming that an average of 10 hectares are planted by each TFA member, each farmer will have an income of 15,000 pesos in the fifth year.

The foresters on the assessment team estimated that over half the increase in members' incomes will be gained from the coffee or similar crops planted on 10 percent of the tree farm. Coffee is a crop that yields revenue equivalent to the average for crops grown on such land. By the tenth year, when the income from coffee and fuelwood has stabilized, each TFA member will have a net annual income of 63,000 pesos, which will increase after the twelfth year when loan payments to NEA/REC are completed.

Operation and maintenance costs were based on the characteristics of each plant, which are described in detail earlier in this section. It was assumed that the two-MW power plant on Bohol be assembled at the site. The 700-kw unit on Masbate is assumed to cost the same per kilowatt as the 1.5-MW units, costs for which were presented in section IV.D. above.

The economic costs of generation, assuming a 20 percent interest rate, are 1.45 and 2.25 pesos per kwh for Bohol and Masbate, respectively (see Table IV.17). Generation costs for diesel power plants on the Bohol NPC grid were about 2.04 pesos per kwh in late 1984, while on Masbate, they were about 2.48 pesos per kwh. The costs of dendro thermal generation on Bohol are 25 percent lower than for diesel power plants and eight percent lower on Masbate.

Generation costs are sensitive to improvements in power plant efficiency. At the level of 12 percent efficiency estimated in the preceding section on power plants, even an improvement of only three percentage points will reduce plantation size by 25 percent or 380 hectares, which is a dramatic improvement considering the limited land available. Further sensitivity analysis is needed to determine the costs for achieving improvements in plant efficiency.

The economic viability of dendro plants hinges on their cost advantage over competing diesel plants. Fuel costs account for 70 to 75 percent of generation costs for diesel units. The international price of crude oil and its products, including fuel oil* and diesel fuel, has declined over the last three years, but the domestic price of oil products increased during this period due to devaluation of the peso.** Further devaluation will lead to increases in both domestic oil prices and generation costs for diesel plants. The economic cost of dendro plants would also increase, but not as much, since they have a smaller foreign exchange component.

Generation costs were also estimated with a lower price of wood, 120 pesos per ton, which is equivalent to the price assumed in the economic and financial analyses presented in the gasifier and charcoal production sections. This is 60 percent of the price of wood assumed for Bohol and 34 percent of that for Masbate. In this case, generation costs decline to 1.34 pesos per kwh for Bohol and 1.83 pesos per kwh for Masbate.

NEA loans money to rural cooperatives at 12 percent interest, which is paid back over a 25-year period. To meet loan payments and annual costs, rural co-ops must charge 1.50 pesos per kwh on Bohol and 2.21 pesos per kwh on Masbate. Adding depreciation to cover the costs of plant and harvesting equipment would raise the rate by eight percent.

Assuming a shadow price of 20 percent for foreign exchange increases the investment cost by 20 percent and the cost of generation by 13 percent on Bohol and 15 percent on Masbate. Generation costs for Bohol increase to 1.70 pesos per kwh and to 2.61 pesos per kwh for Masbate. Using the same adjustment, generation costs for diesel, with its larger foreign exchange component, will increase more than those for dendro thermal plants.

3. Economic Costs and Benefits

Figures IV.14 and IV.15 show the stream of economic costs and benefits for the combined power plant and tree farms on Bohol and Masbate, respectively, over a 25-year period. The economic rate of return on Bohol is 26.1 percent. Assuming foreign exchange is shadow-priced at 20 percent increases the investment cost, which occurs in the earlier years (four years for Bohol and

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*Large diesel plants in the Philippines use fuel oil for power generation.

**In March, 1985, the prices of oil products were decreased as the peso stablized.

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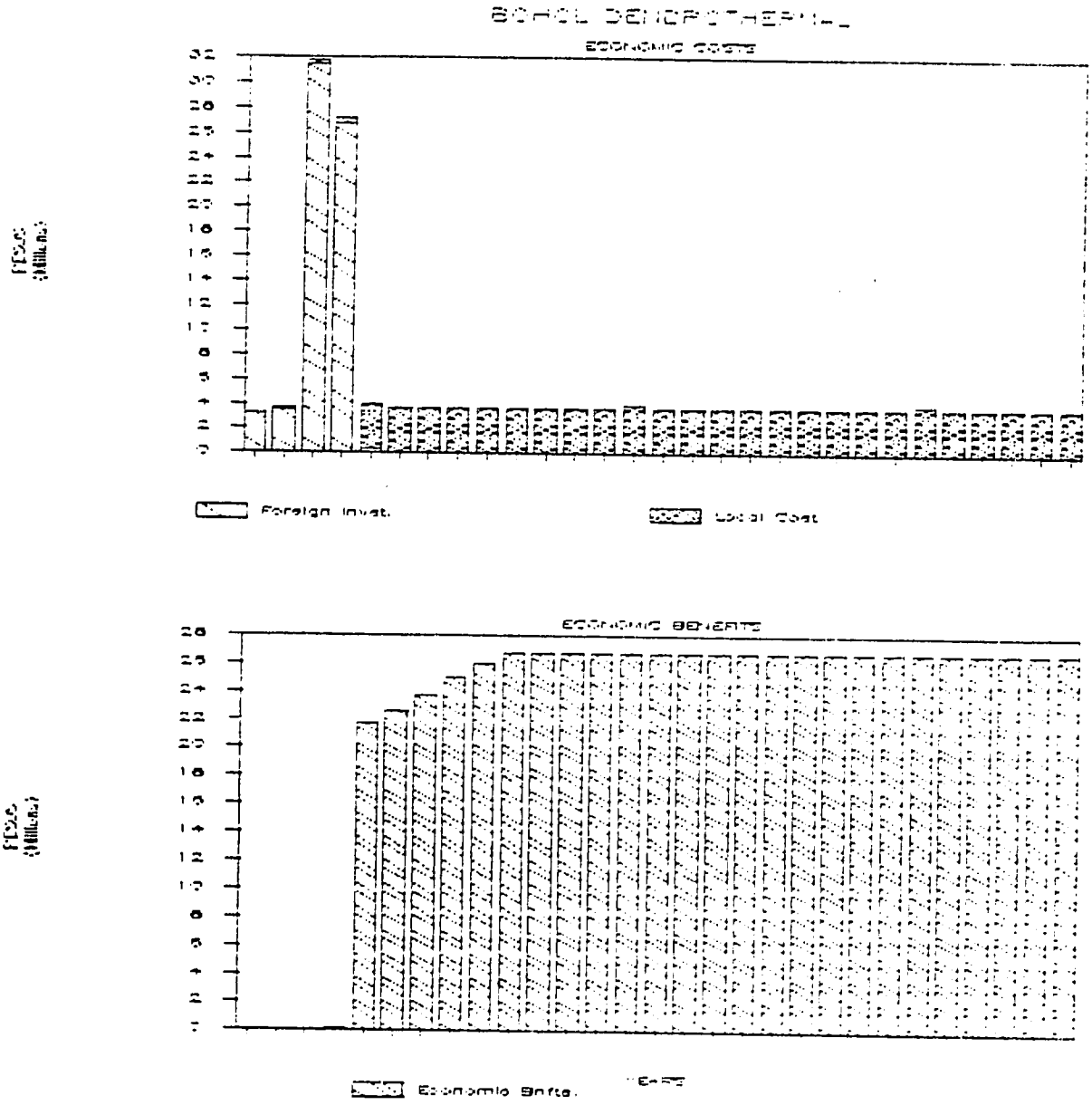
Figure IV.14. Stream of Economic Costs and Benefits for Bohol



	Rate of Return	Benefit-Cost Ratio at 20%
without shadow prices	26.1%	1.4
with foreign investment shadow-priced at 20 percent	22.5%	1.1

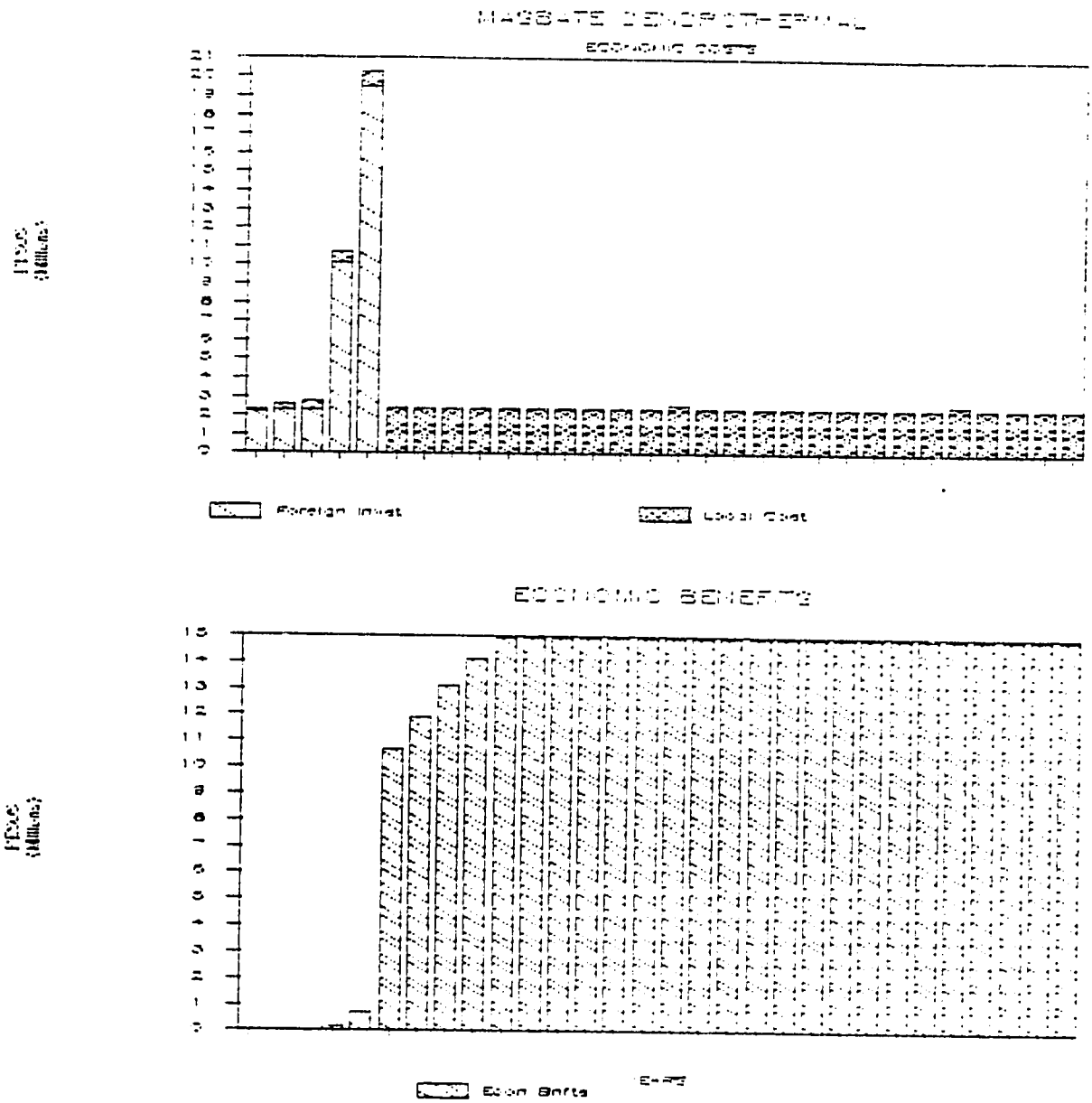
Notes: The analysis assumes that all investment costs are borne in dollar funds.

Costs include investment costs (plantation, harvesting and power plant) and annual operation and maintenance costs, but not fuel costs.

Benefits include revenue from electricity sales(₱2.00 per kilowatt-hour) and the sale of crops.

Graphs show costs with no shadow pricing.

Figure IV.15. Stream of Economic Costs and Benefits for Masbate



	Rate of Return	Benefit-Cost Ratio
without shadow prices	23.2%	1.15
with foreign investment shadow-priced at 20 percent	20.2%	1.00

Notes: All investment costs for first five years are borne by AID in dollar funds, while all subsequent costs are borne in pesos.

Costs include investment costs for plantation, harvesting and power plant, and annual operation and maintenance costs, but not fuel costs.

Benefits include revenue from the sale of electricity and crops.

Graphs show costs with no shadow pricing.

five for Masbate, where slower growing species must be used). It was assumed that additional development costs incurred after the initial period are borne by the TFAs from income earned through tree and crop sales. The rate of return with shadow prices included is 22.2 percent.

The economic benefit-cost ratio is 1.40 for Bohol at a 20 percent discount rate. For the stream of costs, with foreign exchange shadow-priced at 20 percent, it is 1.10. Thus, the project is at a favorable feasibility threshold. The shadow price of unskilled labor is not accounted for in these estimates, but it would reduce tree farm costs, assuming that TFAs employ mostly unskilled labor. However, tree farm maintenance costs account for only 18 percent of the project's operation and maintenance costs. Thus, even if all costs were allocated to unskilled labor--an extreme scenario, project costs would decline by only seven percent, and the discounted benefit-cost ratio would increase only marginally.

A similar analysis was done for Masbate. The rate of return is 23.2 percent for the combined operation of the power plant and tree farm. This rate was derived without adjusting costs to reflect a +20 percent shadow price for the value of foreign exchange. With this adjustment, the net benefits are smaller, and the rate of return declines to 20.2 percent. Thus, at a discount rate of 20 percent, the benefit-cost ratio barely exceeds one. Again, costs using the shadow price of unskilled labor (-40 percent) were not estimated, as the effect of this adjustment would be relatively minor, assuming that unskilled labor in confined mainly to tree farming.

G. Options

The analysis of electricity demand, dendro thermal power plants and fuelwood plantations reveals that:

- a planning process is needed to examine electricity demand in the Philippines in order to identify the combination of supply options that can meet this demand; and

- dendro thermal plants on Bohol and Masbate are economically viable options for supplying electricity, provided several critical issues can be satisfactorily resolved.

The assessment team found there was inadequate coordination between the two major power agencies--the NEA and NPC. Both agencies have laudable objectives, but these goals are often in conflict. The NEA and NPC report to different agencies, are in dispute over rates and bill payments, compete for the same

industrial customers and have no established, coordinated planning apparatus. It is clear that an overall planning process is needed to determine the role of each agency in meeting the demand for power in the Philippines in order to avoid duplication of effort and reduce power costs through economies of scale. In addition, such a process should produce a power expansion program consistent with GOP objectives as well as NEA and NPC expansion options. The project should consider funding such an effort and supplying any outside technical assistance that the GOP feels is needed or would be helpful.

Bohol

The analysis of a dendro thermal power supply option for Bohol found that a two-MW plant could be supported and is economically viable. The demand for electricity from such a plant clearly exists, provided the proposed mini-hydro plant is not built. If funding for the mini-hydro unit is approved by ADB, the economic viability of the dendro thermal plant should be reevaluated, since it would then operate at a capacity factor below the 60 percent assumed here. A low capacity factor might raise generation costs above those for a comparable diesel plant, and a smaller dendro plant should be considered in that event.

The plantation size required to support a two-MW plant was estimated to be about 1,520 hectares, which is close to the total area available at the site (2,000 hectares). The average yield assumed for this plantation--20 wet tons per hectare per year of ipil-ipil--has not been achieved at the site, although soil conditions are suitable for such a yield. Close supervision and adequately skilled personnel, including foresters, agriculturists and soil specialists, are essential if the assumed yields are to be attained. Since power plant construction does not have to begin until the third year, two years prior to harvesting and generation, the initial two-year period should provide ample opportunity to ascertain the plantation's average yield and make a final determination of the site's suitability for a dendro thermal plantation. Lower yields may suggest the advisability of acquiring additional available land, building a smaller power plant, or using the wood produced for fuelwood, charcoal or lumber.

A major alternative to the fuelwood plantation is using the land for crop production. Foresters on the team estimated that farmers would get more revenue by growing annual crops on a tenth of the land (180 hectares) than by selling wood to the plantation. A more careful evaluation of this alternative by professional agriculturists as well as the market for such crops is needed.

Masbate

The team found that a 700-kw power plant is economically viable for the Masbate site. The demand for electricity is ample, provided the rural cooperatives can sell power to the mining companies. Even without the mines, demand is projected to grow adequately, if transmission and distribution lines are extended.

The plantation needed to support a 700-kw plant was estimated at about 1,000 hectares, which is also close to the total land available at the site (1,500 hectares). The required average annual yield of 10 wet tons per hectare is for the slower growing *Gmelina* and *Acacia* species. Soil conditions need to be thoroughly evaluated throughout the plantation before proceeding.

The socioeconomic situation on Masbate is diverse. The farmers are not and do not wish to be organized into TFAs. To ensure an adequate wood supply, a three-tiered plantation system needs to be explored. The first tier would consist of land directly under REC management, the second would include long-term contracts with farmers already settled on the land, and the third would allow for the purchase of wood from plantations outside the immediate BFD area, which would require careful regulation and control. Again, the five years prior to harvesting and generation should provide ample opportunity to determine average yields and decide on a course of action from the options outlined for Bohol.

Should any of the dendro thermal plantations or power plants be implemented, NEA must augment its technical capability--the need for additional forestry expertise, improved field management and better trained operators has already been discussed. Any decisions to proceed would also require a plan on NEA's part to address the institutional and management issues raised in this report. Project funds could be used for this purpose.

V. GASIFIERS FOR IRRIGATION

At the time the project paper was prepared, the approach suggested, as well as the economic and technical analyses, were basically sound. However, FSDC has installed charcoal-burning gasifiers in the field, rather than the wood-chip models given primary consideration in the project paper. This shift, combined with changing fuel costs and inadequate technical and management support, has led to this subproject's current problems.

This section discusses the status of the gasifier project and identifies major problems and constraints. It then provides an analysis of the current institutional, technical and economic aspects of gasifier technology, FSDC and the subproject as a whole. It should be noted that the ARD assessment team found the subproject's original objectives to still be valid and farmers' problems with power supplies as acute as ever.

A. Project Status

Due to the various technical and institutional problems encountered by the gasifier program, a joint Development Project Fund Secretariat and AID team assessed the project status in early 1984. Their report, dated May, 1984, details a number of problems, including an estimate that only 70 percent of the existing gasifiers were operational. FSDC's own assessment during October and November, 1984 basically confirms this estimate. At the time of ARD's assessment, the situation did not seem to have improved and, if anything, may have worsened.

FSDC uses the GEMCOR IS 30/60 system in its irrigation projects. GEMCOR gasifier production is displayed in Table V.1, and an examination of the production figures shows that their primary production of gasifiers is in the I category, which represents the irrigation model 30/60. A total of 497 IS 30/60 units had been produced through 1984, and FSDC has 319 of those units in place at 283 of their ISA irrigation projects. Table V.2 shows the distribution of the FSDC's gasifiers throughout their area divisions. Area IV has the most gasifiers--135 at 120 projects, while area II has the fewest, 16 units at 15 projects.

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Table V.1. GEMCOR Gasifier Production for 1983 through 1984

Year	Total Units	I.	L.W.	RM	6S	TM	Ice	BM	BM-150	Ths	DHS	HM	Other
1981	84	56	34	4									
1982	712	247	156	8		2	2	298	1	1			
1983	182	126	3	1	5	2	5	17	1	8	4		
1984	102	68	1		2	3				3		13	12

Table V.2. Number of Projects and Installed Gasifiers by Area

	Area I	II	III	IV	V	VI	Total
Number of Projects	74	15	23	120	22	29	283
Number of Gasifiers	86	16	24	135	28	30	319

The status of the 319 gasifiers in the field is of great concern, and the AID/MHS quarterly report indicates there are a variety of problems, including:

- maintenance problems,
- cost of charcoal,
- lack of diesel fuel,
- lower fuel substitution percentages,
- system operation is difficult,
- increased demands on operators' time,
- mismatches between engines and gasifiers,
- need for training program,
- lack of spare parts, and
- high turnover rate among trained mechanics.

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This partial list points up the many difficulties encountered in the use of these gasifier systems. In their December, 1984 report,* FSDC lists 128 of the units as operational, but only 32 or 10 percent of the total number of gasifiers were actually in use. (Table V.3 is a status table supplied by FSDC.) The low percentage of operational systems was attributed to the time of year, high cost of charcoal and typhoon damage as well as the other reasons listed above. Of the nonoperational units, 57 had defective or damaged diesel engines; this total figure is broken down by region in Table V.4.

Table V.3. Status Summary of Gasifiers as of October, 1984

Category	Number of Projects	Number of Gasifiers
Operational		
In Use	31	32
Not in Use		
-Insufficient Rain/Harvest	24	25
-Insufficient Fuel; High Charcoal Cost; No Working Capital; High Operating Costs	38	42
-Other Reasons	27	29
Inoperational		
Ongoing Maintenance		
-Gasifier Equipment and Accessories	27	33
-Engine/Pump; Other Irrigation Components	81	99
Underrated Gasifier	26	29
Pull-Out	29	30
Totals	283	319

*FSDC. "The Gasifier for Irrigation--Sub-Project Assessment and Recommendations." Final draft, February, 1985.

Table V.4. Breakdown of Gasifier Projects with Defective Engines by Area

	Area						
	I	II	III	IV	V	VI	Total
Number of Projects	8	1	2	30	6	5	52
Number of Pump Sets	8	1	3	33	7	5	57

Before the ARD team began to develop alternative courses of action for the gasifier program, the institutional and technical problems with this subproject were reviewed. The remainder of this section presents the results of the team's review of these issues.

B. Institutional Assessment

Since 1983, the national government has not provided FSDC with a budget for counterpart funds, as was originally envisioned. Although funds were made available to cover the capital costs of many FSDC projects, the Office of Budget and Management (OBM) did not approve the requests for budgets to cover program management and implementation. Because the gasifier project was considered a locally funded project, it is not a funding priority for OBM. FSDC has therefore requested additional funding from ESF to cover program management costs which were supposed to be FSDC counterpart costs. As of February, 1985, ESF and FSDC had not reached an agreement concerning the sharing of counterpart costs. Consequently, the gasifier program has been practically at a standstill for the past year.

In spite of the various difficulties that have been encountered in the implementation of the gasifier program, it remains a very high priority with FSDC, a message which has been communicated from the central office to the lowest levels of the agency. In fact, following the May, 1984 AID/ESF assessment report, the FSDC responded with two constructive activities:

- the Information, Education and Motivation (IEM) program was planned and initiated; and
- an internal evaluation of the gasifier project was conducted.

IEM is intended to increase the understanding of gasifier technology at all levels of the organization, including the ISAs.

The IEM program is also attempting to develop local capability, at the provincial and area levels, to service gasifiers.

There are several factors behind the major importance of the gasifier program to FSDC. First, one of the major sources of FSDC funds--collections of loan amortization from ISAs--has decreased in the last two years. Most ISAs operate pump irrigation systems, and increases in the cost of both electricity and diesel fuel hav made it increasingly difficult for ISAs to remain financially .iable. FSDC views the gasifier program as a key to enhancing I A viability which should, in turn, enable FSDC to improve its financial situation.

A second factor is FSDC investments in GEMCOR. FSDC is the largest shareholder (45 percent) in GEMCOR, which is currently the only supplier of gasifiers for the project. As a result of the prevailing economic crisis, GEMCOR is experiencing rising operational costs in combination with a reduced demand for its products. It has reported net losses from operations every year for the past four years. In 1983, its net loss was ₱3.1 million from ₱3.9 million in net sales, and although the 1984 financial statements were still being prepared, GEMCOR officials expect a net loss of almost ₱2 million from ₱4.1 million in net sales.

During the past two years, GEMCOR has had severe cash flow problems, but in 1984, it initiated measures to regain control of its financial situation and has reduced overhead, operating and marketing expenses from ₱4.4 million in 1983 to roughly half that figure. GEMCOR has also tried to diversify its product line and market by shifting its attention toward industrial customers as well as venturing into the production of non-gasifier agricultural machinery, such as hammer-mills and conveyor systems. It has reduced its labor force from 242 in 1982 to 151 in 1983 and 60 by the end of 1984. Today, GEMCOR has a total of 40 regular and 20 casual employees. Of these 60 staff members, 20 are in administration and management, while the remaining 40 provide direct labor in manufacturing.

From 1982 to 1983, FSDC orders of gasifiers accounted for 60 to 70 percent of GEMCOR sales. In 1984, the FSDC share of total GEMCOR sales fell to 56 percent due to the reduced scale of gasifier project implementation. This year, GEMCOR is targeting an estimated ₱1 million in orders of add-on filters and ₱5 million of gasifier units from FSDC. FSDC has already committed to ordering the add-on filters, but it is doubtful whether the target of ₱5 million in gasifiers can be attained as FSDC currently has an inventory of 112 units.

GEMCOR hopes to meet the shortfall in FSDC gasifier sales by seeking orders from private industrial customers. However, the current economic crisis and high interest rates will make it difficult for GEMCOR to expand its market in the industrial

sector. Thus, GEMCOR will continue to remain heavily dependent on FSDC patronage for its survival--if FSDC were to cancel its gasifier orders this year, GEMCOR would be hard put to remain in business and FSDC might have to accept the loss of its P8 million investment in GEMCOR. In sum, although there are several potential gasifier suppliers who would be willing to meet FSDC requirements, FSDC has not made a serious effort to seek out and develop other avenues of procurement.

It is clear that in order for GEMCOR to remain an acceptable supplier of gasifier systems, it will need to improve the quality and reliability of its product and generate a range of unit designs to match the diversity of field requirements. GEMCOR will also have to provide prompt and dependable service after the sale. Because of its "exclusive supplier" relationship with FSDC, it currently has little incentive to improve its product or service. In addition, its unstable financial condition would appear to hamper its ability to respond to these requirements. Technical issues that must be addressed by GEMCOR are fully discussed in a subsequent section.

GEMCOR is affected by a larger financial situation that continues to worsen not only for FSDC, but many other organizations in the Philippines as well. Although an examination of FSDC's financial condition was not directly within either the mandate or time and resource constraints of the ARD team's assessment, the team's impression (based on conversations with FSDC officials) was that the situation has not been clearly addressed by FSDC. Reportedly, the main potential source of new revenue is new enterprises, mostly at the KAISA level, but there was little indication that these enterprises will soon yield a monetary return for FSDC or aid in improving its financial situation. In addition, the team was not made aware of any new procedures or efforts to improve the accounting and financial monitoring of loans and loan repayments. While admittedly subjective, these impressions are important because FSDC's financial capability and the availability of skilled personnel appear to be two key elements in transforming the current gasifier program into a more successful effort.

1. Program Management

Site Selection

As has been documented in many other reports, the FSDC process for gasifier site selection is inadequate, which has resulted in installations at inappropriate locations. Few guidelines were provided to local staff at the KAISA level on the economic and managerial requirements of gasifiers--rather, the documentation provided consisted of gasifier operation manuals,

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GEMCOR brochures, sales kits that promised substantial cost savings from gasifier use, and procedures for concluding loan agreements with ISAs. The guidelines did not specify the criteria and procedures for conducting a site-specific evaluation of the viability of gasifier operation. In most cases, the feasibility reports merely contained pro forma cost-benefit calculations.

Similarly, there are institutional factors which may complicate the operation of gasifiers by ISAs. Since ISAs ultimately decide whether or not to purchase a gasifier, they should be apprised of the institutional implications of operating a gasifier and developing a woodlot as a fuel source. FSDC does not always appear to have provided ISAs with such information. (A subsequent section on the implications of ISA-level management discusses this problem in greater detail.) Clearly, the site-selection process should be made more rigid and comprehensive to ensure that ISAs are fully prepared to receive gasifiers.

Field Technical Support

FSDC admits that field-level technical support for the gasifier program is inadequate. Few, if any, provinces have trained mechanics who are capable of diagnosing gasifier problems and then correcting them. Furthermore, there is currently no plan to provide adequate technical capability in the field, and although all area offices maintain trained diesel mechanics on their staffs, the mobility of these mechanics is a pressing issue. With financial constraints being experienced by FSDC at all levels, including the KAISAs, travel funds are sorely inadequate. As budgets continue to shrink and releases are delayed, travel and travel-related expenses are budget items that are easily sacrificed.

At present, most of the mechanics in area offices no longer make routine inspection visits to gasifier sites, except for locations close to their offices. Instead, they usually remain "on call" at the area offices, traveling only in response to requests for assistance from KAISAs or ISAs. Even so, they are often unable to answer to such requests promptly and prioritize their response based on the ISA's degree of need and location, attempting to give their attention to ISAs that would be unable to irrigate their fields without assistance. As a result, ISAs with inoperative gasifiers that can still use a diesel pump to irrigate are given a lower priority. These responses to budgetary constraints were reported by area office personnel and confirmed in interviews with staff members at the KAISA level. Certainly, many technical problems could probably be prevented or corrected immediately if trained gasifier mechanics made periodic, routine visits to each gasifier site.

A related issue is the procedure for actual repair work on a gasifier unit. FSDC policy has been to provide the mechanic's service for free, but charge for spare parts in cases where the ISA is found to be responsible for the damage. It also shoulders all repair costs when the unit is determined to be defective (and therefore, the responsibility of FSDC or GEMCOR). The problem with this arrangement is that the mechanics ultimately decide who is at fault and usually lay the blame on the ISA. Even when it can be demonstrated that a unit was defective from the time of installation, neither FSDC nor GEMCOR possess the financial resources to absorb the additional repair costs.

Monitoring and Evaluation

In general, the only types of data being transmitted between FSDC field and central offices are of the financial and technical sort. Thus, little information concerning social or institutional issues at the ISA level is reaching FSDC's higher management levels. The implicit view is that KAISA offices, staffed with institutional officers, are well-equipped to handle nontechnical issues. However, this approach has its costs since gasifier technology may actually impose additional pressures on ISAs that can cause institutional problems. (The most significant of these problems are described in a subsequent section on the implications of ISA-level management.) While these concerns may be discussed at the KAISA level, there is no formal monitoring of the project's institutional aspects at higher management levels, and many issues are left unresolved because KAISAs are unfamiliar with solutions to their problems.

The technical and financial data being collected at the KAISA and ISA levels are transmitted to area offices for processing. However, during this assessment, most of the data in both the area and central offices were either in raw form or not analyzed in a way that would be meaningful for higher management. It appeared that most of the information was being processed only when special reports were requested. In summary, monitoring and feedback on the gasifier subproject are occurring only sporadically.

NIA Takeover of Gasifiers

In several documented cases, ISA pump systems with gasifiers have been absorbed by NIA because they have either been programmed for rehabilitation by NIA or included in the NIA's national system projects command area. These instances argue for closer coordination between NIA and FSDC as well as a means of determining during the site-selection process whether an ISA will be covered by future NIA programs. Clearly, an ISA should not

have to shoulder the obligations of a gasifier loan if it will not have any use for the gasifier in the future.

At present, both NIA and FSDC are represented in a central coordinating committee which monitors the two agencies' overlapping projects. An agreement (see Appendix H) has been reached concerning cases where NIA national systems absorb FSDC irrigation projects. Under this arrangement, NIA compensates FSDC for the ISA's loans less the assessed value of the equipment to be removed by FSDC, cost of the project area retained under FSDC jurisdiction and total amortization already paid to FSDC by the ISA. While a clear agreement exists for NIA national system projects, FSDC and NIA have not agreed on the financial resolution of cases where FSDC and NIA communal system projects overlap. This matter still needs to be clarified by the central coordinating committee.

In terms of new FSDC projects, the existing agreement with NIA is that FSDC must secure NIA clearance for any FSDC irrigation project. Clearance is given for sites which NIA projects will not cover in the next four years. Although FSDC justifies this arrangement by arguing that farmers can receive substantial benefits within a four-year time span, FSDC should consider the financial implications. Gasifier project loans have a four-year grace period, so it is conceivable that NIA could ask FSDC to remove a gasifier which the ISA has made no payments on and has already depreciated in value for four years. In view of FSDC's tight financial situation, it does not seem reasonable for FSDC to provide ISAs with equipment that they need not pay for if it is pulled out in four years or less.

Loan Amortization Period

The life expectancy of a gasifier unit has not been clearly determined. However, it would be unwise to permit loan amortizations beyond the useful life of the equipment. Estimates place the life of a gasifier at six years, but the current loan amortization period extends several years beyond that.

2. Implications of ISA-Level Management

Gasifier operation poses two basic types of issues related to management by the ISAs:

- operator workload and compensation, and
- mechanisms for securing fuel contributions from members.

Operator Workload and Compensation

Gasifier technology requires several adjustments on the ISA's part. One focal point of change is the operator's workload. In most cases, the pump operator is retained as the operator of the diesel engine and gasifier. Gasifier operation increases the time and effort required of the operator--compared to using just the diesel pump, the gasifier requires an additional two to four hours of time for each day of operation. In addition, the operator must lift sacks of charcoal, break it into pieces of the appropriate size and load it into the gasifier as well as clean the gasifier regularly. In the process, the operator becomes soiled practically from head to foot. In short, the operator must do more work and may perhaps endure more stress with a gasifier. Consequently, over time, the operator may develop some psychological resistance to using the gasifier and maintaining it properly, and may actually discourage ISA members from wanting to use it.

Thus, compensating operators for the additional effort required by a gasifier is an issue that ISAs must consider since an operator who is unhappy will have little incentive to keep the equipment in proper condition. ISAs have various ways of compensating operators. Some receive daily, weekly, monthly or yearly salaries. Others are paid a percentage of the crops harvested. Still others are compensated according to the number of liters of diesel fuel or sacks of charcoal used. These arrangements affect how the operator uses the gasifier.

For example, in one of the Iloilo ISAs, operators were paid based on the liters of diesel fuel consumed. When the gasifier was being used, the operator received ₱.5 per liter of diesel fuel consumed, but when the pump was run purely on diesel, he was paid ₱.25 per liter. Although there are no data to permit a definitive conclusion, the assessment team feels there are potential problems with this compensation scheme. By basing the operator's pay on the consumption of diesel fuel, he has little incentive to achieve optimal efficiency in substituting diesel for charcoal.

Fuel Contributions

The systems that ISAs use to secure fuel contributions from members are also worthy of note. In some instances, farmers contribute cash or "cavans" of unhusked rice before or at the end of each cropping season, and ISA officers handle the procurement of diesel fuel and charcoal. In other cases, farmers bring the required fuel each time their fields are to be irrigated. Naturally, the former system is ideal for gasifier/pump operation--it assures a ready fuel supply since the proper quantity and quality of both diesel fuel and charcoal can be

purchased in advance by the ISA. Further, bulk purchases can often be made at a better price and may facilitate transportation and storage. However, this system demands that the ISA be well organized and managed with effective systems for collection, control and financial management.

The latter system can pose problems for both the ISA and operator. When members bring their own contribution of diesel fuel and charcoal, the operator may have to use different grades of charcoal, perhaps some of substandard quality. Also, members may bring less diesel fuel and more charcoal than required or vice versa, depending on the relative availability of the two fuels, which can cause technical problems later on. A technician would diagnose such problems as technical in nature, even though the root cause was of an institutional nature.

FSDC technical and institutional personnel should recognize some of the implications of gasifier technology and be trained to handle them. As yet, the capability to solve such problems has not been evidenced at the KAISA level.

3. Tree Production Units

At most of the sites visited by the assessment team, woodlot development was far behind the target of three or more hectares per gasifier with the unavailability of land cited as the main reason for this shortcoming. Most of the units are located in lowland areas where the available land is already devoted to agricultural or residential use. Those areas reported as being developed for woodlots were generally found in the back yards of homes, along roadsides or waterways, or in public areas, such as school grounds.

In places where trees were ready for or already being harvested, most of the fuelwood was earmarked for home consumption, and it can be assumed that trees planted in back yards will also be used in the home. Furthermore, the team did not find a woodlot that was supplying the needs of a gasifier nor an ISA with a well-conceived plan for utilizing a woodlot to fuel its system. One explanation for this state of affairs is the fact that GEMCOR gasifiers are designed to use charcoal. As a result, there were no operational woodlot models that could be evaluated. Further, it seems clear that no good model has been developed, even in theory. However, there are several options for ISAs to consider, each with advantages and disadvantages. The individual ISA should select the option that best suits its capabilities and situation.

First, an ISA could hire un- or under-employed persons to develop and maintain woodlots, which is the plan suggested in the project paper. It assumes there is available land suitable for

growing fuelwood trees, and will require the ISA to engage in closer supervision and control of the farming and harvesting operations than has been the case so far. In addition, the contractual arrangement or model for this option has yet to be clearly developed.

Second, an ISA could mobilize its own labor force to develop woodlots, with all the members sharing the responsbility for the work of farming and harvesting. This model also assumes there are available sites for woodlots that can be operated on a communal basis. Only the most mature, well-organized ISAs can handle this option, as it is perhaps the most management-intensive, requiring complex systems of coordination and control.

Third, farmers could continue to contribute fuel on an individual basis by either producing wood in their back yards or purchasing it from outside sources. This is the scheme currently practiced by most ISAs and may be the only viable option in areas where suitable land for woodlots is unavailable.

Finally, FSDC could identify people who have access to land that can be developed into woodlots. FSDC would provide the inputs needed to develop the woodlots, and the ISA would enter into a contract with each individual to buy or harvest the wood at a set price. This option permits access to private land and reduces ISA management responsibilities.

These are only some of the possible alternatives. There are certainly others, as the experience of the past three years in woodlot development has shown that field situations are diverse. Thus, ISAs and KAISAs should be prepared to depart from the model suggested in the project paper, if required. However, ISAs should be prepared to to seriously consider the technical, management and financial implications of each alternative before choosing among them. Likewise, FSDC should be prepared to present a "menu" of options to the ISAs and assist them in making this decision.

4. Information, Education and Motivation Program

The IEM program is FSDC's primary response to problems identified in the AID/ESF evaluation of May, 1984. The IEM program document is presented in Appendix I because it is important in understanding how FSDC's higher management views the steps needed to address problems in the field. FSDC informed the team that the IEM program had always existed and had simply been updated, enlarged and improved. It appeared to the assessment team that IEM does not address the specific technical and institutional problems that must be resolved before any progress on the gasifier subproject can be made. Rather, IEM assumes that solutions to various problems are known, FSDC personnel are

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available and the gasifier program can proceed as planned. The team believes that further work must be done and decisions made before IEM can fruitfully be undertaken.

5. Summary of Key Insitutional Issues

If the gasifier subproject is to continue, a number of key institutional issues will have to be addressed. These issues and the ARD assessment team's observations concerning them are discussed in this summary section.

The gasifier procurement process should be open to other suppliers. Of course, this may not prevent FSDC from preferring GEMCOR, but it might encourage the development of other qualified gasifier companies, and would give all firms an incentive to improve their products and service. Specifications could be prepared for development of a prototype wood-chip gasifier and firms invited to submit proposals that would include engineering capability as well as costs.

There should be an incentive for gasifier suppliers to be more user-oriented and sensitive to ISAs' training, skill and service requirements. One option is to offer a minimum trial period of operation with payment released to the supplier only after an ISA is satisfied with the equipment. This would motivate suppliers to provide equipment that truly meets user needs, give adequate training on operation and maintenance, and ensure that savings in fuel costs justify purchase of the equipment from the start. Another alternative would be to offer a lease/purchase agreement, with a fixed monthly rental price that could be justified by savings in fuel costs and an option to purchase after a given period.

Given the current financial difficulties faced by both FSDC and GEMCOR, and the lack of qualified technical personnel, particularly at the provincial level, an infusion of additional funds for both program management and technical services will be needed to effectively implement the gasifier program. However, in the opinion of the assessment team, it will also be necessary to reduce the scale of project implementation in the short term, gradually expanding it again once essential technical and management capabilities are established. The IEM program was recently initiated to build such technical capability nationwide, and should also seek to develop a prompt, reliable system of after-sales service that can ensure the availability of spare parts in each province.

A guide for site selection and feasibility assessment should be developed that includes technical, economic and institutional criteria. It should be usable by field personnel and should also

require a review of NIA plans, if any, for the irrigation system under study.

FSDC should be prepared to write off loans on gasifier projects which do not prove financially viable, since ISAs that are unable to operate their units will not pay for them. The terms of loan agreements should also be revised and adjusted in view of the life expectancy of the gasifier unit. FSDC should be prepared to present ISAs with a variety of woodlot development options, and flexibility and sensitivity to local circumstances should be encouraged. There should be a willingness to consider other alternatives if the current model or approach is not feasible in a specific situation.

C. Technical Assessment

A sketch of the GEMCOR IS 30/60 gasifier is presented in Figure V.1. The original system, excluding the diesel engine pump set, has two primary components:

- the reactor/gasifier, and
- gas clean-up unit.

A cross section of the reactor is shown in Figure V.2, primarily as it was designed by Dr. Cruz.*

The reactor simply converts charcoal/fuelwood into a combustible gas, solid portion and liquid product by combusting a fraction of the carbon in the fuel, thus producing a high-temperature environment for driving the gasification and pyrolysis processes. These two processes require a reduced oxygen supply, compared to combustion, and result in a wet, low-Btu producer gas as well as char and tar components. The gasifier design is intended to reduce the tar and char fractions while maximizing the gas produced.

Proper gasifier design permits the correct air-to-fuel ratio for the gasification process, normally by defining the inlet tuyere and grate or choke-plate diameters. The tuyeres' diameters determine the amount of air supplied, while the choke-plate or grate openings define the charcoal/wood inventory in the reaction zone. The air-to-fuel ratio controls the gasification temperatures--the higher the temperatures and the longer the gas is maintained at a high temperature, the better the fuel-to-gas conversion. This reasoning is the primary logic behind selecting a downdraft gasifier, especially for use with an engine. The gas

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*Cruz, I. B. "Producer Gas from Agricultural Residues--Its Production and Utilization in Internal Combustion Engines."

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Figure V.1. Schematic of GEMCOR IS 30/60 Model Gasifier

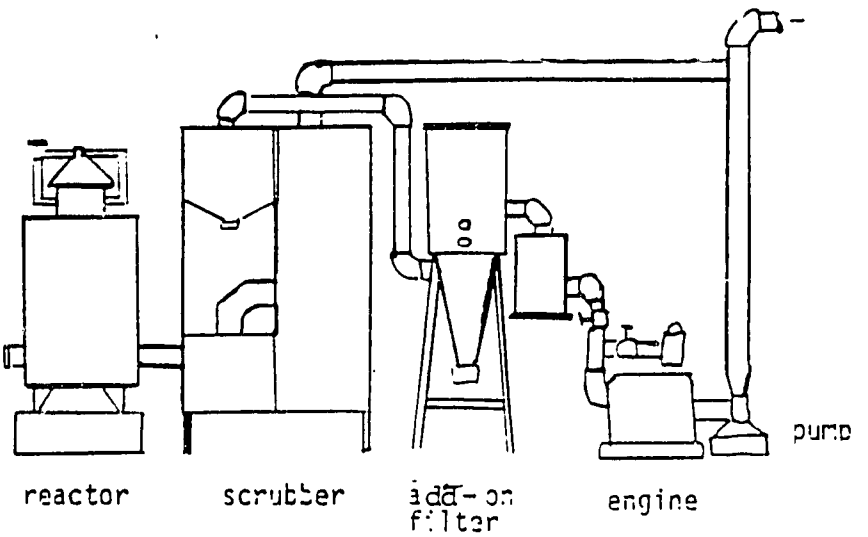
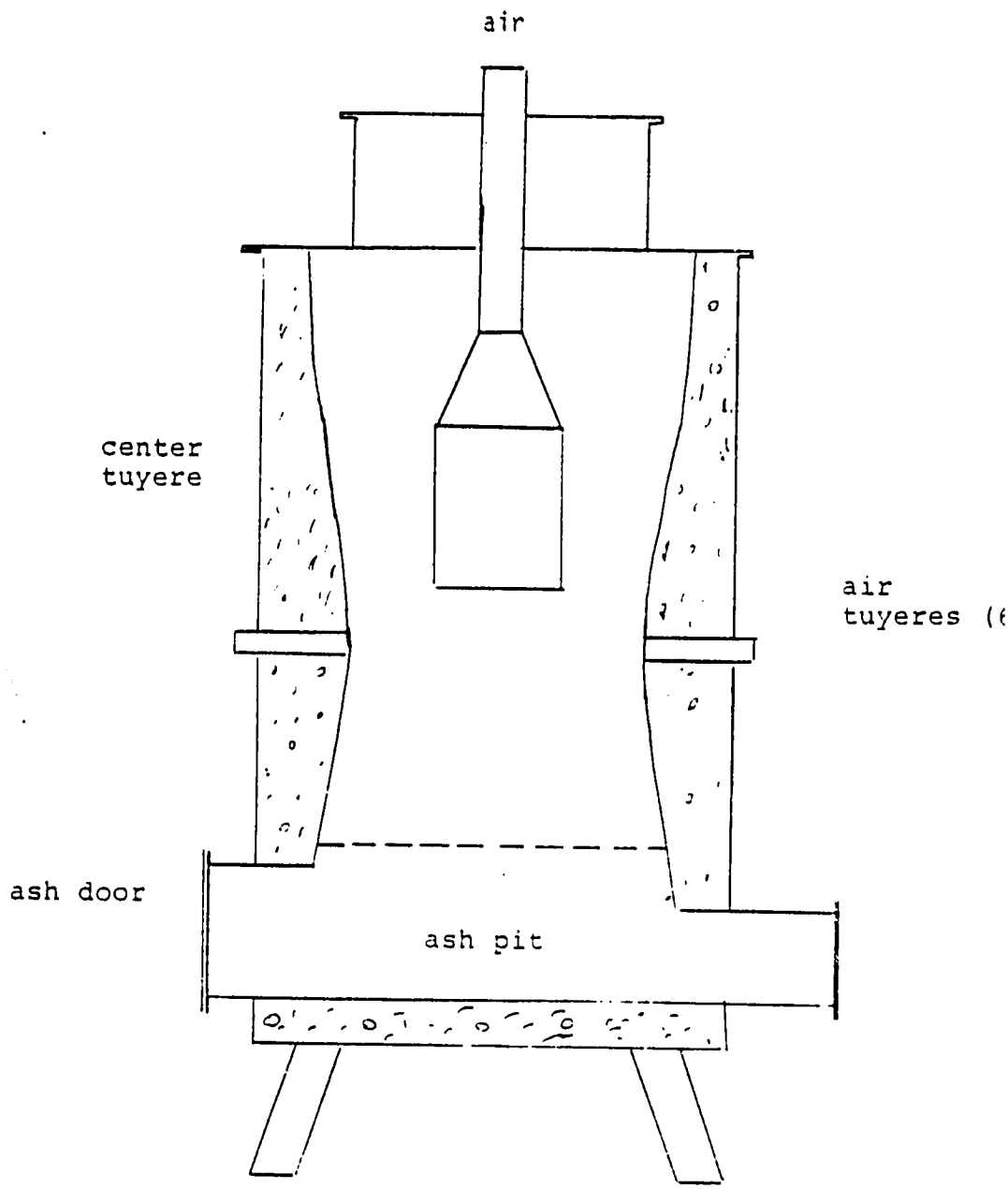


Figure V.2. Cross Section of GEMCOR Downdraft Gas Producer



is sucked through the high-temperature char and ash from the tuyeres to the grate, thus cracking the tar produced in the initial pyrolysis conversion. A sketch of a normal downdraft system appears in Figure V.3 for comparison with the GEMCOR design in Figure V.2.

Several problems with the GEMCOR design are immediately apparent--constriction of the charcoal feed area before the gasification tuyeres and possible difficulty in defining the proper air introduction path into the reactor. The problem with constricted solid flow is evidenced by reports from several users that they must continually poke the charcoal feed to ensure a proper fuel supply. An examination of the Imbert gasifier,* illustrated in Figure V.3, points up the difference. In the Imbert system, the area starts to be reduced after air is introduced through the tuyeres. This restriction concentrates the char and available oxygen as the reaction progresses toward the grate.

The tuyeres in the Imbert system are designed to provide high-velocity air injection into the fuel bed, while the GEMCOR tuyeres can be sealed with pegs so that just the top air supply is used or the top can be sealed so that only a portion or all of the six side tuyeres are used. During the field visits, the team observed all possible combinations, including a top which did not seal. This lack of air control in combination with a porous fuel bed causes a situation where air leaking into the system can cool the reactions, thus producing high tar levels. The fuel bed of charcoal pieces must be carefully prepared to ensure good air flow and gasification consistency, as large variations in the field can disturb the gasification process and/or produce high tar loadings. In sum, consistent operation is the most important parameter in defining the gasification processes for good performance, and the team's examination of GEMCOR systems in the field found that reactor operation appeared to very inconsistent across units and time periods.

1. Cyclone and Wet Filter

The next important element in a gasifier system is the cyclone and wet filter unit, a cross section of which is shown in Figure V.4. The GEMCOR unit is neatly packaged and includes a cyclone solids separator with a water seal in the dipleg, baffle-plate scrubber and oil-bath filter. Producer gas flows out of the cyclone separator into the bottom of the scrubber, and the baffle-plate unit has a multi-function that includes gas cooling

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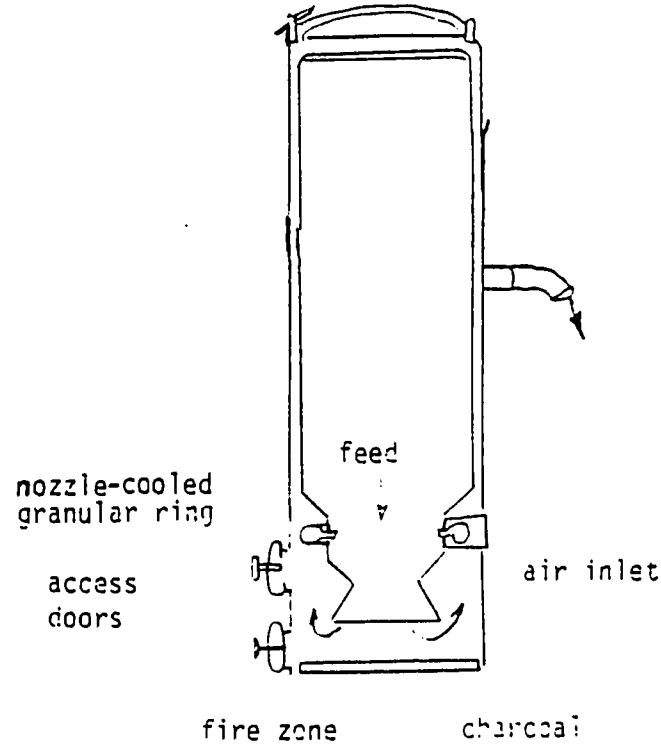
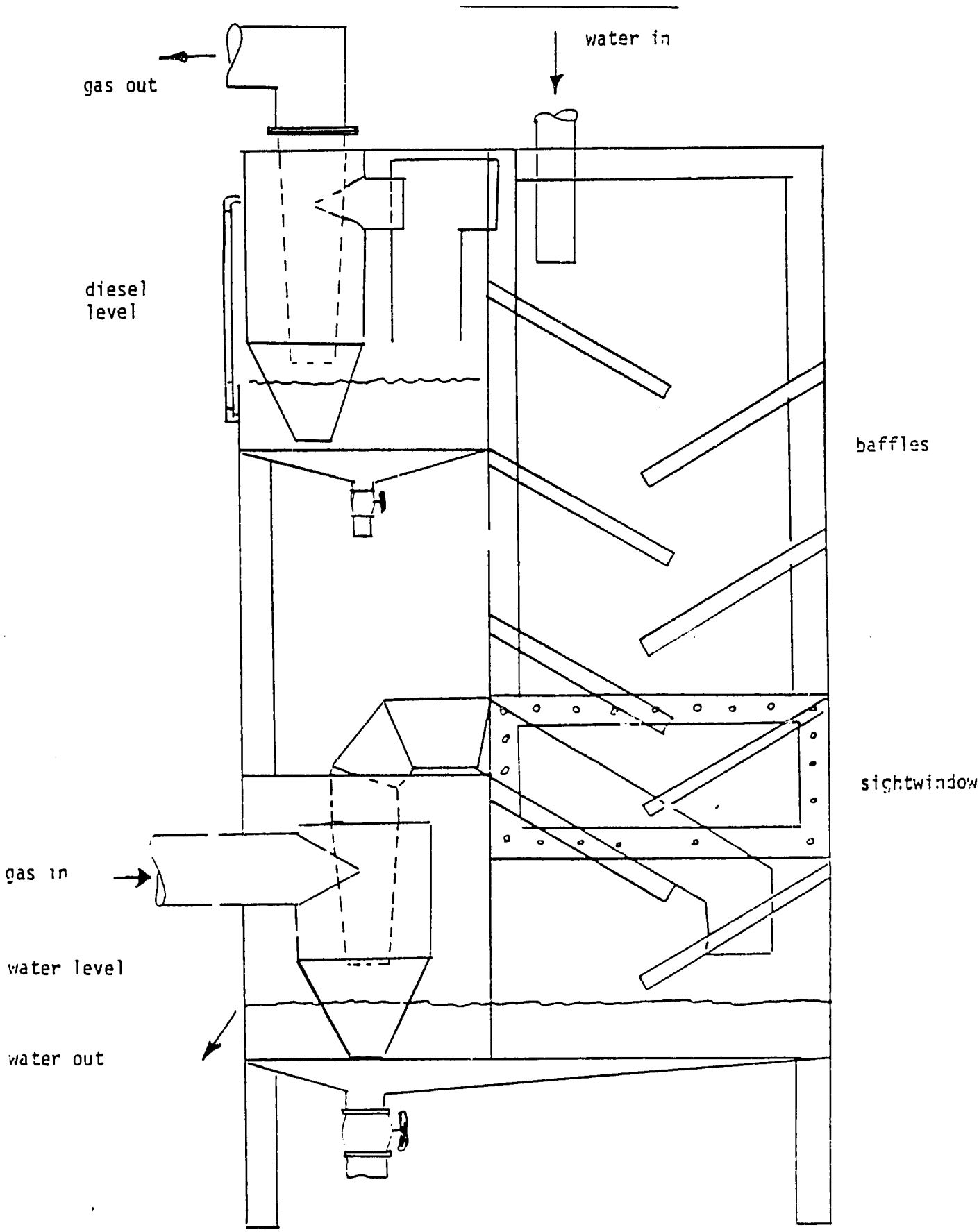
*Goss, John and Kaupp, A. "State of the Art for Small Scale (to 50 kw) Gas Producers--Engine Systems." BIORESOURCES FOR ENERGY, USDA, Forest Service.

Figure V.3. Cross Section of Imbert Downdraft Gas Producer




water in
gas out
diesel
level
baffles
sightwindow
gas in
water level
water out

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and scrubbing. The gas flowing up and around the baffle plate is flooded with water from the top, The cooled and clean gas then exits the wet scrubber to enter the oil-bath filter, which allows the gas to pass over a surface of diesel fuel through another cyclone before leaving the device.

Several observations were made which could help improve the cyclone/scrubber's operation. First, the initial cyclone with the water seal permits solids removed from the gas stream centrifugally to float on the surface. Thus, re-entrainment can occur, loading the gas with particulates. A dry dipleg would have a good chance of improving the cyclone's performance. The large entrance pipe into the cyclone suggests a low entrance velocity, which causes poor solid removal. An inlet velocity in the range of 50 to 90 feet per second will improve solid removal by increasing the forces applied, but will also increase the pressure drop in the system's cyclone component.

Second, the gas leaving the cyclone enters the baffle-plate wet scrubber, but nothing ensures contact between the gas and water. An increased pressure drop for the water stream on the plates could improve water distribution and thereby, the water-to-gas contact.

Third, and even more important, is leveling of the scrubber. Most of the units in the field visited by the assessment team did not appear to be level. This causes the water flow on a specific side to increase, thus reducing the potential for contact between water and gas necessary for good particulate removal.

Fourth, water cools the gas during its passage through the wet scrubber. The cooled wet gas then enters the section of the clean-up unit that contains kerosene. Discussions with operators in the field indicated that the kerosene is staying clean, which suggests an ineffective clean-up system--the kerosene would be dirty if the scrubber were working properly. Again, re-entrainment may be occurring on top of the kerosene.

Next, the gas flows from the wet filter into the engine or an add-on filter. FSDC has begun to implement changes in the design with the add-on filter program in response to the GEMCOR assessment which found that the carry-over of carbon and tar into the engines was damaging the engines' internal components. BED personnel* reported doing an engine overhaul (both removal of the head for valve service and a major overhaul of the piston, rings, bearings, etc.) after only 2,000 hours of operation. The add-on filter includes another cyclone where the exhaust gas enters a demister layer and passes into a glass wool filter with a rice-

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*Personal meeting with BED personnel. February, 1985.

hull center before going through a final paper filter, which is simply a paper air filter from an Isuzu truck.

During field visits, the assessment team evaluated two add-on filter installations. The first unit showed signs of tar accumulation in the primary glass filter and the final paper filter was saturated with water after only an hour and a half of operation. Thus, it appears that tar will plug the filter assembly quite quickly, which will cause maintenance difficulties. In fact, operators will probably discard the filters because it will be almost impossible to clean the tar from the filter element and replacement filters will be equally difficult to obtain due to the ISAs' locations. The second unit visited by the team was fitted with a manometer gauge to permit pressure-drop measurements across the filter. A delta pressure measurement was made and indicated a water drop of one centimeter. In checking with GEMCOR in Manila, the team discovered that a 10-centimeter drop is expected, which suggests that in this system a bypass was made so that the gas flows around the final filter element.

These two incidents indicate some of the problems that may arise with the filter assembly and its use, but another important point is the loss of engine efficiency due to reduced flow through the complicated filtering system. A small boost in pressure needs to be included in the total filter train and the cyclones reviewed to evaluate the feasibility of three low-efficiency units. It seems almost certain that one or two high-efficiency units could provide the needed solids removal.

In a similar vein, one of the primary reasons for using charcoal is the dryness of this fuel and the absence of tar production during gasification. Most gasifiers that are designed to burn charcoal use a dry clean-up system because the tar has already been removed during the charcoal-making process. For example, at the University of Missouri-Rolla, a small, charcoal-fuel fluid bed is being developed. The clean-up system consists of an internal, high-efficiency cyclone, glass wool filter, common radiator/cooler and dry filter element. This system is very economical to build and circumvents problems with moisture in the filtering clean-up system.

In light of the preceding discussion, the assessment team believes there are problems with the engines due to tar and carbon in the gas. FSDC's field investigation indicated that engines were damaged as a result of carbon deposits in the cylinder head, on top of pistons and in valves, and concluded that these problems were due to improper gasifier operation and maintenance. The ARD team questions this conclusion in view of the design of the gasifier/clean-up unit, which tends to produce a gas heavily loaded with particulates. The add-on filter program will aid in particulate reduction, but also has the

potential to impose another large maintenance requirement and additional operator responsibilities.

2. FSDC/GEMCOR Field Operations

The installation, operation, maintenance and safety instructions supplied with the gasifiers are presented in Appendix J. Besides being too brief, the instructions are also incorrect and unclear. They do not require leveling of the scrubber system and suggest a firing procedure that is opposite to the one given by GEMCOR for efficient and clean operation of the gasifier. GEMCOR engineers suggested that the units be fired using the side tuyeres and closing off the top, while the operating instructions state exactly the opposite. During the team's field visits, all types of variations in the firing procedure were found, including removal of the center cone. While it was impossible for the team to measure the operating parameters of the various systems, the one that seemed best visually was operated with the top closed so that air was introduced only through the side tuyeres, which concurs with the recommendation of the GEMCOR engineers.

Many of these problems could be avoided by requiring GEMCOR to operate the units before shipping. FSDC knows the exact requirements of the pump facility prior to ordering the gasifier. With these pump/engine specifications, GEMCOR could operate the system prior to shipping to adjust the tuyere diameters to exactly match the demands of the diesel engine at the facility that will be receiving the unit. This procedure would eliminate operating problems with air adjustment and should optimize the gasifier's performance at that specific site.

GEMCOR has prepared miniature IS 30/60 models, including the gasifier and clean-up train. These cutaway models permit effective demonstrations of the principles involved in gasifier operation and should be especially helpful in discussing technical problems in the field. The actual field training will be performed by field engineers from each of the area offices. They appear knowledgeable, but have not had in-depth technical experience with gasifiers, and the discrepancies between the written operating instructions and GEMCOR's suggested procedure will be a problem.

The lack of technical assistance to field engineers is apparent in both the IEM program and overall gasifier development project. Dr. Cruz has not worked on the gasifier program since 1981, and according to him, has a very limited role in IEM (perhaps two hours a week). Regardless, his facilities are very limited. In discussing his laboratory, he stated that no one at PNOC or University of the Philippines (UP) can provide access to a chromatograph for gas analysis. The inability to measure the

quality of the gas produced is an almost insurmountable problem in attempting to develop an efficient gasifier system. Similarly, the need to develop good char and tar measurement procedures are equally important to the overall specification of engine/gasifier performance and final success of the GEMCOR equipment.

Another important issue in the IEM program is maintaining a highly trained staff of diesel mechanics. FSDC has a high turnover rate among these personnel because of the demand for skilled diesel mechanics in both the private sector and for positions overseas. These outside pressures result in a work force that is constantly changing, but these personnel need training and experience to understand the complexities of the gasifier/diesel engine system. One consequence of this situation may be inadequate maintenance support for the ISAs' valuable pumping resource.

3. Wood-Chip System

The original contract proposal stated that both wood-chip and charcoal gasifiers would be developed. As previously noted, the development of a gasifier system that uses wood chips and/or charcoal requires a well-defined, technically supported system. The basic concepts for such a system should take into account work done in Europe during World War II. Literature on Swedish experience with small, state-of-the-art gasifier systems is available through AID, as is the work of researchers in Thailand and India. One other important piece of literature relating to the design and operating characteristics of gasifiers, specifically systems using diesel fuel, is a translated Swedish document, which details post-war work in that country on the topic.

The present GS model gasifier has some of the features expected in a downdraft system. Its dimensions should be compared to the Swedish systems or those developed by the University of California at Davis. The size of the gasifier should be specific to a given engine size, and the system (both gasifier and clean-up module) modified for engines with different capacities. The percentage replacement desired should be carefully analyzed, especially as it relates to reduced engine efficiency above a 50 percent replacement level.

The charcoal gasifier system needs to be replaced by a unit that uses a less expensive fuel. Commercial applications of the IS 30/60 gasifier have used either wood or coconut-shell charcoal for fuel, but to continue using this system, a low-cost replacement char needs to be found. In India, Dr. P. D. Grover has developed a charred biomass fuel produced from crop residues

that he calls Paru fuel.* He has developed a process to pyrolyze such crop residues as corn cobs, peanut hulls, coffee grounds, etc. into a charred biomass that is similar to charcoal. The charred material is extruded by machine to produce a pelletized, tubular char and will make a good replacement for charcoal. In locations were low-ash crop residues are available, a feasibility analysis of such a substitution should be performed. On the other hand, in areas where expensive charcoal (₱2 to ₱3 per kilogram) is the only charred fuel available, wood will have to be the substitute fuel, but the IS 30/60 cannot perform the gasification function in its present form.

A wood-chip gasifier does have economic potential, but a carefully planned, technically supported, long-term development process must be implemented to produce an acceptable design. The development work could be done by either the private sector or GEMCOR, or both. The experience of Joyti Solar Institute in Baroda, India could be helpful in this development work, as AID and the Ford Foundation have been supporting a wood-chip gasification project there.**

If an economical substitute for charcoal can be found, several tasks will need to be undertaken. The gasifier clean-up system will have to be reexamined for efficiency and pressure drop. Excessive pressure drop can be reduced by eliminating one or more of the three cyclones, and a close study of the filters needs to be performed as well. In the assessment, several items were mentioned to improve gasifier performance and should be considered. The firebox for the new wood gasifier could perhaps be designed to fit into the present unit, although several questions would have to be answered before this modification could be made. The principal items noted in this regard were cost savings, if any, and the compatibility of the IS 30/60 unit and the new wood-fired gasifier design in terms of size. Finally, a technical support structure must be developed with the final goal of clean, cool gas delivered to the engine, using consistent feedstock and procedures throughout the gasifier network.

Once a laboratory model of an integrated system has been fully tested, then the idea of inserting a firebox in the present gasifier could be analyzed and its merit evaluated. Field-testing should be a well-planned exercise with superior technical

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*P. D. Grover and M. Birveiji, "A Pelletized Charred Biomass Fuel from Agricultural Residues," FIRST DOE/GOI BIOMASS COAL WORKSHOP PROCEEDINGS, New Delhi, India, November, 1983.

**S. Kumar, "A Woodchip Gasifier for Driving a Small Irrigation Pump/Engine Set," FIRST DOE/GOI BIOMASS COAL WORKSHOP PROCEEDINGS, New Delhi, India, November, 1983.

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and mechanical support, including engineers, scientists and diesel mechanics. Test sites should be close enough so that travel time is reasonable and gas samples can be taken to Manila for testing. After satisfactory field operation has been demonstrated, marketing plans can be prepared, including manpower and operating cost requirements. The procedure for gasifier system development should include:

- a review of previous work;
- preparation of several suggested designs, including GS systems;
- technical review;
- selection of the most promising systems;
- review of the firebox insert concept and construction of a prototype with 50 percent replacement and 50 horsepower (HP);
- extensive laboratory testing, including gas analysis, particulate loading, conversion efficiencies, conversion as a function of moisture content and evaluation of the clean-up system in terms of both cooling and cleaning;
- modification of the gasifier to correct any deficiencies;
- demonstration of adequate operation, including extended periods of running a prototype engine;
- planning and then conducting field demonstrations, including daily performance monitoring and the collection of samples for laboratory analysis;
- evaluation of system performance; and
- preparation of a marketing plan, including adequate maintenance and technical support as well as a reasonable rate of return.

It is not possible to suggest one or two steps that will quickly fix the units now in the field. Rather, a careful process of review, testing and development should be undertaken based on FSDC/GEMCOR's past experience. Only in this way can current technical problems be resolved and a reliable product developed for sale and installation in the field.

Thus far, there have been minimal plantings of woodlots intended to fuel the gasifiers of FSDC irrigation projects. One ISA in Capiz estimated that they have only 20 percent of the required woodlots, and others visited by the ARD team, including those in Pangasinan, have very small woodlots, if any. Backyard and roadside ipil-ipil plantings are not usually undertaken as even this land is used for food crops like bananas, malunggai and fruit trees. Moreover, ipil-ipil plantings in these areas would likely end up being put to household use.

Assuming that the technical and economic problems with the FSDC gasifier program can be overcome, fuelwood support for the project could come from a number of sources:

- individual farmers could grow or procure their own fuelwood, either chips or charcoal;
- ISAs could undertake plantings on available land, such as unpopulated roadsides and canal dikes; and
- potentially, a wood chip market could be developed for ISAs that do not have woodlots.

1. Woodlot Management Capability

FSDC has demonstrated that it can mobilize rural communities to embark on tree planting projects, but to be effective, such a program requires the services of forestry technical personnel at both the central and field offices. To assist in planning, monitoring and evaluating a woodlot program, as well as provide technical assistance to ISAs, the central office needs four forestry specialists:

- a forestry economist/forest development planner,
- a social forestry specialist,
- a fuelwood harvesting/processing specialist, and
- a silviculturist/forest protection specialist.

The area offices should have one forester each, who is skilled in silviculture, social forestry and harvesting/processing. All Tree Project Supervisors (TPSs) should also undergo short training courses in fuelwood plantation management and harvesting as well as charcoal processing. Finally, FSDC should explore the feasibility of working jointly with the Bureau of Forest Development (BFD) in cases where BFD social forestry

projects are situated near existing or planned ISAs and fuelwood production will be a significant component of ISA projects.

2. Fuelwood/Charcoal Supplies

Household needs for fuelwood are still being adequately met throughout the country, and there is even an excess in some areas, such as Regions 2, 8, 9, 10, 11, 12 and some parts of 4. The supply of fuelwood is becoming more limited in Region 1 because of the large fuelwood consumption of the tobacco industry, Region 3 due to a lack of additional fuelwood production areas, and Regions 6 and 7 as a result of the sugar processing mills. Additional fuelwood requirements in these areas, including those of the gasifier program, will have to be satisfied by new sources, either new fuelwood plantations or bringing in wood from areas with an oversupply. In the case of charcoal, Regions 1, 3 and 7 as well as the urban centers are already experiencing shortages. The price of charcoal in these areas is 25 to 100 percent higher than in other parts of the country.

The fuelwood/charcoal requirements of the current gasifier program were originally estimated at a little less than 1,000 hectares (three hectares per gasifier unit) of ipil-ipil plantations. Given the development of plantations on relatively good sites, the original estimate should produce a sufficient supply. Thus, the gasifier program's possible effect on deforestation is not likely to be significant, considering the fact that its fuelwood requirement is only about .05 percent of the annual national fuelwood consumption.

E. Financial and Economic Analyses

Financial Analysis

Up to this point, this discussion has focused primarily on the charcoal-fired, IS 30/60 irrigation gasifier system. In this section, the economics of this system will be considered as well as those of a wood-chip gasifier that is yet to be developed. The costs for the wood-chip system include chipping and drying, although drying will be accomplished by using waste heat from the diesel engine, thus eliminating any additional energy demand.

Total costs for the complete fuel cycle were calculated for both wood chips and charcoal as a function of fuel cost. In all cases, the diesel engine was assumed to be 50 HP with the specific fuel flow suggested in the 1984 FSDC assessment. This fuel flow of 0.26 liters per Bhphr gives an efficiency of 27 percent, which was used throughout this analysis as the figure

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for overall diesel operational efficiency. A table of assumptions, presented in Appendix K, is directly compared with those made in the original project paper. In examining the project paper, it appeared that gasifier efficiency was ignored, thus reducing the wood or charcoal fuel requirements in the economic analysis. Also, the project paper suggested a cost of ₱1.2 per liter for diesel fuel, while the present cost is ₱7.5.

The cost comparison for the IS 30/60 gasifier had to be prepared as a function of charcoal costs, since these vary throughout the country. FSDC's assessment suggested charcoal prices ranging from ₱1.2 per kilogram up to ₱2.7. Thus, the fuel, operating and total costs for driving a 50-HP diesel engine were calculated as a function of charcoal costs varying from ₱1 per kilogram up to ₱4. These costs were then compared to those of an all-diesel operation, the baseline for economic performance.

Decisions relating to fuel substitution were made in several ways. An evaluation of logbook data collected from ISAs showed a constant rate of diesel to charcoal use in every case. Because such a constant ratio is not likely, the assessment team chose to disregard these data. From discussions with GEMCOR personnel, Dr. Cruz and others,* a substitution rate of 50 percent seemed reasonable. Several other important assumptions were made in preparing the cost comparisons. Gasifier efficiency was assumed to be 70 percent, and the efficiency of the diesel engine was reduced by five percent in the dual fuel operation, which is a conservative figure in view of the fact that many investigators* suggest larger reductions. Details of the calculations are included in Appendix L.

Figures V.5, V.6 and V.7 show the fuel, operating and total costs for the IS 30/60 gasifier system for 50 percent diesel fuel substitution. For all three figures, the basic index is an all-diesel operation, and the additional curve relates to fines loss. Charcoal must be prepared by breaking it into small lumps, about the size of two pesos, but this process produces fines which cannot be used in the gasifier. Thus, the curves for charcoal use are for 0 and 20 percent fines loss. The actual system value for fines loss is probably somewhere between these two extremes, depending on the quality of the charcoal.

The curves are disappointing in that they show only limited savings, if any, over the range of charcoal prices suggested by

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*Meeting with GEMCOR engineers, February, 1985. Personal conversation with Dr. Cruz, February, 1985. Stahl, Gunther, "Some Aspects of Producer Gas Operation of International Combustion Engines," PROCEEDINGS BIOMASS GASIFICATION WORKSHOP, Chulalongkorn University, Bangkok, Thailand, June, 1984.

Figure V.5. Fuel Costs for IS 30/60 Gasifier System with 50% Diesel Fuel Substitution

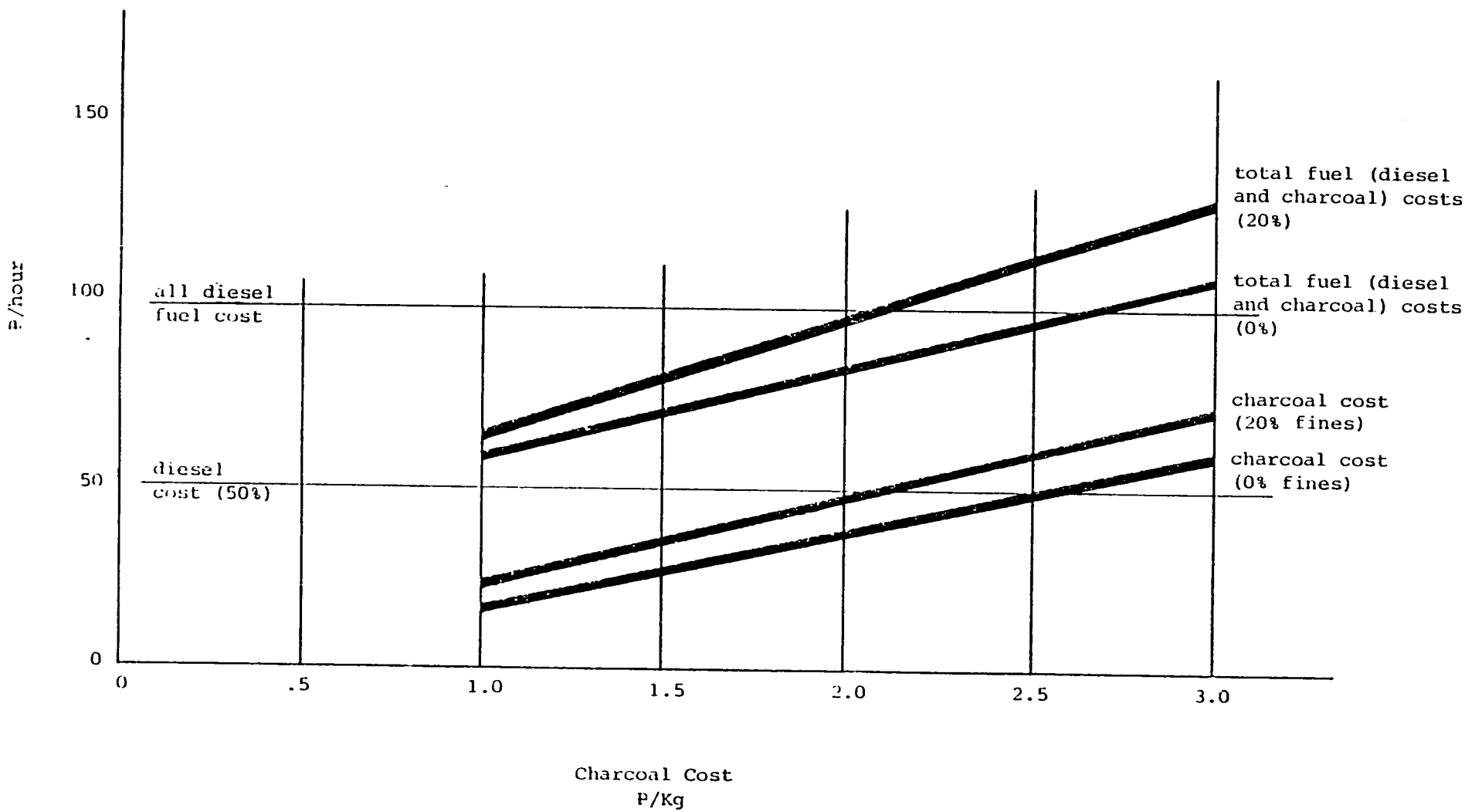


Figure V.6. Operating Costs for IS 30/60 Gasifier

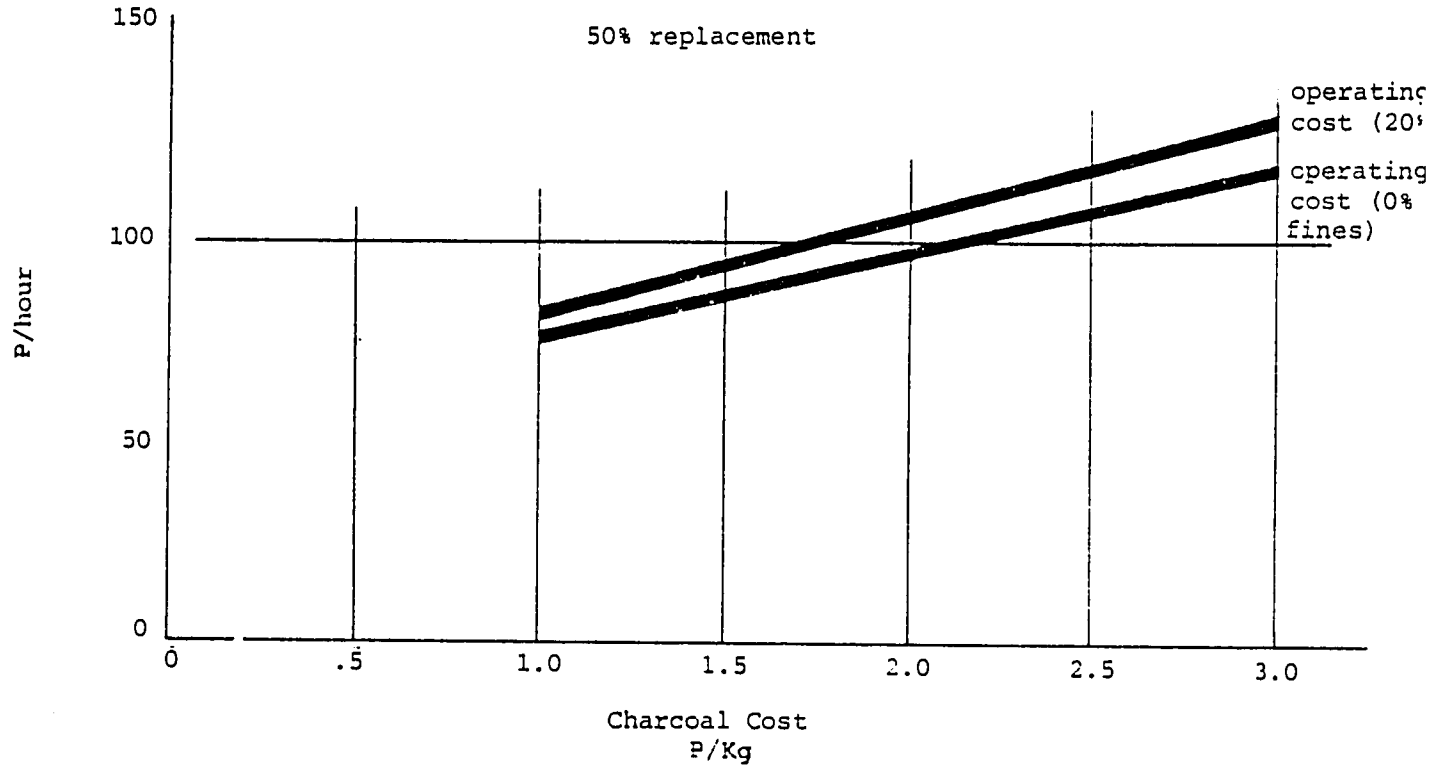
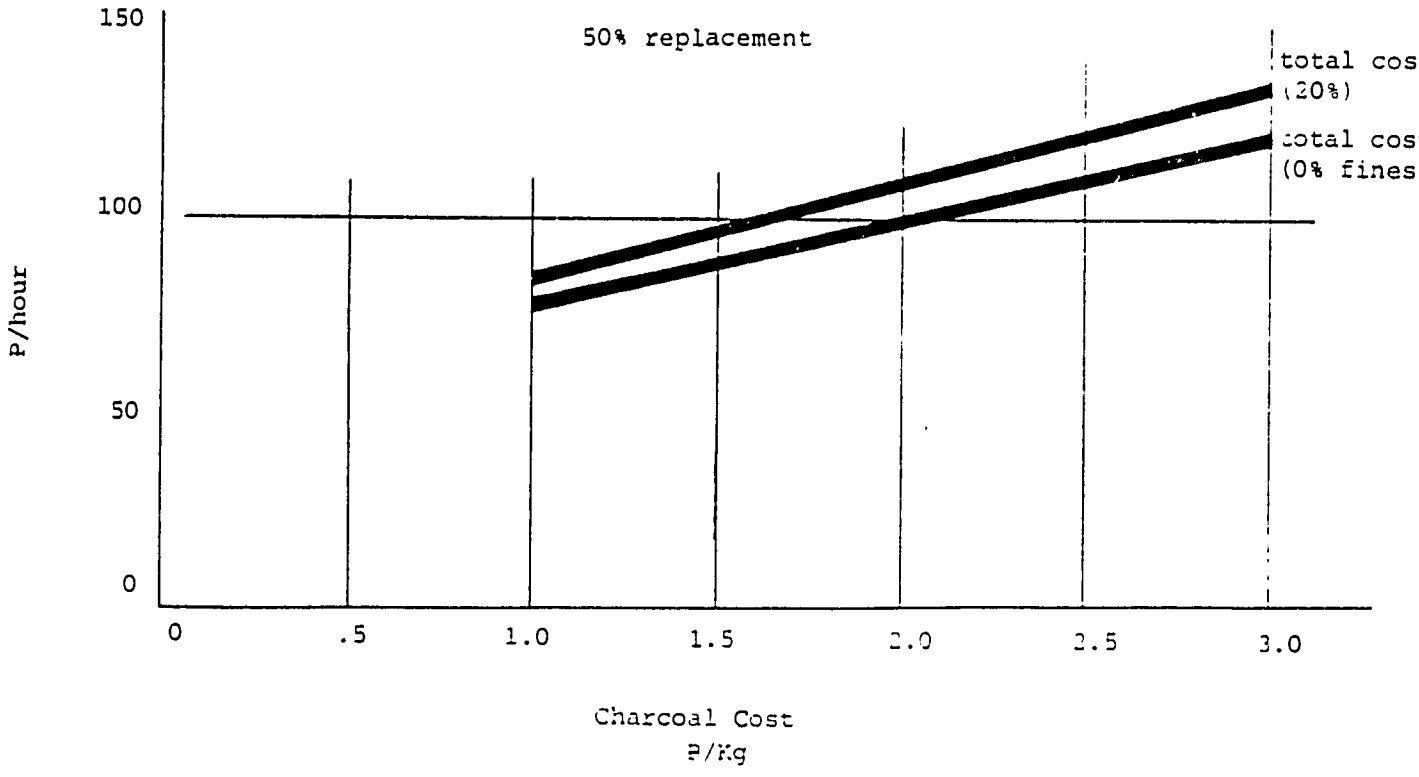


Figure V.7. Total Costs for IS 30/60 Gasifier



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FSDC. The point at which total costs are equal for 50 percent diesel fuel substitution is ₱2.05 per kilogram for 0 percent fines and ₱1.68 for 20 percent fines loss. The savings at ₱1.2 per kilogram is only 15 percent for 0 percent fines loss.

Given this disappointing economic performance, another set of curves was produced for 70 percent replacement of diesel fuel. In this case, engine efficiency was reduced by seven percent from the 27 percent suggested by FSDC. However, economic performance is only slightly improved. The break-even point is ₱2.19 for 0 percent fines and ₱1.73 for 20 percent fines loss. Even at a price of ₱1.2 per kilogram for charcoal, the percentage profit is low.

The other alternative was to examine a wood chip operation. The IS 30/60 has not been used comercially with wood chips and the gas clean-up system appears inadequate. It is assumed that a new gasifier system would have to be developed for this application. It would seem that the GS model could be used with wood chips, although a new clean-up system would have to be designed. Curves for the wood-chip system were produced assuming a cost of ₱120 per MT for green wood, which is chipped by hand at a cost of ₱.25 per kilogram and then placed in a dryer driven by engine exhaust. (A 12-HP, I.C. engine-powered wood chipper is available from Matools, Inc. in Manila for approximatley ₱7,000 and could be used if hand chippping proves unreliable.) Moisture content of the dried chips was assumed to be seven percent. The use of oven-dried wood chips greatly reduces problems with wood gasification, and although the wood-chip dryer has to be developed, the concept is simple and the complexity of fabricating the device minor. The GROW facility at the University of Missouri-Rolla is currently testing such a device, and the results will be available in the near future.

As in the previous analyses, the substitution level chosen was 50 percent. The curves prepared for a range of ₱.2 to ₱.9 per kilogram are shown in Figures V.8 and V.9. The flatness of the curves is important as it shows a reduced sensitivity to changes in fuel prices. Although the cost of the IS 30/60 with a secondary filter was used, equipment costs might be higher, depending upon whether the supplier was GEMCOR or the private sector. The clean-up equipment needs to include a hot filter or cyclone, wet scrubber and demister. The dryer will basically be a box with trays, designed to permit engine exhaust, mixed with air for temperature control, to pass throughout the unit. The design of the GS model appears to be moving in the direction of a wood-chip gasifier, but it is essential that dry chips be used, not just air-dried material. The proposed gasifier/clean-up system seems to represent a reduction in actual pieces of equipment over the IS 30/60, thus resulting in a conservative fixed cost.

Figure V.8. Fuel Costs for Wood-Chip Gasifier

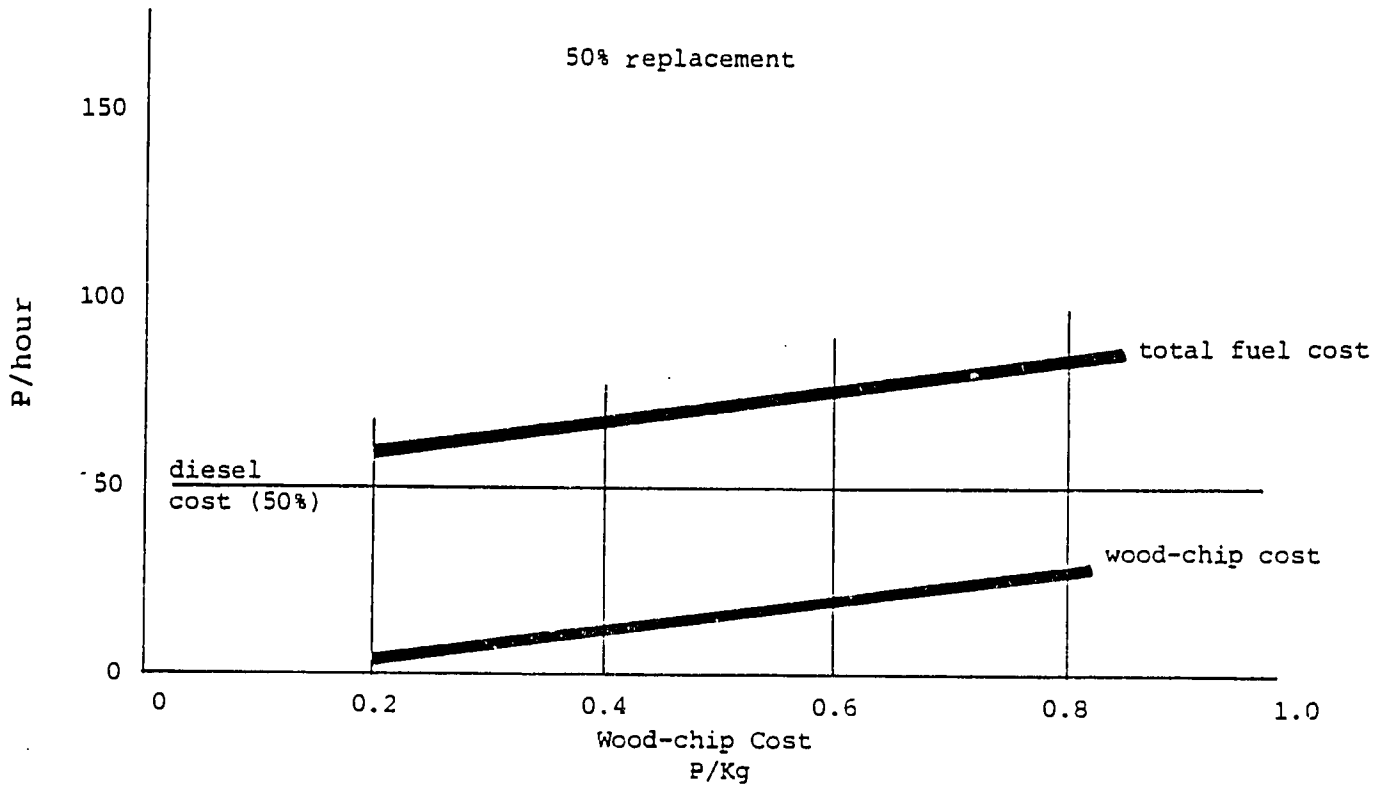
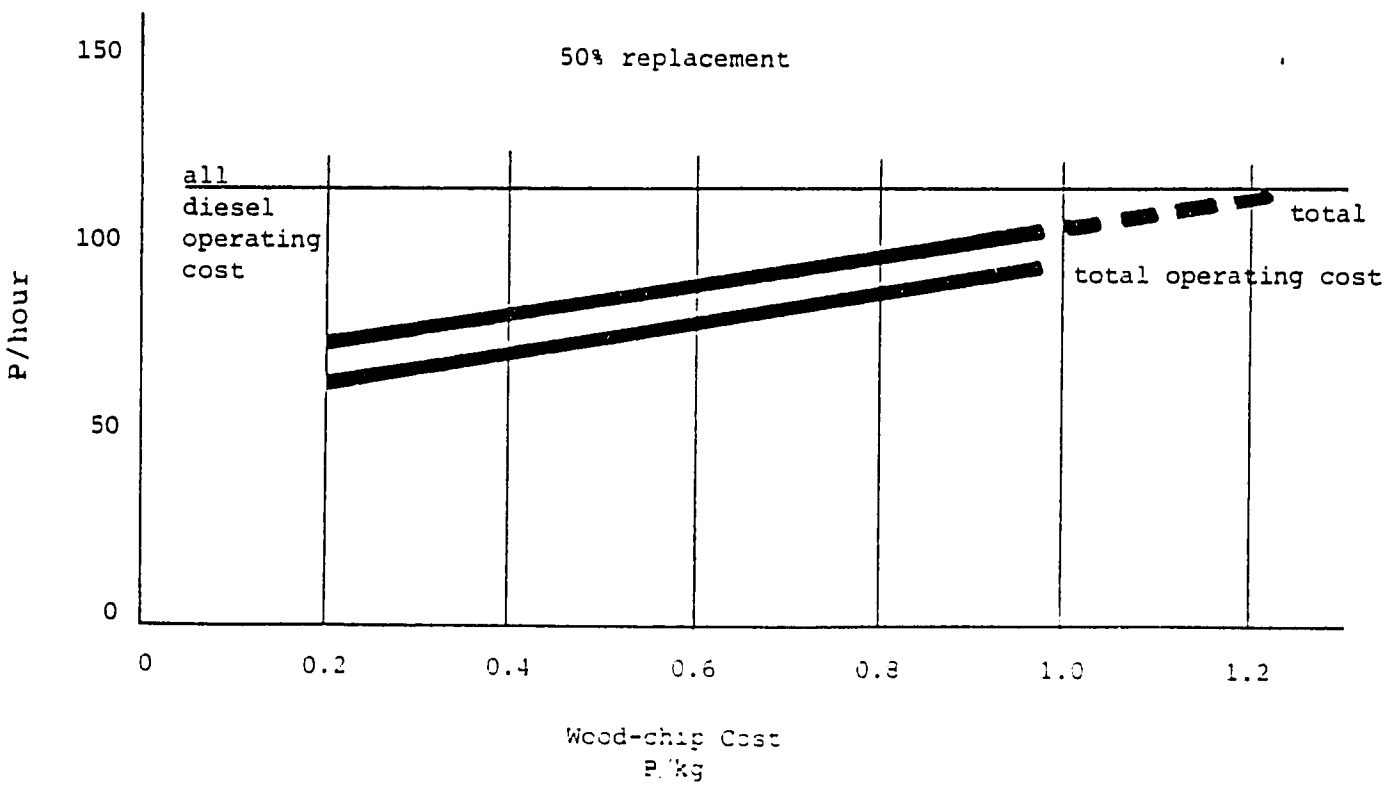


Figure V.9. Operating and Total Costs for Wood-Chip Gasifier



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Following a review of the assessment team's financial analysis of the IS 30/60 unit, FSDC performed its own analysis, using a similar method and presentation of the data. The team reviewed FSDC's analysis and found it was not entirely accurate because:

- no change in engine efficiency as a function of fuel replacement was taken into account; and
- no increased maintenance costs were included to cover gas clean-up and the high maintenance requirements of the diesel engine.

Economic Analysis

As envisioned in the project paper, the gasifier subproject was to have two components--woodlots and gasifiers, with the former providing the wood to fuel the gasifiers. Unfortunately, most of the gasifiers in operation use charcoal, bought on the open market, as a feedstock. The assessment team's analysis shows that the operation of gasifiers using wood chips from local plantations is economically and financially viable, while using charcoal, purchased on the open market as a substitute for wood, is not. The price of charcoal is sufficiently higher than that of wood so as to make the use of charcoal in gasifiers uneconomical.

The economic analysis indicates that charcoal-burning gasifiers have a negative cash flow for the life of the gasifier, given a charcoal price of two pesos per kwh. If the price of charcoal relative to diesel fuel were to decline, charcoal gasifiers might become economically attractive. However, the price of charcoal is tied to that of diesel fuel. An increase in the price of oil will lead to increases in the prices of all oil products, including diesel fuel, LPG and electricity generated from oil. Charcoal is a substitute for LPG in cooking and electricity in ironing. Thus, because the demand for LPG and electricity will decline as their prices rise, the demand for charcoal will increase, forcing an increase in its price as well.

It was assumed that a three-hectare woodlot could provide all the wood chips needed to fuel a gasifier, and the cost per hectare of growing the wood was assumed to be identical to that for charcoal fuelwood plantations. This is a conservative assumption since yields from small neighborhood plantations located next to agricultural land could be as much as twice as high as those for charcoal fuelwood plantations. Table V.5 shows all of the capital investment costs for a wood-chip gasifier and assumes no matching counterpart funds.

Table V.5. Capital Investment Costs for Wood-Chip Gasifier

	Pesos	Dollars*
Plantation	2,400	133
Gasifier	30,000	1,667
Total	32,400	1,800

*Pesos converted to dollars at the rate of 18 pesos per dollar.

The wood-chip gasifier is expected to cost ₱30,000 with annual operating and maintenance costs of ₱14,040 (see Figure V.10). Fuelwood costs would be ₱16,180 per year, compared to diesel costs of ₱58,500. The financial internal rate of return thus translates to 87 percent. The economic internal rate of return using a shadow price of +20 percent for foreign exchange amounts to roughly 72 percent. If the cost of charcoal is assumed to be ₱2 per kwh, the net benefit is negative since cash flow would be negative throughout the life of the gasifier subproject. Hence, gasifiers which burn wood chips are a viable alternative to those fueled by charcoal.

F. Options

Given the economics of the current charcoal-burning gasifier system and likely trends in the charcoal, wood and diesel fuel markets, the development of a wood chip-burning gasifier is the only viable economic strategy. As already noted, farmers face increasingly higher energy costs over the long term, and the project's original objectives remain valid. The main option, then, is to undertake a development program for a wood-chip gasifier and at the same time, address institutional issues at FSDC.

The only other real option is to stop the gasifier program now, more because institutional and funding issues cannot be resolved, rather than an inability to deal with technical problems. (Background information on these institutional and funding issues has already been presented in this section.) Should this option be chosen, a plan must be developed to address the issue of gasifiers currently in place at ISAs, as neither FSDC nor AID can simply forgive the outstanding loans. Farmers have been provided with a technology that can work, but was perhaps put in the field too quickly in this case. ISAs with charcoal-burning gasifiers should be provided with free

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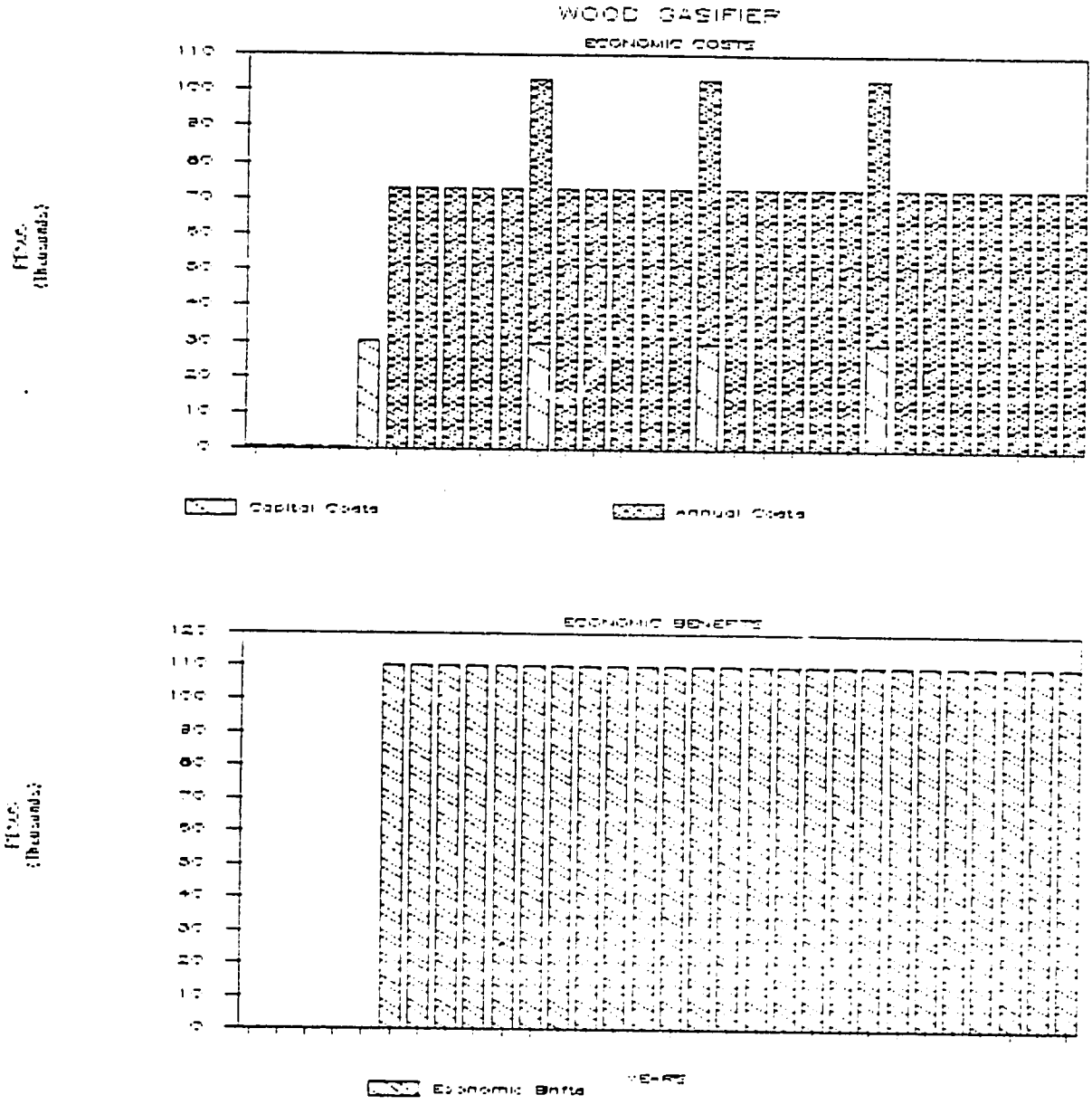
Figure V.10. Economic Costs and Benefits of Wood-Chip Gasifiers



	Rate of Return
Without Shadow Pricing	87%
With Shadow Pricing	75%

Notes: Costs include investment costs of ₱30,000 per gasifier as well as operation and maintenance costs of ₱14,000 and diesel fuel costs of ₱58,500.

Benefits include diesel fuel savings and sales of excess wood at ₱120 per ton.

Gasifiers are replaced every six years.

installation of the new system once it is developed or have the current system removed. If the loan is forgiven and the present system simply left there, FSDC must determine what help will be given to the farmers involved. Thus, this plan has to address alternatives that will help alleviate the problems farmers have with an energy supply for their irrigation operations. Participating farmers need to have the situation clearly explained to them as well as the approach that FSDC will take. Stopping the program without a follow-up plan would have very negative effects.

If the main option of developing a wood-burning gasifier is pursued, a number of subsidiary issues will have to be addressed, and plans developed by FSDC and AID before proceeding.

First, the institutional issues summarized in the preceding subsection B.5. must be resolved, particularly the solicitation of other gasifier suppliers through a bidding process. This seemed to be a possibility to the ARD team, as other companies have apparently expressed interest in developing a wood-chip gasifier for the project.

Second, whoever develops the wood-chip gasifier must implement a development process similar to the one discussed in subsection C.3. above. The overall goal of this process would be to produce a wood-chip gasifier that burns dried wood chips or pucks. Specifically, the gasifier must be designed to produce low-tar gas from dry wood, the clean-up system to cool and clean the gas, and a wood-chip dryer to use engine exhaust as its heat source. The development process for the wood-chip gasifier must be technically supported with equipment and manpower. Based on the above, possible modifications of the IS 30/60 should be examined in terms of both cost and compatibility, as well as possible changes in the current clean-up unit. A training program for both the IS 30/60 and new wood-chip unit must be provided.

Third, both the gasifier supplier and FSDC must augment their technical capability. This will require outside technical assistance and project funding. Such a technical assistance package would help design and backstop the gasifier development process on a month-to-month basis, and would also help in the design and implementation of an extensive training program for FSDC personnel, who would eventually be charged with the improved IEM program. The extent to which the private sector in the Philippines can be brought into training aimed at fieldwork could be determined during the first stage of a technical assistance contract.

If this option is chosen, it will require time to change the focus of project activity and engage the required technical assistance from both outside and inside the Philippines. It will

also demand redirection of budgetary expenditures within the subproject. This means that FSDC will have to agree fully to pursue the modified gasifier design and required programmatic changes, and an AID-financed technical assistance team will have to work with FSDC to design and organize the subproject's new thrust.

VI. CHARCOAL PRODUCTION

Since the project paper was prepared, the demand for charcoal in the Philippines has increased. Conversion devices have been performing well, but insititutional and management problems as well as low yields from woodlots have all hampered the success and progress of this subproject. Again, the assessment team found that the program's objectives are still valid and the need to address the charcoal problem even more urgent than it was several years ago. This section focuses on management problems encountered by the project as well as technical problems with the woodlot plantations. Corrective measures to improve production are discussed, and a complete economic analysis is also presented.

A. Project Status

Since their inception in 1981, FSDC charcoal production projects have not met their yearly accomplishment targets. Of the 40 projects identified, only 29 were implemented with the remaining 11 being deferred primarily due to "peace-and-order" problems. The 29 projects were started before securing RED project approval in 1982 and hence, were initially supported by FSDC internal funds. The understanding with the ESF secretariat was that retroactive financing would become available after approval of the RED project by AID. In response to the subsequent request for retroactive financing, an assessment of the 29 projects was conducted in 1984. The results were that:

- 12 projects were approved for retroactive financing;
- one that was initially approved was later recommended for cancellation following repeated fires at the site;
- 10 were recommended for deferment/cancellation because of unsatisfactory tree growth; and
- six are still under review.

FSDC has attributed the charcoal production projects' disappointing accomplishment records to the poor quality of the sites provided by BFD, unavailability of water and insufficient rainfall, lack of technical expertise among project personnel, unstable peace and order conditions at several sites and financial constraints recently experienced by FSDC. These factors were identified by FSDC in their assessment conducted during the last quarter of 1984. Appendix M contains the assessment report's important conclusions, a general description

of the program's status and maps showing the location of the most extensively developed plantation sites.

B. Program Management

Charcoal production projects are implemented by FSDC's KAISAs, and each KAISA is given a program management loan to cover the salary of a TPS. One TPS is assigned to every project site and is responsible for the institutional development of CPAs, which are composed of 10 to 15 farm families each. The TPS also supervises tree-farming activities and provides technical assistance to CPAs on the tree-farming and charcoal production aspects of the project. Both central and area office personnel are supposed to provide administrative support in the form of training programs for TPSs and CPA members, technical manuals on project implementation, and loans for the development of tree plantations and charcoal production facilities.

1. Technical Management

From the start, FSDC was ill-equipped to undertake the charcoal production project. They lacked the personnel needed to evaluate the technical suitability of the sites assigned to them by BFD as well as staff members with prior experience in managing such projects. They were unable to hire TPSs with appropriate forestry backgrounds, and then, TPS training was conducted in-house, thus failing to tap the expertise available at BFD or the universities.

Although a project implementation manual was finally prepared in 1983 and a project feasibility evaluation guide was written by AID/ESF staff in 1984, neither FSDC area offices nor KAISAs had staff members with the training and experience needed to make effective use of these materials. The lack of adequate technical expertise at all levels of the organization prevented any meaningful analysis of, and response to, field data. Technical data were submitted by field units to the area and central offices, but there did not appear to be any regular processing of the information for use in decision-making by higher management. Even when the appropriate decision-makers recognized the existence of technical problems, they did not have the skills or experience to handle situations that did not conform to the model described in the manuals. Another problem was the inadequacy of travel budgets at all levels, particularly for visits to project sites, most of which are in relatively inaccessible locations.

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2. Institutional Issues

Similarly, FSDC lacks the institutional development expertise needed to implement the charcoal production projects. Although it has substantial experience in lowland, irrigated communities, conditions in the uplands are so diverse and complex that the methods used in irrigated areas cannot be directly transferred to the uplands. Farmers in lowland areas have a common need for irrigation water, which provides a basis for organization, but a shared need or focal point for organizing in the upland areas is less clear.

When FSDC began implementing the charcoal projects, there were no clear guidelines on handling institutional issues, which included:

- the process used to organize potential association members;
- procedure for selecting members;
- types of skills needed by association members and ways of developing necessary skills; and
- how a TPS could ensure that association members would be able to assume responsibility for the management operation of the charcoal production modules.

As the projects were implemented, technical problems were always of the highest concern, leaving little time to address these and other institutional issues. An example is the "Feasibility Study Preparation Guide," which completely neglects institutional factors in its site feasibility analysis. Again, FSDC implicitly assumed that KAISAs would have the necessary institutional expertise, given their history of establishing irrigators' associations.

As a result, existing monitoring and information systems do not include indicators of institutional development, and both project and TPS performance have been evaluated solely on the basis of technical and financial information. Likewise, targets, plans and activity schedules focus on various aspects of tree cultivation, neglecting institutional factors that are not so easily measured.

Thus, the process of learning to deal with the project's institutional dimension has not been well coordinated. Although the initial project sites could have afforded a chance to generate and share lessons and experiences, there was little information exchanged or interaction between the TPSs or project

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managers. Such interaction would have provided an opportunity for reflection and refinement of the project model.

Finally, at the projects visited by the ARD team, it appeared that benficiaries were only minimally involved in the decision-making with many of the key policy decisions being made by the TPS. At one site, farmers had warned the TPS that in their experience, ipil-ipil did not grow well in a particular area. Despite their apprehension, the TPS insisted that they continue to plant ipil-ipil, even after its initial growth was unsatisfactory. It was apparent from the site visits that the farmers had little understanding of the project's financial aspects apart from the knowledge that they were incurring loan obligations for all the tree farm's expenses and they would have to pay back those loans when charcoal began to be produced. In other words, CPA members viewed themselves more as laborers on a tree farm, being paid on the basis of their physical accomplishments, rather than as owners of a small enterprise that they would need to manage and operate effectively. As a result, the members were still far from having a sense of project ownership.

3. Viability of the CPA Organizational Model

Participant Selection

The project paper intended that CPAs would be composed of landless, un- or under-employed people who would be willing to work on a full-time basis to develop and operate the 100-hectare charcoal production modules. In practice, TPSs have had difficulty finding individuals who meet these critiera. Thus, many CPAs are comprised of lowland farmers and landless agricultural laborers who are willing to work on the tree farms only when they are not needed on lowland farms. Moreover, the periods when workers are most needed for tree-farming activities coincide with peak labor demands on the lowland farms.

In other instances, landless persons have joined CPAs, but have not remained for long. One reason is that there are periods of the year when work on the tree farms must be suspended because of inclement weather, inaccessibility of the work site or delays in the release of funds. Landless workers who are dependent on daily wages from the tree farm for their subsistence cannot afford to remain at the site without being paid.

Membership Restrictions

The immediate incentive for CPA membership is the regular salary paid for work on the tree farm. Thus, there are cases

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where members think that more participants in the association would reduce their opportunities to work and their salaries would have to be cut to accommodate the additional members. They may also feel that if there are more CPA members, they will receive a smaller share of the enterprise's potential profits. As a result, some associations have limited the size of their membership to under 15 or have volunteered to manage a module larger than 100 hectares. Such membership restrictions may reduce the attainment of equity objectives by limiting the number of individuals that can benefit from the project.

A similar issue is the practice of some associations to hire nonmembers to work on a daily basis when members are unavailable. At one tree farm, the CPA was using as much as 80 percent of its budget for member salaries to hire nonmembers to do the work. These cases raise questions about the fairness and/or desirability of having nonmembers, who do not share in the profits from tree farm operations, doing the work. It may or may not be appropriate depending upon the regulations under which the scheme operates.

Role of the TPS

The TPS is supposed to play a major role in developing the CPA's capability to manage its own affairs. When project implementation begins, the TPS usually serves as the manager of the enterprise, making all the major decisions and paying association members a daily wage. Hence, one major task of the TPS should be to manage the transition from members viewing themselves as employees receiving instructions to owners of the enterprise with decision-making responsibilities.

Currently, a TPS has little incentive to ensure that the CPA makes this transition. First, the TPS is a KAISA employee whose salary is drawn from the project mangement loan, which is a KAISA obligation. If the CPA becomes entirely independent and self-reliant, it would not need the TPS's services and it would not make sense for KAISA to keep paying the TPS's salary out of the project management loan. If the KAISA could not pay the salary from its own resources, continued employment of the TPS would be unlikely. Thus, as long as the TPS remains indispensable to the CPA, his employment is relatively secure.

A second related issue is the incentive for KAISAs to foster self-reliant CPAs. All of the KAISAs are currently seeking sources of income and charcoal production is a potential source of revenue, if it is economically viable. A KAISA can justify a share in the profits from this enterprise only if it continues to provide a service to the CPA, such as the supervisory function of the TPS or marketing of the charcoal. Therefore, the KAISA itself may have interests that are inconsistent with the

objective of building local capacities for self-management of income-generating enterprises.

4. Land Tenure

At nearly all the charcoal production sites, FSDC has been unable to secure Industrial Tree Plantation (ITP) leases from BFD. Research conducted by the Institute of Philippine Culture on social forestry projects found that land tenure security is a major factor in motivating farmers to adopt effective conservation and forest rehabilitation practices. Unless tenure security is guaranteed to the CPAs, members will not be fully committed to developing the land.

There appears to be a lack of BFD support in several areas:

- site selection,
- getting the permit needed to enter an area, and
- securing ITP leases.

One possible explanation for this is that BFD is reserving the best, most productive sites for its own social forestry projects. Another is that BFD may feel that projects using foreign funds should properly be within their domain. Although follow-ups have been made by FSDC personnel at both the central and regional offices of BFD, a positive response has not been forthcoming.

C. Kiln Performance

The assessment team visited FSDC kiln sites in Antique and at Pampanga Agricultural College--a blueprint of the kiln design is presented in Appendix N. A technical review of the kilns' construction and operation found that they are a good design, well-constructed and operated in a thorough manner. Yields from the kilns appear to indicate an efficiency of 17 to 20 percent, e.g., 8.9 to 10.6 cubic meters (4.9 to 5.8 metric tons) of ipil-ipil wood to one metric ton of charcoal. This conversion efficiency is about what should be expected from a Brazilian beehive kiln or similar design. The ARD team believes this is an appropriate kiln, and would not suggest any changes in either its design or operation. A portable kiln design might be of interest for several locations and could be considered as a development project.

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D. Technical Assessment of Woodlot Production

Since 1981, 7,712 hectares at 40 projects have been planted in giant ipil-ipil, but only 15.1 percent or 1,168 hectares have been established, according to a 1984 FSDC report. A 1984 AID assessment of 13 projects found a very low growth performance for the established plantations--0.08 to 2.25 cubic meters per hectare per year. These low growth figures are primarily due to soil acidity, the droughts of 1982 and 1983, and very high planting densities. A field visit by the ARD team to two sites (Antique and Ilocos Norte) confirmed the low growth rates--at best, 13 and eight cubic meters per hectare at three years of age for the two sites, respectively.

As far as existing projects are concerned, growth on the plantations can be significantly improved in two ways:

- thinning to an effective spacing of one by two meters or 5,000 stems per hectare; and
- replanting portions where ipil-ipil does not grow with *Acacia auriculiformis* at a spacing of two by two meters.

Thinning should increase the volume yield by four or five times, and *Acacia auriculiformis* is expected to yield 10 or more cubic meters per hectare annually at the better sites, even if the soil is acidic.

With respect to planned charcoal projects, the best strategy for ensuring good growth, which is critical for a viable project, is to negotiate for better sites, regardless of whether they are on forest, A and D or private land, although the latter two usually afford better sites. Agroforestry cropping systems on both A and D and idle private land can be the best land use in some areas. In the case of private land, FSDC may lease from or enter into joint ventures with the owner. This approach should first be demonstrated by FSDC in strategic areas, such as Regions 1, 3, 6 and 7.

1. General Guide for Species Selection

Table VI.1 provides a simple guide for selecting fuelwood species for a given site, given soil pH and elevation. The table is restricted to *Leucaena leucocephala* (L) and *Acacia auriculiformis* (A), two fast-growing tree species with good fuelwood properties that complement each other on a wide range of soils. As the table shows, in the pH range of 5.6 to 7.5, *Leucaena* grows faster than *Acacia*, although the latter would also grow well. Both species are expected to grow at comparable rates

on soils with a pH of 5.1 to 5.5, but outside of these ranges, Acacia will outgrow Leucaena.

Table VI.1. Two-Way Fuelwood Species Selection Guide

elevation in meters	soil pH 5	5.1-5.5	5.6-6.5	6.6-7.5	8.0-9.0
400	A	A;L	L[2];A	L[1];A	A
450-550	A	A;L	L[3];A	L2;A	A
600-700	A	A;L	L[3];A	L[3];A	A

[1]These are good sites for ipil-ipil, yielding at least 120 cubic meters per hectare in four years.

[2]Ipil-ipil on these sites will produce at least 100 cubic meters per hectare in five years.

[3]At these sites, ipil-ipil will yield 75 cubic meters per hectare in five years.

Some additional notes on the information in the above table are as follows:

- 20 to 40 grams of phosphate fertilizer should be added per hill at the first weeding, if the phosphorous content of the soil is less than 40 parts per million;
- inoculated giant ipil-ipil seeds should be used;
- Acacia is a better crop than Leucaena in areas prone to erosion;
- Acacia is expected to grow well (at least 10 cubic meters per hectare annually) even on very acidic or basic soils, provided that soil nutrients are adequate; and
- other promising fuelwood species that can provide better watershed cover than Leucaena and give good yields over a wider range of soil conditions include Eucalyptus camaldulensis, Cassia spectabilis, Calliandra calothyrsus and Casuarina equisetifolia--these species should be tried before introducing

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them on a large scale, as Casuarina, for example, has been observed to be susceptible to insect attack in various parts of the country.

An appropriate professional forester should be consulted for other technical details on fuelwood plantation management.

2. Expected Fuelwood Yields

Plantation yields will depend on the site's quality, species and, to some extent, the spacing or stand density. Available site quality data from 12 FSDC charcoal projects provide only an indication of soil pH. Because more soil samples need to be gathered and figures on nutrient contents were unavailable, only rough yield estimates can be made.

The soil pH data does indicate that ipil-ipil would not grow well in some areas of the Ilocos Norte, Capiz, Antique I, Surigao del Norte, Lanao del Norte (I and II) and Misamis Oriental projects. In the parts of these projects where ipil-ipil can develop and grow, a yield of 10 cubic meters per hectare per year is attainable under adequate nutrient and good spacing conditions. At other projects, such as those in Cagayan, Iloilo, Davao del Sur, Agusandel Sur and Maguindanao, better yields of 15 to 10 cubic meters per hectare annually can be realized, given adequate nutrients and better spacing. With the present spacing of one by one meter on FSDC fuelwood plantations, only 25 percent of the potential wood yield from the various sites can be achieved.

3. Optimal Spacing/Density and Some Cropping Regimes

Spacing varies with the species and planting/plantation. In single- or double-row plantings, Leucaena is best spaced at one meter, while for Acacia, the spacing should be increased to 1.5 meters or two by 1.5 meters. In plantations, Leucaena may be planted using a one by two meter spacing or at a rate of 5,000 stems per hectare, but Acacia should be spaced at two by two meters or 2,500 stems per hectare. These species may also be planted using irregular spacing regimes to simulate roadside conditions throughout a plantation. Roadside trees have been observed to grow twice as large as "inside" trees within forest plantations. The general guideline in designing spacing regimes is to maintain an optimal initial plantation density--4,000 to 5,000 and 2,500 to 3,000 trees per hectare for Leucaena and Acacia, respectively.

In forest plantation projects, it is often desirable to intercrop the long-term tree crops with annual or seasonal crops. In fuelwood plantations, the intercrop could be ipil-ipil for

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leaf-meal, peanuts, corn, cassava, ginger or other crops. Naturally, intercropping should only be attempted on sites that are better than average in terms of nutrients, accessibility and terrain. Figure VI.1 illustrates one possible variation for an ipil-ipil fuelwood cropping system. In the figure, other crops such as peanuts, corn or cassava could take the place of the "leaf-meal" rows. For the cropping system illustrated, 70 percent of the potential fuelwood and 30 percent of the annual leaf-meal yield per hectare should be realized.

Figure VI.1. An Ipil-Ipil Fuelwood Intercropping System

one meter	two rows of fuelwood trees spaced one by one meter
four meters	
one meter	two rows of leaf-meal trees spaced one by .4 meters
four meters	
one meter	two rows of fuelwood trees spaced one by one meter
four meters	
one meter	two rows of leaf-meal trees spaced one by .4 meters

4. Kiln Planning

In the case of existing projects, the number and size of charcoal kilns to be constructed must correspond to sustainable plantation yields, but this figure will not necessarily be the same as the number of kilns originally planned. Kilns may be either fixed on site or portable, depending on the source and supply of fuelwood. For future projects or the expansion of current ones, plantation areas for charcoal production need not be contiguous, but should be within an "economic charcoal production zone." This zone will depend on the cost of transporting fuelwood to fixed kilns or moving portable kilns to the fuelwood source. The maximum distance that still permits the profitable operation of a kiln is affected by the cost of transporting either the fuelwood or kiln and defines the "economic zone" of charcoal production. This zone must be determined for each individual charcoal operation.

To improve the efficiency of TPSs and kiln operators, a manpower training workshop/course is proposed. A fuelwood harvesting and charcoal training course should be held at Pampanga Agricultural College for TPSs and ISA charcoal kiln

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operators with field tests at the trainees' own sites, and a short training session in fuelwood plantation establishment and management should be arranged with the University of the Philippines at Los Banos (UPLB). The training should include a field trip to the NIA Pantabangan Watershed fuelwood plantation and charcoal operation.

5. Site Selection

Many implementing agencies, such as the FSDC, BFD, Natural Resources Development Corporation (NRDC), MHS and National Dendro Development Corporation/National Electrification Administration, do not realize that many of their upland projects, which are intended to improve the standard of living for participants, can in fact, aggravate the situation in these areas if the programs are not properly executed. One example is forest plantation projects that are not viable. In such cases, farmers/ associations are given loans based on their accomplishments in terms of plantation development and are required to repay the loans at minimal interest rates within a specified time frame. This has the effect of unfairly passing on the burden of rehabilitating degraded forest lands to the poorest members of society.

While the rehabilitation of degraded land does provide such benefits as erosion control, soil/water conservation, restoring unproductive land to productivity and the amelioration of adverse environmental conditions, the cost of such rehabilitation should be the responsibility of a larger segment of the population than just poor people, since benefits are usually not confined to program participants. In fact, on poorer land, greater benefits may actually be enjoyed by nonparticipants who live further down the watershed.

These observations indicate a need to distinguish between land rehabilitation projects that are people-oriented versus those that focus on production/utilization. The costs of people-oriented projects must be borne by the government or grants/trust funds established for such purposes, while the latter type of programs may legitimately be financed by low-interest loans, such as those offered by FSDC, NRDC, MHA and other institutions.

More specifically, the FSDC's ITP charcoal projects, such as those in Barbasa, Antique, Piddig and Ilocos Norte which yield much less than 15 cubic meters per hectare per year (the estimated yield at Barbasa is 13 cubic meters per hectare at best, while the Piddig project may not even produce eight cubic meters per hectare at three years old), are clearly land rehabilitation projects, not financially viable "production" projects. As such, if FSDC insists on the repayment of its plantation development loans, then poor ISA members are

shouldering the cost of forest land rehabilitation, which is inconsistent with one of the basic objectives of these projects. Either these projects must not be implemented on poor sites or the loan and financing policies must be changed.

Of course, fuelwood production on good sites and the accompanying charcoal processing are utilization activities and should be treated as economic ventures. Even in the case of land rehabilitation projects, once the plantations are developed and harvestable fuelwood is adequate to support a viable charcoal operation, charocal production project loans as they are currently offered should be made available to ISAs. The economic analysis which follows indicates the viability of such operations.

Certain recommendations and options for consideration are implied by the preceding discussion. First, the selection of sites for future plantations should take into account site quality, accessiblity and topography. FSDC should work with communities on A and D lands as these sites are usually better and more accessible. Negotiations should be conducted with BFD for better site sizes, and FSDC should consider making the BFD Director or MNR minister a member of its Board. It should also consider working with BFD on its Integrated Social Forestry projects, where FSDC could finance plantation development and charcoal processing. FSDC should enter into leases or joint ventures with private landowners and/or claimants of A and D lands, and then provide incentives to project workers in the form of revenue sharing and local communities in terms of social services to foster effective plantation development and protection. FSDC can facilitate ITP applications in the BFD's autonomous areas (Regions 2 and 6), if the area applied for is less than 100 hectares, while bigger areas can be divided into phases to encourage the regional authority to process ITP lease agreements.

Second, FSDC should devote as much attention to the project's institutional aspects as technical ones. It should not rely entirely on its experience with lowland irrigators' associations because the situation in the uplands and forest areas is more diverse and complex. FSDC needs to develop a process for testing new institutional approaches in the uplands and learning how to handle the various issues encountered in the field. There are no proven development approaches for the uplands that can be applied in all situations. FSDC will have to learn from its experiences and share its knowledge with other agencies attempting to implement similar projects.

Third, FSDC should clarify the role of the TPSs, including their technical and institutional targets. A TPS's performance should not be evaluated in purely technical terms. Fourth, FSDC should encourage both field officers and TPSs to be more

responsive to local needs and requirements. The project paper should not be adhered to indiscriminately--rather, it should be considered an indicative model than can be altered to suit local conditions.

Fifth, farmers should not be made to pay off bank loans for sites that are not economically viable. Current project sites should be studied in detail in terms of their technical, institutional and financial feasibility, and alternative uses of the land also considered. For example, at certain sites, fruit trees, rather than fuelwood species, may provide higher incomes for the farmers. In the case of existing plantations, FSDC should write off plantation development loans of ITP projects that are not viable, i.e., those yielding less than 15 cubic meters per hectare per year. At both existing and planned plantations, access roads must be provided as part of project development and the costs incurred charged to community development, not the ISA.

Finally, to improve the planning and scheduling of projects and activities, FSDC should give a higher priority to projects in areas with deficient supplies of charcoal and fuelwood, such as Regions 1, 3, 4, 6 and 7. FSDC should also develop comprehensive fuelwood/charcoal programs based on logical area units, such as island provinces, major river basins or areas with a fuelwood-based industry (for example, the Ilocos provinces have a fuelwood-based tobacco industry), in order to respond to local needs as well as develop a national program that can supply both local and foreign markets. Sectoral tradeoffs and environmental effects must be seriously considered in these planning efforts.

A subsequent section that presents available options for the charcoal production subproject is partially based on the considerations discussed here.

E. Economic and Financial Analysis

The charcoal subproject has two major components--the production of fuelwood and its conversion to charcoal. The financial and economic viability of these components were evaluated separately, since it is possible to grow wood and then sell it as either fuelwood or lumber, if it is of high quality. Furthermore, the financial and economic viability of the wood production component improves substantially if part of the wood can be sold as lumber. Export-quality lumber fetches up to 10 times the price of fuelwood, so even if only a small fraction of the wood can be grown to lumber quality and exported, it will provide large returns for the TFA and its members. All of the capital investment costs for a 100-hectare module charcoal production project, assuming no matching counterpart funds, are shown in Table VI.2.

Table VI.2. Capital Investment Costs for Charcoal Production from a 100-Hectare Plantation

	Pesos	Dollars*
Plantation	800,000	44,000
Kiln	75,000	4,000
Total	875,000	49,000

*Pesos converted to dollars at the rate of 18 pesos per dollar.

1. Wood Production

Fuelwood production in woodlots or even along roadsides can be a financially viable undertaking, provided annual growth is at least 15 cubic meters per hectare or 1,500 cubic meters for a 100-hectare plantation. A woodlot project which yields at least that amount would produce an 18 percent financial internal rate of return, given the following assumptions:

- a loan to cover development costs of ₱8,000 per hectare at 12 percent a year, with a grace period of four years, payable in eight years thereafter;
- maintenance costs of ₱1,100 per hectare, beginning in the second year;
- intercrop revenues of ₱2,000 per hectare for two years after replanting or coppicing; and
- a value for fuelwood on the stump of ₱120 per cubic meters.

Assuming that foreign exchange, used to pay for development costs during the first five years to establish the plantation, is shadow-priced at 20 percent, the resulting economic internal rate of return for the wood production component is 15 percent. The economic benefit-cost ratio at a 20 percent discount rate would be less than one.

The internal rate of return would improve considerably if:

- intercropping provides cash crops each year, rather than for just two, as assumed; and/or
- the price of fuelwood is higher than ₱120 per cubic meter.

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Both assumptions are plausible since intercropping on an annual basis is feasible for dendro thermal plantations on Bohol and Masbate, and the price of fuelwood on these islands is reportedly far higher than ₱120 per cubic meters. Whenever higher fuelwood prices prevail at a plantation site, the project's financial/economic viability will improve. Furthermore, if a fraction of the yield can be sold as lumber, it will add significantly to the project's economic viability.

2. Charcoal Kilns

Annual production of 1,500 cubic meters of wood is more than sufficient for five charcoal kilns, and it was assumed that excess wood will be sold on the open market. Each kiln will be charged 38 times a year, with the average charge being seven cubic meters. The kiln's initial cost was estimated at ₱15,000, with annual operation and maintenance costs of ₱2,090 per kiln. The latter figure assumes labor costs of ₱32 per person-day, rather than the ₱15 suggested by FSDC, which is lower than the minimum agricultural wage. Kiln efficiency was assumed to be about 15 percent, provided the fuelwood is dry. Thus, a 1,500 cubic meters of wet wood should yield 133 tons of charcoal. The price of charcoal was assumed to be ₱2 per kilogram.

The financial internal rate of return for the charcoal component is extremely high at over 100 percent. The combined internal rate of return for the charcoal kiln and fuelwood production is 39 percent (see Figure VI.2). The economic internal rate of return at 30 percent is lower, assuming that foreign exchange is shadow-priced at +20 percent. The economic benefit-cost ratio, with the stream of costs and benefits discounted at 20 percent, is 1.68.

Thus, the subproject is economically and financially viable if undertaken as a combined fuelwood and charcoal production program. If only fuelwood production is implemented, its economic viability will be contingent on revenue derived from intercropping and a higher price for wood.

F. Options

Several factors point to the need for continued emphasis on charcoal production in the Philippines. As already indicated, there is a strong market demand for this commodity, and the economics of charcoal production are attractive. However, this activity needs to be considered from the perspective of the overall forest products industry. The most recent studies of this industry indicate that by the mid-1990s, major shortages

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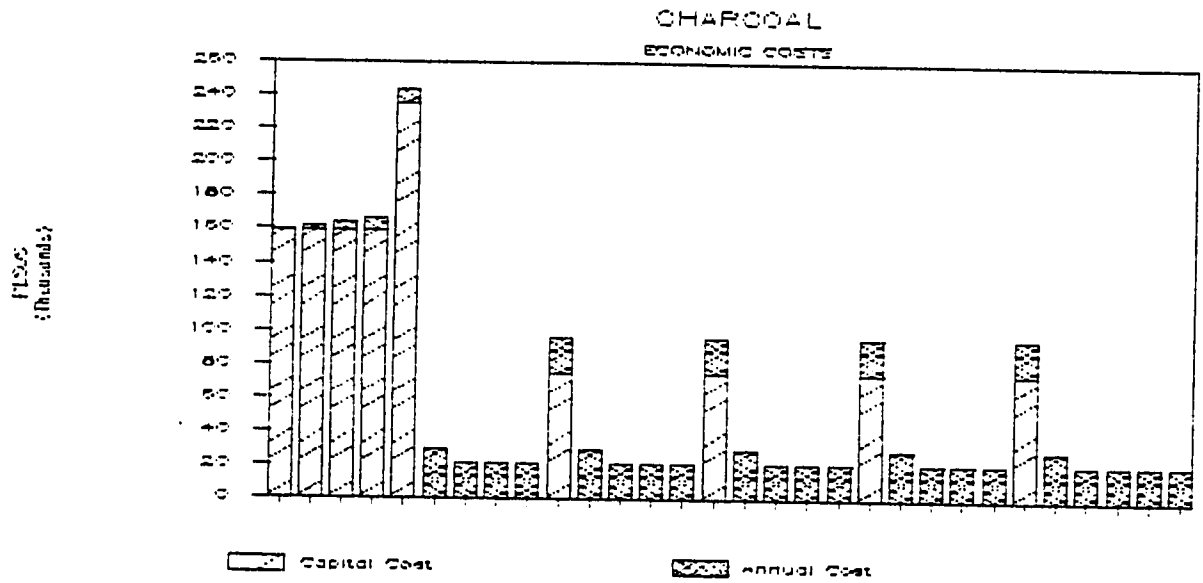
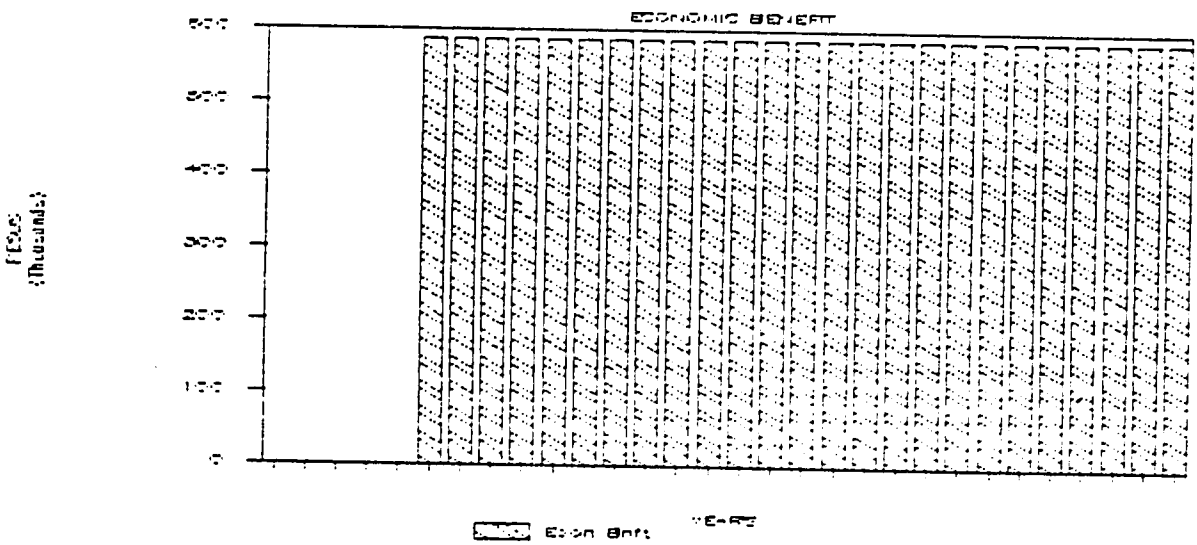
Figure VI.2. Economic Costs and Benefits of Charcoal Production





	Rate of Return	Benefit-Cost Ratio
Without Shadow Pricing	39%	
Shadow Pricing at 20%	30%	1.68

Notes: The graphs show combined costs and benefits from the woodlot and kiln operations.

Benefits include charcoal revenue at P2 per kilogram and excess wood revenues at P120 per ton.

Kilns are replaced every five years.

Costs include operation and maintenance of both the kilns and plantations.

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will occur for certain types of lumber and other products.* Given population increases, heightened pressures on the use of available land and rising local demand for wood products, these projections do not seem unreasonable.

As indicated in the discussion of charcoal and fuelwood markets in Section III, there is little definitive information concerning these markets, with the exception of information from studies of highly localized areas. A well conceived, designed and executed study of the demand and supply of charcoal and fuelwood in the Philippines needs to be carried out. The recent MOE study on demand has neither an appropriate focus nor the detail needed to provide a clear picture of the demand situation. Its scope is too general, while that of more localized studies is too narrow. Whatever the direction taken with the charcoal production subproject, a thorough, nationwide study of both supply and demand for these two fuels should be undertaken. Although such research will require substantial time and effort because of the variation between islands, only in this way can sound planning and good decisions be made about the placement of charcoal production projects. In any case, such a study is badly needed by various groups in the Philippines.

It did not appear to the assessment team that a truly viable alternative currently exists to working with FSDC to improve their program. However, two general problem areas must be addressed if the FSDC charcoal production project is to continue and be successful:

- technical forestry capability in the field must be greatly augmented; and
- the approach to wood production or cooperative formation must be changed.

<u>One option</u> would be to require FSDC to use its counterpart funds to increase its in-house technical and managerial capability to address problems that have become apparent. However, given the current financial situation of both the GOP and FSDC, this is not likely, thus leaving the project to seek out both new funding and an organizational format for its activities. As stated above, the team had neither the resources nor the time to fully examine such possibilities, but none of the institutional alternatives that are readily apparent, such as the BFD, were considered viable. Therefore, choosing this option will probably lead to further analysis and reprogramming in cooperation with the GOP before a new direction for the charcoal production project can be established.

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*RATIONALIZING THE WOOD INDUSTRY, draft report by the Industrial Forestry Task Force of FDC, UPLB, December 1984.

A second option would be to utilize project funds to address the subproject's problems at FSDC. This would require that a full staffing and management plan be prepared which all parties agree upon before proceeding. AID could provide technical assistance to FSDC to develop such a plan. The rest of this subsection discusses major items that would have to be addressed in the plan and suggests possible formats for improved approaches to wood production as well as institutional options.

Deficiencies in technical areas can be addressed more quickly than institutional ones. FSDC should employ more foresters at all levels, and the production problems mentioned earlier in this section should be addressed. FSDC could also secure forestry consultants to advise both its central office staff and field managers. Another possibility is working out an arrangement with BFD to supply some or all of the needed technical field expertise. While such an approach does have potential problems associated with coordinating the efforts of two separate agencies, it should help resolve some of the site selection problems related to BFD.

Although technical constraints can be addressed in the near future, it will be more difficult to develop institutional expertise. At present, several other institutions in the Philippines have attempted to develop methodologies and approaches for uplands development and social forestry. These projects are designed to generate more experience and knowledge in order to better understand the limitations, issues and potential of establishing uplands development projects. However, most of the agencies involved are still only in the early stages of this process. FSDC needs to undertake a similar process that will involve testing alternative field approaches as well as methods for organizing and building skills in uplands communities. At the same time, FSDC needs to be conscious of ways it can expand upon this process so as to bolster its own internal capability to implement such projects.

In the initial part of this learning process, FSDC will have to focus its attention and management resources on a few selected projects, closely monitoring the implementation of these projects while being sensitive to the concerns of both field personnel and project beneficiaries. This will permit FSDC to gradually identify project elements which work as well as those that do not. It will also allow FSDC to gradually refine its implementation procedures along with the systems and organizational structures necessary to support those new approaches. However, this process requires time, a willingness to invest resources and be flexible, and openness to change. Both AID and FSDC will have to decide whether they are prepared to make a commitement to this type of learning process as it will entail a substantial reduction in the current scale of project

implementation along with a concentration of financial, management and technical resources.

To facilitate the learning process, it may be desirable to have other agencies implement charcoal production projects on a pilot and cooperative basis. BFD is certainly a strong candidate for such project implementation, given its ability to provide the required technical expertise internally. In fact, BFD has already initiated projects that are more participatory and client-oriented. Discussions with the BFD Upland Development Working Group about the possibility of introducing a joint charcoal production trial project at a new site or one of BFD's existing pilot sites could lead to testing of this alternative approach. Such an approach could be an efficient way of generating the lessons needed to further refine both the project's design and the organizational models currently available. Several of the various formats for private-sector and cooperative participation that should be considered by the project are discussed below.

In the first format, loans would be provided to KAISAs to develop tree farms and charcoal-making operations. KAISAs would hire local labor to develop the sites, while KAISA personnel would manage all operations. Once an operation proves reliable, an association of workers would be organized and trained in the management of enterprise operations. Project and land ownership would then be transferred to the association, which would assume the loan obligations. (Loans would not include site costs, such as roads and marginal land improvement.) KAISAs would then be repaid the loans through either a share in the project's net profits or a commission on charcoal sales. Under this format, KAISAs would have a greater incentive to ensure that sites are technically acceptable and projects financially feasible. Furthermore, the approach protects CPA members from undertaking loan obligations for the development of project sites that are clearly uproductive or unprofitable.

Under a second possible format, FSDC/KAISA would enter into contract-growing or satellite-farming arrangements with individual landowners. Farmers would provide the land and labor, while FSDC would supply all other required inputs free of charge. Farmers would then be required to sell their trees exclusively to FSDC/KAISA at a predetermined price, which could be negotiated regularly or computed as a percentage of the prevaling market price in the area. In this format, FSDC has a strong incentive to see that reforestation occurs and charcoal production operations are mutually profitable. In addition, it can begin to develop charcoal production projects even on land that is privately owned and/or noncontiguous, although this might require implementation of the third format as well. Such land is likely to be more fertile and productive than sites offered by BFD. Furthermore, individual landowners may have a stronger incentive

to develop their own property, as opposed to land that is merely leased. Moreover, this format caters to those who are already engaged in other economic activities, but want to supplement their income through the production of fuelwood or charcoal. The compensation scheme for FSDC ensures that is is paid only when a production unit is financially viable. BFD should be included in the technical support for this format.

In the third format, FSDC/KAISA would organize separate associations to operate portable kilns for charcoal production. Tree farmers would then call on these kiln operators to convert their wood to charcoal on-site. Kiln operators would be paid a percentage of the charcoal produced and could serve several associations of tree producers in a given area on an as-needed basis. FSDC/KAISA would be compensated by a share of the charcoal produced or fees for rental of the portable kilns. This format could be applied in situations where tree farming is done by individuals, rather than on a group basis. The individual tree farmers can realize the economic advantages of converting wood to charcoal without having to be directly involved in charcoal-making.

In summary, the second option requires the development of:

- a technical forestry staffing plan, and
- a trial management approach to tree production.

Both of these activities should be financed by project funds.

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Appendix A

Scope of Work for the Reassessment

This appendix contains the scope of work for the assessment presented in this report. One modification in the statement of work was made in Manila after discussions with AID mission personnel. It was determined that item b. under the dendrothermal subproject heading, regarding the relative merits of the French and British power plants, was a low priority. Thus, this subject is covered in the report, although the level of analysis was reduced from that detailed in the scope of work contained in this appendix.

STATEMENT OF WORK

Assessment of Rural Energy Development Project

I. Background

The USAID Mission to the Republic of the Philippines will conduct a reassessment of the Rural Energy Development Project, which consists of dendrothermal power generation, charcoal production, and gasifier subprojects. The present economic crisis in the Philippines has left the GOP implementing agencies unable to meet their counterpart funding obligations for project operations. The agencies have requested major realignment or augmentation of the USAID project budgets, prompting the Mission to reassess the project's continued feasibility, particularly in light of problems and delays encountered during the initial implementation phase and significant changes in the fuelwood markets during the same period. A rapid update of the original Project Paper analyses with respect to changed economic conditions and accumulated technical and administrative experience will provide a sound basis for a decision on the future scope and direction of the project and on the necessary reorganization of the project budget.

II. Scope of Work

The following scope of work will be undertaken to update the analysis carried out in the Project Paper, utilizing, to the extent possible, existing data and Philippine professionals knowledgeable of the pertinent fields:

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A. Technical Feasibility

Objective: To assess the technical feasibility of dendrothermal, gasification, and charcoal production technologies, and to recommend any necessary modifications; to provide technical guidelines for continued project implementation.

1. Dendrothermal Subproject

   a. Review existing data and experience with dendrothermal power generation in the Philippines and assess the likelihood of the successful introduction and expansion of the technology in the Philippines.

   b. With attention to technical feasibility and cost, compare the relative merits of modifying existing French and British units versus procuring American models.

   c. Describe the nature, magnitude, and tractability of environmental impacts such as particulate emission and cooling water discharge.

   d. Assess the technical capability of National Electrification Administration (NEA) and Rural Electric Cooperative (REC) staff members to provide adequate plant operation and maintenance.

2. Gasifier Subproject

   a. Conduct a field study of a sample of existing gasifiers to determine technical problems responsible for inoperation.
   For operating gasifiers, estimate the net decrease in petroleum usage effected by the program on a per unit, per annum basis.

   b. Assess the technical and financial feasibility of modifying existing units and the modifications necessary in the design and installation of additional units. Assess the appropriateness of GEMCOR's technology and the availability of alternative technologies.

   c. Assess the efficiency and technical advisability of the use of woodchips rather than charcoal in the gasifiers; recommend measures to increase the units' flexibility.

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d. Assess the likely gasifier life cycle and its effect on diesel engine life.

e. Assess the technical capability of Farm Systems Development Corporation (FSDC) staff, Integrated Service Association (ISA) members, and gasifier equipment supplier(s) to provide adequate gasifier operation and maintenance.

3. Charcoal Subproject

a. Conduct a field study of a sample of existing kilns to discover any technical problems.

b. Recommend any feasible modifications to improve kiln operation.

c. Assess the technical capability of FSDC staff and Charcoal Producer Association (CPA) members to provide adequate kiln operation and maintenance.

4. Woodlot Component - all three subprojects

a. Review the current status of the woodlot components of all three subprojects, describe existing plans, actual achievements, and major constraints.

b. On the basis of a literature survey and selected site visits, determine the continued technical feasibility of woodlot plans with respect to species selection, site selection, woodlot management, and sustainability.

c. Estimate realistic yield projections and their implications for the timing and scale of the introduction of dendrothermal, gasifier, and charcoal conversion technology.

d. Assess the technical capabilities of NEA and FSDC to implement their respective woodlot programs; recommend additional staff, training, or procedures necessary to implement the programs.

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B. Institutional/Administrative Feasibility

Objective: To assess the resources of the National Electrification Administration and the Farm Systems Development Corporation -- their organizations, procedures, and staff -- necessary to suport their respective rural energy subprojects; to assess the ability of their associated organizations, such as RECs, ISAs, and CPAs to implement the subprojects; and to provide institutional/administrative guidelines for continued project implementation.

1. Dendrothermal Subproject

a. Review the current status of NEA's dendrothermal power generation program: describe existing plans, actual achievements, and major constraints.

b. Review the adequacy of NEA's provisions for monitoring of field activities, feedback and response, procedures for site selection, accounting and reporting, and coordination with other relevant agencies.

c. Assess the financial and managerial capability of RECs to implement the dendrothermal program. Recommend criteria by which individual RECs should be selected for the program. Recommend technical assistance and procedural changes needed for effective project implementation.

d. Evaluate the viability of Tree Farmers' Associations (TFAs) in terms of benefits and liabilities offered to the individual farmer, coordinated management of the various woodlot modules, and support supplied by the REC and NEA, including input supplies, technical training, and financial management. Determine the adequacy of woodlot land tenure systems.

e. Recommend needed modifications of the existing REC and TFA organizational structures, particularly as required to address the overall planning and management of woodlot operations and sale of produce. Estimate additional staff, training, and procedures necessary for effective project implementation.

2. Gasifier Subproject

a. Assess the current status of FSDC's gasifier program, particularly any response made to the recommendations of the joint MHS/USAID evaluation of May 1984; describe existing plans, actual achievements, and major constraints.

b. Assess the adequacy of FSDC's provisions for field technical support, monitoring of field activities, feedback and response, procedures for site selection, financial management, accounting and reporting, and coordination with other relevant agencies. Recommend technical assistance and procedural changes needed for effective project implementation.

c. Assess the financial and managerial capability of KAISAs and ISAs to implement the gasifier program. Review criteria by which individual ISAs are selected for the program.

d. Assess the viability of Tree Production Units in terms of benefits and liabilities offered to the individual farmer, coordinated management of the gasifier woodlot, and support provided by FSDC, including input supplies, technical training, and financial management. Review adequacy of woodlot land tenure system.

e. Recommend useful modifications of the existing FSDC and ISA organization structures, particularly as needed to clarify responsibility for woodlot management, to facilitate communication of gasifier problems to FSDC, and to speed FSDC response.

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3. Charcoal Subproject

a. Review the current status of FSDC's charcoal production program: describe existing plans, actual achievements, and major constraints.

b. Assess the adequacy of FSDC's provisions for monitoring of field activities, feedback and response, procedures for site selection, accounting and reporting, and coordination with other relevant agencies.

c. Review the success of the CPA system: assess whether or not CPAs are financially and managerially viable institutions to implement the charcoal program. Review criteria by which groups at specific sites are selected for organization into CPAs and recommend new criteria.

d. Examine CPA's in terms of benefits and liabilities offered to the individual farmer, coordinated management of the woodlot, and support provided by FSDC, including input supplies, technical training, and financial management. Determine adequacy of woodlot land tenure systems.

C. Economic and Financial Feasibility

Objective: To reassess the economic and financial feasibility of the three subprojects in the light of significant increases in fuelwood production costs, lower than previous projected yields, and present and projected trends in the oil and biomass fuel markets. In particular, the economic feasibility section will include the following:

(i) assessment of the project's economic viability through an economic internal rate of return (EIRR) analysis of each of the three component investments. Review assumptions made in the original project paper on yields, input and output shadow prices (e.g. for land, labor and foreign exchange), tree farm

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development costs and timeframe to full production levels, and capital equipment cost, and revise or recast the analysis as appropriate. Undertake sensitivity analyses given various assumptions on the levels of costs and benefits. In particular, the sensitivity to international oil price decreases should be examined.

(ii) analysis of the economics of wood-based fuel vis-a-vis principal end-use alternatives, i.e., oil-based products and/or other non-conventional energy forms. Estimates of the price elasticity of the demand and supply of fuelwood and charcoal will also be included.

(iii) discussion of the project's economic impact in terms of income distribution, employment generation and the environmental costs and benefits associated with water and air pollution and with reforestation of denuded marginal lands, respectively. In the case of the latter, an assessment should be conducted of the extent to which increased demand for fuelwood as a result of the project may lead to further deforestation.

The financial feasibility section will include the following:

(iv) analysis of the financial costs and returns of establishing and operating the tree farms and fuelwood conversion processes for each of the three subprojects. This will include an assessment of whether or not the financial returns in each component are sufficient for the beneficiary groups to pay back the loans over a reasonable period of time, and a discussion of the appropriate interest rate to be charged to the beneficiary groups.

(v) comparison of the market prices of wood-based energy forms vs. their oil-based alternatives, with examination of the possibility that the prices of the former may become so high from increased production costs as to render them financially less attractive than the latter.

1. Wood-Fired Power Plant

Economic Feasibility

a. Considering adjustments in fuelwood production costs and relatively lower oil prices, compare the total economic costs of domestically produced wood-based energy vs. oil-based energy and/or other non-conventional power sources as appropriate and/or a connection to the existing or planned national power grid.

b. Given three specific project sites for dendro thermal plants, determine the market for the plants' electricity output. Determine the economic internal rate of return (EIRR) of the specific investments as discussed in (i) above.

c. Compare the cost of energy arising from a woodfuel power plant vs. a diesel-based power plant or a hydro power plant (if feasible) within each of the three project site areas.

d. Analyze the economic impact of the subproject as discussed in (iii) above.

Financial Feasibility

e. Reassess the financial costs and returns of both the tree farm development and the power plant using reasonable assumptions on input prices and on output levels and prices. Revise or update the costs of establishing and operating tree farms and the purchase and installation of power plants.

f. Determine whether or not the returns are sufficient for the farmers and the REC to pay back the loans involved and still achieve a reasonable net income, as discussed in (iv) above.

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2. Charcoal Production

Economic Feasibility

a. Given new production costs and oil prices, compare the total economic costs of charcoal vs. its oil or gas based alternatives for both household and industrial uses.

b. Determine the EIRR of charcoal production as discussed in (i) above.

c. Analyze the economic impact of the subproject as discussed in (iii) above.

d. Assess the market for charcoal in project sites, with particular emphasis on the growth in demand for charcoal by industries and households and on the possible price elasticity of demand.

Financial Feasibility

e. Reassess the financial costs, returns, and breakeven points of both tree farm and charcoal production components, based on reasonable information on input and output prices.

f. Based on the subproject's performance to date, recommend a revised financial assistance program including measures to improve the financial viability of FSDC and the farmers involved in the charcoal production program.

3. Gasifier

Economic Feasibility

a. Based on current and projected oil prices and fuelwood production costs, compare the total economic costs of using gasifiers (both charcoal and woodchip) vs. diesel fuel for pumping irrigation, as discussed in (ii) above.

b. Based on reasonable assumptions on woodlot development, operations and maintenance costs, gasifier equipment construction costs, and diesel substitution efficiency, determine the EIRR of using gasifiers for irrigation as discussed in (i) above.

c. Analyze the economic impact of the subproject as discussed in (iii) above.

Financial Feasibility

d. Review and analyze the factors that make the gasifiers financially more or less attractive to use as compared to oil-based fuels.

e. Based on updated financial data, reassess the financial costs and returns of the program as discussed in (iv) above.

f. Given the subproject's performance to date, develop a financial assistance program and recommend measures to enhance the financial viability of the program.

IV. Assessment Interpretation

Once the technical, financial, economic, and institutional/administrative analyses have been completed, the contractor(s) should prepare a summary and preliminary interpretation of results for each subproject. Rather than presenting a final conclusion and recommendations, the contractor should enumerate the options open to USAID and the implementing agency regarding whether and how to proceed. The contractor should specify key decision points and summarize actions necessary together with the implications of alternative courses of action. The final interpretation of the contractor's findings will be conducted in-house at USAID/Manila in collaboration with the implementing agencies.

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ENERGY INTERCHANGE AGREEMENT BETWEEN THE NATIONAL POWER CORPORATION (NPC) AND THE ELECTRIC COOPERATIVES

STATEMENT OF POLICY

Subject to technical feasibility and economic viability, NPC will assist electric cooperatives by "wheeling the energy" generated from a Dendro Thermal or Mini-Hydro Plant owned and/or operated by electric cooperatives. This feedback energy shall be transmitted through the NPC system from the interchange point to one or more "receiving points" in the same grid. The energy so transmitted can thus be utilized to serve the loads of as many cooperatives as possible. This aims to avoid duplication of transmission facilities.

IMPLEMENTING GUIDELINES

1. For "wheeling the energy", a transmission and transformation loss of ten percent (10%) shall be imputed. Ninety percent (90%) of the feedback energy shall therefore become available at the "receiving points" to serve the loads of the receiving cooperatives concerned. Said "receiving points" shall be defined in each interchange agreement.

2. The interchange point and the "receiving points" shall be at different locations in the NPC system but their power source should come from the same NPC Grid.

3. NPC shall bill the generating cooperative concerned for energy delivered by NPC to the generating cooperative at the interchange point.

4. If the actual energy delivered by NPC at the "receiving points" is greater than ninety percent (90%) of the feedback energy, then NPC shall bill the receiving cooperatives concerned for the energy difference.

5. The generating cooperative concerned shall provide and install at the interchange point the complete metering equipment to measure energy flowing out of the generating cooperative's system. The specifications of the cooperative's metering equipment, however, shall be subject to approval by NPC.

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6. The NPC shall provide and install at the interchange point the complete metering equipment to measure energy flowing into the generating cooperative's system. The specifications of the NPC metering equipment, however, shall be subject to acceptance by the cooperative.

7. NPC reservés the right to refuse interconnection of the Dendro Thermal or Mini-Hydro Plant if the NPC system will be adversely affected by such interconnection.

8. NPC shall not be liable for any damage to the Plant of the generating cooperative concerned when synchronized into the NPC system.

9. NPC and all the cooperatives concerned shall sign and execute a standard power contract incorporating therein as an integral part of the contract the foregoing implementing guidelines and waiving the contract provisions on minimum monthly charges. When the Mini-Hydro or Dendro Thermal Plant is not in operation for more than 50% of the time during the billing month, then the contract provisions on minimum monthly charges shall apply except that when the Mini-Hydro or Dendro Thermal Plant is shut-down for regular maintenance and the generating cooperative gives NPC at least five (5) days advance notice or when the Mini-Hydro or Dendro Thermal Plant is shut-down due to force majeure and the generating cooperative gives appropriate advice to NPC within 24 hours of such occurrence, then the minimum monthly charges shall not apply.

9. The demand charges shall still apply for NPC's power delivery at the interchange point and the "receiving points".

Appendix C

Output of Generation Planning Model Used by
NPC's System Planning Department

CEBU W/ DENDRO

1984 PLANT DISPATCH SUMMARY

PLANT NAME	TYPE	BASE CAP.	PEAK CAP.	FOR	MAIN DAYS	LOADG ORDER	BASE GEN.	PEAK GEN.	TOTAL GEN.
NAGA THLE	COAL	38.4	48.0	0.07	30	1	283.6	38.9	322.5
VECO THLE	COAL	5.3	6.7	0.07	15	2	36.7	5.2	41.9
CEBU D. I	OIL	10.0	33.0	0.07	15	3	62.9	63.4	126.3
CEBU D. II	OIL	5.0	16.0	0.07	15	4	28.0	17.2	46.0
CEBU D. II	OIL	5.0	16.0	0.07	15	5	26.5	9.8	36.3
CEBU D. II	OIL	5.0	16.0	0.07	15	6	24.2	5.8	30.0
VECO D.	OIL	0.0	27.7	0.07	15	7	0.0	5.5	5.5

1984	0.0	364.4	0.0	244.1	608.5

SYSTEM PEAK DEMAND - - - - - - - - - = 112.8 MW

LOSS OF LOAD PROBABILITY - - - - - - = 4.2619 DAYS/YR

SYSTEM ENERGY REQ'T. - - - - - - - - = 610.2975131000 GWH

UNSERVED ENERGY - - - - - - - - - - = 1.056216705217 GWH

VPG-SPD-CORPLAN
MFD/DAA.02-23-85

VISAYAS PROBABILISTIC SIMULATION >>

CEBU W/ DENDRO

1990 PLANT DISPATCH SUMMARY

PLANT NAME	TYPE	BASE CAP.	PEAK CAP.	FOR	MAIN DAYS	LOADG ORDER	BASE GEN.	PEAK GEN.	TOT GEN.
NAGA 2	COAL	41.6	52.0	0.07	30	1	311.6	20.6	332.
NAGA THER	COAL	30.4	48.0	0.07	30	2	222.7	12.8	235.
VECO THER	COAL	5.3	6.7	0.07	15	3	24.5	1.8	26.
DENDRO	COAL	3.1	4.5	0.07	30	4	12.7	1.2	13.
CEBU D. I	OIL	10.0	33.0	0.07	15	5	37.5	15.9	53.
CEBU D. II	OIL	5.0	16.0	0.07	15	6	16.5	4.1	20.
CEBU D. II	OIL	5.0	16.0	0.07	15	7	14.9	2.2	17.
CEBU D. II	OIL	5.0	16.0	0.07	15	8	13.3	1.2	14.
VECO D.	OIL	0.0	27.7	0.07	15	9	0.0	1.0	1.

GENERATION MIX

YEAR	HYDRO	COAL	GEO.	DIESEL	TOTAL
1990	0.0	607.9	0.0	106.6	714.5

SYSTEM PEAK DEMAND - - - - - - - - - = 128.2 MW

LOSS OF LOAD PROBABILITY - - - - - = .6079 DAYS/YR

SYSTEM ENERGY REQ'T. - - - - - - - - = 715.3994785172 GWH

UNSERVED ENERGY - - - - - - - - - - = .9912546300133 GWH

VPG-SPD-CORPLAN
MFD/DAA.02-23-85

VISAYAS PROBABILISTIC SIMULATION >>

CEBU W/ DENDRO

2000 PLANT DISPATCH SUMMARY

PLANT NAME	TYPE	BASE CAP.	PEAK CAP.	FOR	MAIN DAYS	LOADG ORDER	BASE GEN.	PEAK GEN.	TOTAL GEN.
NAGA 2	COAL	41.6	52.0	0.07	30	1	311.3	32.9	344.2
NAGA THER	COAL	38.4	48.0	0.07	30	2	257.7	24.9	282.6
VECO THER	COAL	5.3	6.7	0.07	15	3	30.8	3.2	34.0
DENDRO	COAL	3.1	4.5	0.07	30	4	17.1	2.9	20.0
CEBU D. I	OIL	10.0	33.0	0.07	15	5	50.4	34.5	84.9
CEBU D. II	OIL	5.0	16.0	0.07	15	6	22.2	9.1	31.3
CEBU D. II	OIL	5.0	16.0	0.07	15	7	20.9	6.1	27.0
CEBU D. II	OIL	5.0	16.0	0.07	15	8	18.3	3.9	22.2
VECO D.	OIL	0.0	27.7	0.07	15	9	0.0	3.5	3.5

GENERATION MIX

YEAR	HYDRO	COAL	GEO.	DIESEL	TOTAL
2000	0.0	680.8	0.0	168.9	849.7

SYSTEM PEAK DEMAND - - - - - - - - - = 148.3 MW

LOSS OF LOAD PROBABILITY - - - - - = 3.3217 DAYS/YR

SYSTEM ENERGY REQ'T. - - - - - - - - = 851.7082175318 GWH

UNSERVED ENERGY - - - - - - - - - - = 1.999349120547 GWH

VPG-SPD-CORPLAN
MFD/DAA.02-23-85

VISAYAS PROBABILISTIC SIMULATION >>

CEBU W/ DENDRO AND P. BARGE # 2

2010 PLANT DISPATCH SUMMARY

PLANT NAME	TYPE	BASE CAP.	PEAK CAP.	FOR	MAIN DAYS	LOADG ORDER	BASE GEN.	PEAK GEN.	TOTAL GEN.
NAGA 2	COAL	41.6	52.0	0.07	30	1	311.5	46.5	358.0
NAGA THER	COAL	30.4	40.0	0.07	30	2	279.3	35.9	315.2
VECO THER	COAL	5.3	6.7	0.07	15	3	36.3	5.8	42.1
DENDRO	COAL	3.1	4.5	0.07	30	4	21.0	4.0	25.0
CEBU D. I	OIL	10.0	33.0	0.07	15	5	62.2	65.2	127.4
CEBU D. II	OIL	5.0	16.0	0.07	15	6	29.6	21.2	50.8
CEBU D. II	OIL	5.0	16.0	0.07	15	7	28.0	14.3	42.3
CEBU D. II	OIL	5.0	16.0	0.07	15	8	25.3	9.6	34.9
P. BARGE 2	OIL	0.0	7.0	0.07	15	9	0.0	4.6	4.6
P. BARGE 2	OIL	0.0	7.0	0.07	15	10	0.0	3.6	3.6
P. BARGE 2	OIL	0.0	7.0	0.07	15	11	0.0	2.7	2.7
P. BARGE 2	OIL	0.0	7.0	0.07	15	12	0.0	1.9	1.9
VECO D.	OIL	0.0	27.7	0.07	15	13	0.0	3.1	3.1

CEBU W/ DENDRO AND P. BARGE # 2

2000 PLANT DISPATCH SUMMARY

PLANT NAME	TYPE	BASE CAP.	PEAK CAP.	FOR	MAIN DAYS	LOADG ORDER	BASE GEN.	PEAK GEN.	TOTAL GEN.
NAGA 2	COAL	41.6	52.0	0.07	30	1	311.3	32.9	344.2
NAGA THER	COAL	30.4	40.0	0.07	30	2	257.7	24.9	282.6
VECO THER	COAL	5.3	6.7	0.07	15	3	30.8	3.2	34.0
DENDRO	COAL	3.1	4.5	0.07	30	4	17.1	2.9	20.0
CEBU D. I	OIL	10.0	33.0	0.07	15	5	50.4	34.6	85.0
CEBU D. II	OIL	5.0	16.0	0.07	15	6	22.2	9.0	31.2
CEBU D. II	OIL	5.0	16.0	0.07	15	7	20.9	6.3	27.2
CEBU D. II	OIL	5.0	16.0	0.07	15	8	18.3	3.9	22.2
P. BARGE 2	OIL	0.0	7.0	0.07	15	9	0.0	1.5	1.5
P. BARGE 2	OIL	0.0	7.0	0.07	15	10	0.0	1.0	1.0
P. BARGE 2	OIL	0.0	7.0	0.07	15	11	0.0	0.7	0.7
P. BARGE	OIL	[illegible]	7.0	0.07	15	12	0.0	0.5	0.5
VECO D.	OIL	0.0	27.7	0.07	15	13	0.0	0.7	0.7

CEBU W/ DENDRO AND P. BARGE # 2 4'4

2010 PLANT DISPATCH SUMMARY

PLANT NAME	TYPE	BASE CAP.	PEAK CAP.	FOR	MAIN DAYS	LOADG ORDER	BASE GEN.	PEAK GEN.	TOTAL GEN.
NAGA 2	COAL	41.6	52.0	0.07	30	1	311.5	46.5	358.0
NAGA THER	COAL	38.4	48.0	0.07	30	2	279.3	35.9	315.2
VECO THER	COAL	5.3	6.7	0.07	15	3	36.3	5.8	42.1
DENDRO	COAL	3.1	4.5	0.07	30	4	21.0	4.0	25.0
CEBU D. I	OIL	10.0	33.0	0.07	15	5	62.2	65.2	127.4
CEBU D. II	OIL	5.0	16.0	0.07	15	6	29.6	21.2	50.8
CEBU D. II	OIL	5.0	16.0	0.07	15	7	28.0	14.2	42.2
CEBU D. II	OIL	5.0	16.0	0.07	15	8	25.3	9.8	35.1
P. BARGE 2	OIL	0.0	7.0	0.07	15	9	0.0	4.4	4.4
P. BARGE 2	OIL	0.0	7.0	0.07	15	10	0.0	3.6	3.6
P. BARGE 2	OIL	0.0	7.0	0.07	15	11	0.0	2.7	2.7
P. BARGE 2	OIL	0.0	7.0	0.07	15	12	0.0	1.9	1.9
P. BARGE 1	OIL	0.0	7.0	0.07	15	13	0.0	1.3	1.3
P. BARGE 1	OIL	0.0	7.0	0.07	15	14	0.0	0.9	0.9
P. BARGE 1	OIL	0.0	7.0	0.07	15	15	0.0	0.6	0.6
P. BARGE 1	OIL	0.0	7.0	0.07	15	16	0.0	0.4	0.4
VECO D.	OIL	0.0	27.7	0.07	15	17	0.0	0.6	0.6

GENERATION MIX

YEAR	HYDRO	COAL	GEO.	DIESEL	TOTAL
2010	0.0	740.3	0.0	271.9	1012.2

SYSTEM PEAK DEMAND - - - - - - - - - = 171.6 MW

LOSS OF LOAD PROBABILITY - - - - - = .4748 DAYS/YR

SYSTEM ENERGY REQ'T. - - - - - - - - = 1014.000090074 GWH

UNSERVED ENERGY - - - - - - - - - - = 1.335138537074 GWH

CEBU W/ DENDRO AND P BARGE #2 & 1

2015 PLANT DISPATCH SUMMARY

PLANT NAME	TYPE	BASE CAP.	PEAK CAP.	FOR	MAIN DAYS	LOADG ORDER	BASE GEN.	PEAK GEN.	TOTAL GEN.
NAGA 2	COAL	41.6	52.0	0.07	30	1	311.2	54.4	365.6
NAGA THER	COAL	38.4	48.0	0.07	30	2	286.0	42.9	328.9
VECO THER	COAL	5.3	6.7	0.07	15	3	39.6	6.8	46.4
DENDRO	COAL	3.1	4.5	0.07	30	4	21.4	4.9	26.3
CEBU D. I	OIL	10.0	33.0	0.07	15	5	67.5	81.5	149.0
CEBU D. II	OIL	5.0	16.0	0.07	15	6	32.5	28.6	61.1
CEBU D. II	OIL	5.0	16.0	0.07	15	7	31.2	22.5	53.7
CEBU D. II	OIL	5.0	16.0	0.07	15	8	29.2	15.7	44.9
P. BARGE 2	OIL	0.0	7.0	0.07	15	9	0.0	7.1	7.1
P. BARGE 2	OIL	0.0	7.0	0.07	15	10	0.0	5.8	5.8
P. BARGE 2	OIL	0.0	7.0	0.07	15	11	0.0	4.6	4.6
P. BARGE 2	OIL	0.0	7.0	0.07	15	12	0.0	3.5	3.5
P. BARGE 1	OIL	0.0	7.0	0.07	15	13	0.0	2.7	2.7
P. BARGE 1	OIL	0.0	7.0	0.07	15	14	0.0	1.9	1.9
P. BARGE 1	OIL	0.0	7.0	0.07	15	15	0.0	1.3	1.3
P. BARGE 1	OIL	0.0	7.0	0.07	15	16	0.0	0.9	0.9
VECO D.	OIL	0.0	27.7	0.07	15	17	0.0	1.4	1.4

GENERATION MIX

YEAR	HYDRO	COAL	GEO.	DIESEL	TOTAL
2015	0.0	767.2	0.0	337.9	1105.1

SYSTEM PEAK DEMAND - - - - - - - - - = 184.6 MW

LOSS OF LOAD PROBABILITY - - - - - = 1.244 DAYS/YR

SYSTEM ENERGY REQ'T. - - - - - - - - = 1106.999264712 GWH

UNSERVED ENERGY - - - - - - - - - - = 1.772614824649 GWH

BOHOL I ELECTRIC COOPERATIVE, INC.
Maca-as, Tubigon, Bohol

COMPARATIVE STUDY OF ELECTRIC RATE IN EVERY MUNICIPALITY
BASED ON THE NUMBER OF CONSUMERS AND KWH SALES
FOR THE MONTH OF AUGUST, 1984 BILLING

MUNICIPALITY	COST OF POWER PURCHASED	OPERATION/ MAINTENANCE EXPENSE	CONSUMERS ACCOUNT EXPENSE	ADMINISTRATIVE/ GENERAL EXPENSE	AMORTIZATION EXPENSE	INTEREST EXPENSE	ACTUAL COST PER KWH	INCOME (Loss)
Sevilla	₱ 1.395	₱ 0.80	₱ 0.235	₱ 0.156	₱ 0.202	₱ 0.13	₱ 2.92	(₱ 0.99)
San Isidro	1.395	0.80	0.235	0.156	0.202	0.13	2.92	(0.99)
Sikatuna	1.395	0.70	0.22	0.156	0.202	0.13	2.80	(0.87)
Batuan	1.395	0.46	0.18	0.156	0.202	0.13	2.52	(0.59)
Dimiao	1.395	0.38	0.167	0.156	0.202	0.13	2.43	(0.50)
Bilar	1.395	0.34	0.16	0.156	0.202	0.13	2.383	(0.45)
Lila	1.395	0.295	0.15	0.156	0.202	0.13	2.33	(0.40)
Balilihan	1.395	0.29	0.144	0.156	0.202	0.13	2.32	(0.39)
Catigbi-an	1.395	0.25	0.146	0.156	0.202	0.13	2.28	(0.35)
Corella	1.395	0.21	0.14	0.156	0.202	0.13	2.23	(0.30)
Carmen	1.395	0.18	0.135	0.156	0.202	0.13	2.20	(0.27)
Alburquerque	1.395	0.176	0.134	0.156	0.202	0.13	2.19	(0.26)
Antequera	1.395	0.17	0.133	0.156	0.202	0.13	2.185	(0.255)
Loboc	1.395	0.14	0.13	0.156	0.202	0.13	2.153	(0.223)
Loay	1.395	0.10	0.12	0.156	0.202	0.13	2.10	(0.17)

Bohol I Electric Cooperative, Inc.
COMPARATIVE STUDY OF ELECTRIC RATE . . . . .

MUNICIPALITY		COST OF POWER PURCHASED	OPERATION/ MAINTENANCE EXPENSE	CONSUMERS ACCOUNT EXPENSE	ADMINISTRATIVE/ GENERAL EXPENSE	AMORTIZATION EXPENSE	INTEREST EXPENSE	ACTUAL COST PER KWH	INCOME (Loss)
Panglao	21,118	P 1.395	P 0.10	P 0.12	P 0.156	P 0.202	P 0.13	P 2.10	(P 0.17)
Loon	51,681	1.395	0.09	0.12	0.156	0.202	0.13	2.09	(0.16)
Maribojoc	21,133	1.395	0.08	0.12	0.156	0.202	0.13	2.08	(0.15)
Sagbayan	33,697	1.395	0.07	0.117	0.156	0.202	0.13	2.07	(0.14)
Inchanga	28,667	1.395	0.07	0.117	0.156	0.202	0.13	2.07	(0.14)
Clarin	19,151	1.395	0.045	0.11	0.156	0.202	0.13	2.04	(0.11)
Danis	27,530	1.395	0.036	0.118	0.156	0.202	0.13	2.03	(0.10)
Calape	39,113	1.395	0.035	0.11	0.156	0.202	0.13	2.03	(0.10)
Baclayon	14,632	1.395	0.036	0.11	0.156	0.202	0.13	2.03	(0.10)
Cortes	56,753	1.395	0.02	0.11	0.156	0.202	0.13	2.01	(0.08)
Tubigon	51,434	1.395	0.02	0.11	0.156	0.202	0.13	2.01	(0.08)

N O T E : • Actual electric rate charged in every municipality = = = = = P 1.93
VVVVV

• Actual cost per KWH is based on the Monthly Financial and Statistical Report for the month of August, 1984.

COST OF POWER PURCHASED

Actual Cost plus System's Loss

OPERATION and MAINTENANCE COST

Total Expenses - - - - - - - - - P 63,923.00 per month

Estimated Kilometer (distance) 550 kilometers

OPERATION and MAINTENANCE EXPENSES per kilometer = $\frac{63,923}{550}$

= P 116.20 PER KM

EXAMPLE: Sevilla (36 km. from Tagbilaran City)

P 116.20 x 36 = $\frac{\text{P 4,183.20}}{\text{KWHSales of Sevilla}}$

= $\frac{\text{P 4,183.20}}{5,173}$

= P 0.80

EXAMPLE: San Isidro (21 kilometers from Tubigon)

P 116.20 x 21 = $\frac{\text{P 2,440.20}}{\text{KWH Sales}}$

= $\frac{\text{P 2,440.20}}{3,053}$

= P 0.80

CONSUMERS ACCOUNT EXPENSE - - - - - - - - - - - - P 67,267.00

Labor	P 49,243.00	= 0.106 per KWHr
Office Supplies	7,729.00	
Gasoline/Oil and Spare Parts	10,295.00	
	P 67,267.00	

EXAMPLE: Sevilla (36 kilometers from Tagbilaran City)

$\frac{10,295}{550 \text{ km}}$ = - P 18.70 per kilometer

18.72 x 36 = $\frac{673.92}{\text{KWHr Sales}}$ $\frac{673.92}{5,173}$

0.13 plus Fixed Expenses

0.13 plus 0.106 = 0.235

Appendix D

Environmental Analysis from GIT October, 1984 Evaluation

VI. ENVIRONMENTAL ANALYSIS

A. INTRODUCTION

The dendro thermal project utilizes two basic power generation processes:

- o Steam turbine/generator systems.
- o Wood gas/diesel engine generators.

Each of the two processes, typified by low and medium pressure solid (wood) fueled boiler-turbine-generator and gasifier-engine-generator power systems, have fundamental differences in environmental impact. No differentiation is made (except where noted) between the Balfour Beatty low pressure steam systems, Alsthom-Atlantique medium pressure systems, or other proposed steam systems, as the environmental aspects of these systems are quite similar. Both processes produce somewhat similar waste streams composed of solid, gaseous and liquid components. In addition, the gasifier system produces pyrolytic tars. Table 15 provides the approximate quantities of wastes expected from the two processes at the various rated power generation rates. The environmental impacts of these wastes are a function of the quantities, compositions, and disposal options available for each of these waste streams.

1. Solid Wastes

The solid wastes produced by the two power plant processes are charcoal and ash. From a standpoint of maximum yield of electric power per unit input of fuel, the power systems are expected to produce a negligible quantity of charcoal. Production of charcoal is expected to be limited to transient conditions such as start-up and generator trip. From an environmental standpoint, therefore, the proportion of charcoal to ash from either process is not relevant. The final ash production is expected to be 2,449 kg per MWh (5,400 lb/MWh) for steam systems and 1,723 kg per MWh (3,800 lb/MWh) for wood gas systems. This equates to approximately 1 percent by weight of the fuel wood input.

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C. DUVANT DESIGN

At the time of writing, the stations were incomplete.

Very limited worldwide experience exists with this technology.

The two gasifier-based stations should be viewed as experimental.

Performance of the engine when running in dual-fuel mode is not expected to present any problems, although a key issue, with significant impact on economics, is how much diesel fuel will be required to supplement the low-Btu gas.

Numerous technical issues affect performance of the gasifier. These will not be resolved until at least one of the stations is started up.

The gasifier system is a complex process which includes sophisticated process control equipment. The ability of local personnel to assume responsibility for station operation remains in doubt.

There has been but little interchange of technical information between the manufacturer, Duvant, and NEA staff. A formal training program for potential station operators has yet to be instituted.

D. JAPANESE DESIGN

No findings or conclusions could be made on the Japanese design.

E. AMERICAN DESIGN

No findings or conclusions could be made on the Stone and Webster design.

F. SUMMARY

It is the assessment of the engineering team that the 17 Category 1 and 2 plants will function as designed with the incorporation of the specific modifications recommended. The overall effort by NEA, equipment suppliers, A & E's and construction contractors was well managed, and no serious errors were made by any party. Problems which have occurred to date are related primarily to financial difficulties, and some lack of experience with biomass systems. Bank funding should eliminate the financial difficulties, and the experience gained during the past five years should preclude future technical problems.

Table 15

Summary of Waste Outputs

Specific Waste Output for the Two Power Generation Processes

Waste Output	Steam Turbogenerator System	Wood Gas/ Diesel Engine Generator System
Wood Ash	5,400 lbs/MWh	3,800 lbs/MWh**
Stack Particulates	11 lbs/MWh	nil
Thermal Waste*	15.3 MMBtu/MWh	0.39 MMBtu/MWh
Liquid Wastes	nil	185.4 lbs/MWh**

Average Waste Ouput for the Two Power Generating Processes

Waste Output	Steam Turbogenerator System	Wood Gas/ Diesel Engine Generator System
Wood Ash	15,900 lbs/hr	3,380 lbs/hr
Stack Particulates	32 lbs/hr	nil
Thermal Waste*	45.0 MMBtu/hr	0.35 MMBtu/hr
Liquid Wastes	nil	165.0 lbs/hr

*Heat to river cooling water.
**Estimated values since Duvant technical data not available.

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Ash wastes from wood combustion are considered less detrimental than solid residues from coal and other fuels. A typical ash analysis for wood fuel is shown in Table 16 (16). Only trace amounts of heavy metals, phosphorus, and nitrogen are present; thus the hazards to the environment are limited. Ash from wood burning is, however, considered solid waste and as such is subject to the provisions of a solid waste management program which is appropriate for the environment and government regulation. The ash is a chemical base made up primarily of potassium, silica, sodium hydroxide and calcium carbonate. In the United States, the typical method of disposal is landfill because of its good characteristics of low leachate rate and low toxicity to plants. Protective measures can prevent surface runoff (containing ash) from contaminating streams due to high alkalinity and turbidity which can harm aquatic life.

The ash disposal systems at all plants currently under construction utilize a dry storage at the plant site for temporary storage of ash removed from the combustion system. Ash removal may be either a manual or a mechanized operation depending on the design of the equipment supplier. The actual transporting of the ash to the plant storage area is usually a manual operation.

A preliminary investigation of the plant sites has indicated that the problem of runoff has not been addressed. The grading at most sites is designed to allow water to drain into the local stream. It is suggested that sites be regraded as required to retain water in the ash storage area. It is recognized that, due to the large quantity of rain at the plant during the summer, containment of all water is not possible. It is recommended that drainage be routed such that it mixes with the acidic runoff from the wood storage pile such that both streams are neutralized.

Wood ash is frequently used as an alkalinity builder in pulp and paper forestry operations in the United States similar to current practices of slash-and-burn techniques in agriculture common in the Philippines. Thus, it is desirable to utilize the ash products of the power plants to return nutrients and to adjust soil acidity of the fuel wood plantations. Success in this program means that the following three potential problems should be addressed:

Table 16

Typical Wood Ash Analysis
(Percent by Weight)

			White-Fir Bark*	Spruce Bark*	Redwood Bark*
Silica	as	SiO_2	1.7	32.0	14.3
Iron	as	Fe_2O_3	3.2	6.4	3.5
Titanium	as	TiO_2	0.0	0.8	0.3
Aluminum	as	Al_2O_3	3.2	11.0	4.0
Manganese	as	Mn_3O_4	3.9	1.5	0.1
Calcium	as	CaO	60.8	25.3	6.0
Magnesium	as	MgO	3.0	4.1	6.6
Alkalies	as	Na_2O	10.4	10.4	25.0
Sulfate	as	SO_3	3.0	2.1	7.4
Chloride	as	Cl	0.4	trace	18.4
Carbonate	as	CO_2	11.5	7.0	14.0
Undetermined			--	--	--

*Salt-water stored.

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- Handling and transportation of ash products to fuel wood plantations.

- Proper administration of ash according to soil requirements.

- Controlling runoff to rivers and streams bearing fish as a food source.

Transportation of ash throughout the plantation will be difficult due to the poor road system, although the Lasso cable system might be used to distribute the ash. Correct application to supply the proper dosage of nutrients to the soil and prevent runoff should be determined with the REC dendro coordinator.

It is anticipated that some combination of landfill and soil treatment will be employed at all sites depending primarily on soil conditions of the fuel wood plantations. The small quantity of ash produced at the power plant sites coupled with the remote locations should cause ash disposal to have minimal effect on the environment.

2. Liquid Wastes

One source of liquid waste that is common to both power plant processes is rainfall runoff from wood storage piles. This leachate is primarily composed of turpentines. The environmental hazard of this leachate is reduced, however, due to several factors. First, the wood used for fuel in the power plants is primarily composed of low resinous woods which have a much lower turpentine content than other softwoods. Second, the wood will be stored as logs, which reduces the ability of rainfall to leach turpentines from the wood. Thirdly, many turpentines are volatile and thus are released to the atmosphere. Thus, the major hazard would be the contamination of ground waters with turpentines, which are not toxic but do impart objectionable taste and odor.

The proposed design of the Japanese plants will incorporate outside chip storage, which will increase the amount of turpentines leached from the wood.

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The design of the open chip storage area should assure that drainage does not run directly to a stream. As discussed earlier, mixing of drainage from the ash and wood storage areas could be used to neutralize the waste stream.

The wastewater from the gasifier power plant process, however, does present serious environmental problems. As reported by J. V. Maxham, the wastewater from a similar fixed bed updraft gasifier located at Texas Tech University (Lubbock, Texas) includes a very high COD (in the range of 50,000 to 70,000), high TOC (in the range of 11,000 to 13,000), and a very high color (17). In addition, the wastewater is acidic (due, mostly, to acetic and proprionic acids) and fairly toxic, probably due to the phenols and creosols. The treatment alternatives available fall into three basic categories: physical/chemical, biological and pretreatment prior to discharge to a municipal biological system.

An inspection of the gasifier sites by the engineering team has indicated that there is a potential for contamination of the nearby streams. The water from the gas scrubbers is discharged directly into these streams at a flow rate of 75 liters per hour (20 gallons per hour). While this flow rate is small compared to the river flow rates of 719,778 liters per hour (190,166 gallons per hour) at OMECO and 359,889 liters per hour (95,083 gallons per hour) at ANTICO, a problem does exist.

The liquid discharge from the gasifiers requires a thorough investigation, including sampling to determine the specific pollutants being dumped into the nearby water. Additional pollution control equipment may be required to reduce BOD and COD levels.

Five physical/chemical treatment processes are available. All have major difficulties when applied to the treatment of wood gasification wastewaters. Activated carbon adsorption, when used in conjunction with a high rate fixed film activated sludge process, does, according to J. V. Maxham (18, 19) provide sufficient levels of treatment in both COD removal and color removal when applied at a rate of about one pound of activated carbon per gallon of water. The cost of such treatment, however, is prohibitive. It also creates a solid waste problem of similar proportions to the original wastewater problem. Ozoneation is another feasible process, but the consensus is that its cost would exceed that of even activated carbon. Solvent extraction was investigated by Kao (20) and, though some success in reducing toxicity was achieved

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utilizing methylethylketone, sufficient treatment levels to allow discharge to surface waters or even direct discharge to a biological system were not achieved. Also, the cost of solvent extraction would be very high. Research is continuing to isolate a solvent providing both reasonable costs and sufficient treatment levels, but nothing promising is yet available.

A fourth physical/chemical possibility is to borrow evaporative technology now in common usage in the pulp and paper industry for treating the spent black liquors of sulfite pulping operations. The process basically uses a cascade system to distill the aqueous and volatile phases of the black liquor until a solids content of about 70 percent by weight is achieved. The solids are then incinerated to produce ash. It is not known if this technology can be applied to the treatment of wood gasification wastewater. The components of the wastewater can be said, a priori, to be very different from the pulp black liquor. Its water content is much higher (which implies a higher energy requirement), and it is likely to contain a higher proportion of volatile compounds which could present other problems. It is almost certain that substantial R & D work would have to be undertaken prior to the application of evaporative technology to the wood gasification wastewater.

All biological wastewater treatment systems employ some form or combination of aerobic or anaerobic digestion. A wide spectrum of biological processes were investigated by J. V. Maxham (17). From an energy standpoint, the most advantageous process would be anaerobic digestion to yield methane. A further advantage of anaerobic digestion was found to be the higher loading rates achievable. The disadvantages of anaerobic digestion include a greater sensitivity to shock loading, a more prolonged and difficult start-up period, and a lack of dependability in COD reduction.

A more consistent and easily managed system was a high-rate fixed film activated sludge process with nutrient addition. COD reduction in the 70-80 percent range was achieved utilizing this process which is not, by itself, sufficient to allow discharge to surface water.

Direct discharge of this waste stream will have detrimental effects on aquatic life and possibly human life in the event the stream is subsequently utilized for irrigation and/or fishing. The exact level of impact is dependent on the assimilative capacity of the stream to accept a high BOD, turbidity, and acidity stream.

3. Gaseous Wastes

All of the gaseous wastes will result from the direct combustion of wood in the steam power plants and of wood gas and diesel in the gasifier-engine power plants. The qualitative combustion products of the wood fuel, similar for both processes, are water vapor, carbon dioxide and traces of nitrogen oxide. Carbon monoxide will also be present in very low levels depending on the trim of the boilers and tune of the wood gas/diesel engines. Sulfur compounds are negligible since wood is naturally low in these compounds. However, if high sulfur diesel is used in the gasifier-engine-generator sets, some traces will be present even with small quantities of the fuel.

Table 17 presents a summary of the emission factors and the size of boiler required to produce 100 tons per year of the pollutant. Emissions of 100 tons per year or less are acceptable levels for gaseous emissions. As seen in the table, sulfur and nitrogen oxides should not present a problem. The variation in carbon monoxide and hydrocarbon emissions accounts for the problems of incomplete combustion. The current systems proposed for the dendro program should present no problems in meeting the required standards.

Overall, the emissions from these power plants will be less than the current emissions produced to generate the power that is to be displaced in the dendro thermal program.

4. Particulates

Emission factors for particulates emitted from wood-fired boilers without cleanup systems are presented in Table 17 (21). And boiler systems without particulate cleanup like the Balfour Beatty designs are expected to emit approximately 5 kg per MW of power produced. Systems with cyclone collectors (Alsthom-Atlantique) will produce about half that quantity. The characteristics of the particulates are the same as those for the solid wastes in that environmental hazards are quite small for the power plants with their low levels of emissions and rural locations.

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Table 17

Typical Wood Fired Power Plant Emissions

	Emission Factor ($lb/10^6$ Btu)	Size Boiler Required to Produce 100 Tons/Year of Pollutant
Sulfur Oxides	0.017	98,039
Carbon Monoxide	0.23 - 6.98	72,464 - 2,388
Hydrocarbons	0.23 - 8.14	72,464 - 2,048
Nitrogen Oxides	0.25	66,667
Particulates	3.49	4,775

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5. Environmental Regulatory Compliance

In accordance with Presidential Decree No. 1586, all projects and project proposals whether public or privately undertaken must be reviewed so that socio-economic undertakings are reconciled with the goals of maintaining environmental quality (22). Under Section 4 of the Decree, all projects or areas in which projects are undertaken that are deemed critical to the environment must obtain an Environmental Compliance Certificate (ECC) to construct and operate such a project. Projects and areas in which projects are to be undertaken are determined critical by the President of the Philippines by his own initiative or upon the recommendation of the National Environmental Protection Council (NEPC).

At the time of printing, nine sectors are outlined as environmentally critical per Proclamation No. 2146 (22), which are:

- Non-ferrous metals industry.
- Iron and steel industry.
- Mining.
- Pulp and paper industry.
- Dams and reservoirs.
- Petroleum and petrochemical industries.
- The chemical industry.
- Agriculture.
- Urban growth.

Since dendro-thermal power plants are not on this list, only those power plants located in environmentally critical areas must obtain an ECC.

To obtain an ECC, a package of information called Environmental Impact Documentation (EID) must be submitted to NEPC. This package contains two components:

1. Project Description (PD).
2. Environmental Impact Statement (EIS).

The project description component of the EID describes the project and project site characteristics (prior to developmental activities) and identifies whether or not further study is necessary prior to project implementation. In detail, the PD must include the following:

- Descriptions of existing environmental conditions (prior to project implementation).
- Project size and scale.
- Process diagram, work program, plan of operation, and PERT chart.
- Project outputs of effluents, emissions, and/or solid wastes.
- Waste disposal plan/waste management plan.

The EIS is far more detailed in that it must address the primary, secondary, and tertiary impacts of the proposed project. This document should weight the environmental/health effects with the socio-economic effects on the region.

It is implied that the EID should be submitted to the NEPC prior to project implementation; however, the expressed language of such is not found. Details with examples of the preparation of this documentation are presented in the Environmental Impact Assessment Handbook available from the NEPC (22).

Under the rules and regulations of the NEPC, Article II, Section 2, it is possible to obtain a waiver in obtaining an ECC for reasons of national interest. Those plants that may be located in environmentally critical areas may pursue this route if additional pollution control adversely affects plant economics. Obtaining this waiver would thus be done on the basis of the socio-economic impact the plant would have on the local populus.

At present, the 11 plants under construction are not known to be located in environmentally critical areas, and an ECC should not be necessary. However, the National Pollution Control Commission (NPCC), which certifies pollution abatement equipment, and the NEPC should be consulted on each plant system and plant site for any special environmental problems that might arise.

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Two problems have been found by the study team which may require special considerations for NEPC. First, the Balfour Beatty steam power plants discharge cooling water at 46°C, which exceeds NEPC standards set at 40°C (23). This small difference may have little impact except at locations of small streams. Second, the gasifier-engine power plants dicharge gas cooling waters of 80°C temperature and high chemical content. Although this effluent stream is quite small (2 ton/hr), it may have a noticeable effect on water quality downstream if the water source is used for fishing, irrigation and/or drinking (Class AA through D stream).

Table 18 presents a summary of the river water flows for the INEC, ISELCO I and ISELCO II plant sites and the required cooling water flow for the power plant. During the dry season, the discharge of cooling water from the power plant will cause a rise in the river water temperature. However, the dry season occurs at the same time as the maximum water temperature, and thus thermal pollution should not be a problem.

Table 18

Analysis of British Design Plants
River Water Cooling Systems

Plant	Equipment Water Required (gpm)	Maximum River Flow (gpm)	Minimum River Flow (gpm)
INEC	3212	31,698	10,460
ISELCO I	3212	316,985	158,492
ISELCO II	3212	63,397	9,510

25102 Federal Register / Vol. 49, No. 119 / Tuesday, June 19, 1984 / Proposed Rules

ENVIRONMENTAL PROTECTION AGENCY

40 CFR Part 60

[AD-FRL-2489-1]

Standards of Performance for New Stationary Sources; Industrial-Commercial-Institutional Steam Generating Units

AGENCY: Environmental Protection Agency (EPA).

ACTION: Proposed rule and notice of public hearing.

SUMMARY: This proposal would revise Subpart D of 40 CFR Part 60 as it currently pertains to emissions of particulate matter and nitrogen oxides from industrial-commercial-institutional steam generating units. The proposed standards would limit emissions of particulate matter and nitrogen oxides from all new, modified, and reconstructed industrial-commercial-institutional steam generating units capable of combusting more than 29 MW (100 million Btu/hour) heat input. Under the proposed standards, emissions of particulate matter and nitrogen oxides would be reduced by an estimated 22,000 to 46,000 Mg (24,000 to 51,000 tons) per year and an estimated 11,000 to 28,000 Mg (12,000 to 31,000 tons) per year, respectively, from new, modified, and reconstructed industrial-commercial-institutional steam generating units built in the next 5 years.

Revised sulfur dioxide emission standards are currently under development for industrial-commercial-institutional steam generating units and will be the subject of a separate rulemaking action. Consequently, the sulfur dioxide emission standards under Subpart D of 40 CFR Part 60 would remain in effect for industrial-commercial-institutional steam generating units larger than 73 MW (250 million Btu/hour) heat input capacity until revised sulfur dioxide standards are proposed. Similarly, emissions of particulate matter from oil-fired industrial-commercial-institutional steam generating units with heat input capacities greater than 73 MW (250 million Btu/hour) would also continue to be regulated by Subpart D of 40 CFR Part 60 until revised standards for particulate matter emissions from oil-fired steam generators are proposed as part of the rulemaking to revise the sulfur dioxide emission standards. Electric utility steam generating units larger than 73 MW (250 million Btu/hour) heat input capacity would not be covered by the proposed standards. They would continue to be subject to separate standards under 40 CFR Part 60, Subpart Da.

The proposed standards would implement section 111 of the Clean Air Act and are based on the Administrator's determination that industrial-commercial-institutional steam generating units cause, or contribute significantly to, air pollution which may reasonably be anticipated to endanger public health or welfare. The intent of this rulemaking it to require new, modified, and reconstructed industrial-commercial-institutional steam generating units to achieve emission limits reflecting the best demonstrated technological system of continuous emission reduction, considering costs, nonair quality health and environmental impacts, and energy requirements.

A public hearing will be held to provide interested persons an opportunity for oral presentation of data, views, or arguments concerning the proposed standards.

DATES: *Comments:* Comments must be received on or before September 17, 1984. *Public Hearing:* A public hearing will be held on August 1, 1984, beginning at 10:00 a.m. Persons wishing to present oral testimony must notify Ms. Shelby Journigan at the address below by July 26, 1984.

ADDRESSES: *Comments:* Comments should be submitted (in duplicate if possible) to: Central Docket Section (LE-131), Attention: Docket Number A-79-02, U.S. Environmental Protection Agency, 401 M Street, SW., Washington, D.C. 20460.

Public Hearing: A public hearing will be held at the ERC Auditorium, Corner of Highway 54 and Alexander Drive, Research Triangle Park, N.C. Persons wishing to present oral testimony must notify Ms. Shelby Journigan, Standards Development Branch (MD-13), U.S. Environmental Protection Agency, Research Triangle Park, North Carolina 27711, telephone number (919) 541-5624.

Background Information Documents: The background information documents (BID's) for the proposed standards may be obtained from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, telephone number (202) 783-3238 (GPO stock number 055-000-00216-9). The background information documents include EPA-450/3-82-006a "Fossil Fuel Fired Industrial Boilers—Background Information Volume 1: Chapters 1-9," EPA-450/3-82-006b "Fossil Fuel Fired Industrial Boilers—Background Information Volume 2: Appendices," and EPA-450/3-82-007 "Nonfossil Fuel Fired Industrial Boilers—Background Information." The price of the three-volume set is $28.00.

The cost reports for steam generating units and control devices may be obtained from the National Technical Information Service, U.S. Department of Commerce, Springfield, Virginia 22161, telephone number (703) 487-4650 (NTIS stock number PB-83-119438). The cost reports include EPA-450/3-82-021 "Costs of Sulfur Dioxide, Particulate Matter, and Nitrogen Oxide Controls on Fossil Fuel/fired Industrial Boilers" (NTIS stock number PB-83-119438), and EPA-450/3-83-004 "Costs of Particulate Matter Controls for Nonfossil Fuel-fired Boilers" (NTIS stock number PB-83-19365). The price is $20.50 and $13.00, respectively, for each volume in printed copy, or $4.50 for a microfiche copy of each volume.

Information on spreader stoker steam generating units gathered in a three-volume joint study by the American Boiler Manufacturing Association (ABMA), Department of Energy (DOE), and Environmental Protection Agency (EPA) may also be obtained from the National Technical Information Service (NTIS stock number DE81030264-Vol. 1; DE81030265-Vol. 2; DE81030266-Vol. 3). These reports include DOE/ET/10386-T1 (Volumes 1, 2, and 3) "Emissions and Efficiency Performance of Industrial Coal Stoker Fired Boilers." The price is $26.50 each for volumes 1 and 2 and is $35.50 for volume 3 (printed copy). The cost of a microfiche copy of each volume is $4.50.

Docket: Docket Number A-79-02, containing supporting information used in developing the proposed standards, is available for public inspection and copying between 8:00 a.m. and 4:00 p.m., Monday through Friday, at EPA's Central Docket Section, West Tower Lobby, Gallery 1, Waterside Mall, 401 M Street, SW., Washington, D.C. 20460. A reasonable fee may be charged for copying.

FOR FURTHER INFORMATION CONTACT: Mr. Fred Porter or Mr. Walter Stevenson, Standards Development Branch, Emission Standards and Engineering Division (MD-13), U.S. Environmental Protection Agency, Research Triangle Park, North Carolina 27711, telephone number (919) 541-5624.

SUPPLEMENTARY INFORMATION:

Preamble Outline

I Proposed Standards
II Summary of Environmental, Energy, and Economic Impacts
III Rationale
A. Selection of Source Category
B Selection of Pollutants, Fuels, and Affected Facilities

C. Selection of Formats for Emission Limits
D. Selection of Demonstrated Emission Control Technology and Emission Limits
1. Nitrogen oxides
2. Particulate matter
3. Consideration of demonstrated control technology costs
E. Selection of Regulatory Alternatives
1. Consideration of economic impacts
2. Consideration of national impacts
F. Selection of Best System of Continuous Emission Reduction
G. Performance Test Methods and Monitoring Requirements
1. Particulate matter
2. Nitrogen oxides
Modification and Reconstruction Provisions
Analysis of Information Requirements
Regulatory Flexibility Analysis
I. Public Hearing
II. Docket
Request for Comments
Miscellaneous

Proposed Standards

Standards of performance for new urces established under Section 111 of : Clean Air Act reflect:

' application of the best technological tem of continuous emission reduction ich (taking into consideration the cost of ieving such emission reduction, any air quality health and environmental act and energy requirements) the ministrator determines has been nustely demonstrated (section 111(a)(1)).

..e proposed standards would revise particulate matter and nitrogen des emission limits in Subpart D of 40 R Part 60 for industrial-commercial- itutional steam generators over 73 V (250 million Btu/hour) heat input acity and would set new standards industrial-commercial-institutional am generating units larger than 29 V (100 million Btu/hour) heat input acity. The proposed standards would revise the standards for sulfur xide currently included in Subpart D 0 CFR Part 60. The sulfur dioxide ndards in Subpart D will continue to ly to industrial-commercial- itutional steam generating units of ter than 73 MW (250 million Btu/ r) heat input capacity.

he proposed standards apply to all .. modified or reconstructed strial-commercial-institutional m generators which have a capacity ore than 29 MW (100 million Btu/) heat input and which fire coal, oil, ral gas, wood, or municipal-type l waste and mixtures of these fuels and without other fuels. Electric ty steam generating units with ter than 73 MW (250 million Btu/ heat input capacity will continue covered under Subpart Da of 40 Part 60

Only those steam generating units with a heat input capacity of greater than 29 MW (100 million Btu/hour) for which construction, modification, or reconstruction is commenced after June 19, 1984 would be affected by the proposed standards. "Construction" is defined by 40 CFR 60.2 to mean "fabrication, erection or installation of an affected facility." *Sierra Pacific Power Co.* v. *EPA*, 647 F.2d 60 (9th Cir. 1981). The affected facility for this standard is the steam generating unit as defined in the proposed standards (§ 60.41b). "Commenced" is defined by 40 CFR 60.2 to mean "than an owner or operator has undertaken a continuous program of construction or modification or that an owner or operator has entered into a contractual obligation to undertake and complete, within a reasonable time, a continuous program of construction or modification." The phrase "contractual obligation" means a contractual obligation that cannot be cancelled without incurring significant liability. *Potomac Electric Power Co.* v. *EPA*, *650 F.2d 509, 513–515 (4th Cir. 1981).*

Particulate matter standards are proposed for coal-, wood-, and municipal-type solid waste-fired steam generating units, as well as for steam generating units firing mixtures including these fuels. For coal-fired steam generating units, the proposed particulate matter standard is 22 ng/J (0.05 lb/million Btu) heat input. For steam generating units which fire wood or municipal-type solid waste, the proposed particulate matter standard is 43 ng/J (0.10 lb/million Btu) heat input. For steam generating units which fire coal with wood, solid waste or other fuels, applicability of the proposed standard would be determined based on the amount of coal combusted relative to other fuels. Steam generating units which have an annual capacity factor for wood, solid waste or other fuels greater than 5 percent and which have an enforceable Federal, state or local operating permit which specifies that while the unit is operated, an annual capacity for wood, solid waste or other fuels is to be maintained above 5 percent, would be subject to the proposed particulate matter standard of 43 ng/J (0.10 lb/million Btu) heat input. If a steam generating unit combusts coal but has an annual capacity factor for wood, solid waste, or other fuel of 5 percent or less, or if there is no Federal, state or local operating permit, the proposed particulate matter standard of 22 ng/J (0.05 lb/million Btu) heat input would apply.

Steam generating units in the 29 through 73 MW (100 through 250 million Btu/hour) heat input capacity range that would have an annual capacity factor of 30 percent or less, based upon the combustion of coal, wood, or municipal-type solid waste, and which have an enforceable Federal, State or local operating permit limiting the annual capacity factor of the steam generating unit for these fuels to 30 percent or less on an annual basis, would be subject to a particulate matter standard of 86 ng/J (0.20 lb/million Btu) heat input.

The annual capacity factor for determining the applicable particulate matter standard would be calculated by dividing the actual annual heat input to the steam generator from firing coal, wood, solid waste or mixtures of these fuels by the potential annual heat input to the steam generating unit from all fuels. The potential annual heat input is defined as the product of the maximum rated heat input capacity (MW or million Btu/hour) times 8,760 hours per year.

The proposed opacity standard for all steam generating units firing coal, wood, or solid waste is 20 percent opacity (six-minute average).

Performance tests to determine compliance with the particulate matter emission limits would be conducted using Reference Method 5 or 17. Reference Method 3 would be used for gas analysis and Reference Method 1 for the selection of sampling points. Reference Method 9 (a 6-minute average of 24 observations) would be used to determine compliance with the opacity standard. Continuous opacity monitoring would be required for all steam generators. Semiannual reports of excess opacity would be required if any excess emissions are monitored during a 6-month period.

Nitrogen oxide (NO_x) standards are proposed for industrial-commercial-institutional steam generating units with a heat input capacity above 29 MW (100 million Btu/hour) which fire natural gas, oil, coal or mixtures of these fuels with or without other fuels.

The proposed NO_x emission limits are 301 ng/J (0.70 lb/million Btu) heat input for pulverized coal-fired steam generating units, 258 ng/J (0.60 lb/million Btu) heat input for spreader stoker coal-fired steam generating units, and 215 ng/J (0.50 lb/million Btu) for mass-feed stoker coal-fired steam generators. For lignite-fired steam generating units, the proposed NO_x standard is 258 ng/J (0.60 lb/million Btu) heat input, except for lignite mined in North Dakota, South Dakota, or Montana that is combusted in a slag tap type furnace for which the proposed

Appendix F

Financial Flow for a 1,000-Hectare Tree Plantation

Table 1. Estimated cost and returns of dendrothermal plantations (1985 prices*)

Effective area = 1000 ha

Year	Fixed Cost (Plt'n Dev't Cost)	Maintenance** Cost	Wood sales	Net
1	₱1731500			(1731500)
2	1731500			(1731500)
3	1731500			(1731500)
4	1731500			(1731500)
5		110625	4000000	3889375
6		110625	4000000	3889375
7		110625	4000000	3889375
8		110625	4000000	3889375
9-25		110625	4400000	4289375

* Expenses for soil tests, site classification, supervision, and other administrative expenses are excluded.

** does not include harvesting cost

Assumptions:

1 - Yield: 20 wet tons/ha/yr

2 - Wood req./yr = 19000 tons/yr, 40% MC

3 - Yield in 2nd rotation onwards increased by 10% over the 1st harvest.

4 - Cost of wood = ₱200/wet ton

5 - Cost of labor = ₱29.50/MD

6 - Expected annual harvest of 20,000 tons/yr.

The excess of 1000 tons maybe sold as fueld-wood or charcoal.

Table 3. Financial flow: 120 ha agroforestry farm:
Trees + coffee cropping system

Agroforestry:

- Area to be planted = 30 ha/y for 4 yr or 120 ha
- Planting of permanent trees at 200 trees/na.
- Planting of permanent agricultural crops like coffee, black pepper

A. Coffee:

Year	Devt. Cost	Maintenance Cost	Gross Sales	Net
1	64125	-	-	(64125)
2	361965	86940	-	(448905)
3	361965	174880	-	(536845)
4	361965	266245	180000	(448210)
5	297840	365460	675000	10700
6		375260	1546200	1170940
7		384160	2743200	2359040
8		384160	4011300	3627140
9		384160	4964400	4580240
10		384160	5792400	5408240
11		384160	5792400	5408240
12		384160	5792400	5408240
13		384160	5792400	5408240
14		384160	5792400	5408240
15		384160	5792400	5408240

Assumptions: Agroforestry development program:

Total Area = 120 ha: 30 ha/yr

Species mix= Permanent trees (narra) and coffee

Permanent trees to be planted 1 year ahead of coffee

Density:

Trees - 200/ha

Coffee - 1100/ha

Cost estimates: Per ha

1. Seedlings: Trees - ₱200
   Coffee - 5085
2. Estab. Cost:

   Trees - ₱2137.5 +

   Coffee - 4843.0

3. Recurring Cost - 2898/ha/yr

4. Harvesting cost - 295/ha/yr

5. Yield:

Age	Kg/ha	Price
3	200	₱6000
4	550	16500
5	968	29040
6	1330	39900
7	1463	43890
8	1609	48270
9	1770	53100
10-15	1997	59910

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9	1770	53100
10-15	1997	59910

TABLE 1. Cost breakdown for plantation development; 1000 ha @ 200 ha/yr.

	Fixed Cost	Maintenance Cost	Wood Sales	Net Income
1	1868300*	164000**		(2032300)
2	1638300	164000		(1802300)
3	1638300	164000		(1802300)
4	1638300	164000		(1802300)
5	1638300	164000		(1802300)
6		429500	3500000+	3070500
7		429500	3500000	3070500
8		429500	3500000	3070500
9		429500	3500000	3070500
10		429500	3500000	3070500
10-25		429500	3500000	3070500

*includes

Plant. devt. cost	-	1638300
Nursery const.	-	10000
Site class (soil & topo survey)	-	20000
Capital expenses	-	200000
		1868300

**Adm. cost

+Cost of wood = P7/20 kilos or P350/ton

COST BREAKDOWN:

I. Nursery construction (servicing total area		10,000
II. Seedling production (per ha)		
a. seeds, plastic bags, tools, supplies, etc. = 1/3 kilo		600
b. Labor		
Sowing	1 MD	29.50
Potting	20	590
Care & maintenance	30	885
Transport	10	295
SUB-TOTAL (a + b)		2,499.5
III. Plantation Devt.		
Site preparation	50	1,475
Planting	15	442.5
Replanting & fert.	5	147.5
1st weeding	30	885
2nd weeding	20	590
3rd weeding	15	442.5
Fire break const.	15	442.5
Fert. (2 bags)		600
Tools		150
Contingency		517
SUB-TOTAL		5,692
Maintenance cost (second rotation)	45 MD/ha	1,327.5

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Appendix G

Fuelwood Harvesting and Transportation

Eulogio Tagudar

Bohol Electric Cooperative -- BOHECO II

The dendro thermal plantation site is located in Barangays Ilaya and Datag, Municipality of Tnabanga, Province of Bohol. The area includes rolling/gentle terrain, hills and mountains, with rounded and sharpridged hills and mountains and small bottom lands in between. These irregular terrain patterns at the BOHECO dendro thermal plantation site would necessitate careful preparation of a logging plan, so that fuel wood harvesting and transportation will not only be economical, but will also minimize soil erosion and ecological problems.

Proposed Dendro Thermal Forest Plantation

Harvesting costs were estimated for a plantation of 944 hectares at BOHECO, expected to yield about 105 cubic meters per hectare. With a four-year harvesting cycle for planted trees, annual production is estimated at 23,620 cubic meters and daily production of 105 cubic meters. The same costs per hectare were used for both Bohol and Masbate. The cost estimates in the financial and economic analyses were then scaled to reflect the plantation size needed for a two-MW plant on Bohol and a 700-kw plant on Masbate.

Annual Operating Plan

Before harvesting commences, an annual operating plan must be prepared. A forest inventory should be conducted of the plantation by module for a particular year to determine the area to be logged and volume harvested, including an estimate of the diameter range of trees to be harvested.

The annual operating plan should be prepared at least two months before each calendar year or the next harvest and should include the following principal features:

- area in hectares to be logged by module;
- volume in cubic meters to be harvested by module;
- location of the areas to be logged by module;
- kind of equipment and tools needed for felling, debranching, skidding, crosscutting and hauling or transporting fuelwood to the dendro thermal power plant; and
- sketch of the area to be harvested.

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The Fuelwood Plantation Harvesting Operation

Fuelwood plantation harvesting involves the sequential operations of felling, debranching, crosscutting, skidding and transporting or hauling fuelwood to the plant site.

Harvesting the estimated daily production of 105 cubic meters will require the following equipment, tools and manpower. A polyethelene pipe slide operation will produce 72 cubic meters per day or about 70 percent of the volume to be delivered. This operation will require 29 fallers and crosscutters, and 12 laborers to operate the chutes. In terms of equipment and tools, 750 meters of 12-meter sections of polyethylene pipe slide (this is available in the Philippines and would be purchased by BOHECO), 29 bow saws, 29 axes and 29 bolos are needed.

A carabao sled operation will produce 33 cubic meters per day or about 30% of the volume to be delivered. Manpower requirements include 13 fallers/crosscutters, and 10 men to operate the carabaos and carry, pile and tie fuelwood on the sleds. The equipment and tools needed are 8 sleds, 10 carabaos, 13 bow saws, 13 axes and 13 bolos.

A carabao cart operation will deliver 105 cubic meters daily to the plant site. This operation will need five carabao operators as well as 15 laborers to pile, carry and load the carts. The equipment required is five carts and seven carabaos.

Three timekeepers will be needed for every 28 personnel because the operation is scattered over a wide area. Two supervisors will also be needed, one for the polyethylene pipe slide operation and the other for the carabao sled operation.

Hauling truck operations will be contracted out, but supervised by the two aforementioned supervisors. Truck operators will be paid for the fuelwood delivered at a rate of ₱1.00 per cubic meter per kilometer.

Construction of the roads needed for both trucks and carabao carts will be done using equipment from the Bohol Provincial Engineer of Ministry of Public Works and Highways. Accordingly, BOHECO will pay all the expenses incurred (e. g., gasoline, diesel fuel, lubricants etc.) during road construction.

All of the personnel needed for the harvesting operation will be chosen from present occupants of the area, except timekeepers and supervisors, who will be hired by the REC. Since harvesting will be done by module, the Tree Farmers' Associations will be responsible for hiring the required personnel. Work animals or carabaos will come from each module, and there are no less than 100 carabaos at the BOHECO site.

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The actual harvesting operation begins with felling. Trees are felled using bow saws, axes and bolos. Bow saws will be used to fell and crosscut trees that are eight centimeters in diameter or larger and the axes for trees smaller than eight centimeters in diameter, while the bolos will be used to cut branches, twigs and tops. Care should be taken to avoid unnecessary injuries to the stumps of trees that are eight centimeters in diameter or larger, as this can impede or prevent coppicing. Thus bow saws should be used for this purpose, and the stump cut at a slant and about 10 to 20 centimeters above the ground.

Debranching and crosscutting is the next step in the harvesting operation. After a tree is felled, the branches and twigs are trimmed off and then crosscut using a bolo at the top or tree length in the carabao sled operation or in one-meter lengths for the polyethylene pipe slide operation. This is followed by piling in one continuous operation. In the polyethylene pipe slide operation, felling should not occur over 50 meters from either side of the pipe slide line, and in the carabao sled operation, not more than 100 to 200 meters from either side of the cart road, although these distances will depend largely on the terrain.

Skidding in the polyethylene pipe slide operation is accomplished by laying the 12-meter sections of polyethylene pipe slide on the ground in the center of the harvesting area. The sections can be bolted together to form a line of 250 meters or less, on a slope from 29° to 46°. On one side of the pipe slide line, one slide operator carries and piles the one-meter lengths of fuelwood to the pipe line, and another drops them to the chute. Another two men work on the other side of the pipe slide line, and every two to four hours, the operators change places. The operation can begin at the upper portion of the line and move down until the area is completely harvested. After the first area is finished, the polyethylene pipe slide can be disassembled and transferred to the next area by the laborers. Normally, a gang of four men can harvest about 18 cubic meters per day. In the Philippines, polyethylene pipe slide is used extensively by the Celophil Resources Corp. at Abra to harvest pine logs on steep terrain. Polyethylene pipe slide should be seriously considered for small operations like the REC tree farms because:

- it is very cheap and can be used for long periods of time;

- assembly is simple and could easily be learned by Filipinos; the pieces can be disassembled, transferred and reassembled by the laborers; and

- maintenance costs are low, unlike imported yarding machines which are expensive and difficult to operate.

In the carabao sled operation, one man is needed to operate two carabaos, and one carabao and another man are required to carry, pile and tie the fuelwood to the sled prior to hauling it by carabao to the loading station. Carabao sleds are made of two strong poles, each about eight centimeters in diameter, with another pole nailed across the lower ends of the two poles and a yoke attached to the upper ends with abaca rope. Pegs on the sides of the sled prevent the load from falling off. One advantage of the sleds is that all the parts are readily available locally so they can easily be repaired by the farmers, who have been using these sleds for many years. The average load per trip is approximately one-half cubic meter, so a team should, and easily could, make a minimum of eight to 10 trips per day.

An innovative carabao cart design* was successfully used in a pulpwood operation with falcata trees in the Paper Industries Corporation of the Philippines at Surigao del Sur. The cart has four wheels mounted on separate axels and is equipped with mechanical brakes to control its speed while descending and hold it in position when pulling uphill. The cart is designed with a tongue mounted on a fulcrum that permits both upward and sideways movement. The wheels are balloon tires which can float on soft ground or muddy spots in the road. The cart is estimated to cost about ₱15,000 and five would be needed to deliver the daily requirement of 105 cubic meters of fuelwood to the plant, since it is estimated that a cart can carry from three to five cubic meters per trip. All of the cart's parts, including the tires, can be produced in the Philippines, and the cost is suitable for the BOHECO site, which has eight months of rain.

Road Construction

According to BOHECO officials, and confirmed in a report by Hodam and Associates, Inc., there are 15.2 kilometers of existing dirt roads and 7.8 kilometers of new roads will need to be constructed. However, the existing 15.2 kilometers of road is in such dilapidated conditions that it will require a lot of repair, ditching, surfacing and alignment before hauling can begin. Since harvesting will occur simultaneously in all the modules for a period of 12 months, the roads connecting the plant site and the modules should be constructed at least two years before harvesting the fuelwood plantation. This is, unlike harvesting operations in the timber industry, where an area is logged year after year starting from the area nearest the log pond and gradually working up to the end of the area. As a result, road construction can proceed segment by segment or only in areas where the timber company will operate during the year. In contrast, in the BOHECO area, road construction will have to be done over practically the whole site to connect all

*Hodam & Associates Report

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the modules. If it were done segment by segment, only a few modules would be accessible for harvest each year, and other modules with four-year old plantations would complain of having no roads near their harvestable fuelwood.

The reasons for advance road construction include:

- allowing ample time for roads to stabilize before the harvesting operation;
- the equipment for road construction borrowed from the Provincial Engineer's office or the Ministry of Public Works and Highways may not be available at one time; and
- it rains in the area almost 8 to 10 months of the year.

Since these roads will be used daily to deliver fuelwood to the power plant, a good road bed and proper maintenance are required. Hodam and Associates, Inc. reported that it will cost approximately ₱34,200 per kilometer to rehabilitate the 15.2 kilometers of existing, but dilapidated, roads. The road system is very important to assure sustained delivery of fuelwood, in order to optimize operation of the dendro thermal power plant and avoid brownouts. It is estimated that five trucks will be needed to deliver the fuelwood to the plant site, as they will haul about four cubic meters per load.

Socioeconomic Impact

First, tree farmers will realize an income they have never enjoyed before. Second, employment will be created in the numerous activities of an agro-forestry farming project, including establishment of the tree farms, production of agricultural crops, and harvesting, hauling and processing of fuelwood trees at the dendro thermal power plant. Third, the opportunities for increased income among tree farmers will generate additional benefits, such as an improved standard of living for rural people, and participation in local community affairs and local government among others. Fourth, accessibility of backward areas through the construction and maintenance of access roads, and will also create business opportunities for people from the site and adjacent communities.

Environmental Impact

As described elsewhere in this report, fuelwood will be harvested by strips, i.e., one strip every four years, using the plan in which one-fourth of the module is planted every year. Thus, the BOHECO site will have almost three-fourths of its area covered with green ipil-ipil trees at all times. Skidding and moving fuelwood across creeks or ravines and along slopes using a polyethylene pipe slide will have little or no effect on surface soil, since fuelwood passing through the chutes does not touch the ground.

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The clearcuts will also have very little effect on soil erosion because the area has eight to 10 months of rainfall, which will promote rapid regrowths of coppice from stumps and the natural regeneration of ipil-ipil seeds upon exposure of the mineral soil to full sunlight. Several other species of underbrush, such as grasses, shrubs and other fast-growing weeds, will germinate as soon as the ground is exposed to sunlight. The entire area covered by plant growth will minimize river siltation.

On the whole, the presence of green ipil-ipil canopies throughout the area is perceived to have a predominantly positive impact on the environment.

Recommendations

In order for BOHECO to manage the operation of a dendro thermal plantation successfully, the following recommendations are made. First, a team should be formed from BOHECO organization to:

- draw up schedules for purchasing equipment and tools, sleds, carabao carts, work animals and other required materials;
- confer with the Bohol Provincial Engineer or officials from Ministry of Public Works and Highways about construction of the truck and carabao cart roads, and method of payment for that work;
- formulate budgets for the purchase of the necessary tools and equipment;
- prepare for organization of the harvesting operation and the required personnel, including job descriptions, spheres of authority and responsibilities; and
- locate contractors to haul fuelwood to the plant site and agree on the mode of payment.

Second, a Supervisor should be hired and trained. Third, local and national officials should be consulted about the manner by which fuelwood will be manifested and disposed of in accordance with the law. Fourth, the action programs needed to have the operation succeed should be prepared. Finally, a forest inventory of the areas to be harvested in a particular year should be conducted to ascertain whether there will be excesses so that other sources can be sought if shortages will occur.

Masbate Electric Cooperative -- MASELCO

The proposed dendro thermal plant and fuelwood plantation on Masbate is located at Barangays Mada, Simawa and San Jose, Municipality of Uson, Province of Masbate. At present, there is no passable access road to the area, except for a dirt road about four kilometers from the provincial road. The remaining

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10 to 12 kilometers are unfinished bulldozed roads and foot trails. The plantation site is relatively moderate, to gentle with some rough areas. The elevation ranges from 200 meters above sea level at the river on the eastern boundary to a high point of 564 meters above sea level, which is more or less on the southern boundary of the proposed tree farm. There will be uphill harvesting along the western boundary that cannot be avoided.

Tree Farmers

From the assessment team's interview with some MASELCO officials and residents at the site, there are about 96 people residing within the proposed fuelwood plantation site, who do not want to be organized into modules of 100 hectares each. They claim that under such an arrangement, they will lose ownership of an area they have occupied for a long time. Others maintain that the land was owned/claimed by their parents, who gave it to them. If these residents cannot be organized into tree farm associations by modules, it shall complicate the orderly planting and harvesting of the area, unlike other REC plantation sites, which are organized into modules, such that only the head of each module need be contacted to schedule planting and harvesting. However, this case is not yet hopeless, and the following recommendations should be implemented.

First, a team should be formed to conduct a rough survey of the area actually occupied and claimed by the 96 residents and other claimants living inside the proposed fuelwood plantation site. These locations should be plotted approximately on a map to give MASELCO an overview of the actual situation at the proposed site.

Second, a registry of the area (in hectares) occupied and claimed, agricultural crops (both perennial and annual) on each claimed area, and present vegetative cover on unclutivated protions of the claimed area should be prepared. From this list, MASELCO can determine the area that can be planted under their control.

Third, with the survey map as a basis, MASELCO should temporarily organize the occupants into a loose module consisting of about 150 hectares with about 3[illegible] heads of households. One to two modules should be supervised by MASELCO agriculturists, agro-forestry or extension officers, who will campaign for planting of the modules under their supervision. Officers will record all plantings in their respective sectors by year and the area planted, so that the area to be harvested can also be scheduled four years later. In this unique situation, the officers will need to have a lot of perseverance, patience and sincerity in dealing with occupants and convincing the farmers to plant trees.

Fourth, in order to develop about 1,000 hectares, at least three to six agro-forestry or extension officers should be required to handle the whole MASELCO dendro thermal plantation.

Alternative proposal would be an area to be developed by MASELCO as a guarantee for an assured wood supply for the power plant.

Harvesting and Transportation

Road construction will be complicated, as roads will have to be as close as possible to either the tree farmers' lot or some sort of carabao cart or sled road that reaches the individual tree farm. MASELCO's expenses for construction for carabao cart or sled roads will essentially be the same as for the BOHECO roads since the equipment used will come from the Provincial Engineer's Office or the Ministry of Public Works and Highways.

Harvesting will be done by the tree farmers, using a carabao sled, like the tree farmers of Surigao del Sur who sell falcata pulplogs to the Paper Industries Corporation of the Philippines (PICOP). Tree farmers without carabaos can have their trees harvested by contract. Felling operations should basically follow the procedures already described, but ipil-ipil trees should be cut at tree length. The 1984 costs for PICOP harvesting contracts were ₱3 per cubic meter for felling/crosscutting and ₱35 per cubic meter for skidding for a total of ₱38 per cubic meter. 1985 costs would be from ₱45 to ₱55 per cubic meter.

Again, loading and hauling can be done by contract, but subsidized by MASELCO to provide more employment in the rural areas. PICOP pays a loading cost of ₱5.75 per cubic meter for a manual system, in which two to three men stay on top of the truck to pile the fuelwood, while 3 to 4 men remain on the ground to carry and lift the wood for loading. Hauling by contract will also be subsidized by MASELCO. PICOP pays a hauling cost of approximately ₱1.00 per cubic meter per kilometer.

Recommendations

The key to successful implementation of the dendro thermal plantation on Masbate is a scheme whereby MASELCO has its own tree farm to assure a ready supply of fuelwood for the power plant, while at the same time, the REC develops an agro-forestry tree farm program for occupants, so that the tree farmers involved will be amenable to developing their areas to ipil-ipil or other suitable trees for sale to MASELCO. This approach is proposed because it would be risky and dangerous for MASELCO to rely on a wood source that it has no control over. PICOP is a prime example -- it relied for too much of its pulpwood supply (about 60 to 70%) from tree farmers, procuding the rest (only about 30 to 40%) on its own plantation. When the tree farmers found a market with higher prices for their pulpwood, PICOP could only buy 30 to 40% of its pulpwood requirement from the tree farmers. Therefore, the decision to build a power plant on Masbate should depend largely on the ability of MASELCO to sell its plan to tree farmers and make it work for the mutual benefit of both MASELCO and the residents.

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Cebu Electric Cooperative -- CEBECO II

Because there is no available information or data on the proposed plant and fuelwood plantation sites at Tuburan, Cebu, the following steps are recommended. First, an aerial topographic map of the proposed area should be secured to provide firsthand information on the terrain, location of creeks and rivers, and other pertinent information. Second, a perimeter survey of the site should be conducted to determine the available area in hectares. Third, an application should be filed with the Bureau of Forest Development for an industrial tree plantation or tree farm lease agreement for the area. Fourth, a team should be formed to gather the following basic information:

- names of household heads and number of members in each family;
- area in hectares actually occupied or cultivated;
- agricultural crops planted by each family;
- water supply, such as river or creeks;
- area claimed, but not cultivated, by each family;
- accessibility of the area by roads, trails or water;
- means of transportation and communication between the area and the nearest town or city;
- organization or association formed by the residents;
- "peace-and-order" situation in the area;
- reactions to CEBECO's proposed tree farm development program; and any
- other relevant information.

Finally, while waiting for approval of the application for a tree farm lease and collecting the basic information discussed above, CEBECO II should:

- hire and train agroforestry or extension officers in the formation/organization of cooperatives patterned after RECs, in order for proposed technical personnel to learn how to develop tree farm plantations and allow them to visit successful REC projects in Luzon or elsewhere in the Visayas;
- with a cooperative landowner, begin establishing pilot demonstration plots to show people how to establish tree farms; and
- in cooperation with concerned government agencies, gather soil samples from the proposed tree farm area to test the soil pH and determine whether soil nutrients are available or lacking.

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Appendix H

IMPLEMENTING GUIDELINES REGARDING ARRANGEMENT FOR BISA PROJECTS AFFECTED BY THE PROPOSED NIA NATIONAL IRRIGATION SYSTEMS

To resolve the issues relating to the supervision and mode of irrigation fee collection as well as financial arrangements for BISA projects now covered or soon to be covered by the NIA National Irrigation Systems, the Central Coordinating Committee has agreed on the following implementing guidelines:

1. FSDC shall pull-out the PMEAS installed in BISA projects covered by NIA systems upon the instance of the ISAs concerned, provided the NIA National Irrigation System is fully operational and can provide sufficient water to the ISA.

2. After the pull-out, the ISA shall be retained and supervised coordinatively by NIA and FSDC. The NIA will take care of the irrigation operation, maintenance and water management aspects, while FSDC will take care of the development of farm systems enterprises. FSDC in handling the institutional activities shall see to it that the policy and guidelines of NIA on the operation maintenance and water management aspects are being followed. This shall be subject to modification depending on the outcome of evaluation to be conducted after one cropping season following this guidelines.

3. The financial arrangement after PMEA pull-out from the project shall be as follows:

   a) The loans outstanding shall be computed as:

Total project cost		₱XXX	
Add:	Interest as of date of pull out	XXX	₱XXX
Less:	Assessed value of Returned Pump Motors Engine Accessories	₱XXX	
	Cost of retained project (if not fully covered by the NIA system)	XXX	
	Amortization paid	XXX	
	Outstanding loan		₱XXX

   b) ISA shall acknowledge its outstanding loan and transfer it to NIA under terms and conditions in accordance with NIA policy.

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c) After the necessary contracts are perfected NIA will compensate FSDC of the outstanding loan in behalf of the ISA and consider this as part of NIA project cost. Said compensation shall be offset against FSDC outstanding loan/accounts with NIA. Otherwise, payments of NIA to FSDC shall be staggered over a period of five years.

d) ISA shall repay NIA in accordance with the contract.

Recommended by:

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Assistant Administrator
For Operations
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JOSE L. JAURIGUE, JR.
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Appendix I

IEM Program on Gasifier Technology

I. RATIONALE

Largely on account of its renewable resources, the Philippines has very strong potential to become self-sufficient in energy. Hence, the Philippine government has put emphasis on bioenergy development such as the gasifier technology which has excellent prospect for institutionalization since its biomass fuel requirements can be more than adequately met by a massive tree planting effort in the country's vast land area.

Since 1979, the Farm Systems Development Corporation (FSDC) has embarked on a program to promote the widespread use of gasifier in the countryside through its rural development program, notably in irrigation and other agricultural applications.

In conjunction with the University of the Philippines College of Engineering, FSDC in 1979 initiated its commitment by installing five (5) units of diesel engine driving centrifugal pumps with charcoal-fed gasifiers at the FSDC demonstration farm in Bulacan. Since then, about 287 diesel and electric fueled irrigation projects of FSDC have been converted to gasifiers while another 250 units are slated for conversion this year.

These figures evidence that FSDC's initial efforts in motivating the farmers to shift from oil to gasifier has been successful. FSDC's thrust towards promoting gasifier on a wider scale neccesitates a different strategy, however. For the users to fully enjoy the benefits of the technology and consequently to deeply appreciate the value of the gasifiers, their capability to use the gasifier properly has to be fully developed and support services have to be available to propagate the technology and to provide remedial measures for the continued use of gasifiers. In this vein, FSDC shall implement an Information, Education and Motivation (IEM) Program on Gasifier Technology to ensure the gasifier's intitutionalization in the rural communities.

II. OBJECTIVES

The overall objective of the IEM Program on Gasifier Technology is to popularize the gasifier technology in the countryside and even-

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tually to see its application and proper use not only in irrigation but also in other agricultural and rural applications.

The specific objectives of the IEM Program are as follows:

1. To create awareness of and develop an appreciation for gasifier technology and its benefits among the rural people.
2. To develop the skills of the users in the installation, operation, maintenance and trouble-shooting techniques for gasifiers.
3. [illegible]
4. To provide continuing education and training programs for both program and non-program beneficiaries.

III. CONCEPTUAL FRAMEWORK

The shift from the customary conventional to non-conventional energy sources demands a realigning in the normative behavior of the target users. In the case of irrigation, retrofitting the system with a gasifier requires the farmer not only to ensure availability of charcoal fuel, it also requires him to modify some practices in the operation and maintenance of the irrigation system. Such adjustments in the already established lifestyle of the farmers pose tremendous obstacles in the ready acceptance of change, in this case the adoption of the gasifier technology,

To overcome this resistance to change, the benefits derived from adopting gasifier as alternative energy source should be perceived by the farmer as greater than the costs it will take him to shift to gasifier. The IEM Program on Gasifier Technology shall ensure this desired result through its three components, namely: information, education and motivation.

Information - is the communication process where the gasifier technology is made known to the rural community. Its primary objective is to create awareness in the rural community. Awareness development is the initial and most basic requisite for disseminating the gasifier technology and its benefits. Through this intervention, the countryside populace is made conscious of the role of the new technology in the economic development of their community, region or the country. The rural folks develop an awareness that opportunities offered by the technology can be translated into profit-making ventures. Awareness development

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can be promoted through interpersonal as well as mass media, such as slogans and success stories in print and broadcast media.

Education - is the process of imparting knowledge and training to the target beneficiaries. Its primary objective is to develop capabilities of the users in the use and application of the gasifier technology. Through this intervention, the adopters learn to use the gasifier properly from installation, operation, to maintenance, and keep abreast of current developments in the technology and the equipment. Related/auxiliary services will also be developed inorder to support and strengthen the continued patronage of the technology. That the users learn to use the gasifiers properly is crucial to the success of the alternative energy program because the participation of the cooperators is contingent on the results of the use and application of the technology and the equipment. Skills development can be promoted by training, workshops and other experiential models of learning.

Motivation - is the process of developing in the individuals proper mental attitudes towards the gasifiers technology. Its primary objective is to generate interest in the technology. Through this intervention, the community members accept the technology, sustain their participation and enhance their appreciation of the technology. The motivational aspect of the program aims to make the people start building up enough confidence to explore available opportunities in their environment such as the new form of energy source. The proper mental attitudes can be created by reinforcing positive behaviors (e.g., acceptance of the technology, actual use of the gasifier).

The IEM Program shall not address solely the target users who are the ultimate beneficiaries of the gasifier technology. To facilitate the institutionalization of the gasifier technology, agencies/institutions at the provincial or municipal level which can render auxiliary or related services shall be motivated to provide such crucial services. These institutions include repair shops and vocational schools. Through the IEM Program, the private shops shall be enjoined to provide maintenance and repair

services while the vocational schools shall be motivated to develop skilled gasifier operators.

The general inputs of the IEM Program are summarized below:

INFORMATION	EDUCATION	MOTIVATION
Energy situation Alternative energy sources Gasifier -technology -benefits -models -products Role of FSDC in energy programs	Skills on the installation, operation, maintenance and trouble-shooting techniques. Skills on related or auxiliary services	Appreciation of indigenous natural resources, local talent, local inventions. Self-reliance in energy. Identification with the the gasifier product/ quality/performance
Impact of gasifier on the farmer, his family, his community, the nation	Development on gasifier technology and equipment	Risk-taking Striving for excellence
Uses/Application of gasifier technology	Learning from feedback of use or application of gasifier technology/ equipment	Incentives (social, economics)
History of gasifier How to avoid commonly Encountered problems		

IV. OPERATIONAL FRAMEWORK

To carry out the IEM Program, a multi-level organizational network is formed where a core group each from the Farm Systems Development Corporation's Central Office (CO), the FSDC field offices or Area Offices (AO) and the provincial federation of farmers' organization or KAISAs (Kalipunan ng mga ISAs) oversee the imple-

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mentation of the IEM Program at the farmers' organization of ISA (Integrated Services Association) level--the primary target of the IEM Program. The core group is tasked to facilitate/undertake/ participate in the following activities in the implementation of the IEM Program.

1. Training and development of program implementors and program beneficiaries
2. Information campaign
3. Reinforcement program
4. Support services
5. Monitoring and evaluation of the program

V. STRATEGY OF IMPLEMENTATION

As mentioned earlier, to implement the IEM Program, the following specific strategies shall be undertaken at the Central Office, the Area Offices and the KAISAs.

A. Training Program for Program Implementators and Beneficiaries

The training program aims to develop the capabilities of both program implementors and beneficiaries.

1. Training Approach and Methodology

Two types of training shall be conducted, namely, Trainors' Training and Pump Operators' Training. The former is designed for a core group of trainors at the Central Office, the Area Offices and the KAISAs. The latter is designed for the gasifier end-users, the pump operators at the ISA level.

The training course, particularly the Trainors' Training, approximates a vocational training where the emphasis is on the technical component of the subject. To ensure that the training course meets this criterion, FSDC shall negotiate with the National Manpower and Youth Council (NMYC), the government's leading technical skills training

center, to participate in the development of the training program, development of training materials, conduct of the training of the provincial staff, and monitoring of activities at the ISA level. Participants from the FSDC Central Office and Area Offices and the NMYC initially undergo the Trainors' Training in Manila. These participants subsequently fan out to different KAISAs to echo the Trainors' Training. Accordingly, the newly-trained KAISA mechanics and Institutional Officers shall conduct the Pump Oerators' Training at the ISA level.

B. Selection of Trainees

To ensure the success of ier technology, both the program implementors and the program beneficiaries will be selected carefully in order that competent and reliable trainors and users will propagate the technology.

Criteria for program implementors include a strong/solid background in mechanical engineering or similar educational background and personal characteristics such as leadership and receptiveness to role as trainor.

Criteria for program beneficaries include strong leadership potentials and entrepreneurship.

C. Training Participants

The participants to the training shall come from the Central Office, the six Area Offices, and 57 KAISAs which are involved in gasifier sales/distribution or managing ISAs with gasifier-driven pumps, and 537 ISAs which are the end users of the technology.

The breakdown of the participants is as follows:

- Mechanical Engineers from CO = 10
- Three Mechanical Engineers per AO = 18
- One mechanic and one Institutional Officer per KAISA = 114

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- One pump operator per ISA = 537

Total 679

D. Logistical Requirements

The Trainors' Training and the Pump Operators' Training require equipment that shall be used as tools for learning. These include the gasifier equipment and its component parts and accessories.

A mock-up of the gasifier equipment, for example, will be used to enable the participants to examine more analytically its components and functions. The Trainors' Training will further use audio-visual materials like slide tapes and VTRs. Participants at all levels will each be provided with an operator's/mechanic's manual as handy reference.

E. Staffing

The training staff for the Trainors' Training will include FSDC trainors and the National Manpower Youth Council staff. The latter will also be tapped to provide their expertise for the subsequent trainings at the KAISA level.

FSDC Central Office/Area Offices staff trained in the Trainors' Training will be organized into training teams. They will be deployed in the six Area Offices to render staff support in the conduct of subsequent trainings, particularly at the KAISA level. With an NMYC counterpart, the KAISA trainors will serve as full time staff in the training of pump operators at the ISA. These groups make up the core of training teams.

2. Trainors' Training Curriculum

The Trainors' Training course underscores the technical component of the gasifier technology. A comprehensive and thorough understanding of the technology, its applications, its actual operation and maintenance will be acquired. In addition, the training shall develop effective trainors for the dissemination of the proper and popular used of the gasifier technology and equipment. The Trainors' Training shall make use of the formal

classroom type of teaching methodology and hands-on experience. The latter shall require the use of gasifier equipment and its various accessories.

Following is a general curriculum for the Trainors' Training, the particulars of which shall be finalized in coordination with NMYC. The training shall be conducted for 11 days.

A. Knowledge

1. gas producer technology
2. principles of combustion and gasification
3. economic advantages of gasifier use
4. components of engine and gasifier equipment and their functions
5. gasifier applications with focus on gasifier on irrigation
6. procedures on installation and operation of gasifier for irrigation
7. techniques in equipment care and maintenance/trouble shooting
8. areas of difficulty and alternative measures
9. critical factors in gasifier operation
10. safety measures
11. basic technical training concepts and principles
12. concepts on extension communication
13. parts of a technical training design, pointers on design preparation
14. techniques in technical training management/evaluation
15. monitoring procedures

B. Skills

1. installation of gasifier equipment operation, care and maintenance, trouble shooting of engine and gasifier equipment
2. extension communication/IEM strategies
3. technical training design preparation
4. facilitating demonstration, practicum and simulation activities
5. training documentation and evaluation

C. Attitude

1. appreciation and acceptance of the technology
2. achievement motivation training
3. self-reliance

3. Pump Operators' Training Curriculum

The Pump Operators' Training stresses the basics of the gasifier technology and the gasifier equipment's installation, operation, maintenance and trouble shooting requirements. The training is expected to develop the users not only as skilled operators of the gasifier equipment but also as effective trouble shooters in order that they may be able to maintain the capacity and life span of the equipment.

A skills-oriented five-day training, it shall capitalize on hands-on experiences such as simulation exercises, demonstrations, practicum and workshops. The gasifier equipment and its accessories would be made available for the hands-on training.

The 5-day formal Pump Operators' Training precedes the one cropping season on-the-job training (OJT). For the duration of the OJT, the KAISA training team and the NMYC representative shall coach the pump operators regularly. The training team shall regularly monitor the performance of the pump operators and shall use the results to determine the additional coaching requirements of the pump operators. In contrast to the formal training whose content is generalized for all training participants, the OJT is more individualized and caters to the specific training needs of the pump operators.

The general curriculum for the pump operators' training is enumerated below.

A. Knowledge

1. principles of combustion and gasification
2. components of gasifier equipment for irrigation

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and their functions

3. procedures on engine and gasifier operation
4. techniques in care and maintenance of engine and gasifier equipment
5. common problems encountered and trouble shooting techniques
6. critical factors in engine and gasifier operation
7. record-keeping procedures
8. safety precautions

B. Skills

1. engine and gasifier equipment operator
2. care and maintenance of engine and gasifier equipment
3. preventive maintenance and trouble shooting techniques
4. monitoring/record-keeping of gasifier activities (i.e., fuel consumption)

C. Attitude

1. recognition, appreciation and acceptance of the technology
2. achievement motivation training

B. Information Campaign

The information campaign shall be implemented at several levels - FSDC Central Office, FSDC Area Office, KAISA, ISA and local institutions which can help institutionalize the gasifier program (eg., vocational schools, repair shops). The training teams at the Central Office, Area Offices and the KAISAs shall be deployed to implement the IEM Program at their corresponding levels (eg., KAISA training team shall develop and produce the information campaign materials for the KAISA) and to assist the training teams succeeding team on the implementation levels conduct the IEM Program (eg., Area Office training team shall assist the KAISA training team develop materials). At the ISA level where the information campaign is most critical, the KAISA training team shall supervise the

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organization of a core group to serve as channel of communication to existing and potential beneficiaries. The core group at the ISA shall be composed of formal and informal community leaders. The KAISA training team shall include local institutions that can assist in institutionalizing the gasifier technology among the targets of its information campaign.

The information campaign shall rely on interpersonal channel and other communication media such as print materials, audio-visual productions and visual aids. At the ISA level, information campaign shall also use local communication media such as dance, music festival and folk media to ensure that the information is well-understood and well-received.

The following presents an information campaign plan at the ISA, KAISA, Area Office and Central Office.

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1. ISA LEVEL

Information Campaign Plan

CONTENT	OBJECTIVE	TARGET AUDIENCE	MEDIUM
1. Orientation		ISA members	VTR showing
i. the country's energy situation	To underscore the need to become self-reliant in energy.		
ii. the gasifier technology	To create awareness of alternative energy sources		
iii. uses/application in BISA Program	To develop appreciation of the technology		
iv. benefits of the gasifier	To motivate the farmers to shift to gasifiers		
2. Alternative sources of energy	To create awareness of alternative energy sources	ISA members	Posters
3. Gasifier products/models	To appreciate versatility of the technology	ISA members	Photo-exhibit
4. How to avoid commonly encountered problems	To neutralize the adverse effects of publicity of some unsatisfactory experience with gasifiers	ISA members	"Peryodikit" (wall newspapers)
5. Cultural program	To instill feeling of cooperation and striving for excellence	ISA members	Music/Dance festival;
6. BISA Forum -development in the ISA regarding gasifier	To exchange experience and thresh out problems	ISA members	Interpersonal

2. KAISA LEVEL

CONTENT	OBJECTIVE	TARGET AUDIENCE	MEDIUM
1. Orientation			
i. Concept and strategy of implementation of IEM Program on Gasifier Technology	To gain understanding and acceptance of IEM Program on Gasifier Technology	KAISA management and staff	Interpersonal (meeting)
ii. Implication to KAISA functions			
2. VTR Presentation			
i. The country's energy situation	To underscore the need to become self-reliant in energy	KAISA management and staff; Provincial institutions (eg., private shops, vocational schools)	VTR Showing
ii. The gasifier technology	To create awareness of alternative energy sources		
iii. Uses/Applications in the BISA Program	To develop appreciation of the technology		
iv. Benefits of the gasifier			
3. Publication			
-Success stories of ISAs adopting gasifier technology	To generate interest in the technology	Local institutions (eg., repair shops; vocational schools)	Newsletter
4. Gasifier products/models	To develop appreciation of the technology's versatility	KAISA management and staff; repair shops; vocational schools	Photo exhibit/Posters

3. AREA OFFICE LEVEL

CONTENT	OBJECTIVE	TARGET AUDIENCE	MEDIUM
1. Orientation			
i. Concept and strategy of implementation of IEM Program on Gasifier Technology ii. Implication to Area Office functions	To gain understanding and acceptance of IEM Program on Gasifier Technology	Area Office;Management and staff	Interpersonal (meeting)
2. VTR Presentation			
i. The country's energy situation ii. The gasifier technology iii. Uses/Applications in the BISA Program iv. Benefits of the gasifier	To underscore the need to become self-reliant in energy To create awareness of alternative energy sources To develop appreciation of the technology	Area Office; Management and staff	VTR showing
3. Gasifier products/models	To appreciate versatility of the technology	Area Office;Management and staff	Photo exhibit/Posters

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4. CENTRAL OFFICE

CONTENT	OBJECTIVE	TARGET AUDIENCE	MEDIUM
1. Orientation			
i. Concept and strategy of implementation of IEM Program on Gasifier Technology ii. Implication to Central Office functions	To gain understanding and acceptance of IEM Program on Gasifier Technology	Central Office; Management and staff	Interpersonal (meeting/briefing)
iii. Implication to FSDC's umbrella program, the Barangay Integrated Services Association (BISA) Program	To realign program thrusts according to implications of the IEM Program on Gasifier Technology vis-a-vis BISA Program	Central Office; Management and staff	
2. VTR Production			
i. The country's energy situation ii. The Gasifier Technology iii. Uses/Applications in the BISA Program iv. Benefits of the gasifier	To develop awareness and appreciation of the gasifier technology	Central Office/ Area Offices/KAISAs/ Provincial linkages	
3. VTR Translation	To evoke greater acceptance of the technology by translating into Pilipino the VTR production	KAISA/ISA/Provincial linkages	

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C. REINFORCEMENT PROGRAM

During the implementation of the gasifier program, a reinforcement package is crucial to the sustenance of interest in and use of gasifier technology and equipment.

Reinforcement shall come in the form of incentives such as awards, recognition and prizes. Incentives shall function as stimuli to get more people to venture in gasifier technology. Incentives shall be awarded for outstanding performance in the promotion of gasifiers. Beneficiaries of these incentives shall come from FSDC Central Office, FSDC Area Offices, KAISA and other local organizations/institutions (eg., vocational schools, private shops) and linkages (eg., NMYC). Another area for awarding incentives is outstanding performance in application/use of gasifier equipment. Beneficiaries for the latter type of incentives include ISA pump operators and KAISA mechanics.

The KAISA training teams in coordination with their Area Office counterpart, shall develop the criteria for outstanding performance in promoting and using the gasifier technology and equipment, respectively.

D. SUPPORT SERVICES

The following support services shall further strengthen and hasten the institutionalization of the gasifier technology - establishment of linkages with NMYC and other agencies, consultancy and availability of service/repair shops.

Linkages. The NMYC shall be tapped to develop, in coordination with FSDC, the Trainors' Training and the Pump Operators' Training. It shall also assist FSDC in conducting actual training at the provincial level and in monitoring ISA activities related to the application of the gasifier technology. Aside from manpower, the regional training centers, facilities and other logistics of NMYC shall be tapped for the activities mentioned above. For its part, FSDC shall extend man-

power support to KAISA/ISA trainings through its previously trained Central Office and Area Office staff.

Liaison shall likewise be established with public and private institutions to promote the gasifier technology in the school communities. The FSDC Central Office/Area Offices shall establish linkages with privately or publicly owned vocational institutions to accredit gasifier technology in their curricula.

Service/Repair Shops. Private shops located in the provinces/municipalities shall play a pivotal role in institutionalizing the gasifier technology. They shall be encouraged to include repair of gasifier equipment as one of their services. The availability of this very crucial service locally shall provide the much-needed impetus to motivate the farmers to accept and use the gasifier. The service shall remove the remaining indecisiveness of prospective users in favor of adopting the technology.

Consultancy Services. IEM Program shall strive to update the gasifier users and the local institutions providing auxiliary services on new developments in gasifier technology, applications, maintenance and safety measures. To accomplish this, objective, consultants from the University of the Philipoines College of Engineering, the Gasifier and Equipment Manufacturing Corporation (GEMCOR) and other noted experts on gasifier shall form a core group of consultants. The consultants shall initially provide consultancy services to the training team tasked to train and monitor performance of the pump operators. Aside from new developments in the gasifier technology, the consultants shall also address common and persistent problems related to gasifiers. The consultants may also provide similar services to the local institutions providing support services to gasifier technology and equipment.

E. MONITORING AND EVALUATION SYSTEM

The monitoring scheme will provide a mechanism for managing the flow of information to different levels for purposes of

assessment and decision-making. The information operated by the mechanism will not only serve to check whether the activities are being implemented as planned but also to provide the data-base for evaluating the effectiveness of the Communication and Training Program for Gasifier Technology as a whole.

1. Monitoring - for operations control purposes, it will:

   a. provide information on the progress of implementing the IEM Program for the gasifier technology,
   b. provide information on problems encountered and remedial measures that need to be taken,
   c. provide operators and the core training teams in terms of accomplishing tasks,
   d. generate project level data inputs for the evaluation of the IEM Program.

2. Evaluation - for evaluation purposes, it will:

   a. determine the effectiveness of the IEM Program of Gasifier Technology,
   b. identify the factors or elements that contribute to the effectiveness of the pump operators and the core training teams in assuming their responsibilities in program implementation,
   c. assess the effects of the non-ISA beneficiaries participation in the implementation of the program,
   d. redefine methods and implementation guidelines to render the IEM Program on Gasifier Technology more effective in achieving objectives.

VII. SYSTEMS OF OPERATION

The IEM Program on Gasifier Technology will have a network of implementing units, namely, the ISA, KAISA, Area Office and the Central Office.

A. ISA Level

The ISA members will perform the following activities:

1. identify the pump operator
2. oeganize a core group to implement the IEM Program
3. produce IEM materials from indigenous resources
4. report on the Pump Operators' performance

B. KAISA Level

The KAISA will be the chief implementor of the IEM Program in the field. Its functions consist mainly of training and development activities:

1. trains and develops the pump operators
2. produces communication materials for the KAISA/ supervises ISA production of communication materials
3. provides consultancy services to the ISA beneficiaries
4. recommends incentives to be awarded to outstanding performers in the promotion or application of the gasifier technology at the ISA and the community levels.
5. monitors and evaluates the implementation of the program
6. developes tactical plans to facilitate the program's implementation
7. confirms the selection of pump operators in the ISA
8. submits reports/comments/recommendations to the Area Offices

C. Area Office

The Area Office will bridge the gap between the Central Office and the field implementors and beneficiaries and other users of the program.

1. conducts orientation seminar for area personnel regarding the program
2. in coordination with CO/NMYC representatives, conducts trainings of KAISA participants
3. Develops communication materials for the Area Office/ supervises KAISA production of communication materials

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4. monitors the status/progress of implementation at the provincial level
5. conducts spotckecking activities on the implementation of the program
6. submits reports and recommendations to Central Office on the progress/status of implementation
7. provides consultancy and support to KAISA and non-ISA beneficiaries on matters pertaining to the program's implementation
8. confirms incentives to be awarded to outstanding performers in the promotion of the gasifier technology at the KAISA, ISA and non-ISA community.

D. Central Office

The Central Office, as program planner, will continue to initiate plans of action that bear implications on the nationwide implementation of the program:

1. develops the concept on IEM Program for Gasifier Technology
2. formulates the training course, design and materials in coordination with NMYC
3. presents the IEM Program on Gasifier Technology to the Administrator, Area Managers, for approval
4. assists Area Trainors in the training of the KAISA training team
5. develops VTR and other communication materials for the Central Office/Area Office/KAISA/ISA linkages
6. monitors the status/progress of the program
7. conducts periodic evaluation regarding status and implementation of the program
8. provides consultancy and support to the Area Office/KAISA/Non-ISA beneficiaries on matters pertaining to the program and the gasifier technology
9. submits reports and recommendations to the Administrator on the progress/status of the program.

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Appendix J

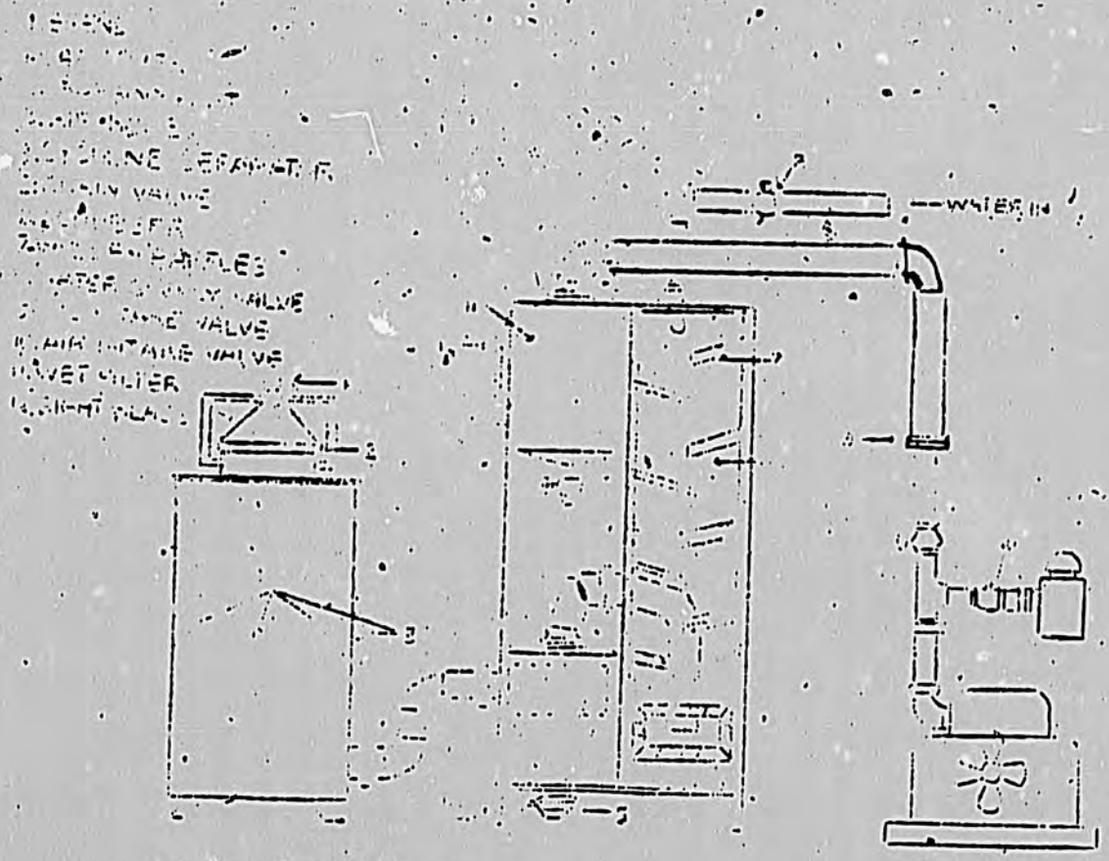
Instructions Supplied with GEMCOR Gasifiers

INSTALLATION PROCEDURES:

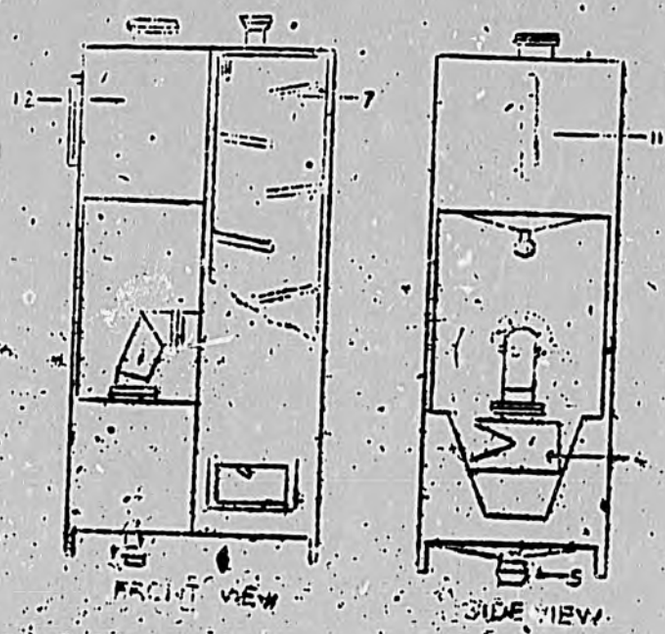
1. Check parts list of the delivery.
2. Determine piping requirement between gas scrubber to engine.
3. Construct concrete foundation for the gas scrubber and reactor and let the foundation dry for at least 24 hours.
4. Fix the gas scrubber on top of the foundation and fit the reactor.
5. To prevent gas leakages, apply PVC pipes adhesive to the joints before installation. Be sure PVC pipes are installed firmly.
6. Fill [illegible] at the wet filter to the indicated mark.
7. [illegible] on it that the collapsible grate is in proper position.
8. [illegible] preliminary test run and check for leakages on the [illegible] equipment and on piping installation.

OPERATING PROCEDURES: (refer to Figure 2)

1. Inspect Gas Producer system for leaks and tighten all fittings firmly.
2. Start engine with the air valve (10) fully open and the gas valve (9) closed. Warm-up engine for 5-10 min. at normal RPM.
3. While warming up the engine, remove cap cover (1), open the charging port (2), and load fuel (any carbonaceous material) up to air hole (3) level. Pour a little amount of liquid fuel and start the fire on top of the fuel bed.
4. When the fuel bed is already burning fully, add more fuel to fill the reactor up to the neck.
5. Close the top cover and secure fil bolts. Consequently open water supply valve (8) to introduce water to the scrubber. If necessary open the drain valve located below the scrubber in order to maintain a 1" to 3" water level below the gas inlet.
6. Gradually open the gas valve to introduce producer gas into the engine. This would automatically increase the RPM of the engine.



[illegible] THE DIAGRAM OF [illegible] GAS INSTALLATION



4- GAS CYCLONE FILTER
5- GATE VALVE
11- SIGHT GLASS
12- WET FILTER
7- WOODEN BAFFLES

FIG. 2 DRAWING OF A FUEDER

7. After sometime, increase producer gas intake and decrease air intake to minimize the use of diesel fuel oil (DFO). Adjust engine governor to the proper setting to maintain normal/ operating rpm of the engine. If too much smoke is being emitted by the engine, increase air intake.

8. As fuel continues to burn, the quality of the gases produced inside the reactor gets better; hence, increase gas intake and decrease air intake. Proper manipulation (mixing) of the gas and air valve would result to better engine operation.

9. When the fuel is already a hot bed of fire, plug the air holes w/ the wooden pegs in order to slow down the burning rate of fuel inside the reactor.

10. During operation, observe the following precautions:
    a. Maintain level of fuel at the air hole, never let it go below the air holes.
    b. Always see to it that the water level in the scrubber is maintained. Water in must be equal to water out.
    c. Maintain DFO level mark at the wet filter. Never drain wet filter during operation.
    d. As a preventive measure, secure and tighten all bolts and nuts, caps and screws before operation.

    During gas producer operation, the system must be air tight at all times.

SHUTDOWN PROCEDURES: (Refer to Figure 2)

1. Open fully the air valve (10) and close the gas valve.
2. Open fully of the drain valve, and close the water supply valve. Let all the water out to clean the scrubber.
3. Secure all wooden pegs to the air holes.
4. Replace cap cover and top cover of the reactor.
5. Release engine governor to idle position and stop the engine.

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MAINTENANCE SCHEDULE

Schedule		Frequency
1. Reactor		
a. Ash pit	- removal of ash	- 50 hours
b. Collapsible grate	- check position	- 50 hours
c. Mortar lining	- check for leaks cracks	- as necessary
d. [illegible]ng for air holes	- check for burns	- as necessary
2. Cyclone Separator		
a. Drain [illegible]	- removal of ash	- before/after operation
b. [illegible]	- check for leaks	- as necessary
3. [illegible]		
a. [illegible]	- check for [illegible]	- as necessary
b. [illegible]	- [illegible]	- as necessary
[illegible]	[illegible]	- as necessary
[illegible]	[illegible]	- as necessary
[illegible]	[illegible]	- as necessary [illegible] hours
[illegible]	[illegible]	- as necessary
[illegible]	[illegible]	- as necessary
[illegible]	[illegible]	- as necessary
[illegible]	[illegible]	- [illegible] hours

NOTE: [illegible] the reactor, [illegible] precaution.

[illegible]

The following [illegible] are needed to repair cracks or spalled mortars in the reactor lining:

1. Estimate volume of patching material needed.
2. Extend [illegible] of crack up to metal for cohesiveness. Clean surface of cracks.
3. Gradually add water to refractory mortar and stir until mixture has thick consistency.
4. Patch area firmly. Avoid air formation to prevent cracks. If large areas are to be patched, apply mold to hold patched refractory. Moreover, place reactor in a horizontal position to patch damaged areas.
5. Air dry patched area for two (2) days and oven dry for another two (2) days for best curing of refractory.
6. For oven drying, burn pieces of any combustible material inside the reactor for approximately five (5) hours a day.

Best Available Document

TROUBLE SHOOTING GUIDE

TROUBLE	CAUSE	REMEDY
1. the engine is abnormally weak	- woodchips/charcoal - load of reactor almost empty	- reload with woodchips/charcoal
	- bridging of woodchips/charcoal inside the reactor	- poke fuel load to remove bridging or drain reactor
2. too much smoke at engine exhaust	- less air entering engine	- adjust air valve
3. too much vibration of the engine	- too much/excess DFO at wet filter.	- drain DFO at wet filter to desired level.
4. engine sucks in H2O (water)	- too much/excess water at gas scrubber	- drain water at gas scrubber to desired amount.

SAFETY PRECAUTIONS:

1. Hydrostatic test or leakage test of the gasifier system specially the pipings should be conducted occasionally to prevent carbon monoxide leakages.
2. Do not drain any components of gasifier while it is in operation to avoid carbon monoxide inhalation.
3. When opening the reactor top cover, avoid placing any part of your body over the reactor to prevent burns resulting from gas blowouts. Allow one minute before looking inside the reactor to avoid carbon monoxide inhalation. The use of gas masks for the above activity is recommended.
4. Avoid contact with the hot gasifier components (e.g. reactor) to prevent burns.
5. In the unavoidable event of draining a still hot reactor, avoid touching the ashbers (and other hot objects drained from the reactor) with your bare hands to prevent burns.

MONITORING CHART

Figure 3 shows the recommended monitoring chart for recording the performance data of your gasifier powered system.

ENGINE SPECIFICATIONS:

Make : _____
Model : _____
Horsepower : _____
Rated RPM : _____
No. of Cylinder : _____

Date	Time	Diesel Fuel Consumption				Charcoal consumption (Sacks/Kg)	Oil Pres (PSI)	Temp.	RPM	Remarks
		100% Diesel		Dual						
		Start	End	Start	End					

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Appendix K

Table of Assumptions for Financial Analysis of Gasifiers

		Project Paper	Review
a.	Diesel Engine	65 hp	50 hp
b.	Diesel Fuel Consumption Operated on 100%	18.1 liters/hr	13 liters/hr
	Operated on 50% reduction substitution	N/A	6.5 (assumed 5% efficiency loss)
	Charcoal	N/A	18.4 kg/hr (0% fines)
	Wood chips	N/A	28.5 kg/hr
	Operated on 70% substitution		(assumed 7% efficiency loss)
	Diesel	5.43 liters/hr	3.9 liters/hr
	Wood chips	43.3 kg/hr	N/A
	Charcoal	N/A	26.9 kg/hr
c.	Diesel cost	₱ 3.20/liter	₱ 7.50/liter
d.	Woodchip labor	₱ 0.135/kg	₱ 0.25 /kg
e.	Hours of operation	1200	1200

Appendix L

Details of Calculations for Financial Analysis of Gasifiers

Calculations Economic Analysis

Diesel Only (.841 Sp Gr. Diesel)

*Assume Diesel Flowrate(6) = 0.26 lirwea/Bhp hr

$$\frac{Btu}{Bhphr} = \frac{.026 \text{ liters/Bhphr} \times 1000 \text{ cm}^3/\text{liter}}{(2.54)^3 \text{cm}^3/\text{in}^3 \times 1728 \text{ in}^3/\text{ft}^3} \times 62.4 \text{lb}/\text{ft}^3 \times .841 \times 19400 \text{ Btu/lb}$$

$$= 9366 \frac{Btu}{Bhphr}$$

$$\text{Mech. Eff} = \frac{Wo}{Qi} = \frac{2545 \text{ Btu/hphr}}{9366 \text{ Btu/hphr}} = .272$$

Wo - Workout Btu/hr =27.2%
Qi - heatin Btu/hr

Assume
50 horsepower diesel

Liters/hr = 50hp x .26 liters/hphr
= 13 liters/hr

Cost/hr = 13 Liters/hr x ₱7.5/liter = ₱97.5/hr
Assume Diesel Cost (1) = ₱7.5 liter

Charcoal 50 Bhp (50% replacement)

Diesel Component

$$\text{Liters/hr} = \frac{13 \text{ liters}}{2} = 6.5 \text{ liters/hr.}$$

Peso Cost (₱/hr) diesel = 6.5l/hr x ₱7.5/Liter

= ₱48.75/hr

Assume 5 point loss in eff. due to Producer gas operations

Eff = 27.2 - 5 = 22.2

$$\text{Eff} = \frac{Wo}{Qin} = \frac{50 \times 2545}{Qin}$$

$$Qin = \frac{50 \times 2545 \text{ Btu/nphr}}{.222}$$

573,198 Btu/hr

$$Qin \text{ Producergas} = 573{,}198 - \frac{6.5 \text{ liters} \times 1000\text{cc/liter}}{(2.54\text{c/in})^3 \times 1728 \text{ in}^3/\text{ft}^3} \times 62.4\text{lb/ft}^3 \times .841 \times 19{,}400 \text{ Btu/lb}$$

= 339686 Btu/hr

$$Qin \text{ (charcoal) Gasifier} = \frac{339{,}686}{.7} = 485{,}267 \text{ Btu/hr}$$

* Assume Gasifier Eff = .7

Charcoal required = 485,267 Btu/hr / 12,000 Btu/lb
HHV Charcoal = 12,000 Btu/lb

= 40.4 lb/hr

Gasifier eff suggested by GEMCOR

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Charcoal $= \frac{40.4}{2.2} = 18.4$ kg/hr

Fuel cost = 18.4 x ₱/kg + Diesel cost

= 18.4 x ₱1/kg + 46.75

= ₱67.15/hr

Charcoal cost = ₱1/kg

Fuel cost = 18.4 x 2.5 + 46.75

= 94.75

Charcoal cost = ₱2.3/kg

Charcoal (20% Fine Loss) $= \frac{18.4 \text{ kg/hr}}{.8} = 23$ kg/hr

Charcoal Cost = 23 x ₱1/kg

= ₱23/hr

Total Fuel Cost = 23kg/hr x ₱1/kg + ₱48.75/hr

= 71.55

Oil & Lubrication Cost (1b) (Diesel only) = ₱3510/1200 hrs = ₱2.925/hr
Oil & Lubrication (Producer Gas) = ₱7020/1200 hrs = ₱5.85/hr
Maintenance (Diesel) (1b) = ₱5850/1200 hrs = ₱4.88/hr
Maintenance (Producer Gas) = ₱7020/1200 hrs = ₱5.85/hr

Operating Cost = Fuel Cost + Maintenance Cost + Lubrication Cost

Diesel (only) = 94.75 + 4.88 + 2.93 = 102.56

( )Diesel Gasifier(IP/kg) = 67.15 + 5.85 + 5.85 = 78.85

Diesel/Gasifier (20% Fine) = 71.75 + 5.85 + 5.85 = 83.45
(1P/kg)

Amorization

Gasifier + Final Filter = ₱30,000
based on 12% interest farmer pays
6 year life
Semiannual Payments

$$P = \frac{30,000\ (.06)}{\left[1 - \left(\frac{1}{1.06}\right)^{12}\right]} = 3578.1/\text{semiannual payment}$$

$$\text{Hourly Cost} = \frac{3578.31}{600} = ₱5.96/\text{hr}$$

2) Amortization

Gasifier + Final Filter = ₱30,000
Social discount rate = 15%
6 yr life
Semiannual Payment

$$P = \frac{30,000\ (.075)}{\left[1 - \left(\frac{1}{(1.075)}\right)^{12}\right]}$$

$$= ₱3878.33$$

$$\text{Hourly Cost} = \frac{3878.33}{600} = ₱6.46/\text{hr}$$

Total Cost = Operating Cost + Fixed Cost

= 78.85 + 5.96 = ₱84.81/hr 0% FNS
P1/kg char.

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Fuel Cost (50% Replacement)

Charcoal Cost ₱/kg	Diesel Cost ₱/kg	Charcoal Cost (10%) ₱/hr (18.4kg/hr)	Charcoal Cost (20%) ₱/hr (23/kg/hr)	Total Fuel (10% FNS) ₱/hr	Total Fuel (20% FNS) ₱/hr
1	48.75	18.4	23.0	67.15	71.75
2	48.75	36.8	46.0	85.55	94.75
3	48.75	55.2	69.0	103.95	117.75
4	48.75	73.6	92.0	122.35	140.75

Operating Cost

Charcoal Cost ₱/kg	Total (0%) Fuel ₱/hr	Total (20%) Fuel ₱/hr	Lubrication Cost ₱/hr	Maintenance (0%) Cost ₱/h	Total (20%) Operating ₱/hr	Total Operating ₱/hr
1	67.15	71.75	5.85	5.85	78.85	83.45
2	85.55	94.75	5.85	5.85	97.25	106.45
3	103.95	117.75	5.85	5.85	115.65	152.45
4	122.35	140.75	5.85	5.85	134.05	152.45
Diesel only	97.5					

Total Cost (12% FSDC Rate)

Charcoal Cost ₱/kg	Total (0%) Operating ₱/hr	Total (20%) Operating ₱/hr	Fixed Cost (12%) ₱/hr	Total (0%) Cost	Total (20% Cost
1	78.85	83.45	5.96	84.81	89.41
2	97.25	106.45	5.96	103.21	112.41
3	115.65	129.45	5.96	121.61	135.41
4	134.05	152.45	5.96	140.01	158.41

Total Cost (15% Social Discount Rate)

Charcoal Cost ₱/kg	Total (0%) Operating ₱/hr	Total (20%) Operating ₱/hr	Fixed Cost (15%) ₱/hr	Total (0%) cost ₱/hr	Total (20%) Cost ₱/hr
1	78.85	83.45	6.46	85.31	91.77
2	97.25	106.45	6.46	103.71	110.17
3	115.65	129.45	6.46	122.11	135.91
4	134.05	152.45	6.46	140.51	158.91

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50 Bhp ; 70% Replacement

All diesel = 50 hp x .26 liter/hp hr = 13 liters

70% replacement

Diesel flow = .3 x 13

= 3.9 liters/hr

Peso Cost/hr = 3.9 x ₱7.5 liter = ₱29.25/hr

Assume 7 point loss in eff.

Mech eff = .27 - .07

= . 2

$$Q_{in} = \frac{50hp}{\text{Total Mech. eff}} = \frac{50hp}{0.2} \times 2545 \text{ Btu/hphr}$$

= 636,250 Btu/hr

$$Q_{in\ \text{Prod. gas}} = Q_{in\ \text{Total}} - Q_{in\ \text{Diesel}}$$

$$= 636{,}250 - \frac{3.9 \text{ liters} \times 1000 \text{ cc/liter} \times 62.4 \times .841 \times 19400}{(2.54)^3 \times 1728}$$

= 636,250 - 138.920

= 497,329

$$\text{kg/hr charcoal gasifier} = \frac{497{,}329 \text{ /hr}}{(.7)\ 2.2 \text{ lb/kg} \times 12{,}000 \text{ Btu/lb}}$$

Assume Gasifier eff = .7

$$= \frac{18.8}{.7} = 26.9 \text{ kg/hr}$$

kg/hr Charcoal (20% fines loss) = 33.6 kg/hr

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1) Amortization
Gasifier + Final Filter = ₱30,000
based 12% Farmers Pay
6 years life gasifier
Semiannual Payments

$$P = \frac{30{,}000\ (.06)}{\left[1 - \left(\frac{1}{1.06}\right)^{12}\right]}$$

= ₱3578.31/semi annual payment

$$\text{Hourly Cost} = \frac{3578.31}{600\ \text{hrs}} = ₱5.96/\text{hr}$$

2.) Amortization
Gasifier + Final Filter ₱30,000
Social Discount rate = 15%
6 yr life
Semiannual Payment

$$P = \frac{30{,}000\ (.075)}{\left[1 - \left(\frac{1}{1.075}\right)^{12}\right]}$$

= ₱3,878.33

$$\text{Hourly Cost} = \frac{3878.33}{600}$$

= ₱6.46/hr

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Fuel Cost (70% diesel replacement)

Charcoal Cost ₱/kg	Diesel Cost P/hr	Charcoal Cost 0% Fines ₱/hr (26.9)	Charcoal Cost (20% Fines) ₱/hr (33.6)	Total Fuel ₱/hr	Total Fuel (20% Fines) ₱/hr
1	29.25	26.9	33.6	56.1	62.9
2	29.25	53.8	67.2	83.1	96.45
3	29.25	80.7	100.8	109.95	129.2
4	29.25	107.6	134.4	136.9	166.1

Operating Cost

Charcoal Cost ₱/kg	Total Fuel ₱/nr	Total Fuel (20% Fines) ₱/nr	Lubrication Cost ₱/nr	Maintenance Cost ₱/nr	Total Operating 0% (20%) ₱/nr	Total Operating ₱/nr
1	56.1	62.95	5.85	5.85	67.8	74.6
2	83.1	96.5	5.85	5.85	94.8	108.2
3	109.95	129.2	5.85	5.85	121.65	140.9
4	136.09	166.1	5.85	5.85	148.6	177.8
Diesel	97.5		2.925	4.88	105.3	

Total Cost (12% FSDC rate)

Charcoal Cost ₱/kg	Total Operating ₱/hr	Total (20% FNS) Operating ₱/hr	Fixed Cost ₱/hr	Total (0%) Cost ₱/hr	Total (20% FNS) Cost ₱/hr
1	67.8	74.6	5.96	73.8	80.6
2	94.8	108.25	5.96	100.8	114.2
3	121.65	140.9	5.96	127.6	146.9
4	148.6	177.8	5.96	154.6	183.8

Total Cost (15% Social discount rate)

Charcoal Cost ₱/kg	Total (0%) Operating ₱/hr	Total (20%) Operating ₱/hr	Fixed Cost (15%) ₱/hr	Total (0%) cost	Total (20%) Cost
1	67.8	746	6.46	74.3	81.1
2	94.8	108.2	6.46	101.3	114.7
3	121.65	140.9	6.46	128.2	147.4
4	148.6	177.8	6.46	155.1	184.3

Wood (50% replacement)
All diesel
50 hp Diesel
13 liter/hr
Fuelcost = 13 x 7.5

= ₱97.5/hr

Wood (50% replacement)

Diesel = .5 (13 liters/hr) = 6.5 liters/hr

Diesel Cost = 6.5 liters/hr x ₱7.5 liter
= ₱48.75/hr

Assume 27% Eff. for Diesel
Assume 5% loss due to Producer Gas

Diesel EFF (Producer Gas Mode) = .27 - .05
.22

$$Eff = \frac{Wo}{Qi} = \frac{50Hp \times 2545 \text{ Btu/hphr}}{Qi}$$

$$Qi_{Total} = \frac{50 \times 2545}{.22} = 578{,}409$$

Qi prod gas = Qtot - Qin Diesel

$$= 578{,}409 - \frac{6.5 \text{ liter} \times 1000\text{cc/liter}}{(2.54)^3 \text{ c.m}^3/\text{in}^3} \times 624\text{lb/++3} \times 841 \times 19{,}400 \frac{\text{Btu}}{1728 \text{ in}^3/\text{ft}^3}$$

Qi prod gas = 346874 Btu/hr

$$\text{Kg/hr (drywood 7\% moisture)} = \frac{346{,}874}{.7\ (7900)(2.21^{b}/\text{kg})}$$

= 28.5 kg/hr

Assume Gasifier eff. - .7
HHV wood (7% moisture) = 7900

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Wood Cost

Delivered green Wood ₱120/m^3

Chip (by hand)	10 bags/day/man	₱32/day
Green	₱32/man day	₱3.2/bag
Assume (24 kg/bag)		₱.133/kg

Chip cost (Dry) = ₱.133/kg x .93 dry moisture/.5 green moisture

= ₱.25/kg

Cost Wood Dry (7%) = $\frac{120 \times .93}{.5}$

= ₱223.2/m^3

= cost wood + cost chipping

Cost Woodchips/kg = ₱.223/kg + ₱.25/kg

= ₱.473/kg

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Wood

Woodchip Cost = 28.5 kg/hr x ₱ /kg (Woodchips)

Fuel Cost (50% Replacement) Woodchips

Woodchip Cost ₱/kg	Diesel Cost ₱/hr	Woodchip Cost ₱/hr (28.5 kg/hr)	Total Fuel Cost ₱/hr	Lubrication Cost ₱/hr	Maintenance Cost ₱/hr
0.2	48.75	5.7	54.45	5.85	5.85
0.4	48.75	11.4	60.15	5.85	5.85
0.6	48.75	17.1	65.85	5.85	5.85
0.8	48.75	22.8	71.55	5.85	5.85
All diesel	97.5				

Total Operating Cost

Woodchip Cost ₱/kg	Total Fuel Cost ₱/hr	Total Operating Cost ₱/hr	Amortization 12% ₱/hr	Amortization 15%	Total Cost (12%) ₱/hr	Total Cost (15%)
0.2	54.45	66.15	5.96	6.46	72.11	72.61
0.4	60.15	71.85	5.96	6.46	77.81	78.31
0.6	65.85	77.55	5.96	6.46	83.51	84.01
0.8	71.55	83.25	5.96	6.46	89.21	89.71
all diesel					105.3	

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Appendix M

THE CHARCOAL PRODUCTION PROJECT ASSESSMENT REPORT

FSDC, January, 1985

BACKGROUND

The Farm Systems Development Corporation (FSDC) is one of the government agencies responsible in implementing the Government of the Philippines' (GOP) Charcoal Production Project. Under this mandate, FSDC started the Tree Resources for Energy and Enterprise (TREE) Program whose objectives are: (1) to develop reliable, affordable and renewable energy resources, primarily firewood and charcoal; (2) to replace imported fossil fuels; (3) to generate employment; and (4) to improve local ecological balance. The program entails the establishment of energy tree farms by upland farmers in all regions to serve as a resource base for local charcoal production for industrial enterprises and household use. The tree farms will normally range in size from 200 to 1000 contiguous hectares, depending on land availability and energy demand. The tree farms are divided into 100-hectare modules growing ipil-ipil trees (Leucaena leucocephala) on a three-year rotation cycle. Five charcoal kilns are required for each module. The charcoal produced under this program will be used to meet: (1) concentrated industrial demands for process heat such as ore smelting, portland cement manufacturing, ceramics and sugar refineries; (2) small rural industry user such as brick and lime kilns, crop driers and commercial ovens; (3) rural and urban household needs; and (4) fuel needs of commercially produced gasifier units adapted to irrigation pumps, rice mills, iceplants and farm and transport vehicles. With the assistance from the USAID, the program aims to develop approximately 21,000 hectares of tree farms.

PRESENT STATUS

Since the start of the program in 1981, 43 projects covering 19,248 hectares have been identified for implementation. Of these, plantation development activities were undertaken on 40 projects (16,355 has.) with 7,712 hectares planted with ipil-ipil trees. However, based on the assessment made last August 1984 only 1,168 hectares (15.1%) of the planted area were found to be effective. This low performance maybe attributed to the following major factors:

1. The long drought in 1982 and 1983
2. The acidic soil condition
3. The unstable/critical peace and order condition
4. Institutional problems like presence of claimants

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5. Rat infestation

6. Forest fires

Others factors which may have contributed to the low performance are:

1. Few farmers are staying permanently in the project area to undertake maintenance and care activities.
2. Inaccessibility of the project sites - some projects are more than 5 kms. away from the nearest all-weather roads.
3. The slope of the project area are very steep (more than 45%).
4. Inavailability of material inputs like fertilizers.
5. Limited budget allocation for labor.
6. The lack of technical expertise to oversee the plantation development.

Using relevant information gained from the three-year experience in the implementation of the project and using updated prices of inputs, a feasibility study was undertaken for a 100-hectare model project. The study shows that a 100-hectare project can provide an average return on investment of 31.5% and a benefit-cost ratio of 2.25 (discounted at 40%) to project beneficiaries or an average annual income of ₱22,873.00 per farm family over the first six years, subject to the following conditions and assumptions:

1. The net plantable area should be at least 100 hectares either in contiguous block or adjacent patches.
2. Soil is suited to ipil-ipil trees (ph 5.5 to 8.5).
3. At least 60% of the project area has a slope of less than 45% and at least 60% of the area to be planted has a slope of less than 30%.
4. The proposed kiln sites should not be more than 5 kms. to the nearest all-weather road through favorable terrain; not more than 150 kms. to the market; and not more than 500 meters from the cutting area, if manual hauling.
5. Springs or creeks within the project site are adequate for nursery operations.
6. Stable peace and order conditions exist/military activities do not result to long term disruption of civilian activities.

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7. The cost of plantation development per hectare is ₱6,678.00.

8. Yield per hectare after three years is:

   51 tons for fuelwood
   10 tons for leafmeal

9. Farm gate price per ton is:
   ₱2,000.00 for charcoal
   ₱ 800.00 for leafmeal (dried)

10. Kilns have the following properties:
    Rated capacity per cycle - 5 tons
    Number of cycles per year - 32
    Cost per unit - ₱27,500.00
    Conversion efficiency of fuelwood to charcoal - 28.8%

(A financial summary of the feasibility study of a model 100-hectare project is shown in Annex I.)

Applying these conditions/assumptions to the 40 projects in which plantation development were undertaken, initial studies show that:

1. Implementation of the development activities on 19 projects (9,510 hectares) is advisable.

2. A more detailed study should be undertaken on 10 projects (3,000 hectares).

33. Implementation of development activities on 11 projects (3,845 hectares) is not advisable.

Other factors which affected the implementation of the program are the delay in securing the Industrial Tree Plantation (ITP) Lease for our projects from the Bureau of Forest Development (BFD) and the coverage of 9 projects (5,203 has.) of our TREE Projects under Presidential Proclamation 2282 which states that lands covered by this proclamation are alienable and disposable. (A listing of projects covered by P.P. 2282 is found in Annex II.)

To date only 2 projects (1,250 has.) have been issued their ITP lease. This has been mainly due to the bureaucratic red tape and our inability to give the necessary "incentives" to those processing the lease applications. Coordination with the Shares in Kabuhayan Program Office, the agency implementing Presidential Proclamation 2282, has been undertaken as early as March 1984 to clarify the status of our projects covered by the said proclamation; however, nothing much has been settled since the implementing guidelines for this program were issued only last October 8, 1984.

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Technical assistance/consultancy services are being provided by Hodam & Associates, Inc. (HAI). To date, HAI has completed the yield prediction model and the transport system model, and is presently undertaking a nursery plantation development project for alternative species in Floridablanca, Pampanga.

So far, an additional 33 projects covering 8,498 hectares have been identified for future implementation. A list of these projects is found in Annex III.

RECOMMENDATION

Considering the status of the program, the following are recommended:

1. The plantation development budget allocation per hectare be increased from ₱3,500.00 to ₱6,700.00. With this adjustment, necessary inputs can be procured and the necessary labor for maintenance and care can be hired.

2. The Area Offices should be provided with at least one forestry specialist to beef-up the technical capability of the Area Offices.

3. Reorient project beneficiaries on their roles as ISA members, strengthen leadership capabilities/skills of officers and provide necessary support for an effective KAISA-ISA relationship.

4. Continue the implementation of plantation development activities on the following 19 projects:

   a. Sarrat, Ilocos Norte
   b. Dingras, Ilocos Norte
   c. Paracelis, Mt. Province
   d. Iguig, Cagayan
   e. Labo, Camarines Norte
   f. Barbaza I, Antique
   g. Barbaza II, Antique
   h. Lope de Vega, Northern Samar
   i. Pilar and Pres. Roxas, Capiz
   j. San Joaquin, Iloilo
   k. Matanao, Davao del Sur
   l. Bayugan, Agusan del Sur
   m. Tagbina, Surigao del Sur
   n. Bucas Grande, Surigao del Norte
   o. Datu Paglas, Maguindanao
   p. Tubod I, Lanao del Norte
   q. Tubod II, Lanao del Norte
   r. Polanco, Zamboanga del Norte
   s. Naawan, Misamis Oriental

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5. Defer the plantation development activities on the following 10 projects until a detailed study has been undertaken:

   a. Labrador, Pangasinan
   b. Floridablanca, Pampanga
   c. Torrijos, Marinduque
   d. Uson, Masbate
   e. Tuburan, Cebu
   f. Tarlac, Tarlac
   g. Calatrava, Negros Occidental
   h. Balete, Aklan
   i. Siaton, Negros Occidental
   j. Bagumbayan, Sultan Kudarat

   Reasons for the deferment of these projects are shown in Annex IV.

6. Stop the plantation development activities on the following 11 projects:

   a. Gen. Tinio, Nueva Ecija
   b. Aritao, Nueva Vizcaya
   c. Tineg, Abra
   d. Legaspi, Albay
   e. Antequera, Bohol
   f. Liloan, Southern Leyte
   g. Tantangan, South Cotabato
   h. Libungan, North Cotabato
   i. Mati, Davao Oriental
   j. Oroquieta City, Misamis Occidental
   k. Mansalay, Mindoro Oriental

7. Inasmuch as a number of projects will be producing charcoal in the near future, a study on the kiln efficiency should be undertaken. It is recommended that this undertaking be included in the services to be provided by HAI.

8. A thorough and detailed study and evaluation should be undertaken for future projects prior to their implementation.

FINANCIAL REQUIREMENT

To continue the implementation of the 19 projects a total of ₱12,356,612.00 is needed for its plantation development and ₱1,578,462.00 for its project management. Should the 10 deferred projects be implemented, ₱4,404,950.00 and ₱870,920.00 will be needed for their plantation development and project management, respectively. Breakdown of these requirements per project is found in Annex V.

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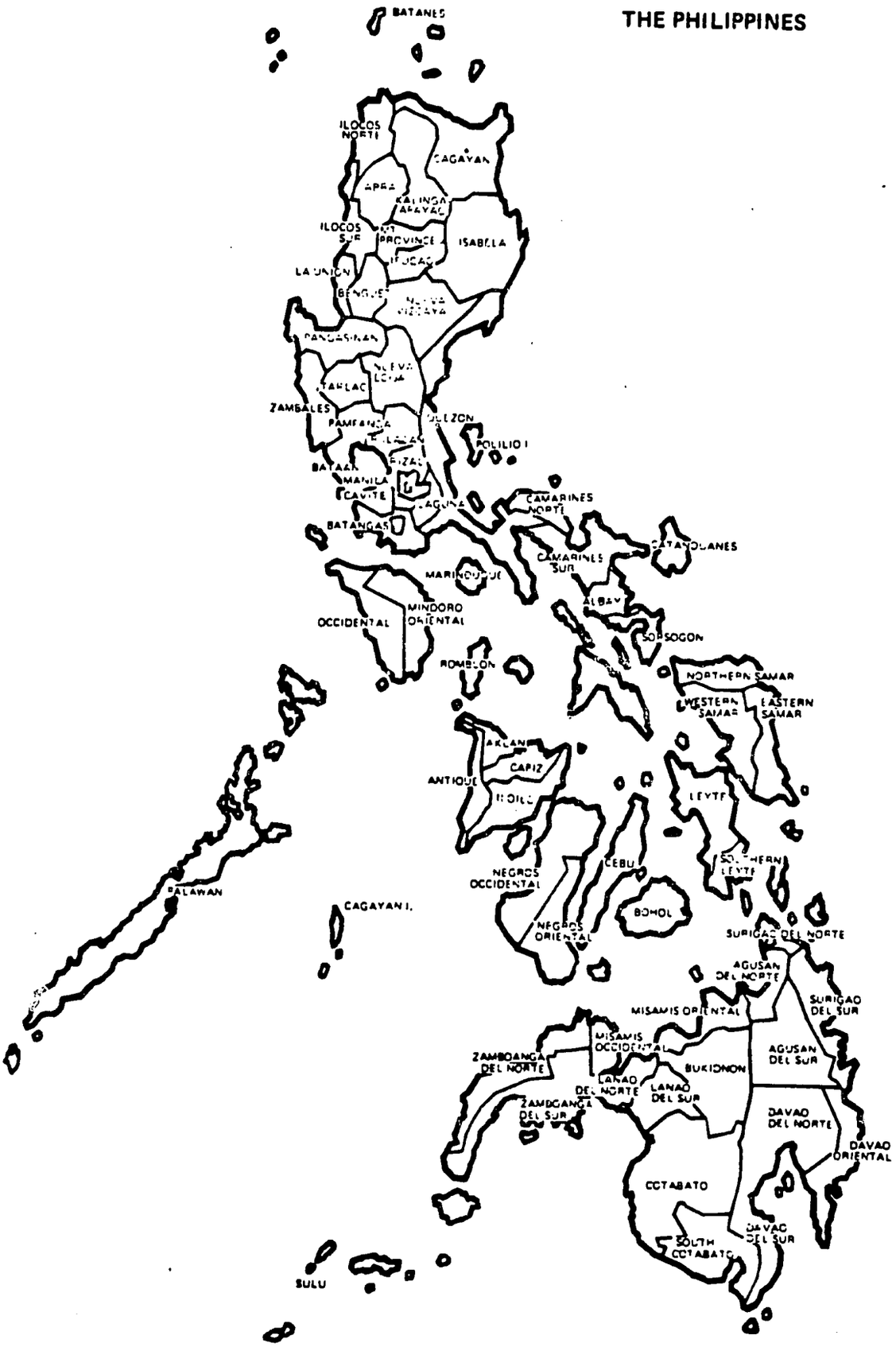
The implementation of the 33 new projects covering 8,498 hectares will require ₱45,549,280.00 for plantation development and ₱7,865,030.00 for project management. Annex VI shows the requirements of the individual projects.

THE PHILIPPINES



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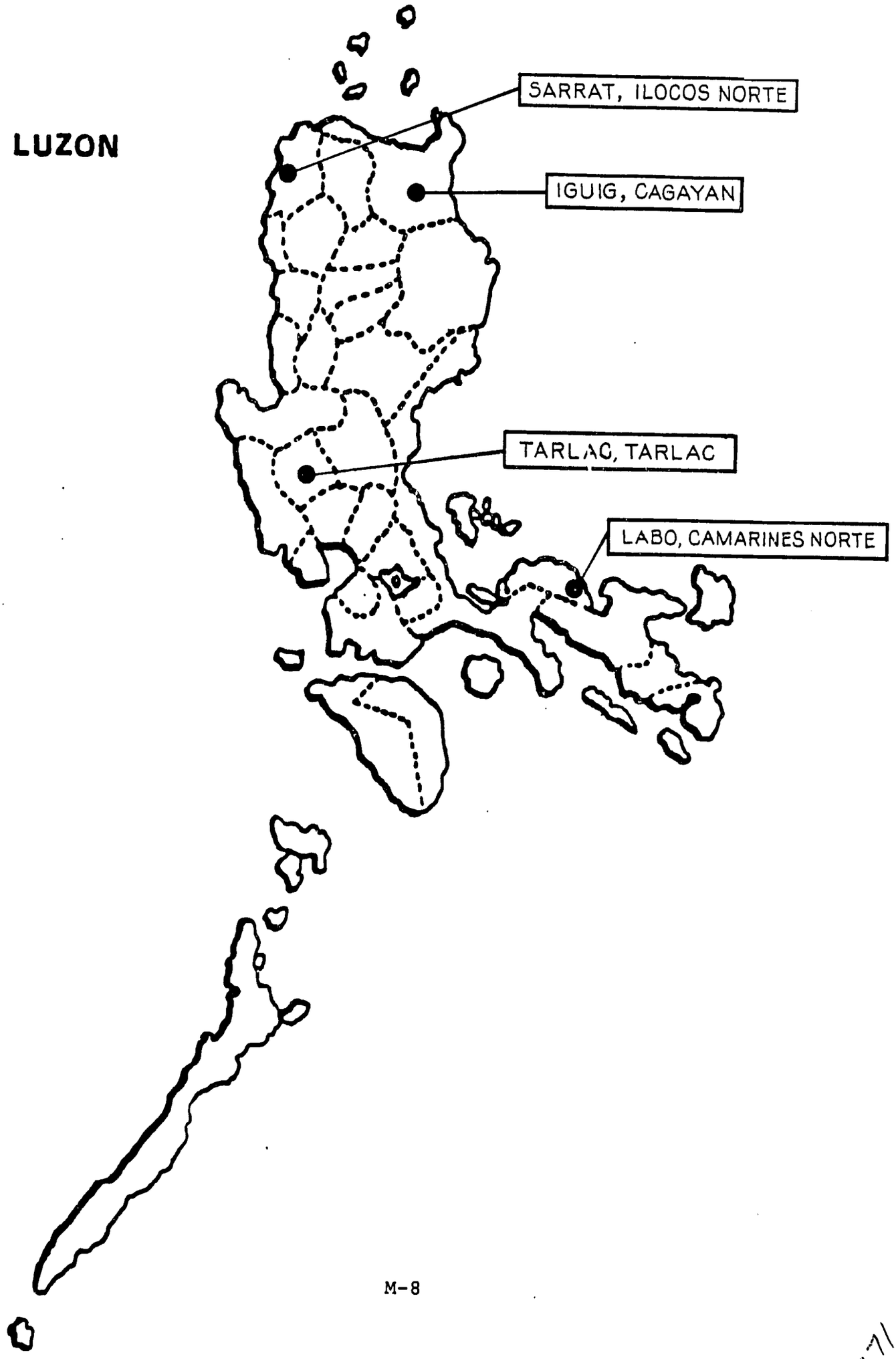
LUZON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IGUIG, CAGAYAN
TARLAC, TARLAC
LABO, CAMARINES NORTE

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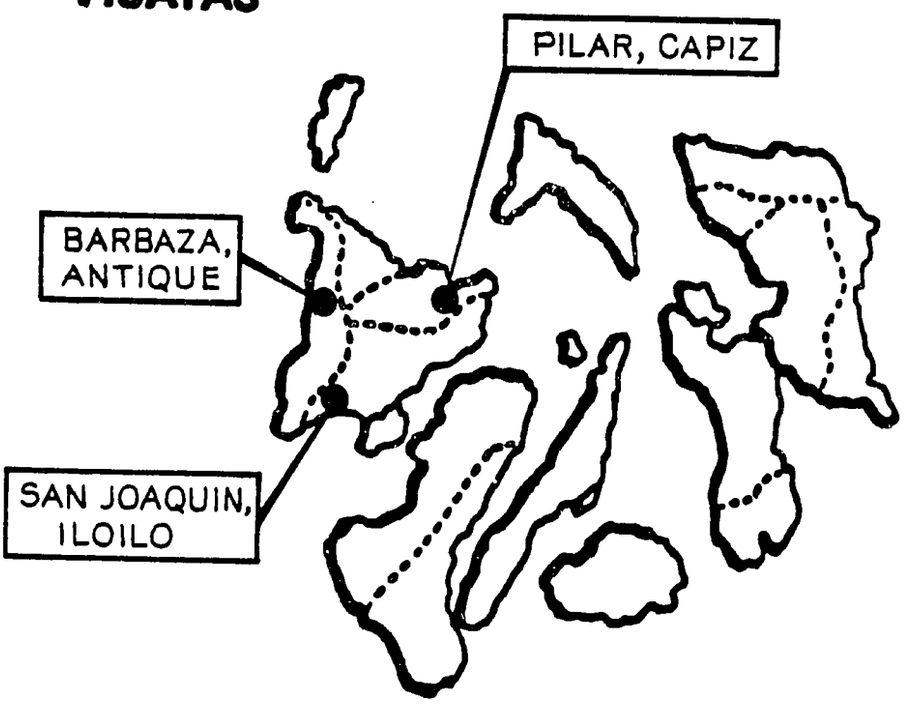
VISAYAS



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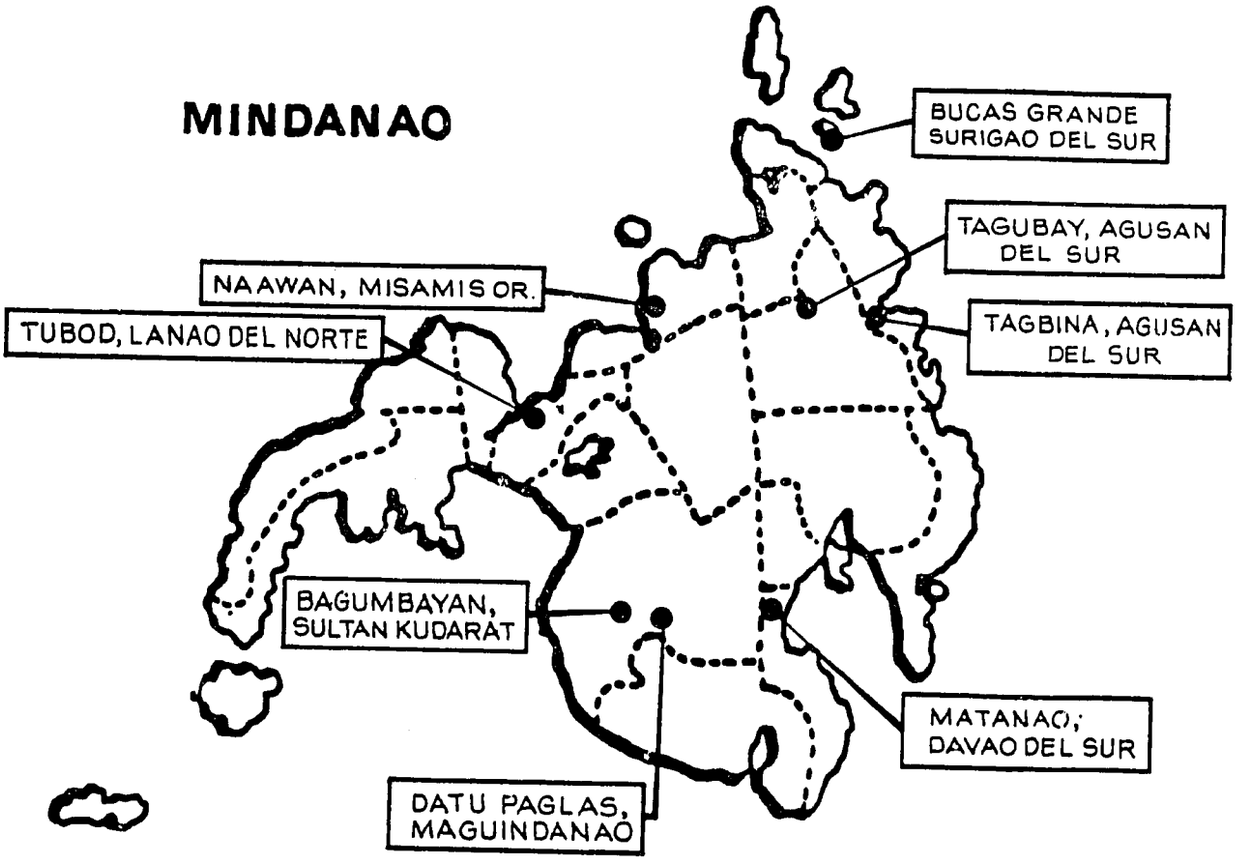
MINDANAO
BUCAS GRANDE
SURIGAO DEL SUR
TAGUBAY, AGUSAN
DEL SUR
NAAWAN, MISAMIS OR.
TAGBINA, AGUSAN
DEL SUR
TUBOD, LANAO DEL NORTE
BAGUMBAYAN,
SULTAN KUDARAT
MATANAO,
DAVAO DEL SUR
DATU PAGLAS,
MAGUINDANAO

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Appendix N

Blueprint of Charcoal Kiln Design

Appendix O

Persons Met: FSDC

Manila

Venido C. Atienza
Le Jayme Jalbuena
James P. Cabanatan
Christina P. Guinto
Wilden C. Domopoy
Serafin Gacho

Area I

Earl Dacanay, Area Manager
Bartolome Untalan, President, Mabuenta ISA
Cesar de Vera, President, Balingueo ISA
Amado Aquino, General Manager, Pangasinan KAISA
Josie Villanueva, General Manager, Ilocos Norte KAISA

Area IV

Hannibal Manikan, Area Manager
Nilo Inabi, Area Enterprise Supervisor
Joseli Mationg, ESD Head, Area IV
Patricio Tobias, FAD, Area IV
Gus Bacabac, General Manager, Iloilo KAISA
Rodel Obordo, General Manager, Capiz KAISA
Estrella Andres, General Manager, Antique KAISA

Persons Met: NEA and Rural Electric Cooperatives

Manila

General Pedro G. Dumol, Administrator
Ms. Annabelle Adriano

Bolinao

Arnulfo B. Cabrera, General Manager, PANELCO I

Cebu

Engr. Benhur L. Salimbangon, General Manager, Cebu II
Fr. Francisco Silva, General Manager, Cebu I
Jose D. Cabotabo, Jr., District Leader, Cebu II

Bohol

Carlos B. Itable, General Manager, BOHECO I
Virgilio C. Fortich, Special Project Director
Benedicto L. Legaspo, Agriculturist
Ismael P. Villamor, Chairman of the Board

Masbate

Edgar Agliam, NEA Project Manager
Abelardo Calica, Vice-President, MASELCO
Emilio Espinosa, Jr., Provincial Governor

Persons Met: Economic Support Fund Secretariat

Gerry Duran
Charlie Dugan
Marilou Montejo

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