BIBLIOGRAPHIC DATA SHEET

1. CONTROL NUMBER: PN-AAK-593

2. SUBJECT CLASSIFICATION (695): TA00-0000-G662

3. TITLE AND SUBTITLE (240): Rural electrification for Indonesia; report of the NRECA study team

4. PERSONAL AUTHORS (100)

5. CORPORATE AUTHORS (101): National Rural Electric Cooperative Association

6. DOCUMENT DATE (110): 1976

7. NUMBER OF PAGES (120): 154p.

8. ARC NUMBER (170)

9. REFERENCE ORGANIZATION (130): NRECA

10. SUPPLEMENTARY NOTES (500)

11. ABSTRACT (950)

electric power plants

Indonesia

12. DESCRIPTORS (920)

Rural development
Rural electrification
electric power generation

13. PROJECT NUMBER (150): 4970267

14. CONTRACT NO.(140): AID/ASIA-C-1347

15. CONTRACT TYPE (140): —

16. TYPE OF DOCUMENT (160)

AID 590-7 (10-79)

497-0267
PN-AAK-593

RURAL ELECTRIFICATION FOR INDONESIA

Report of the NRECA Study Team

JAKARTA • INDONESIA

May 1978

RURAL ELECTRIFICATION

FOR

INDONESIA

Report of the NRECA Study Team

Jakarta, Indonesia

May 1976

ACKNOWLEDGEMENTS

In the preparation of any study and report there is bound to be valuable input from a wide number of people whose names are not recorded. The Study Team sent to Indonesia under USAID contract with the National Rural Electric Cooperative Association is especially grateful to the many Indonesians who opened their offices, their homes, and their hearts to the visiting American consultants. They included officials from village to national levels, staff employees of the U.S. Embassy, and people from the common walks of life. All of them gave information which helped shape this Report. All of them contributed understanding for the islands of the Indonesian Archipelago and the people who make this an important part of today's world.

The Team is especially grateful to the following officials who were responsible for travel arrangements to possible project areas, for briefing conferences, and for informational material:

Minister of Manpower, Transmigration and Cooperation -- H.E. Prof. Dr. Subroto; Minister of Public Works and Electric Power -- H.E. Dr. Ir. H. Sutami; President-Director of PLN - Prof. Suryono; Director-General for Cooperatives -- Ir. Ibnu Sudjono; and in the Directorate-General for Cooperatives -- Ima Soewandi and Drs. Soeprapto.

Appreciation goes also to USAID Mission Director Thomas C. Niblock for his patience and encouragement, and to the members of his staff for their contributions to the Report.

NRECA STUDY TEAM

George W. Cornog, Team Leader
M.W. Schwartz, Engineer
Virgil Herriott, Rural Electrification Consultant
Charles E. Ham, Rural Electrification Consultant
Phil Costas, Economist
Donald H. Cooper, Cooperative Specialist
and Report Writer

TABLE OF CONTENTS

		Page
Acknowledgements		
Table of Contents		3
List of Tables, Charts, Maps		4
Background and Summary		
I.	Introduction	7
II.	Summary and Recommendations	10
III.	Objectives and Scope of Study	14
IV.	Status of Electric Supply in Indonesia	18
Proposal		
V.	Program Recommendation	27
VI.	Economic and Social Assessment	32
VII.	Program Auhtority and Agency	38
VIII.	The Cooperative Approach	45
IX.	Two Model Electric Cooperative Systems	52
Program Guidelines		
X.	Engineering and Construction	86
XI.	Materials, Equipment, Warehousing	90
XII.	System Management and Operations	96
XIII.	Training and Technical Assistance	104
Costs and Benefits		
XIV.	Projecting the Program	108
XV.	Evaluating Program Benefits	116
Attachments:		
1.	Economic Annex -- Rural Electrification	1-1
2.	Alternative Costs of Generation	2-1
3.	Basic System Criteria	3-1
4.	NRECA International Assistance Program	4-1
5.	The Philippine Experience	5-1

LIST OF TABLES, CHARTS, MAPS

Title	Chapter	Page
Locations Visited for Project Consideration	III	17
Population and Electrical Energy Statistics (Java)	IV	21
Population and Electrical Energy Statistics (Sumatra)	IV	22
Population and Electrical Energy Statistics (Kalimantan and Sulawesi)	IV	23
PLN Java Network	IV	25
Rural Electrification Recommendations	V	31
Chart of Organization for Rural Electrification Authority	VII	43
Model Electric Distribution System (A) -- Tangerang	IX	56
Model Electric Distribution System (B) -- Trenggalek	IX	57
Project Assumptions for Tangerang Model	IX	58
Project Assumptions for Trenggalek Model	IX	59
Total System Load Forecast for Tangerang Model	IX	60
Total System Load Forecast for Trenggalek Model	IX	61
Financial Forecast for Tangerang Model	IX	62
Financial Forecast for Trenggalek Model	IX	63
Total Plant Investment -- Tangerang Model	IX	78
Total Plant Investment -- Trenggalek Model	IX	79
Total Connections -- Tangerang Model	IX	80
Total Connections -- Trenggalek Model	IX	81

Title	Chapter	Page
Investment per Connection -- Tangerang Model	IX	82
Investment per Connection -- Trenggalek Model	IX	83
Financial Forecast -- Tangerang Model (graph)	IX	84
Financial Forecast -- Trenggalek Model (graph)	IX	85
Central Java -- Phase I	XIV	112
Central Java -- Phase II	XIV	113
Central Java -- Phase III	XIV	114
Possible Kabupaten Development	XIV	115

INTENTIONALLY

LEFT BLANK

I. INTRODUCTION

Indonesia is fortunate among the developing nations of the world. Its 3,000 inhabited islands contain a reservoir of natural and human resources that should be the envy of less favored parts of the earth. No survey has yet fully counted the wealth in minerals, forest, water resources, and agricultural land that is untouched.

For all its undeveloped wealth, Indonesia's people as a whole have not shared in the benefits. Annual per capita gross domestic product in 1975 was estimated at only 55,800 rupiah or US$135 (expressed in 1973 prices).

Nearly 80% of the population of 130 million depend on farming and other rural based activity, yet this is where the most widespread poverty is found. Almost two-thirds of the Indonesian people live on the island of Java which represents only 7% of the total land area.

Fewer than one out of a hundred rural families has electricity, in contrast to Jakarta where 24 out of 100 households use electricity. There is a low availability of electric service even in the cities considering the nation's fossil-fuel and hydro resources for power development. Including the kilowatt-hour consumption of large industries and public facilities, the per capita consumption of electricity in Indonesia amounted to only 17 kwh per year in 1973.

This is in contrast with:

	Kwh Used per Capita per Year
U.S.A.	7,100
Japan	4,800
Taiwan	1,000
South Korea	440
Malaysia	440
Philippines	300
Thailand	140
Laos	7

The experience of developed nations in every part of the world shows that electric power is one of the basic requirements for increasing industrial production, for boosting agricultural yield, for establishing the network of communication which can hold a developing economy together, and for satisfying the need for improvement in the living standard for a growing population. Fortunately, it has been demonstrated that the rural poor can afford electric

light and power if made available by well managed distribution systems. And when the rural poor have electricity, the improvement in their level of living benefits the whole nation.

In the rural electrification program in the United States of America after 1935 this lesson in rural development was well learned. More recently and much closer to Indonesia, the Government of the Philippines is using nationwide rural electrification as a key developmental program with positive results showing even in the first several years in terms of higher yields of rice from supplemental pump irrigation, more jobs from new industrial production in rural towns, and general improvement in the quality of life for the rural poor. A survey just completed in northern Mindanao in the Philippines lists small medical clinics, pumped water supply, fuller use of schools, better protection from fires and crime, and opportunity for evening recreation as positive benefits. Surveys of people's attitudes reveal that consumer-owned electrification has brought hope and human dignity to replace the despair of rural poverty.

Population studies indicate that approximately 50% of the Indonesian population is age 15 or younger. The expanding educational system and improved communication may raise the level of expectations of the new generation. The result could be dissatisfaction with conditions as they existed in rural areas for centuries and increasing exodus to the already overcrowded cities. Expanded rural electrification can do much to offset this.

The Government of Indonesia has been exploring ways to bring a better way of life to the broad masses of people who have been existing from day to day without the advantages found among the more fortunate. One of the basic objectives of Repelita II (the Indonesian Government's second 5-year program) is to raise the standard of living of the people. Electricity is recognized as one of the causative factors that promotes development through better use of natural and human resources. If such a program is to benefit the rural poor, electricity must be available to consumers at a monthly cost they can afford and without payment of a connection charge.

A program of rural electrification must be considered in harmonious relationship with other infrastructure programs: irrigation, roads, marketing. It must be placed in the hands of an agency which has adequate authority and enough trained manpower to carry out the assignment. Financing for the program must be assured on a continuing basis. Planning and scheduling must be initiated early and maintained with sufficient lead time at all stages so as to equate achievement with promises and so as to avoid costly delays or

bottlenecks during the engineering and construction stages of system development. Sufficient technical assistance, auditing controls, and management guidance must be provided at local project operational levels to assure (1) financial viability for the system and (2) adequate 24-hour service at the lowest possible cost to rural consumers.

Such a development program can be expected to call upon some of the best engineering and management personnel available in Indonesia. Understanding of program objectives should be required at all levels of leadership in order to win the wholehearted support essential to the success of any local cooperative electric distribution system. A large-scale training program would have to be mounted to develop leaders who understand the objective of low-cost areawide electric coverage, a consumer-owned cooperative approach, if this is to be used, and service orientation with devotion to efficient operations.

This Report describes a program of rural electrification which its authors believe can be mounted successfully in Indonesia. It suggests a phased program beginning in 12 sub-provinces. It describes a national organization to supervise the program, and uses two model areas to outline how the program would be carried out at the local level. It discusses costs and benefits. Attachment 1 deals in a preliminary way with the questions of ability of low income farmers to afford electricity, and of financial impact of rural electrification on the national budget and the overall power program. Both questions are answered positively.

Both low-interest, long-term loans and technical advisory services will be needed. The cooperatives cannot be expected to service loans on terms more stringent than currently provided by the U.S. Agency for International Development and the soft loan window of international banks. Any higher interest rates would require subsidy by the Government of Indonesia. It is assumed in any event that the Government of Indonesia would provide low-cost financing for local currency costs of the program in the form of equity participation through capital suscription in the national administrative agency.

II. SUMMARY AND RECOMMENDATIONS

Status of Rural Electrification.

The Republic of Indonesia's List of Project Aid Proposals for FY 75/76 calls for a study of prospects for expanding rural electrification as a means of providing a more equitable distribution of goods and services for the rural population.

A few small cooperative projects for rural electrification have been carried out in areas outside the network of the State Electricity Enterprise, Perusahaan Umum Listrik Negara (PLN), and at least one province has undertaken to launch its own small-scale projects for rural electrification.

These systems draw power from small diesel and hydro powered generators. The enthusiasm manifested by villagers for even such limited service and costly sources of electricity reinforces the timeliness of efforts to expand and improve electric service at the farm and village level. Present plans of PLN do not provide for rapid extension of service to villagers.

The decision of the National Economic Development Planning Board (BAPPENAS) to investigate the possibilities of expanding rural electrification activities is therefore quite timely. This is especially true given the heavy investment already made and continuing to be made to provide for an inter-connected power grid on the island of Java and the opportunity this provides to develop a comprehensive network of local distribution systems in which existing microhydro and diesel generation is related most efficiently to central station power.

Offer of Pre-feasibility Study.

Based on recent successes with rural electrification programs in other countries and in line with the mandate of the U.S. Congress to concentrate the resources of the Agency for International Development toward improving the lot of the rural poor, the USAID made an offer to the Chairman of BAPPENAS on November 10, 1975, to sponsor the proposed pre-feasibility study.

The offer was to provide a team from the National Rural Electric Cooperative Association (NRECA) to make the study. The NRECA is a non-profit organization in the private sector of the U.S. economy, representing nearly 1,000 rural electric cooperatives. These are financially sound systems

serving 8 million member-consumers. The Study Team would survey prospective sites with the idea of producing pre-feasibility proposals for electric power distribution systems in selected areas, and of proposing an institutional structure for administration of what hopefully could become a nationwide program.

The offer of the USAID was accepted on November 21, 1975, through the Minister of Manpower, Transmigration, and Cooperatives; and the Director General for Cooperatives was appointed as the Indonesian coordinator for the study.

NRECA Study Team.

A four-man team arrived in Jakarta to begin work on February 9, 1976, after a brief stopover en route to observe the Philippine rural electrification program. A fifth member joined the team on March 1. While the principal point of coordination continued to be the Directorate General for Cooperatives, close contact was maintained throughout the study with the Directorate General for Electric Power and the PLN in the Department of Public Works and Electric Power and with the Directorate General for Rural Development in the Department of Internal Affairs.

The team traveled to seven provinces in their survey of rural areas in Indonesia and into parts of at least 35 different kabupaten*. The trips were coordinated through provincial governors, and local officials were contacted whenever possible.

Sixteen different general areas were identified as promising sites for further consideration if the Phase I program recommendations (see Chapter V) should be adopted. No attempt was made to define the precise geographic boundaries of any future cooperative. Two areas were studied more closely so that the models described in Chapter IX could be constructed. The models are for the purposes of illustration only and are not intended to be a recommendation as to where any cooperative should be established.

Rural electrification is greatly needed throughout Indonesia for all the people, and much further study should go into the selection of sites for initiating a program. Full feasibility studies should be a pre-requisite to

---

*Administrative district below province level.

establishing any rural electric cooperative. The participation and involvement of local people is important to that process in addition to the assistance and support of leaders in government at all levels.

The Team was encouraged throughout its work by the keen interest at all levels in programs to expand electric service to rural areas and to follow through on the commitment of Repelita II* to improve the well being and productivity of the rural poor. Discussions with national and local officials, at provincial universities, and with private citizens indicated electric power to be a very high economic and social goal for the rural areas. The absence of home lighting and economical power for local industry was pointed out as one of the sharpest contrasts between life for the rural poor and that of people in cities and especially the well-to-do.

Conclusions Reached.

The Team concluded that conditions are favorable for rather spectacular progress in rural electrification in Indonesia. They were especially impressed with the nation's great energy resources in potential large-scale hydro-generating sites and fossil fuels, and by dense population settlement patterns which should favor low-cost construction of distribution systems. The Team believes if its recommendations are followed that the typical farm family can receive electricity for home lighting cheaper than current costs paid for kerosene!

There is reason to believe that electric service to rural people can be achieved most effectively and with greater benefit to the poor by member-owned rural electric distribution systems operated as cooperatives -- provided the cooperatives have access to long-term, low-interest loans and to guidance and technical assistance from a national administrative body established for that purpose. The team was impressed by the strong philosophical commitment to the cooperative approach at senior levels of government as well as the spirit of gotong-royong** at the village level.

---

* Second 5-year development program.
**Mutual aid community service.

With this background and these approaches in mind, the team recommends the concerned Indonesian agencies consider the desirability of mounting a Phase I rural electrification program of up to 12 initial local distribution systems operated as consumer-owned cooperatives closely coordinated with and, where feasible, drawing upon PLN central station power.

The Phase I program could be installed at a cost of some 1.66 billion rupiahs (US$4 million) per individual system, or 20 billion rupiahs (US$48 million) for 12 systems. If it should be decided to locate a system in a remote location where PLN power is not available and a diesel plant must be installed, the system cost would approximate 2.5 billion rupiah (US$6 million). The very dense population clustering along rural roads (625 per square kilometer average in Java) makes the capital investment per consumer low in comparison to other countries with successful rural electrification programs.

The Team's recommendation should in no sense be considered an offer by USAID to provide financial support for a rural electrification program. It is rather a recommendation to USAID and the Government of Indonesia which offers the possibility of being the basis for consideration of negotiations for financing a rural electrification program.

There are also recommendations for creation of a national body to administer the programs; for training activities keyed to each skill needed; for financial criteria to assure viability of the overall proposal, as well as of the individual cooperatives, and for technical assistance to help implement the proposed program.

The team estimates the Phase I program should bring electricity to homes occupied by 1.4 million people, half of whom would be served in the first year as backbone lines are installed, with the other half being connected over the next 5-10 years. Among the most obvious benefits from rural electrification would be jobs for additional people as local industry develops, less costly power for irrigation pumps, evening use of school and other buildings for education and social improvement purposes.

Should experience with Phase I justify expansion of the program, a Phase II program to establish a backbone cooperative distribution system in more of Indonesia's 233 kabupaten would be a logical follow-on development. The organizational structure for Phase I has been proposed with this in mind. Indonesia would then have the basic network in place for steady expansion of electric power service to virtually all its rural people over the succeeding years. It is noteworthy that the Phase I program itself would serve more rural customers than are being served from all sources in 1976. And the service would be 24 hours a day, adequate for the needs of local industry.

III. OBJECTIVES AND SCOPE OF STUDY

Data and recommendations in this Report derive from travel to proposed sites for rural electrification projects, from conversations and conferences with Indonesians at many levels, and from best available statistics and other informational sources.

Objectives and scope of the study are set forth in AID Task Order No.2 (Project No. 498-11-995-249) substantially as follows:

Objectives:

1. To conduct a preliminary reconnaissance study to determine the potential for rural electrification, and to ascertain the best approach to organizing and implementing a program of rural electrification in Indonesia.

2. To investigate approximately eight areas (actually 16 were visited) selected in consultation with USAID and the Government of Indonesia (GOI) and make prefeasibility studies of four of these areas (actually two detailed studies have been prepared) based upon criteria to be agreed to by NRECA, USAID, and the GOI.

Scope of Study:

1. Appraise the overall social and economic effects a rural electrification program would have on development including agricultural productivity, agro-industries, and improvement of living standards in rural areas.

2. Relate the U.S. experience in the establishment, development, management and operation of rural electric systems to the situation in Indonesia.

3. Appraise existing plans for rural electrification and assess public and official attitudes toward such a program.

4. Analyze the economic, social, and political conditions affecting the organization, operation, and financing of rural electric cooperatives.

5. Determine the manner in which rural electric cooperatives could contribute to the development of other cooperatives such as credit unions and thus become part of a dynamic cooperative program in the selected rural areas.

6. Investigate potential government support for the cooperative approach to rural electrification and the extent and

manner in which financing could be made available to cooperatives.

7. Gauge the degree of local support for rural electric cooperatives, including financial support, which can be expected.

8. Investigate approximately eight areas (actually 16 were visited) where conditions seem most favorable for the establishment of pilot rural electric cooperatives, and, using criteria to be agreed to by the GOI, USAID, and NRECA, make prefeasibility studies in approximately four areas (actually two detailed studies have been prepared) taking into consideration such factors as the availability of firm power, economic and social conditions of the people, availability of local financing, and willingness of the people to provide self-help participation.

9. Recommend suitable methods for establishing, supervising, controlling and regulating rural electric cooperatives until they can be operated on a sound and efficient basis by local people.

10. Determine the types of management, organizational, and technical training which may be required and how such training may be arranged to ensure the success of rural electric cooperatives.

The written Report contains findings on the matters listed above, other pertinent information, and system design data.

The team also has made a series of presentations to officials of the Government of Indonesia, reviewing the findings, exploring alternatives, and determining key issues, prior to preparing the final Report.

It should scarcely be necessary to observe that the most important objective of all in making the study was to arrive at a consensus which would be a program which Indonesian officials and the people of Indonesia can adapt to their own particular needs and to their own way of life. The consultants on the Study Team agree in their belief that this must be an Indonesian program from start to finish. Any rural electric cooperatives which come into existence on these islands of the Indonesian Archipelago will be owned by Indonesians, managed by Indonesians, serve Indonesians, and reflect Indonesian needs and conditions, no matter what technical assistance may be offered and accepted from managers, electrical engineers, and cooperative specialists from the rural electric cooperatives in America or other nations.

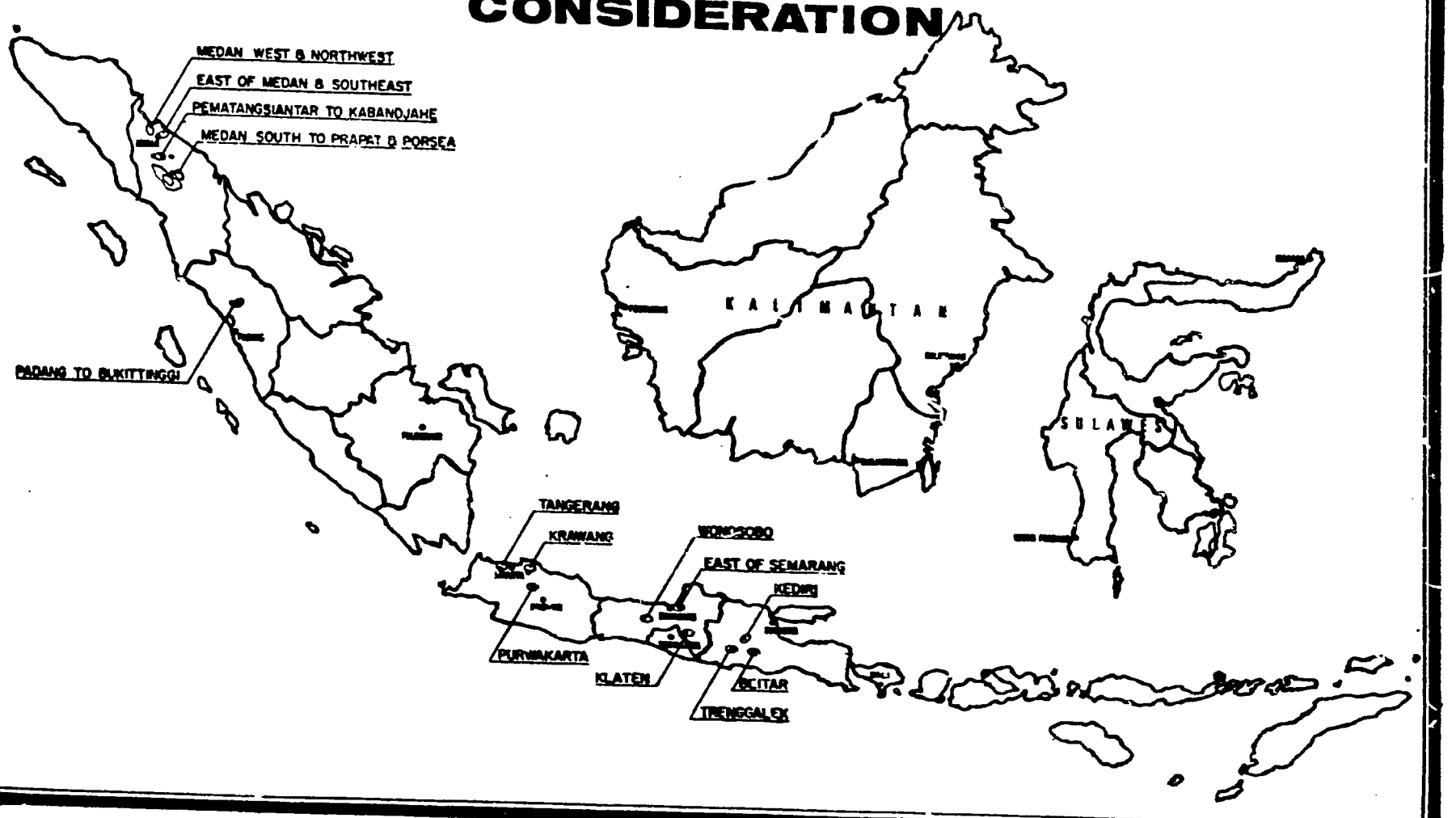
Locations Considered.

As the basis for gathering information needed and for making recommendations, the team of consultants from the U.S.A. visited the following locations:

	Locations visited	Province
(1)	Northern portion of Kabupaten Krawang	West Java
(2)	Central portion of Kabupaten Purwakarta	West Java
(3)	Eastern portion of Kabupaten Tangerang	West Java
(4)	Area between Semarang and Demak	Central Java
(5)	Area east of Wonosobo	Central Java
(6)	Klaten and northeast of Klaten	Central Java
(7)	Trenggalek	East Java
(8)	Blitar	East Java
(9)	Kediri	East Java
(10)	Area east of Medan to Lubukpakam	North Sumatra
(11)	Area between Lubukpakam and Porshe	North Sumatra
(12)	Area between Pematang Siantar and Kabanjahe	North Sumatra
(13)	Area northeast of Binjai	North Sumatra
(14)	Area east of Bukittinggi	West Sumatra
(15)	Bukittinggi to Padangpanjang	West Sumatra
(16)	Padangpanjang to Padang	West Sumatra

Other locations recommended to the survey team which were not visited due to lack of time included areas in Aceh, Bali, South Kalimantan, and South Sulawesi. These areas should be considered when further studies are made.

LOCATIONS VISITED FOR PROJECT CONSIDERATION



IV. STATUS OF ELECTRIC SUPPLY IN INDONESIA

There can be no rural electrification program without the necessary generating capacity. Power supply planning goes hand in hand with the financing and construction of distribution lines to serve Indonesia's population. It is expected that most of the rural electric cooperatives proposed in this study would purchase their wholesale power requirements from PLN, the State Electricity Enterprise (Perusahaan Umum Listrik Negara).

PLN.

Under a 1972 government regulation, PLN as a state-owned enterprise reporting to the Department of Public Works and Electric Energy has responsibility for generating, transmitting, and distributing electric power in Indonesia. However, the power facilities at the disposal of PLN are not at present sufficient to meet expressed demand. In this situation, industrial enterprises and individuals are allowed to build and operate generating stations to meet their own needs, and in some instances to serve nearby consumers. Generating plants below 50,000 KVA can be licensed by PLN; larger ones require approval by the Minister of Public Works and Electric Energy, on PLN recommendation.

These so-called "captive" installations constitute an estimated 40-60% of the total installed capacity of the nation. It can be stated that these isolated privately owned facilities are for the most part an expensive and uneconomic way to supply electricity.

Generating Capacity.

PLN's total installed capacity amounted to 922 MW at the end of 1975. This does not include the 125 MW Juanda hydro station from which PLN buys power. This generating plant is part of a multi-purpose installation operated by the Jatiluhur Authority, an independent government-owned enterprise. Including Juanda, electric generation capacity is 43% hydro, 25% fossil-fueled steam, 27% diesel, and 5% gas turbine.

About 80% of Indonesia's installed capacity is on the island of Java; 15% is on Sumatra, and the remaining 5% is on other islands of the archipelago. Largest plant is the 150 MW Tanjung Priok installation in Jakarta. The other plants are widely scattered and some are quite small.

Actual generation (including purchases from Jatiluhur) by PLN amounted to 2,932,000 MWH in 1973. Of this amount,

52.8% was consumed in the metropolitan Jakarta area. Most of the remainder was for other major cities. The rural population get less than 1% of Indonesia's electric power.

Transmission Facilities.

Transmission facilities of PLN include about 3,000 kilometers of lines ranging from 25 to 150 KV, and about 1,350 MVA in combined transformer capacity. Transmission construction now underway will establish a grid in Java.

Distribution System.

Electric distribution systems in Indonesia reflect many different design and construction standards because they were built over the years under a variety of financing, ownership, and government controls. World War II and the struggle for independence destroyed many lines, leaving them to be rebuilt with whatever materials were at hand. Voltage standards vary, but PLN has established nationwide standards for new construction and in the rehabilitation it is undertaking in some of the cities. Inasmuch as rehabilitation programs affect customer-owned appliances as well as the PLN system design and construction, it may be many years before all of the existing distribution systems are rebuilt. Consideration of rural systems may be left to the last.

New standards for distribution voltage levels are 6 KV, 10 KV, and 20 KV. Service utilization are set at 220 volt for single-phase and 220/380 volt for three-phase.

Planned Expansion in Repelita II.

Repelita II (Second Five Year Plan) calls for approximate doubling of the generating capacity under PLN's control. This would add 1,100 MW by April 1979. Planning projections also call for 3,700 kilometers of transmission line to be built, with 2,490 MVA of substation capacity. Projections for distribution systems would add 8,500 kilometers of primary and 11,000 kilometers of secondary distribution lines, with 1,880 units of distribution transformer mostly in urban centers. When this planning was announced, the investment cost for the 5-year period was estimated at Rupiah 380,000 million, of which about 64% would be foreign exchange (US$586 million).

Prospect for Rural Areas.

Very little of this would seem to be anticipated for rural areas. One report published by PLN says that "the

development of rural electrification may be carried out by constructing Microhydro Power Plants and Diesel Power Plants and distribution substations tapping from the existing network".* Another report** proposes Rupiah 1,639 million (US$3.9 million) for a 5-year program of additional micro-hydro plants. Figures on cost per installation vary widely, but the number of households which could be served over the next 5 years would come out at roughly the consumer-membership of one rural electric cooperative system in the program recommended in this Report.

Most of the rural electrification projects visited by the NRECA advisory team and all of those described in conference presentations consist of a very small hydro or diesel powered generator, with a low voltage line serving approximately 100-200 customers. Service is provided for lights during evening hours.

It is not practical to expand the size of the micro-hydro plants. Seasonal fluctuations in water flow at some locations reduce the firm power capability considerably. Probably these existing plants can be integrated into new and larger systems if an overall plan for expanded rural electrification can be implemented. Maximum economic benefits could then be realized.

A great number of small hydro sites appear to be available in Sumatra. It is possible that some of these and others in the outlying islands may prove practical for development to serve small or isolated communities where more economical central station service cannot be made available in the the foreseeable future.

It seems obvious that the existing approach to rural electrification will not get the job done. Taking another approach, the projected expansion of generation stations and transmission grid by PLN does suggest that power at many locations can be available for allocation to rural electric distribution systems by the time those systems are built and ready for energization (2 or 3 years).

---

* Meeting the Public Power Sector in Indonesia, 1974, Background paper 3, page 10.

**The Public Power Sector in Indonesia, 1974, Investment Planning, page 34.

Power Supply Must Be Assured.

It seems equally obvious that in any program of rural electrification availability of sufficient wholesale amounts of power must be assured prior to project initiation. There must be, then, substantial coordination and cooperation between PLN and whatever agency of the Government of Indonesia is charged with administration of the rural electrification program.

To fully utilize rural distribution systems, there must be assurances of sufficient resource potential for generating the tremendous amounts of power which will be demanded through the decades ahead. A study prepared for the National Energy Seminar held in Jakarta in 1974 anticipates an installed capacity of 64,000 MW for Indonesia in the year 2000.

Projected fuel or energy sources for this total are shown as follows:

Coal to produce	8,000 - 16,000 MW(12-25%)
Oil and natural gas to produce	12,000 - 39,000 MW(20-61%)
Nuclear energy to produce	15,000 - 25,000 MW(23-39%)
Hydro-generation	4,000 - 5,000 MW(6- 8%)
Geothermal generation	500 - 6,000 MW(1- 9%)

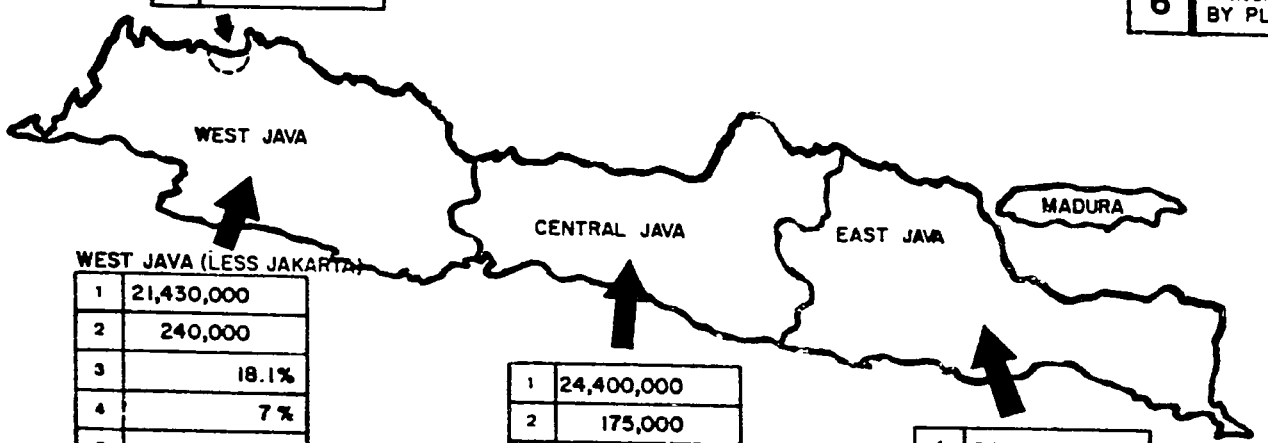
Such a level of energy source input would require production figures greatly increased over present levels. Coal production is reported at around 100,000 tons per annum and would have to be increased to some 25 million tons per annum by the year 2000. The share of generation allocated to oil and natural gas fuels in this study would require 150 to 500 million barrels of oil per annum by the year 2000.

The above fragmentary statistics are included to indicate the kind of considerations which are going to be needed at the highest levels of economic planning in implementation of and extensive rural electrification program as suggested.

POPULATION AND ELECTRICAL ENERGY STATISTICS 1975

BY PLN OPERATIONAL DIVISION

LEGEND	
1	POPULATION
2	CONSUMER UNITS SERVED BY PLN
3	% OF TOTAL INDONESIAN POPULATION
4	% CONSUMER UNITS NOW SERVED BY PLN
5	ANNUAL KWH PER CONSUMER UNIT
6	ANNUAL KWH PER CAPITA BY PLN DIVISION



JAKARTA ONLY

1	4,600,000
2	163,000
3	3.8 %
4	21 %
5	2760 Kwh
6	98 Kwh

WEST JAVA (LESS JAKARTA)

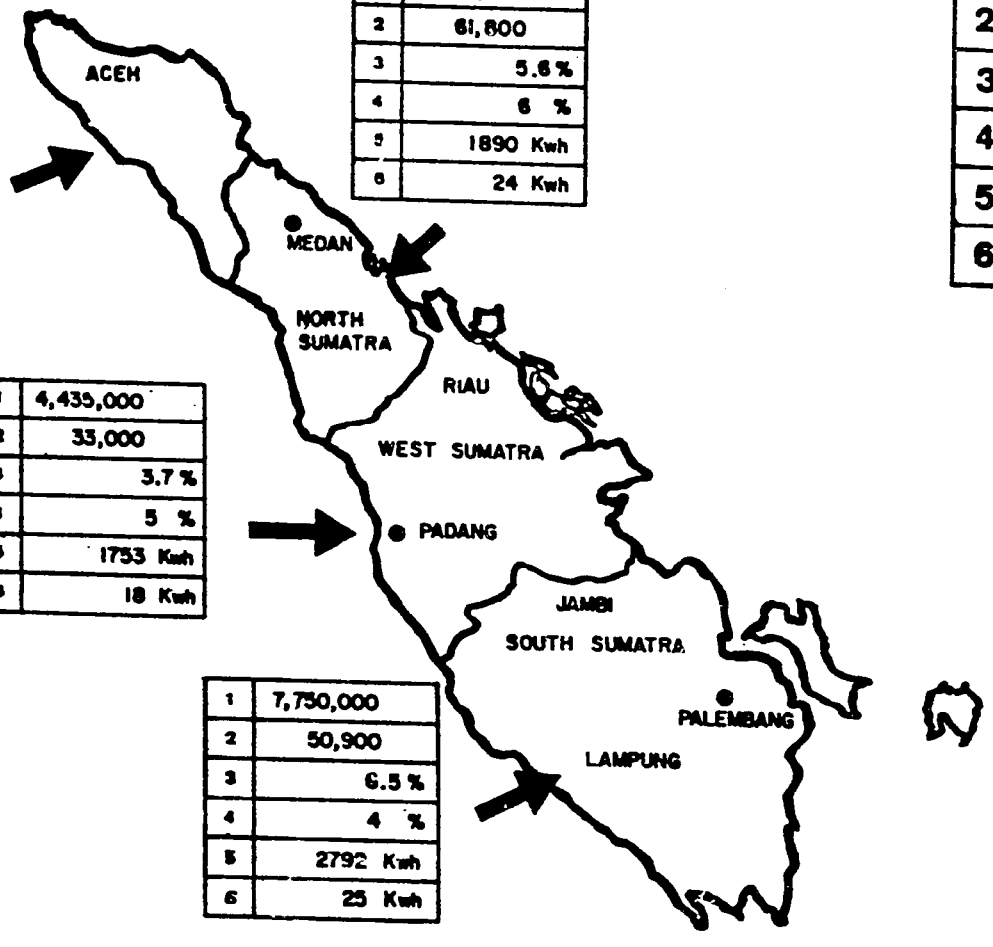
1	21,430,000
2	240,000
3	18.1%
4	7 %
5	2600 Kwh
6	29 Kwh

1	24,400,000
2	175,000
3	21%
4	5%
5	1919 Kwh
6	19 Kwh

1	25,525,000
2	230,000
3	21%
4	5%
5	1882 Kwh
6	23 Kwh

POPULATION AND ELECTRICAL ENERGY STATISTICS 1975

BY PLN OPERATIONAL DIVISION



1	2,010,000
2	11,900
3	1.7%
4	4 %
5	1600 Kwh
6	13 Kwh

1	6,623,000
2	61,800
3	5.6 %
4	6 %
5	1890 Kwh
6	24 Kwh

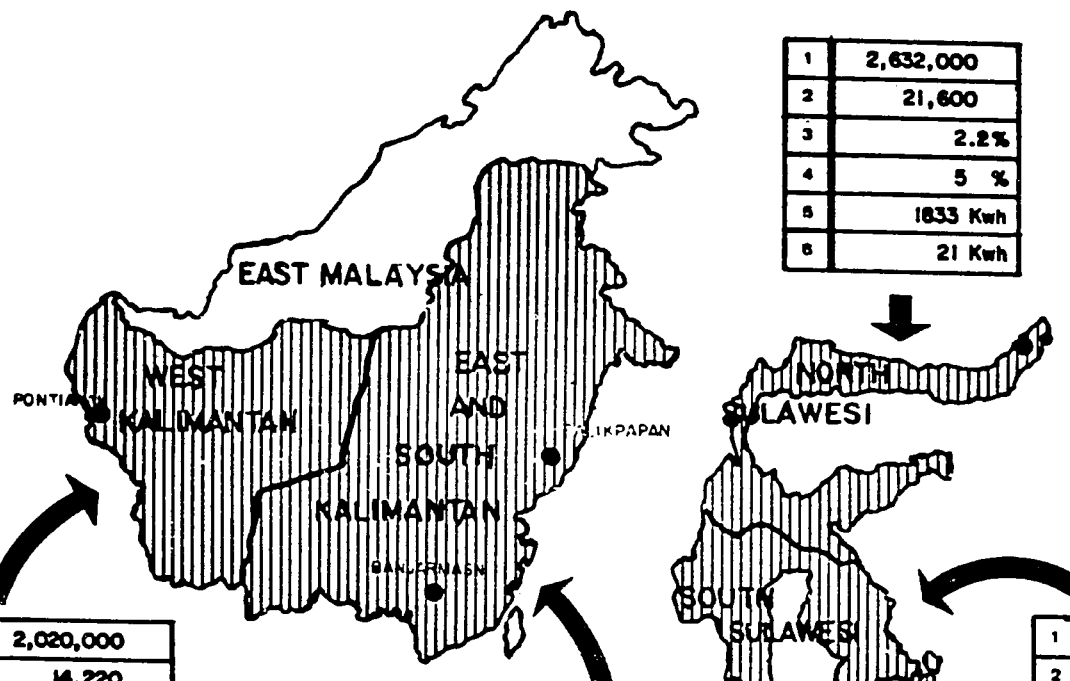
1	4,435,000
2	33,000
3	3.7 %
4	5 %
5	1753 Kwh
6	18 Kwh

1	7,750,000
2	50,900
3	6.5 %
4	4 %
5	2792 Kwh
6	25 Kwh

LEGEND

1	POPULATION
2	CONSUMER UNITS SERVED BY PLN
3	% OF TOTAL INDONESIAN POPULATION
4	% CONSUMER UNITS NOW SERVED BY PLN
5	ANNUAL KWH PER CONSUMER UNIT
6	ANNUAL KWH PER CAPITA BY PLN DIVISION

POPULATION AND ELECTRICAL ENERGY STATISTICS
1975
BY PLN OPERATIONAL DIVISION



1	2,632,000
2	21,600
3	2.2%
4	5 %
5	1833 Kwh
6	21 Kwh

1	2,020,000
2	14,220
3	1.7 %
4	4 %
5	2081 Kwh
6	13 Kwh

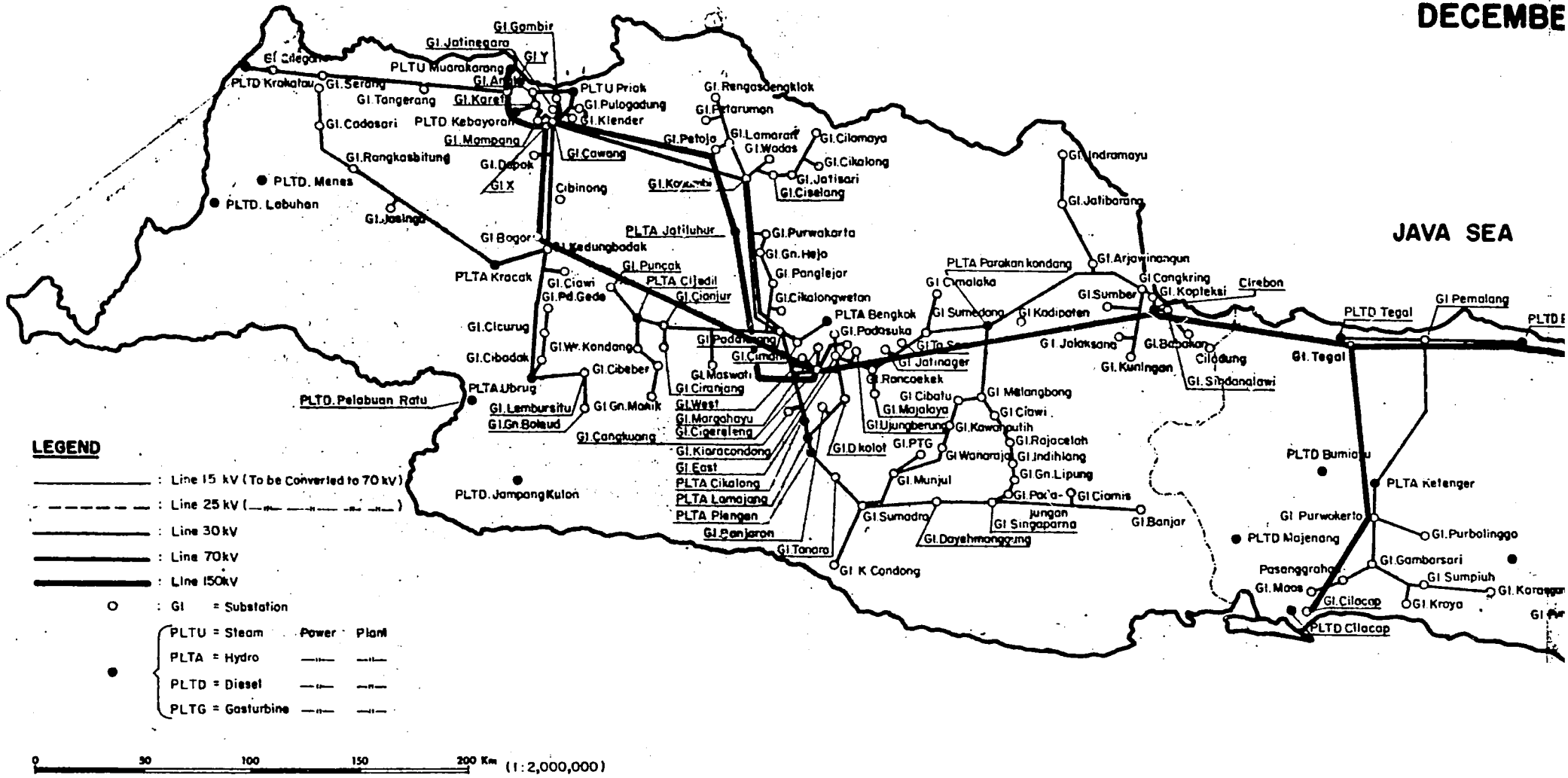
1	3,132,000
2	24,300
3	2.6 %
4	5 %
5	2240 Kwh
6	24 Kwh

1	5,900,000
2	26,500
3	5%
4	3%
5	2331 Kwh
6	14 Kwh

LEGEND	
1	POPULATION
2	CONSUMER UNITS SERVED BY PLN
3	% OF TOTAL INDONESIAN POPULATION
4	% CONSUMER UNITS NOW SERVED BY PLN
5	ANNUAL KWH PER CONSUMER UNIT
6	ANNUAL KWH PER CAPITA BY PLN DIVISION

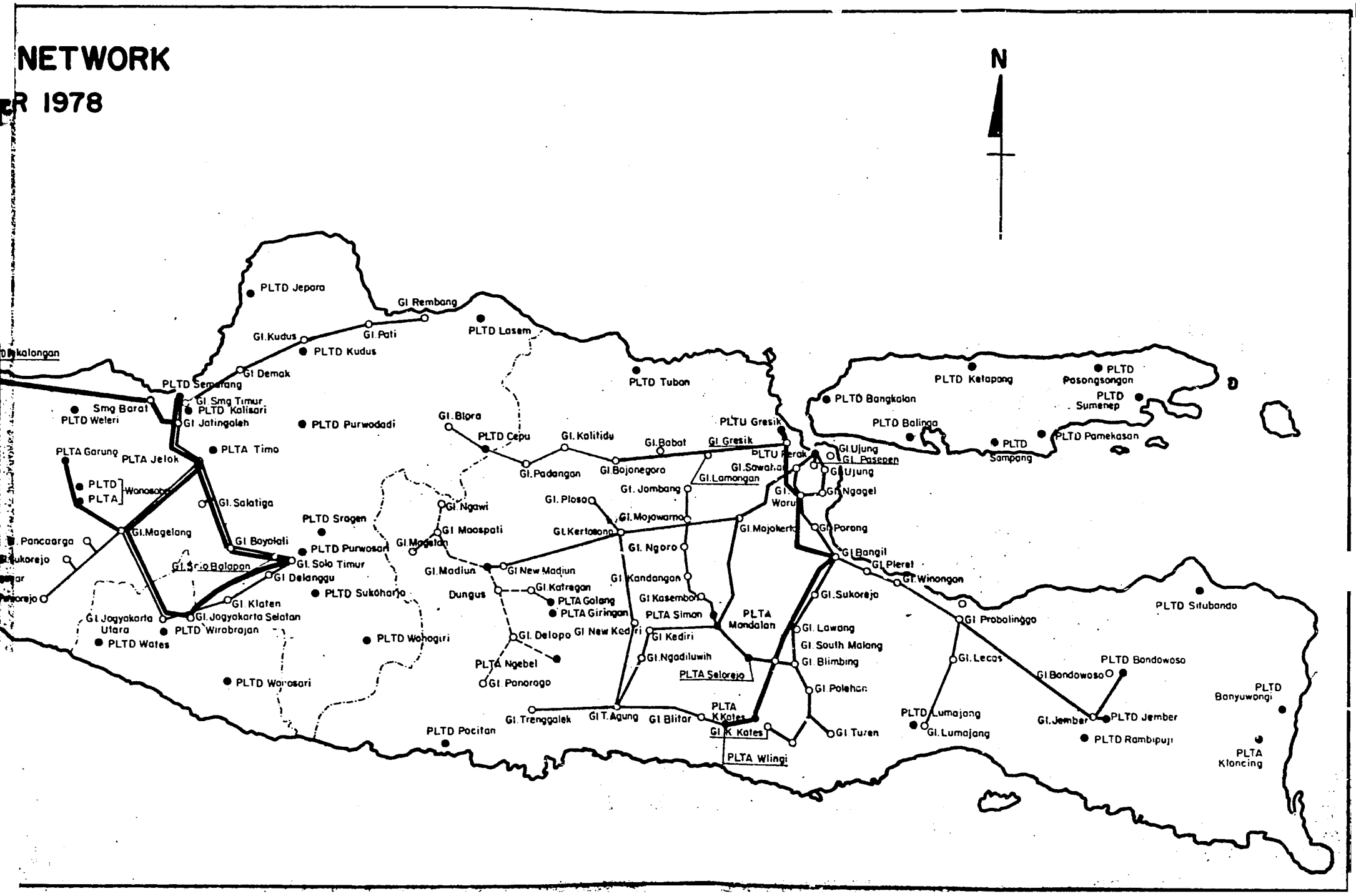
PLN JAVA

DECEMBE



BEST AVAILABLE DOCUMENT

NETWORK
R 1978



V. PROGRAM RECOMMENDATION

Some Criteria for Program Consideration.

Experience with both pilot projects and proposals for full-scale rural electrification in various countries has yielded some criteria for estimating the prospects of success in advance of commitment. The following are some initial considerations in making a determination about the outlook for rural electrification:

(1) Does the country have energy resources for generating the amount of electric power which will be required?

(2) Is there sufficient generating plant capacity in existence, planned, or within the nation's capability?

(3) Is there a substantial rural population so situated geographically that distribution systems could be constructed economically?

(4) What is the threshold income that will determine whether or not a rural family will become a consumer of electric service and be able to pay for it? Is there a high enough percentage of the rural population above that threshold income to make rural electrification feasible?

(5) Are there agricultural and other area resources which could be sufficiently more productive by the application of electric power to make the program worthwhile?

(6) Would electric service in rural areas result in job and income-producing industries or businesses?

(7) Is there a minimum network of transportation (roads, railroads, waterways) and communications to facilitate the construction and maintenance of rural electric systems?

(8) Can the nation devote a large enough share of its investment potential to the program within its overall commitment to economic and social development?

(9) Does the prospect for financial stability of the nation in the years ahead appear to justify foreign loans on low-interest, long-repayment-period terms?

(10) Are the prospects for political stability good?

(11) Do the nation's leaders and opinion makers evidence

a commitment to the improvement of the living conditions of the rural poor?

(12) Are there historical precedents or recognizable social or cultural characteristics which suggest that rural people will accept a pattern of consumer-owned cooperatives and work together for their own mutual benefit?

(13) Is there justification for assuming that the rural distribution system loans will be repaid to the government as scheduled?

Indonesian Conditions Appear Favorable.

The NRECA Study Team has concluded that the above considerations can be satisfied and that conditions are favorable for acceleration of the Government of Indonesia's rural electrification program, provided several institutional measures are undertaken and low-interest, long-term financing becomes available.

In the next chapter, on "Economic and Social Assessment", analyses in some detail spell out several factors which appear to encourage this view and to support the recommendations for a full rural electrification program.

The Team recommends establishment of a new, national organization for administering and financing a phased program to provide electric service to the majority of rural Indonesians over a 25-30 year period.

It recommends a Phase I program to make loans for construction of up to 12 local distribution systems in selected kabupaten, and that such systems be owned and operated by their members as cooperatives, with strong support and supervision from the national agency.

Steps Recommended.

Realization of such a program would entail the following steps:

(1) Establish a top-level national agency to administer the program. It should work in close harmony with PLN, the Directorate for Cooperatives, and other concerned bodies at the national, provincial, and local levels.

(2) Bulk power should be purchased from PLN wherever that is feasible. Wholesale power rates would need to be

negotiated at close to the cost of power.

(3) Consumer-owned cooperatives should be organized and chartered to provide rural electrification at selected locations where a full feasibility study has indicated a system can be constructed economically and operated successfully. Each would be a membership organization with its own board of directors and general manager.

(4) Full system financing for construction and for supplementing initial operations would be from the national government agency, along with technical assistance and suitable controls and auditing. Loans to the cooperatives would be low-interest and long-term, with a grace period before repayments start.

(5) Include a standard housewiring program to accompany the cooperatives' sign-up drive for consumer-members. Provision for credit on easy terms should be a part of the housewiring package.

(6) The program would be financed in part by foreign loans and in part by Indonesian funds, perhaps in approximately even sharing. The foreign loans would need to be long-term, with a low rate of interest and a grace period.

(7) Technical assistance in rural electrification could be furnished by a team of experienced advisors from countries with a successful cooperative program.

(8) A Phase I program would include up to 12 rural electric cooperatives to have backbone systems ready to energize about two years after project initiation. The program objective would be to have each cooperative serve a minimum of 10,000 households and other consumers by the end of the first year of operations, with the prospect of doubling that figure later. The program expectation might be to have 8 of the initial 12 systems paying actual operating costs (including cost of power) by the end of the third year. The cooperatives should be meeting all interest and amortization payments on their loans within 7-10 years of start-up.

(9) Success of the program will require a large and continuous training schedule at all levels: within the national agency, for the board, general manager, and staff of each cooperative; and for the member-consumers. The bulk of training must be performed in Indonesia rather than in a foreign country.

(10) Economies in engineering, construction, and operation of the rural electric systems will require adherence to predetermined standards and specifications for design and materials. Construction economies are essential if the cooperatives are to become financially sound businesses while offering service at low rates. Such standards and specifications for systems in rural areas are already well developed and field tested.

(11) Materials and equipment for the construction program should be purchased by the national agency, warehoused and issued to the projects as needed. This suggests a "pipeline" of supply for economy and quality control.

Estimated cost for the proposed 12 cooperative rural electrification systems would be Rupiah 20 billion (US$48 million), or Rupiah 1.66 billion (US$4 million) each. At present prices and based on preliminary estimates, this would construct a system with substation, primary and secondary lines, transformers, service drops, and headquarters adequate to serve the power needs of small and medium industry, irrigation and other agricultural uses, and 10,000 households initially -- 20,000 later with additional investment of Rupiah 625 million (US$1.5 million) in each system.

If a system is built in an isolated location where PLN power is not available, approximately 830 million rupiah (US$2 million) more would be needed to install a diesel generating plant.

Each local distribution system would initially cover several kecamatan* and bring home lighting to 60,000 people -- 120,000 within 10 years (6 persons per household). Phase I would therefore serve 1.4 million rural people in 10 years -- considerably more rural people than enjoy electricity from all programs to date -- and establish the institutional base for accelerated extension of service to other areas.

---

*Administrative district below kabupaten level.

RURAL ELECTRIFICATION

RECOMMENDATIONS

- TO PROVIDE ELECTRIFICATION TO INDONESIAN VILLAGERS FOR :
  - SMALL INDUSTRY
  - AGRICULTURE
  - HOME AND OTHER USES
- BY ESTABLISHING A NEW NATIONAL AGENCY TO PROVIDE LOW INT. LONG TERM LOANS AND TECHNICAL ASSISTANCE TO
- LOCALLY OWNED AND OPERATED ELECTRIC COOPERATIVE DISTRIBUTION SYSTEMS
- PURCHASE POWER WHOLESALE FROM PLN
- INITIATE 12 ELECTRIC COOPERATIVES COSTING APPROX. $ 4 MILLION (Rp. 1,660 MILLION) EACH
- INITIALLY SERVING 120,000 CONSUMERS BRINGING HOME LIGHTING TO ¾ MILLION PEOPLE WHICH SHOULD BECOME 1½ MILLION IN 10 YEARS
- MEETING OPERATING EXPENSES 2 YEARS AFTER ENERGIZATION
- ABLE TO BEGIN REPAYMENT OF LOAN IN 6-10 YEARS
- POSSIBLY EXPANDING TO MORE THAN 200 COOPERATIVES WITHIN 20 YEARS PROVIDING 24-HOUR, LOW COST ELECTRIC POWER TO AREAS IN EACH KABUPATEN.

VI. ECONOMIC AND SOCIAL ASSESSMENT

The recommendations in Chapter V are based on a finding that Indonesia has the capability of generating sufficient electric power for its total needs (see Chapter IV), that the benefits of area-wide rural electrification are worth the costs (see Chapter XV), and that the economic and social assessments of such a program are favorable. This part of the Report addresses itself to this assessment, and a more detailed analysis appears as "Attachment 1. Economic Annex".

Threshold Income.

Threshold income, or the point at which the rural family feels it can afford to sign up for electric service, is important in estimating how many consumers the distribution system can count on having to the kilometer of line it constructs. The more households connected per kilometer of line, the lower the investment cost per consumer -- and ultimately, the lower the retail charge for electricity to the consumer.

Based on comparisons with the Philippines and El Salvador, where the threshold per capita incomes for rural electrification consumers are the equivalent of US$1.69 (Rupiah 700) and US$2.89 (Rupiah 1,200) monthly, it can be estimated that the threshold income level in Indonesia will be about US$2.89 (Rupiah 1,200) monthly. This estimate is based on an assumed monthly family income for six persons of US$17.34 (Rupiah 7,200) of which there would be an electricity charge of US$1.20(Rupiah 500)/monthly, minimum per family connection (equivalent to 15 kwh/month at an estimated price of US$.08 or Rupiah 33.2/kwh). Over 90% of the rural Indonesian population have incomes in excess of this US$2.89 (Rupiah 1,200) level.

The Cost of Lighting.

As a further indication of the ability of the rural population to pay for electricity, it is useful to compare the cost of electricity with what is currently being spent on kerosene for lighting. The average rural family consumes 16.2 liters of kerosene monthly at a cost of US$1.56 (Rupiah 648) (equivalent to US$.26 or Rupiah 108 per capita) almost exclusively for lighting and representing about 3% of its income. With electricity, the same amount of light could be provided with about 10 kwh of electricity at a monthly cost of US$.80 (Rupiah 332) per family (US$.133 or Rupiah 55.3 per capita).

This is about half what is currently being spent on kerosene. Indeed the net savings on average lighting expenses alone would pay the estimated $24 cost of house wiring in about 2 years. If a minimum monthly electricity charge of US$1.20 (Rupiah 500) per connection is assumed, and given the fact that use of kerosene for lighting decreases as per capita income decreases, then it can be estimated that at all per capita income levels above US$6.75 (Rupiah 2,800)/month, a switch to electricity would reduce consumer lighting expenditures. About 55% of the Java rural population have incomes at or above this level.

In summary, over 90% of the rural population have sufficient income to afford minimum electricity consumption. Fifty-five percent could probably reduce their lighting expenditures by switching to electricity from kerosene.

Serving the Rural Poor.

It is also important to estimate how broad a spectrum of the Indonesian income distribution the consumers of rural electrification are likely to represent.

Based on comparisons with El Salvador and the Philippines, it appears probable that the median per capita income for consumers of electricity in rural Java will be about US$8.92 (Rupiah 3,700)/month. This corresponds to the income that is estimated to be required to provide a minimally adequate level of nutrition. Two-thirds of the rural Java population have income at or below this level. Based on the above it is apparent that the bulk of the consumers of electricity will be among the rural poor.

This satisfies the inquiries of financing institutions which would provide concessional loans only on the rationale that the funding will go into development which substantially benefits the rural poor.

Kerosene vs. Electricity.

It has been found that the rural household's first use of electric service is for lighting. Other uses come later. It is worthwhile, then, to explore the economic savings of switching to electricity in place of kerosene for lighting.

A pressurized lantern requires one liter of kerosene for 6 hours of operation. The economic cost of this kerosene is US$.17 (Rupiah 70). This includes a US$.072 (Rupiah 30) indirect subsidy provided by the government. The following table shows the actual cost of kerosene:

	Rupiah	U.S.$
Indonesian wholesale price	18/liter	.043/liter
Indirect subsidy	30/liter	.072/liter
True economic wholesale price	48/liter	.116/liter
Distribution and marketing	22/liter	.053/liter
Economic retail cost	70/liter	.17/liter

A kerosene lantern of this type provides illumination approximate to that of two 40-watt florescent lights. The economic cost of providing electricity for these lights for an equivalent period is only US$.055 (Rupiah 23), on the basis of estimates already cited.

Diversity of Electrical Load.

No distribution system could survive as an economic entity if it depended on household lighting alone. It would scarcely amount to a minimum billing of 15 kilowatt hours a month and would be entirely confined to the evening hours. This would leave the distribution system with an uneven and more expensive loading. Even more widespread household consumption, such as an electric iron, pump for running water, refrigerator, fan, or radio would not change the system's load factor much. Other types of electric consumers are necessary to balance the load and get more economical use of the capital invested in the distribution system.

It is imperative that the cooperative provide service for off-peak uses such as street and security lighting during the night, pump irrigation, and industrial-commercial loads such as rice and corn mills, ice plants, refrigeration for food stores, and a variety of handicraft and processing enterprises. Development of such consumers for connection to the rural distribution system not only helps the cooperative's operating feasibility, but has economic and social benefits for the people in the communities served. Power use development, therefore, must be an important component of rural electrification.

Site Selection.

The locations selected for rural electric cooperatives should be those in which varied kinds of power load can be developed, so far as possible. This is why full feasibility studies need to precede the organization of any cooperative or the approval of any loan by the government agency for rural electrification.

Site selection would consider such factors as:

-- Economic feasibility -- a mixture of farm families and some in the communities who are tradesman, workers,

professionals; varied income levels but including the low-income families; crop land or other resources which can be developed further by use of electricity; opportunity for small industry development; potential street and security lighting; community water supply pumping, schools, clinics, shops and other diversified loads.

-- A definable area, with political or geographical boundaries.

-- Population of from 100,000 to 500,000 people.

-- Roads, waterways, or railroad for transportation.

-- A source of wholesale power supply.

-- Some common community identity -- cultural or lingual bond; evidence of other cooperative or group participation activities.

-- Assurance of support from local officials.

It might be advisable to include among the selected initial projects a variety of locations, population sizes, economic levels, and anticipated operating conditions, so as to furnish base data for comparison in starting later projects. Some useful experience could be obtained, for instance, by building one of the initial systems around a diesel generator plant for power supply in an area where no PLN wholesale power can be obtained.

Economic Costs of Rural Electrification.

The economic costs of rural electrification can be considered to include the consumer's investment in house-wiring, the costs of distribution, bulk power purchases (which include appropriate capital charges for generation and transmission investments), and operation and maintenance of the rural electrical system.

Distribution investment per consumer served is a function of construction costs per kilometer, population density, and the percent of the adjacent population who become consumers. Because of the much greater population density on Java, it is estimated that distribution investment per connection on Java will be one-half that required in the Philippines -- even with conservative estimates for construction costs and the percent of the population who become consumers. It is projected that distribution investment will average about US$180 (Rupiah 74,700)/connection. Housewiring costs will equal about US$24 (Rupiah 10,000)/connection.

Bulk power purchases are assumed to cost US$0.04 (Rupiah 16.6)/kwh at present prices. For the economic assessment, an additional US$0.015 (Rupiah 6.225)/kwh was added to correct for the current subsidy on petroleum fuel PLN is receiving.

For the purpose of the assessment, the economic benefits of rural electrification are considered to consist of two components. One component is the value of kilowatt hours sold at the projected market price of US$0.073 to US$0.08/kwh (Rupiah 30.3 to 33.2/kwh). The range is considered an appropriate, indeed probably a conservative, measure of the economic value of electric power given the fact that many of the rural systems in the Philippines charge more than this and that PLN currently charges US$0.06/kwh (Rupiah 24.9) in many areas of Indonesia and is unable to meet the demand at that price. The second component of benefits is the economic savings of using electricity rather than kerosene for lighting.

Although lack of data precluded their inclusion in the preliminary economic analysis, at least two other benefits are of potentially major significance. It is generally agreed that Java is confronted with an increasing and alarming soil erosion problem because of the heavy use of forest cover for firewood. The use of electricity for household rice cookers could reduce the current consumption of wood for cooking.

Another potential benefit, described in more detail in other sections of the Report, is the decreased cost and increased efficiency of electric motors powered by central station service in place of individual diesel engines. This has special importance to commercial and industrial enterprises such as rice mills, ice plants, and the larger shops.

Based on the above estimates and the detailed projections made for load growth and operation and maintenance costs, the economic internal rates of return for the two illustrative projects examined in Chapter IX of this Report are 25% and 30%. Even with a one-third reduction in projected load growth, the internal rates of return would be 20% and 23% -- still very satisfactory.

Attachment 1 contains preliminary projections of the magnitude of financing that might be available for rural electrification in the future. Based on the assumptions in Attachment 1, it is estimated that such financing (for associated generation and transmission investments as well as rural distribution) might reach annual rates of US$160 million (Rupiah 66.4 billion) in 1985 and US$540 million

(Rupiah 224.1 billion) in 1995.

The average investment required per rural electric consumer is estimated at:

	US$	Rupiah
Distribution	180	74,700
Generation	166	68,890
Transmission	34	14,110
Total	380	157,700

This data indicates that financing may be available for the adding of up to 400,000 new rural consumers in 1985 and up to 1.4 million in 1995.

Under this set of assumptions, 8% of the rural population would have electricity by 1985 and 45% by 1995.

VII. PROGRAM AUTHORITY AND AGENCY

Consideration of PLN.

Since 1972, PLN (the state-owned electricity enterprise, Perusahaan Umum Listrik Negara) has had authority and responsibility for all generation, transmission, and distribution of electric power. Created in 1965, PLN has taken over an assortment of privately owned systems which served at various points on the main islands. PLN issues permits for operation of a considerable number of plants which serve a single industry and in some instances a few nearby consumers. The Government agency controls all rates and service conditions for electricity sales throughout the country. It does the planning, construction, and operation for the entire industry with the exception of the so-called "captive" plants.

In proposing a rural electrification program for Indonesia, the Study Team considered whether such a development, requiring large-scale financing at special terms, standardization of design and materials for low-cost rural distribution system, a non-profit areawide coverage concept, and intensive large-scale training with assistance from overseas, would be a commitment which PLN would want to undertake in view of its already heavy responsibilities in improving and operating its generation and transmission.

For all rural electric program planning, PLN should be considered the preferred power supplier, although there might be situations on locations where other arrangements would be necessary. PLN can be expected to be vitally concerned in any proposal involving electric service for people in rural areas.

Other governments which have undertaken full-scale rural electrification chose to create a separate agency which could devote its total attention to the many specialized details of such a program. In both the United States and the Philippines, rural electrification was assigned to a separate administration or authority reporting directly to the President. This was done by Presidential decree in both instances. Both countries have other separate national agencies concerned with generation and transmission and with regulation of the power industry.

Consideration of the Directorate for Cooperatives.

In the Government of the Philippines, unlike the U.S., there is a Bureau of Cooperatives, much like the Indonesian

Directorate General for Cooperatives under the Department of Manpower, Transmigration, and Cooperatives. Discussions with officials in this Indonesia Department reveal great interest in the potential benefits of cooperative rural electrification but agreement that such a technical and specialized program might best be administered by a separate authority. It is recommended, though, that any such new office in the Government coordinate its planning and progress with the Directorate for Cooperatives. It is believed that there could be close relationships between the already developing multi-purpose agricultural cooperatives and the new electric cooperatives to realize mutual benefits.

Legal Basis.

Before any beginning is made to draft a proposed decree or law for an Indonesian rural electrification authority, an examination of the U.S. Rural Electrification Act of 1936, and more especially the Philippine Presidential Decree No.269, is recommended. Whatever is drafted for Indonesia would have to be Indonesian in approach and content, to serve Indonesian needs, but a review of experience with some good and some not-so-good features elsewhere might make an Indonesian program more successful. The legal consultants who helped draft enabling acts and decrees for other nations would also be available in the event their services might be useful to the Government of Indonesia.

It is recommended that a careful search be made of existing laws and regulations which might unwittingly hamper an Indonesian rural electrification authority in its tasks of lending money to consumer-owned systems, getting the lines built, and helping the cooperatives achieve financially sound operations.

Following enactment of an enabling decree or law, the Indonesian rural electrification authority would require some months of organizing, staff development, and preparation of policies and procedures. During this period detailed feasibility studies and engineering plans could be prepared for the first cooperatives. This period can also be used for organization of cooperatives, education and information programs, etc.

Organization and Staff.

Some idea of what a national lending and administrative agency might look like is offered in a very tentative chart shown at the end of this chapter. It is suggestive only, to indicate some of the main functions the organization probably would include. It would be presumptive at such

an early stage in program proposal to suggest size or composition of staff for rural electrification authority. It may be helpful, however, to know that the REA in the U.S.A. has 850 employees to administer a rural electrification and a rural telephone program. In the Philippines, NEA has a staff of 525, and 15 consultants from the U.S.A. Engineers, accountants, training specialists, writers, lawyers, management-business administration specialists, and cooperative advisors make up some of the important components of an agency staff for a rural electrification program.

Suggested Functions.

Whatever basic decree or law is promulgated by the Government of Indonesia, it should provide authorization for those functions essential to success of the many aspects of the program. A listing of these follows:

(1) To assume responsibility for carrying out a comprehensive program of full electrification of rural areas of the country. This would be done on a basis of low-interest, long-term, 100% financing and technical assistance to rural electric cooperatives.

(2) To make a feasibility study prior to loan approval which will show clearly that a proposed project is expected to be economically sound and serve the objectives of the rural electrification program.

(3) To secure repayment of the loan on a predetermined schedule following a grace period, and to assure, through provisions of the standard loan agreements, operating conditions in the borrower cooperative systems which should make such repayment possible.

(4) To assist people in rural communities to organize electric cooperatives and to make application for a loan to build a suitable electric system. This would include the necessary information and coordination with local officials.

(5) To make sure that the local rural electric project complies with all laws, regulations, ordinances, that it holds clear title to necessary property, and that it has right-of-way easements for its lines.

(6) To assist each project in securing adequate supply of bulk power at the lowest possible cost, utilizing PLN wherever possible, and to maintain right of approval of all power supply arrangements.

(7) To specify standards and specifications for the design and construction of the project systems to assure economy, safety, and suitability for rural distribution.

(8) To specify standards for materials and equipment to be used in construction to assure high quality and lowest feasible cost.

(9) To purchase materials and equipment for system construction through international bid and through local procurement where possible; to provide warehousing, inventory, and allocation and trans-shipment in the required amounts to the individual rural systems in accordance with their construction schedules.

(10) To provide or supervise adequate engineering, architectural services, and construction of the lines, headquarters, and other facilities for project completion. This could include force account construction by the cooperative's own staff where adequate training can be provided. The Indonesian rural electrification authority would provide final inspection of all lines and construction before they are placed in operation and before final payment is made for engineering and construction.

(11) To make low-interest loans to the cooperatives for re-lending to members for housewiring costs, and to establish standards for housewiring in order to assure safety. This lending program is an important component in helping poor families secure electric service. It could include credit for electrical equipment and appliances and for small industries using electricity. An alternative would be to have the electric cooperatives sponsor credit unions with initial capital for this purpose.

(12) To provide written requirements, policies and procedures, and guidelines to the cooperatives for the functioning of their organization and the operation of their enterprise. These should include, for example, accounting manuals, billing andcollecting procedures, warehousing and inventory instructions, safety requirements, personnel administration, reporting forms, etc.

(13) To advise and assist the borrower electric cooperatives with field personnel who may provide counseling and instruction to the boards of directors, general managers, and staff of the cooperatives. This may be supplied in the early stages of the program by foreign consultants who have the necessary experience; but employees of the Indonesian rural electrification authority should be trained to take over this function as rapidly as possible. Later, to an

increasing extent, the staff of the local electric cooperative can be expected to acquire training and experience which should decrease the amount of assistance needed from the government agency.

(14) To receive periodic reports from the borrower cooperatives (monthly operating and financial reports are suggested).

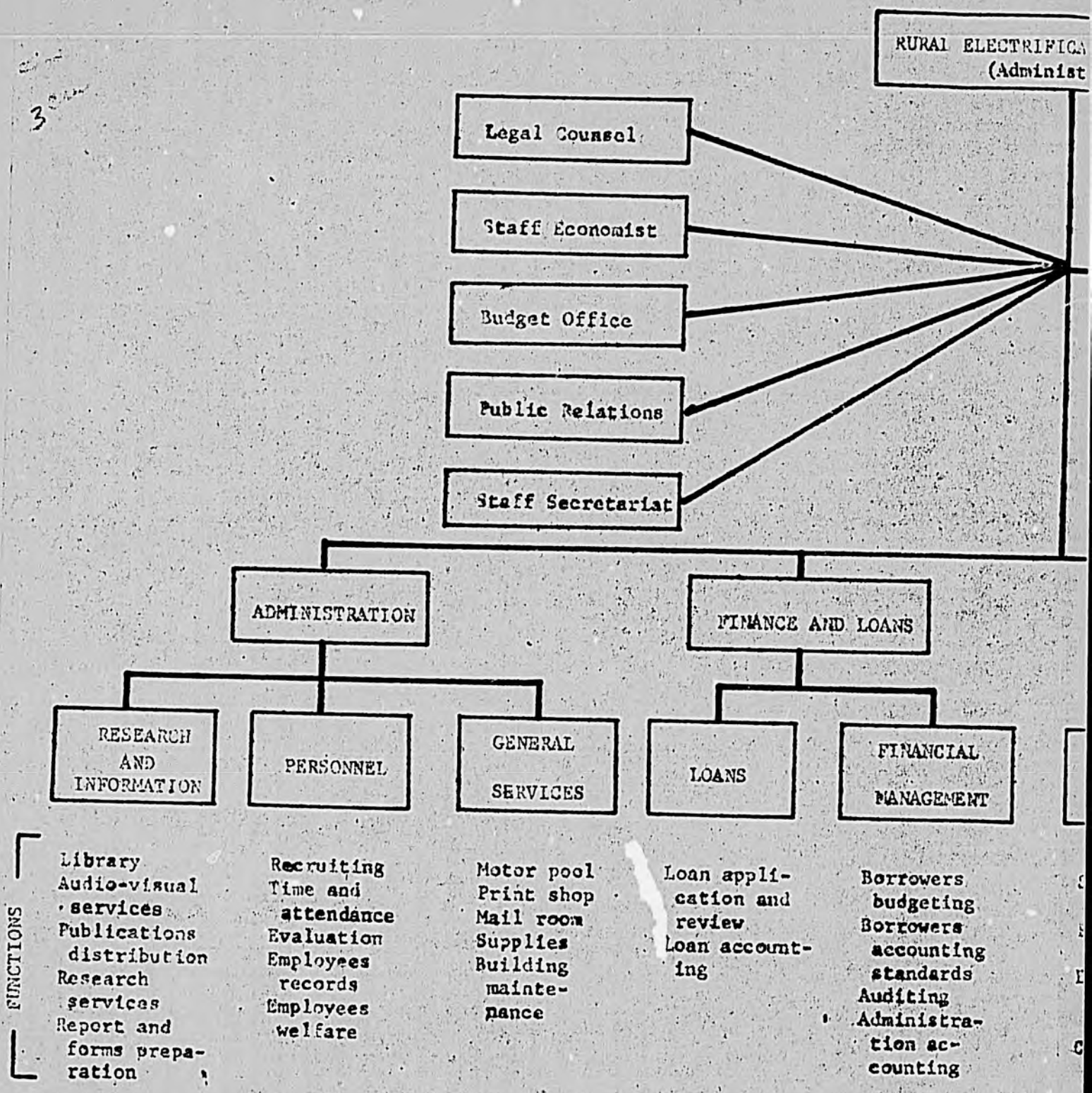
(15) To conduct training courses, seminars, and conferences on all phases of the rural electrification program for all levels of leaders and employees in both the electric cooperatives and the Indonesian rural electrification authority.

(16) To make frequent audits.

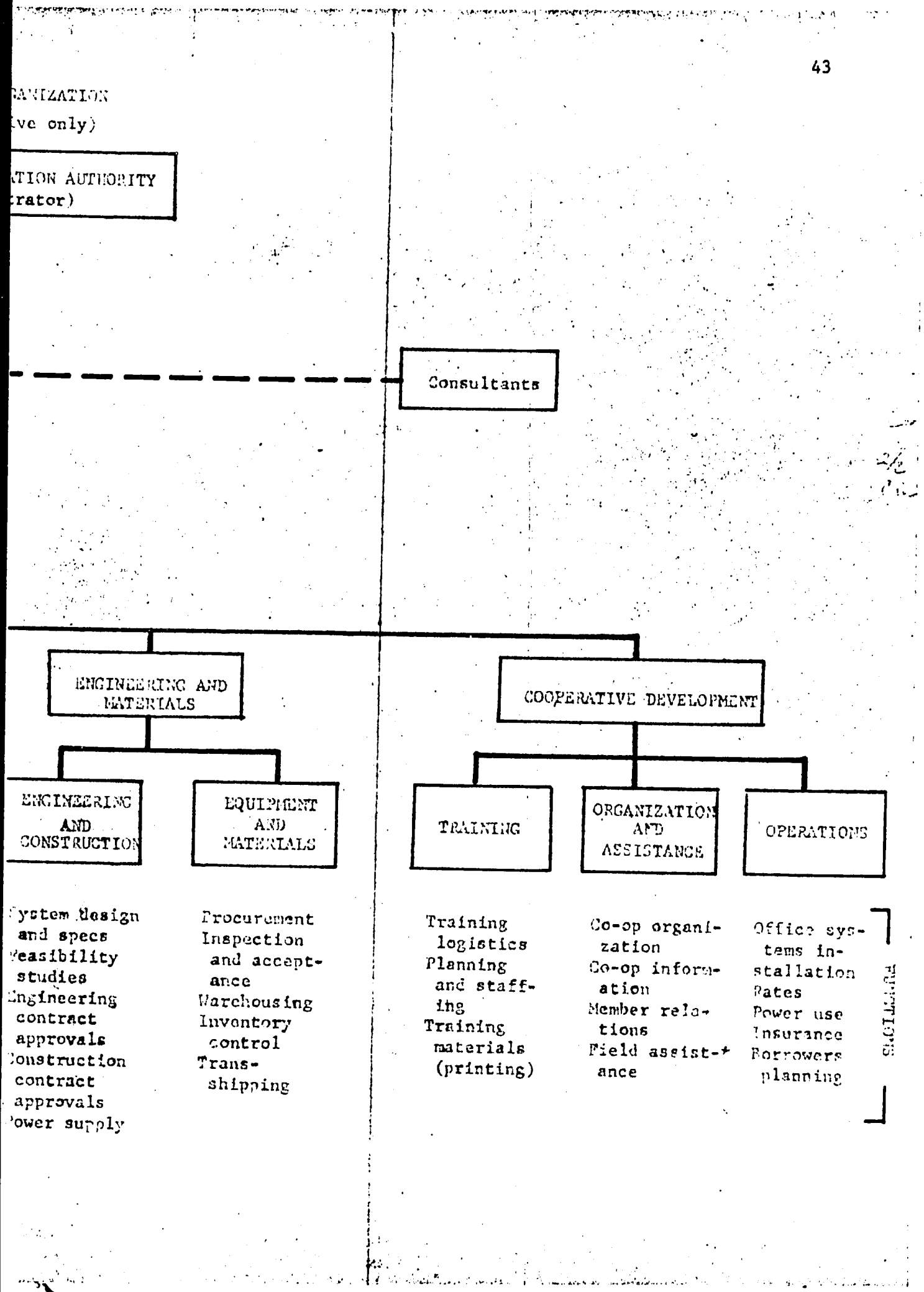
(17) To present the needs and progress of the program to all levels of government and to the general public in order that understanding and support may be strong and widespread.

BEST AVAILABLE DOCUMENT

CHART OF ORG
(Illustrati



* Field assistance specialists to visit borrower systems in company with appropriate NRECA consultants and personnel from Finance and Engineering.


ANIZATION
ve only)
TION AUTHORITY
rator)
Consultants
ENGINEERING AND MATERIALS
COOPERATIVE DEVELOPMENT
ENGINEERING AND CONSTRUCTION
EQUIPMENT AND MATERIALS
TRAINING
ORGANIZATION AND ASSISTANCE
OPERATIONS
System design and specs
Feasibility studies
Engineering contract approvals
Construction contract approvals
Power supply
Procurement
Inspection and acceptance
Warehousing
Inventory control
Trans-shipping
Training logistics
Planning and staffing
Training materials (printing)
Co-op organization
Co-op information
Member relations
Field assistance
Office systems installation
Rates
Power use
Insurance
Borrowers planning
PRINTING

INTENTIONALLY

LEFT BLANK

VIII. THE COOPERATIVE APPROACH

Background.

The cooperative approach to enterprise has been tried in Indonesia with varying results. Many of the early cooperatives failed for lack of capital, inexperienced management, poor understanding of members' responsibilities, or dishonesty. In the mid-1960s, it was found that in some instances the membership lists of cooperatives had been turned over to communist party organizations. There were cooperatives which appeared to be more interested in politics and nebulous idealistic objectives than to the economic practicality of improving the living conditions of the members.

Since 1966, the Government has encouraged a renewed interest in developing cooperatives which have a more practical concept of their role in the economy and which promise more productive returns for their members.

A new Cooperative Law No.12 was enacted in 1967, and since then the number of cooperatives increased each year. Membership, investment, and revenue also show rather steady increases.

The Directorate General for Cooperatives estimates there are 3,600 multi-purpose cooperatives now, in addition to specialized cooperatives for copra, batik, and other production. The most prevalent type of organization is the B.U.U.D. (Badan Usaha Unit Desa or Cooperation of Village Unit). Production and marketing of rice is the main function, with government support andregulation. Total membership is estimated at about 2 million. The village or primary cooperatives are grouped in secondary cooperatives at the pusat* level.

It appears likely that rural electrification would require separate cooperatives for a number of reasons, but there could be a close working relationship between the electric cooperatives and other types.

Rural electric cooperatives, along the lines of the nearly 1,000 which grew so successfully in the U.S.A. and the 54 which already are serving 340,000 consumer-members in the Philippines, have not been tried in Indonesia. It becomes

---

* District center.

important, therefore, to take a look at the structure and function of the rural electric cooperatives now tested in a dozen countries.

What is a Rural Electric Cooperative?

A rural electric cooperative is a low-cost way for farm and village people to bring electric service to their homes and industries and public facilities. It is a legally chartered business enterprise owned and controlled by the consumer-members who use the service. There will need to be initial government financing and technical assistance, but the local members are responsible for the success of the project. Through their board of directors, and the general manager and his staff, they are responsible for the cooperative's financial viability, high-quality electric service at lowest practical cost, and for maintaining the enterprise as a democratically controlled organization which will benefit the entire community including the poorest farmer.

A rural electric cooperative should be examined as a physical electric system, in order to see how it may serve the needs of the people who will be using the service.

A rural electric cooperative should be examined as an economic enterprise which must pay its own way after the initial period of getting under way. Construction and operating costs must be held to a minimum. Retail rates for electric service must be high enough to make the cooperative financially sound but low enough to attract consumers. Consumers must pay their electric bills, and the cooperative must pay its bills. Officers, employees, and the member-owners should take pride in paying off the loan from the government after the grace period.

It is important to estimate what the electric service can do to provide more jobs and higher income; how it can increase agricultural yield and stimulate additional small-scale industries; and the ways in which it can improve the quality of life.

A rural electric cooperative should be examined as an institution, in order to understand ownership, control, and lines of authority and responsibility. This can also say something about the place of the cooperative in the communities where it serves, and what it does to help build human dignity in rural people.

The Rural Electric Cooperative as a Physical Electric System.

Where possible, the cooperative would expect to purchase power for its consumers from the PLN. It would have to be delivered to the system substation at available transmission voltage. From here it would be carried on the cooperative's primary lines at 20 KV. The distribution system would be multi-grounded wye with common neutral, using ACSR conductor. Secondary system is planned to be 220/380 V, 3-phase, Wye system and 220/440 V, 3-wire, single phase system. System frequency is 50 cycles. Much of the secondary system can be underbuild, using the same poles as the primary lines.

The entire system could be built to standards and specifications already available and widely used in rural design and construction in the United States and practically all other countries. Forty-four percent of all electric distribution mileage in the U.S.A. was built to specifications and standards engineered and tested by the Rural Electrification Administration (REA) in the years following the start of the rural electrification program in 1935. REA system design and standardization of materials cut the cost of conventional line construction in half.

For each of the initial projects, an area of roughly 400 square kilometers with a population of perhaps 200,000 is contemplated. This might correspond to several kecamatan, but not necessarily so. Typically, this could include about 10,000 households by the end of the cooperative's first year of operations, estimating an initial 30-40% sign-up of potential consumers for service. Extensions to about 20,000 consumers can be expected, and this would require very little additional cost in the backbone primary system. The Phase I construction would result in 250-300 kilometers of pole line.

Phase II construction would require additional lines as needed in order to achieve full areawide coverage. An essential concept for rural electrification is the construction of a system to serve every household and every industrial, commercial, public building, security light, and pump irrigation consumer who wants electricity. The rural electric cooperative would serve the most heavily clustered population first, but instead of just stopping with the denser areas, it would extend laterals to serve more widely scattered consumers in the later stages of the program as viability becomes apparent. Financial feasibility would be based on the whole system rather than on each individual line.

Each cooperative system would have headquarters office and warehouse, conveniently located for servicing the lines and serving the consumer-members.

The consumer's housewiring would be his own responsibility, but it must meet the cooperative's standards and pass inspection before the service is connected. Financing by the cooperative on easy terms for consumer housewiring is recommended. Such financing could be provided out of special loans for this purpose by the government agency to the cooperative.

The Rural Electric Cooperative as an Economic Enterprise.

The Government of Indonesia would need to furnish the initial capital for the rural electric cooperative system in the form of a loan on easy terms through the lending and administrative agency created to sponsor and supervise the program. Each loan would need to have a low interest rate and a long enough period for amortization to roughly match the accounting period for depreciation of the system. There would need to be a grace period before loan repayment begins, in order that the system can be constructed, commence service, and reach a net margin position in its operations.

The government agency would complete a full feasibility study prior to approving a loan, to assure that the money is to be invested in a financially feasible project.

It is recommended that some portion of the initial loan be earmarked for operating expenses for its first months of operations, as there would be payroll and other administrative and service expenses prior to the collection of revenue from consumer billings.

Beyond the initial loan, the national rural electrification agency shouldexpect to make subsequent loans to assist the cooperative in reaching full areawide coverage.

The cooperative should be programed to secure revenues from sale of service sufficient to cover operating costs including cost of power by the end of the third year. By the fifth to seventh year, the enterprise should reach a break-even level, including allowance for depreciation and scheduled loan repayments which can begin at that point. Between the seventh and tenth year from energization, the cooperative should be developed to a level where it can be considered financially viable.

The loan to the cooperative from the government agency would be secured by loan contract and mortgage. Terms should specify program objectives which the cooperative must maintain, and agency technical assistance, policy and procedures requirements and guidelines, and recourse in

the event of default. Security of the loan to the cooperative would be protected by requiring approval of the government agency in the appointment of the general manager, adherence to a prescribed accounting system designed for the rural electric cooperatives, full monthly reports on operations, and standard requirements on personnel administration, rates and billing practices, insurance, etc.

At present prices, it is estimated that US$4 million would construct Phase I of a rural electric system in any one of the initial locations considered in the present study. Many other areas would no doubt offer comparable attractiveness for rural electrification by a cooperative. upiah would be advanced to the borrower system only as needed to meet construction costs. The cooperative would be expected to pay its bills promptly, and after the grace period to make its loan service payments on time.

In turn, the cooperative must set its retail rates at a reasonable level, be sure to get member understanding about the nature of their obligations as consumer-member-owners, and require prompt payment of electric bills.

The membership fee should be nominal, set low because the construction costs of the system will be 100% financed from government and foreign loan funds. There would be no connection fee. A goal of rural electrification is to encourage all potential consumers to use the cooperative's service for lights and power, rather than to limit the number of consumers and the amount of electric energy used. "Load limiters" presently used in many places would have no place in rural electric cooperatives. It is expected that individual household consumption by the end of the first year of operations would be around 15 kwh per month. As new consumers are added their low initial use would dilute the increasing consumption figures of older users, so the average usage will continue to be low for a number of years. A monthly billing for a minimum user who is allowed up to 15 kwh might be around Rupiah 500. Power sales to small industrial and commercial consumers will improve the system's load factor.

If a cooperative shows a net margin in its operations, this is not a "profit" to be drained off or belonging to the business enterprise. It is held by the cooperative as members' equity, and measures the share of ownership in the enterprise. Margins may be used for any corporate purpose allowed by the government agency or the by laws of the cooperative. The objective, however, is not to build net margins, but to provide good service and keep rates low.

There must be periodic audits of the cooperative's accounts at random times. In addition, it is contemplated that advisors from the government agency, including those available from NRECA and possibly from other places with cooperative rural electrification experience, would be working with the Indonesian rural electric cooperative to assist it to conduct its operations in efficient, business-like manner.

The Rural Electric Cooperative as an Institution.

A cooperative starts with people. The purpose is to serve people. The people served are the owners and therefore have the ultimate control. In a cooperative there are no absentee stock-holders to drain off profits.

Obviously, several hundred or several thousand people can not run an enterprise or control an organization on a day-to-day basis. In a cooperative, the member-owners usually meet once a year, to hear reports, to consider broad policy and direction of the cooperative, and to elect the board of directors. In a large cooperative, meetings can be held on a district basis so there can be more democratic participation.

During the year, members are kept informed by radio announcements, posters, and with a periodic newsletter. Also, smaller village meetings may be held.

The board of directors, usually numbering from 5 to 15, is elected to represent the interest of the members in making policies, hiring and holding accountable a general manager, and taking responsibility for the success of the cooperative. The board has clearly definable authority and functions. These do not include the day-to-day operations. The board hires a trained general manager to run the business for the member-owners.

The general manager gets his policy guidelines from the board, and he reports to the board, usually at monthly board meetings. Within guidelines from the board, the manager hires employees, supervises the staff, keeps the electric system in good repair, assures satisfactory service to the member-consumers; provides connections to additional consumers, administers procedures for meter-reading, billing and collecting, and for accurate and detailed record keeping. His performance is reviewed from time to time by the board, and he can be terminated by the board for poor performance or dishonesty.

The employees are hired, supervised, and terminated if necessary by the manager. They are selected for ability to perform specific jobs and are given continuous training to improve the performance of their duties.

If the cooperative fulfils its function as a leading institution in the community, it is expected to sponsor and assist in community-building activities and be a leader in such improvements as better water supply, school lighting for night use, refrigeration, health and medical facilities, family planning, etc. by cooperating with agencies responsible for those functions.

Members of rural electric cooperatives should learn pride of shared ownership and become better citizens of Indonesia and of their local communities through broadened interest and participation in what the cooperative is doing.

IX. TWO MODEL RURAL ELECTRIC COOPERATIVES

Tangerang and Trenggalek.

For model purposes, two different areas selected from within the kabupaten visited by the NRECA Study Team were selected for pre-feasibility study. They might be considered among possible locations for rural electric cooperative projects. One of these is in the eastern portion of Tangerang (West Java) and the other is in Trenggalek (East Java). They differ in population density and apparent income level; both are wet rice agricultural regions.

System requirements and operating forecasts for the two areas were projected on the basis of certain assumptions in order to have a starting point for inquiry as to project feasibility. It must be stressed that the data used in these two models are illustrative, and that the feasibility studies which later must be made should be based on further investigation. The format for these projections is patterned after methods tested and used for rural electric cooperatives for 40 years in the U.S.A. and more recently in several developing countries. The techniques have been proven valid by comparison of actual results with projections in the operating history of close to a thousand cooperative distribution systems.

Assumed Cost of Power.

A word of caution may be necessary in looking at the assumptions which will be listed below. Cost of power is an example. It is a major factor in determining whether there can be a rural electrification program, but at the time of preparing this Report in May 1976 there is no way of determining what the actual cost of wholesale power is to be.

For model rural electric system projection, the assumed cost of wholesale power purchased from PLN has been set at an average of 16.6 rupiah (US$0.04) per kwh, including energy and demand charge if any. The cost of power is examined in more detail in Chapter XII. It may be useful to note that in a neighboring country where a full-scale rural electrification program is developing, the average wholesale power cost for 16 cooperative distribution systems tied to the Luzon grid of the Philippine National Power Corporation was US$0.0382 per kwh last year.

Other Assumptions.

A second assumption is that electric energy distributed by the cooperative would be metered and sold to the member-consumer at an average price of 30.3 rupiah (US$0.073) per kwh in the Tangerang area and at an average price of 33.2 rupiah (US$0.08) per kwh in the Trenggalek area. No load limiters would be used. Residential and small commercial consumers would be billed for electricity actually used. Commercial-industrial users with loads exceeding 25 KW would be billed on a combination demand and energy rate. For the present study, an assumed retail rate which would average for residential use about 15 kwh with a minimum billing of about 500 rupiah (US$1.20) per month seems a reasonable balance between what most rural households can afford and what amount would be required by the cooperative to meet operating expenses on an accrual basis.

Another of the important assumptions in the two models is that a significant number of connections will be for other than households. These will be stores and shops, schools and other public buildings, rice mills and other small industries, street lights, and water pumping for irrigation and for domestic and commercial consumption. It is estimated that by the tenth year more than half of the total kwh sold by the cooperative will be to these users. This data is shown in two tables, "Project Assumptions" and "Total System Load Forecasts", which appear at the end of this chapter. These are separate tables for the Tangerang and for the Trenggalek models.

In these two examples, initial capital to pay the full cost of building the system is provided by loan funds from the Indonesian rural electrification authority. It is assumed that the 40-year loan, with interest computed in the two models at 2% per annum, is to be paid back over a 35 year period out of revenues from retail sale of electric energy. There would be a 5-year grace period after the system is first energized during which payments of interest and principal on the cooperative's loan are deferred. Accumulated interest during the 5 years is added to debt service payments over the ensuing 35 years.

The average investment per connection in the physical plant of the two models is computed at approximately Rupiah 99,600 (US$240) and Rupiah 153,500 (US$370) at the end of the first year of operation, assuming nearly 17,000 connections for the one system and nearly 10,000 for the other. By the end of the tenth year of operation, however, on the reasonable assumption of more than doubling consumers, the average investment per consumer-member should

have dropped to about Rupiah 64,000 (US$154) and Rupiah 79,500 (US$191) respectively. This reduction in average investment per connection is possible because after the initial backbone lines are in place, the average cost of each additional connection for service wires, meters, and a few additional transformers is only about Rupiah 33,200 (US$80). The effect of added consumers in relation to plant investment is shown in two series of three graphs: "Total Plant Investment", "Total Connections", and "Investment per Connection".

All cost figures in the tables for the two models are expressed in 1976 U.S. dollars. However, the construction cost estimates include a 20% contingency which includes anticipated inflation during the interval before actual construction.

Tables on costs for the two models are included at the end of this chapter. "General Plant Costs" for headquarters and equipment are estimated to be identical for Tangerang and Trenggalek. Separate tables show the figures for "Estimated Initial Investment" covering all engineering and construction costs for the initial system. Subsequent tables present the breakdown figures for a standard kilometer or unit of various types of pole line, transformers, services and meters, miscellaneous items, and security lights.

Calculating debt repayment of $4 million at 2% over the 40-year with a 5-year grace period is a matter of formula, and is shown for the sixth through the tenth years of the "Financial Forecast" tables for the two model cooperatives. It appears as entries in line 16. Interest calculations are to be found in line 5. Other expenses are: cost of power (line 2); operating, maintenance, and administrative expense (line 3). In converting from accrual accounting to a cash basis, depreciation estimated at an average 3% per annum of gross plant investment and interest on the loan are moved to line 10 and 11.

The allowance for operating expenses (line 3) was computed at 5.5% of gross plant investment. This figure was arrived at from experience in other areas with varying operating conditions.

Working out the projections reveal that on an accrual basis, both models would have revenues in excess of total expenses in the sixth year and an accumulated margin in the tenth year. On a cash basis, both would require loan funds from the Indonesian rural electrification authority for operating expenses to supplement revenues in each of the first 3 years. There would be a small cash balance in the fourth year. They would experience a deficit cash position in the fifth and perhaps the sixth year when repayments begin

on their government loan, and then improve their cash position rapidly in subsequent years. This is shown on the two "Financial Forecast" graphs.

Conclusions To Be Drawn.

An analysis of the data and information relative to the two model systems permits drawing the following conclusions:

(1) The extremely high population density results in electric service being available to a very large number of homes with the construction of only a limited original backbone system.

(2) The incremental investment required to connect additional homes along the original backbone system will be very small compared to the investment required for the backbone system. The effect of connecting these additional homes is to reduce significantly the average investment required per connection. This reduction in turn makes the system feasible at very low levels of use. (Even with construction costs per kilometer of line estimated to be approximately 50% higher that those in the Philippines and even assuming that only 30-40% of residences along the lines will connect when service is initially available compared to 50% in the Philippines, the initial average investment per connection is still only 50-60% of that in the Philippines.)

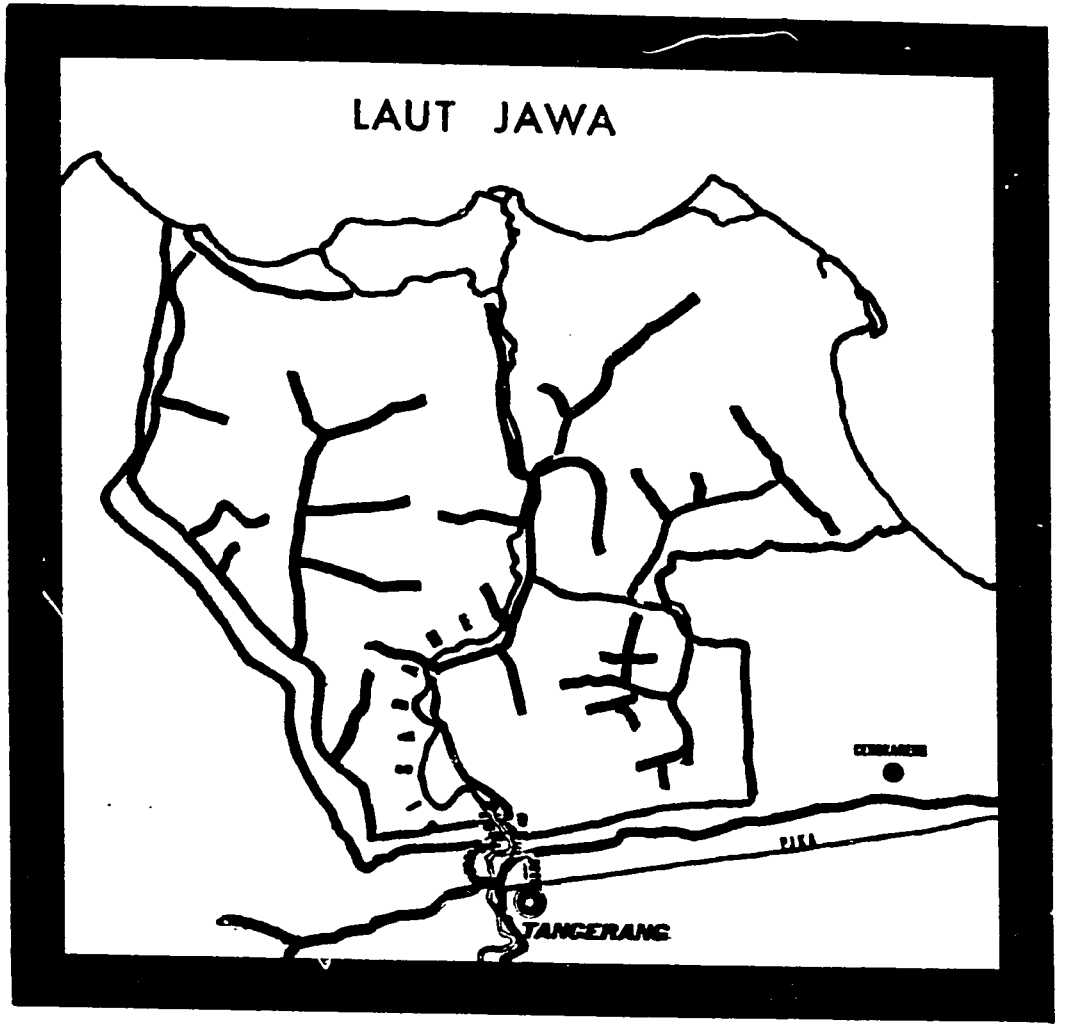
(3) The cost per kwh sold for the system including all direct costs declines as additional homes and other loads are connected and as average levels of use increase. This would permit lowering the rates to follow the declining costs.

(4) The cost of bulk power purchased is a very significant item in the total cost of providing service to members and will become a larger percentage of the total cost as levels of use increase.

(5) Feasibility, including scheduled debt service payments should be possible with rates which offer electricity at a cost as low as or lower than alternative energy sources even when levels of use are low and when only 60-70% of the homes are connected to the system.

(6) Long-term loans with low interest costs and a deferment period are necessary to permit rural systems to achieve feasibility in the early years.

MODEL ELECTRIC DISTRIBUTION SYSTEM (A)



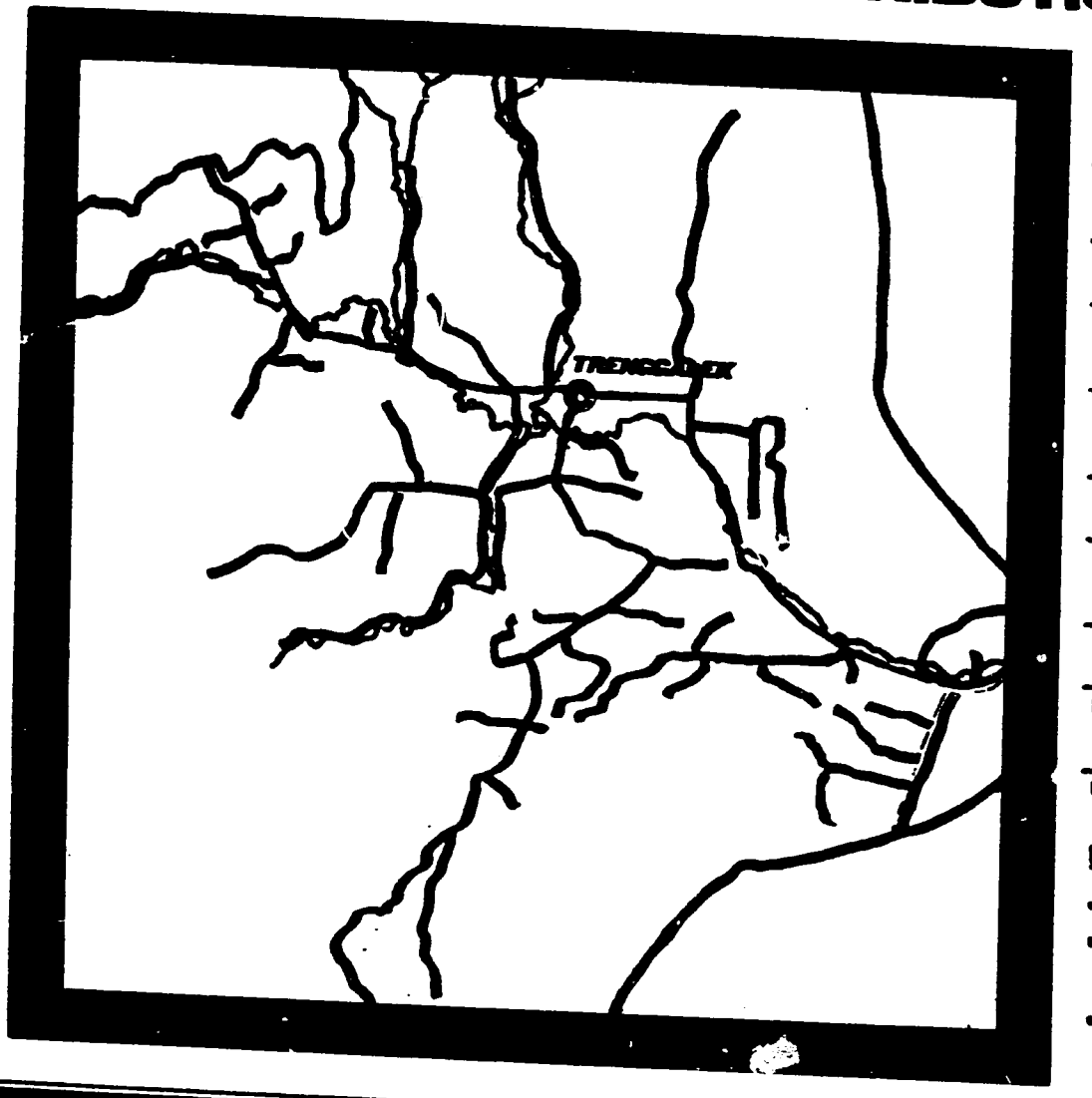
INITIAL LINE LENGTH	220 KM.
INITIAL NUMBER OF CONSUMERS	16798
NUMBER OF CONSUMERS, END OF TEN YEARS	37005
INITIAL CONSUMERS, PER CENT OF POTENTIAL CONSUMERS IN AREA	47 %
CONSUMERS END OF TEN YEARS, PER CENT OF POTENTIAL CONSUMERS IN AREA	79 %
TOTAL INITIAL INVESTMENT	$ 4,057,000 (Rp. 1,683 MILLION)
TOTAL INVESTMENT, END OF TEN YEARS	$ 5,688,000 (Rp. 2,360 MILLION)
INVESTMENT/CONSUMER, INITIAL	$ 242 (Rp. 100,500)
INVESTMENT/CONSUMER, END OF TEN YEARS	$ 154 (Rp. 63,900)

US $ 1 = Rp. 415

LEGEND

- 3 PHASE 11.55/20 KV LINES
- 1 PHASE 11.55 KV LINES
- SUBSTATION
- INITIAL SYSTEM BOUNDARY

MODEL ELECTRIC DISTRIBUTION SYSTEM (B)



INITIAL LINE LENGTH	289 KM.
INITIAL NUMBER OF CONSUMERS	9580
NUMBER OF CONSUMERS, END OF TEN YEARS	24970
INITIAL CONSUMERS, PER CENT OF POTENTIAL CONSUMERS IN AREA	32%
CONSUMERS END OF TEN YEARS, PER CENT OF POTENTIAL CONSUMERS IN AREA	68%
TOTAL INITIAL INVESTMENT	$ 3,536,000 (Rp. 1,467 MILLION)
TOTAL INVESTMENT, END OF TEN YEARS	$ 4,770,000 (Rp. 1,980 MILLION)
INVESTMENT/CONSUMER, INITIAL	$ 369 (Rp. 153,000)
INVESTMENT/CONSUMER, END OF TEN YEARS	$ 191 (Rp. 79,300)

US $ 1 = Rp. 415

LEGEND

- 3 PHASE 11.55/20 KV LINES
- 1 PHASE 11.55 KV LINES
- SUBSTATION
- KABUPATEN BOUNDARY

PROJECT ASSUMPTIONS FOR TANGERANG MODEL

Description	Operating Year									
	1	2	3	4	5	6	7	8	9	10
1. Population growth rate (%)	2.25	2.25	2.25	2.25	2.25	2.25	2.25	2.25	2.25	2.25
2. Number of people per house	6	6	6	6	6	6	6	6	6	6
3. Houses in area	38,500	39,366	40,252	41,158	42,084	43,031	43,999	44,989	46,000	47,036
4. Houses connected -% of total	40	43	46	48.6	52	55.8	59.5	63	66.5	69.5
5. Number of connections:										
a. houses	15,400	17,000	18,500	20,000	21,900	24,000	26,200	28,400	30,600	32,700
b. small commercial and public buildings	1,100	1,350	1,600	1,850	2,100	2,350	2,600	2,850	3,100	3,350
c. water systems	30	40	50	60	70	90	110	140	170	200
d. power loads-25 KVA or more	18	21	24	27	30	35	40	45	50	55
e. security lights	250	300	350	400	450	500	550	600	650	700
6. New connections	16,798	1,913	1,813	1,813	2,213	2,425	2,525	2,535	2,535	2,435
7. Total connections	16,798	18,711	20,524	22,337	24,550	26,975	29,500	32,035	34,570	37,005
8. Gross investment-US$ (000)	4,057	4,213	4,360	4,507	4,685	4,880	5,084	5,288	5,492	5,688
9. Investment/connection-US$	241	225	212	201	190	181	172	165	159	154

PROJECT ASSUMPTION FOR TRENGGALEK MODEL

Description	Operating Year 1	2	3	4	5	6	7	8	9	10
1. Population growth rate (%)	2.25	2.25	2.25	2.25	2.25	2.25	2.25	2.25	2.25	2.25
2. Number of people per house	6	6	6	6	6	6	6	6	6	6
3. Houses in area	30,000	30,675	31,365	32,070	32,793	33,530	34,284	35,056	35,845	36,651
4. Houses connected-% of total	30	39	44.6	49.9	51.8	53.7	55.4	57.1	58.6	60
5. Number of connections:										
a. houses	9,000	12,000	14,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000
b. small commercial and public buildings	400	700	1,000	1,200	1,400	1,600	1,800	2,000	2,150	2,300
c. water systems	50	60	70	85	100	120	140	160	180	200
d. power loads-25 KVA or more	10	13	17	21	25	30	35	40	45	50
e. security lights	120	180	240	280	320	340	360	380	400	420
6. New connections	9,580	3,373	2,374	2,259	1,259	1,245	1,245	1,245	1,195	1,195
7. Total connections	9,580	12,953	15,327	17,586	18,845	20,090	21,335	22,580	23,775	24,970
8. Gross investment-US$ (000)	3,536	3,806	3,997	4,178	4,279	4,379	4,479	4,578	4,674	4,770
9. Investment/connection-US$	369	293	260	237	227	217	210	203	196	191

TOTAL SYSTEM LOAD FORECASTS FOR TANGERANG MODEL

Description	Planning Year 1	2	3	4	5	6	7	8	9	10
1. Houses connected	15,400	17,000	18,500	20,000	21,900	24,000	26,200	28,400	30,600	32,700
2. Average kwh/month	15	17.5	20	22.5	25	30	35	40	45	50
3. Kwh/month (000)	231	297.5	370	450	547.5	720	917	1,136	1,377	1,635
4. Small commercial and public buildings connected	1,100	1,350	1,600	1,850	2,100	2,350	2,600	2,850	3,100	3,350
5. Average kwh/month	125	150	175	200	250	300	350	400	450	500
6. Kwh/month (000)	137.5	202.5	280	370	525	705	910	1,140	1,395	1,675
7. Water systems connected	30	40	50	60	70	90	110	140	170	200
8. Average kwh/month	600	600	600	600	600	600	600	600	600	600
9. Kwh/month (000)	18	24	30	36	42	54	66	84	102	120
10. Power loads -25 KVA or more connected	18	21	24	27	30	35	40	45	50	55
11. Average kwh/month	1,500	1,550	1,625	1,700	1,775	1,850	1,925	2,000	2,100	2,200
12. Kwh/month (000)	27	32.6	39	45.9	53.2	64.8	77	90	105	121
13. Security lights connected	250	300	350	400	450	500	550	600	650	700
14. Average kwh/month	50	50	50	50	50	50	50	50	50	50
15. Kwh/month (000)	12.5	15	17.5	20	22.5	25	27.5	30	32.5	35
16. Total service connected	16,798	18,711	20,524	22,337	24,550	26,975	29,500	32,035	34,570	37,005
17. Kwh/month-total sold (000)	426	571.6	736.5	921.9	1,190.3	1,568.8	1,997.5	2,480	3,011.5	3,586
18. Kwh/year-total sold (000)	5,112	6,858.6	8,838	11,062.8	14,283	18,825	23,970	29,760	36,138	43,032
19. Annual % system loss	17	17	17	15	15	12	12	12	10	10
20. Kwh/year purchased (000)	5,981	8,024.6	10,340.5	12,722.2	16,425.5	21,088	26,846.4	33,381.2	39,751.8	47,335.2
21. Annual system load factor (%)	20	22	25	27	30	32	34	36	38	40
22. MW peak load	3.41	4.16	4.72	5.38	6.25	7.52	9.01	10.57	11.94	13.51

TOTAL SYSTEM LOAD FORECAST FOR TRENGGALEK MODEL

Description	Planning Year 1	2	3	4	5	6	7	8	9	10
1. Houses connected	9,000	12,000	14,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000
2. Average kwh/month	15	17.5	20	22.5	25	30	35	40	45	50
3. Kwh/month (000)	135	210	280	360	425	540	665	800	945	1,100
4. Small commercial and public building connected	400	700	1,000	1,200	1,400	1,600	1,800	2,000	2,150	2,300
5. Average kwh/month	125	150	175	200	250	300	350	400	450	500
6. Kwh/month (000)	50	105	175	240	350	480	630	800	967.5	1,150
7. Water systems connected	50	60	70	85	100	120	140	160	180	200
8. Average kwh/month	600	600	600	600	600	600	600	600	600	600
9. Kwh/month (000)	30	36	42	51	60	72	84	96	108	120
10. Power loads - 25 KVA or more connected	10	13	17	21	25	30	35	40	45	50
11. Average kwh/month	1,500	1,550	1,625	1,700	1,775	1,850	1,925	2,000	2,100	2,200
12. Kwh/month (000)	15	20.2	27.6	35.7	44.4	55.5	67.4	80	94.5	110
13. Security lights connected	120	180	240	280	320	340	360	380	400	420
14. Average kwh/month	50	50	50	50	50	50	50	50	50	50
15. Kwh/month (000)	6	9	12	14	16	17	18	19	20	21
16. Total services connected	9,580	12,953	15,327	17,586	18,845	20,090	21,335	22,580	23,775	24,970
17. Kwh/month-total sold (000)	236	308.2	526.6	700.7	895.4	1,164.5	1,464.4	1,795	2,135	2,501
18. Kwh/year-total sold (000)	2,832	4,561.8	6,439.6	8.408.4	10,744.6	13,974	17,572.6	21,540	25,620	30,012
19. Annual % system loss	17	17	17	15	15	12	12	12	10	10
20. Kwh/year purchased (000)	3,312.4	5,337.3	7,534.3	9,669.7	12,356.2	15,650.9	19,681.3	24,124.8	28,[illegible]	33,013.2
21. Annual system load factor (%)	20	22	25	27	30	32	34	36	38	40
22. MW peak load	1.89	2.77	3.44	4.09	4.70	5.58	6.61	7.65	8.47	9.42

FINANCIAL FORECAST FOR TANGERANG

Starting First Year after Energization

All Figures in US$ (000. Power Cost at US$0.04/kwh Purchased. Revenue at US$0.073/kwh Sold.

ACCRUAL BASIS	Operating Year									
	1	2	3	4	5	6	7	8	9	10
1. Operating revenue	373	501	645	807	1,042	1,374	1,749	2,172	2,641	3,141
2. Cost of power	239	321	414	509	657	843	1,074	1,333	1,590	1,893
3. Operating, maintenance, administrative expense	223	232	240	248	258	268	275	291	302	312
4. Depreciation	122	126	131	135	141	146	153	159	165	170
5. Interest	81	84	87	90	94	98	102	106	110	114
6. Total operating expense (Lines 2+3+4+5)	665	763	872	982	1,150	1,355	1,604	1,889	2,167	2,489
7. Margin (line 1-6)	(292)	(262)	(227)	(175)	(108)	19	145	283	474	652
8. Accrued margin	(292)	(554)	(781)	(956)	(1,064)	(1,045)	(900)	(617)	(143)	509
CONVERSION TO CASH BASIS										
9. Margin (Line 7)	(292)	(262)	(227)	(175)	(108)	19	145	283	474	652
10. Depreciation (Line 4)	122	126	131	135	141	146	153	159	165	170
11. Interest (Line 5)	81	84	87	90	94	98	102	106	110	114
12. Cash margin (Lines 9+10+11)	(89)	(52)	(9)	50	127	263	400	548	749	936
GENERAL FUND BALANCE										
13. Operating loan	89	52	9	0	0	0	0	0	0	0
14. Balance prior year (Line 17)	(89)	(52)	(9)	0	50	(27)	24	204	524	1,037
15. Cash margin (Line 12)	0	0	0	50	127	263	400	548	749	936
16. Debt service payment	0	0	0	0	204	212	220	228	236	244
17. Balance (lines 13+14+15-16)	0	0	0	50	(27)	24	204	524	1,037	1,729

FINANCIAL FORECAST FOR TRENGGALEK

Starting First Year after Energization

All Figures in US$ (000). Power Cost at US$0.04/kwh Purchased. Revenue at US$0.08/kwh Sold.

ACCRUAL BASIS	Operating Year									
	1	2	3	4	5	6	7	8	9	10
1. Operating revenue	265	365	515	672	860	1,118	1,406	1,723	2,050	2,401
2. Cost of power	133	213	301	387	494	626	787	965	1,127	1,321
3. Operating, maintenance, administrative expense	194	209	220	230	235	241	246	252	257	262
4. Depreciation	106	114	120	125	128	131	134	137	140	143
5. Interest	71	76	80	83	86	88	90	92	94	95
6. Total operating expense (Lines 2+3+4+5)	504	612	721	825	943	1,086	1,257	1,445	1,618	1,821
7. Margin (line 1-6)	(239)	(247)	(206)	(153)	(83)	32	149	278	432	580
8. Accrued margin	(239)	(486)	(692)	(845)	(928)	(896)	(747)	(469)	(37)	543
CONVERSION TO CASH BASIS										
9. Margin (Line 7)	(239)	(247)	(206)	(153)	(83)	32	149	278	432	580
10. Depreciation (Line 4)	106	114	120	125	128	131	134	137	140	143
11. Interest (Line 5)	71	76	80	83	86	88	90	92	94	95
12. Cash margin (Lines 9+10+11)	(62)	(57)	(6)	55	131	251	373	507	666	818
GENERAL FUND BALANCE										
13. Operating loan	62	57	6	0	0	0	0	0	0	0
14. Balance prior year (Line 17)	0	0	0	0	55	3	67	249	561	1,028
15. Cash margin (Line 12)	(62)	(57)	(6)	55	131	251	373	507	666	818
16. Debt service payment	0	0	0	0	183	187	191	195	199	203
17. Balance (Lines 13+14+15-16)	0	0	0	55	3	67	249	561	1,028	1,643

GENERAL PLANT COSTS

FOR TANGERANG AND TRENGGALEK MODELS

Description	US$	Rupiah (000)
Land (1½ to 3 hectares)	10,000	4,150
Site improvements (grading, fencing, roads, etc.)	10,000	4,150
Buildings		
a) Headquarters	125,000	51,875
b) Warehouse and maintenance shops	50,000	20,750
Working capital	150,000	62,250
Communications equipment		
a) Base station	15,000	6,225
b) Mobile units	5,000	2,075
Transportation equipment	105,000	43,575
Tools and equipment	15,000	6,225
Test and laboratory equipment	10,000	4,150
Office equipment	15,000	6,225
Total for general plant	510,000	211,650

Estimated Construction Costs.

A "standard unit" or "standard kilometer" approach was taken to arrive at estimated system construction costs.

Average quantities for a "standard" kilometer were based on design criteria (described elsewhere), number of consumers, and terrain.

Pricing is based on available present day (1976) prices in Indonesia of materials and equipment, labor, and other construction costs. The relationship between labor and materials is based on experience in other countries since construction methods and type of system for rural electrification as proposed have not been previously used in Indonesia.

In estimating the costs of model electric distribution systems, a layout was made on an area coverage concept to serve a percentage of the potential consumers in the area. The models were predicated on growth within the area being serviced with minimal capital expenditure. Main feeders of the system are sized to provide capacity for extensions outside the initial service area, based on voltage drop considerations.

All estimates for materials are based on utilization of the types of equipment and materials described elsewhere in this report. A contingency of 20% has been used in estimating the model systems' costs. This should be adequate to provide normal contingencies plus a 2-year inflation factor to allow for anticipated interval of time before the systems could be implemented.

ESTIMATED INITIAL INVESTMENT

Tangerang System

Description	Quantity	Unit	Unit Price (US$)	Extension (US$)
Primary lines, 20 KV				
3-phase, 4-wire, #2/0 ACSR	45	km.	5,522	248,490
3-phase, 4-wire, #2 ACSR	9	km.	4,118	37,062
Single-phase, 2-wire #4 ACSR	69	km.	2,550	175,950
Secondary system				
Underbuild, 2-wire, #2 ACSR	123	km.	1,023	125,829
Pole line, 3-wire, #2 ACSR	97	km.	2,992	290,224
Transformers	8,000	KVA	33.70	269,600
Services				
2-wire	16,000	each	58	928,000
3-wire	798	each	90	71,820
Sectionalizing equipment	Lump-sum	-	30,000	30,000
Clearing right of way	65	km.	90	5,850
Security lights	250	each	150	37,500
Substation				
Power transformer 10/12.5 MVA	1	each	207,500	207,500
Substation fence, yard improve.	1	each	4,200	4,200
70 KV air break switch G.O.	3	each	2,750	8,250
Power circuit breakers 20 KV	3	each	15,200	45,600
Disc switches, 1 pole, 20 KV	24	each	155	3,720
Power fuses 70 KV	3	each	900	2,700
70 KV incoming bay	2	each	2,800	5,600
Tranformer bay	1	each	2,200	2,200
20 KV feeder bay	3	each	2,700	8,100
Subtotal				2,508,195
General plant	Lump sum	-	510,000	510,000
Engineering-supervision-training 12%				362,183
Subtotal				3,380,378
Contingencies 20%				676,076
Total initial investment				$ 4,056,454

ESTIMATED INITIAL INVESTMENT

Trenggalek System

Description	Quantity	Unit	Unit Price (US$)	Extension (US$)
Primary lines, 20 KV				
3-phase, 4-wire, #2/0 ACSR	26.5	km.	5,522	146,333
3-phase, 4-wire, #2 ACSR	11.5	km.	4,118	47,357
Single-phase, 2-wire, # 4 ACSR	135	km.	2,550	344,250
Secondary system				
Underbuild, 2-wire, #2 ACSR	173	km.	1,023	176,979
Pole line, 3-wire, #2 ACSR	96	km.	2,992	287,232
Transformers	7,500	KVA	33.70	252,750
Services				
2-wire	8,900	each	58	516,200
3-wire	560	each	90	50,400
Sectionalizing equipment	Lump sum	-	47,000	47,000
Clearing right of way	110	km.	90	9,900
Security lights	120	each	150	18,000
Substation				
Power transformer 7500/9375 KVA	1	each	171,500	171,500
Substation fence, yard improve.	1	each	4,200	4,200
70 KV air break switch G.O.	1	each	2,750	2,750
Power circuit breakers 20 KV	2	each	15,200	30,400
Disconnect switches 1 pole, 30 KV	15	each	155	2,325
Power fuses, 70 KV	3	each	900	2,700
70 KV incoming bay	1	each	2,800	2,800
Transformer bay	1	each	2,200	2,200
20 KV feeder bay	2	each	2,700	5,400
Subtotal				2,120,676
General plant	Lump sum	-	510,000	510,000
Engineering-supervision-training 12%				315,680
Subtotal				2,946,356
Contingencies 20%				589,271
Total initial investment				$3,535,627

COST ESTIMATE - 11.55/20 KV PRIMARY POLE LINE

Standard Kilometer

Three-phase construction, #2/0 ACSR

Description	Quantity	Unit	Unit Cost (US$)	Extension (US$)
Poles	9	each	125	1,125
Pole top units				
C-1	6	each	60	360
C-2	2	each	115	230
C-3	1	each	70	70
A5-1	1	each	20	20
Conductor, 2/0 ACSR	4,000	meters	0.55	2,200
Guys	5	each	13	65
Anchors	5	each	12	60
Pole grounds	9	each	13	117
Total material				4,247
Labor (20% of material)				850
Other construction costs (10% of material)				425
Total cost per standard kilometer				$ 5,522

COST ESTIMATE - 11.55/20 KV PRIMARY POLE LINE

Standard Kilometer

Three-phase construction, #2 ACSR

Description	Quantity	Unit	Unit Cost (US$)	Extension (US$)
Poles	9	each	125	1,125
Pole top units				
C-1	6	each	60	360
C-2	2	each	115	230
C-3	1	each	70	70
A5-1	1	each	20	20
Conductor, #2 ACSR	4,000	meters	0.28	1,120
Guys	5	each	13	65
Anchors	5	each	12	60
Pole grounds	9	each	13	117
Total				3,167
Labor (20% of material)				633
Other construction costs (10% of material)				318
Total cost per standard kilometer				$ 4,118

COST ESTIMATE - 11.55/20 KV PRIMARY POLE LINE

Standard Kilometer

Single-phase construction, #4 ACSR

Description	Quantity	Unit	Unit Cost (US$)	Extension (US$)
Poles	9	each	125	1,125
Pole top units				
A-1	6	each	20	120
A-2	2	each	35	70
A-4	1	each	70	70
Conductor, #4 ACSR	2,000	meter	0.19	380
Guys	4	each	13	52
Anchors	4	each	12	48
Grounds	9	each	13	97
Total material				1,962
Labor (20% of material)				392
Other construction costs (10% of material)				196
Total cost per standard kilometer				$ 2,550

COST ESTIMATE - 220/440 VOLT SECONDARY SYSTEM ON PRIMARY POLE LINE

Standard Kilometer

Single-phase construction, 2-wire, # 2 ACSR

Description	Quantity	Unit	Unit Cost (US$)	Extension (US$)
Secondary fixtures				
J-5	12	each	4	48
J-6	4	each	6	24
J-10	6	each	5	30
Conductor, #2 ACSR	2,000	meter	0.28	560
Guys	5	each	13	65
Anchors	5	each	12	60
Total material				787
Labor (20% of material)				157
Other construction costs (10% of material)				79
Total cost per standard kilometer				$ 1,023

COST ESTIMATE - 220/440 VOLT SECONDARY POLE LINE

Standard Kilometer

Single-phase construction, 3-wire, #2 ACSR

Description	Quantity	Unit	Unit Cost (US$)	Extension (US$)
Poles	10	each	110	1,100
Secondary Fixtures				
J-5	16	each	4	64
J-6	6	each	6	36
J-8	8	each	4	32
Conductor, #2 ACSR	3,000	meter	0.28	840
Guys	4	each	13	52
Anchors	4	each	12	48
Pole grounds	10	each	13	130
Total material				2,302
Labor (20% of material)				460
Other cosntruction costs (10% of material)				230
Total cost per standard kilometer				$ 2,992

COST ESTIMATE - TRANSFORMERS

Cost per KVA

Single-phase, 11.55-220/440 Volts, 50 Hertz

Description	Total KVA	Quantity	Unit	Unit Cost (US$)	Extension (US$)
The "MIX" of transformers by sizes (KVA) needed per 100 installations is estimated as					
50 KVA	100	2	each	915	1,830
37½ KVA	112.5	3	each	821	2,463
25 KVA	375	15	each	605	9,075
15 KVA	1,050	70	each	507	35,490
10 KVA	100	10	each	486	4,860
Total	1,737.5 KVA				53,718
Total material/KVA		$\frac{53,718}{1,737.5}$			30.92
Labor (6% of material)					1.86
Other construction costs (3% of material)					0.92
Total cost per KVA					$ 33.70

COST ESTIMATE - SERVICES AND METERS

Standard Unit

Single-phase, 2-wire, #6 Duplex

Description	Quantity	Unit	Unit Cost (US$)	Extension (US$)
Poles	0.1	each	100	10
Service supports				
K-10	1	each	1	1
K-11	1	each	3	3
J-8	0.1	each	4	1
Conductor				
#6 Duplex Aluminium code word "Vizsla"	30	meter	0.35	11
Meter, single-phase, 2-wire, 220 V with socket	1	each	19	19
Total material				45
Labor (20% of material)				9
Other construction cost (10% of material)				4
Total cost per standard unit				$ 58

COST ESTIMATE - SERVICES AND METERS

Standard Unit

Single-phase, 3-wire, #4 Triplex

Description	Quantity	Unit	Unit Cost (US$)	Extension (US$)
Poles	0.1	each	100	10
Service supports				
K-10	1	each	1	1
K-11	1	each	3	3
J-8	0.1	each	4	1
Conductor				
#4 Triplex Aluminium, code word "Barnacles"	30	meter	0.60	18
Meter, single-phase, 3-wire, 220/440 V with socket	1	each	36	36
Total material				69
Labor (20% of material)				14
Other construction costs (10% of material)				7
Total cost per standard unit				$ 90

COST ESTIMATE - MISCELLANEOUS ITEMS

Prices per Unit

Description	Material (US$)	Labor (US$)	Other Construction Cost (US$)	Total Cost (US$)
Gang operated, 3-phase, pole top switches, 20 KV	1,600	150	50	1,800
Reclosers, single-phase, 20 KV	1,100	60	20	1,180
Reclosers, 3-phase, 20 KV	5,300	500	150	5,950
Fuses, single pole, 20 KV	140	15	5	160
Regulators, single-phase 14.4 KV, 50 Hz, with protection and bypass switches				
3 x 72 KVA (banked	13,400	1,500	250	15,150
3 x 144 KVA (banked)	15,200	1,700	300	17,200
3 x 288 KVA (banked)	19,300	1,900	500	21,700
1 x 36 KVA	3,900	300	90	4,290
1 x 72 KVA	4,200	250	75	4,525
Power transformers 30 x 70-11.55/20 KV, 3-phase 50 Hz., OA/FA, with load tap changer in the low tension winding and standard taps in high voltage winding				
5000/6250 KVA-55°C rise	129,000	6,450	3,225	138,675
7500/9375 KVA-55°C rise	160,000	7,500	4,000	171,500
10000/12500 KVA-55°C rise	194,000	8,500	5,000	207,500
Power fuses, single-phase, 70 KV	800	75	25	900
Gang operated air break switches, 3 pole, 70 KV, steel mounting	2,375	300	75	2,750
Disconnect switches, 1 pole, 20 KV	120	25	10	155
Power circuit breaker, 3 pole, 20 KV	14,300	700	200	15,200

(Continued on next page)

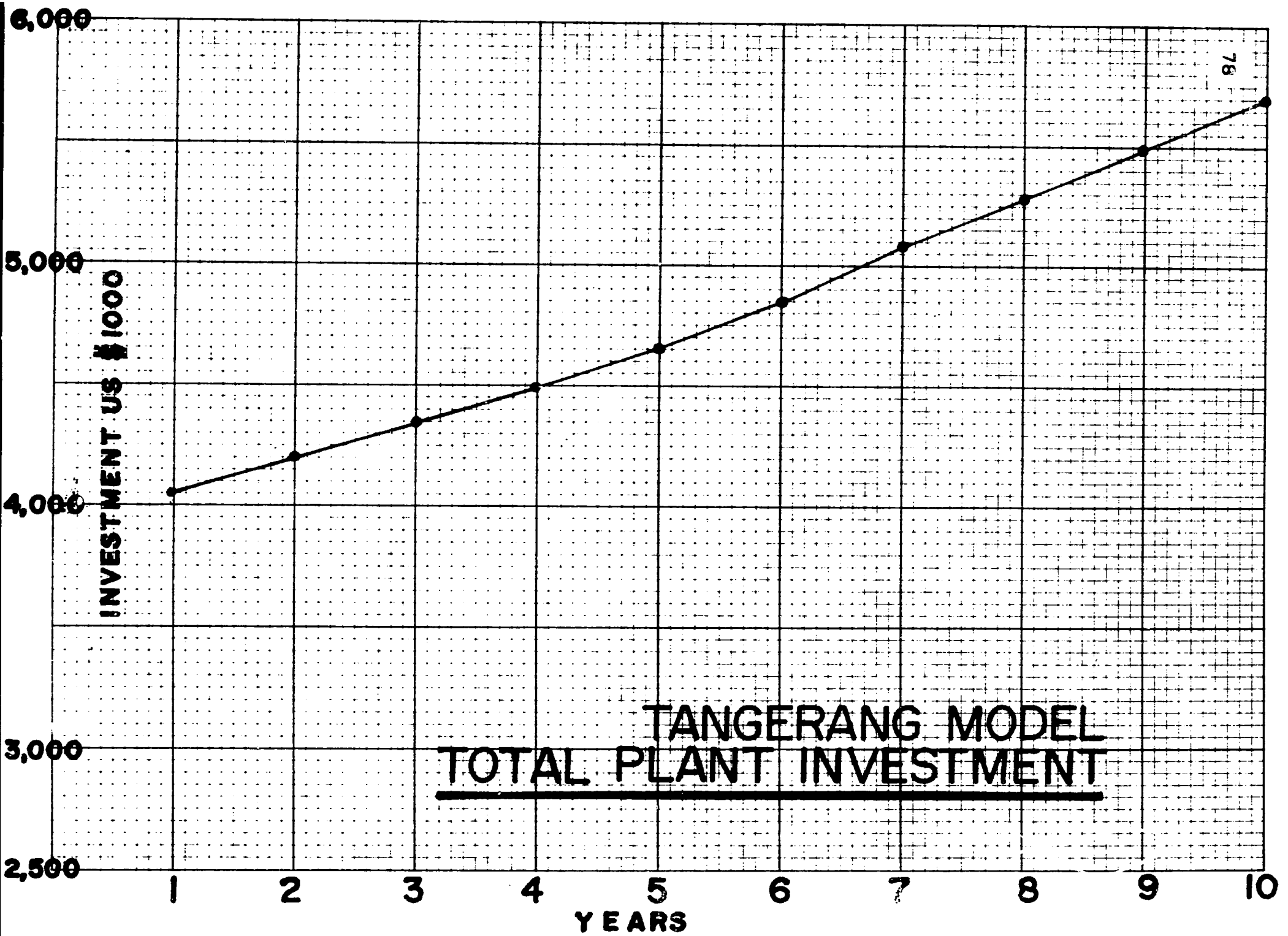
Description	Material (US$)	Labor (US$)	Other Construction Cost (US$)	Total Cost (US$)
Steel structure, bus, insulators, foundations, grounding etc. for				
70 KV incoming bay	1,800	700	300	2,800
Transformer bay	1,500	500	200	2,200
20 KV feeder bay	1,800	600	300	2,700
Substation fence, yard improvement	900	2,500	800	4,200

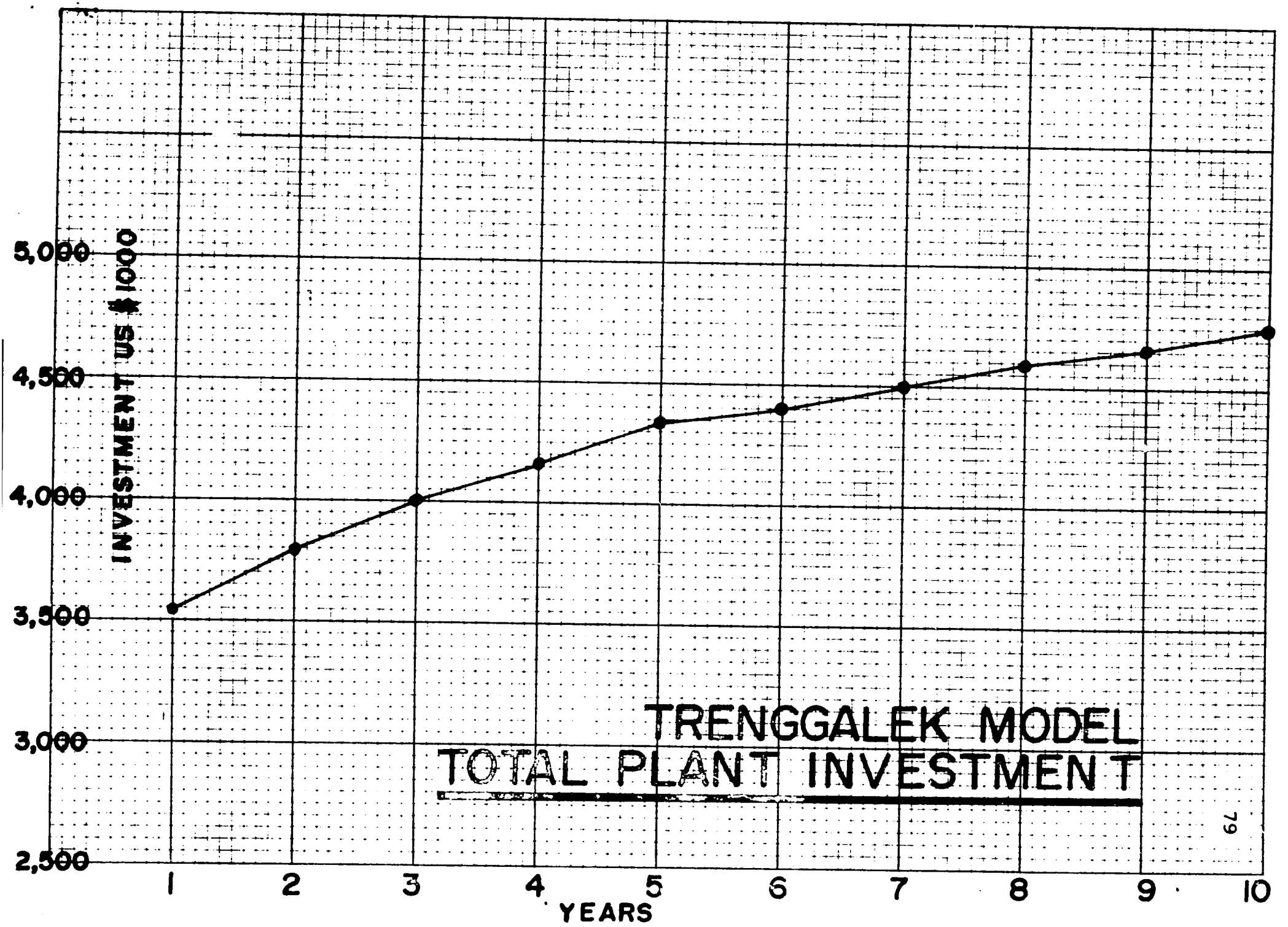
COST ESTIMATE - SECURITY LIGHTS

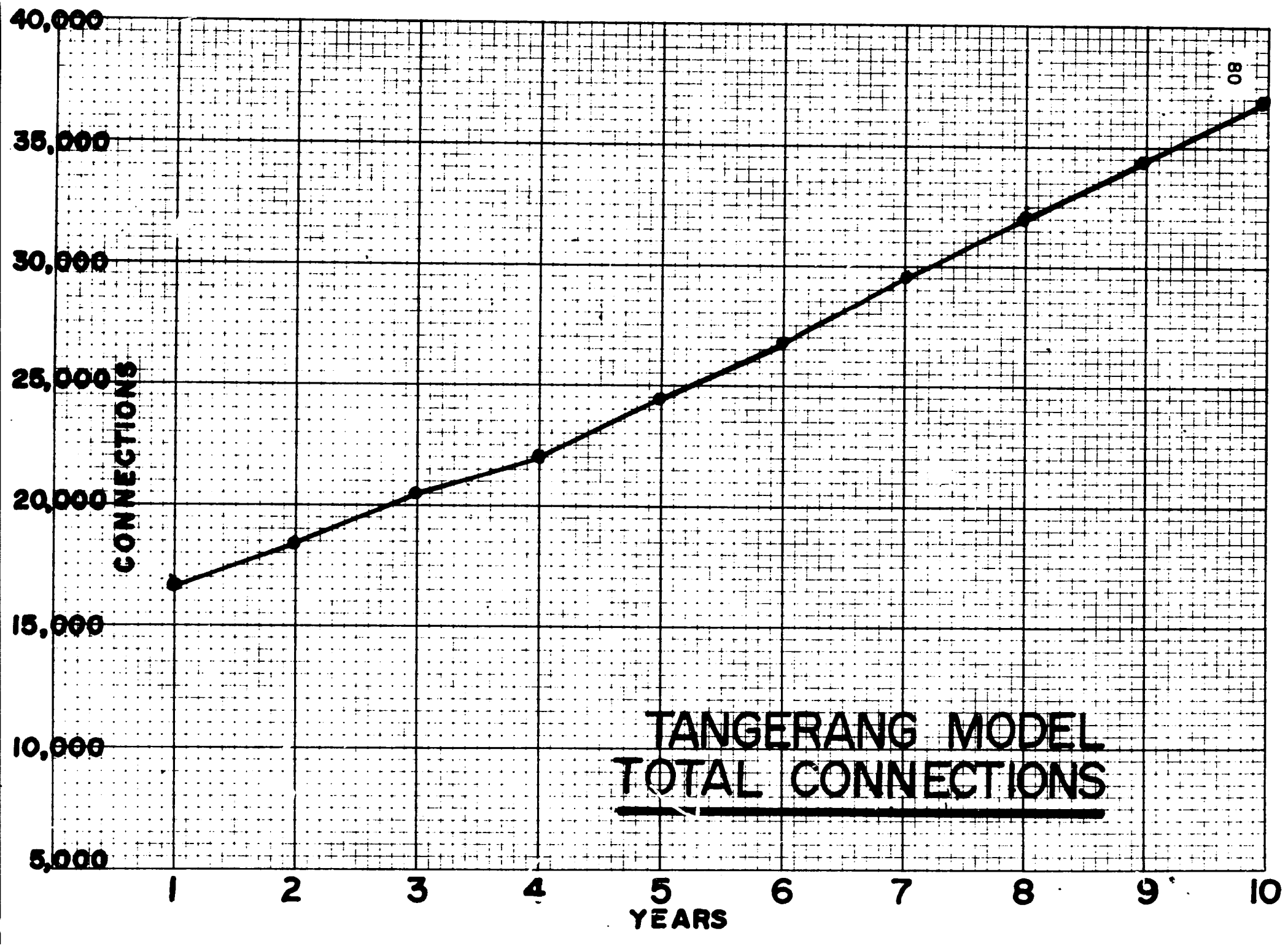
Standard Unit

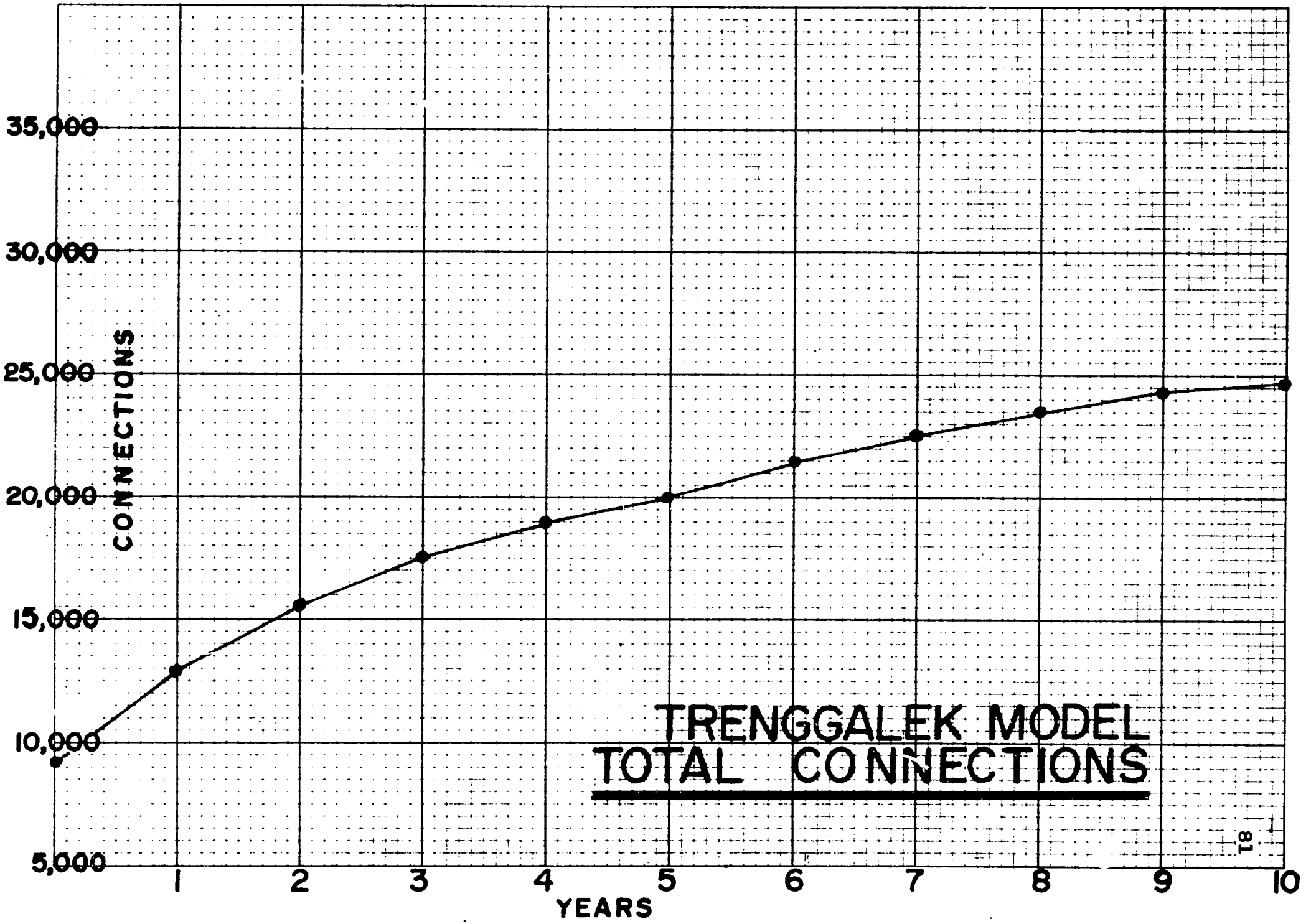
Mercury Lamp (175 watt), Luminaire and Control

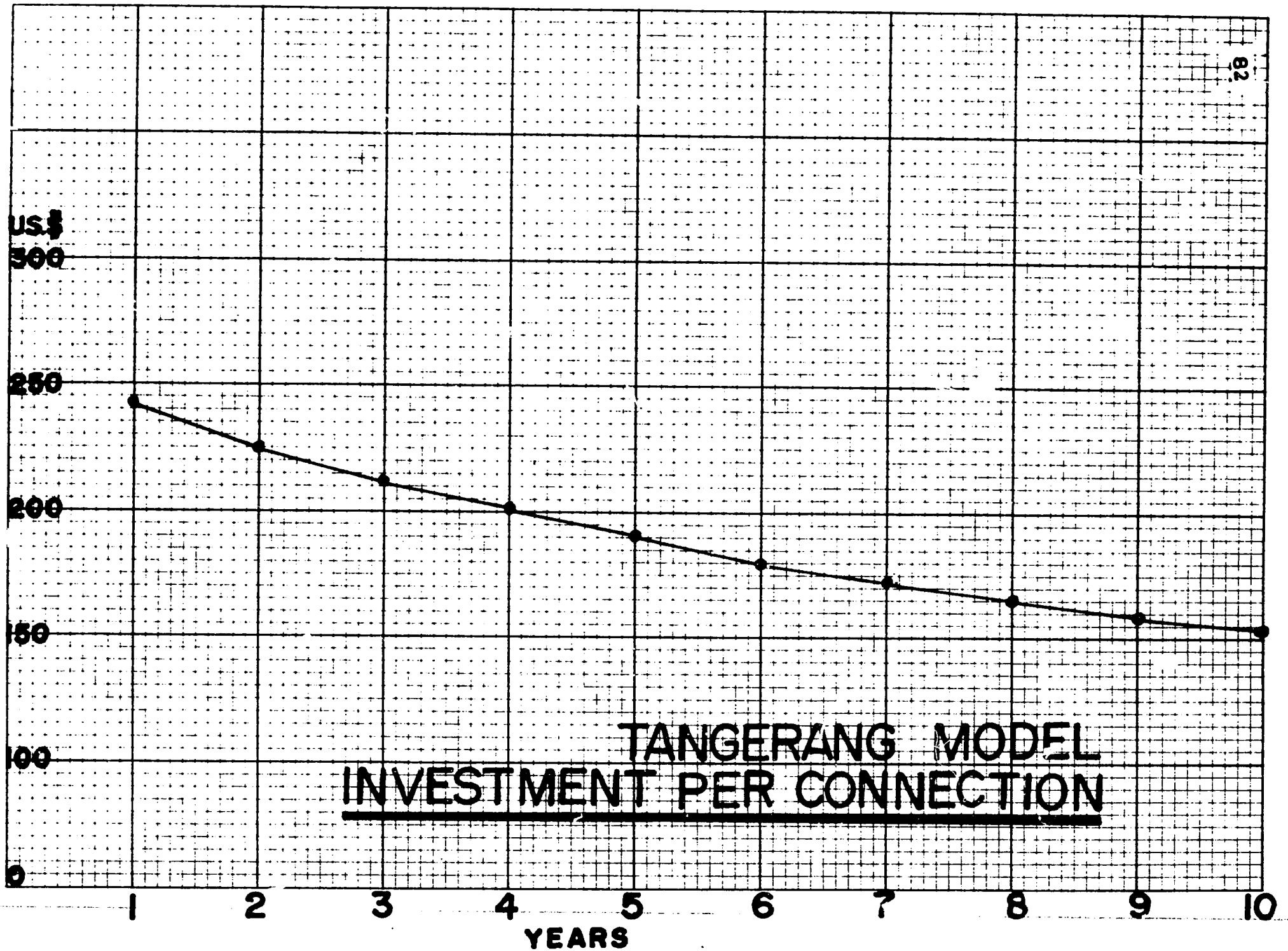
Description	Quantity	Unit	Unit Cost (US$)	Extension (US$)
Luminaire	1	each	85	85
Lamp (175 watt)	1	each	8	8
Mounting bracket	1	each	12	12
Photo control	1	each	10	10
Total material				115
Labor (20% of material)				23
Other construction cost (10% of material)				12
Total cost per standard unit				$ 150

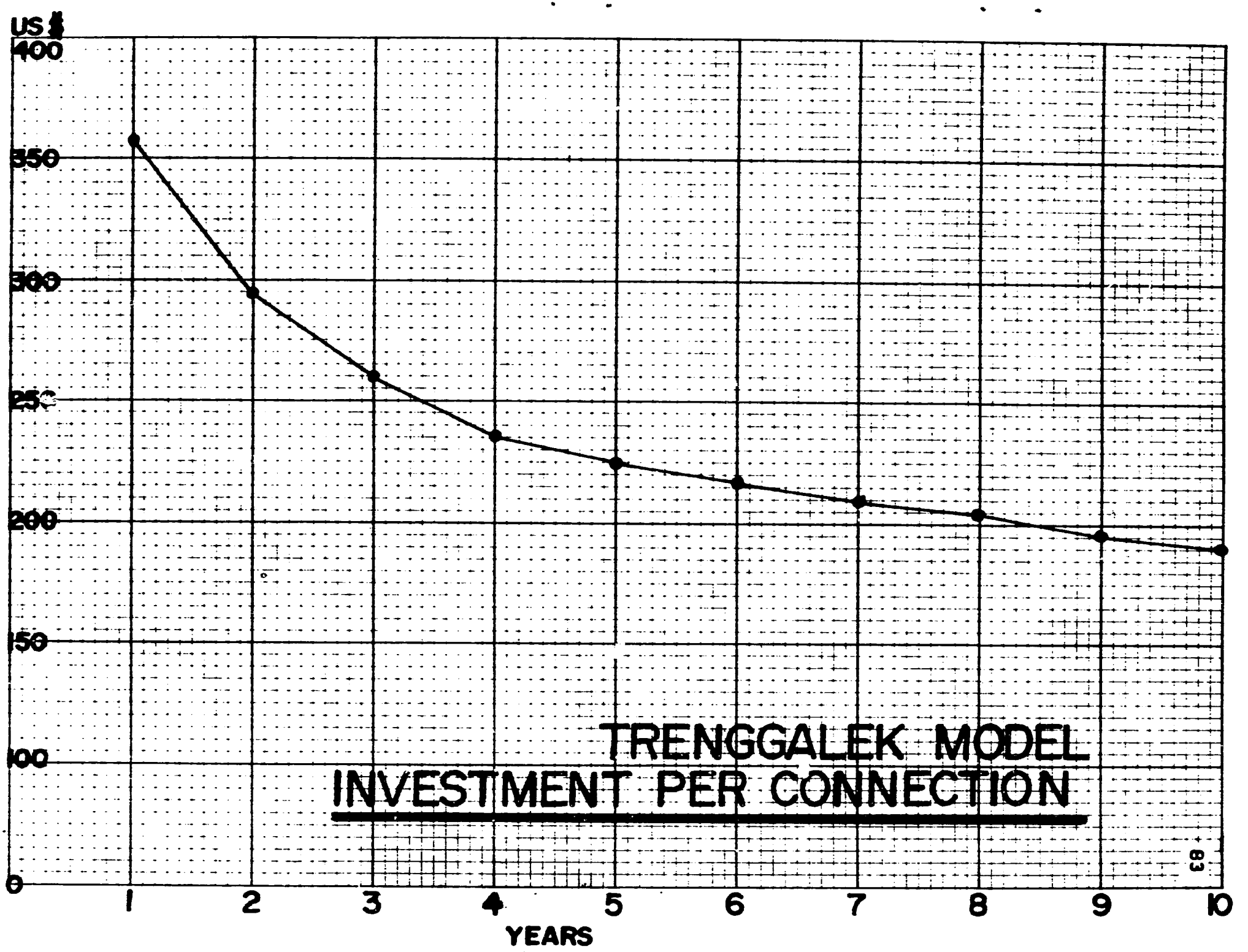

TANGERANG MODEL
TOTAL PLANT INVESTMENT
INVESTMENT US $1000
6,000
5,000
4,000
3,000
2,500
1
2
3
4
5
6
7
8
9
10
YEARS

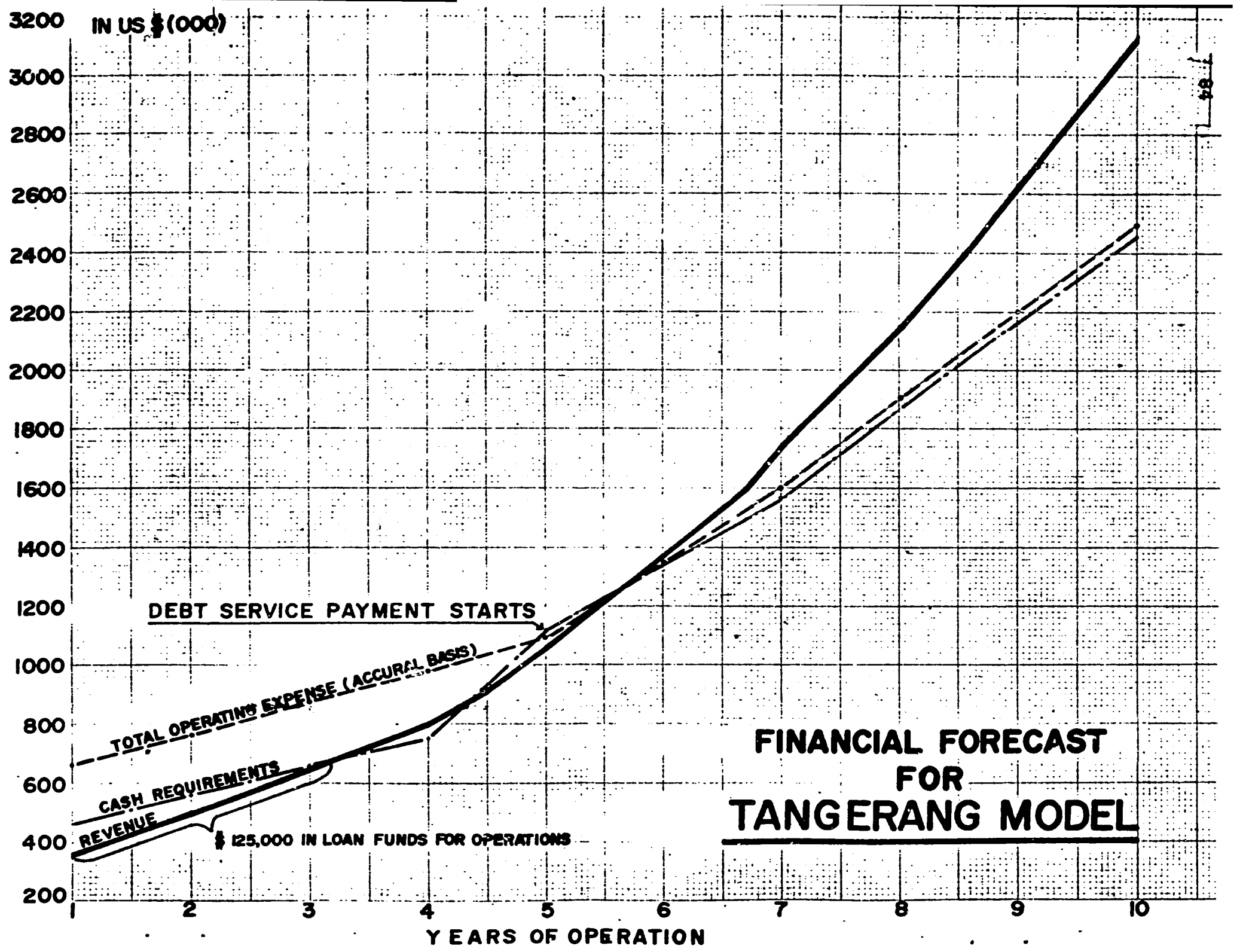

TRENGGALEK MODEL
TOTAL PLANT INVESTMENT
INVESTMENT US $ 1000
5,000
4,500
4,000
3,500
3,000
2,500
1
2
3
4
5
6
7
8
9
10
YEARS

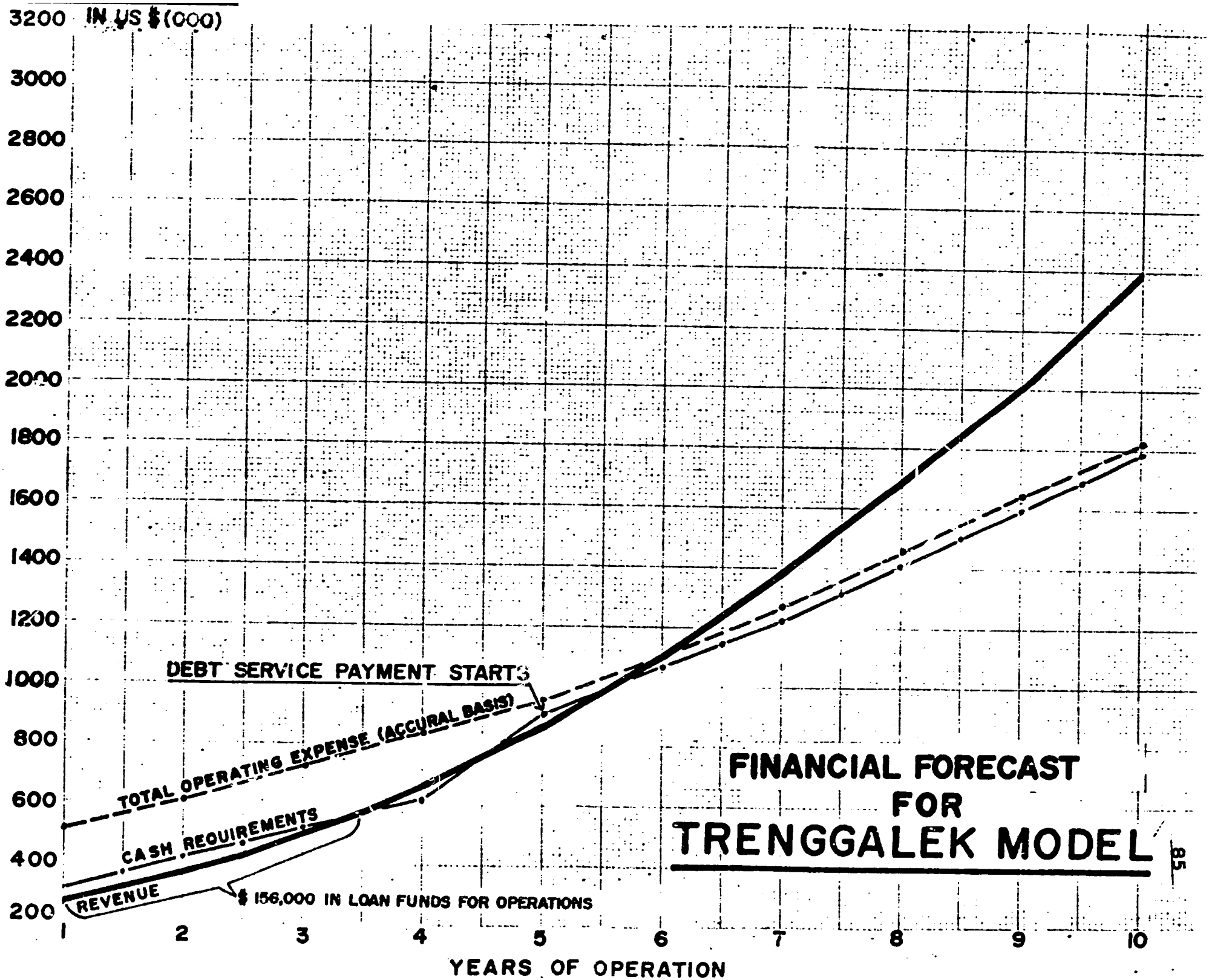

TANGERANG MODEL
TOTAL CONNECTIONS
CONNECTIONS
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
1
2
3
4
5
6
7
8
9
10
YEARS


TRENGGALEK MODEL
TOTAL CONNECTIONS
CONNECTIONS
35,000
30,000
25,000
20,000
15,000
10,000
5,000
1
2
3
4
5
6
7
8
9
10
YEARS


US.$
300
250
200
150
100
0
1
2
3
4
5
6
7
8
9
10
YEARS
TANGERANG MODEL
INVESTMENT PER CONNECTION


US $
400
350
300
250
200
150
100
0
1
2
3
4
5
6
7
8
9
10
YEARS
TRENGGALEK MODEL
INVESTMENT PER CONNECTION


IN US $ (000)
3200
3000
2800
2600
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
1
2
3
4
5
6
7
8
9
10
YEARS OF OPERATION
DEBT SERVICE PAYMENT STARTS
TOTAL OPERATING EXPENSE (ACCURAL BASIS)
CASH REQUIREMENTS
REVENUE
$ 125,000 IN LOAN FUNDS FOR OPERATIONS
FINANCIAL FORECAST
FOR
TANGERANG MODEL



FINANCIAL FORECAST FOR TRENGGALEK MODEL

X. ENGINEERING AND CONSTRUCTION

General.

Implementation of rural electrification projects must be based on lowest feasible system investment to obtain maximum benefits. This means that general system guidelines should be followed to assure adequate voltage and reliable service as economically as possible.

Further, many of the older distribution system design and construction criteria now used in Indonesia should not be considered in designing and constructing these new rural distribution systems.

Conditions in Indonesia affecting the design and construction of rural lines are similar to those encountered in other countries, therefore standards and criteria used in like areas of those countries can be safely used in Indonesia. In Java and some other locations rural population density is unusually high, but in general the clustering appears to be along the roads, This may cause right-of-way clearing and staking problems, but the high density is an advantage rather than a problem in system design.

With high consumer density, but small demand per consumer and initial low revenue anticipated, it becomes the responsibility of the project engineer to utilize every tool and method at his command to build low-cost, safe systems, with a lifespan and reliability commensurate with the need for good rural service and moderate rates.

Type of System.

Elements of distribution systems should be serviceable for long periods of time. Therefore, they should be designed with much thought given for future requirements. Since customers and additional loads will not develop on any fixed pattern, as much flexibility as possible must be considered so that if loads "shift" the distributing system can also "shift" with least expenditure.

Systems should also be built simple and straightforward, without operating restrictions, so that operational errors will be minimal. Present-day system components (transformers, poles, insulators, conductors, sectionalizing equipment etc.) are very reliable and when properly utilized obviate the necessity of duplicate distributing facilities. Emergency capacity in various parts of the system should

be provided by short-time overloads (as defined in Attachment 3) on a single contingency basis, without redundancy.

Radial feeder systems should be used, preferably fed from a regulated bus. However, existing feeders suitably protected to isolate faults on the new system may be used to feed it, provided satisfactory regulation and capacity are available on the existing feeders.

Three-phase feeders and laterals should be built from bulk power buses to points where it is feasible to divide the loads beyond. From these points, single-phase lines should be constructed along with single-phase taps from the three-phase system to serve consumer loads. Three-phase construction should be held to a minimum consistent to load growth and voltage drop.

The existing systems in Indonesia are 50 hertz, and this usage is too extensive to consider a change. Voltage standards for the Indonesian Archipelago were set by the Director General for Power and Electricity, Ministry of Public Works and Power, by Decrees Nos.08/K/70 and 09/K/70. Primary voltage of 20 KV (nominal) with a maximum of 24 KV is now being used extensively and does not require introduction of another class or size of equipment and materials.

Secondary voltages are being changed from 127/220 V to 220/380 V (nominal). Use of this new standard voltage is almost mandatory for any new rural construction, because motors, appliances, lighting equipment and bulbs are being marketed for 220/380 V service. The new voltage also reduces consumers' wiring costs.

For residential and small commercial loads, 10 KVA and below, the service voltage should be 220 V, two-wire, single-phase. This permits a motor size of 10 HP or under. For loads of 50 KVA and below, 220/440 V, three-wire, single-phase should be used with individual motor size limited to 10 HP. However, for miscellaneous commercial and industrial loads, 25 KVA and above, 220/380 V four-wire, three-phase should be used, if individual motors 15 HP minimum or other three-phase equipment, 25 KVA or more are, to be installed. Maximum load at this voltage is 500 KVA.

All new three-phase rural distribution systems should be overhead wood pole line, with bare aluminium conductors, standard fittings, pole-type transformers, overhead services, and meters. The system should be four-wire wye, with multi-grounded common neutral. There must be effective grounding

as defined by the National Electrical Safety Code, Handbook No.81, U.S. Bureau of Standards, Washington, D.C., U.S.A.

System Design Criteria.

Complete and detailed design criteria which would apply to rural distribution systems suitable for Indonesia were developed and will be found in Attachment 3.

Implementing the Engineering and Construction.

Large outlays of money for system design can be avoided by using already available standard design/criteria, construction specifications and drawings, and approved materials. All of these have been thoroughly field-tested in close to a thousand rural electric cooperatives, and are available from the Rural Electrification Administration in the U.S.A.

With feasibility study maps showing prospective consumers and suggested routing of lines it is believed that minimal electrical design engineering will be needed. In fact only a voltage drop diagram (REA Bulletin 45-1) to determine phasing and wire size with a sectionalizing diagram (REA Bulletin 62-1) to determine location, size and type of automatic sectionalizing devices, appear to be necessary. However, a great amount of skilled field (survey) engineering will be required to properly stake lines and designate construction units with due regard to economy and safety.

In implementing distribution and transmission construction projects for PLN, many Indonesians have been trained and instructed both in Indonesia and abroad by foreign engineering and construction firms handling these projects. Using some of this personnel, it would appear that adequate engineering skills to handle rural system work described above is available. Further, with some supervision from out-of-country sources in the initial years, these locally trained personnel should be able to perform the required service.

Since all the work will be done in Indonesia, the major portion on job site, it is believed two foreign advisors who are experienced design engineers for supervising general system design, and material procurement, along with one experienced field engineer for each rural system under construction will be adequate to handle the work, along with Indonesian personnel. These engineers could be from the national agency, direct contract personnel, or be part of an engineering or service organization.

Presently, in certain areas, local contractors are constructing overhead electric lines, under foreign engineers'

supervision. It is reasonable to assume if all materials are furnished by the national agency, that local contractors could construct strong, safe systems in approximately 50 km. segments per contract. The supervising field engineer assigned to each rural system along with his Indonesian fieldmen could supervise and manage such contract construction.

It is recommended that local contractors should construct lines, as described above, and that the cooperative's own personnel should run service lines and install meters since this phase of the work involves consumer contact, billing, etc. which should not be done by contractors.

These suggested methods would make maximum use of local personnel, construct quality systems at minimum cost, and would in some 3 to 5 years enable local personnel to construct system without assistance from foreign advisors.

XI. MATERIALS AND EQUIPMENT

Source, Type, Procurement, and Handling.

Adequate supply of proper materials and equipment is essential to timely and low-cost construction. All materials and equipment must conform to predetermined standards and specifications to assure high quality and safe construction, compatibility of components, and lowest pricing through large orders. Another crucial determination in ordering is sufficient lead time and planning to permit a sound pipeline of supplies to be created and maintained. With this in mind, it is prudent to procure bulk materials for several projects in a continuing program rather than for a single "pilot" project at a time. Computerized ordering, receiving, warehousing, inventory, and allocation to the various construction projects should be projected from the start of the program.

This concept envisions the Indonesian rural electrification authority as the"wholesale" agent, responsible for purchasing, warehousing, and distributing to the contractors the materials and equipment required for system construction. In this manner, purchase of materials may be started as soon as program financing is made and initial feasibility studies have been completed. This would substantially shorten the time needed to energize a project.

A detailed "List of Approved Materials" has been developed over a period of many years by the Rural Electrification Administration, in Washington, D.C., for the rural electric cooperatives in the U.S.A. With very few changes, to accomodate differences in Indonesian frequencies and required transformer ratings, the standards could be used here. The publication is REA Bulletin 43-5.

Standard identification of items facilitates the use of standard invitation-to-bid forms and simplifies price comparison on bidding by suppliers, stocking, handling, etc.

Warehousing the quantity of materials to be used in the recommended electrification program promises to be a monumental task, so scheduled deliveries are worth consideration.

It is also suggested that materials procured from foreign sources might be imported through the less crowded ports, with warehousing possibly provided at several points on Sumatra and Java.

Certain materials must be obtained from overseas sources. However, investigation has determined that limited amounts of other materials of sufficient size and quality may be obtained locally. One objective of the recommendation for an extended rural electrification program would be the creation of a market to utilize new lines of production in Indonesia. This would provide additional job opportunities.

Analysis, comments, and suggested source of some materials and equipment are detailed below.

Poles.

Several years ago, Power Research Institute (PRI), in Jakarta, made an exhaustive study of timber resources on Java that would be suitable for use as poles supporting overhead electric and communication systems. This report found that several species of suitable woods were available but that treating facilities for handling lengths suitable for poles were minimal.

Subsequently, in 1971, a consulting firm working on projects in Central Java continued this analysis and determined that Rasamala species found in Central and West Java were suitable for poles. Further, with selective cutting and the then available treating facilities, it was thought some 8,000 treated wood poles with lengths up to 12 meters could be made available for use on the Central Java projects. The number of treated poles anticipated at that time did not materialize for a number of reasons, principally the difficulty of obtaining the "green" poles at the woods area on an acceptable schedule. Other types of poles were used to build the projects at hand.

On surveying the treated wood pole situation today, some improvement is evident. Three wood species in various areas have been found suitable for treated poles:

(1) Keruing - (Dipterocarpus SPP) in Kalimantan.
(2) Damar Laut - (Shoera and Hopea SPP) in South Sumatra.
(3) Rasamala - (Altingla excelsa) in Central and West Java.

Treating facilities are somewhat improved with a total of seven plants capable of producing treated poles. However, only three plants have cylinders of sufficient length to produce the full range of pole lengths required. These plants with classification, capacities, and location are:

Location	Classification	Capacity (Cubic Meters) Two Shifts	Approximate No. of Poles Per Day
Medan area	limited	10	200
Medan area	limited	10	200
Medan area	unlimited	10	200
Jambi	limited	10	200
Jakarta	limited	10	200
Bandung	unlimited	40	800
Cikampek	unlimited	30	600

It is realized that this entire plant capacity cannot be used for poles for a rural electrification program, but it is apparent that with placement of orders in quantity and proper supply of green poles, production of some 50,000 or more treated poles per year is possible.

Problems in the assumed supply of green poles and the average price of treated poles makes the possibility of obtaining poles on an economic basis questionable. The supply of Rasamala is controlled by the Government Forest Service, and it is expected that only limited amounts of green poles of this species might be secured. Keruing and Damar Laut poles are harvested from leased concessions along with other merchantable timber. The supply of these would be limited only by available coastal shipping for transport to the treating plants. Sufficient quantities of treated wood poles should be obtainable, provided orders could be placed sufficiently in advance of required delivery date. Current prices from treating plants are high and the price is believed not to be based on actual production costs, but simply on "what the traffic will bear". It is reported that the price of AWPA treated poles (16 kg/m^3) from a plant in Java average:

Rupiah 60,000 (US$144.60) for Rasamala, and
Rupiah 50,000 (US$120.50) for Keruing and Damar Laut.

It is further reported that Keruing and Damar Laut poles are furnished at Java treating plants for about Rupiah 25,000 (US$60.25) per green piece.

As stated above, these prices appear high but since there is little, if any, competition, there is no alternative if local wood products are to be used. While the use of local resources to their full capability should be encouraged, the rural electrification program should not be used to support existing prices for poles. Development of full-scale rural electrification should bring prices down by putting production on a better organized basis.

In order to test the world market price delivered to Indonesia, it is suggested in implementing the rural electrification program recommendation that a reasonable number of treated poles be advertised for overseas procurement. In this way local suppliers may take a closer look at their costs from a competitive point of view and supply local needs at a lower price.

Other types of poles might be considered for construction, such as spun or pre-stressed concrete poles and tubular steel poles.

Concrete poles are relatively heavy and handling costs are more than for treated wood. Only a few poles of this type have been used in past years (Surabaya area) and there are presently no manufacturing facilities, consequently no prices or production information available. In other Southeast Asia areas where satisfactory woods are in short supply, concrete poles are produced in quantity at prices on the order of US$75-$80 (31,000-33,200 rupiah) for an average size distribution pole at the plant. One cooperative in the Philippines manufactured its own concrete poles with a labor-intensive process.

Welded tubular steel poles, painted, are produced in many localities in Indonesia. These poles can be fabricated close to the job site from imported steel tubes. Satisfactory designs exist for fabricating a quality pole. However, the cost plus the need for different type of fixture attachments, using "pole bands" instead of bolts, make the use of steel poles marginal.

From the above discussion it is apparent that the options on pole procurement and use, in order of their value, are:

(1) Use local treated wood poles, but bring prices down to a more realistic level.

(2) Use imported treated wood poles.

(3) Establish a concrete pole industry with prices based on manufacturing costs.

(4) Use steel poles, but provide for all fixture attachments using pole bands.

Cross Arms and Anchor Logs.

Treated cross arms and anchor logs should be procured locally according to REA standards.

Line Conductors and Service Cables.

As described elsewhere, bare aluminum cable steel reinforced (ACSR) should be used for line conductors. Likewise, twisted, self-supporting service cable, aluminum alloy, bare neutral types, should be used.

One local cable manufacturer's plant which was visited had a competent and satisfactory operation. The plant has complete facilities for drawing, stranding, insulating, and cabling of aluminum as well as copper conductors. On the day of the visit, however, the entire aluminum section of the plant was shut down due to lack of orders, even though some 200 tons of rod were on hand to process small runs. It was ascertained the aluminum plant has an annual capability of 6,000 tons of single-layer or multi-layer cables and that if orders in excess of this amount were available, additional equipment would be installed in the original planned expansion area. It was reported that pricing is competitive with overseas delivered CIF price, provided that raw materials imported, i.e. steel core wire, aluminum rod, and insulating materials, could be "duty free". If duty was paid on raw materials and the overseas finished material was also taxed, then the locally produced conductor would be considerably cheaper.

The Study Team suggests all line conductor and service cables be procured locally. If the cable manufacturer cannot make satisfactory arrangements with customs, then raw materials should be imported duty free by the Indonesian rural electrification authority and turned over to the manufacturer for stranding and finishing. This would keep an established industry in business and shorten supply lines.

Consumers' Meters.

Watthour meters manufactured according to American National Standards Institute (ANSI) publications have ratings and characteristics far in excess of most Indonesian rural consumers' needs. Meter requirements for some 97% of the service in the recommended program would be single-phase, 220 volt, 5 ampere, 50 hertz. The meters specified should be those using less stringent overload, thermal, and power factor characteristics than required by ANSI. It is believed adequate meters manufactured to other than ANSI standards, which will have characteristics compatable with the intended service, can be procured for some 50% of the cost of an ANSI meter. Meters for large loads and all power meters should be purchased according to ANSI publication for 50 hertz. To conform with principles stated elsewhere in this Report, no load limiters should be purchased or installed.

Other Materials.

All other materials and equipment should be purchased using standard GOI and foreign source procurement procedures. No local industries were found producing acceptable materials, with the possible exception of transformers. A transformer plant producing three-phase distribution units was visited and found to be producing quality products using modern, adequate production equipment. This plant has no engineering staff per se, and is producing equipment according to "borrowed" designs. At present this plant cannot produce suitable single-phase transformers due to lack of competent designs. However, this plant has the capability of becoming a source for distribution transformers.

XII. SYSTEM MANAGEMENT AND OPERATIONS

Relationship between Borrower and Lender.

The Indonesian rural electrification authority would be vested with the usual controls which a lending institution has over a borrower's operations to protect the security of the loan. These would include approval of the cooperative's selection of general manager, access to accounting books and records, prohibition against incurring other indebtedness, and relief in event of default.

In the sort of rural electric cooperative approach recommended in this Report, however, the controls to be exercised by the lending and administrative agency go quite a bit further than that. There are compelling reasons for this more stringent supervision.

The rural electric cooperative is, indeed, created as a self-contained, locally owned and operated business enterprise. Its financing, however, comes 100% from the national agency for the construction of the system and the only security it can offer is the physical plant and the potential earning power of the cooperative. As mortgage holder, the national agency is compelled to require that the construction of lines and other facilities be in accord with proper standards and specifications. And it must assure operating procedures which will keep the cooperative financially viable.

The relationship of the National Electrification Administration and borrower cooperatives in the Philippines is illustrative, as stated in NEA Bulletin No. 10:

"NEA's authority and regulation over electric cooperatives and the responsibilities of electric cooperatives as borrowers of NEA funds are set forth in Presidential Decree No. 269. The electric cooperative, as a corporate entity, is vested with all powers necessary or convenient for the accomplishment of its corporate purpose. NEA encourages and expects its electris cooperative borrowers to exercise a high degree of initiative and responsibility for their development as viable service enterprises and for their operation as member-owned, non-profit cooperatives providing adequate and dependable electric service on an area coverage basis. The extent of independent action by the electric cooperatives will be subject to the requirements of NEA in its capacity as lender and as the grantor of franchises for the purpose of assuring their attainment of area coverage".

In some of the rural areas, it may not be possible for the cooperative to obtain a manager and key emplyees who have the experience and skills needed to operate the accounting, budgeting, system maintenance, and other functions for providing electric service. It becomes the responsibility, therefore, of the national agency to set forth standard hiring requirements, position descriptions, and detailed operating procedures. Along with this assistance, a continuing training program will be needed so that people from local communities in the cooperative's service area can be hired and can become competent.

During the organizing stages of the cooperative and in the first operating years, it is expected that the national agency will scritinize closely and advise at every step. This can be started with a combination of overseas advisors and field personnel with experience and special training in such skills as housewiring, installing service connections, meter reading, billing and collections, bookkeeping and accounting, warehousing, etc. The field staff of the national agency should travel with and learn from advisors drawn from countries with successful rural electrification cooperatives. They should work with policy statements, procedures bulletins, manuals of instructions and guidelines issued by the national agency.

As the cooperatives develop and mature with experience, the overseas advisors can be withdrawn and the assistance of the agency field personnel can be reduced gradually.

The relationship between lender and borrower in the initial years, then, may appear rather paternal in character. The Indonesian rural electrification authority must be concerned with setting up cooperatives which comply with the overall national program objectives. The board of directors of the cooperative and the general manager may need guidance in carrying out area-wide coverage to provide service to every household and every commercial-industry-agricultural enterprise that wants it and can pay the low rates. Guidance, reminders, explanations, and assistance may also be required to keep the enterprise running efficiently and assistance may also be required to keep the enterprise running efficiently and economically, to treat employees fairly, to adhere to cooperative principles and practices for genuine membership control in a democratic manner, and to make reports regularly and accurately.

Line of Authority in the Cooperative.

The line of authority within the cooperative starts with the assembled membership in the annual or special meeting.

It is here that the board of directors is elected. The board is legally responsible for the affairs of the cooperative and reports back to the membership periodically.

But neither the board as a whole nor the members of the board individually try to manage the day-to-day operations of the enterprise. They leave that to a general manager who is hired by the board with the advice and approval of the national rural electrification authority. He is responsible to the board, and he hires and supervises the staff of employees, in conformance with policies approved by the board. The employees, in turn, are responsible to the general manager.

The table of organization in the cooperative probably should include an administrative assistant and three or four top supervisors reporting directly to the manager; line superintendent, chief engineer, office manager, and member relations director. It is difficult to prescribe in advance the number of employees which will be needed, but five or six might be enough during the pre-construction period. This could increase to 35-45 during the construction stages, and reach around 60 when the cooperative reaches full operating status following energization of the lines. More would be added as necessary with the growth in number of consumer-members. Over-staffing is a danger that must be avoided in order to keep the retail rates for electric service low.

Using Operating Data.

Operating figures must be kept up to date at all times so that the several departments and the general manager can judge strengths and weakness in providing service and in keeping the business financially viable. The manager should report to the board in writing each month, and copies of these reports must be submitted to the national administrative agency as required.

Good system management and operations can be encouraged by the national agency through the issuance of standard manuals on such aspects as accounts for rural electric cooperatives, work order procedures, personnel practices, service drops and installations, line inspection and maintenance, voltage regulation, etc. Supplies of necessary forms for billing, materials charge-out, motor pool, monthly financial and statistical reporting, etc. also should be furnished by the national agency except in those cooperatives close to cities where adequate printing facilities exist for copying the authorized forms.

Management objectives, based on operating data, should include:

Maximum connections of consumers per kilometer of line.

This yields a lower plant investment per consumer and makes debt repayment easier to achieve.

High ratio of prompt collections on billings. This can be measured by progress in reduction in aging of accounts receivable.

A satisfactory trend line in the operating ratio less power cost, as a measure of efficiency. In the U.S.A., the rural electric cooperatives used to regard a figure not exceeding 30% as satisfactory.

A necessary refinement of the above ratio is the measuring of departmental expenses (maintenance, administration, billing and collecting, etc.) against total expenses and against revenue, with the objective of keeping these as low as possible without sacrificing quality of service.

Productivity of employees, measured by number of consumers, by kilometers of line, and by revenue.

Lowest possible figure for "blackouts" when portions of the system are shut down leaving consumers without power.

Low system losses of energy.

Retail Rates.

Rate schedules are usually determined with several factors interacting to produce a compromise which contains at least two main elements:

(1) The schedules must be tied realistically to the economic limitations of the people who must pay the bill; and

(2) Must produce, when applied to the usage characteristics, enough revenues to (a) meet the debt obligation, (b) pay for operations and maintenance, (c) develop prudent reserves for the cooperative, and perhaps provide some measure of self-generated capital for expansion.

In countries and in times not hampered by energy shortages, there should also be an incentive component to the schedule to encourage consumers to make more abundant use of electricity. They must believe that their investment in a greater use of electricity is worthwhile when equated to be social and economic benefits derived from that use. If the rate schedules are too low, so that even fixed costs of the system cannot be met, no volume of abundant usage will rescue the cooperative from its problems. Schedules which are too high will generally depress consumption and lead to consumer dissatisfaction rather than give any significant increase

in revenue.

The majority of residential consumers will have very low monthly kwh consumption. Consumption ranges and demands being considered by this Report are so small that a uncomplicated approach to rates is taken at this time. As projects come into operation and experience is gained, it may be possible to establish rate schedules based on a better statistical basis and more responsive to the actual needs of the individual cooperative and its members.

At the least, rate schedules should be simple so that explanation to the consumer is easy. This is especially important when the cooperative first begins service. As the system matures, average consumption increases, diversified commerce and industry comes to the area, and new loads develop, there will be a need to establish different schedules for application to new consumer classifications. Existing schedules then may become more sophisticated to properly correspond to the cooperative's and the consumer's interests.

In the financial analysis in another section of this Report, an average revenue per kwh sold for all classes of service is used. Until the actual cooperative areas and actual investment costs are defined, it is believed that no attempt at definitive rate schedules for the various classes of service should be undertaken. Schedules may vary from one cooperative to another when the rural electrification program gets under way. There is an alternative approach, however, which may need to be examined. That would be a uniform, country-wide base rate for all rural electric cooperatives.

In detailed feasibility studies, to be made later, suggested rate schedules to yield sufficient revenues to make each particular cooperative viable will be presented. The two model projects in this Report have been shown to be viable with average rates of Rupiah 33.2 (US$0.08) for Trenggalek and Rupiah 30.3 (US$0.073) for Tangerang.

It is to be remembered these rates are average for all classes of service. "Social rates" used in some countries for very-low-income households, should be lower than this average, with commercial and industrial and security light rates being higher. This is consistent with present practices in Indonesian and felt to be appropriate.

PLN Rates.

PLN has indicated it would be willing to sell power for resale to rural electric cooperatives at transmission

voltages from its network to the limit of its capability and capacity. PLN believes it has responsibility under present regulations to furnish power to the ultimate consumer, even though distribution is accomplished using certain facilities not owned and operated by PLN. Further, PLN expressed the opinion that household consumers provided with service through a rural cooperative system should enjoy the same preferential rate treatment enjoyed by "social rate" consumers served directly by PLN.

PLN's rate policy is to serve "social rate" consumers at an average rate per kwh lower than the composite kwh rate for all classes of service.

To assure continuance of this policy and to establish an average wholesale rate which will be feasible for the proposed rural systems the following analysis is made:

(1) PLN's revenue is roughly divided as follows:

Operating expenses 71%,

Depreciation and debt service 29%.

(2) Distribution and customer's service requires 20.2% of total operating expense.

(3) Distribution system is 32.4% of the fixed assets of the company.

(4) The proportion of revenue used by the distribution system can be ascertained as follows:

Operating expense	(71% x 20.2%) =	14.3%
Depreciation and debt service	(29% x 32.4%) =	9.4%
Total		23.7%

(5) With an average social rate per kwh of Rupiah 20.75 (US$0.05), then 23.7% or Rupiah 4.92 (US$0.012) per kwh would be required by the distribution system.

When using the above average social rate along with other revenues there is a deficit of some 2.65% in meeting the company's obligation. It is assumed that general tariffs might be changed or operating improvements made to cover this deficit. This would require an average rate of Rupiah 16.25 (US$0.0392) per kwh for power sales at transmission voltage.

The above methodology is for demonstration purpose only. The percentages and numbers were extracted from various

available PLN papers and reports, but do not take into account system losses of energy. It is believed, however, that sufficient accuracy is attained to conclude that wholesale rates at transmission voltages could be about 24% less than the average kwh rate for energy sold through PLN's distribution system.

System Losses of Energy.

Every distribution system experiences some line losses which are normal. These must be kept to a minimum. Better loading, proper spacing of transformers, correct sizing of conductors, and right-of-way clearing to prevent branches from rubbing against the lines are some of the measures to be taken. By far the greatest losses of energy occur, however, from faulty metering and theft of power. In a consumer-owned cooperative, a good member relations program should be able to effectively discourage this.

System losses above 15% point to operating problems which need attention. Management should never expect to substitute higher retail rates to make up for loss of revenue due to system energy losses.

Housewiring.

Adequate minimum standards for the wiring of houses and other buildings for electric service is an essential part of any rural electrification development. So is a financing plan which will extend low-cost credit to the individual consumer-member.

Actual installation of housewiring may be done by the cooperative personnel or by private contractors in the local community. The latter approach is recommended. However, because there are not likely to be housewiring electricians in the unserved areas where the cooperative is building its lines, the Indonesian rural electrification authority should make provisions for a training program at locations where a projected cooperative is being started. The village housewiring electrician course could be offered under the local sponsorship of the cooperative, with instructors, charts, and sample mock-ups furnished by the national agency.

It would be the obligation of the individual consumer-member to get his own premises wired, and he could get the names of installers from the cooperative's list of graduates from the instruction course. Arrangements for payment of labor charges would be made by the consumer-member. A recommended price list issued by the cooperative would curb overcharging.

Materials for houswiring would be procured by the national agency and issued to the cooperatives for re-issue to village housewiring electricians at cost plus a markup for handling. The estimated average cost of the wiring for a small home is Rupiah 10,000 (US$24), but this could be lowered slightly by a bulk purchase program for the materials.

All installations would have to be inspected and approved by the cooperative before the service connection is installed. This is a safety requirement.

For those consumer-members who cannot pay cash for their housewiring, the cooperative should have loan funds from the rural electrification authority for relending at a low rate of interest. Such consumer loans could be repaid to the cooperative as an addition to the monthly billing for energy consumed. It is estimated that approximately 75% of the members of projected rural electric cooperatives will need these loans for housewiring. This would amount to a total of roughly Rupiah 75 million (US$181,000) per system to be loaned by the national agency to the cooperative for re-lending to its members.

XIII. TRAINING AND TECHNICAL ASSISTANCE

Scope of the Training Job.

There are available in Indonesia many qualified engineers, accountants, and cooperative specialists. The proposed rural electrification program will create a continuing need for more. Skilled technicians and administrative people will be required for the staff of the national rural electrification authority and initially for the 12 rural electric cooperatives. If a full-scale nation-wide program is determined to be a development objective, then manpower recruiting and training become even more critical. Experience in other nations indicates that relatively unskilled persons can be trained for useful positions in rural electric cooperatives.

The Indonesian rural electrification authority may require some 200 employees by the end of its first year. Beyond that, the number and composition of staff would depend upon the extent of the program adopted by the Government of Indonesia. Planning for future growth to make feasibility studies and loans and to provide training and supervision for a hundred cooperatives would require relatively heavy staffing at the top levels for planning and administration than would be required for an initial 12 systems. The National Electrification Administration in the Philippines now carries a roster of 550 employees to administer a program for 75 cooperatives.

A very rough approximation, without knowing the scope of program requirements, might call for the following:

Administrative, management and supervisory (including specialized skills)	50 employees
Engineering	12
Materials purchasing and warehousing	3
Financial, accounting, auditing	12
Research, writing, public information	6
Legal	3
Cooperative specialists	6
Training specialists	4
Supporting staff (technical and clerical)	100

Each cooperative, figuring 10,000 consumers, would need about 60 employees by the end of the first year of operations after the lines are energized. These would include:

Administrative, management and supervisory	5 employees
Engineering	1
Materials purchasing and warehousing	1
Financial, accounting, auditing	3
Research, writing, public information	1
Cooperative specialists	1
Linemen	6
Mechanics	2
Supporting staff (technical and clerical)	40

Training Requirements.

All of these people, plus the directors on the board of each cooperative and perhaps up to 50 volunteer local community leaders are going to require some training in the concept of non-profit, areawide coverage, cooperative rural electrification. Most of them will also need training conference, seminars, or workshops in skills which they will be using in their new jobs.

While the comprehensive training program proposed represents an investment of a considerable sum of money, it is absolutely essential to the success of the program. In the U.S.A. it was found that there simply were not enough electrical engineers and skilled technicians available in the entire nation when the REA program was undertaken in 1935-36. The successful program in that country was built on a strong foundation of training and skills development. A full curriculum of pertinent courses was offered in the early years of REA, the government lending and administrative agency. In more recent years training program have been taken over and enlarged by the National Rural Electric Cooperative Association (NRECA) and state associations of electric cooperatives working with NRECA.

Government officials and representatives from power companies, cooperatives, and development agencies in more than 50 nations have gone to the U.S.A. to visit rural electric projects there and to participate in a variety of training experiences. The present proposal for an Indonesian program would emphasize training opportunities which can be offered within the country.

The Philippine program leans heavily on its own training resources developed by the National Electrification Administration (NEA) with the assistance of an Advisory Team of nine consultants contracted from the NRECA. Eight of these nine have put in from 6 to 30 years as general managers of rural electric cooperatives, and seven of them are experienced electrical engineers. One of the nine is a cooperative organization and management specialist with 17 years experience

in REA and 8 years with NRECA. One is an agricultural engineer. NEA has made full use of their special skills in setting up a training staff which has reached 14,000 Filipinos with formal courses, workshops, seminars, and conferences. Subjects covered include:

Cooperative management, supervisory skills, utility accounting and bookkeeping, budgeting and planning, meter reading, billing procedures, work order preparation, warehousing and inventory, system design, construction standards and specifications, staking the line, housewiring, safety and first aid, cooperative principles and practices, member relations in cooperatives. Courses for housewiring electricians also may be needed.

The NEA Administrator is now planning to develop training facilities in the Philippines which will serve interested visitors from nations throughout southeast Asia where rural electrification is being considered.

National Program Guidelines.

Part of the training program needs to be built on statements of policy, guidelines, and procedures issued by the national rural electrification authority. Not all of the important subjects can be covered initially, but the series should be started as early as possible. The purpose would be to assist the boards of directors, general managers, and staff of the cooperatives in all aspects of the program they will be implementing.

A few examples of subjects to be included would be:

Functions and responsibilities of the board of directors, the job of the general manager, board-manager relations, how to prepare and use a budget, long-range planning, monthly financial and statistical reports, retail rates, meter reading procedure, billing and collecting practices, key operating ratios, personnel administration, motor pool operations, warehousing materials, inventory control, safety program and accident reporting, membership signup, how to plan and hold the annual membership meeting, bylaws for the rural electric cooperative, rights and responsibilities of the member, housewiring installation service drops and service entrances, etc.

There would be a large number of bulletins or issuances covering engineering and construction. These would cover system design, materials specifications, and construction standards. They are highly technical subjects but are most important in securing program-wide standardization for

economy, for assuring a well-built system which will give satisfactory service and last a long time, and to provide safety in operating the system and using electric service.

All of these may be readily adapted from the series of REA Bulletings developed over 40 years of experience by the Rural Electrification Administration, U.S.D.A., Washington, D.C. 20250, U.S.A. Some of them already have been modified as needed for use in the Philippines which has conditions more nearly like those in Indonesia than the United States.

As these guidelines and specifications are issued by the national agency, copies should be delivered to the borrower rural electric cooperatives.

Working with the Borrower Cooperatives.

Success of the program is going to depend on the amount and the quality of guidance and supervision which the national agency gives to the individual rural electric cooperatives in the organizing period, during the engineering and construction stages, and through the early operating years.

In addition to the formal training program and the issuance of policy and procedures guidelines and requirements, a field assistance staff must be created, trained, and put into action. These are employees of the rural electrification authority who will travel to the cooperatives and work with the general manager, the key employees, and the board of directors. Their job would be to interpret the national program policies and procedures, and to provide counselling and assistance on whatever problems develop, and to assure compliance with standards of efficient operations, safety, and member ownership. They would be, in fact, an extension of the agency's training program.

It is suggested that during the development years of the program, assistance be brought in from the NRECA to work with the agency's field staff. The recommendation would be to use the advisors as counterpart people who would encourage the agency's field personnel and the key personnel of the cooperatives to absorb as much as possible from their experience gained from many years of management. (For further information on advisory services for the program, see Attachment 2, "Technical Assistance for Cooperative Rural Electrification".)

XIV. PROJECTING THE PROGRAM

One or two pilot projects -- or even a Phase I rural electrification program of 12 cooperative systems -- would have only a limited benefit for a country as large as Indonesia. A token endeavor could scarcely justify the setting up of a lending and administrative agency, concessional financing from overseas sources, "pipeline" materials supply and a special training program. The benefits from extension of rural electrification, as demonstrated in the United States, Taiwan, and the Philippines, are derived largely from the full area-coverage concept.

Two Kinds of Expansion.

If full-scale development is contemplated, there could be two kinds of expansion following the Phase I undertaking. One of these would be the feasibility study and organization of additional cooperative distribution systems, perhaps one in each kabupaten to give geographic spread to the national program. The other kind of expansion could be extension of the lines of the Phase I systems to cover more of the potential service area. Both aspects of the expansion program could be carried on simultaneously.

Three maps of Central Java at the end of this chapter illustrate how this might be undertaken in Phase I, Phase II, and Phase III rural electrification. As suggested earlier in this Report, one cooperative might be able to serve an entire kabupaten where a small population combined with satisfactory terrain and communication lines makes this advisable. Larger kabupaten might be served by several cooperatives as illustrated in the map entitled "Possible Kabupaten Development" (page 115).

Assumptions for Program Projections.

For purposes of projection, there must be several assumptions:

(1) What are the key figures involved in one model cooperative system which could be regarded as typical? Of the two models presented for illustrative consideration in Chapter IX, the one for the Trenggalek area may be considered the more typical in population density, geographic situation, power supply availability, income level, anticipated power demand, and expected economic development following energization of an area-coverage, non-profit distribution system. This, then, serves as the assumed base for projecting a rural electrification program in this study.

(2) How many rural electrification cooperatives should be projected each year after the Phase I program? An average of 12 systems a year are contemplated for this projection. It is believed that the figure will be less for the beginning years of a continuing program and somewhat higher in later years due to the accumulating effect of training and experience.

(3) Completion time from organization to energization of a distribution cooperative may be assumed to be 24 months, based on experience elsewhere. The first two or three undoubtedly will require longer than that, while those started later may reach energization in a little under the 24 months assumed.

Projection Proportions.

Using these assumptions, the proportions of a projected program can be roughly discerned at the end of 10 years or 20 years. On the basis of full feasibility studies and determinations as to power costs, investment and manpower inputs, and the kind of national administrative authority desired, it should be possible to make year-by-year program projections.

It is essential to consider such projections, but they should be re-evaluated annually in the light of additional information gained from experience.

It is most important to make sure projects are not scheduled beyond the resources capacity which must sustain them. Will there be generating capacity and construction of transmission line ready to serve the distribution power requirements on the projected schedule? Will the pipeline of materials, equipment, and warehousing function at a level which will permit the projected schedule for construction of distribution systems? Will the financing for system construction and initial operating credit and housewiring loans be available?

A year-by-year projection covering financial requirements only is presented in the table on page 111. It suggests that a program with 12 cooperatives started in 1978 would reach a total of 132 by the end of 1998. Required investment in new rural distribution systems would be US$48 million or Rupiah 20,750 million in the first program year. By 1988, the annual investment requirement would be US$66 million or Rupiah 27,390 million. The total investment to be advanced through the proposed Indonesian rural electrification authority would be US$638 million or Rupiah 264,770 million during the first 10 years.

To estimate total cost of electrifying Indonesia's rural areas and its impact on the electric sector of the economy, the investment in generating plant and transmission lines should be included. They must be provided, whether by PLN or in some other manner. Constructing distribution systems can serve no purpose unless their required power supply is generated and transmitted to delivery points. It is generally accepted that the generating plant investment is a little higher (110%) than that for distribution plant with equal capacity, and that transmission runs at about 20% of distribution system investment. Therefore, it can be calculated that of any investment for complete electrification, distribution plant makes up about 43%, generation about 48%, and ransmission about 9%.

These financial input requirements for generation and transmission are shown on the table, even though they are not considered for the financing of the rural electric cooperative themselves. Totals are estimated at US$115 million or Rupiah 47,725 million in the first year and US$151.8 million or Rupiah 62,997 in thetenth year.

Alternate Sources of Generation.

For purposes of this study and Report, it has been assumed that generation and transmission for rural electric cooperatives would be provided by PLN and sold at a rate near cost to the distribution systems. Considering the magnitude of the power requirements in the projections and considering that some rural developments in the outlying islands may be beyond reach of PLN installations, it may be useful to consider what are possible alternatives in future years.

In this country microhydro installations have been used, but the overall practicality for an areawide rural coverage is limited. In the United States before the development of a national grid, many remote rural electric cooperatives operated their own diesel generating plants. Nearly all of these have now been phased out as too expensive to operate. In the Philippines, however, 29 of 52 operating cooperatives are supplying their members with power from diesel generator sets. This is expensive, but there is no alternative source of power. Substantial numbers of people pay the high cost of electric service rather than do without.

Some comparisons in costs of alternative sources of electric power in the future are presented in Attachment 4 of this Report Future investment which the Government of Indonesia might consider in the electric sector is further considered in the latter part of an "Economic Annex -- Rural Electrification" which is Attachment 5 to this Report.

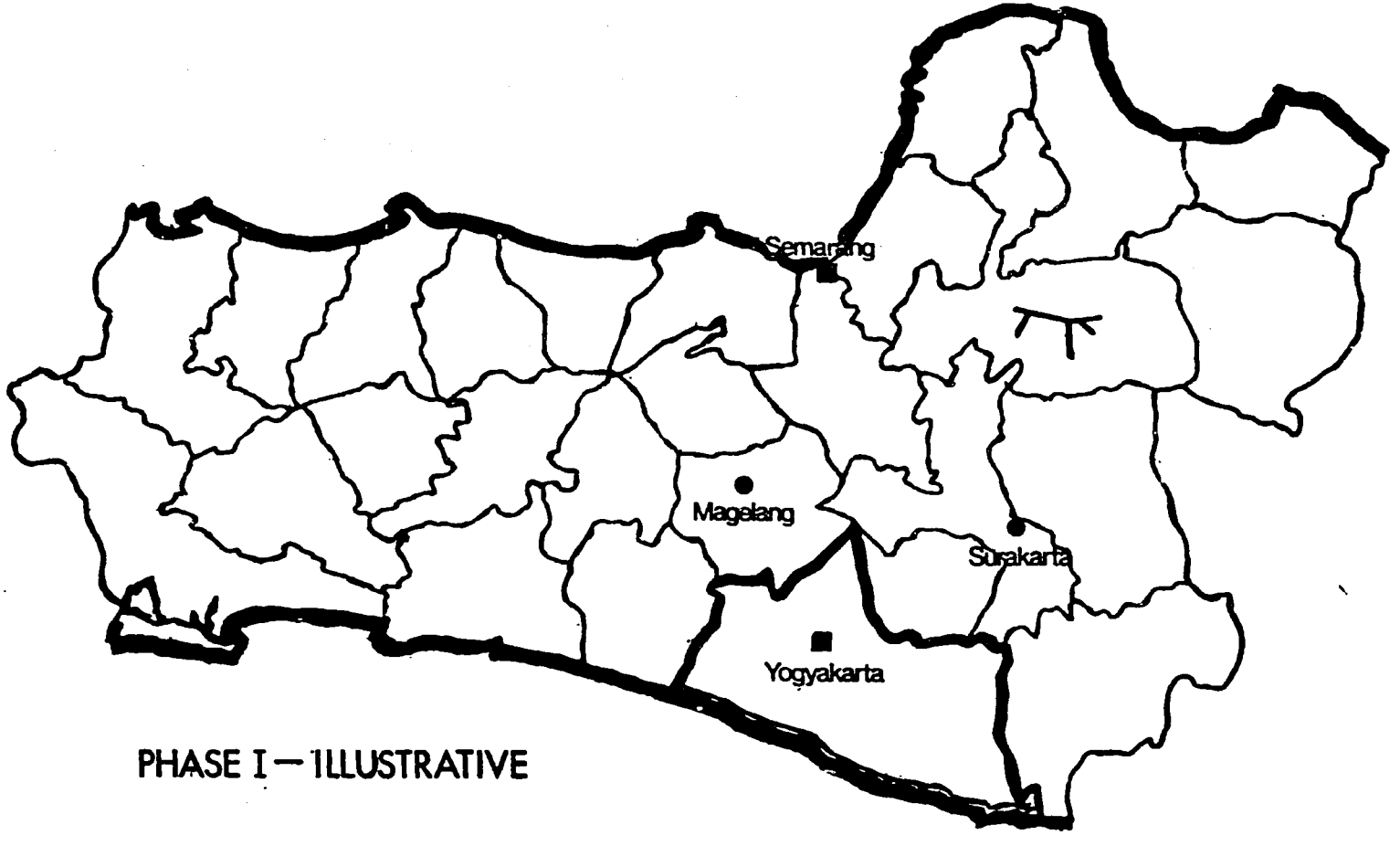
INVESTMENT IN PLANT, YEAR-BY-YEAR, FOR A 10-YEAR PROGRAM

OF RURAL ELECTRIFICATION

(Millions of US$)

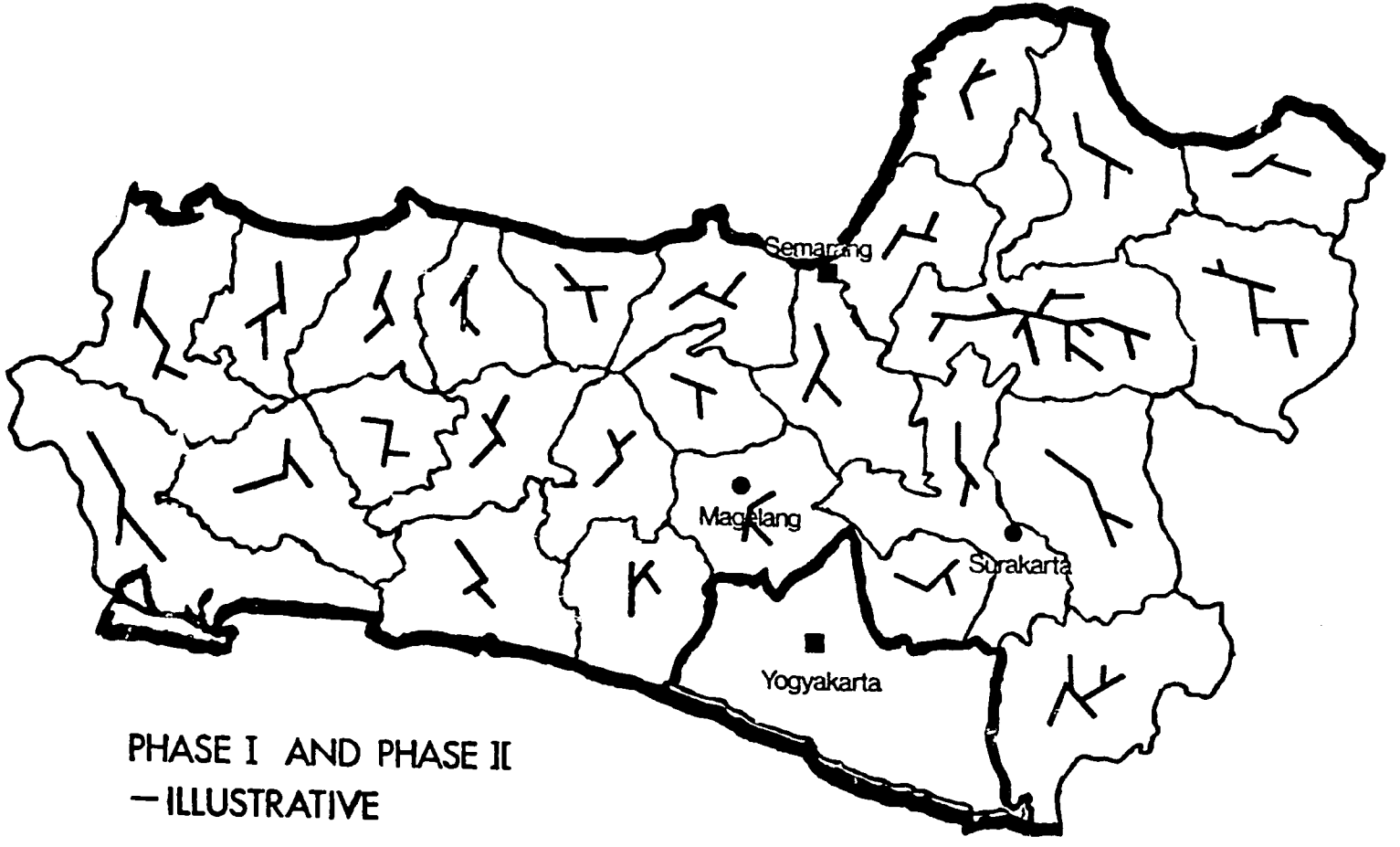
	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	Total
Total Number of Systems	12	24	36	48	60	72	84	96	108	120	132	132
Required New Distribution Investment	50.0	51.6	53.2	54.8	56.4	58.0	59.6	61.2	62.8	64.4	66.0	638.0
Required New Generation Investment	55.0	56.8	58.5	60.3	62.0	63.8	65.6	67.3	69.0	70.8	72.6	701.7
Required Transmission Investment	10.0	10.3	10.6	10.9	11.3	11.6	11.9	12.2	12.6	12.9	13.2	127.5
Total	115.0	118.7	122.3	126.0	129.7	133.4	137.1	140.7	144.4	148.1	151.8	1467.2

CENTRAL JAVA



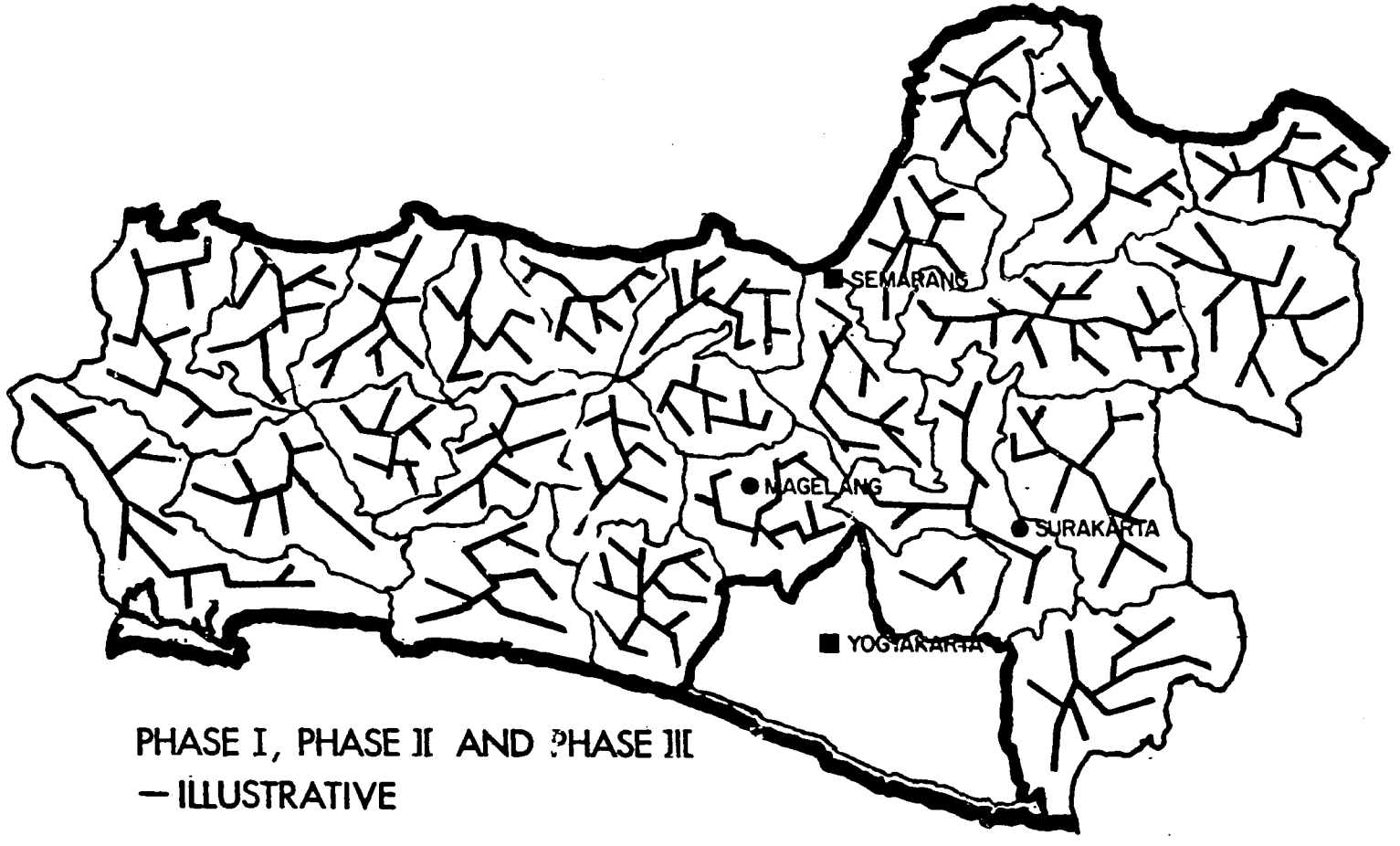
PHASE I — ILLUSTRATIVE

CENTRAL JAVA



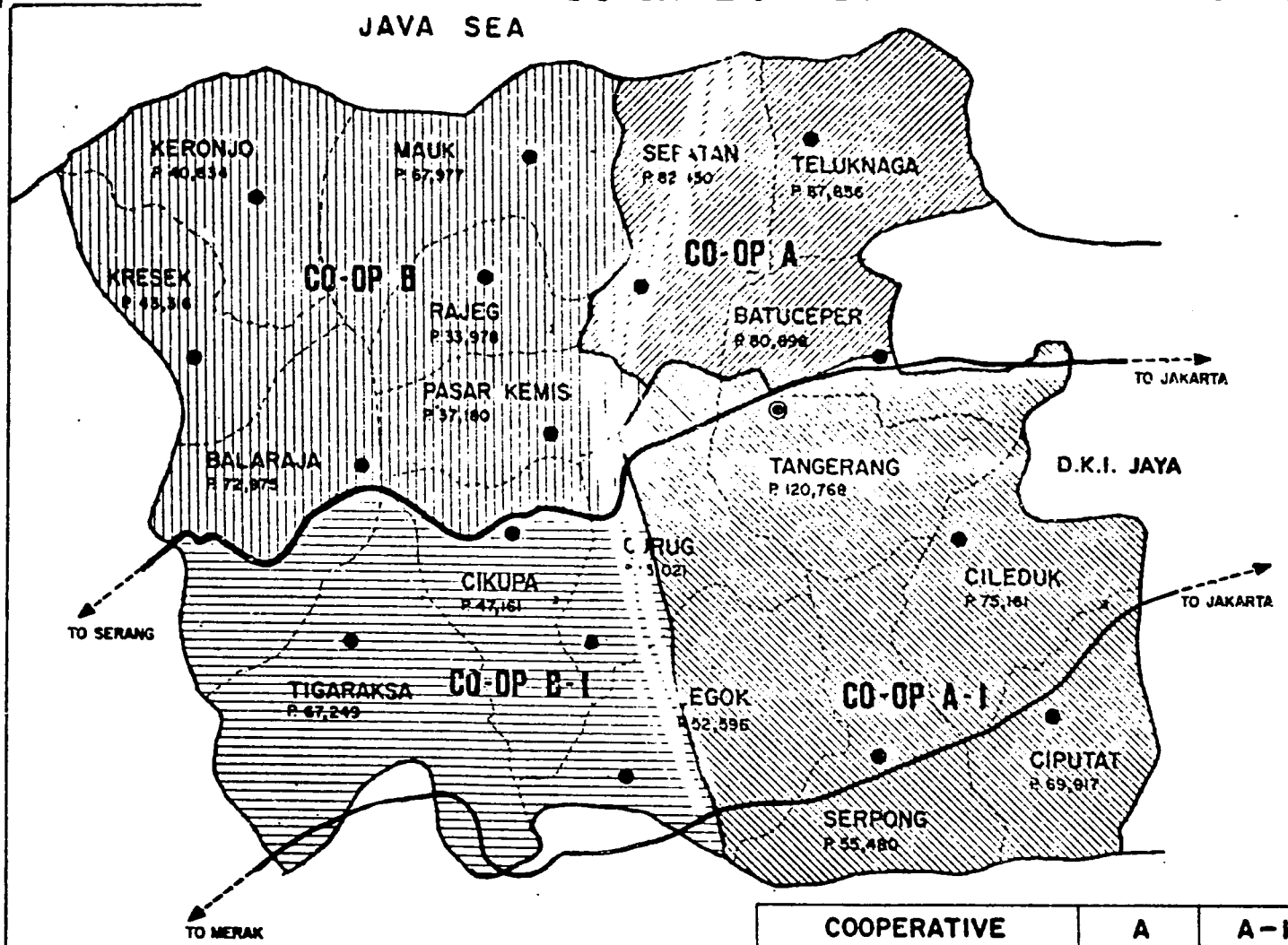
PHASE I AND PHASE II
— ILLUSTRATIVE

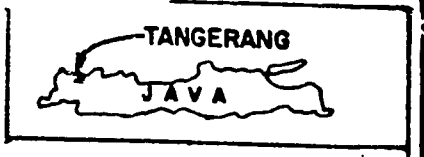
CENTRAL JAVA



PHASE I, PHASE II AND PHASE III
— ILLUSTRATIVE

POSSIBLE KABUPATEN DEVELOPMENT





COOPERATIVE	A	A-I	B	B-I	TOTAL
POPULATION (LESS TANGERANG CITY)	230,982	280,560	249,990	245,180	1,006,712
INITIAL NUMBER OF CONSUMERS	16,798	20,500	18,180	17,830	73,308
INITIAL CONSUMERS, PERCENT OF POTENTIAL COSTUMERS IN AREA	47%	45%	45%	45%	45.50%
TOTAL INITIAL INVESTMENT	$ 4,057,000 (Rp.1,684 MILLION)	$ 4,850,000 (Rp.2,013 MILLION)	$ 4,345,000 (Rp.1,803 MILLION)	$ 4,280,000 (Rp.1,776 MILLION)	$ 17,532,000 (Rp.7,276 MILLION)
INVESTMENT/CONSUMER, INITIAL	$ 242 (Rp100,500)	$ 237 (Rp.98,350)	$ 239 (Rp.99,185)	$ 240 (Rp.99,600)	$ 239,50 (Rp.99,400)

US $ 1 = Rp. 415

XV. EVALUATING PROGRAM BENEFITS

The REA Pattern.

During World War II, the Government of the United States of America kept its rural electrification program alive despite shortages in copper and other metals, manpower and financing. Allocations were made to the rural electric cooperatives because they were providing the vital power needed to step up farm production. This was also a time when vital industries were being moved out of cities which had become vulnerable. The electric cooperatives were supplying power in the countryside where it was suddenly needed. New defense installations were located around the nation's perimeters with regard for whether rural electrification was in place.

Since then, rural electric cooperatives have continued to spread and increase heir service capacity, helping to make the American farmer the most productive in the world. Crops from U.S. electrified farms (now 98%) help to feed the hungry people of many nations today. When the Rural Electrification Administration in Washington, D.C., made its first loans to electric cooperatives in 1935, only one farm in 10 had electric service. At that time the average farmer was feeding himself and 9 other people. By 1975 he was feeding himself and 56 other people. Of course, improved seed, better breeding stock, fertilizers, and other developments all contributed to this great leap forward, but electrification played a part in this, too, by helping the farm family earn extra income to buy the other ingredients for successful agriculture.

In Other Countries.

Other countries have seen the benefits that arise from bringing electric power to rural areas, and have incorporated rural electrification in their plans for social and economic development. The president of the Philippines, Ferdinand E. Marcos, has called that country's rural electrification "the cutting edge" of the development program. It is recognized as one of the prime factors in the campaign to narrow the gap between the affluent and the very poor people in the rural areas.

Although measuring the direct exclusive contribution of electrification in the campaign to eradicate poverty can be difficult, there is now ample evidence to show that the availability of electric service is an essential element.

World statistics reveal that agriculture is the principal occupation of the rural poor. Any program input which will produce more food for which there is a local need or a commercial market, or which will provide more jobs raises the individual level of living and improves the general economy.

Farming and Fishing.

In a country like Indonesia, where rice is essential to sustain the population, electric power is the cheapest method of pump irrigation for paddies. It can be used in those areas where dry seasons restrict gravity irrigation or where unfavorable topography makes it impossible or too expensive. Studies show electricity for pumping to be from 10 to 60% lower than diesel and gasoline engine power, depending upon the wholesale cost of electricity.

Electric pumping for wet rice irrigation is most frequently cited as a benefit because it makes possible two crops a year instead of one -- and in some instances three instead of one or two. But other crops, too, benefit from electric water pumping. One result which has not been surveyed but which is obvious to the observer who spends time in the villages is the improvement in produce from small vegetable patches when an ample supply of water is pumped to spigots at convenient locations.

Another staple of diet in Indonesia is fish. Fish ponds play an increasingly important role in the commercial supply of fish, and here again electric pumping is an economic gain over alternate power sources where fresh water ponds are used.

Getting fish and other seafood to market calls for electric power to supply cold storage and to produce ice to prevent spoilage. The Survey Team gathered no figures on this, but were assured during their visits that more ice and cold storage plants would be a high priority use of electric power if it could be brought to the rural areas. Data from the Philippines indicates that existing ice plants are shifting from expensive, small diesel generation to the cheaper electric power supplied from the rural electric cooperative's lines. New plants are being built in several locations which are now served for the first time by a cooperative distribution system.

Sampling surveys made in the service areas of two Philippine cooperatives showed central station electric service to be from 10 to 40% lower in cost for rice mills than the inefficient diesel units which were in use.

All of these findings are in line with fragmentary but similar observations in several Latin American nations where pilot rural electric cooperatives have been developed.

Any country which intends to develop poultry and dairy agro-industry must first develop adequate low-cost electric service because there is no alternative power that will do the job of night-lighting, pumping and heating water for sanitation, and cooling to prevent spoilage.

Possibilities for Industry.

Turning now to small and medium size industries, there are dependable statistics available through the World Bank, U.N. Agency for International Development, the United Nation development offices, and other research and financing agencies to document the results which can be expected from extension of adequate electric power at reasonable rates to rural communities.

In one of the Philippine's 52 operating electric cooperatives where recent survey data was collected, 297 new small manufacturing industries, processing plants and commercial establishments were started in the first 4 years of rural electrification. A total of 1,062 new jobs were created. This took place in the service area of Misamis Oriental Rural Electric Service Cooperative. Other similar surveys are being made, so that information on creation of new jobs in the rural areas served by additional cooperatives can be available shortly.

The MORESCO study referred to above was completed in January 1976 by Xavier University, Cagayan de Oro City. It found further that the income threshold for families who could afford electric service was lower than what had been presumed. Studies in other countries report similar findings. In El Salvador, for instance: "Families begin to consume electricity at very low income levels of around US$40 annually (that would be 16,600 rupiah) per capita; this is in the lowest tenth of per capita income in El Salvador (average per capita income was US$320 in 1972). The number of families connected and their average consumption levels rise very rapidly with income level -- a doubling of income more than doubles average consumption."*

---

*International Bank for Reconstruction and Development, "Costs and Benefits of Rural Electrification", P.U. Report No. RES 5, page 74.

Throughout the Philippines, as in other countries, it is found that after the cooperative had built the electric line and was offering a credit plan for housewiring, it did not take marginal-income families long to decide that electric lighting was cheaper than the use of kerosene or candles.

Kerosene Vs. Electric Lighting.

For Indonesia, the average monthly consumption of kerosene for lighting is estimated at about 16 liters per household in rural areas. This would operate a pressurized kerosene lantern such as a Petromax for about 3½ hours per night. The cost at the current subsidized price of kerosene comes to about 640 rupiah for a month. The light from a pressurized kerosene lantern is about equivalent to two 40 watt florescent tubes. In a month this would total 10 kwh of electricity, representing a cost of about 332 rupiah (US$0.80) at the projected retail rate of 33.2 rupiah (US$0.08) per kwh used in this Report. This would indicate that electric lighting would cost about half the present cost of lighting with a kerosene lamp.

There are additional factors to be considered. Electric lighting is safer and less trouble than kerosene. And the cost of housewiring against the cost of a lamp also favors electricity if one considers the comparative life expectancy of the two. The cost of the kerosene subsidy to the Indonesian Government is substantial and that constitutes still another factor in evaluating a rural electrification program.

Another interesting finding in the Xavier University survey already cited was the more hopeful attitude about the future which rural people revealed after electric lights and power brought benefits into their lives.

Other Benefits.

Other benefits should also be cited:

-- There is the added security of night lighting. One woman in Sapang Palay, Bulacan Province of the Philippines, spoke for many when she said: "Now there are lights on the road where the bus stops. I walk to my house feeling safe. No more fear of the dark." Sapang Palay is a resettlement community of 8,000 families removed from Manila's squatter slums. The rural electrification program financed by the National Electrification Administration now serves 65 % of the households there.

-- Three new industries have built plants in Sapang Palay now that electricity is available and they already provide 250 new jobs, with more coming by the end of this year. Jobs in rural communities keep people from migrating to already overcrowded cities.

-- Health and sanitation is greatly improved anywhere by low-cost electric power. It has been used in villages to pump water for the families. Rural medical clinics use the electricity to boil water and sterilize instruments, to refrigerate vaccines and medicines, and to furnish lighting in the evening and at night.

-- Electricity brings to the many very small stores and shops better lighting and a refrigerator so that perishable foods and cold drinks can be sold. Even where ice can be purchased, electric refrigeration is cheaper and more efficient.

-- Village schools -- and here again the Philippine experience is cited -- are more fully used by electric lighting which permits evening classes and community activities in the buildings. In some areas television can be utilized to make up for lack of teachers, especially in technical subjects.

-- There is a safety factor in electric lighting, by reducing the danger of household fires from open-flame lighting.

-- Benefits of rural electrification to women can be measured by tabulating their responses when asked how they use electric light and power in the home. Survey data point first to appreciation of the better, cheaper lighting in finishing up evening household chores and in extending the family income with handicrafts and other cottage industry which can be done at night. The first appliance purchased is usually an electric iron to replace charcoal irons and other cumbersome methods of pressing clothes. More affluent households purchase refrigerators, electric sewing machines, electric fans, radios.

Some of the above benefits can be measured and evaluated by statistical methods. Others are not susceptible to this kind of quantitative appraisal, and these may be of even more importance in the long run.

One of these is the sense of participation that can come from membership in a rural electric cooperative. In every nation there are great masses of people who exist outside the mainstream of that pattern of life which characterizes government and business concerns. For many parts of Indonesia there exists a spirit of community sharing in

work that has to be done, but throughout most of the world the rural poor are observed to feel alienated from what happens bryond their family and immediate neighborhood.

It has been observed that cooperatives bring to their members some realization of ownership in a small way. With a good member relations program and honest operations which are truly consumer-oriented, the cooperative can build among its members a substantial sense of "belonging" and responsibility. It is this sort of attitude that lends dignity to individual human beings who are so often referred to as "the rural poor".

ATTACHMENT 1. ECONOMIC ANNEX - RURAL ELECTRIFICATION

Summary.

This annex seeks to address four questions relevant to rural electrification in Indonesia. These are:

Can the rural Indonesian population afford electricity? How broad a spectrum of the Indonesian income distribution are the consumers of electricity likely to represent? Are the economic benefits of rural electrification sufficient to justify the investment costs? Approximately how much investment financing can be expected to be available for allocation to rural electrification in the future?

In summary, the answers to these questions are as follows: Based on available information on rural Java, it appears highly likely that 90% of the rural population are potential customers for rural electrification. Indeed, perhaps as high as 55% of the rural population could reduce their current cash outlay on lighting by switching to electricity. Data on the income distribution of rural users of electricity in El Salvador and the Philippines, when compared with Indonesia, would indicate that 50% of consumers of electricity are likely to come from the bottom two-thirds of rural Java society. The analysis of the economic costs and benefits of two illustrative rural electrification projects on Java shows internal rates of return of 25% to 30% may be expected. Finally, with regard to financing availabilities, a preliminary assessment would indicate that an annual level of up to $75 million in 1985 and $250 million in the year 1995 (in 1976 prices) may be estimated for the type of rural electrification distribution program that is under review here. Cumulatively, under this maximum projection, 8% of the rural population would be connected to electricity by 1985 and 45% by 1995. Actual investments and connections may be less than this, however, depending on the rate at which a rural electrification program is implemented.

Can Electricity Be Afforded?

The minimum monthly per capita charges (assuming a family size of six) for electricity in the Philippines and El Salvador are Rp. 48 and Rp. 26. The threshold monthly per capita income levels for electricity consumers in the Philippines and El Salvador are about Rp. 700 and Rp. 1,200 respectively. The minimum monthly electricity charges represent 6.9% and 2.2% of the threshold incomes in the Philippines and El Salvador. If one applies the higher of these percentages to Indonesia and assumes a minimum electricity use charge in Indonesia of 15 KWH/month at $.08/KWH ($1.20 monthly per family or $0.20 (Rp. 83) per capita), then the threshold monthly income level for electricity consumption in Indonesia can be estimated at Rp. 1,200. Over 90% of the rural Java population have incomes at or above this.

It is worth commenting on the somewhat surprising fact that although the minimum monthly charge for electricity in El Salvador is lower than in the Philippines, the threshold income level for electricity consumption is higher in El Salvador. Although this may be a reflection of statistical and social-economic differences between the two countries, a probable cause relates to costs of alternative sources of lighting. The lower the income level of the consumer, the greater the probability that his primary use for electricity will be lighting. The El Salvador analysis is based on 1972 data. Petroleum prices at that time were such that kerosene lanterns were a cheaper source of light than electricity. Hence, the relatively lower interest by the poorer strata of the population in using electricity even with a low minimum monthly charge. The result being a higher threshold income for electricity consumption. In contrast, the Philippines' assessment was carried out in 1975, after the price of petroleum products had tripled. At current prices, lighting with electricity is significantly cheaper than lighting with kerosene. Hence the lower income threshold in the Philippines.

One can also seek to assess the ability of the rural Indonesian population to pay for electricity by analyzing what is currently being spent on kerosene (primarily for lighting). Based on the 1969/70 consumption survey, the average rural per capita consumption of kerosene is one half that of urban areas. Given total kerosene consumption of 5.5 billion liters, this indicates that the average per capita consumption of kerosene in rural areas is currently 2.7 liters monthly. For a family of six this is equal to 16.2 liters monthly at a cost of Rp. 648 (equivalent in value to about 3% of average monthly income). This amount of kerosene would operate a pressurized kerosene lantern for about 3½ hours a night throughout the month. Such a lantern provides light roughly equivalent to two 40-watt fluorescent bulbs. During a month, the electrical equivalent of the above kerosene lamps would require about 8.4 KWH of electricity. At a price of $.08/KWH (Rp. 33/KWH) this would cost Rp. 280 per family (Rp. 46 per capita). This is less than half what is currently being spent on kerosene by the average rural Indonesian family. At these prices and rates of utilization, the net savings on lighting expenses would cover the cost of house wiring in about two years. (It is worth commenting that the significant advantage of electrical lighting is a reflection of the sharp increase in the price of petroleum products in the past few years. To produce an equivalent amount of light, one-sixth the amount of fuel is required with electrical generation as with a kerosene lamp.)

If one assumes that (a) the above estimate that on the average 3% of rural income is spent on kerosene applies to all income levels and (b) the minimum allowed <u>household</u> monthly electricity charge is Rp. 500 (15 KWH at $.08/KWH), then at all <u>per capita</u> income levels above Rp. 2,800/month, a switch to electricity would reduce consumer expenditures. About 55 percent of the Java rural population have incomes at or above this level.

In summary, two alternative approaches indicate that (a) the threshold income for electricity consumption in Indonesia would be about Rp. 1,200/

month (90% of the rural Java population having higher incomes) and (b) at monthly per capita incomes above Rp. 2,800 (55% of the rural population having higher incomes), consumers would save money by switching to electricity. It seems highly likely that the bulk of the Indonesian rural population can afford electricity. Naturally, area specific household surveys will be necessary to verify the applicability of this general conclusion to specific project sites.

Income Distribution of Electricity Consumers.

Data are available in the USAID on the per capita income distribution of rural consumers of electricity in El Salvador and the Philippines. The attached graph compares these with the distribution of per capita income in rural Java.

Several comments regarding the data are necessary before trying to milk it for whatever relevant information it contains. First, making these comparisons requires converting income data in pesos and colons to dollars and then to rupiahs. Any or all of the three foreign exchange rates involved may be inappropriate for making inter-country income comparisons. Second, the income distribution information was probably obtained differently and with different inaccuracies in each country. Third, the data for El Salvador are for 1972 and should be adjusted for the real economic growth, inflation, and changes in income distribution that have occurred in the last three years. In addition, in 1972 the price of kerosene favored its use over electricity for lighting, strictly on a cost basis. This price relationship has now been reversed and presumably will lead to an increasing portion of the lower income population using electricity in El Salvador. Fourth, the Indonesian data are based on a 1969-70 survey of consumption distribution. Although adjustments have been made for inflation and real economic growth, no correction has been made for changes in the pattern of consumption distribution or the difference between income and consumption. Lack of available information has made it impossible to make any of these adjustments. However, since the data have been primarily used for comparisons within individual countries (e.g., rural electricity consumers in the Philippines in relation to the rural Philippine population as a whole), these data shortcomings have been minimized.

In any event, crude as they must be, certain comparisons may be made using the attached data. In particular, it is useful to relate median income levels for electricity consumers and median and average income levels for the rural population as a whole. It must be borne in mind that the applicability of the general conclusions reached below will have to be verified through project specific feasibility studies.

The median monthly per capita incomes for the rural populations as a whole in Java, the Philippines, and El Salvador are Rp. 2,900, Rp. 2,400, and Rp. 3,200 respectively. In the Philippines and El Salvador the median incomes of consumers of electricity are 1.5 and 1.8 times greater than the median incomes of the rural population as a whole.

As discussed above, as a result of the increase in kerosene prices, it is to be expected that a greater portion of the poorer strata of the El Salvador rural population will become consumers of electricity. This should result in the ratio of median incomes of electricity consumers to the overall rural population in El Salvador declining to a figure closer to that of the Philippines. Applying the Philippine ratio of 1.5 to Java, results in the estimate that the median income of consumers of electricity in rural Java will be 1.5 x Rp. 2,900 or Rp. 4,350 monthly. Based on the estimated income distribution in rural Java, this indicates that 50% of the consumers of electricity will come from the bottom 75% of society.

An alternative approach is to relate the median income of electricity consumers directly to the corresponding percentile on the overall income distribution. The median income for electricity consumers corresponds to the 67th percentile of the overall Philippine income distribution and the 72th percentile in El Salvador. Since the overall income distribution is more unequal in El Salvador than in the Philippines and more unequal in the Philippines than in Java, one would expect that the median income of electricity consumers on Java would correspond to a lower percentile than in either the Philippines (67%) or El Salvador (72%). However, using the Philippines figure as a conservative estimate yields a median per capita income for consumers of electricity in rural Java of Rp. 3,700 monthly.

For perspective it is worth noting that an estimated 67% of the rural Java population have levels of income less than the estimated Rp. 3,700 required monthly to provide a minimally adequate level of nutrition. Based on the above it seems highly likely that the bulk of the consumers of electricity will belong to the rural poor.

Economic Benefits and Costs of Rural Electrification.

The economic costs of rural electrification are the investment in house wiring, distribution, and bulk power purchases (which include an appropriate capital charge for marginal generator and transmission investment), and operations and maintenance of the rural electrical system. The cost of housewiring is estimated at $24 per home.

Distribution investment per customer served is a function of basic per kilometer construction cost (here conservatively estimated at 50% greater than in the Philippines), population density (four times higher in Java than in the relevant areas of the Philippines), and the percent of the adjacent population that it is estimated will initially connect (50% in the Philippines and estimated at a conservative 30% to 40% in rural Java). The net result of the above comparative figures is a distribution cost per connection in Indonesia that is 50% of that in the Philippines. After the initial basic system investments are made, the marginal investment required for additional connections falls sharply. For the two illustrative systems analyzed here, the investment per connection falls from $240 to $370 in the first year to $80 to $90 in the tenth year. Over a several year period distribution investment will average about $180/connection.

Total initial distribution investments for the two illustrative systems are $4.1 million and $3.5 million.

Bulk power purchases are projected to cost $0.04/KWH based on the current recommended tariffs for PLN. This includes an appropriate allowance for depreciation of generation and transmission investment. Therefore, no additional charge needs to be added for additional PLN investments that may be required in the future. For the economic assessment, an additional $0.015/KWH was added to adjust for the current fuel subsidy PLN is receiving (price of petroleum fuel is about 50% of true economic cost).

For the purpose of this analysis, the economic benefits of rural electrification have been considered to consist of two components. One component is the value of KWH sold at a price of $0.08/KWH (for Trenggalik kabupaten) or $0.073/KWH (for Tangerang kabupaten). These are considered appropriate, indeed probably conservative, measures of the economic value of electric power given the fact that many of the rural electric systems in the Philippines charge more than this and that PLN currently charges more than $.06/KWH in many areas of Indonesia and is unable to meet the demand at that price.

The second component of benefits is the economic savings of using electricity for lighting rather than kerosene. A pressurized kerosene lantern requires one liter of kerosene for six hours of operation. The cost of this kerosene is:

Indonesian wholesale price	Rp.	18/liter
Indirect subsidy		30/liter
True economic wholesale price		48/liter
Distribution and marketing		22/liter
Economic retail cost		70/liter

A kerosene lantern of this type provides illumination approximate to that of two 40-watt fluorescent lights. Their daily operation requires 0.48KWH $\left(\frac{2x40x6}{1000}\right)$.

That is to say, one liter of kerosene in a lantern provides an amount of light equivalent to 0.48 KWH. Alternatively, one KWH (at an economic cost of $0.095, of which about $0.03 is fuel cost) provides an amount of light equivalent to that provided by 2.08 liters of kerosene in a lantern (at an economic operating cost of Rp. 145 ($0.35) all of which is for fuel). The economic savings per KWH used for lighting are $0.255 ($.35-$.095). For the analysis carried out here, it has been assumed that 50% of electricity consumption will be residential and that in the first year 80% of residential electricity utilization will be for lighting and that this will decline to 50% by the tenth year.

Based on the above assumptions and estimates relative to costs and benefits and the detailed projections made by the consultants for load growth, investment costs, and operation and maintenance, the economic internal

rate of return for the illustrative Tangerang and Trenggalik projects are 30% and 25% respectively. To check the sensitivity with regard to the projections made for load growth, the latter were reduced by 33%. This reduced the internal rates of return to 23% and 20% -- still a very satisfactory rate of return.

Future Investments in the Electric Sector.

Guessing what might be a rough order of magnitude of available future financing for rural electrification requires estimating (1) future growth in GDP, (2) total government investment as a per cent of GDP, (3) the portion of government investment allocated to the electric power sector, and (4) the portion of electric power investment allocated to rural electrification. All of these are highly speculative and any results must be considered indicative only.

The assumptions made are:

1) GDP in 1976 will equal $38 billion and grow thereafter at 7.5% annually (in constant prices).

2) As a high alternative, investment in electric power is projected to remain at the same percent of GDP that it is now.

3) Reflecting recent government statements, government investment will fall from 9.2% of GDP in 1976 to 7% in 1978 and remain at that percentage.

4) As a medium alternative, electric sector investment is projected to remain at its 1976 level of 11.7% of government investment.

5) As a low alternative, electric sector investment is projected to decline from 11.7% of government investment in 1976 to 8% by 1980. (The latter percentage represents the planned Repelita II allocation to the electric sector.)

The results of these assumptions are the following:

Government Investment in Electric Sector

Year	High Alternative	Medium Alternative	Low Alternative
1976	$ 410 million	$ 410 million	$ 410 million
1980	550	415	285
1985	785	600	410
1990	1,130	860	590
1995	1,620	1,230	840

For the purpose of discussion, it is assumed that the high alternative represents a probable upper limit of future GOI investment in the electric

sector and that investment directed toward rural electrification plus the associated generation and transmission investment required will ultimately rise to no more than one third of total electric sector investment. For the purposes of assessing the high alternative, it is estimated that in 1985 20% of total electric sector investment will be directed toward rural electrification (including associated generation and transmission as well as rural distribution) and that this will increase to 33% by 1995. This would yield total funds available for rural electrification in 1985 of 0.2x785= $158 million and 0.33x1,620=$540 million in 1995.

Rough estimates of average investment required per rural electric customer are (in 1976 prices):

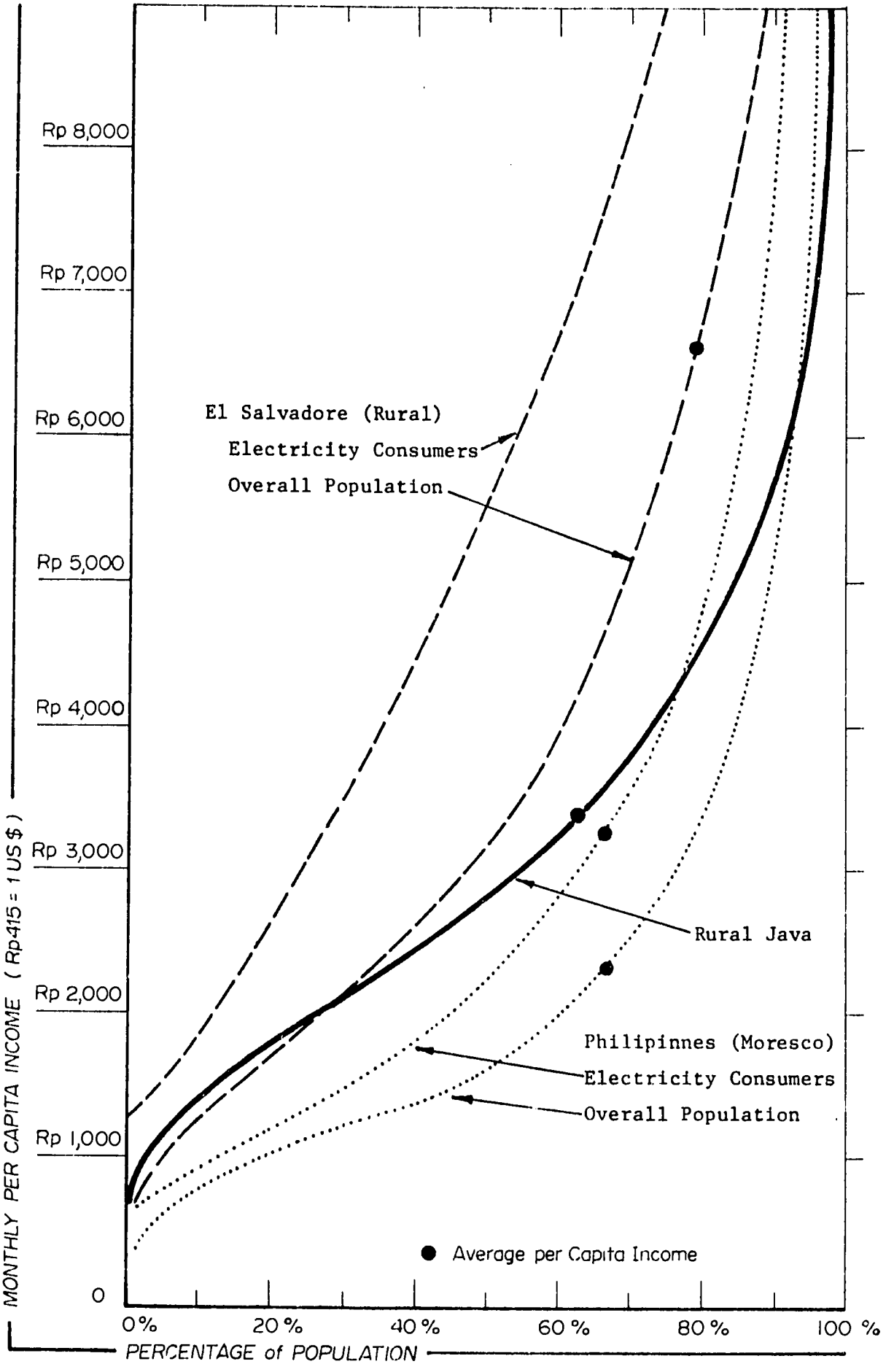
Rural distribution	$180/connection
Generation cost of 0.38 KW at $450/KW	166
Primary transmission costs	34
Total	$380/connection

This in combination with the preceding paragraph yields estimates for the number of new rural customers added in 1985 and 1995 of 400,000 and 1.4 million respectively. Under this set of assumptions, 8% of the rural population would have electricity by 1985 and 45% by 1995. With regard to the investment in rural distribution (the type of investments this loan proposal is addressed to), at $180/connection these figures indicate annual rural distribution financing potential availabilities in 1985 of $75 million and $250 million in 1995.

Although based on very speculative projections the above estimates probably are close to the upper limit of possibility. Alternatively, utilization of the low projection of total electric sector investment would reduce rural distribution investment financing availability. Similarly, utilization of a more conservative estimate of the fraction of total electric sector investment that will be allocated to rural electrification would also reduce the pace of projected rural electrification.

Prepared by James A. Norris, May 1976

Per Capita Income Distribution



ATTACHMENT 2. ALTERNATIVE POWER SOURCES

In considering power sources for rural electric service in Indonesia or in any other country, the choices are limited by available resources and the existing pattern of generation and transmission. Power supply for Indonesia was discussed in Chapter IV of this Report. In consideration of the very large demands which would be required to sustain a full program of electric distribution systems for the rural areas, it may be useful to examine costs of the possible alternatives.

There would seem to be three alternatives for the future:

(1) Purchase power needs from an existing transmission network or plant.

(2) Construct and operate fossil fuel generating plants.

(a) Steam

(b) Gas turbine

(c) Diesel

(3) Construct and operate hydro generating plants.

(a) Conventional plants

(b) Minihydro installations

Purchased Power

PLN presently operates the only central station power network in Indonesia. There is a large amount of "captive" or private generation operating, which, as central service becomes available, is being shut down or placed in "cold" reserve. As described elsewhere, PLN is expanding its network and generating facilities and expects to nearly double its installed generating capacity by the end of 1979. Generation will be added incrementally through that time and long-range plans for additions exist, based on load projections developed in part by statistics on population growth and part by consideration of unserved areas. With the development of PLN's system under construction, it would appear that by the time rural distribution systems could be constructed, firm power from PLN's grid would be available to meet the needs of rural distribution systems. This is particularly apparent in Java, North and West Sumatra. PLN, as stated elsewhere in this Report, has determined that it has a responsibility to provide such power.

Generating Plants (Fossil Fuel)

In considering the size of generating capacity needed in the formative and early operating stage (10-15 years) of a rural system to meet consumer demands, steam and gas turbine type generating units are entirely too large (20 MW and larger) for consideration to supply a simple

system. Diesel electric units in the 2000 KW range would be satisfactory for use to supply individual rural systems. To ensure reliability, a minimum of two units should be installed initially with more units added as demand increases. Investment in a diesel plant is estimated in 1978-1979 dollars to be US $450 (Rupiah 186,750) per nameplate KW.

For an initial installation of two standard commercial units rated at 2100 KW each, the estimated installed cost ready to operate would be US $1,890,000 (Rupiah 784.4 million). Cost per kwh delivered may be calculated as follows:

ASSUMPTIONS

(1) Minimum unit size: 2625 KVA

2100 KW @ 80% P.F.

(2) Investment per KW: US $450 (Rupiah 186,750)

(3) Heat rate--typical engine (new):

Load %	KW @ 80% P.F.	BTU/kwh
100	2100	9760

(4) Heat content--diesel fuel: 19,200 BTU/pound

(5) Cost of fuel:

	Consumer price	Real price
Cost/litre	Rp 22 (US $0.053)	Rp 44 (US $0.106)
Cost/pound	Rp 11 (US $0.0265)	Rp 22 (US $0.053)

Specify gravity of fuel is about 0.904.

(6) Operation and maintenance costs (without fuel): 3.5% of investment

(7) Depreciation (20 year life): 5% of investment

(8) Cost of money:

Opportunity (commercial banks) 15% of investment

PLN (World Bank) 8.5% of investment

Concessionary (USAID) 2% of investment

(9) System annual plant factor: 20%

COST OF DIESEL PLANT GENERATION

Cost of money (in %)	2	8.5	15
Depreciation as % of investment	5	5	5
Operation and maintenance (less fuel) % of investment	3.5	3.5	3.5
(1) Total annual fixed charge rates	10.5%	17.0%	23.5%

(2) Fuel cost:

	Consumer price	Real price
Cost/million BTU $\left(\frac{\text{price} \times 10^6}{19{,}200}\right)$	Rp 572.92 (US $1.38)	Rp 1,145.83 (US $2.76)
Fuel cost/kwh $\left(\frac{\text{cost/million BTU} \times \text{heat rate}}{10^6}\right)$	Rp 5.59 (US $0.0135)	Rp 11.18 (US $0.027)

(3) Generating cost/kwh at 20% plant factor:

Cost of money	2%	8.5%	15%
Fixed charges/kwh	US $0.027	US $0.044	US $0.06
	Rp 11.21	Rp 18.26	Rp 24.9

$$\left(\frac{\text{Investment} \times \text{annual fixed charge rate}}{8760 \times .2}\right)$$

(4) Generating cost + fuel cost = cost/kwh

(5) Cost of power (diesel generation) per kwh:

Cost of money	Fuel cost/litre	
	Rp 22 (US $0.053)	Rp 44 (US $0.106)
2%	US $0.0405 Rp 16.80	US $0.0539 Rp 22.39
8½%	US $0.0575 Rp 23.85	US $0.0709 Rp 29.44
15%	US $0.0735 Rp 30.49	US $0.0869 Rp 36.08

Hydro Power Plants

The construction of conventional hydro sites is time-consuming and costly, with a construction period of four to seven years and an investment of US $800-$1,200 per KW delivered. These factors would make development of such power sources unsuitable for rural systems in their initial stages, particularly if the investment is assumed to be made under the rural electrification program suggested in this Report.

Minihydro plants are small (50KW-200KW) and can be installed within a short time span, since the civil construction work is relatively simple and units usually are available in stock sizes. The investment per KW, however, is usually much higher than conventional plants. A recent installation in Sumatra was reported in the press as being rated 80 KW and costing Rp 61,758,000 (US $148,800) or Rp 772,000 (US $1,860) per installed KW. Using these values, we can estimate the cost/kwh:

Investment/KW	US $1,860 (Rp 772,000)
Operation and maintenance costs	1% of investment
Depreciation	3% of investment
Cost of money	2% or 8.5% or 15%
Annual fixed charge rates	6% or 12.5% or 19%
Plant factor	20%

$$\text{Cost/kwh} = \frac{\text{Investment x annual fixed charge rate}}{\text{8760 x plant factor}}$$

Cost of money	2%	8.5%	15%
Cost/kwh	US $ 0.064	0.133	0.201
	Rp. 26.56	55.2	83.42

Conclusions

It may be seen from the above analysis that purchasing bulk power at network transmission voltages, where available, is the preferred source for rural electric systems. Some of the reasons are:

1. Since load factors on rural systems are low, a better use of installed capacity is obtained by operating such systems from a large network rather than from isolated plants. By using power from the grid, maximum economy of fuel will also be achieved.

2. The normal growth of a rural system requiring more energy will be easier to supply from a grid due to the diversity of a large system over isolated generation.

3. By using available investment funds in this program for constructing lines rather than generating plants, more population can enjoy electric service.

4. Maintenance of generating plants requires skilled mechanics. To employ such skills for two or three machines may be considered a waste of manpower.

5. It is apparent that there is no appreciable saving in self-generation over purchased power. In fact purchased power should in the long pull be more reliable and should effect rupiah savings.

6. Assuming the use of concessional rate loan money for self-generation financing, however, generation costs of isolated diesel plants would be competitive or possibly lower than PLN central station sources. Of course, this consideration could be applied to other forms of generation as well. The conclusion to be drawn is that, under certain circumstances, isolated rural electrification systems could be developed with no financial penalty compared to those using energy from the grid.

ATTACHMENT 3. BASIC SYSTEM CRITERIA

ELECTRICAL DESIGN CONSIDERATIONS

1. Frequency.

Any new rural distribution system in Indonesia should be 50 hertz, to conform with existing usage.

2. Distribution Voltages (Nominal).

a. By Decrees No.08/K/70 and 09/K/70 of the Director General of Power and Electricity, Ministry of Public Works and Power, voltage standards for distribution systems in Indonesia have been established. The primary voltage of 20 KV (nominal) with a maximum of 24 KV is the most attractive voltage to be used for rural projects. This voltage is now being used extensively in Indonesia and does not require introduction of another class or size of equipment and materials. Further, the reduction in voltage drop and losses for the same loading, wire size, and line length more than offsets the slight additional costs of using this higher voltage over a 7.2/12.47 KV primary system. Voltage drop and losses at 11.55/20 KV are 0.3888 compared to 1.0 at 7.2/12.47 KV primary. Increase in capacity or line length using the same voltage drop and wire size are 2.572 at 11.55/20 KV compared to 1.0 at 7.2/12.47 KV primary.

The system may be safely operated near the maximum primary voltage (13.8/23.9 KV) since manufactured equipment and designed insulation levels are 125 KV BIL minimum. This higher level of voltage will increase system capability and capacity at no increase in cost.

b. Secondary voltages in all areas of Indonesia are being changed from 127/220 V, four-wire, three-phase to 220/380 V (nominal) four-wire, three-phase. Motors, appliances, equipment, lighting fixtures, and lamp bulbs are being marketed for the 220/380 V service making the use of this standard voltage attractive if not mandatory. Further, use of this voltage will reduce consumers' wiring costs. Single-phase systems should be two-wire 220 V, and three-wire 220/440 V. Three-phase systems should be four-wire 220/380 V.

3. Service Voltages (Nominal) with Use and Maximum Loadings.

a. 220 V, two-wire, single-phase should be used for miscellaneous residential and commercial loads, 10 KVA and below. Maximum individual motor size is 10 HP.

b. 220/440 V, three-wire, single-phase should be used for miscellaneous residential and commercial loads, 50 KVA and below. Maximum individual motor size is 10 HP.

c. 220/380 V, four-wire, three-phase should be used for miscellaneous commercial and industrial loads, 25 KVA and above, provided individual motors 15 HP minimum or other three-phase equipment, 25 KVA or more, are installed. Maximum load at this voltage is 500 KVA.

d. Industrial or commercial loads of 500 KVA or more should be given special consideration on a case by case basis. They may be served at primary voltage (11.55/20 KV, four-wire, three-phase) or 220/380 V, four-wire, three-phase, dependent on rate structure and availability of large transformers.

4. Insulation Level, Creepage Distance, Etc.

a. Insulation for the primary system must withstand normal operating voltages and switching surge voltages without flashover or failure. Sufficient impulse insulation strength (BIL) must also be provided so that the system can be protected by suitable lightning arresters. Further, insulators and bushings, in air, must have adequate creepage distance so that there will be practically no 50 hertz leakage current. At altitudes over 1,000 meters or in contaminated areas extra creepage should be provided.

b. Since standard equipment has been developed for this voltage class (14,400 V, line-to-ground) and has been in service and proven world-wide for many years, the system should be designed to meet these insulation parameters, using standards for material and equipment specified by the American National Standards Institute, New York City, U.S.A., and in REA Bulletin 43-5, Rural Electrification Administration, Washington, D.C., U.S.A.

(1) Basic insulation level (BIL) - distribution class, 125 KV.

(2) Switching surge voltage - three times normal line-to-ground voltage.

(3) Minimum creepage distance (approximately 1 inch/1000 volt - 13 inches.

(4) Extra insulation to be provided at line angles and deadends to preclude flashover due to increased values of surge voltage caused by reflection.

(5) No increase in standard creepage distance for systems constructed below 1,000 meters in areas relatively free from contamination. Should it be determined that sections of the system require increased creepage distance they should be considered for each individual case.

(6) Equipment used will be according to the standards noted and meeting these insulation and creepage values:

(a) Line insulation, pin insulators - use ANSI Class 56-1, insulators.

Leakage distance	13 inches (33 cm.)
Wet flashover	60 KV
Dry flashover	95 KV
Critical impulse flashover	150 KV

(b) Line insulation, angles and deadends, suspension insulators - use two insulator units per deadend, ANSI Class 52-4.

Wet flashover	90 KV
Dry flashover	155 KV
Critical impulse flashover	255 KV

(c) Equipment bushing insulation, distribution class - ANSI-C57.12 series.

Bushing creepage distance	17.75 inches (45 cm.)
Withstand voltages	
10 seconds wet	36 KV
1 minute dry	42 KV
Impulse withstand voltage (BIL)	125 KV

(d) Transformer winding insulation distribution class - ANSI-C57.12 series.

Impulse withstand voltage (BIL), full wave	125 KV
Impulse, chopped wave	143 KV
Minimum flashover time 2.25 micro-seconds	
Low frequency dielectric	40 KV

(e) Secondary and service system will be designed using material and equipment for less than 300 V phase-to-ground, according to ANSI standards:

i. Insulators (spools) for secondary conductors will be ANSI class 53-2 and 5304 with these electrical values:

Low-frequency dry flashover		25 KV
Low-frequency wet flashover,	vertical	12 KV
	horizontal	15 KV

ii. Insulators (spools) for service conductors will be ANSI class 53-1 with these electrical values:

Low-frequency dry flashover		20 KV
Low-frequency wet flashover,	vertical	8 KV
	horizontal	10 KV

iii. Covering on phase conductors of multiplex service cables should be cross-linked polyethylene (XLP), with minimum thickness of covering:

#2 AWG and smaller	0.45 inches (1.15 mm)
#1/0 AWG through #4/0 AWG	0.60 inches (1.52 mm)

Covering shall be capable of withstanding continuously, from conductor to ground, applied voltage of 1000 V at 50 hertz for 5 minutes.

5. Voltage Levels, Spreads, and Drops.

a. ANSI C84.1 presents standards for maintaining adequate voltage levels at service and utilization points. These points are defined as:

(1) "Service point" - the point at which systems of supplier and user are connected (kwh meter).

(2) "Utilization point" - the line terminal of the equipment using energy (lamp socket, convenience outlet, motor terminals, etc).

b. Lighting and appliances can operate on a fairly broad spread of voltage above and below their rated voltages. Of course, when the spread is held closer to the rated or nominal voltage, better operation will be achieved. Accordingly the following voltage ranges have been selected as acceptable system voltage levels and spreads.

VOLTAGE RANGES (220 V base)

	Minimum	Maximum
Utilization point	198	231
Service point	203	231

c. Using the above acceptable service point range (203-231 V), the corresponding permissible voltage spreads at various points on the distribution system may be determined by using voltage drops indicated below for each segment of the system. The total drop permitted at point of service under maximum load conditions should be the maximum voltage delivered to the customer nearest the bulk power supply point (substation) and the minimum voltage delivered to the customer fartherest from the substation. Regulating equipment used on the system will have a voltage regulating relay with a bandwidth setting that can control feeder voltage to plus or minus 1.0 V (220 V base). Therefore, maximum voltage drop which may be allocated to the various parts of the distribution system will be (231-203) - (2 x 1.0) = 26.0 V. The following drops may allow some variations in regulator settings.

VOLTAGE DROPS - MAXIMUM LOAD CONDITIONS

System Component	Maximum Voltage Drop (220 V base)	Percent Voltage Drop (approximate)
Substation regulated bus (output) to primary terminals of last distribution transformer	14.0	6.37
Distribution transformer	3.0	1.36
Secondary and service	6.5	2.95
Total at consumer's meter	23.5	10.68
Consumer's interior wiring	5.0	2.27
Total at utilization point	28.5	12.95

VOLTAGE LEVELS AND SPREADS - 220 V BASE

Location	Voltage Levels (volts) Minimum	Voltage Levels (volts) Maximum	Voltage Spread (volts)
Substation transformer (unregulated)	208	242	34
Substation bus (regulated)	226.5	231	4.5
Distribution transformer primary terminals (last transformer)	214.5	231	16.5
Service point (consumer's meter)	203	231	28
Point of utilization	198	231	33

d. The above normal voltage levels, especially those at point of service and point of utilization, are the basis for system design; and the system should be operated within these limits so that the consumer's equipment will give satisfactory service. These levels are based on the following:

(1) Substation outgoing voltage is regulated with a voltage bandwidth setting not exceeding 1 V on a 220 V base.

(2) Values used in above tables are center values of the regulator band width.

(3) Only sustained voltages apply to table values. Variations of short duration (switching, motor starting, etc.) are not considered.

(4) Input voltages to bulk power supply point (substation) are kept within prescribed limits so that regulating equipment can operate within its prescribed limits, ± 10% of normal operating voltage.

6. Feeder Loading.

In determining feeder loadings, initial construction cost and quality of service desired are the most important factors to be considered. These considerations generally tend to oppose each other, in that lower construction costs will dictate heavily loaded feeders, while improved service requires more feeders lightly loaded. A compromise which allows initial costs, losses, and voltage regulation to determine the loading has proven to be an adequate solution.

In rural areas where initial load density on the order of 5 to 8 KVA per square kilometer with an annual load growth of 1-3%, it appears that feeder loading will be determined by voltage drop and desired reliability. Reliability will be determined by feeder length and number of sectionalizing points. Feeders, of course, should be voltage limited and with allowable voltage drops described above in Section 6. A 2/0 AWG-ACSR three-phase, four-wire feeder operating at 90% power factor and 11.55/20 KV with uniformly distributed load will have a capacity of 40860 KW-kilometer.

With a feeder rating of 4.0 MW the feeder would have a length of approximately 23 kilometers from source to last transformer. Assuming a rectangular feeder area with a main feeder 17 kilometers in length with laterals on each side of the main, 6 kilometers in length would make a feeder area of some 204 square kilometers. The load would be approximately 21.8 KVA/square kilometer which would be satisfactory for 10 years based on 13% annual growth of an initial load of about 6.4 per square kilometer.

The above loads are total loads per square kilometer and a coincidence factor should be applied in calculating definitive conductor sizes to feed an area.

Actual physical layout of a system, with bulk power points located outside the service area, could change basic feeder areas which in turn could change optimum wire size and feeder loading. However, for purpose of this study a feeder area of 200 square kilometers is used. To provide for emergencies or short-time overload conditions, feeders or lines may be operated up to 90% of the thermal capability of the conductor, without loss of service life of the conductor.

7. Transformers and Secondary Systems.

The initial load density in KVA/square kilometers enumerated above may be also stated as being about 7 KVA/line kilometer, this initial load density may be used for design of the secondary system provided a growth factor and coincidence factor is applied. The optimum transformer spacing could then be determined by the maximum length of a given secondary conductor operating with the maximum permissible voltage drop (6.5 V). With an initial load density of 7 KVA/line kilometer and a coincidence factor of 0.90 and with an annual growth rate of 13%, the load density in 10 years would be $7 \times 0.9 \times (1 + 0.13)^{10} = 21.38$ KVA/line kilometer. A 15 KVA transformer may be adopted as a base size unit.

It may be assumed that a balanced uniform load on a three-wire secondary will be fed two ways from each transformer and that a peak rating of 150% of the individual transformer rating can be safely used for design. With this assumption and using a 25 KVA transformer (22.5 KW at 90% power factor), optimum transformer spacings with various size conductors may be:

UNIFORM DISTRIBUTED LOAD

Wire Size	Voltage Drop Volts (220V base)	KW-Meters 90% P.F. 3-wire, Single-phase	Load KW (½ the 150% rating of 75 KVA transformer)	Optimum Length of Secondary (meters)	Optimum Transformer Spacing (meters)
# 4 ACSR	6.5	3682	16.875	220	440
# 2 ACSR	6.5	5586	16.875	330	660
#1/0 ACSR	6.5	8252	16.87	490	980

To maintain a reasonable balance between number of transformers and secondary conductor size and to allow use of one size larger transformer (25 KVA) over base size (15 KVA), three-wire secondary system of #2 ACSR phase wires with neutral sized according to primary system requirements should be used. Maximum length of secondary system (transformer to last consumer) should not exceed 350 meters (approximately three spans). Transformers should be located using the moment arm method to find a load center.

Along primary lines, effort should be made to place transformers on the optimum spacing of approximately 700 meters (6 spans). In this way transformers may be changed out as the load develops to a maximum of 25 KVA units without relocating or respacing. When load increases beyond the 25 KVA capability another transformer may be installed between existing units cutting the secondary conductors on intermediate poles. This will give additional capacity with minimum expense.

Transformer selection should be according to:

(a) Thermal capability (maximum load without damage to insulation),
(b) Voltage drop (adequate voltage under maximum load), and
(c) Economics (annual costs).

Single-phase transformer installations meeting this criteria should be sized according to this table:

Rating 65°C (KVA)	Maximum Peak Load* Permitted (KVA)	Minimum Economic Loading (KVA) 30% Load Factor Annual Average Load	Minimum Economic Loading KVA (peak)
10	15.8	-	-
15	23.7	4.9	16.3
25	39.5	5.4	18.0
37.5	59.25	10.3	34.3
50	79	11.8	39.3

* According to ASNI C57.92, with an ambient temperature of 40°C a peak of 1.58 rating is permitted for one hour following 50% equivalent load in percent of rated KVA every 24 hours with no loss of transformer life expectancy.

8. Services.

Services for residential and small commercial customers should be multiplex, self-supporting, service drop cable. Cable should have a bare ACSR neutral messenger, with stranded all-aluminum cross linked polyethylene insulated (600 V) phase conductors. Duplex cable should be sized 6 AWG and 4 AWG. Triplex and quadruplex cable should be sized 6, 4, 2, or 1/0 AWG.

Choice of number of service wires should follow maximum loadings given in Section 3 above, "Service Voltages (Nominal) with Use and Maximum Loadings".

9. Voltage Regulation.

Bulk power source (substation bus) should be regulated by tap changing under load equipment, integrally a part of the step-down transformers. It is anticipated in the initial stage design of the rural system that no line type regulating equipment will be needed since line lengths and loads tend to keep the system within acceptable voltage limits.

When system loads and line lengths grow to the extent that acceptable voltage limits are exceeded, then line regulators generally applied with shunt capacitor banks should be installed. Single-phase, outdoor, step-type, platform mounted units should be used, banked for three-phase operation, with by-pass switches.

10. Capacitor Banks.

Line-type shunt capacitor banks, switched and unswitched, may be used to improve power factor thereby reducing losses. The initial system should be designed for growth, and while capacitors will improve voltage and increase line capacity, in the early years use of capacitor banks solely for this purpose appears to be unnecessary and the installation expense does not appear justified.

As load grows in future years, capacitor installation for voltage improvement and capacity release should be considered and compared with costs of additional feeder construction, or additional substation capacity.

Total capacity of fixed capacitor banks on a feeder or substation bus should not be more than required to correct power factor to a value approaching unity, at light load conditions.

Total capacity of switched capacitor banks on a feeder or substation bus should not be more than the additional quantity of capacitors required to correct power factor at peak load to a value approaching unity.

Capacitor banks should be group protected by expulsion fuse cut-outs, and lightning arresters, one per phase with co-ordinated fuse links. Fuses should have a continuous rating of not less than 1.35 times rated bank current, with a total clearing characteristic not exceeding zone 1 standard capacitor case rupture curves as shown in NEMA Std. CP-1. Fault currents at point of capacitor installation should be ascertained and fuse clearing times carefully checked with case rupture curves.

The application of capacity banks to the system should be made in conjunction with voltage regulating equipment, if such equipment is required.

11. Lightning Protection (Arresters).

Selection of arrester voltage ratings should be based on line-to-ground (not line-to-neutral) voltages existing on the system under fault conditions.

The system to be protected is solidly grounded with four-wire, multi-grounded, common neutral lines. The voltage impressed across the unfaulted phases line-to-ground will, therefore, be only a percentage of the line-to-line voltages, under fault conditions.

Based on IEEE Transactions Paper 71TP-452, which details experience and practice for selecting arrestor ratings, an 18 KV arrester should be used on four-wire, multigrounded, common neutral distribution lines, maximum voltage 13.8/23.9 KV.

Use of 18 KV arresters commercially produced according to ANSI C62.1 will provide acceptable protection for 125 KV BIL distribution equipment.

In locating arresters on the distribution system, all line leads and ground leads connecting the arrester to the system and the protected equipment must be as short as possible to reduce the impedance paths of surge current during lightning discharge. Voltage across leads could completely nullify the protective characteristics of the arrester; therefore, precautions should be taken to keep leads short.

Location	Remarks
Overhead transformers	Connect to each source high voltage phase wire. Ground lead solidly interconnected to common neutral, transformer tank and transformer secondary neutral.
Capacitor banks unswitched	Connect to each source high voltage phase wire of banks with 500 KVAR rating or less. Banks of higher capacity do not need protection since a surge of magnitude to charge the bank is unlikely. Ground leads solidly interconnected to common neutral, capacitor cases and bank ground.
Capacitor banks switched	Same as for capacitor banks unswitched, except install on all banks regardless of capacity.
Regulators, line type	Mount on regulators and connect to each high voltage phase, line and load side. Ground lead solidly connected to common neutral and equipment ground.

It is believed that with high speed breakers set for an instantaneous reclosure that arresters placed along the lines for line protection are not required.

12. Fused Cut-outs and Fuses.

Open, drop-out expulsion type fused cut-outs should be used, rated 100 amps, minimum, 26 KV maximum, 125 KV BIL, 7000 amps. symmetrical and 6000 amps. assymetrical interrupting capacity (minimum).

Fused cut-outs should be used for capacitor bank protection, protection of single-phase taps at main feeder tap points, and sectionalizing points.

Fuses should be NEMA ratings type "T" to obtain satisfactory coordinating characteristics.

13. Sectionalizing and Switching.

Coordinated automatic sectionalizing devices should be used on all primary distribution circuits. Automatic reclosing devises should be used where appropriate.

Radial three-phase feeders and major three-phase taps, which cannot be looped, may use three-phase reclosers of appropriate size as required to protect important areas.

Fused cut-outs should be used on single-phase taps for coordinated protection of the system. Cut-outs should be equipped with hooks so that they will be "load break" when used with a portable load break tool. No fused cut-outs should be used in a three-phase circuit. However, cut-outs equipped with solid disconnecting switch blade may be used in lightly loaded three-phase circuits for manual sectionalizing.

A sectionalizing plan for each feeder should be made using acceptable methods to determine short circuits and sectionalizing points.

In applying sectionalizing devices, it should be remembered that the "sectionalizing factor", a factor less than unity, directly affects the service reliability of the feeder. Depending upon circuit length the following general considerations will be helpful. Since each feeder configuration presents different problems, good judgment must be exercised in each case to achieve best results.

a. Four reclosers or other automatic sectionalizing devices in series on a circuit usually are considered adequate, depending upon line length, in order to obtain reliable coordination. Non-automatic devices such as disconnect switches, spaced between automatic devices, will be helpful in system operations to minimize circuit outage during permanent faults.

b. Branch lines connected to the main circuit vary in their importance to service reliability depending upon length and at what point they are connected to the main circuit. They are the most vulnerable to faults affecting service reliability. Therefore, every branch circuit should be sectionalized regardless of length or connected load. The objective of sectionalizing branch circuits is to protect the main trunk circuit against permanent outage.

c. Lateral circuits connected to branch circuits are usually referred to as second, third, or fourth line sections and have a successively lesser possibility of impairing service reliability. They can be correspondingly longer in length or exposure before a sectionalizing device is justified.

d. Any branch or lateral circuit exposed to unusually hazardous conditions should be sectionalized with an automatic device.

e. Where a main trunk line is bifurcated (extending in two different directions), automatic sectionalizing devices, preferably reclosers, should be used to sectionalize each of the circuits at the junction point.

f. All sectionalizing locations should be easily accessible.

g. Sectionalizing devices should be located so as to minimize service interruption to important loads; i.e., if a sectionalizing device is to be located near an important load, it should be placed beyond that load.

h. When any changes are made to the system, such as additions or revisions of line or increase in size of the substations, a supplementary study should be made to keep the sectionalizing program up to date and to see that rating of devices is still adequate. Periodic checks of peak loads on sectionalizing devices should be made, to ensure that overloads do not occur with load growth.

14. Grounding.

All poles should have a ground assembly (driven or butt wrapped) with the common system neutral tied to this assembly.

A minimum of two driven grounds per kilometer will be used to make the system "effectively grounded" according to NESC rules. Driven grounds should be 5/8" x 8'-0" Copperweld type rods and should have a resistance of less than 10 ohms individually, isolated and not connected to the grounding system, after installation. If this resistance is not obtained, additional sections should be driven to a greater depth. Driven grounds should be used at all poles on which transformers, capacitor banks, regulators, reclosers, switches or arresters are installed. Driven grounds are also to be used at all secondary deadends.

In addition to above grounding all down guys without strain insulators are to be connected to the common neutral system. All down guys are to be securely bonded to their anchor rods, using anchor rod banding clamps.

15. Conductors, Type and Kind, Economic Size.

Present pricing determinations indicate that ACSR (Aluminum Cable Steel Reinforced) bare conductors should be used for primary and secondary lines.

Considering kwh losses and estimated construction costs, using annual cost rates and growth factors applicable to rural systems, it is believed that the following sizes may be accepted as standards for use as line conductors on rural systems in Indonesia.

Use	Phase	Size of Conductors AWG	
		Phases	Neutral
Main feeders	3	2/0	2
Laterals	3	2	2
Taps	1	4	4

For service conductors these sizes should be adequate:

Size	Type	KW-Meters
# 6	Duplex	175
# 4	Duplex	275
# 4	Triplex	600
# 2	Triplex	900
# 2	Quadruplex	1,200
# 1/0	Quadruplex	2,000

16. Substation.

Power may be bought from the PLN grid system at transmission voltages (30 or 70 KV).

Substations should be located with due regard to present and expected load centers of the cooperative's service area. The site should be one which will permit expansion to provide space for the ultimate transformer capacity, number of feeders, and possible capacitor bank.

The substations should be custom designed to fit the location and requirements, using latticed, galvanized steel structures and completely outdoor equipment. Circuits and equipment should be simple and uniform consistent with requirements. Applicable portions of REA Bulletin 65-1, "Guide for the Design of Substations", should be followed to obtain an adequate and safe station.

Transformers should be three-phase outdoor, oil filled, with standard 55°/65°C ratings, provided with forced air cooling equipment, high voltage off-load taps, and ± 10% underload tap changing equipment. Transformers should have at least 7.5% impedance. Sizes, OA 55°C rating, should be 5,000 KVA, 7,500 KVA, or 10,000 KVA. Units should be 50 hertz, delta-wye connected. High tension voltage should be dual rated (30 x 70 KV nominal) where initial transmission voltage is 30 KV. This voltage is being discarded in the rebuilding of the PLN with 70 KV substituted. Low tension voltage should be 12.5/21.65 KV nominal.

Power fuses should be used for high tension protection of the transformers, with suitable continuous and interrupting ratings.

Power circuit breakers, single tank, with reclosing, phase and ground relays, should be used for feeder breakers. No transformer secondary circuit breaker should be provided. Feeder breakers should be minimum size with continuous and interrupting ratings according to circuit requirements. Isolating switches with feeder interconnections to allow servicing of feeder breakers should be provided.

Mechanical Design Consideration.

All mechanical design should be in accordance with REA Bulletin 160-2, "Distribution Line Design (Mechanical)". This REA Bulletin is based on the National Electrical Safety Code, Sixth Edition, (NESC) of the U.S.A. However, certain changes described below should be made in loadings to conform with Indonesian weather conditions.

All construction should be in accordance with REA Form 803, "Specifications and Drawings for 14.4/24.9 KV Line Construction".

Both of the above published documents have been tried and tested, updated from experience, and have been the basis of constructing hundreds of thousands of kilometers of low investment, high reliability, economical electric lines.

Indonesian Conditions.

From available weather records of Indonesia a maximum design wind velocity (actual) of 80 kilometers per hour (22.25 meters/second) appears to be satisfactory. This is equivalent to approximately 50 miles per hour. Using acceptable pressure-velocity formula, these wind pressures may be used for an "Indonesian Loading Zone" in the line design standards mentioned above.

Cylindrical surfaces:

$$P = 0.0025V^2 = 0.0025(50)^2 = 6.25 \text{ pounds/sq.ft.}$$

Flat surfaces:

$$P = 0.004V^2 = 0.004(50)^2 = 10 \text{ pounds/sq.ft.}$$

Design temperatures according to Indonesian conditions may be:

Maximum tensions in conductors - 60°F(15°C)
Minimal vertical clearances - 90°F(33°C).

With the modifications above and no ice loading, REA Bulletin 160-2 can be used for mechanical line design in Indonesia. This can be obtained from: Rural Electrification Administration, U.S. Department of Agriculture, Washington 20250, D.C., U.S.A.

ATTACHMENT 4. NRECA INTERNATIONAL ASSISTANCE PROGRAM

The National Rural Electric Cooperative Association (NRECA) is the national service organization of the rural electric systems of the United States. The membership of NRECA consists of nearly 1,000 rural electric cooperatives and public power districts in 46 states. These systems employ approximately 42,000 full-time employees and serve 7 million households and other consumers. The entire program operates on a non-profit basis.

In 1935, less than 11% of the farms of the United States were receiving reliable service from a central generating station. Today, nearly 99% are receiving service. This was accomplished through the Rural Electrification Administration (REA), an agency of the U.S. Government which provided long-term, low-interest, 100% financing to rural electric cooperatives.

The use of member-owned cooperatives to provide service in thinly populated areas has been one of the principal factors in the phenomenal success of rural electrification in the United States. Other important features were: the concept of full areawide coverage; the reduction of construction costs for rural lines through standard design and specifications; the provision of consumer credit for wiring, plumbing, and appliances; intensive education and promotion of consumers' use of power; and the availability of managerial and technical assistance along with Government financing.

NRECA's International Programs Division has found that in most developing nations from two-thirds to three-fourths of the population are dependent upon agriculture for a meager livelihood. Similar portions of the countries' gross national product and export commodities come from the land. Yet in the past, most investment in electric power facilities has been channeled into urban centers, by-passing and neglecting the important rural sector. NRECA believes that dynamic rural electrification can bring advantages of modern technology into the lives of the people most effectively, and therefore is a major key to increasing agricultural productivity, providing jobs, and improving the quality of life in rural areas, overseas as in the U.S.

The basic concept, therefore, has been to promote in the less-developed countries the proven pattern of success of the REA program in the United States, with necessary adaptations to fit the particular needs of the country and its rural people.

NRECA can draw upon the professional staffs of nearly 1,000 member systems, as well as on its own professional consulting staff to provide training and consulting services overseas on a short-term basis or to supervise planning and construction activities for electric system development on a long-term basis.

NRECA is thus the organization or corporate mechanism or conduit by which the many years of experience of these 1,000 rural electric systems can be made available to provide assistance where there is a request for it.

ATTACHMENT 5. THE PHILIPPINE EXPERIENCE

In giving rural electrification a top priority in the Philippines, President Ferdinand E. Marcos called it "the cutting edge of the effort to move towards development of the country because whether the program is agricultural productivity, large scale industry, family planning, or small and medium scale industry, electrification is the principal requirement. We will not be able to succeed in our economic and social development program unless rural electrification succeeds because it is the crucial and critical project."

These words were spoken at Malacanang Palace in August 1973, when Presidential Decree No. 269 was signed. This action gave authority to the National Electrification Administration to carry out full rural electrification in all the provinces of the nation.

Prior to that time, a National Power Survey in 1965 had laid the base for better development of electric power, with generation and transmission grids on Luzon and Mindanao under the National Power Corporation as major goals. Two pilot projects for rural electrification were inaugurated in 1971 -- the Misamis Oriental Rural Electric Service Cooperative (MORESCO) on the northern edge of Mindanao and a similar rural electric cooperative known as VRESCO at the northern end of Negros Island. These two systems now serve about 7,500 and 14,200 households and other consumers respectively. They are making scheduled repayments of the construction loan they received through the Government of the Philippines (GOP) and the U.S. Agency for International Development (USAID).

Meanwhile additional USAID low-interest, long-term loans made possible the start of feasibility studies and organizational starts for other consumer-owned cooperative distribution systems. Financing for these projects comes from additional USAID loans which now total $58 million, with another $20 million currently under consideration, and from GOP funds. The NEA is capitalized at one billion pesos. NEA funnels the necessary funds for engineering, construction, and initial operation of the systems in 40-year loans at 2% and 3% interest, with a 5-year grace period before repayments start.

By the end of 1975, NEA had made loan commitments to 60 cooperatives for a total amount of 948.5 million pesos. Actual releases of fund by January 31, 1976, amounted to

449 million pesos, of which 203 million was the peso equivalent of U.S. dollars which had been put into the program, and 246 million came from in-country sources. It should be pointed out here that substantial additions to the USAID loans comes into the program in the form of United States "excess property" materials which are turned over to the GOP at extremely low prices.

Seventy-five rural electric cooperatives have been organized to date. Of these, 54 have energized all or part of their system and are serving a combined total of 345,000 households and other consumers. The number of percent of connections made to serve small and medium size industries is not known, although surveys now being made indicate electric power is being used to establish new ice plants, furniture making enterprises, machine repair shops, sawmills, and clothing industries. Rice mills are shifting from expensive small diesel power to cooperative central station electricity. A count has been made of 185 electric pumps installed in the last 2 years to irrigate 13,300 hectares of rice paddies and vegetable crop land. There is a program to install electricity in schools for evening classes and the teaching of industrial skills. NEA has trained several thousand barrio electricians for house-wiring, linemen, accountants, and other job seekers for better paying jobs provided directly and indirectly by the new rural electric cooperatives.

All of this fits in with the Philippine Government's Four-Year Development Plan for Fiscal Years 1974-77 which has its objectives stated in part as follows:

"One of the top priority projects of the government is the total electrification of the whole country. In the rural areas, the aim is to provide the power needs essential to increase the productivity in both agriculture and industrial activities. This will be done by enhancing the benefits of irrigation and farm mechanization as well as by promoting the development of small and medium scale industries in the rural sector. Obviously, these programmed activities presuppose the availability of cheap and continuous electric power in these areas. Likewise, providing electricity for lighting and household appliances will also contribute to raising the welfare of the rural population in terms of conveniences and comfort relative to social development, particularly to education and health.

"Consequently, with the view that, ultimately, rural development is contingent on the availability of economical and reliable electric power, the present rural electrification

program becomes basically important to the new agrarian reform program."

Philippine electrification has been hard hit by the sudden skyrocketing of oil prices which set in shortly after the program got into full stride. About half of the nation's rural systems are in isolated areas or on islands beyond the reach of the NPG grid with its supply of hydro generated power. These cooperatives must generate their own power from diesel plants. The high cost of fuel oil makes the retail price of electric power for self-generation double and in some cases triple what is paid by consumers connected to the Luzon and Mindanao (Marie Christina) grid. Retail rates are spread, then, through a range of about 20 to 60 centavos per kwh, or $0.03 to $0.09. Most cooperatives have a minimum rate up to 15 kwh, and this might be in the neighborhood of $1.00 to $1.50.

About a third of the consumers keep their power consumption at or below the minimum. In early stages of energization, about 40% of the households sign up for service. Over half of these, in sampling surveys, prove to be one or two room nipa or woven bamboo houses, occupied by families in the low income sector. Even in communities of squatters who have been moved out of Manila about three-quarters of the households sign up for electric service. Collection of billings at the end of the month typically run from 80 to 95%.

There is widespread realization that in most of the provinces electric lighting costs less than kerosene or candles.

Consumers generally show a highly favorable attitude toward electrification. Evidence is the prompt payment of bills, low incidence in stealing electricity by meter bypass, etc., and large attendance at the annual membership meetings.

Consumer interest is encouraged from the very start of a project. The NEA first selects community leaders representing a wide range of interests and has them meet to learn about the costs and benefits of electrification. The government's offer to consider financing and technical assistance for an electric cooperative is given to this PECT committee with the understanding that further initiative will have to come from the local communities. If enough interest is shown through petitions, local meetings, and resolutions, then NEA and the PECT group schedule a public meeting at which District electrification Committees (DEC) are elected. The DEC then elects from among their members an interim board of directors for the proposed cooperative. This group secures a charter for the cooperative which makes them legally responsible until the cooperative's first annual membership meeting selects a

regular board of directors. The interim board signs a loan contract with NEA, hires a general manager with NEA approval, and proceeds with the necessary engineering, construction, training program, and membership sign-up.

The first 2 to 3 years have presented many problems. These have been found principally in handling of materials, engineering and construction (adherence to specifications), and in management of the cooperative systems. The obstacles have been surmounted one by one, and the picture today is optimistic, especially when compared with the early months.