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Indonesia
Rural Electrification Review

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CURRENCY EQUIVALENTS

Currency Unit = Indonesian Rupiah (Rp)
US$1 = Rp 1,110 1/
Rp million = US$900.90 1/

GOVERNMENT OF INDONESIA AND PLN FISCAL YEAR

April 1 - March 31

ABBREVIATIONS

ADB	-	Asian Development Bank
BAPPENAS	-	National Development Planning Board
BPS	-	Central Bureau of Statistics
BRI	-	Bank Rakyat Indonesia
DIP	-	Project Development Budget
DGE&NE	-	Directorate General of Electricity and New Energies of the MME
DPEC	-	Directorate for the Promotion of Electric Cooperatives of the MOC
GOI	-	Government of Indonesia
KUD	-	Village Cooperative Unit
MHA	-	Ministry of Home Affairs
MME	-	Ministry of Mines and Energy
MOC	-	Ministry of Cooperatives
PLN	-	National Public Electricity Enterprise
PDO	-	Project Development Office of the MOC
REA	-	Rural Electrification Agency
USAID	-	US Agency for International Development
VEO	-	Village Electrification Organization

1/ This exchange rate, which prevailed at the time of the mission, is used in this report. As of September 12, 1986 the official exchange rate was adjusted to 1,644 Rp/US$.

This report is based on the work of a rural electrification mission which visited Indonesia in October 1985. Its members were Andres Liebenthal (mission leader, energy economist), John Chang (financial analyst), Darayes Mehta (power engineer), Mark Gellerson (economist, consultant) and Edward Gaither (institutional specialist, consultant). The mission was assisted by Vatsal Thakor (senior power engineer). The extensive assistance provided by the PLN for the preparation of this report is gratefully acknowledged. A draft of the report was discussed with the Government in September 1986.

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ABSTRACT:

The Government of Indonesia is faced with a situation where its current rural electrification (RE) strategy, which largely consists of financing PLN's extension into every village according to Repelita targets, is no longer affordable under its current resource constained conditions. Given these circumstances, this report explores the options available to the GOI to increase the efficiency of investments and increase the mobilization of non-governmental resources devoted to RE, and develops a plan of action to implement the recommended options. Basically, to increase the efficiency of investments the GOI needs to optimize technical designs to adapt them to rural conditions, improve the affordability of RE among the poorer households to take advantage of economies of scale, ensure that the villages that are selected for RE are those that can benefit the most, and provide a reliable source of finance for RE development. To mobilize nongovernmental resources, the GOI needs to consider the policy incentives that will be necessary to make it financially attractive for private investors and village organizations to invest in RE. To lead and manage the comprehensive set of actions required to take advantage of the available options, the GOI needs to undertake substantial reform of the institutional and policy framework associated with rural electrification.

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RURAL ELECTRIFICATION REVIEW

SUMMARY AND RECOMMENDATIONS

Background and Objectives

1. As expressed in the Government of Indonesia's (GOI) Broad Outlines of State Policy, the objective of power sector development is to improve the welfare of the population in both rural and urban areas and to support and stimulate economic activities. While PLN (the National Public Electricity Enterprise) had been connecting customers in rural villages since the early years of its establishment, "rural electrification" (RE) began to receive special attention and emerge as a specific objective only in the late 1970s, when the GOI became concerned about the uneven distribution of electricity in rural vs. urban areas.[1/]

2. RE was first specified as a separate objective for the implementation of Repelita III, the third (1979/80-1983/84) five-year development plan of the GOI. By the end of Repelita III PLN had 1.2 million connected customers in rural areas, or about 6% of rural households, far below the 35% electrification ratio in urban areas. To reduce this difference, the GOI has committed PLN to connect an additional 1.6 million rural households during the Repelita IV period (i.e., by 1989), which would raise the rural electrification ratio to 13%. By the end of Repelita V (i.e., by 1994) PLN is planning to add 2.4 million rural households and raise the electrification ratio to 21%. As indicated in the Repelita IV plan, this effort would have required about Rp 1,631 billion (in constant 1985 prices),[2/] or about 19% of PLN's total investments (and 2% of total public investment). During Repelita V, the RE program is planned to require about Rp 2,290 billion, or about 23% of PLN's projected investments.[3/] With these expenditures, which represent the limit of what the GOI feels it can devote to RE given its macroeconomic resource

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1/ In this report RE is defined as the supply of electricity to rural areas. Following the GOI's definition, rural areas are all areas not situated within the National Capital or a Provincial Capital, District Capital, Special Area Capital, Municipality or Administrative Town.

2/ Rp 968 billion constitute the RE investment program and Rp 663 billion the associated generation and transmission investments at the grid.

3/ Including Rp 1,360 billion for the RE program as such and Rp 930 billion for generation and transmission.

constraints, the official RE program will have reached only about 21% of rural households and 40% of the villages by the end of Repelita V in 1994.[4/]

3. Since the Repelita IV plan was finalized, the Government's resource position has deteriorated substantially. Budgetted development expenditures during the first two years of Repelita IV are only 75% of planned levels and fell as low as 50% for 1986/87. With the recent weakening and uncertain outlook for oil prices, further expenditure cuts are likely. Implementation of the plan target for RE would absorb nearly 4% of public investment during Repelita IV. Under these conditions, the Government will have little option but to scale back its RE program and actively seek alternative financing mechanisms to supplement budgetary resources.

4. Capital expenditures represent, moreover, only the beginning of a long series of public resource requirements associated with the RE program. The mission estimated that with current pricing policies,[5/] levels of consumption and operating costs, PLN's RE program implies an operating deficit of about RP 7/kwh in grid-connected RE schemes and Rp 44-56/kwh (depending on fuel efficiency) in diesel-based RE schemes (see para. 5.14-15). Thus, PLN's RE program is not financially viable and incurred an estimated cash operating deficit of about RP 19.3 billion from PLN's total internal cash generation of Rp 179 billion in 1984/85. As RE expands in the course of Repelitas IV and V, the operating deficits are expected to grow at an accelerating rate. To illustrate, the mission has tentatively estimated that the incremental sales of electricity in the 7,000 villages to be electrified during the Repelita IV period will be associated with incremental operating deficits (growing from Rp 2.3 billion in 1984/85 to Rp 18.5 billion in 1988/89 (in constant 1985 prices). This is in addition to the deficits associated with the growing projected sales in the 8,000 odd villages electrified prior to Repelita IV, which will increase from Rp 18.0 billion in 1984/85 to Rp 21.3 billion in 1988/89. While, in the absence of accurate information, these projections can only be regarded as tentative, they serve to illustrate the speed at which the RE program is becoming a major financial drain on PLN.

5. The GOI is thus faced with a situation where it no longer can afford its planned RE investment program, and yet the pace of development of RE is running far behind the rising expectations among villagers. The GOI's current strategy, which largely consists of financing PLN's extension into every village according to the Repelita targets, is not sustainable under current conditions. Under these circumstances, what are the options available to the GOI? Basically, the options that need to be explored lie in the direction of increasing the efficiency of investments and increasing the mobilization of nongovernmental resources devoted to RE. To increase the efficiency of investments, the GOI needs to consider providing a reliable financing program,

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4/ This is far lower than rural household electrification ratios in neighboring countries, such as Malaysia (72% in 1983), Thailand (40% in 1984) and Philippines (22% in 1980).

5/ i.e., keeping tariffs at current levels in constant (real) terms.

ensuring that the villages that are selected are those than can benefit the most, improving the affordability of RE among the poorer households, and reducing the unit costs of electricity distribution in rural areas. To mobilize nongovernmental resources, the GOI needs to consider the policy incentives that will be necessary to make it financially attractive for private investors and village organizations to invest in RE and operate the systems in an efficient manner consistent with the objectives of economic development. To lead and manage the comprehensive set of actions required to effectively take advantage of the available options, the GOI needs to consider a substantial reform of the institutional and policy framework associated with rural electrification.

6. The objective of this report is to assess those options, and to formulate a set of recommended measures that will make it possible for the GOI to reduce its commitment of public resources and increase the effectiveness of the RE program through improved efficiency of investments and channelling of village resources.[6/] What follows is a summary of its main findings and recommendations.

Economic Justification of the Program

7. The economic justification for the RE program such as is planned under Repelita IV cannot be taken for granted and shows a wide range of variation (mainly as a result of economies of scale) depending on the size of the village to be electrified, its income level, and the source of electricity (grid-supplied or diesel-generated). The mission evaluated the rates of return for a set of villages believed to be representative of the types that are in the program, postulating alternative scenarios in relation to the level of petroleum prices and the consumers' willingness-to-pay. On this basis, the economic justification for the grid-based electrification of large, average- and high-income villages appears to be adequate (para 2.46).

8. The economic case for RE investments in smaller, grid-connected villages is weak, particularly after the recent decline in oil prices. The rates of return for such projects appear to be consistently below the opportunity cost of capital (estimated at 10-12%). However, the economic justification is highly sensitive to the mission's estimate of the villages' willingness-to-pay. Under these circumstances, the above results should not be regarded as conclusive, but the prudent management of investments would suggest that the smaller villages be electrified only if they make a commitment to and establish an organizationl framework necessary for making a substantial contribution towards the cost of electricity supply (para. 2.47). The conditions and requirements for the implementation of such a strategy are discussed below.

6/ This report is a follow up to the recent Indonesia: Power Sector Investment Review (World Bank, Report No. 5486-IND, September 1985). A recent report which has made a substantial contribution to this subject is Regional Rural Electrification Survey, Asian Development Bank, 1983.

9. The economic returns on diesel-based RE, which accounts for about 14% of the proposed program, are clearly inadequate. The GOI is aware of this, and has limited the planning of new diesel systems to kecamatan (sub-district) seats. The priority given to kecamatan seats is a reflection of the GOI's geographical distribution priorities and is expected to coincide with concentrations of public and private activities. Nevertheless, diesel-based RE represents a low-return use of resources at a time when the Government can ill afford it. To alleviate this burden, it would again be desirable to focus the resources of the program on those villages that are committed to making a substantial contribution towards the cost of electricity supply (para. 2.48).

10. In the course of analyzing the economics of RE the mission also evaluated the merits of increasing within-village electrification ratios. As a result of budget constraints and the attention given to the number of villages in the electrification targets, PLN is often able to offer electricity connections to only part of a village. This practice neglects to take advantage of economies of scale obtainable from increased load densities in the RE infrastructure. To maximize the social benefits of RE, as well as economic rates of return, the RE program should aim at connecting the bulk of the households and productive users in a village.[7/] This would require some adjustments of current policies, such as the rollover of the connection charge into the capacity charge,[8/] an expansion and redirection of the rural electrification credit to finance housewiring expenses and an exemption from the demand charge for low-income residential users (i.e., the bottom third of households in an average income village). As discussed in Chapter II, the economic benefits of such changes in policy should exceed the associated costs (para. 2.61). The financial implications of such policies are discussed in paras. 5.21-5.22.

Reducing Costs through Cost-Conscious Technical Optimization

11. The review of PLN's technical approach to RE indicated the need for an increased cost consciousness at the technical level. While PLN cannot be accused of not being cost-conscious, its cost-savings efforts tend to be limited to cutting expenditures and reducing waste within a static framework of standards and procedures, rather than through systematic review of these regulations to see if there are lower-cost ways of doing things. In regard to the RE program, PLN has adopted a set of regulations primarily based on the requirements of urban areas, and these are rigorously followed by every manager and staff in the field, regardless of the substantial amount of additional costs that these regulations imply. Given the growing size of PLN's RE investments, it has become desirable to take advantage of every opportunity to reduce the costs of the program.

7/ I.e., all the households located in the village compound.

8/ I.e., the elimination of the connection charge as such, to increase the affordability of RE among the poor, accompanied by a corresponding increase in the monthly capacity charge in order not to increase the financial losses associated with RE.

12. Specifically, the mission recommends that the GOI take advantage of opportunities for major cost savings through (para. 3.39):

(a) a comprehensive revision of technical design and construction standards to adapt them to the lower load densities and load factors prevailing in rural areas. PLN has already begun revising some of its standards, but the actual use of the revised standards is lagging behind.

(b) the improvement of central procurement procedures and other measures to reduce cost of equipment and materials such as the adoption of international competitive bidding,

(c) the promotion of greater competitiveness among installation contractors, such as opening up opportunities for village electric organizations to handle their own construction with technical assistance and financing from PLN, and

(d) steps to reduce distribution losses including promotion of improved power factors in RE schemes.

A number of specific suggestions, covering most aspects of RE, have been described in Chapter III. In the mission's estimate, based on its preliminary review, the cost-conscious revision of current technical design and construction standards (i.e., item (a) above) should by itself bring about cost savings of the order of 30% (para. 3.33).

Reforming the Institutional Framework

13. The RE sector of Indonesia has emerged as a two-tier complex of responses to a serious imbalance between supply and demand. On an upper, publicly financed tier, we see a formal and technically sustainable program, dominated by and centered around the PLN, but also promoted by the Ministry of Cooperatives and some provincial governments. This formal RE program of the GOI is currently serving about 18% of the villages. On a lower, "free market" tier, there has developed a large number of unregulated village electrification operations, apparently largely based on the initiative of individual entrepreneurs, but enjoying sporadic support from the GOI. These informal RE operations are currently serving about 27% of the villages, albeit with a quality of supply that is generally far inferior to that of PLN. This two-tier structure of the RE sector suffers from three fundamental flaws: (i) the publicly financed tier reaches less than a fifth of the villages at present and is planned to serve less than half of the villages ten years from now; (ii) the unregulated tier operates in a precarious and unsafe manner, and the quality of its output is not suitable to stimulate productive users who cannot afford their own electricity generation; and (iii) there is no mechanism for integrating the resources mobilized by the villages into a sustainable contribution towards the villages' development.

14. The proliferation of unregulated non-PLN operations provides evidence of organizational skills and rudimentary technical capabilities that could potentially be channelled into higher quality service that could

contribute to the villages' economic development. This will require the implementation of a strategy to mobilize village resources by providing financial incentives for local investors or cooperatives to invest in RE, upgrade their operations and cater to as many customers as possible. It is postulated that the mobilization of village resources can be accomplished through the establishment of licensed village electric organizations (VEOs) owned and operated by villagers. The VEOs would be financially autonomous companies or cooperatives with the objective of extending electricity to the bulk of the households and productive users. They would either purchase power in bulk from PLN or operate their own diesel power stations. As the VEOs would establish their local systems or take over from PLN the responsibility for the supply of electricity at the village level, PLN's role in RE would be progressively limited to the supply of electricity in bulk (para. 4.21-26).

15. On the basis of its review of the current institutional framework, the mission identified the key institutional elements that would need to be established or strengthened to implement the recommended strategy to mobilize village resources to invest in RE (paras. 4.15-4.20):

(a) an institution with single-point (leadership) responsibility for the entire RE program carried by the GOI;

(b) reliable source of finance to complement the resources to be mobilized by the VEOs with funds to be provided by the GOI and foreign donors;

(c) a framework for the establishment and chartering of VEOs on the basis of a defined service area with at least 10,000 potential customers;

(d) a comprehensive program of training and technical assistance for the VEOs;

(e) a framework for tariff regulation that would allow VEOs to set their own tariffs based on their financial requirements, including a reasonable return on investment, subject to regulatory approval.

16. In the mission's view, the magnitude and complexity of the challenges involved in steering and financing the electrification of 50,000-odd villages, combined with the identified weaknesses in the current institutional framework for the pursuit of this task, justify the consideration of a new agency. The mission therefore recommends that the GOI consider the establishment of an autonomous Rural Electrification Agency (REA) as the lead agency for the program, with primary responsibility for formulating policies and plans for the program and for mobilizing the necessary resources to carry out those plans. The REA would basically act as the promoter, licenser, financier and provider of technical assistance to the VEOs. The justification and responsibilities of the proposed agency are discussed in paras. 4.27-4.36.

Financial Implications of the Recommended Measures

17. The preceding sections have outlined a variety of policy options to increase the efficiency of the RE program and reduce its dependence on budgetary resources. To analyze the financial implications of the recommended policies, the mission has adopted the Repelita IV RE investment program as a Base Case and designed hypothetical sensitivity cases designed to simulate the impact of the effective implementation of policies to achieve technical efficiency, maximum connections, resource mobilization and breakeven tariffs. The financial simulations confirm that, taken either individually or in combination, the proposed measures will lead to substantial savings in budgetary resources, given a specific electrification target. In fact, for a hypothetical case incorporating the combined effects of the major recommended policies, the projections indicate that the Repelita IV target of electrifying 7,000 villages could be achieved with public resource requirements 40% lower than are implied in the Base Case, and that each of the villages could have two to three times the number of customers envisaged in the current plan (paras. 5.26-5.29). While these results are indicative of the benefits of the recommended measures, their achievement would still be associated with substantial public resource requirements for capital expenditures.

18. In the absence of accurate information on the costs and results of the RE program, the mission's computations can only be regarded as tentative. Nevertheless, the order of magnitude of the estimated savings serves to illustrate the synergistic effects of taking advantage, in a combined manner, of:

(a) cost optimization of technical design;

(b) economies of scale of low-voltage distribution and small-scale diesel generation;

(c) mobilization of nongovernmental resources through appropriate incentives, and

(d) enhanced cost recovery through tariffs.

19. The optimization of technical designs, construction standards and installation practices on the basis of the specific requirements and conditions of rural areas will allow a substantial reduction in the unit costs of electricity supply. The report's estimate of a 30% reduction in capital expenditures (para 3.33) is only meant to be illustrative, but is based on concrete suggestion and examples. The potential for such savings should be confirmed by a comprehensive revision of standards, which is already under way in PLN, and which is likely to find even more opportunities for cost reductions. In addition to these technical savings, which were incorporated in the financial simulations, the cost of distribution materials could also be reduced, to a comparable extent, through improvements in the procurement process.

20. The existence of economies of scale obtainable from increasing the load density by adding more customers, given a specific distribution infra-

structure, is based on technical principles applied to village situations postulated to be representative. This is subject to uncertainty as the mission collected no specific information on the locational pattern of households within the village boundaries (i.e. the number of hamlets per village). Even so, the average size of villages in different regions,[9] the fact that the larger villages tend to be electrified first and the general impression that villages tend to have a main center where most of the population is clustered, support the conclusion that substantial economies of scale can be achieved.

21. As discussed in Chapter IV, the main evidence for the availability of nongovernmental resources that could be integrated into the RE program is the existence of a large number of unlicensed operators in all parts of the country. The main question here relates to the ability of the official RE program to channel those resources into a regulated environment, with the objective of providing a higher quality service, serving a higher proportion of the population and reducing unsafe practices and financial abuses. In the mission's view, this objective can be achieved with a appropriate incentives, principally by allowing the operators to set their own tariffs, but also including financial and technical assistance.

22. The enhanced recovery of costs through tariffs is the only option that offers the potential for making the RE program financially viable. If this option is not implemented, the publicly financed RE program will remain a growing drain on public resources and the possibility of channelling non-governmental resources into the program will be unfeasible. The main question here relates to the ability of the rural population to afford an increase in tariffs such as postulated in the report. In the mission's view, the risks associated with this question can be substantially reduced by conditioning the electrification of a village to its ability to establish a VEO that will be able to raise a capital contribution and make a commitment to raising tariffs to the level of financial viability. In other words, the commitment to achieving financial viability through appropriate tariffs would focus the RE program on those villages than can make a substantial contribution towards the costs, through the establishment of a VEO. This focus is consistent with the maximization of benefits of the program, and the objective of bringing the drain on public expenditures associated with the RE program under control. The results obtained by the mission should therefore be regarded as hypothetical, but illustrative of the implications of the proposed policies.

A Recommended Plan of Action

23. The objective of this review has been to explore the options available to the Government to bring the unsustainable expenditure of public resources associated with its RE program under control and correct the serious imbalance between the supply and demand for electricity in rural areas by increasing the efficiency of investments and increasing the mobilization of

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9/ Which ranges up to 860 households/village in Java, 860 in Bali, 940 in South Sulawesi and 1,051 in West Nusa Tenggara.

nongovernmental resources devoted to RE. The preceding sections have outlined the report's assessment of the existing program and the major options from the economic, technical, institutional and financial perspective. From this assessment has evolved a set of recommended policy and institutional measures that combine to form a plan of action that would allow the Government to significantly enhance the effectiveness and reduce the costs of its RE program.

24. The principal policy and technical measures which form part of the recommended plan of action are the following:

(a) the maximization of village electrification ratios through making RE affordable to the poor. This will require:

(i) the rollover of the connection charge into the demand charge for small residential (R1) customers in rural areas (para. 2.57),

(ii) the expansion and redirection of the RE credit program to finance housewiring expenses (paras. 2.53-57),

(iii) the exemption from the demand charge of residential users of less than 10 kWh per month (para. 2.60);

(b) the implementation of a framework that would allow VEOs to set their own tariffs subject to regulatory approval on the basis of covering operating costs plus a reasonable margin for debt servicing and a return on investment. The tariff level required to achieve this objective would depend substantially on the strategy chosen by the Government to finance RE capital expenditures (paras. 5.26-5.29);

(c) an acceleration of PLN's ongoing comprehensive revision of technical design and construction standards to adapt them to rural conditions (para. 3.33);

(d) the reduction of the cost of equipment and materials by, inter alia:

(i) the improvement of central procurement procedures including measures such as the adoption of international competitive bidding (para. 3.35); and

(ii) devising means to reduce the cost of installation by local contractors, i.e., by opening up opportunities for village electric organizations to handle their own construction (para. 3.36); and

(e) the implementation of a rural electrification management information system (REMIS) to provide accurate and timely information on the physical implementation and financial performance of the RE program (para. 5.03).

25. The principal <u>institutional measures</u> which form part of the recommended plan of action are the following:

(a) the promotion of licensed village electric organizations (VEOs) as the principal vehicle for mobilizing village resources and implementing the RE program (para. 4.24). This will require (para. 4.28):

(i) a framework for the establishment and licensing of VEOs on the basis of a defined service area,

(ii) the implementation of a tariff framework that would allow VEOs to become financially viable by charging a tariff that would recover operating cost, debt service requirements and a reasonable return on investments. The level of the required tariff level would be determined in part by the financing strategy chosen by the GOI,

(iii) a reliable source of finance for RE construction to complement the resources to be mobilized by the VEOs, and

(iv) a comprehensive program of technical assistance;

(b) the establishment of a Rural Electrification Agency (REA) as the lead agency for the RE program, with primary responsibility for formulating policies and plans for the program on the basis of national objectives and requirements and for mobilizing the necessary resources to achieve these targets. To function effectively in its assigned task, the REA should concentrate the authority to (para. 4.32):

(i) borrow and raise funds from the GOI and foreign donors and onlend its funds on terms that reflect its cost of funds plus a fee to cover administrative expenses,

(ii) set technical and financial standards for the licensing of VEOs,

(iii) regulate tariffs charged by VEOs,

(iv) develop a program of training and technical assistance to VEOs, relying on technical expertise contracted with PLN, and

(v) promote research and development in technical aspects of RE.

26. This recommended plan of action is expected to enable the GOI to scale back the public expenditures associated with the RE program in line with macroeconomic realities while at the same time substantially achieve, or possibly increase the target number of new customers by increasing the efficiency of resource utilization, complementing public with nongovernmental resources, and increasing cost recovery through appropriate tariff policies. The proposed approach would rely on resource mobilization and willingness-to-

pay capacity of villages as the criteria for village selection and thus ensure that the program will focus on those villages that have the greatest ability to benefit from RE and provide an adequate economic justification for the investments. Of course, the development of a comprehensive and integrated plan of action is bound to involve many risks and require a lengthy process of learning and adaptation on the part of all the participating institutions. Nevertheless, the potential rewards associated with reducing public expenditures and increasing the effectiveness of the RE program through implementation of the recommended plan of action appear to make it worthwhile.

INDONESIA

RURAL ELECTRIFICATION REVIEW

I. THE CONTEXT OF ELECTRIFICATION IN RURAL AREAS

Background

Objectives and Definition

1.01 As expressed in the Government of Indonesia's (GOI) Broad Outlines of State Policy the objective of power sector development is to improve the welfare of the population both in rural and urban areas and to support and stimulate economic activities. While PLN (the National Public Electricity Enterprise) had been connecting customers in rural villages since the early years of its establishment, "rural electrification" (RE) began to receive special attention and emerge as a specific objective only in the late 1970s, when the GOI became concerned about the uneven distribution of electricity in rural vs. urban areas. RE was then recognized as a major component of the GOI's village development strategy, to be pursued on the basis of its developmental merits, in addition to being an extension of PLN's regular commercial activities. RE is thus defined as the supply of electricity to rural areas.[10/] Since the principal objective is to improve the welfare of the population and stimulate economic development, RE also includes those electric supply activities which are carried out for purely commercial reasons, e.g., to supply industrial customers in rural areas.

The Rural Environment

1.02 The rural sector accounts for about 78% of Indonesia's population of 165 million, comprising about 30 million households. As with the total population, two thirds of the rural population is concentrated on Java and Bali, where the population density, at about 747 persons/km^2, ranks among the highest in the world. The remaining one third of the rural population is much more thinly distributed over the Outer Islands, with a density of only about 80 persons/km^2. This contrast in population density helps to explain the differences between the electric development challenges facing Java, which revolve around the extension of a major grid, from those faced in the Outer Islands where, in addition to the extension of local grids, about half the RE program involves the use of small diesel sets to serve isolated areas.

1.03 A characteristic of the rural areas is that, in comparison with urban areas, they have a much lower level of incomes and social development. Thus, average rural incomes are only about 59% of urban incomes (51% in Java and 70% in the Outer Islands). This income difference is related to the pat-

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10/ For planning purposes the GOI defines rural areas as all areas not situated within the National Capital or a Provincial Capital, District Capital, Special Area Capital, Municipality or Administrative Town.

tern of employment: in the rural areas, 68% of employment is in the primary sectors (mainly agriculture), 11% in secondary sectors, and 21% in services; in the urban areas the corresponding shares are 10%, 20% and 70%, respectively. These income differentials are accompanied by striking differences in social indicators, such as the level of educational attainment and the availability of health care.11/ The urban/rural contrast is also evident in supply of electricity. As of 1984, PLN was serving 39% of urban households, vs. only 7% in the rural areas.

1.04 A second characteristic of the rural environment is that, for developmental purposes, the basic unit is the village (desa), of which there are about 65,000 in Indonesia.12/ The villages vary in size from an average of 860 households in Java and Bali to 436 in Sulawesi, 245 in Sumatra and 155 in Kalimantan. For planning purposes the GOI has defined a three-tiered classification of villages, on the basis of their level of development.13/ As of 1983, about 15% of the villages were in the swasembada (modern) category, 43% were swakarya (transitional) and 41% were swadaya (traditional). The regional breakdown of the developmental status of villages is shown in Table 1.1. This classification is used to coordinate the development efforts of the government agencies. Thus, swasembada villages are entitled to get electricity, paved roads, bank branches, etc.; swakarya villages get priority for water supply, gravel roads, elementary schools, etc. The ultimate objective is of course to motivate every village to attain swasembada status and to fully serve it with the basic services and utilities. The immediate (Repelita IV) target is that 40% of villages should attain swasembada status by 1989.

11/ For a discussion of these see Indonesia: Selected Aspects of Spatial Development, World Bank Report No. 4776-IND, November 1984.

12/ For planning and administrative purposes, a village (desa) is defined as the rural area under the jurisdiction of a village head (kepala desa), i.e., it may include one or more hamlets (kampung) and also isolated farmsteads.

13/ This ranking system, administered by the Ministry of Home Affairs, is based on a broad definition of "development" as measured by seven indicators: (1) source of income, (2) level of production, (3) level of modernization, (4) existence of village institutions, (5) educational level, (6) community spirit, and (7) availability of infrastructure.

Table 1.1: DEVELOPMENTAL STATUS OF VILLAGES, 1983

	Swadaya Traditional %	Swakarya Transitional %	Swasembada Modern %	Total villages
Java	18.5	53.0	28.5	23,480
Sumatra	55.5	37.9	6.6	22,242
Sulawesi	29.9	54.6	15.5	4,470
Kalimantan	71.0	25.1	3.9	8,577
Other islands	44.4	43.3	12.3	5,670
Total Indonesia	41.3	43.3	15.4	64,439

Source: Statistik Potensi Desa, Sensus Pertanian 1983, Biro Pusat Statistik, Jakarta, 1985.

The Extent of Rural Electrification

1.05 The extent of RE in Indonesia is not known with accuracy. The 1983 Agricultural Census of the Central Bureau of Statistics (BPS), which bases its information on the responses of village heads, indicates that over 29,000 villages (about 44%) have some sort of electricity service. The extent of village electrification varies substantially between regions, ranging from 55% in Sulawesi to 45% in Java and 40% in Kalimantan. The extent of within-village electrification also varies significantly. Thus, in only about 34% of the "electrified" villages does the service reach at least half of the households, and in fully 44% of the "electrified" villages the service reaches less than a quarter of the households. The regional breakdown of villages by their electrification status is summarized in Table 1.2.

1.06 An unexpected fact revealed by the still unpublished Agricultural Census information is that only about 40% of the electrified villages have been electrified by the PLN. Thus, the actual number of electrified villages and rural households served by electricity appears to be at least twice as great as had been generally believed. For example, from the GOI's perspective, reflected in Table 1.3, only about 12,000 villages were considered to be electrified as of 1986, all but a few of them served by PLN, while the 1983 Agricultural Census data suggests that some 29,000 villages had some electricity supply. The current extent of rural electrification as supplied by PLN is shown on Map IBRD 19450.

Table 1.2: ELECTRIFICATION STATUS OF VILLAGES, 1983
(%)

	Electrified villages										Nonelec-trified villages	Total villages
	By source		By share of connected households									
			PLN				Non-PLN					
	PLN	Non-PLN	0-25%	26-49%	50-74%	75+%	0-25%	26-49%	50-74%	75+%		
Java	25.0	20.0	8.2	5.3	4.3	7.2	14.4	3.3	1.4	0.9	55.0	100.0
Sumatra	13.4	32.7	4.1	3.3	2.4	3.6	14.2	7.9	5.7	4.9	54.0	100.0
Sulawesi	23.2	31.6	5.7	6.2	4.6	6.7	21.3	6.5	2.5	1.3	45.2	100.0
Kalimantan	6.7	33.2	1.8	1.5	1.4	2.0	10.0	6.8	6.3	10.1	60.1	100.0
Other islands	13.2	19.4	4.8	2.8	2.1	3.5	10.4	3.5	2.1	3.4	67.5	100.0
Total	17.5	26.8	5.5	4.0	3.1	4.9	13.9	5.6	3.6	3.7	55.7	100.0
No. of Villages	11,458	17,622	3,591	2,596	2,052	3,219	9,117	3,667	2,387	2,451	36,587	65,667

Note: The difference in the total number of villages, as compared to Table 1.1, is likely due to the fact that some villages have both PLN and non-PLN service.

Source: Statistik Potensi Desa, Sensus Pertanian 1983, Biro Pusat Statistik, Jakarta, 1985.

Table 1.3. VILLAGES ELECTRIFIED BY GOI

	PLN /a		MOC /b	
	Villages	Customers ('000)	Villages	Customers ('000)
Java	6,382	1,710	-	-
Sumatra	2,892	370	25	5
Sulawesi	1,007	204	36	3
Kalimantan	604	67	-	-
Other islands	754	160	23	4
Total Indonesia	11,639	2,512	84	12

/a As of July 1986. Includes the 1,919 villages electrified with participation of a MOC sponsored village cooperative unit (KUD).
/b As of September 1985, only includes villages electrified by MOC-sponsored electric cooperatives (KLP). About 50 additional villages have been electrified through local initiatives assisted by the MOC.

1.07 The main reason for this lack of awareness of the extent of electrification is that most of the non-PLN services are supplied by unlicensed and unregulated local operators on which the GOI has virtually no information. While the extent of the informal rural electrification activities is surprising, the findings of the 1983 Agricultural Census are corroborated by separate surveys of non-PLN electric companies carried out by the BPS in six provinces over the 1982-84 period,[14/] and a 1985 survey of non-PLN utilities in South Sulawesi by the Ministry of Mines and Energy (MME). On the basis of the mission's own observations, the proliferation of non-PLN electricity suppliers appears to be a continuing phenomenon, reflecting rising expectations and willingness to pay among villages which is not able to be satisfied by PLN's pace of development.

1.08 The lack of awareness of the extent to which non-PLN electricity supplies have proliferated in rural areas may also be related to the fact that the unlicensed operators have not been regarded by the GOI as a solution to meeting the demand for electricity in the villages that are not served by PLN. While not much is known about them, the 1982-84 surveys by BPS indicate that, on average, non-PLN companies provide a service that is far inferior to that of PLN and is not suitable for productive uses. Their facilities tend to be precarious and unsafe. The general pattern that emerges is that of a local

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14/ Survey of the Impact of Rural Electrification and Non-PLN Electric Companies. Vol. I (1982) Central Java, Vol. II (1983) West Java, Yogyakarta and East Java, Vol. III (1984) North Sumatra and South Sulawesi, Biro Pusat Statistik, Jakarta.

organization or entrepreneur which collects contributions from interested customers to set up an operation to provide some service during evening hours (5-6 hours per day). Outages are frequent and repair expenses necessitate additional contributions from the customers. Some evidence suggests that eventually the customers tire of the service and it may cease operation. The customers then motivate the village and district leadership to request PLN to electrify the village as soon as possible. As the equipment is incompatible, PLN has to replace the entire system and start from scratch. If this pattern is generally accurate, then the unregulated operations represent an inefficient use of village resources and it becomes incumbent upon the GOI to find a way to channel these resources into a more sustainable solution to the demand for RE.

The Need for a Review

1.09 As indicated by the preceeding discussion, Indonesia is faced with a situation where its RE activities are in serious imbalance. The provision of a reliable supply of electricity to rural areas is running far behind the demand, both in terms of the number of *swasembada* villages that are "entitled" to electricity [15/] and in terms of the villagers' apparent willingness to risk substantial investments in poorly designed and inefficient initiatives to electrify themselves. In response to this unmet demand, the GOI has launched through PLN a massive RE effort that will more than double (from 1.5 million to 3.2 million) the number of its rural customers during Repelita IV and nearly double it again (from 3.2 million to 5.6 million) during Repelita V. Nevertheless, even at this rate, which represents the limit of what the GOI feels it can devote to RE given its macroeconomic resource constraints, the official RE program will have reached only about 21% of the rural households and 40% of the villages by the end of Repelita V in 1994.[16/]

1.10 It is apparent that the GOI can no longer hope to meet the demand for RE on the basis of its current strategy which largely consists of financing PLN's extension into every village. Under these circumstances, what are the options available to the GOI? Basically, given the overall financial constraints, the options that need to be explored lie in the direction of increasing the efficiency of investments and taking advantage of market forces, i.e., increasing the mobilization of non-governmental resources devoted to RE. To increase the efficiency of investments, the GOI needs to consider providing a stable financial framework, ensuring that the most appropriate RE sites are chosen, improving the affordability of RE among the poorer

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15/ As of 1984, about 8,700 out of 15,300 *swasembada* villages were not electrified. This number will gradually increase if, as planned, the number of *swasembada* villages grows to about 26,000 by 1989 (the end of Repelita IV), and PLN electrifies 7,000 villages during the same period, leaving about 12,400 nonelectrified *swasembada* villages.

16/ This is far lower than rural household electrification ratios in neighboring countries, such as Malaysia (72% in 1983), Thailand (40% in 1984) and Philippines (22% in 1980).

households, and reducing unit costs of electricity distribution in rural areas. To take advantage of market forces, the GOI needs to consider the policy and institutional framework that will be necessary to make it financially attractive for private investors and village organizations to invest in RE and operate the systems in an efficient manner consistent with the objectives of economic development.

1.11 The objective of this report is to assess these options, and to formulate a set of recommended measures that will assist the GOI in meeting the demand for RE through a strategy of improved efficiency of investments and channelling of village resources. To achieve this objective, this report began with a description of the sectoral context of RE in Indonesia. Chapter II evaluates the benefits and overall economic justification of RE. Chapter III outlines possible ways in which the cost of supply could be reduced on the basis of a cost-conscious optimization in technical design standards and construction practices. Chapter IV evaluates the institutional framework of the RE program in light of the potential for taking advantage of market forces for the implementation of the RE program. Finally, Chapter V outlines the financial implications of the recommended measures.

II. THE ECONOMICS OF RURAL ELECTRIFICATION

Introduction

2.01 As indicated in Chapter I, the supply of electricity to villages constitutes an important component of the GOI's long-term village development strategy and is coordinated with the supply of complementary developmental inputs such as roads, bank branches, education, etc. Nevertheless, the pace at which this objective is to be attained needs to be modulated on the basis of consideration of overall macroeconomic resource constraints and a balancing of the relative merits of RE as compared to other developmental requirements. While a review that is limited to a single subsector cannot reach conclusions about the appropriate intersectoral allocation of resources, it is in a position to evaluate the economic merits of the RE program as planned by the GOI. In particular, this chapter will focus on an evaluation of: (i) the economics of rural electrification in Indonesia, and (ii) a set of policy reforms which should be undertaken in order to improve the economic return on RE investments.

2.02 This evaluation will be presented in two parts. In the first part, there is a brief discussion of the conceptually correct measure of the economic benefits of RE. This is followed by an analysis of factors which determine the size of the market for RE and thus the magnitude of economic benefits derived from RE. Since virtually all quantifiable benefits of RE are generated by residential and productive use 17/ consumers, this analysis focuses on two topics: (i) the affordability of RE on the part of potential residential consumers; and (ii) the ability of RE to attract existing productive use consumers and to stimulate the development of new productive uses of electricity. This analysis describes the existing situation based on the most current data available and identifies policy reforms which are likely to increase the economic benefits derived from these two categories of consumers.

2.03 The second part of the chapter provides a quantitative analysis of the economic justification for electrifying different types of rural villages in Indonesia. These villages are differentiated by their sizes, their average income levels, and their sources of electricity supply. These results are used to reach tentative conclusions concerning the economic justification of the GOI's RE program. Finally, several sensitivity analyses are also carried out to assess the economic impact of some of the policy reforms that will be discussed.

The Economic Benefits of Rural Electrification

2.04 The justification of the RE program has to be based on an evaluation of its economic benefits, both social and private, in relation to the opportunity cost of the resources devoted to the program. A basic difficulty in evaluating the merits of RE is that some of its benefits, such as improved

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17/ Productive use consumers use electricity to produce outputs sold in markets. They include home businesses and cottage industries.

security at night, improved access to information and improved educational opportunities, are typically not valued in markets. As a result, the mission was not in a position of quantify them on the basis of the available information. Thus, for the purpose of this report, the economic benefits of RE have been estimated solely on the basis of those benefits which are quantifiable. Such benefits result largely because: (i) RE is often supplied at a lower economic cost than competing sources of energy (mostly kerosene and diesel) which are used prior to the availability of RE; (ii) it may facilitate new types of economic activity; and (iii) it is often perceived as a higher quality, more convenient source of energy. In this section, the specific nature of RE benefits in Indonesia is discussed in qualitative terms. Quantitative estimates are provided later in this chapter.

2.05 For the purpose of this discussion, it is useful to distinguish between two different markets for RE: existing and new. In the former, consumers switch from some other source of energy, including self-generated and battery-supplied electricity, to network-supplied electricity; in the latter, new consumption of (electric) energy results because of the availability of RE.[18/] The economic benefits of RE in existing markets are measured by the economic cost savings which occur as RE is substituted for an alternative energy source. Thus in an existing market the gross economic benefit of RE equals the economic cost of the previously used energy source. This benefit is allocated between society as a whole and the consumer depending upon tariff policies for the two energy sources in question. In new markets, the economic benefits of RE equal the consumers' willingness-to-pay for this new consumption. This can be estimated based on the consumption behavior of residential customers or on the change in profits made by productive use customers.

2.06 It is also important to note that the economic benefits of RE in either existing or new markets can be further disaggregated according to the type of consumer -- either residential or productive use.[19/] In the specific case of Indonesia, it is clear that most of the benefits of RE result from residential consumption.[20/] This is simply because most RE consumption is by residential consumers. The economic benefits for these consumers appear to be fairly evenly divided between new and existing markets. That is, roughly half of residential benefits results because consumers switch from kerosene to electric lighting. The remaining benefits occur because residential consumers

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18/ Such new markets develop because of, among other things, the lower financial cost of RE, technical advantages of electric energy compared to alternative types of energy, and the perceived higher quality and general appeal of electricity.

19/ Institutional or government consumers are ignored for the sake of simplicity.

20/ This is in contrast to the situation in other countries, such as Thailand, India and Malaysia, where most of the consumption of electricity in rural areas is by productive users, including principally irrigation pumping.

increase their use of lighting after electrification, or because they increase their energy purchases in order to utilize such appliances as radios, televisions, casettes, or irons.[21]

2.07 The economic impact of RE through productive use consumers -- primarily small commercial and industrial units and a few rice mills -- appears to be modest. In most cases, it takes the form of cost savings. That is, already existing consumers substitute electricity for some other energy source. The switch is typically electric lighting for kerosene lighting. Various studies, and the mission itself, were able to identify instances where RE led to the establishment of new productive activities or to the expansion of existing productive activities. Examples of the former are ice making, photocopying, and beauty parlors, while examples of the latter are commercial shops, poultry farms and small garment factories.

The Affordability of RE by Households

2.08 Since the basic objective of RE is to improve the welfare of the rural population, it is important to evaluate what fraction of the rural households can afford RE.[22] Insight into this topic can be gained from three approaches: (i) analysis of what nonelectrified households currently spend on energy sources (primarily kerosene) which substitute for electricity;[23] (ii) a study of connection rates and expenditures on electricity by residential consumers in electrified areas; and (iii) surveys of potential consumers as to what they are willing and able to pay for electricity. These three approaches will be discussed in turn.

Household Expenditures on Kerosene

2.09 Data on rural household expenditures for kerosene in 1981 are summarized in Table 2.1. Results indicate that relative expenditures on kerosene decline as income rises. The poorest rural households allocate as much as 5% of their total expenditures to kerosene, with this figure declining to about 1.5% for the "richest" households. This pattern reflects both the income

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21/ A 1984 survey in Central Java indicates the following frequency of uses of electricity by electrified rural households: lighting - 100%, cassettes - 35%, television - 34%, ironing - 34%, radio 27%, fan - 4%, water pump - 4%, refrigerator - 2%, powertools - 2%, sewing machine - 1%. See Evaluation of the Indonesia Rural Electrification Project: Results of 1984 Surveys of Households, Business and Public Facilities, US Bureau of the Census for USAID, December 1985.

22/ It is clear that virtually all rural households desire access to RE. The level of affordability determines the extent to which this desire is translated into actual connections in an electrified area.

23/ This is likely to give a conservative indication of willingness-to-pay since evidence consistently indicates that consumers view electric lighting as being of higher quality than kerosene lighting.

Table 2.1: SHARE OF RURAL HOUSEHOLD EXPENDITURES DEVOTED TO KEROSENE, 1981
(%)

	Total expenditure level (Rp/cap/month) /a										
	0/ 3,000	3,000/ 4,000	4,000/ 5,000	5,000/ 6,000	6,000/ 8,000	8,000/ 10,000	10,000/ 15,000	15,000/ 20,000	20,000/ 30,000	30,000/ 40,000	40,000/ over
Java	5.1	2.3	4.5	4.0	3.5	3.4	3.1	2.7	2.1	1.6	-
Sumatra	4.0	2.2	2.6	2.4	2.3	2.1	1.7	1.9	1.8	1.3	-
Sulawesi	5.3	2.8	2.3	2.2	2.2	2.2	1.6	1.6	1.1	1.0	-
Kalimantan	7.1	1.8	1.9	2.3	2.1	2.1	1.9	1.9	1.9	1.6	-
Other Islands	4.0	2.3	2.0	1.9	1.9	1.9	1.7	1.6	1.4	1.1	-
Total Indonesia	5.2	3.2	3.0	3.2	2.9	2.9	2.6	2.3	2.0	1.5	-

/a Total expenditures proxy total income.

Source: SUSENAS, 1981.

inelastic demand for kerosene and the fact that access to electricity increases with income. Overall, rural households which rely mostly on kerosene for lighting spend roughly 3% of their income on kerosene.

2.10 Since 1981, however, the price of kerosene has increased by about 300% in nominal terms and 190% in real terms. Because household demand for kerosene is apt to be price inelastic and household incomes have not increased as rapidly as kerosene prices, one would expect that the share of household income allocated to kerosene has increased. Data collected in Central Java during 1984 confirms this and suggests a kerosene expenditure share in non-electrified households of between 4.5-6%. The 1984 data also indicates that virtually all (97%) of the non-electrified households use kerosene for lighting, and that only 6% of these households use kerosene for cooking. Based on this most recent data one might infer that a household can afford electricity if its monthly cost is not more than 5% of household income.

2.11 Given this approach, and the household distribution of income in a typical village, one can (conservatively) estimate the fraction of households which can afford electricity. Data which allows this to be done is presented in Table 2.2.24/

Table 2.2: TYPICAL VILLAGE INCOME DISTRIBUTION AND MAXIMUM AFFORDABLE EXPENDITURES ON RE, 1984

Income Distribution Quartile	Av. Monthly Income Per Household (Rp) /a	Maximum Affordable Expenditure/Month (Rp) /b
1st	19,305	965
2nd	42,075	2,104
3rd	57,552	2,878
4th	98,956	4,948

/a Assuming 5.5 people per household.
/b 5% of monthly household income.

Source: Evaluation of the Indonesia Rural Electrification Project: Results of 1984 Surveys of Households, Business and Public Facilities, US Bureau of the Census for USAID, December 1985.

If one assumes that: (i) this income distribution data is representative for average rural villages in Indonesia; and (ii) the minimum monthly bill for a

24/ This data is for an average village in the Banyumas area of Central Java. This area is, on average, somewhat poorer than rural Indonesia as a whole. See V.V. Rao, "Poverty in Indonesia, 1970-1980: Trends, Associated Characteristics, and Research Issues," World Bank, 1984.

residential RE consumer is likely to be approximately Rp 1,230,[25/] this approach suggests that roughly three-quarters of the rural households can afford RE.

Connection Rates in Electrified Villages

2.12 One obtains a different perspective by analyzing residential connection rates and expenditures on electricity in electrified rural areas. Looking at the three electrified villages covered by the 1984 survey in Central Java, one sees that connection rates vary widely from 66% of the households in one village to 9% in another village. Overall, about 24% of the households in this sample of electrified villages were electrified in 1984.[26/]

2.13 It is unclear, however, whether all households in the villages had access to electricity. The mission learned that it is frequent PLN practice to offer electricity supply to only part of a village.[27/] It may therefore be the case that the distribution grid was not extended to all parts of the villages during the first year of electrification. If so, this would produce a downward bias on the rate of household connection.

2.14 Average monthly expenditures on electricity in these three electrified villages was Rp 3,233 or approximately 5% of average monthly household income. By disaggregating this data, one can observe that expenditures on electricity as a percent of income vary greatly with the level of income. For example, the poorest electrified households in the Central Java sample spend up to 15% of their incomes on electricity, while the "richest" spend only about 4%. This pattern appears to result from the fact that the minimum rural residential demand for electricity is relatively income inelastic. For example, the richest households have monthly incomes approximately 7 times higher than the poorest, but only consume about twice as much electricity on average.[28/] Overall, however, this data provides evidence that at least some households are willing to pay much more than 5% of their incomes for electricity.

Expressed Willingness to Pay

2.15 Further insight into the affordability of RE can be obtained by surveying households as to their willingness and ability to pay for RE. This

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25/ Assuming 10 kWh consumption per month, i.e, just enough to replace kerosene lighting (see para. 2.36).

26/ These villages had only been electrified for approximately one year.

27/ Thereby allowing more villages to be "electrified" within a given budget. The economics of such practices are evaluated in para. 2.52.

28/ This low elasticity of demand may be due to the limited elapsed time since electrification, which has not yet led to substantial accumulation of electric appliances.

was done by the 1984 survey in Central Java for three nonelectrified villages. Approximately 63% of the households in these villages indicated a willingness-to-pay for electricity at least equal to Rp 1,500 per month of electricity. This percentage varied considerably between villages -- the highest and lowest being 87% and 39% respectively. Differences in average village income levels are clearly responsible for part of the observed variation in willingness-to-pay. For example, the former village's average per capita income is about 57% higher than the latter village's average per capita income. It is unclear what other factors might also account for part of this observed variation in stated willingness-to-pay for RE.

Review of the Evidence

2.16 Overall, three types of evidence concerning the residential affordability of RE have been supplied: (i) data on expenditures for RE substitutes (kerosene); (ii) data on connection rates and expenditures on RE in electrified villages; and (iii) survey data on willingness to pay for RE. The results from (i) and (iii) are generally consistent and suggest that well over 50% of rural households are likely to be able to afford the monthly charges associated with RE. This conclusion is also consistent with mission observations made during field visits. Results from (ii) are troublesome, however, since they indicate actual connection rates well below 50%. Part of this discrepancy may be due to supply constraints in the surveyed villages, as indicated in para. 2.13. Another partial explanation may be found in the initial charges which residential consumers are required to pay before obtaining electricity. The impact of such charges on RE affordability are considered below.

Impact of Initial Charges

2.17 Residential RE consumers in the PLN system are required to pay a connection charge, a deposit, and the cost of housewiring prior to electrification. This amounts to a lump sum payment of between Rp 65,000-100,000, depending on housewiring costs. Subsidized credit of Rp 56,700 to pay this initial expense was made available to all residential consumers in USAID-funded RE areas in Central Java and to about 10% of residential consumers in other areas (see para. 4.14). Such credits cover the initial connection and housewiring cost and must be repaid (at 6% annual interest) over four years.[29]

2.18 It is clear that the required lump sum payment of Rp 65,000-100,000 greatly reduces the initial affordability of RE. Residential connection rates are starting off at a lower level, and grow at a slower rate, than in the absence of such a charge. Evidence to support this belief is found in the 1984 survey of Central Java. Specifically, less than 15% of the households in nonelectrified villages said they could afford to make an initial lump-sum payment of Rp 55,000. In contrast, about 84% of the households in two villages and 47% of the households in a third village said they could afford

29/ Payment would be in 48 monthly installments of Rp 1,400.

the connection charge if credit was made available. Even if credit is available, however, the repayment requirement would have the effect of increasing the minimum monthly bill by about Rp 1,550 [30] to approximately Rp 2,800 during the initial four years of electrification. This clearly reduces the affordability of RE to households. The policy implications of this finding are discussed in paras. 2.28 and 2.53-58.

Summary

2.19 In summary, rural households clearly want electricity and are willing to pay a significant fraction of their incomes (probably in excess of 5%) to obtain it. It appears that up to 75% of households in typical rural villages can afford the minimum monthly charge for electric service. However, connection costs (even when credit is available) are likely to significantly reduce affordability -- thus lowering the initial household connection rate and slowing its growth over time. Given the existing connection and monthly charges, and very limited credit availability, it is the mission's estimate that residential connection rates in average income villages are likely to start out at somewhat less than 50% (say 30-35%) and may approach 50% in above average income rural villages. This estimate is consistent with the 1983 Agricultural Census results which indicate that roughly 46% of villages served by PLN have electrification rates above 50% (see Table 1.2), and the widespread impression among PLN field managers that about 60% of customers along a distribution line tend to initially connect.[31]

2.20 It is important to note at this point that "affordability" of RE has so far been discussed in the context of the existing tariff, which has remained unchanged since January 1984, and which, by PLN's most recent estimate, is about 35% below the long-run marginal cost (LRMC) of electricity for the case of small residential (R1) customers.[32] While this approach provides an estimate of the amount of electricity that will actually be consumed, given the Government's current tariff policies, it leaves open the question of rural households' affordability of the RE program as a whole, i.e., the affordability not only of the electricity bill, but of the LRMC of electricity. In this approach, the costs of supplying electricity are introduced at a later stage, during the computation of the economic rate of return (para. 2.42 and Annex 2).

30/ Since mid-1985 the credit amount has been increased to 65,700 Rp, with monthly repayments of 1,550 Rp.

31/ It should be noted that PLN's distribution lines tend to follow the main street of the villages, which are likely to concentrate the more prosperous households.

32/ See PLN Tariff Level in 1986/87 Based on LRMC Approach, PLN, May 1986. This estimate combines urban and rural customers. For rural customers alone, the LRMC is considerably higher.

Productive Users

2.21 Experience from a variety of developing countries suggests that electricity is typically demanded by productive use consumers for the following purposes: (i) lighting; (ii) water pumping for irrigation; (iii) motive power; or (iv) cooling. It is seldom an economical source of heat. In Indonesia, the mission was not able to identify any significant, or potentially significant, uses of RE for irrigation pumping.[33/] Thus the principal demands for RE by productive users in Indonesia are for lighting and operating electric motors and equipment. This use occurs primarily in small commercial shops, home/cottage industries, and a few grain mills.

2.22 The magnitude of the demand derived from productive uses of RE depends on the number of productive users and on the uses to which they put electricity. Once again, useful data has been collected in the 1984 survey of Central Java. It shows that most productive users (80%) chose to electrify once RE became available.[34/] This pattern is generally consistent among various productive users with three exceptions -- small industries, restaurants, and agricultural processors. In these three cases, connection rates were 66%, 14% and 75%.[35/] It may be that many small industries and agricultural processors have made significant investments in alternative sources of energy. As these investments wear out, RE connection rates may rise.

2.23 Approximately 83% of electrified businesses in the Central Java sample use electricity for lighting; and for about 61% of the businesses, lighting is perceived as the major benefit of electrification. Lighting is used either for security or for illuminating working areas (especially at night). The next most common business use of electricity is for operating machinery. However, this occurs in only about 12% of electrified businesses.[36/] RE is used for cooling in less than 1% of the businesses. The fact that lighting is the dominant use of electricity by most rural businesses in Central Java is borne out by the fact that average electricity consumption per produtive user is only about 83 kWh per month.

2.24 It is important to try to understand the nature of the demand for RE by electrified businesses. The benefit most frequently cited is increased

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33/ This is noteworthy since irrigation is the principal productive use of RE in several Asian countries, e.g., India and Bangladesh, and typically contributes greatly to the economic and financial viability of RE.

34/ This estimate excludes home industries.

35/ Sample sizes for some of these categories of productive uses are small. Agricultural processing is included in the list of productive uses with below average connection rates largely because the mission observed many examples of nonelectrified rice mills.

36/ Another 6% of the electrified businesses use their own diesel generators to operate machinery.

profits. Survey results suggest that about 36% of electrified businesses experienced an increase in profits. This increase averaged Rp 6,050 per month per electrified business. Such increased profits likely result from either increased production or cost savings. Impressions collected by the mission concerning the productive use of RE in South Sulawesi and East Java are generally consistent with the survey data described above for Central Java. There was uniform evidence that RE led to modest increases in economic activity. In several villages, small businesses such as beauty parlors, photocopying, ice making and battery charging had come into existence after electrification. The use of electric lights or machinery also allowed production increases in such small industries as tool making, garments, textiles, and poultry.[37/] Finally, RE seemed to offer the potential for economic cost savings in certain agricultural processing industries such as rice mills and soybean cake (tahu) factories. In many of these cases, however, lack of information, price distortions, and capital market imperfections prevent these benefits from being realized.[38/] As a result, most such small industries have not yet chosen to switch to electricity for their processing uses.

2.25 In summary, the available evidence suggests that RE has a modest positive impact on the level of economic activity in electrified areas.[39/] Most businesses in such areas choose to electrify and use electricity primarily for lighting. In many electrified villages, a few electricity-dependent businesses have developed. Rice mills, which are potentially the most significant productive use loads in many rural areas, have generally not chosen to electrify up to this point. It is anticipated that productive uses of RE will continue to grow slowly over time in Indonesia. Specific programs and policies to promote productive uses can facilitate their growth somewhat. However, in the absence of coordinated, multifaceted rural development efforts, it is unlikely that RE will lead to dramatic changes in rural economic activity in the near future. The policy implications of this finding are discussed below in para. 2.29.

37/ At least in the villages visited by the mission, there seemed to be adequate market demand to absorb such production increases. Some businesses indicated that their markets actually expanded after electrification due to the improved quality of their products.

38/ Typical reasons for not wanting to switch to electrical equipment include (i) the existing investment in diesel or gasoline-using machinery; (ii) the easy availability of retailer credit for diesel equipment; and (iii) the seasonal nature some activities (e.g., rice mills), which makes it difficult for them to pay the capacity-related portion of the electricity bill during idle months.

39/ This finding is consistent with the impact of RE which is commonly observed in recently electrified areas without significant pumping loads in other countries.

Policy Implications

2.26 The two sections above have reviewed evidence concerning residential affordability of RE and the development of productive uses for RE. The findings presented shed light on a number of policy issues associated with the RE program in Indonesia. These are discussed below.

RE Tariffs

2.27 Given existing PLN tariffs, minimum monthly RE bills appear to be affordable for between 50-75% of the households of average income villages, with a higher percentage in above average income villages, of which many remain unelectrified. The inability of the poorer 25-50% of the rural population to afford electricity at the current tariff is a matter of concern. It is possible that a policy to maximize the number of connections will improve the economic viability and the equity impact of RE in Indonesia. The economic merits of such a policy are explored below. For productive users, there may be some justification for introducing off-peak tariffs and even reducing the demand charge (if most of the demand occurs at off-peak times, as with rice mills). This issue, however, requires more detailed study.

Rural Electrification Credit Program

2.28 Initial connection costs do seem to reduce RE connection rates for both residential and productive use consumers. Here again, it is very likely that an appropriately structured credit program which is made available to all types of RE consumers (rather than just a limited number, as at present -- see para. 4.14), will significantly improve the affordability and the equity impact of RE in Indonesia.[40] The economic merits of this recommendation are explored below.

Productive Use Program

2.29 Despite the fact that USAID funded a pilot RE productive use promotion program in Central Java for several years, it is difficult to identify specific steps which PLN has taken to encourage the productive use of RE. A concerted effort on the part of PLN, or perhaps appropriate local organizations, is needed to provide businesses with information about potential uses of electricity. Steps are also needed to ensure that electrical equipment is readily available at reasonable prices. This is essential if RE is to compete effectively in the productive use market with alternative sources of commercial energy.[41]

40/ In many cases, *de facto* credit programs already exist for alternative energy technologies used by businesses.

41/ Bangladesh presents an interesting case where the Rural Electrification Board and the distribution cooperatives have taken a number of the steps described above. As a result of this, and other factors, productive use consumption far exceeds residential consumption.

RE Site Selection

2.30 The current RE site selection procedure gives priority to the electrification of kecamatan (subdistrict) seats and swasembada villages near the existing grid.42/ This approach is judged to be consistent, in general, with the objective of maximizing the economic benefits of RE since such areas typically have higher incomes, better infrastructure, and more access to Government programs. However, this selection procedure should be strengthened through more explicit consideration of productive use load potential.43/ This may be especially important in the case of Outer Island site selection since residential consumer densities are generally lower and economic viability depends more heavily on productive use load.

Benefits and Costs of RE

Methodology

2.31 The methodology used to estimate economic benefits can be explained most clearly in terms of residential RE consumers. Such consumers substitute electric energy for some previously-used source of energy (typically kerosene) and also increase their consumption of (electric) energy. Benefits to society from fuel substitution are measured by economic cost savings, while the benefits of increased consumption are measured in terms of willingness-to-pay.44/ The two types of gross benefits are shown as areas OCkAQk and QkBCQe

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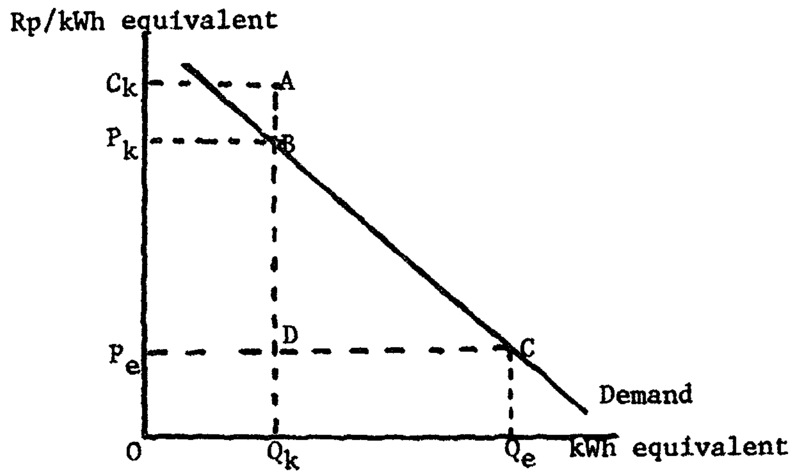
42/ For Repelita IV, first priority is to electrify 555 kecamatan seats, of which 1864 remain unelectrified, even if it means setting up a new diesel plant. Second priority goes to swasembada villages, if they lie within 3 km of a major grid or an isolated diesel system. These will account for about another 6,000 of the 7,000 villages to be electrified. Other villages will be electrified only if they have developable minihydro resources or lie in the path of a MV line built to serve one of the priority villages.

43/ In some cases, more flexibility in the site selection procedure is needed. For example, the procedure should permit a trade off between maximum allowable distance from the grid and magnitude of the projected load.

44/ The quantity of kerosene needs to be converted to electricity at the equivalent light output. The quality of energy obtained from kerosene and electricity is assumed to be the same for simplicity.

respectively in Figure 1 for an average consumer. Qk of kerosene (in kWhs equivalent) are consumed prior to electrification at a financial price of Pk per unit. After RE, Qe of electricity are consumed at a per unit price of Pe. Ck is the economic cost of kerosene (expressed in Rp/kWh equivalent).45/

Figure 1



45/ The shape of the demand curve between points B and C is not known with accuracy, and can be postulated to be either linear or concave. Since the consumer will value each extra unit of electricity (above his old consumption level Qk) somewhere between the old price Pk and the new price Pe, the presumption of the existence of some consumer's surplus benefits (i.e., the difference between the new price Pe and what the consumer would have been willing to pay for it - as indicated by the area BCD under the demand curve) is justified. To illustrate the implications of a range of shapes for the demand curve, the residential consumer's willingness-to-pay will be evaluated on the basis of including either 100% (the Base Case) or 50% (the Low Consumers' Surplus Case) of the area indicated by the triangle BCD. Either method will tend to underestimate the willingness-to-pay, as they neglect the value of the higher quality of light obtainable with electricity.

2.32 If the appropriate values of Qk, Qe, Pk, Pe, and Ck are known, the benefits of RE for a representative consumer can be estimated.46/ These benefits for a single consumer can be multiplied by the number of residential consumers in a village to get an estimate of total RE benefits for residential consumers in a given time period. Over time, these benefits will likely increase (for the same number of consumers) as personal incomes rise and their demand curves shift to the right.47/

2.33 Basically the same approach is taken for productive use consumers. However, due to general uncertainty about the extent to which RE is responsible for new economic activities, only cost savings benefits are estimated for productive use consumers. That is, all productive use consumers of RE are assumed to have switched from some alternative energy source (for both lighting and motive power uses) to electricity.

Parameters

2.34 A variety of parameters are required to implement the methodology described above. At the very least, estimates of Qk, Qe, Pk, Pe, and Ck are needed for average consumers of various types in a given village. Estimates or connection rates for these same categories of consumers are also required.

2.35 Despite the fact that RE has been going on in Indonesia for almost ten years, there is remarkably little data available which describes the RE experience to date. Thus the parameters which underlie the benefit-cost analyses presented here are gleaned from a variety of 1984 sources. Nevertheless, a considerable effort was made to derive a consistent set of parameters which is realistic in light of the RE experience to date and existing economic conditions in rural Indonesia.

2.36 Residential Consumers. Average residential electricity consumption (Qe) in average and above average income villages is determined to be approximately 30 kWh/month and 38 kWh/month respectively based on consumption data for such villages in Central Java.48/ Average equivalent kWhs consumed in the form of kerosene lighting (Qk) in average and above average income villages prior to RE are estimated to be 8.8 kWh/household/month and 11.7 kWh/household/month respectively. These estimates are derived from surveys of kerosene

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46/ An appropriate standard or consumption conversion factor should be applied to area QkBCQe.

47/ It is assumed that Qk and Qe increase by 4% per year based on the gradual accumulation of electrical appliances for which there is considerable pent-up demand.

48/ The share of the rural household's electricity consumption devoted to the various end uses is not known, but for urban households, a 1985 survey by PLN indicates the following (for small residential (R1) customers in Java): lighting - 62%, television - 11%, ironing - 11%, fans - 3%, water pumps - 3%, other - 10%.

use in average and above average income nonelectrified villages in Central Java.49/

2.37 Pe equals the average price per kWh for R1 category residential consumers in the PLN system. Thus Pe = Rp 85.2. Pk equals the financial price of kerosene/liter times the "equivalence factor" and plus the cost of kerosene lamps per kWh equivalent of lighting supplied. Thus Pk = (Rp 200 x 1.7) + Rp 8 = Rp 348. Ck equals the border price of kerosene/liter (adjusted for transport costs) times the "equivalence factor" plus the cost of kerosene lamps. Thus Ck = (Rp 268 x 1.7) + Rp 8 = Rp 464.

2.38 To evaluate the implications of the recent oil price declines, an alternative computation (the Low Oil Price Case) was computed on the basis a set of prices consistent with a crude oil price level of $18/barrel (compared to US$28/barrel used for the Base Case). Thus, in the Low Oil Price Case, Ck = (Rp 180 x 1.7) + Rp = Rp 314.

2.39 Initial connection rates are assumed to be 33% and 50% of village households for average and above average income villages respectively. These connection rates increase to 60% and 75% respectively by the 20th year of electrification.50/

2.40 Productive Use Consumers. Survey data from Central Java suggest that small electrified commercial and industrial customers consume about 87 kWh and 71 kWh per month respectively. Assuming this consumption is for lighting and simply replaces kerosene lighting, then Qk = 71 kWh or 87 kWh equivalent and Ck = (Rp 268 x 1.7) + Rp 8 = Rp 464.51/ Economic cost savings

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49/ See U.S. Bureau of the Census, op. cit. Kerosene consumption for cooking was subtracted from estimates of total kerosene consumption to derive estimates of average monthly kerosene consumption for lighting. Actual estimates were 15 liters/month and 20 liters/month for average and above average villages. This consumption was then divided by the "equivalence factor" for kerosene and electric lighting, i.e., 1.7 liters kerosene burned in a petromax light provides the equivalent of 1 kWH electric light, in order to determine equivalent kWHs consumed for lighting prior to RE. For a discussion of the equivalence between kerosene and electric lighting see Annex 10.

50/ No growth in the number of households per village is assumed.

51/ No growth over time in Qk per productive use consumer is assumed. Here also, Ck = Rp 314 in the Low Oil Price Case.

resulting from the electrification of a rice mill are estimated, based on PLN data, to equal Rp 2,044,000 per year.52/

2.41 Using a crude sample of electrified villages, it was determined that the number of commercial consumers tends to equal about 3% of the residential consumers. The corresponding figure for small industrial consumers is roughly 1%. This proportionality was assumed throughout the analyses for each village regardless of size or income level.

Results

2.42 Alternative economic benefit-cost analyses were done for five types of villages thought to be most representative of those electrified in Indonesia: (i) an above average income village of 700 households which is grid supplied; (ii) an average income village of 700 households which is grid supplied; (iii) an average income village of 300 households which is grid supplied; (iv) an above average income village of 300 households which is supplied by an isolated diesel unit; and (v) an average income village of 300 households which is supplied by a diesel unit.53/ For each type of village, the costs of supply were estimated on the basis of using the long-run marginal cost (LRMC) of electric energy down to (and including) LV level and capacity cost down to (and including) MV level, plus a specific estimate of LV distribution infrastructure costs drawn from PLN's current practices as budgeted for

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52/ This represents the estimated annual economic cost of operating a 22 horsepower diesel rice mill. Annual capital, operating, and fuel cost are estimated to be Rp 503,000, Rp 58,000, and Rp 1,483,200 respectively. The fuel cost measures the economic cost of approximately 5,860 liters of diesel fuel. In the Low Oil Price Case, the annual fuel cost is reduced to Rp 1,005,100 and the gross economic cost savings resulting from rice mill electrification are correspondingly reduced to Rp 1,565,900 per year.

53/ The size and income distribution of the 7,000 villages to be electrified during Repelita IV is not known with accuracy but, based on PLN's target of 1.7 million new RE customers, of which about 1.2 million would be in newly electrified villages, the breakdown of villages could be postulated as follows: Of the 7,000 villages, 3,425 will be in Java, 53 will be supplied by minihydro and the rest from the grid. About 37.5% of these villages could be type (i), 37.5% of type (ii) and 25% of type (iii). Of the 3,575 villages to be electrified outside Java, 2,228 are planned to be supplied by a local grid, 1,000 be diesel generation and 447 by minihydro. The 300 household village should be representative of this group -- about 50% would be above-average income and 50% of average income. Issues associated with the development of minihydro schemes in Indonesia have already been discussed in Indonesia: Power Sector Investment Review, World Bank, 1985.

the Repelita IV program.54/ The resulting estimates of economic benefits and costs of RE derived for each type of village using the methodology and parameters described above are summarized in Table 2.3.55/

2.43 The reference results presented in Table 2.3 contain a number of important findings. First, the economic justification for RE shows a wide range of variation depending on the type of village. As expected, the large, above-average income, grid-supplied village is at the high end of the range and the smaller, average income, diesel-supplied village is at the low end of the range. This is a reflection of the economies of scale of electricity supply, which favor a high density of consumers (as provided by large villages) at the distribution end, and large central station generation, rather than isolated diesel stations, at the generation end (provided transmission distances are not too long). These results thus serve to rank the types of village that are likely to be electrified on the basis of the economic efficiency justification for such investments. Basically, the use of economic criteria would give priority to the electrification of large, high-income villages located near an existing grid.

2.44 Second, the economic justification of village electrification is highly sensitive to underlying postulates about the villagers' willingness-to-pay for electricity. The villagers' willingness-to-pay is difficult to estimate in general, and this is particularly true in a country such as Indonesia, which its wide variety of natural, economic and social conditions, and the large differences in the cost and availability of alternatives to electricity, such as kerosene, diesel fuel and LPG. The report's estimates will therefore need to be treated with caution. In the absence of quantifiable externalities (and therefore of an efficiency argument to justify continued subsidies) the most prudent approach for ensuring that the scarce available resources for RE are concentrated on those villages that can benefit the most is to subject RE to a market test, i.e., by recovering a substantial proportion of the costs of RE from its beneficiaries. In view of the high costs of initial connection and the inability of the majority of the households to pay the initial connection charges, a feasible strategy would be for the Government to continue financing a large share of the initial investment requirements of RE, but to aim to recover the full costs through appropriate tariff policies. The financial and tariff implications of such a strategy are discussed in Chapter V.

54/ As per PLN's most recent estimate for the Java system, the LRMC of energy at the LV level amounts to 62 Rp/kWh (42 Rp/kWh in the Low Oil Price Case) and the LRMC of capacity at the MV level is 64 Rp/kWh, with a load factor of 26% - consistent with the mission's estimated structure of demand. (See PLN Tariff Level in 1986/87 Based on LRMC Approach, May 1986). The additional costs of LV distribution (including connections) ranges from 262,000 Rp/connection (43 Rp/kWh) in 700-household, above-average income grid connected villages to 546,000 Rp/connection (102/Rp/kWh) in 300-household average income grid-connected villages (See Annex 2).

55/ Detailed estimates of economic benefits and costs for each type of village are provided in Annex 2.

Table 2.3: ECONOMIC RATES OF RETURN OF RURAL ELECTRIFICATION BY VILLAGE TYPE

Village type:	Above-average income 700-household grid-supplied	Average income 700-household grid-supplied	Average income 300-household grid-supplied	Above-average income 300-household diesel-supplied	Average income 300-household diesel-supplied
Base case	27	18	9	4	(-1)
Low consumer's surplus case /a	20	11	5	(-5)	(-10)
Low oil price case /b	21	12	6	3	(-2)

/a Incorporates assumption that consumer's surplus of residential users is 50% of that estimated for base case.

/b Incorporates assumption that oil prices will stabilize at $18/barrel-level (vs. $28/barrel in base case). Specifically, the following price assumptions are made:

	Base case	Low oil price case
Fuel oil	$145/ton	$99/ton
High-speed diesel	$273/ton	$185/ton
Kerosene	$284/ton	$192/ton

Source: Mission estimates; see Annex 2.

2.45 Third, the economic justification of RE is also sensitive to the postulated future level of petroleum prices. This occurs because the benefits of electricity, i.e. the value of the cost-saving benefits (derived from the substitution of kerosene and diesel) and the villager's willingness to pay are entirely dependent on the cost of alternative sources of energy; while the costs of electricity supply are only partly related to the cost of energy. Basically, the recent decline in oil prices has reduced the overall economic justification for the RE program as a whole, both in a sectoral context - in relation to alternative means of supplying villages with energy -, and in a macroeconomic context - in relation to investments in other sectors whose benefits have been less affected by the decline in oil prices -. On this basis, the relative priority of the RE program as whole is not likely to be as high under current circumstances as it was when the Repelita IV investment program was formulated.

2.46 Finally, the reference results discussed above shed light on the economic justification for a RE program of the size contained in Repelita IV. This program aims to electricity 7,000 villages between 1984/85 and 1988/89, of which 5,600 are planned to be electrified from the grid, 1,000 based on diesel and 400 on minihydro. Thus by 1989 roughly 15,000 of the 65,000 villages in Indonesia would be electrified by PLN. To the extent that the villages to be electrified in Repelita IV are by and large similar, in terms of income, size and location, to the village prototypes analyzed above, the economic justification for the grid-based electrification of large, average and above-average income villages 57/ appears to be adequate.

2.47 The economic justification for RE investments in smaller, grid-connected villages should be regarded as weak, particularly after the recent decline in oil prices. The economic returns for such project, appear to be consistently below the opportunity cost of capital (estimated at 10-12%) and there is thus no efficiency justification for such investments. However, as indicated above, the efficiency justification is highly sensitive to the villagers' willingness-to-pay for electricity, and the mission's estimates in this regard have to be regarded as tentative. Given the possibility that the willingness-to-pay may exceed th estimates postulated in this report, prudent management of investments would indicate that the smaller villages be electrified only if RE can pass a market test, i.e., if the village is willing to make a commitment to and establish a framework necessary for reimbursing the Government for a substantial share of the fuel costs of electricity supply. The conditions and requirements for the implementation of such a strategy are discussed below in Chapter IV.

2.48 The economic justification for RE based on diesel generation appears to be inadequate to justify the investments. The GOI is aware of this and, as indicated in para. 2.30, uses stricter criteria for electrification by diesel generating sets than by grid extension. In fact, for Repelita IV, the planning of new diesel systems is limitec to kecamatan (subdistrict) seats, of which 1,864 remained unelectrified in 1984 and 555 will be electrified during

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57/ Which predominate in Java, Bali, West Nusa Tenggara and South Sulawesi.

Repelita IV. The remaining diesel based villages on the electrification program are swasembada villages that lie within 3 km of an existing or new diesel system. The priority given to kecamatan seats is a reflection of the GOI's geographical distribution priorities, and may be expected to coincide with concentrations of public and private services. Nevertheless, the high costs of diesel based electrification suggest the need for the GOI to carefully plan and review the feasibility of diesel-based village electrification on a case by case basis, with particular attention to careful site selection in the light of the GOI's regional distribution priorities, reducing unit costs, evaluation of the market including that of productive users and mobilization of local participation.

Summary

2.49 Overall, the justification for a RE program as proposed to be carried out in Repelita IV needs to be carefully reconsidered in the light of the impact of the recent decline in oil prices, which has not only affected its relative priority, but also severely reduced the availability of public resources for all types of investments. On the basis of the analysis presented above, only the grid-based electrification of large villages appears to have adequate economic justification. The electrification of smaller villages, and those that are isolated and require diesel generation, will yield only marginal or inadequate returns unless they are subject to a more rigorous selection procedure, such as the proposed market test, or other ways can be found to increase the benefits and reduce the costs of electrification.

2.50 As discussed before, the large number of smaller villages included in the Repelita IV electrification targets is a reflection of the Government's geographical distribution and rural development objectives. These objectives are basically sound, and are designed to focus electrification investments in villages, both kecamatan seats and swasembada, that concentrate public and private activities and are likely to benefit the most from electrification. However, while the social and distributional consequences of postponing the electrification of small and isolated villages may outweigh the risks of limited rates of return, the deteriorating resource position of the Government makes it unlikely that the electrification targets can be achieved at the rates envisaged in the Repelita IV program. The economic rates of return would then provide a crude but necessary criterion for reducing the RE program while preserving the greatest possible amount of benefits. To reduce the need for such reductions, the mission recommends that the Government explore the available options for increasing the efficiency of investments and mobilization of non-government resources devoted to RE, such as those that will be discussed in this report.

Economic Implications of Raising Electrification Ratios

2.51 The results presented above in Table 2.3 indicate that economies of scale of low voltage distribution are the principal factor explaining the difference between the adequate rates of return estimated for large villages and the inadequate rates of return projected for small villages. As the economics of scale are related to the number of customers that can be reached with a given investment in distribution infrastructure (i.e. the load density) it is useful to explore the economic implications of policy options to increase within-village electrification ratios.[58/]

2.52 Complete vs. Partial Village Electrification. The Base Case analysis assumes that when a village is electrified all households in it are given the opportunity to connect. Depending on average village income, between 33% and 50% of total village households are assumed to connect initially. A sensitivity analysis was done to determine how PLN's frequent practice of offering electricity supply to only part of a village affects the economic returns to village electrification. In this analysis, it was assumed that only one-half of village consumers were offered electricity supply. Connection rates for eligible consumers were assumed to be the same as in the Base Case. Consequently, economic benefits of RE are reduced by one-half. Economic costs, however, are reduced by a smaller amount due to diseconomies of small scale. The result is that rates of return to RE investments are reduced. For example, the ERR for the grid-supplied 700 household above average income village is reduced from 27% to 19%. Thus it is clear that economic efficiency favors higher rather than lower within-village connection rates, at least to the extent that the additional connections can be made without significant investments in infrastructure. This conclusion is explored further below.

2.53 Expanded Credit Program. PLN's high initial lump sum charges clearly reduce the rate at which RE consumers connect. This, in turn, reduces the economic return to RE investment. An important question is whether an expanded program which makes credit available to all RE consumers for initial connection costs is justified economically.

2.54 It is the mission's estimate that such a credit program [59/] would increase initial connection rates in average income villages from roughly 33% to at least 45%.[60/] Similar relative increases in the connection rates of productive use consumers are also likely.

2.55 For an average income, 300 household village supplied from the grid, these higher connection rates imply an increase in the economic return to RE from 9% in the Base Case to 11%. In net present value terms, an expanded credit program increases the net discounted economic benefits derived from

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58/ For simplicity, the following sensitivity analysis has adopted the Base Case as the starting point. The direction and magnitude of the changes described below are expected to be the same as if the Low Consumers' Case or the Low Oil Price Case had been used as the point of reference.

59/ Similar to the one (see paras. 2.17 and 4.14) which is made available by PLN to limited numbers of residential consumers.

60/ Connection rates would likely rise to about 70% after 20 years, as compared to 60% in the absence of credit.

electrifying such a village by about Rp 12.9 million.[61/] Since these benefits far exceed the long-run cost of providing credit, there is clearly a strong efficiency justification for expanding this type of credit program. This justification also exists when credit is made available to larger, or higher income, villages. Moreover, a credit program would certainly improve the distributional impact of RE.

2.56 No Connection Charge. As discussed before (para. 2.19), in average income villages, between 50-75% of the households can afford a monthly electricity bill of about 1,230 Rp (corresponding to about 10 kWh/month), but given the existing initial lump sum payment and limited credit availability, Base Case residential connection rates are likely to start out at about 30-35%. Even with an expanded credit program, the monthly debt repayment of about Rp 1,550 (over the first four years) would tend to limit initial connection rates to about 45% of village households.

2.57 In view of the benefits of higher within-village connection ratios to RE, already demonstrated in previous sensitivity analyses, it is of interest to check the implications of reducing the barriers to connection even further by abolishing the connection charge of Rp 30,000 for small residential (R1) customers in rural areas [62/] and redirecting the RE credit to cover housewiring expenses (of about Rp 30,000-65,000 per household). In the mission's estimate, such a policy would increase initial connection rates in average income villages from about 45% (in the Expanded Credit case) to about 66%, but the average consumption of the additional customers is likely to be only half (i.e., 15 kWh/month) that in the earlier case (30 kWh/month).

2.58 For an average income, 300 household village supplied from the grid, the postulated change in policy would increase the economic rate of return from 9% in the Base Case to 12%. In net present value terms, this policy change would increase the economic benefits from such a project by about Rp 25.2 million, or about Rp 126,000 for each of the 200 customers that are expected to initially connect. Here again, since these benefits far exceed the cost of eliminating the connection charge (of 30,000 Rp/customer) and the cost of the credit (with a maximum of 65,000 Rp/customer) there is good economic justification for implementing the postulated policies.

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61 This is equivalent to about 96,000 Rp for each of the 135 customers (45% of 300 households) that are expected to connect initially. Thus, even if all of them require a credit, the net benefit will exceed the cost of the credit (assumed to be a maximum of 65,000 Rp/household).

62/ The loss of revenue from eliminating the connection charge, equivalent to about 4% of invstment costs, would have to be compensated by a corresponding increase in the capacity charge in order not to increase the financial losses associated with RE. Such a rollover of the connection charge into the demand charge would accomplish the objective of increasing the affordability of RE.

2.59 Maximum Connections. As indicated above, both the economic rate of return of RE, as well as the electrification ratios can be substantially improved through an expanded and redirected credit program and the rollover of the connection charge into the demand charge. However, even with the implementation of such policies there remains about 25-50% of the village population (in average income villages) which cannot afford the minimum monthly electricity bill under the current tariff. As the welfare of this poorer part of the population is as important as that of the other parts, it is of interest to explore the implications of a policy to maximize the number of connections within each village, i.e., to make electricity affordable to all the households that can be connected within the village cluster without significant extension of the LV infrastructure.

2.60 For the purposes of illustrating the implications, the mission assumed that it would be possible to connect 99% of the households,63/ and that the average consumption of the additional 33% of households is going to be only 7.5 kWh/month, i.e., just sufficient to replace their current level of kerosene use for lighting. For the economic analysis , it was not necessary to postulate a tariff level that would apply to this level of consumption, but for the analysis of financial implications, it was assumed that the consumers of less than 10 kWh/month would be exempt from the demand charge (i.e., 7.5 kWh/month would be equivalent to a monthly electricity bill of Rp 529), which would appear to be in the approximate range for affordability in the lowest quartile of the population (see Table 2.2). A complementary measure that would be necessary to maximize the electrification ratio would be a further expansion of the credit program to cover the housewiring costs of the additional customers.

2.61 When the above assumptions are evaluated for the case on average income 300 household village supplied from the grid, the economic rate of return of RE is 12%. In net present value terms, this policy change would increase the economic benefits from such a project by about Rp 24.5 million, or about Rp 82,000 of each of the 297 beneficiary households. Once again, these benefits appear to exceed the cost of eliminating the connection charge and the cost of providing a credit for those customers that need it (assuming that about two-thirds of households will need one.) Thus the economic justification for the postulated strategy of maximizing connections appears to be strong and the social welfare implications, although hard to estimate, are likely to be extremely favorable. The mission therefore recommends that the GOI consider the adoption of appropriate policies to maximize the within-village electrification ratios. The financial implications of such policies are evaluated in Chapter V.

63/ The assumption that 99% of the households would be located in a compact cluster and could be reached with minor extension of the LV infrastructure, is not meant to be representative of any specific village in Indonesia, but only intended to illustrate the postulated policy. While the mission has no information on the number of hamlets per village, the average size of villages in many regions suggests that the existence of 300-household or even 700-household compact clusters does not appear unrealistic.

III. TECHNICAL APPROACHES TO COST REDUCTION

Introduction

3.01 Electrification of rural areas, as compared to urban centers, is characterized by low consumer density, low equipment capacity utilization, low load factors, high capital and operating costs per unit of consumption and low sales revenues per customer. As a result, in view of the growing importance of the RE program in Indonesia and the country's tightening financial constraints, it becomes imperative to review the technical design, construction standards and installation practices adopted for the program, with the objective of assessing their optimality in the light of rural conditions. With this as the objective the present chapter reviews design features and costs of the individual components of the RE systems including grid substations, medium voltage (MV) lines, transformer stations, low voltage (LV) lines and diesel generating stations and identifies potential measures for cost saving. The chapter continues with a discussion of system optimization including such aspects as equipment sizing, power factor correction and distribution system planning and coordination, through which additional cost savings could be realized. Methods for procurement of RE equipment and materials and installation practices adopted are also considered as significant parameters in the overall cost reduction exercise. The policy implications of the discussion are presented in a final section.

PLN's General Approach to Rural Electrification

3.02 Rural electrification, as carried out by PLN, is undertaken from the 20 kV medium voltage (MV) grid as well as from isolated diesel generator stations. Electrification from the grid is restricted to those villages which, apart from other selection criteria, do not require more than about 3 km of 20 kV line extension. Electrification by diesel generator sets (limited to the Outer Islands) provides service for remote villages that cannot be reached by a grid but qualify on the basis of selection criteria that are stricter than those required for grid extension (see para. 2.48).[64/] At present no distinction is made in the standards of design and construction between urban and rural areas and the costs of system components -- main grid substations, medium voltage feeders, low voltage distribution transformer stations and low voltage distribution lines -- are higher than what would be warranted for supplies to rural areas. While PLN has recently started to formulate revised standards for rural areas, the practical implementation of the revised standards has not yet begun. Both the revision of standards and their imple-

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64/ PLN currently operates about 350 diesel systems, with a total capacity of about 681 MW equivalent to 15% of its total generating capacity, but 51% of its capacity outside Java. By the end of Repelita IV (i.e., by 1989), the number of diesel systems is planned to increase to about 600, accounting for 1,437 MW, or about 60% of PLN's capacity outside Java. About half of PLN's diesel systems are reported to provide 24 hour/day service.

mentation needs to be accelerated to take advantage of the large potential savings.

Review of RE System Components

Main Supply System Configuration

3.03 The main high voltage (HV) transmission lines in Indonesia (apart from a 500 kV extra-high voltage (EHV) backbone line), operate at 70 kV and 150 kV. Power is stepped down to the medium voltage (MV) level of 20 kV through grid substations; 20 kV serving as subtransmission and primary distribution voltage. Grid substations are sized for transformer capacity of 10 to 20 MVA (some substations in high load density urban areas have two 16 MVA or two 20 MVA transformers), are spaced at distances of 30 to 40 km and generally have four outgoing 20 kV primary main feeders. This system configuration is sound and optimally suited for power supply in the more densely populated areas. As supplies reach the lower density rural areas, consideration will have to be given to smaller substation transformer sizes in the range of 5 to 10 MVA.

The HV/MV Grid Substations

3.04 The few grid substations visited by the mission exhibited a diversity of design features with regard to land area, equipment layout, HV and MV switching arrangements, substation building size, layout and facilities. Annex 11 presents cost estimates for grid substations of 150 kV and 70 kV having 10 MVA and 20 MVA transformers. The unit costs per kVA are summarized in Table 3.1, which also shows comparative costs of sub-stations in two neighboring countries.

Table 3.1: COST OF GRID SUBSTATIONS

	Indonesia			Thailand /a	Philippines /a
	Actual /b	Reference /c			
Voltages HV/MV(kV):	70/20	70/20	150/20	69/22	66/12
Capacity (MVA)	20	20	20	40	5
Cost (US$/kVA)	50	81	112	28	34
Capacity (MVA)	10	10	10	--	--
Cost (US$/kVA)	87	149	206	--	--

/a Source: Regional Rural Electrification Survey, Asian Development Bank, 1983 (1983 costs escalated by 30%).
/b Based on actual construction cost of a substation in East Java.
/c Based on reference costs used by PLN Pusat.

3.05 The costs per KVA of grid sub-stations appear to be higher than necessary and, since no standard design and costing practices have been established, the actual and reference cost figures within the country itself vary in the ratio of about 1:1.6. Some reasons for the very high costs appear to be: (i) frequent use of the duplicate bus bar system with bus section breaker for both HV and MV voltage levels, (ii) excessive land area acquisition, (iii) overdesign of station building and provision of expensive architectural features, ample rest rooms, air conditioning, etc. and (iv) costly HV bus structures and bus system design. Other reasons could be source of funding for imported components, procurement of equipment and consultants employed.

3.06 Currently most substations are designed to serve urban areas. However, as electrification is extended to more remote areas, where load densities are low, substation costs would become significant in the overall costs of electrification and PLN should consider dropping some of the non-essential features of design (which may be justifiable for high capacity urban substations). In particular, the mission recommends the following:

(a) A comparative study of 150 kV versus 70 kV transmission voltage, where the choice is relevant. The transmission and substation costs are much lower at 70 kV level, but this may be offset by other factors such as higher losses, etc.

(b) The development of standardized substation designs and costing practices with emphasis on cost minimization, considering the following factors:

   (i) Use of single HV and MV bus bar arrangements and no sectionalizing facilities;

   (ii) Minimization of HV switching costs, especially for the less important substations, through means such as tapping of HV lines instead of bussing, using isolators instead of circuit breakers for lines and transformers, using group switching of transformers, and simplifying bus work designs;

   (iii) Minimization of land area and building sizes and facilities.

(c) A study of substation equipment specifications giving consideration to outdoor MV switching arrangements (which are likely to be cheaper) reviewing the scope for reducing costs in the auxiliary, control and protection system designs.

3.07 PLN is already developing and implementing multiple standards for grid substations, depending on the load density of the areas to be served. When these standards are implemented in rural areas, it should be feasible to reduce grid substation costs by at least 30%.

Medium Voltage (MV) Primary Distribution System Configuration

3.08 Three types of MV distribution systems have evolved in Java, based on the system propounded by the country originally funding major electrification in the particular area and the consultant designing the system. Thus in Central Java the system is a three phase, four-wire system having multiple grounding of the neutral and utilizing single phase (phase to neutral) primary distribution for low load density areas. Transformers are single phase or three phase comprising three single phase banks. In East Java, the system is a three phase, three wire, high resistance grounded neutral (i.e., normally effectively ungrounded) system, provided with shield wire for lightning protection. The transformers are predominantly three phase with single phase units connected line to line for low loads. In West Java, the system is a three phase, three wire low resistance grounded neutral (i.e., normally effectively grounded but at times non-effectively grounded) system. The transformers are predominantly three phase with single phase units connected line to line for low loads. All the systems are radial, which is an inherent economic feature.

3.10 PLN considers the system used in West Java to be the most economical, but while it has decided to adopt that system in the Outer Islands, it retains the existing three different systems in the three parts of Java. Considering that the primary distribution systems have extended fairly widely in Java, there is merit in PLN retaining these systems; although there should be no problem in changing the system even in these areas when starting afresh with a new grid substation, as the radial feeders from one substation are not intended to be interconnected with feeders from other substations. The following suggestions are, however, made for reducing costs:

(a) Elimination of shield wire (and consequent reduction of pole height) and use of pin type (instead of post type) insulators for the East Java system. There is no evidence of better line performance with shield wire.

(b) Use of pin type insulators with cross arms (instead of pole mounted insulators) for Central Java

(c) A review of the economics of single phase primary distribution in Central Java, in view of high life cycle costs (See Table 3.2 and Annex 12 which indicate much higher life cycle costs for single phase (phase to neutral) distribution.)

Table 3.2: COSTS OF SINGLE-PHASE VS. THREE-PHASE MV DISTRIBUTION /a
(US$/km)

	Present Value of Costs /b		
	------ Loading (kW) -------		
	500	750	1,000
Single Phase (Phase to Neutral)	3,601	5,768	8,803
Two Phase (Phase/Phase to Neutral)	3,187	4,541	6,548
Single Phase (Phase to Phase)	2,488	3,211	4,222
Three Phase (3-wire)	2,488	2,849	3,355

/a For 35 mm^2 conductor size.
/b Present value of 15-year life cycle costs, discounted at 10%.

Low Voltage (LV) Secondary Distribution System

3.11 Low voltage distribution has been standardized as a 220/380 V system, with single phase 2-wire service for loads up to 10 kVA, single phase 3-wire service for loads between 10 and 25 kVA and three phase 4-wire service for loads between 25 and 500 kVA. The system is planned for a voltage regulation of +5% and -10%. This system is considered to be appropriate for RE in Indonesia.

MV and LV Line Design - Mechanical Considerations

3.12 The MV and LV distribution lines are constructed on poles. Steel and wood poles were used in the past but PLN has now standarized on concrete poles, predominantly of the prestressed type. Both hollow circular spun and rectangular virandal type poles have been standarized and are manufactured by several factories in the country. The standard prestressed concrete pole designs are indicated in Annex 13.

3.13 The design and costing of the distribution lines are based on a span length of 50m (20 poles per km) for the MV lines and 40-50m (20-24 poles per km) for the LV lines and no distinction is made between lines for urban and rural areas. Annex 14 gives the cost breakdown of lines in terms of poles, hardware, insulators and conductors, as furnished by PLN's regional offices. The poles appear to be overdesigned, at least for rural applications. It is suggested that pole designs for rural areas be reviewed based on design analysis given in Annex 15. This analysis is only an illustration and not a substitute for detailed technical analysis. With the proposed shorter poles of lower strength rating than used at present and adoption of longer spans, the comparative costs of poles per km of line would be as indicated in Table 3.3. Even longer spans could be considered for lower conductor sections, resulting in further economy. It is understood from subsequent Bank missions that PLN has already increased the spans for distribution lines which would result in line economy. A detailed optimizing exercise considering spans, clearances and pole sizing is warranted.

3.14 Another approach to reducing the cost of poles for LV lines could be through manufacturing them on location. While steel and cement would have to be transported to the site, the cost of materials is likely to be less than half of the current price of the poles (which includes transportation and erection), which in turn accounts for about 10% of the cost of LV lines. The cost savings associated with local manufacture could be significant. In addition, the local manufacture of poles could be managed by a village electric organization so as to provide means for its members to earn or contribute the equivalent of the connection fee and other initial payments necessary to become a customer of electricity.

Table 3.3: COMPARATIVE COSTS OF POLES PER KM OF LINE

		Line span (m)	No. and types of poles	Cost of poles /a per km (US$)	Overall reduction in line cost (%)
	MV (20kV) Lines				
(a)	Present design (all conductors)				
	(i) East Java	50	21, 14m (350 daN) /b	6,650	
	(ii) Central Java	50	21, 13m (350 daN)	5,910	
(b)	Proposed design				
	(i) 240 mm^2 conductor	65	16, 9m (300 daN)	1,970	20%
	(ii) 150 mm^2 and lower conductors	65	16, 9m (200 daN)	1,610	25%
	LV (400 V) Lines				
(a)	Present design	40	24, 9m (200 daN)	2,640	
(b)	Proposed design	50	20, 8m (100 daN)	1,235	15%
	MV+LV Lines				
(a)	Present design	50	21, 13-14m (350 daN)	6,650	
(b)	Proposed design	55	19, 10m (300 daN)	3,140	15%

/a Cost of a pole is assumed to be proportional to square of the height and square root of the strength as deduced from PLNs cost figures.

/b 1 daN = 1 kg of force (approximately)

Labor Costs for Construction

3.15 It is general practice of PLN to let out on contract all distribution construction work. As labor costs are combined with other items (e.g., the cost of poles includes transport and erection at site) it is difficult to segregate actual labor cost. Table 3.4 indicates comparative installation labor cost figures for lines and transformer stations.

3.16 These installation labor costs appear high and need to be analyzed carefully. It is suggested that the installation labor costs for RE lines should be of the order of about US$700 per km of MV line and US$500 per km of LV line. This would result in overall reduction of about 5% in the cost of MV lines and about 3-4% in the cost of LV lines.[65]

Table 3.4: LABOR COSTS FOR INSTALLATION
(US$)

	East Java/a	Central Java/a	Thailand/b	Man-day Basis/b
MV Line (1 km)	1,013	1,700	412	260
LV Line (1 km)	940	750	412	260
Transformer Station (100 KVA 3-phase)	-	700	119	50

/a These "labor" costs include transport cost of poles and other materials to the site.
/b Source ADB's Regional RE Survey (1983 costs escalated by 30%).
/c Based on 80 man-days per km of line (this is twice the man-day requirement in Fiji) at an average cost of Rp 3500 per man-day (source East Java Distribusi) and 15 man-days for transformer station.

Line Hardware

3.17 Detail costing for MV and LV line insulators and hardware has been obtained for East Java and tabulated in Annex 16. The costing is based on use of expensive post insulators for MV lines (as against pin insulators), pin insulators with cross arms for LV lines (instead of spool insulators), shield wire (which is not necessary) and larger than necessary number of insulators. Annex 16 gives the suggested quantities and costs. A summary of overall cost comparison is shown in Table 3.5.

65/ The Government's policy to foster the development of smaller local contractors by splitting up the installation work into 10-20 km packages may also be contributing to higher installation labor costs, at least in the initial years, when the new contractors are still in a learning phase.

Table 3.5: COMPARATIVE COSTS OF INSULATORS AND HARDWARE PER KM OF LINE (US$)

	East Java	Suggested	Thailand /a
MV Lines	4,470	2,165	1,359
LV Lines	2,050	620	437

/a Source: ADB's Regional RE Survey (1983 costs escalated by 30%).

The above cost reductions would result in approximately 13% reduction in the costs of both MV and LV lines.

Line Conductors - Material Selection and Sizing

3.18 PLN has standardized on the use of all aluminum alloy conductors (AAAC) for both MV and LV lines. For the spans proposed for rural lines and the range of temperature variations encountered, the maximum tensions obtained are well within the capability of all aluminium conductors (AAC), as shown in Annex 15. AAC conductors would be about 10% cheaper than AAAC conductors and would have about 15% lower losses. Their use would reduce the overall cost of lines by about 3%.

3.19 PLN has stand· ~dized on the following conductor sizes:

Table 3.6: CURRENT CONDUCTOR SIZES (mm^2)

	Central Java	East Java
MV Lines		
Mains	240 and 150	150
Laterals	70	70
LV Lines	70 and 50	70 and 50

3.20 Economic studies have been made in the past by PLN's consultants for the selection of conductor sizes, but these do not take into account up-to-date estimates of LRMC (peak and off peak), distinction between urban and rural load growths and ¹oad factors. Annex 17 outlines a suggested method for evaluating the comparative costs of conductors and losses on a life cycle basis. The method takes into account the nature of urban and rural daily load curves, load factors and rates of load growth and long run marginal capacity and energy costs, during peak and off peak periods. The results of the analysis are presented in Annex 17 and a summary of optimum conductor sizes is presented in Table 3.7.

Table 3.7: OPTIMUM CONDUCTOR SIZES FOR VARIOUS LOADINGS

Final Demand		Optimum Conductor Size /a			
		Urban		Rural	
		60% Load Factor, High Growth Rate		30% Load Factor, Low Growth Rate	
MV	LV	MV	LV	MV	LV
- kW (0.8 p.f) -		---------- Conductor mm^2 ----------			
500	5	35	25	35	10
1,000	10	70	35	35	25
1,500	15	70	70	35	35
2,000	25	150	70	70	70
3,000	50	150	70	70	70
4,000		240		150	
5,000		240		150	

/a The table is illustrative and not exhaustive as only a few standard conductor sizes have been considered

3.21 The above table illustrates that for rural type of loads, compared to urban type of loads, it would be more economical to use one size smaller conductor than what has been standarized at present. This would result in overall line cost reductions of the order of 10 to 15% for the rural areas. However, proper analysis of loads is necessary, on a case by case basis, before arriving at the choice of conductor size.

Transformer Station Costs

3.22 The present day costs of 50 and 100 kVA pole mounted rural transformer stations are shown in Annex 18. Suggestions for cost reduction include elimination of expensive control box and cables and reduction in concrete pole and labor costs. This would result in cost reduction of about 16 to 23% depending on the size of the transformer.

Transformer Sizing and Loss Evaluation

3.23 PLN has standardized transformer ratings as 3-phase 50, 100, 160 and 200 kVA and single-phase 10, 25, 37.5 kVA. As transformers can be readily replaced when load grows, the smallest possible transformer size would generally be the optimal. Hence consideration should be given to standardizing transformers at lower than present ratings, especially when smaller villages come within the electrification program in the future. The general practice followed by PLN is to size transformers for the 5th year forecast load replacing transformers at the end of this period. This practice is appropriate. Losses are evaluated by PLN at the rate of US$3600 per kW for iron loss and US$460 per kW for copper loss.

3.24 The analysis presented in Annex 19 evaluates the present value for two alternative transformers sizing methodologies (i) installing say a 100 kVA transformer at start and replacing it by a 200 kVA transformer after the fifth year and (ii) installing a 200 kVA transformer at start. With the transformer costs and loss figures assumed, the following present value figures are obtained.

Table 3.8: COMPARATIVE COSTS OF TWO TRANSFORMER INSTALLATION METHODOLOGIES

	Present Value of Costs	
	Urban load factor and growth rate	Rural load factor and growth rate
	(US$)	
(a) 100 kVA transformer replaced by 200 kVA unit in fifth year	14,908	8,013
(b) 200 kVA transformer used from start	12,502	8,562

3.25 The above figures indicate that while in rural areas it would be desirable to install lower rated transformers at start, this may not be so in urban areas.

3.26 The evaluation of incremental iron and copper losses for transformers, on similar lines as optimization of conductor sizes given in Annex 18, indicates that with the assumed long run marginal costs of capacity and energy at peak and off peak times, the value of 1 kW of iron loss is US$5070 (as against US$3600 used by PLN) while the value of 1 kW of copper loss is $790 for rural loading and $2160 for urban loading (as against US$460/kW used by PLN).

3.27 The above results point to the need for careful analysis of transformer sizing and loss evaluation, for optimization of transformation costs.

Low Voltage Lines (Insulated versus Bare Conductors)

3.28 PLN and their consultants have made comparative cost studies for low voltage lines having (i) insulated bundled wires and (ii) bare conductors, and have come to the conclusion that bare conductor lines are about 2% cheaper. The analysis (see Annex 20) appears to be biased in favor of insulated conductors by: (a) allowing for higher poles for bare conductor lines, which is not necessary, (b) assuming clevis insulators at more than the necessary number of locations, (c) assuming aluminium alloy (AAAC) for bare conductors and all aluminum (AAC) for insulated conductors and (d) considering only the larger conductor sections. If these biases are removed, the mission estimates that bare conductor lines would be about 13% cheaper. While insulated conductor lines would be suitable for urban areas, due to problems of right-of-way clearances and electricity theft, their use in rural areas may not necessarily be justified (the likelihood of theft by direct line tapping is very low in rural villages) except in circumstances where excessive tree cutting is required. Hence the decision to standardize on insulated wire for all LV rural lines needs to be reviewed, especially for remote low demand villages, where the need to cut down on costs is vital.

Isolated Diesel Systems

3.29 With regard to the design of the distribution system itself, the analysis presented in the previous paragraphs for supply from the main grid, is equally applicable to supply from isolated diesel generating stations. In so far as the diesel generating stations are concerned, the following observations are pertinent:

(a) Although PLN has standardized on 40 kW and 100 kW sets, the present tendency is to use 100 kW sets only. In the initial years of electrification, the rural loads are low. The fuel efficiency of the diesel engine deteriorates rapidly at partial loads and the fuel consumption at 10% loading may be as high as four times the fuel consumption at full load.[66] To remedy this imbalance, PLN is currently studying the possibility of tailoring diesel generator sizes to the needs of the load, starting with lowest feasible set rating and replacing with higher rated sets as load grows. For low load density villages it would be desirable to start with 20 kW sets with replacement by 40 kW and 100 kW units. Under the proposal being considered by PLN, the diesel sets would be relocated among the villages on the basis of load. For larger diesel stations multiple size sets in one installation would result in fuel economies.

(b) The cost of a diesel generating station presented in Annex 21 indicates scope for cost reduction through:

(i) simplification and standarization of diesel generator house and operator's residence;

(ii) elimination of costly foundatiors by using transportable skid mounted sets;

(iii) simplifying electrical and mechanical accessories.

66/ Several of the diesel systems on which the mission obtained information reported fuel consumption rates of over 1.0 liter/kWh.

3.30 A detailed analysis of costs has not been made, but a preliminary study prepared with the assistance of the Netherlands estimated that it should be possible to reduce the overall costs by 20% to 30%.[67]

Service Connections

3.31 Service connections are made with multiple, self-supporting, copper conductor, service drop cables. All consumers are metered. The cost estimate for a single-phase service connection of 30 m length, as provided by East Java distribution is indicated in Table 3.9.

Table 3.9: COST ESTIMATE FOR SERVICE CONNECTIONS

Item	Estimated cost US$
Service Drop	
Cable (30 m, 2 x 10 mm^2)	33
Accessories	31
Service Entrance	10
Meter Board	
1-phase kWh meter	17
Accessories	11
Material Cost	102
Labor	14
Transport	3
Total Cost	119

3.32 The cost is considered to be high and it is felt that there is scope for reduction by about 30% through review of the design and construction standards and economic procurement practices. When it is noted that the cost of service connections for supplying a village of about 700 households, could be as much as the cost of the MV and LV networks and the distribution transformer, every effort at reducing the cost of service connections is merited in the context of reducing the overall cost of the RE program.

67/ Indonesia: Power Generation Efficiency Study, Report of the Joint UNDP/World Bank Energy Sector Management Assistance Program, February 1986.

Overall Potential Cost Reduction for RE Systems

3.33 The overall impact on the costs of rural electrification through incorporation of various suggestions made in the report would depend on the configuration of the total RE system. A typical estimate of cost reduction that could be achieved for a rural electrification system drawing about 5 MVA of power from a grid substation is presented in Table 3.10.

Table 3.10: OVERALL COST REDUCTION IN AN ILLUSTRATIVE RE SCHEME

System Component	Present Costing (US$)	Potential Cost Reduction %	Revised Costing (US$)
(a) 150/20 kV 20 MVA, grid substation, pro-rata cost for 5 MVA	560,000	30%	392,000
(b) 20 kV medium voltage network 100 km	1,300,000	32% /a	884,000
(c) 400 V low voltage network 400 km	3,000,000	30%	2,100,000
(d) Distribution transformer stations, 100 Nos.	400,000	20%	320,000
Total	5,260,000		3,696,000
Net percentage cost reduction		29.7%	

/a Although the present study estimates overall reduction of about 46% a smaller figure is used as PLN is understood to have already started increasing the line spans.

Power Factor and Voltage Regulation

3.34 Some of the substations and isolated diesel generator stations were found to operate at very low power factors, of the order of 0.75 lag. With the high costs of capacity and energy supply to rural areas, system losses (especially at peak time) acquire great significance. As losses in the distribution network vary inversely with the square of the power factor and the rural peak substantially coincides with the system peak, maintenance of good power factor becomes a vital issue. While this matter is being actively addressed under the loss reduction program undertaken by PLN for the existing systems, the following aspects need to be given attention in future RE system designs.

(a) Studies for optimizing the costs of distribution systems through proper timing, sizing and location of power factor correcting capacitors is important. By way of example, computation of present worth of life cycle costs for a MV 240 mm^2 conductor line with 0.8 and 0.9 power factors with an ultimate loading of 5000 kW, shows a saving of US$2,558 per km of line (Annex 22). For a 20 km line the saving would be approximately US$50,000. The cost of a 2,500 kVAR capacitor bank for improving the power factor from 0.8 to 0.9 would be about US$30,000 to US$38,000 and its installation could be justified right from the start, although actual capacitor application would be phased. The costs/benefits of capacitor application are well known and are not repeated here.

(b) The predominant load in rural areas is domestic lighting using fluorescent and incandescent lamps. Although fluorescent lamps are more expensive than incandescent lamps (Rp 4700 for a 20 W fluorescent lamp versus Rp 700 for a 60 W incandescent lamp) their use should be encouraged in order to reduce the kW loading. However, as fluorescent tubes have a very low power factor, the use of power factor correcting capacitors (costing Rp 700) should be made mandatory, e.g., through standardization of household wiring schemes. Likewise mandatory power factor requirement of 0.9 lag or better needs to be enforced for industrial and other motive power users.

RE Equipment Procurement and Installation Costs

Procurement and Storage of Equipment

3.35 Prices for RE equipment in Indonesia vary considerably depending upon the source and method of procurement, apart from inherent cost differences due to different specifications used in Central, East and West Java. It was noted that the price differential could be as high as 30% between items obtained by PLN's regional offices from local sources and items centrally bulk procured by PLN, also from local sources. Problems associated with central procurement are: (i) delays due to the lengthy procurement processes and (ii) the inadequacy of the central storage space. If these two problems are resolved, considerable economies would be achieved in the cost of RE equipment. International competitive bidding (ICB) would result in further lowering of equipment costs, when compared to local procurement or procurement under tied bilateral financing.[68/]

Installation Costs

3.36 The high costs of installation on contract have been touched upon in para. 3.16. It is debatable whether the entrusting of pole transport and erection to the pole manufacturer in remote rural areas is the most economical method, as it makes it difficult to evaluate the actual cost of poles. Likewise, the very high costs of installation by contractors point to the need for reviewing the reasonableness of contractor's charges and studying alternative methods of installation such as encouraging village electric organizations to handle their own construction with technical assistance and training provided by the PLN.

Standard Costing and Budgetting

3.37 The mission observed that budgetting for the nationwide RE program is based on costs which not only vary between regions, but which also reflect unit costs which are higher than what is probably obtained in actual practice.[69/] Hence side by side with a systematic technical cost reduction exercise and optimum procurement and installation policies, it is imperative to produce uniform and realistic costing norms for projecting the costs of the overall RE program.

Distribution System Design

3.38 While PLN Pusat (headquarters) is responsible for setting standards and guidelines for distribution system design, detailed design work is done by the regional offices (Wilayas/Distribusis). Overall system design and prepa-

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68/ E.g. under the Bank's Power XIV Project, ICB procurement of distribution material has resulted in the following costs (in million Rp):

Item	International Competitive Bidding (ICB)	Local Competitive Bidding (LCB)	Cost Ratio LCB/ICB
1 complete feeder bay	20	30	1.5
20 kms MV line	280	360	1.3
22.5 kms of LV line	225	270	1.2
7.5 kms LV line (underbuilt)	45	60	1.3
4 MVA distribution transformer	160	240	1.5
3,000 service entrances	135	180	1.3
Total	875	1,140	1.3

69/ See, e.g., Table 3.1.

ration of master plans for growth of the urban and rural electrification networks, looking 5 to 10 years in the future, would require close coordination between the regional offices and PLN headquarters and involve use of special computer techniques, presently available only at the headquarters. At present this coordination appears to be loose and access to central computational aids by the regional office engineers is difficult. It is recommended that stronger emphasis be laid in future on optimal design of distribution systems, through the strengthening of the headquarters unit (cell) concerned with distribution system planning, which should effectively coordinate the work of the regional offices.

Summary of Recommended Actions

3.39 The review of PLN's technical approach to RE indicated the opportunity for major cost savings through:

(a) A comprehensive revision of technical design and construction standards to adapt them to the lower load densities and load factors prevailing in rural areas.

(b) The improvement of central procurement procedures and other measures to reduce the cost of equipment and materials such as the adoption of international competitive bidding.

(c) The promotion of greater competitiveness among installation contractors, such as opening up opportunities for village electric organizations to handle their own construction with technical assistance and training from PLN.

(d) Steps to reduce distribution losses including promotion of improved power factors in RE schemes.

In view of the growing need to increase the efficiency and reduce the costs of the RE program, the mission recommends that the GOI give careful consideration to each of the specific cost saving opportunities that have been described.

3.40 In order to emphasize a corporate commitment to cost-consciousness, and to utilize the large reservoir of talent and experience that resides in PLN's regional offices, the mission recommends that PLN establish a program of small-scale pilot tests and demonstrations of new technical approaches in all of its regions. Of course, to reduce the risk of obvious mistakes and wasted resources, such a program should be guided by an appropriately constituted steering committee at PLN headquarters. This committee would have the power to review and approve the projects proposed by regional offices, and would also be tasked with monitoring and evaluating their results with a view to incorporating them into the official regulations as appropriate.

3.41 To take full advantage of the entire range of cost-saving opportunities discussed in this chapter, the proposed program of controlled testing of alternative approaches should not be limited to technical design standards and construction practices, but should allow for experimentation with all regulations, including those related to procurement, power factor correction and the transfer of construction responsibilities to village electric organizations. While the mission is not in a position to propose specific changes in regulations, the potential rewards associated with a flexible approach to RE design and implementation, without taking undue risks, appear to be worthwhile.

IV. INSTITUTIONAL APPROACHES TO RESOURCE MOBILIZATION

Introduction

4.01 As indicated in Chapter I, the RE sector of Indonesia has emerged as a two-tier complex of responses to a serious imbalance between supply and demand. On the publicly financed upper tier we see a formal and technically sustainable program, dominated by and centered around the PLN, but also promoted by the Ministry of Cooperatives and some provincial governments. This formal RE program of the GOI is currently serving about 18% of the villages. On a lower "free market" tier, there has developed a set of unregulated village electrification operations, apparently largely based on the initiative of individual entrepreneurs, but enjoying sporadic support from the GOI. These informal RE operations are currently serving about 27% of the villages albeit with a quality of supply that is generally far inferior to that of PLN. This two-tier structure of the RE sector suffers from three fundamental flaws: (i) the publicly financed tier imposes an unsustainable financial drain on public resources and can no longer meet the demand for RE; it reaches less than a fifth of the villages at present and is planned to serve less than half of the villages ten years from now. (ii) The unregulated lower tier operates in a precarious and unsafe manner and the quality of its output is not suitable to stimulate productive users that cannot afford their own electricity generation. Basically, it represents an inefficient use of resources and is inadequate to foster economic development. (iii) There is no linkage between the two tiers, i.e., no mechanism for integrating the resources mobilized by the villages into a sustainable contribution towards the villages' development and towards reducing the financial burden of the program on the Government.70/

4.02 While the free-market non-PLN electricity operations, in their current form, do not seem to represent a satisfactory solution to the villages' demand for electricity, they serve to confirm a high willingness to pay on the part of their customers. Information collected by the BPS's surveys of non-PLN companies indicate a range of tariffs at about twice the level of PLN's

70/ In the absence of an established mechanism for upgrading the lower tier operators, a common occurrence, as indicated in para. 1.08, is for the non-PLN operation to collapse and then to appeal to PLN to take it over. In this way, PLN has been motivated to take over 92 such operations to date, and about 73 additional operations are currently in the process of being taken over. This approach is not desirable from an economic perspective because the assets of those operations are not compatible with PLN's, and thus there are no savings in budgetary resources.

tariff for small residential consumers,[71] for inferior quality service. The mission, in October 1985, observed far higher tariffs being charged by two private operators (in South Sulawesi).[72] The monthly fees do not include the initial contribution for setting up the system and periodic assessments for repairs.

4.03 The proliferation of unregulated non-PLN operations also provides an indication of the villagers' willingness and ability to help themselves. They provide evidence of organizational skills and rudimentary technical capabilities that could potentially be channelled into higher quality service that could contribute to the villages' economic development. Such a potentially fruitful complementarity between the local initiatives and the public sector's RE program is currently prevented by the requirement that non-PLN companies charge PLN's tariff in order to be licensed. Since neither bulk purchase from the grid not diesel generation are financially viable under PLN's tariff, these regulations make it impossible for non-PLN operators to exist except on a precarious basis in the under-5 kVA range where no license is required. This range is too small for the local operators to be able to develop the infrastructure required for improving their service.

4.04 The objective of this chapter is to explore possible ways in which the GOI's official RE program could be usefully complemented through taking advantage of the villagers' willingness and ability to help themselves. This chapter consists of three parts. The first part presents the current institutional framework of the RE program and reviews its suitability from the

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71/ The average residential tariffs charged by non-PLN companies were as follows:

Province	Year of survey	No. of companies	Average residential tariff (Rp/kWh)
C. Java	1982	155	90
W. Java	1983	192	203
Yogyakarta	1983	23	253
E. Java	1983	1,799	316
N. Sumatra	1984	203	221
S. Sulawesi	1984	615	189

PLN's average revenue from small residential (R1) customers (rural and urban) was as follows: 1982: 49 Rp/kWh; 1983: 67 Rp/kWh; 1984-86: 85 Rp/kWh.

Source: See footnote 14.

72/ One, in Mandale, charged 1,250 Rp/mo. for 10 W and 3,000 Rp/mo. for 30 W, which is approximately equivalent to 556-694 Rp/kWh. A second one, in Lanna, had ceased operations, but had been charging 14,000 Rp/mo. for 100 W service, equivalent to 778 Rp/kWh. Judging from the length of the lines, at least some of the customers must have been receiving only half of the normal voltage.

perspective of the broader objectives of the program. The second part discusses a potential approach to harness market forces for advancing the objectives of the RE program. The third part discusses institutional reforms that will be required to implement the recommended approach.

The Current Institutional Framework

PLN - The National Public Electricity Enterprise [73/]

4.05 Despite the existence of 18,000-odd non-PLN operations whose spontaneous emergence has already been discussed, PLN is the dominant supplier of electricity in rural areas. Rural electrification was first specified as a separate objective for PLN for the implementation of Repelita III, the third (1979/80-1983/84) five-year development plan of the GOI. The Repelita III objective was to electrify 3,700 rural villages and connect 1 million rural customers. To coordinate the planning and implementation of this objective, PLN set up in 1976 a RE Subdirectorate within its Directorate of Operations. However, while the RE Subdirectorate coordinates the RE program, the actual implementation and operation of the program is the responsibility of PLN's regional offices. The RE Subdirectorate also served as the counterpart for a recently completed USAID-financed RE project to electrify seven rural areas in Central Java.[74/]

4.06 During the Repelita III period, and with the assistance of special allocations from the GOI budget, PLN connected 90% more customers and 56% more villages than the initial target. However, the costs of this achievement cannot be estimated with accuracy, as the special allocations from the GOI budget were accompanied by delays and reductions in PLN's planned allocations from the GOI's investment budget (DIP) and reallocation from non-RE portions of PLN's investment program. This lack of clarity in the understanding of the costs of the RE program constitutes one of the major issues to be discussed in Chapter V (paras.. 5.2 ff). At any rate, as of mid-1986, PLN had connected about 2.5 million customers in 11,639 rural villages. For the Repelita IV period (i.e. by 1989), PLN's target is to add 1.6 million customers and 7,000 villages. For Repelita V (i.e. by 1994), PLN's target is to add 2.4 million customers and 9,500 villages. The financial implications of PLN's RE program are discussed in Chapter V.

73/ For a more detailed description of PLN's rural electrification program, see Implementation of Rural Electrification, PLN-RE Subdirectorate, October 1985.

74/ The USAID-supported RE program had two major components (i) the electrification of seven areas in Central Java on the basis of PLN's grid, and (ii) the electrification of three areas in the outer islands on the basis of diesel gensets operated by independent electric cooperatives.

The Ministry of Cooperatives

4.07 In addition to PLN, the GOI also sponsors rural electrification by the Ministry of Cooperatives (MOC) through its Directorate for the Promotion of Electric Cooperatives (DPEC) and the Project Development Office (PDO). The PDO was established in 1978 to serve as the implementing agency for a second USAID-financed project to set up demonstration electrical cooperatives in three rural areas that were not planned to be electrified by PLN in the near future.75/ As shown on Table 1.3, this project is currently serving about 12,000 customers in 84 villages in Lampung (S. Sumatra), Lombok (W. Nusa Tenggara) and Luwu (S. Sulawesi). This represents about a fifth of its original target.

4.08 The MOC's Directorate for the Promotion of Electric Cooperatives (DPEC) was established in 1979 to provide a framework for the GOI's assistance to cooperative village electrification initiatives. In addition, the DPEC serves as PLN's partner for the implementation of a joint MOC-MME program to assist village cooperative units (KUD) to take over some of the administrative and maintenance functions associated with PLN's RE program. To date, the joint program has succeeded in the takeover by 443 KUDs of at least some RE functions from PLN in 1,919 villages. Aside from the joint program with PLN, the DPEC has facilitated the provision of assistance (mostly financial) to about 111 KUDs serving 243 villages with about 30,000 customers.

Provincial Governments

4.09 In addition to the national-level activities mentioned above, several provincial governments also have their own RE programs. The largest of these are operated by the provinces of Central Java, and East Java. Other provincial and municipal power utilities have existed in the past, but have all been gradually absorbed into the PLN system.

4.10 Central Java established the Provincial Electrification Office, Kalisda, in 1972 to provide electricity to villages that were not served by PLN, either on the basis of taps from PLN lines, or using diesel generators or minihydro as appropriate. Beginning in 1981, Kalisda started to reduce its operational commitments by turning over its systems to the PLN as soon as PLN's grid reached one of its local services, and to focus more on the electrification of new villages. At present, Kalisda operates 51 isolated systems (46 diesel, 5 microhydro) serving about 10,000 customers in 118 villages. In addition, it manages a 600-700 million Rp/year investment program to electrify about 40 villages with about 3,600 customers per year, over two thirds of which will be served by PLN from the grid.

4.11 The East Java Provincial Government began in 1979 to provide PLN with supplementary resources to enhance its RE program within the province. From 1979 to 1984 about 10 billion Rp were added to PLN's budget in this way, which led to the electrification of 591 villages. This represents over half of the 1,104 villages that PLN has electrified in East Java since 1979.

75/ See previous footnote.

The Village Development Grants

4.12 In addition to its formal RE activities, the GOI has also indirectly supported village electrification through the Ministry of Home Affairs' (MHA) program of Village Development (Bangdes) Grants. These grants, which amount to 1.35 million Rp/year/village (approx. 1,200 $US) constitute the development budget of the villages and have, in many cases, been used to purchase diesel generators. As the MHA does not keep statistics on the use of these grants, the proportion that has been devoted to RE is not known. Thus, a substantial number of the 18,000 villages electrified on a non-PLN basis may actually have been supported by the GOI through Bangdes grants. In fact, the MME's 1985 survey in South Sulawesi indicates that 14% of the units it counted had been paid for by Bangdes.

The Rural Electrification Credit Program

4.13 The Rural Electrification Credit (KLP) Program constitutes a second major channel of indirect GOI support to RE activities. This program was initiated in 1983 by the Ministry of Finance, through the Bank Rakyat Indonesia (BRI), to facilitate the RE customers' affordability of the initial lump sum payment necessary to obtain a connection.[76/] In Stage I of this program (i.e., until June 1985), this credit had been extended to about 84,000 households, or about 17% of the rural households electrified during that period. The implementation of this program appears to have been slowed down by inadequate coordination between BRI and PLN, and by the BRI's restrictive creditworthiness criteria.[77/] For Stage II of this program (i.e., from 1986 onward) the credit will be administered by PLN.

The Directorate General of Electricity and New Energies

4.14 To coordinate and regulate this multiplicity of public and private, central, provincial and local RE activities, the MME created in 1985 a Sub-directorate of RE under the Directorate General of Electricity and New Energy (DGE & NE). While its objectives and responsibilities have not yet been codified, its staff is expected to develop guidelines for the establishment of uniform standards, allocation of service areas, monitoring of financial and operational performance and tariff regulation.

76/ Residential RE consumers in the PLN system are required to pay a connection of Rp 30,000, an initial deposit of about Rp 5,000, and a house-wiring fee of Rp 30,000-65,000 in advance of connection. This amounts to a lump sum payment of Rp 65,000-100,000, a major expense in light of median income levels of about Rp 50,000/month (in Java, 1984). The credit would amount to Rp 56,700 per household, repayable in monthly installments over four years with an interest of 6% a year.

77/ Thus, of the Rp 8.8 billion that have been allocated to the credit program, only Rp 4.7 billion would seem to have been disbursed.

The Performance of the Current Institutional Framework

4.15 A review of the performance of an agency or set of agencies responsible for the RE program needs to focus on some key areas of responsibility. Basically, a successful RE agency should:

(a) Have adequate authority and capacity to formulate the policies and targets of the program on the basis of national objectives and requirements and to effectively mobilize the necessary resources to achieve these targets.

(b) Allocate service areas and regulate the operation of village electric systems to ensure sound utility operations.

(c) Help establish and license local electric organizations.

(d) Provide financing for RE investments.

(e) Provide customer credits for wiring, electrical appliances and equipment.

(f) Provide planning and technical assistance to local electric systems in the areas of power supply, finance, engineering, construction and operations.

(g) Provide training in all phases of rural electrification.

(h) Require standardization of design and materials for low-cost rural distribution systems, and provide procurement, warehousing and shipping of material and equipment to village electric organizations to meet their construction requirements.

(i) Establish and promulgate policies which will ensure that customers receive speedy connection upon application.

(j) Foster research and development in technical areas associated with rural electrification.

Table 4.1 summarizes the responsibilities assigned to each of the Indonesian institutions involved with rural electrification.

4.16 A brief analysis of how the above areas of responsibility are allocated in the GOI should provide useful insights:

(a) There is no agency which has the leadership role for the RE program. The existing policies and targets for the RE program have emerged over the last decade in an adhoc manner. The mobilization of resources for the official RE program is entirely dependent on the GOI's budget process. PLN and MOC function mainly as implementing agencies. None of the agencies has drawn up a plan to stem the accelerating financial losses associated with the present program.

Table 4.1: INSTITUTIONAL RESPONSIBILITIES FOR RE

Area of responsibility	PLN	MOC-PDO	MOC-DPEC	DGE&NE
Formulate policies and targets	0	0	0	0
Allocate service areas and regulate tariffs	0	0	0	X
Help establish village electric organizations	X	X	0	0
Provide financing for investments	0	0	0	0
Provide credit for wiring and equipment	X	X	0	0
Provide technical assistance to local systems	X	X	X	0
Provide training	X	X	X	0
Standardization, procurement, warehousing	X	X	0	X
Speedy connection of customers	X	X	0	0
Foster technical R&D	X	0	0	X

Note: X signifies responsibility
0 signifies no responsibility

(b) The regulation of the power sector is in the hands of the DGE&NE. It has no policy on the allocation of service areas to village electric organization, for the approval of special tariffs to make them financially viable, or for the resolution of ongoing financial imbalance imposed by the program on the PLN.

(c) The PLN, jointly with the MOC-DPEC has a program to assist village cooperative units (KUD) to take over some of the administrative and maintenance functions following upon PLN's electrification of a village. The MOC-PDO has a project to establish three diesel based rural electric cooperatives in the Outer Islands.

(d) None of the organizations has the ability to finance RE out of its own resources. All depend on the GOI as a source of finance.

(e) Both PLN and licensed cooperative (i.e., those working with the MOC) customers have access to the Rural Electrification Credit Program to finance their connection fees and house wiring expenses.

(f) PLN and the MOC-PDO provide technical assistance to the cooperatives they have helped establish, but not to unregulated village electric organizations. The MOC-DPEC assists cooperatives in applying for financial assistance from the GOI.

(g) PLN and the MOC provide training to the cooperatives they have helped establish.

(h) PLN electrifies all villages on the basis of its own technical standards which, as discussed before, have not been optimized for RE. It then turns over the administration and maintenance of distribution in some areas to KUD that meet minimum eligibility criteria. The MOC-PDO assists in all phases of the establishment and operation of diesel based rural electric cooperatives, but relies largely on technical and financial assistance from abroad (e.g., USAID) to do so. The DGE&NE is expected to develop some standards adapted to rural areas.

(i) PLN and the MOC-PDO have policies for the speedy connection of customers, but their implementation is hampered by the availability of materials and capacity. The availability of materials and capacity has been a particularly serious problem in the cooperatives established by the MOC-PDO -- a result of complex budgetary and procurement procedures, aggravated by the lack of experience and shortage of technical and managerial capacity of both the coops and the MOC.

(j) PLN has a program to design and implement minihydro projects. The DGE&NE has a program to assess the potential for development of new energy sources.

4.17 The above analysis supports the impression that the absence of an overall leadership function and the fragmentation of responsibilities within the RE program has made it difficult for the various parts of the program, once they got under way, to adapt to changing circumstances and respond to new opportunities that could assist in the achievement of program objectives, such as the adaptation of technical standards, the expansion of within-village electrification targets and the mobilization of village resources. Even though there exist two vertically integrated agencies responsible for implementing RE, they only play narrow technical roles in the formulation of policies and objectives, and their responsibility is limited to the achievement of the targets they are assigned. While the PLN, as the dominant supplier of electricity, possesses ample implementation capacity and technical experience for RE, its commitment to the development of village institutions is limited to its involvement with KUDs, whose objectives are too narrow for the purpose of mobilizing resources for RE. The MOC-PDO, which has virtually the full range of responsibilities needed for the development of village electrical cooperatives, has very limited experience and means to assist them. The scope of the MOC-DPEC is practically limited to providing training. The DGE&NE regulates the power sector, but has not adapted its licensing and tariff policies to the special requirements of RE.

4.18 A second missing link is the absence of a reliable source of finance for RE projects to complement the resources that could be mobilized within the villages. PLN's RE budget combines PLN's own resources with a variety of financial contributions from the GOI in the form of DIP grants, special allocations (such as the Crash Program and the Accelerated Program) and loans, grants from provincial government, as well as financial assistance from abroad, including the World Bank, the USAID, the ADB and the Dutch Government. The MOC-PDO's program has no resources and depends entirely on loans and grants from the GOI and abroad (mainly the USAID). The level of the RE budget, as well as its composition, has fluctuated widely from year to year, which has made it difficult to plan for the orderly and regular implementation of the program. These financing difficulties are aggravated by the absence of leadership within the program, which would have helped to link the financing requirements to the needs and objectives of the program, and avoid such non-starters as the establishment of independent RE coops that are not financially viable, and the expenditure of Bangdes grants on schemes that may not be technically sustainable.

4.19 In addition to the above missing links, other areas in which the current institutional framework appears to be incomplete include:

(a) a framework for the recognition and participation of free market electrification operations;

(b) a comprehensive program of technical assistance to villages to assist their electrification efforts;

(c) a framework for tariff regulation that would allow cooperatives and private companies to set their own tariffs based on their financial requirements, subject to regulatory approval.

Here again, the presence of an overall leadership function for the RE program could have avoided such discrepancies as the encouragement of electrical cooperatives and private electric companies that cannot be viable in light of existing tariff regulations, and the establishment of an agency (the MOC-PDO) with full authority to implement RE projects but without the means to do so.

4.20 Finally, it should be noted that none of the existing public agencies in the RE program is geared toward taking advantage of market forces to complement the limited budgetary resources that are available for RE. The implementation of this strategy would require a drastic reorientation of the current approach to RE. As the main purpose of attempting to integrate market forces into the RE program is to mobilize resources, the discussion in the next section will focus on the conceptualization of a vehicle that would make this possible. The final section will then return to the institutional framework and discuss possible ways in which the development of this vehicle could be stimulated.

The Mobilization of Village Resources

4.21 The development of village-level institutions to take over some of the administrative and maintenance tasks associated with RE has been a policy of the GOI's RE program since its inception in 1979. As indicated above, the pursuit of this policy has led to the implementation of the PLN-KUD cooperation program and the PDO-RE cooperatives program. However, the pursuit of this policy had as its objective the transfer of responsibilities within the existing framework of publicly financed electrification, with no provision for assisting the majority of villages that are not included in the current targets for electrification. In view of the demonstrated willingness of many of these villages to devote substantial financial, organizational and technical resources to supply themselves with electricity, the scope of the existing RE program appears to be narrower than necessary, and neglects the opportunity to extend the reach of the program by complementing the GOI's RE budget with the mobilization of village resources. Basically, more important than achieving the official RE targets is to reorient the RE strategy in such a way that efficient electrification can be made possible for every village that is willing to make a substantial contribution to the required investments and carry the expenses of operating the local RE scheme. Thus to more effectively pursue the basic objectives of RE, the GOI should adopt a strategy to mobilize village resources into RE by making it financially attractive for local investors (either private or cooperative) to invest in RE, to upgrade their operations and to cater to as many customers as possible, both residential and productive users. For the purpose of discussing this recommended strategy, a licensed village electric organization (VEO) may be defined as the organizational vehicle needed for the villagers' participation in the RE program.

4.22 Since the potential for the development of such village electric organizations has never been studied, a useful first step to explore this question would have been to undertake a detailed assessment of the existing unlicensed electric operators, including an evaluation of their ability to mobilize resources and an identification of the possible ways in which PLN's technical and administrative expertise could best be applied to maximize the mobilization of these resources. Such an assessment would have had to take account of local social, cultural and economic characteristics and develop a flexible and responsive approach that the GOI could use to extend the scope of the RE program.

4.23 In the absence of such an assessment, the mission identified a set of organizational objectives and responsibilities that would serve to formulate a framework within which the VEOs, both existing and new ones, could develop and flourish. This framework is substantially adapted from the World Bank/USAID's successful experience with the establishment of Rural Electrification Societies (Palli Bidyut Samities -- PBS) in Bangladesh.79/

4.24 The main objective of a VEO should be to supply electricity to a village. To foster economic development, the electricity supply should reach the bulk of the households (e.g., 95%) and be of sufficient quality to encourage productive users to use it rather than generate their own or use less economic fuels. To achieve these objectives, the VEO should be responsible for the following functions:

(a) to initiate and implement local distribution system expansion with financial and technical assistance from the GOI.

(b) to raise an agreed share of the investment funds required for electrification, either from private sources, if the VEO is a private investor, or through a community approach, if the VEO is a cooperative;80/

(c) to purchase electricity from the PLN grid or to generate it itself;

(d) to transmit and distribute electric power and to carry out consumer connections;

(e) to maintain and operate its own transmission, distribution and generation facilities;

(f) to carry out the commercial activities of meter-reading, billing and collection;

(g) to set its own tariff on the basis of financial requirements, subject to the approval of the GOI; and

(h) to provide technical and financial assistance to consumers for housewiring.

Given a suitable framework of licensing, assistance and incentives, the above responsibilities for the VEO can be carried out by either private companies or

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79/ See Staff Appraisal Report, Bangladesh: Rural Electrification Project, Report No. 3728-BD, World Bank, 1982.

80/ This is already being done in Thailand, where villages that contribute 30% of the required investments get priority for electrification.

cooperative organizations.[81/] A suggested organizational structure for a representative VEO is shown in Annex 23.

4.25 A brief survey of the existing VEOs provides an assessment of their current capacities in relation to the above objectives and requirements:

(a) The PLN-supported KUDs are basically geared to carrying out commercial activities, to install and repair housewiring, and to trim trees along LV lines. The opportunity to purchase electricity in bulk for resale to customers, or to generate and distribute its own electricity, exists in theory, but is not financially viable in light of their required adherence to the same tariff as PLN.[82/] Resource mobilization is not within their objectives.

(b) The MOC-PDO-supported independent electric cooperatives appear to have most of the responsibilities required for successful development but their viability is hampered by a shortage of technical and managerial capacity and their requirement to adopt the same tariff as PLN in the absence of large profitable customers (such as PLN has at its main grids) with which to cross-subsidize their small residential customers. In addition, their establishment and development on the basis of foreign assistance has been seriously delayed by the complexity of budgetary and procurement procedures which they had to follow, aggravated by lack of experience. Under the existing framework they will continue to be dependent on external resources, either GOI or foreign.

(c) The unlicensed village electric operators are evidently thriving, but their limitation to the under-5 kVA niche where they can set their own tariff limits their ability to expand to reach the bulk of the households in a village and to provide a satisfactory quality of service so as to stimulate and attract productive use customers. Thus, although they are able to mobilize their own resources, their

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81/ The regulatory framework should be the same for all VEOs, regardless of their statutory structure, as long as they meet minimum financial and technical qualifications which should be preconditions for obtaining a license.

82/ Under the current power tariff (see Annex 4), the electricity rate for small residential customers (R1) is lower than that for low voltage or medium voltage bulk (industrial) customers (taking into account a typical peak/off peak split of residential load). This makes it impossible for the bulk purchase and resale of power to be financially viable.

contribution to village development is limited by the regulatory framework.[83]

4.26 The impression that emerges is that there exists in the rural areas the capacity to mobilize resources for the efficient development and operation of village electrification schemes and that with an appropriate institutional framework such resources could make a large contribution to the RE program. It is therefore useful to explore the adaptations needed in the current framework for the successful implementation of the proposed strategy of encouraging local investors to invest in RE, upgrade their operations, and to cater to as many customers as possible.

A Recommended Institutional Framework

4.27 As indicated in Chapter I, the GOI can no longer hope to meet the demand for RE on the basis of its current approach which largely consists of financing PLN's extension into every village. As discussed before, the demonstrated willingness and ability of many villages to devote substantial resources of their own to supply themselves with electricity offers the opportunity to extend the reach of the RE program without increasing the GOI's budgetary commitments. This will require the implementation of a strategy to mobilize village resources by providing financial incentives for local investors or cooperatives to invest in RE, upgrade their operations and cater to as many customers as possible. It is postulated that the mobilization of village resources can be accomplished through the establishment of village electric organizations (VEOs) owned and operated by villagers, whose main objective would be to supply electricity to a village on a financially self-supporting, administratively autonomous basis. As the VEOs would establish their local systems or take over from PLN the responsibility for the supply of electricity at the village level, PLN's role would be progressively limited to the supply of electricity in bulk.

4.28 On the basis of the earlier institutional review the additional elements required for carrying out the recommended strategy may be summarized as follows:

(a) a single lead agency responsible for the entire RE program carried out by the GOI;

83/ The option of simply relaxing the 5 kVA limitation to, say 100 kVA, to allow unlicensed village electric operators to expand and upgrade the quality of their services is not desirable in light of the likelihood of continued poor quality service (i.e. inadequate for productive users), low within-village electrification ratios, unsafe practices, financial abuses and other inefficiencies that could and should be substantially reduced with a more comprehensive framework of regulation and support like that proposed below. Nevertheless, it is obvious that unlicensed operators will continue to exist and multiply for as long as the villagers' expectations and willingness-to-pay exceeds the supply capacity of the RE program.

(b) a large-scale reliable source of finance for RE construction to complement the resources to be mobilized by the VEOs;

(c) a framework for the establishment and licensing of VEOs on the basis of a defined service area;[84]

(d) a comprehensive program of technical assistance for the VEOs;

(e) a reasonable framework for tariff regulation that would allow the VEOs to set their own tariffs on the basis of covering operating costs plus a reasonable margin for debt servicing and a return on investment.

4.29 In response to a perceived need to enhance the planning and coordination of RE activities, the GOI has recently (in 1985) established a subdirectorate of RE under the DGE&NE. While its objectives and responsibilities have not yet been codified, it is likely that neither its status nor its size will enable it to fill the leadership responsibility for the RE program in the manner that would be necessary. The need for leadership will therefore have to be met through a substantial upgrading and expansion of the responsibilities of one of the existing agencies, or through the establishment of a new institution, devoted solely to RE.

4.30 Given its dominant role in the RE subsector, and its large reservoir of technical capacity and administrative experience, the PLN would appear to represent a prime candidate to take over the leadership of the RE program. However, the policy-making and licensing functions that would be required to make the leadership role effective would be inconsistent with PLN's current status as a regulated utility, and would involve a blurring of its gradual evolution into a commercially oriented enterprise. PLN should also, on efficiency grounds, attempt to limit the growth of its personnel and focus its efforts on the generation and supply of electricity, rather than on rural development.

4.31 The MOC could also be considered as a candidate to take responsibility for the entire RE program, but its primary orientation is to the development of cooperatives, and its involvement could jeopardize the objective of mobilizing resources from private investors. Also, the development of the RE program is interdependent with that of the energy sector in general and with PLN in particular. The MME should therefore retain the most influence of all Government departments over the program, to the extent that such influence is required. In addition to these regulatory considerations, the MOC also suf-

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84/ On the basis of the experience of the MOC-PDO-sponsored cooperatives in the outer islands, all the unserved areas of the country should be demarcated into service areas that have the potential of serving at least 10,000 customers. This is the minimum size system that can be professionally managed, take advantage of certain economies of scale, and become financially viable.

fers from lack of experience and a shortage of technical and managerial capacity which has severely hampered its ability to implement RE projects in the past.

4.32 In the mission's view the magnitude and complexity of the challenges involved in steering and financing the electrification of 50,000-odd villages, combined with the identified weaknesses in the current institutional framework for the pursuit of this task, justify the consideration of a new agency. The mission therefore recommends that the GOI consider the establishment of an Rural Electrification Agency (REA) as the lead agency for the RE program, with primary responsibility for formulating policies and plans for the program on the basis of national objectives and requirements and for mobilizing the necessary resources to achieve these targets:

(a) To maintain a leadership role over the program, the REA should function as a financial intermediary, and have the authority to borrow and raise funds from the Government and foreign donors and to onlend its funds on terms that reflect its cost of funds plus a fee to cover its administrative costs. The REA would primarily lend to VEOs, but during a 5- to 10-year transition period it could also lend to PLN and provincial enterprises for RE projects in priority areas where there is not enough local initiative to establish VEOs.

(b) To mobilize market resources for investment in RE, the REA should have the authority and capacity to set technical and financial performance standards for the establishment and licensing of VEOs as a precondition for lending.

(c) To strengthen the viability of its borrowers, the REA should develop a program of training and technical assistance to the VEOs, to include all aspects and phases of RE operations. The technical assistance to VEOs could be provided by PLN during a transition period, supplemented by other public and private contractors.

(d) To ensure the financial viability of its borrowers and the recovery of its funds the REA should have the authority to regulate the tariffs charged in RE areas. During a transition period (e.g., five to ten years), the GOI should consider introducing a special bulk tariff to promote the establishment of VEOs, that would initially maintain and gradually reduce the cross-subsidy that PLN's RE customers currently obtain from large profitable customers on PLN's main grid (see para. 5.28).

(e) To keep up with and promote technical changes, the REA should encourage and monitor pilot projects designed to demonstrate innovative approaches to cost saving design and project implementation, as well as the mobilization of local resources. These R&D projects could be done at the PLN, VEOs, or suitable technical institutions (see paras. 3.40-41). The REA should also periodically evaluate the results of the schemes it finances.

In addition to these new responsibilities, which are intended to cover gaps in the current framework, the REA should, for the sake of efficiency and streamlining the RE program, also take over the RE-specific responsibilities of the PLN, MOC and DGE&NE. Even so, these organizations would continue to be involved in RE, the PLN as a supplier of bulk power and, during a 5 to 10-year transition period, technical assistance and implementer of RE in those areas where there is not enough local initiative to establish VEOs but where RE is warranted on economic and/or geographical distribution grounds, the MOC as a source of training for cooperatives, and the DGE&NE as the coordinator of the development of RE with that of the power system as a whole.

4.33 The benefits of a new entity such as the proposed REA could be summarized as follows:

(a) The GOI would, through the REA, maintain an overview of its investments in the RE program and be able to modulate its rate of implementation on the basis of the availability of resources and the relative priority of RE vs. other government programs. The implementation of RE would become independent of the financial capability of PLN, and its growing financial losses could be brought under control.

(b) The efficiency and effectiveness of the RE program could be increased through decentralizing the implementation, operation and maintenance responsibility to organizations with suitable profit incentives and concentrating in one agency both the responsibility for satisfactory performance of the program and the authority to ensure satisfactory performance. Thus the REA should find it in its own self-interest for RE to be successful. This does not appear to be the case up to now because of PLN's dual commercial and social objectives.

(c) The implementing agencies, which should primarily consist of VEOs but could include the PLN and perhaps some provincial enterprises during a 5- to 10-year transition period (toward exclusive reliance on VEOs) would benefit from a stable source of funding to complement their own resources. They would also be able to obtain satisfactory financial returns on their investments in RE. However, while the VEOs and eventually also the REA should be expected to become financially viable, the size of the RE program would still depend in large part on the GOI's willingness and ability to make continued and substantial financial contributions to the program through the REA.

(d) PLN would benefit from the transfer of a large share of its "socially oriented" activities to third parties, which would enable it to concentrate on the generation and supply of electricity on a bulk basis, as far as the rural areas are concerned.

(e) The raising of funds from foreign sources would be simplified and facilitated by a clear separation of commercial-utility from rural oriented activities, which are of particular interest to many donors.

(f) The rural areas would benefit from having an agency that is more closely attuned to their capacities and requirements, and would have a strong interest in the promotion of rural development.

(g) The private sector would obtain financial and technical assistance to invest in RE under conditions that allow it to make a reasonable rate of return, while being protected from competition through a licensing system. If the incentives to participate in the official framework are not sufficiently attractive, private investors would of course continue to be free to operate in an unregulated manner as they are doing at present.

(h) Last, but not least, the country as a whole would benefit by a shift from a target-driven program with sometimes questionable economic justification to a Government-assisted but market-driven industry concentrated in those villages which have demonstrated an ability to make a substantial financial contribution and are committed to make RE financially viable.

4.34 While the appropriate allocation of functions and responsibilities for the proposed Rural Electrification Agency will have to be studied in detail to fit it within the organization framework of the GOI, the mission believes that it should be set up as an autonomous agency along the lines of similar organizations in India, Bangladesh and the Philippines.[85] Basically, the REA would report to a Board of Supervisors consisting of a chairman, appointed by the Government, representatives of Ministries such as MME, MOC, Finance and Home Affairs, and representatives of PLN, business, farmers, and industrial organizations from the rural areas. The organizational structure should be appropriate for its objectives and responsibilities. The initial staffing could be drawn from the current agencies involved in RE.

4.35 As indicated before, the development of the RE program is interdependent with that of the power sector as a whole, and will require close coordination and collaboration with the DGE&NE and PLN. To ensure close collaboration at the management and technical levels, the mission recommends that the President of PLN be an ex officio member of the Board of Supervisors of the REA. Also, until the REA develops its own technical capabilities, the mission recommends that arrangements be made for the regional and local offices of PLN to provide technical assistance and training to VEOs on the basis of a contract with the REA. Such technical services would initially be subsidized by the GOI or PLN, but should eventually be funded out of the REA's own resources.

4.36 The financial relation between the REA and the VEOs would basically be formulated in a standard loan agreement including terms and conditions acceptable to different donors for the total construction cost of the RE

85/ For a description of institutional structures for RE throughout Asia, see Regional Rural Electrification Survey, Asian Development Bank, 1983.

scheme, which would be owned by the VEOs.86/ The terms and conditions could also be tailored to the economic potential of the area served by the VEO, so as to achieve the distributional objectives of the Government. The debt is secured by a mortgage. Besides lending the initial cost of the scheme to the VEOs, the REA would also finance the VEOs' working capital requirements and future system expansions carried out by the VEOs. A description of recommended financial principles and arrangements governing the REA is provided in Annex 24.

86/ Except in the case where the REA provides grants for RE. In such cases, not expected to be common, the REA would retain a proportional share of ownership.

V. FINANCIAL ISSUES

Introduction

5.01 The achievement of the GOI's planned rural electrification targets represents a significant commitment of resources, equivalent to at least 2% of total public investments over the Repelita IV (1984/85-1988/89) period, and somewhat more during Repelita V (1989/90-1993/94). In addition, the revenues generated by PLN's RE activities are expected to fall short of the corresponding operating costs by a significant amount which, unless tariffs are adjusted, will rapidly rise as RE expands. As a consequence, the achievement of the RE targets will impose a growing financial burden on PLN and the GOI. This growing financial burden is occurring at a time when the GOI is faced with tightening resource constraints and there is a need to strengthen PLN's deteriorating financial performance. It is therefore useful, as part of this review, to discuss the major financial issues associated with the RE program. These issues revolve around (a) the need for separate accounting information on RE; (b) the need for accurate information about the financial implications of the RE program; and (c) the need for defining a financing strategy for RE investments. For the sake of expediency, the discussion in this chapter will focus on GOI's Repelita IV RE program, which is being implemented by PLN.

The Need for Separate Accounting Information

PLN's Accounting System

5.02 The examination of the existing data collection and recording system for RE programs was accomplished by means of visits to a number of PLN's local management units at Cabang (Branch) and Ranting (Sub-branch) levels. While information on cash revenues and expenses is available, the present accounting system does not generate necessary information at these levels on assets in operation or under construction. Overhead costs, depreciation and interest expenses are not allocated to these low level units and have not been compiled for reporting purposes. The preparation of RE accounting information and reports differs among the various units. Adequate accounting information is one of the essential elements of RE management and will require the development of an integrated system.

5.03 To provide a better basis for (a) evaluation of PLN's financial performance; and (b) decision-making in regard to the affordable rate of implementation of the RE program, the mission recommends that PLN design and implement a rural electrification management information system (REMIS) on the basis of the following approach:

(i) a definition of RE which is the same for budget purposes as well as other statistical purposes, i.e., RE should be defined as the supply of electricity to rural areas as defined by the GOI;

(ii) identification of the information requirements of management and reporting requirements in regard to the RE program;

(iii) establishment of an accounting system for the RE operation at the appropriate administrative level; and

(iv) organization of a systematic and prompt transfer of the required information from the appropriate accounting and management records.

5.04 To enable the RE accounting system to be implemented and operated effectively, PLN has proposed to prepare detailed implementation plans and timetables for consultation with the Bank. PLN will specify the strategy to be adopted in implementing the new accounting procedures. This will be a desirable and achievable first step toward a more effective and integrated REMIS.

Financial Reporting

5.05 The measurement of RE financial performance is an important objective of the design of the REMIS. For the purpose of establishing this system, PLN will need to identify the key elements in the RE financial management reports which will be prepared from the various selected basic units as defined under the RE program. These reports will include, among others, the information on the following general items:

(a) installed capacity, energy production system losses, and fuel consumption and efficiency and staffing statistics;

(b) numbers of villages and consumers, contracted capacity and sales in kWh and rupiah, by types of tariff categories;

(c) units' "profitability", giving details of operating revenues and expenses, including depreciation and allocated overhead and interest expenses; and

(d) pro forma balance sheet, showing assets in operation, construction work in progress, funds allocated from the various sources, and other assets and liabilities.

5.06 These types of reporting are essential and by enhancing the quality and conformity of accounting information made available to PLN's management as well as the GOI, they will facilitate the identification of operating losses and the determination of the compensation for PLN's socially directed programs.

5.07 By means of the new REMIS, the RE program will achieve a greater degree of accountability, particularly in terms of budgetary planning and execution. The GOI (and PLN's management) will also have reliable financial and related statistical management information to assist in planning, monitoring and evaluating its RE activities. It should also provide a sound statistical basis, which together with a clear definition of responsibilities of the proposed REA and PLN, will be essential to the establishment of a stable financing framework for the RE program.

Financial Implications of the RE Program

5.08 As of mid 1986, PLN had connected about 2.5 million customers in 11,639 rural villages. The costs associated with this achievement are not known with accuracy, as PLN's RE activities are integrated with its regular operations, and accounting information on RE has not been separated. For example, while PLN maintains a so-called RE investment budget this RE budget accounts for only a fraction of the investments associated with PLN's RE activities. Thus, as of 1984, of PLN's then 1.7 million customers in 8,847 electrified villages, only 0.7 million customers in 5,842 villages could be attributed to the RE budget, and the rest to PLN's regular distribution extension program. Even for the Repelita III period, during which RE was already a clearly defined objective, only about 39% of the customers and 67% of the villages added in rural areas can be attributed to the RE budget (See Table 5.1).[87/]

5.09 This dichotomy between the scope of PLN's RE budget and the range of PLN's RE activities is a symptom of confusion about PLN's dual role. Basically, PLN is a public enterprise (perusahaan umum) with both commercial and social objectives. As a commercially oriented enterprise, it is expected to achieve a satisfactory financial performance, and can be expected to extend its service to rural areas only to the extent that it is financially viable.[88/] On the other hand, as a socially oriented enterprise it is expected to achieve the official RE targets set out in the Repelita IV and V development plans, which include many villages and customers that are not of commercial interest. To assist PLN in achieving these two objectives, the Government has supplemented PLN's regular financial resources with loans, DIP grants and special allocations (see Table 5.2).

5.10 However, the manner in which funding for RE has been made available has made it difficult to evaluate PLN's financial performance and to plan for the financing of the RE program in the future. While it is not the intention of this review to discuss PLN's financial performance, it is hoped that this section will make a contribution in this regard by assessing the financial implications of the RE program.

Revenues from RE

5.11 The electricity tariff is regulated by the GOI through the MME, which has adopted a uniform structure throughout the country in accordance with broad policies and goals. Under this tariff structure the same rates apply to both urban and rural areas (see Annex 4). In 1984/85 PLN's 1.7 mil-

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87/ The fact that (during Repelita III) about 61% of customers and 33% of villages in rural areas were connected out of PLN's regular distribution extension budget does not imply that these services may be regarded as financially viable.

88/ Although, as sugested by para. 5.02, PLN has not been able to determine this viability with any clearly defined methodology.

Table 5.1: SUMMARY OF PLN'S RURAL ELECTRIFICATION ACTIVITIES, 1977-85

	Repelita II		Repelita III					Repelita IV
	1977/78	1978/79	1979/80	1980/81	1981/82	1982/83	1983/84	1984/85
Rural Consumers ('000)								
New - RE Program /a	3.8	5.9	56.7	50.0	167.7	76.2	190.0	157.6
New - Regular /b	n.a.	n.a.	96	168	72	205	290	252/d
Cumulative /c	n.a.	280	382	607	729	1,102	1,468	1,689/d
Electrified Villages								
New - RE Program /a	76	119	586	548	1,680	607	1,188	1,038/d
New - Regular /b	n.a.	n.a.	263	190	219	692	867	476/d
Cumulative /c	n.a.	2,244	2,626	3,402	4,169	6,541	8,015	8,847/d

/a Budget target.

/b Actual - Bank staff estimate, assuming one-year lag between budget target and realization of new customers/villagers financed under the RE program.

/c Actual.

/d As of September 1984.

Source: PLN.

Table 5.2: PLN'S RURAL ELECTRIFICATION INVESTMENTS, 1977-85

	Repelita II		Repelita III					Repelita III
	1977/78	1978/79	1979/80	1980/81	1981/82	1982/83	1983/84	Total
	(Rp mln current)							
Total RE Program Budget	1,494	1,628	13,535	62,705	46,967	93,454	47,503	264,164
PLN - Self-generated	1,494	1,628	2,719	-	4,704	59,009	105	66,537
PLN - Loan funds	-	-	-	715	5,555	7,391	18,995	32,656
GOI - DIP	-	-	10,009	15,113	17,384	24,751	9,076	76,333
GOI - Special Allocation /a	-	-	-	45,690	17,667	-	17,147	80,504
East Java Government	-	-	807	1,187	1,657	2,303	2,180	8,134
	(US$ mln current)							
Total RE Program Budget	3.6	3.9	21.7	100.0	74.3	141.4	49.0	386.4
	(%)							
Share of RE program budget in PLN Investments	0.6	0.5	4.6	20.7	9.5	16.0	4.9	-

/a The crash program in 1980/81 and 1981/82 and the accelerated program in 1982/83 and 1983/84.

Source: PLN.

lion rural customers accounted for a third of PLN's total 5.1 million customers. Their distribution by tariff category, and the associated sales and revenues, is not known in detail. However, village customers generally belong to the "small residential" class (encompassing tariff categories S1 and R1), which are the intended beneficiaries of PLN's socially oriented activities. For Indonesia as a whole, this "small residential" class included 3.7 million customers (73% of PLN's total), and accounted for 21% of its energy sales and 18% of its revenue. Their average consumption was 53 kWh/mo, and the average price they paid was 85 Rp/kWh.

5.12 To estimate the revenues for its RE activities, the mission obtained from PLN some information on a sample of representative RE schemes, including a grid-served scheme in Java and nine isolated diesel systems in the Outer Islands. In this sample, the small residential consumers accounted for 98% of PLN's customers, 89% of electricity sales and 86% of revenues in Java, and 91% of customers, 80% of sales and 73% of revenues in the outer islands. This corroborates the impression that RE schemes are primarily serving the intended beneficiaries of PLN's social orientation. Their average consumption and price of electricity is summarized on Table 5.3

Table 5.3: AVERAGE CONSUMPTION AND REVENUE, ALL INDONESIA VS. RURAL CUSTOMERS

	All Customers			Small Residential Customers		
	All /a	Rural /b		All /a	Rural /b	
	Indonesia	Java	Outer Island	Indonesia	Java	Outer Islands
Avg. Consumption (kWh/mo)	179	46	49	53	42	43
Avg. Revenue (Rp/kWh)	98	96	97	85	93	97

/a Based on PLN sales statistics.
/b Based on a small sample of rural schemes (see Annex 5).

Costs of Operation

5.13 Electricity supply in the rural areas of Java is provided through an interconnected central grid system, while in outer islands about half of electricity supply is based on local grids and half is based on isolated diesel generation. During the mission, an analysis was carried out to estimate the average operating cost of supplying electricity based on the two types of supply. Historical operating costs were collected from a number of selected villages in Java as representative for the grid-connected RE schemes and in outer islands for the isolated RE schemes.

5.14 The results of the cost analysis reveal that for an isolated RE scheme the average direct operating cost 89/ including fuel was 154 Rp/kWh, as against 105 Rp/kWh for an interconnected RE scheme (Annex 5). The latter includes the grid supply cost consisting of both fuel and capacity costs at the delivery point.

Estimation of Operating Deficits

5.15 The estimate of operating deficits is based on the comparison of sales revenues and operating cost. As summarized in Table 5.4, PLN's RE activities are still associated with substantial financial losses. The estimated operating deficits before financing amount to 7 Rp/kWh for customers connected to a major grid and 44 Rp/kWh for customers served by a diesel based system.

Table 5.4: ESTIMATION OF FINANCIAL PERFORMANCE OF RURAL ELECTRIFICATION SCHEMES

Rp per kWh sold in constant 1985 price	Grid-connected RE schemes	Isolated RE schemes
Average revenues/a	98	98
Operating costs/b	105 /c	142 /d
Surplus or deficit before financing	(7)	(44)

/a Based on estimated average revenues from all tariff categories.
/b Cash expenses including payment for bulk supply (estimated at Rp 75/kWh based on PLN's MV tariff) for grid-connected schemes and excluding depreciation for distribution infrastructure.
/c Based on PLN 1984/85 accounts for East and West Java generation and transmission and distribution.
/d Based on representative RE schemes in outside Java islands, with a diesel fuel consumption efficiency factor of 0.5 liter/kWh.

Source: Annex 5.

5.16 The above results indicate that with current pricing policies, levels of consumption and operating costs, the publicly financed RE program in

89/ Cash expenses including payment for bulk supply (valued at the long run average incremental cost at the MV substation of Rp 95/kwh) for grid-connected schemes and excluding depreciation for distribution infrastructure.

Indonesia is not financially viable. As RE expands in the course of Repelitas IV and V, the expected operating deficits would have a significant impact on PLN's financial performance and could become a growing drain on PLN's internal funds. To illustrate the magnitude of this effect, the mission estimated that the incremental sales of electricity in the villages to be electrified during the Repelita IV period (1984/85-88/89) would be associated with incremental operating deficits 90/ growing from Rp 2.3 billion in 1984/85 to Rp 18.5 billion in 1988/89 and Rp 22.6 billion in 1993-98, aggregating to Rp 153 billion over the 10-year period, 91/ equivalent to 16% of the projected capital expenditures of Rp 968 billion for the Repelita IV RE program.

Financing of Capital Expenditures

5.17 For the Repelita IV period (1985/84-88/89), PLN's target was to add 1.6 million customers and 7,000 villages. The projected capital expenditures required to achieve this target amounted to Rp 968 billion (see Annex 6) on the RE (LV distribution) side and an additional Rp 663 billion in associated generation and transmission expansion at the grid. This would have been equivalent to about 19% of PLN's planned investments and 2.1% total planned development expenditure during Repelita IV.

5.18 The financial results of an RE investment program such as that planned for Repelita IV will depend on the strategy that is adopted for financing RE capital expenditures. To illustrate the implications of alternative financing strategies, the mission postulated that the GOI could finance the RE capital expenditures under Repelita IV through a financial intermediary such as the proposed Rural Electrification Agency (REA) to the Village Electrification Organizations (VEO), which would be responsible for the implementation and operation of RE projects (see Chapter IV). The financing of the RE program was postulated to fit one of the following scenarios (defined to explore the range of available options):

(i) Grant contributions from GOI;

(ii) Interest-free borrowing with 2 years of grace plus 15-year repayment of principal; and

(iii) Borrowing at 6% p.a. with 2 years of grace plus 15-year repayment of principal.

5.19 Given the proposed Repelita IV RE program, the implications of the alternative financing scenarios may be outlined as follows:

(a) Capital expenditures will be Rp 968 billion, the same for all scenarios.

90/ In constant 1985 prices.

91/ This does not include the deficits associated with the growing sales in the 8,000-odd villages electrified prior to Repelita IV.

(b) Total internal cash generation (i.e., the operating surplus or deficit) will add up to Rp -153 billion over the first 10 years (as discussed in para. 5.18) for all scenarios.

(c) Total debt service over the first 10 years will range from nil under scenario (i) to Rp 333 billion under scenario (ii) and Rp 583 billion under scenario (iii).

(d) Total public resource requirements (total grant or loan, plus interest expenses, minus internal cash generation) of the program over the first 10 years will, as a result of the different levels of interest charges, vary from Rp 1,082 billion under scenarios (i) and (ii) to Rp 1,348 billion under scenario (iii). This illustrates the interrelationship between the financing requirements of the program, as they would have to be reflected in the public sector budget, and the choice of financing options.

These results, summarized on Table 5.5, illustrate the fact that, while the physical content and economic costs of the RE program remain unchanged, the financial implications of the program are subject to a wide range of variation solely on the basis of the financing strategy chosen to implement it.[92/] Once the sensitivity of the financial performance and budgetary requirements of the program to the choice of financing strategy has been understood, we can proceed to analyze the financial implications of the major policy recommendations contained in this report.

Financial Implications of the Recommended Policies

5.20 The earlier chapters have outlined a variety of policy options to increase the resource use efficiency of the RE program and reduce its dependence on budgetary resources. As discussed in the report, these options revolve around reducing unit costs through optimization of technical designs, construction practices and procurement rules, increasing the benefits of the program through making electricity affordable to the bulk of the rural population, and reforming the institutional framework of RE so as to facilitate the mobilization of nongovernmental resources. To analyze the financial implications of the recommended policies, the mission has adopted the previously outlined Repelita IV investment program as the Base Case and defined hypothetical cases designed to represent the following policies (as if they had been effectively implemented at the beginning of Repelita IV in 1984/85):[93/]

92/ While in this illustration the same terms are postulated to apply to all VEOs, in practice the REA could tailor the financing terms to different categories of villages, depending on the GOI's social and geographical distribution priorities.

93/ For the purposes of this analysis, the associated Rp 663 billion investment in generation and transmission investments for the grid are assumed to be recovered by PLN through the bulk tariff.

Table 5.5: FINANCIAL REQUIREMENTS OF THE REPELITA IV RURAL ELECTRIFICATION INVESTMENT PROGRAM
(Rp billion, 1985 prices)

Financial indicators	Financing strategy: Grant contribution	Loan /a at 0% interest	Loan /a at 6% interest
Total capital expenditures /b	968	968	968
Nongovernment contribution /e	39	39	39
Government grants/loans /b	929	929	929
Interest charges /c	0	0	266
Internal cash generation /c	-153	-153	-153
Total public resource requirements /c /d	1,082	1,082	1,348

/a All borrowings with two-year grace plus 15-year repayment.

/b During Repelita IV period.

/c Cumulative over first ten years after initiation of program.

/d Government grant contribution or loan plus interest charges (where applicable) minus internal cash generation.

/e Customer contributions, i.e. the connection charge.

Source: Annex 8

(a) technical efficiency;

(b) maximum connections;

(c) resource mobilization; and

(d) break-even tariffs.

These results of these hypothetical cases are presented below and summarized on Table 5.6.

5.21 Technical Efficiency Case: As summarized in para. 3.39, major cost savings for the RE program can be achieved through a revision of technical design and construction standards, improved procurement procedures, the use of VEOs to handle system installation, and improved power factor correction. While the full magnitude of the attainable cost savings is difficult to gauge, the mission estimated that the cost reduction attainable through the optimization of technical design and construction standards alone would amount to about 30% of the cost of RE distribution (see para. 3.33). On this basis, the capital expenditures required for the Repelita IV RE program could be reduced to Rp 704 billion, 27% less than the Base Case. This would of course entail a proportional reduction in debt service requirements under financing scenarios (ii) and (iii). The operating deficit of the program would also be reduced, by about 17%, inter alia as a result of improved fuel efficiency in the diesel-based portion of the program.[94] The combination of these two efficiencies leads to a reduction in total public resource requirements of about 26% when compared to the Base Case.

5.22 Maximum Connections Case: As concluded in para. 2.61, the social and economic benefits of village electrification could be substantially enhanced through maximizing the connection rate among the households and other users who live in the main cluster or clusters of the village that is to be electrified. To make electricity affordable to the bulk of the households will require the rollover of the connection charge into the demand charge, an expansion and redirection of the credit program to finance housewiring costs to about one half to two thirds of the households, and the exemption from the demand charge of consumers of less than 10 kWh/month.[95] Due to economies of scale, such a policy would result in a 76% increase in sales when compared to

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94/ Fuel efficiency of isolated systems is postulated to improve from 0.8 liter/kWh to 0.5 liter/kWh as a result of better tailoring of generator sizes to the load.

95/ These measures are expected to raise the initial within-village connection rates from about 33% (in an average-income village) to include all the households that live in the main hamlet of the village (i.e., those that live between customers that would already be reached in the Base Case). This is expected to raise the within-village connection rates to between 66-99%.

Table 5.6: FINANCIAL REQUIREMENTS OF ALTERNATIVE POLICY OPTIONS AND FINANCING STRATEGIES /a

Policy option: / Financing strategy: / Financial Indicators	Base case			Technical efficiency			Maximum connections			Resource mobilization			Breakeven tariff		
	Grant	0% inter-est	6% inter-est	Grant	0% inter-est	6% inter-est	Grant	0% inter-est	6% inter-est	Grant	0% inter-est	6% inter-est	Grant	0% inter-est	6% inter-est
	Rp billion, 1985 prices														
Total capital expenditures /a	968	968	968	704	704	704	957	957	957	957	957	957	957	957	957
Nongovernment constributions /a /d	39	39	39	28	28	28	0	0	0	239	239	239	239	239	239
Government grants/loans /a	929	929	929	676	676	676	957	957	957	718	718	718	718	718	718
Interest charges /b	0	0	266	0	0	193	0	0	274	0	0	205	0	0	195
Internal cash generation /b	-153	-153	-153	-127	-127	-127	-96	-96	-96	-96	-96	-96	-10	141	164
Total public resource requirements /b /c	1,082	1,082	1,348	803	803	996	1,054	1,054	1,327	814	814	1,020	728	577	759
	Rp kWh														
Average revenue to recover operating costs	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	106	106	106
Average revenue for breakeven	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	106	129	145

/a During Repelita IV period.
/b Over initial ten-year period.
/c Government grant or loan plus interest charges minus internal cash generation.
/d Includes customer connection charges or village electric organizations' capital contribution, where applicable.

Source: Annex 9.

the Base Case, and a 36% increase in capital expenditures and 76% increase in fuel expenses when compared to the Technical Efficiency Case.

5.23 The financial implications of maximizing the number of within-village connections while implementing technical efficiency are that capital expenditures will be 1% lower, the operating deficit will be 24% lower 96/ and total public resource requirements will be 2-3% lower than in the Base Case, depending on the financing scenario. Basically, with the same expenditure of public resources, the postulated policies would allow the RE program to have two to three times the number of beneficiaries (customers) within the electrified villages.

5.24 Resource Mobilization Case: While the above results are encouraging, they do not reflect the full range of options available to the Government, particularly in regard to the mobilization of nongovernmental resources. As discussed in Chapter IV, the provision of an appropriate framework of licensing, assistance and incentives could open up the possibility of attracting substantial contributions to the RE program from village electric organizations. While the extent to which village cooperatives and private investors may be able to invest in RE is difficult to estimate, the example of Thailand suggests that a 30% share may be a reasonable target to set. The Resource Mobilization case may thus be defined by the requirement of a 30% initial capital contribution on the part of the VEOs, all other policies remaining in place as in the Maximum Connection case. 97/

5.25 As expected, the major financial implications of the Resource Mobilization case in comparison with the Base case are related to the substantial reduction in the public resources required to achieve the Repelita IV target of electrifying 7,000 villages. In fact, the projections indicate that the savings in public resources would amount to 25%. In addition, as in the Maximum Connections case, each of the newly electrified villages would have two to three times the number of electrified households envisaged in the Base case.

5.26 Break-even Tariff Case: In addition to stimulating VEOs to contribute a share of capital expenditures, the Government has the option of transferring a greater share of the costs of RE to its beneficiaries through the implementation of appropriate tariff policies. This would provide an appropriate market test for the ability of the villages to benefit from the investment to the extent necessary to justify its implementation in these resource-constrained times. As indicated in para. 4.29, an essential requirement for resource mobilization is the implementation of a tariff framework that would

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96/ As a result of economies of scale, total sales revenue and fuel costs are estimated to rise by 76%, but other cash operating costs by only 36%.

97/ Of course, the hypothesis of a 30% cost-sharing target should not exclude the possibility that the REA may want to set different target levels for different categories of villages depending on the GOI's social and regional distribution priorities.

allow the rural electrification schemes, (i.e., the VEOs) to set their own tariff. Basically, RE tariffs should be set on the basis of covering operating costs (e.g., as shown on Table 5.4) plus a reasonable margin for debt servicing and/or return on investment, depending on the financing strategy adopted.[98/]

5.27 To illustrate the financial implications of the recommended tariff strategy, the mission postulated that the RE schemes will achieve financial viability by raising their tariffs to (a) recover operating costs from the first year and (b) reach break-even level, i.e., recover operating costs and debt service requirements from the third year (after a grace period of two years).[99/] The Break-even Tariff case incorporates the above tariff assumptions to the Resource Mobilization case. The Break-even Tariff case therefore simulates the combined implementation of all the major RE policies recommended in this report.

5.28 A comparison of the financial indicators of the Break-even Tariff case with those of the Base case (para. 5.19) indicates the following:

(a) capital expenditures are 1% lower;

(b) total internal cash generation ranges from a deficit of about Rp 10 billion under scenario (i) to a surplus of about Rp 164 billion under scenario (iii);

(c) total debt service requirements are 23% lower under scenarios (ii) and (iii).

(d) Total public resource requirements will be about 40% lower than in the Base case, by the end of the first ten years of the scheme, as a result of the substantial recovery of costs from RE customers. After 17 years the loan will have been fully repaid, as assumed.

(e) The average revenue required to recover operating costs is Rp 106/kWh, which is 8% more than the 1985 average of Rp 98/kWh assumed for the Base case. This level represents the weighted average of what would be needed in grid-connected schemes with what is needed in diesel-based schemes.

98/ To encourage efficiency, the tariff should be based on a determination of the expected cost of an efficient operation, rather than on the basis of reimbursing operators for actual costs (disregarding the level of efficiency).

99/ For simplicity, the break-even tariff level is defined as the constant (levelized) tariff that is just high enough to enable the VEOs to meet their debt service obligations (interest and principal) to the REA at the end of 17 years (2 years grace plus 15 years repayment). The VEOs are assumed to make no profits until after the end of this period.

(f) The additional tariff adjustment required to recover debt service requirements ranges from nil under scenario (i) to Rp 23/kWh under (ii) and Rp 39/kWh under (iii).100/ This illustrates the implications of alternative financing strategies.

Overall, the recommended break-even tariff strategy would result in a gradual increase in average tariff ranging from about 10% to 50% over the current level, depending on the financing option chosen. Of course, an additional option would be to lower the projected break-even tariff level by reducing the projected bulk tariff charged by PLN below the level (of 75 Rp/kWh) postulated for these simulations [see para. 4.33 (d)].

5.29 Of particular interest is the implication that the public resource requirements to electrify a target number of villages will be 40% lower than in the Base Case. This reflects, of course, the operating surplus of the program that would result from the implementation of a break-even tariff. Under this assumption, the cumulative public resource requirements, will peak in year five of each scheme (i.e., at the end of the construction period) and gradually decline thereafter as the operating surpluses of the VEOs are used to repay the loan to the REA. Thus, an appropriate tariff framework such as was postulated for the Breakeven Tariff case is the only option available that would put a cap on public expenditures associated with a particular RE scheme, by making it financially viable.

Concluding Notes

5.30 In the absence of accurate information on the costs and results of the RE program, the above results can be regarded as only tentative. Nevertheless, the order of magnitude of the estimated savings serves to illustrate the synergistic effects of taking advantage, in a combined manner, of:

(a) cost optimization of technical design;

(b) economies of scale of low-voltage distribution and small-scale diesel generation;

(c) mobilization of nongovernmental resources through appropriate incentives; and

(d) enhanced cost recovery through tariffs.

5.31 The optimization of technical designs, construction standards and installation practices on the basis of the specific requirements and conditions of rural areas will allow a substantial reduction in the unit costs of electricity supply. The report's estimate of a 30% reduction in capital

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100/ This additional increase is only required until the initial loan (from the REA) has been fully repaid at the end of 17 years. Thereafter the tariff could be readjusted on the basis of the reasonable rate of return requirements of the owners of the VEO.

expenditures (para. 3.33) is only meant to be illustrative, but is based on concrete suggestions and examples. The potential for such savings should be confirmed by a comprehensive revision of standards, which is likely to find even more opportunities for cost reductions. In addition to these technical savings, which were incorporated in the financial simulations, the cost of distribution materials could also be reduced, to a comparable extent, through improvements in the procurement process. The capital expenditure savings postulated under the Technical Efficiency hypothesis should therefore be regarded as conservative.

5.32 The existence of economies of scale obtainable from increasing the load density, given a specific distribution infrastructure, is based on technical principles applied to village situations postulated to be respresentative. This is subject to uncertainty as the mission collected no specific information on the locational pattern of households within village boundaries (i.e. the number of hamlets per village). Even so, the average size of villages in different regions,[101/] and the general impression that villages tend to have a main center where most of the population is clustered, support the conclusion that substantial economies of scale can be achieved in the range estimated by the mission for compact 300-household villages.

5.33 As discussed in the report, the main evidence for the availability of nongovernmental resources that could be integrated into the RE program is the existence of a large number of unlicensed operators in all parts of the country. The main question here relates to the ability of the official RE program to channel those resources into a regulated environment, with the objective of providing a higher quality service, serve a higher proportion of the population and reducing unsafe practices and financial abuses. In the mission's view, this objective can be achieved with appropriate incentives, principally by allowing the operators to set their own tariffs, but also including financial and technical assistance. However, there is no prior experience in Indonesia with the proposed approach and no exact parallel in other countries of the proposed institutions. The associated financial implications should therefore be regarded as hypothetical.

5.34 The enhanced recovery of costs through tariffs is the only option that offers the potential for making the RE program financially viable. If this option is not implemented, the publicly financed RE program will remain a growing drain on public resources and the possibility of channelling non-governmental resources into the program will be unfeasible. The main question here relates to the ability of the rural population to afford a 10-50% increase in tariffs, (in real terms) such as postulated in the financial projection.[102/] Based on the information available to the mission (see para. 2.11) from an average-income village, a tariff increase of 10% is

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101/ Which ranges up to 860 households/village in Java, 800 in Bali, 940 in South Sulawesi and 1,051 in West Nusa Tenggara.

102/ Such increases are not uncommon. As mentioned in Chapter II the price of kerosene increased by 190% in real terms since 1981.

affordable with current incomes, but 50% will lead to a decline in electricity demand unless customers are willing to spend more than 5% of their incomes on electricity, or their incomes enjoy a substantial increase in the intervening period. While such declines in demand (and hence in benefits of RE) are less likely in higher income villages, this again points to the advisability of conditioning the electrification of a village to its ability to establish a VEO that will be able to raise a capital contribution and make a commitment to raising tariffs to the level of financial viability.[103/] In other words, the commitment to achieving financial viability through appropriate tariffs would focus the RE program on those villages than can afford to make a substantial contribution to costs, through the establishment of a VEO. This focus is consistent with the maximization of benefits of the program, and the objective of bringing the drain on public expenditures associated with the RE program under control. The financial projections of the Breakeven Tariff Case should therefore be regarded as hypothetical, but illustrative of the implications of the proposed policies.

5.35 As indicated before, the results obtained in this chapter have been estimated on the basis of assuming the effective implementation of the postulated measures from the beginning of the Repelita IV program. In reality, the development of a comprehensive and well-integrated strategy such as was simulated is bound to require a lengthy process of learning and adaptation on the part of all the participating institutions. What is needed initially is a recognition of the need to adjust and reform the current program so as to be able to control the growing drain on public resources and eventually take advantage of the opportunities for reducing the costs and spreading the benefits of the program to substantially greater numbers of beneficiaries and villages than currently possible. In view of the benefits of the postulated measures and the economic, technical and financial desirability of obtaining those benefits as soon as possible, the mission recommends that the Government carefully consider and implement the proposed strategy.

103/ Given the circumstances of the village, the require tariff level may be lower than was estimated in the financial projections for the program as a whole, given the postulated mix of different types of villages.

INDONESIA

RURAL ELECTRIFICATION REVIEW

Electrification Status of Villages, 1983

	Electrified villages (by source and share of connected households)								Nonelec- trified villages	Total villages
	PLN				Non-PLN					
	0-25%	26-49%	50-74%	+75%	0-25%	26-49%	50-74%	75+%		
Electrified Villages, by per- cent of Connected Households										
Java	1,984	1,280	1,046	1,735	3,468	801	330	226	13,282	24,152
Sumatra	922	744	552	806	3,213	1,782	1,284	1,108	12,228	22,639
Sulawesi	263	284	212	308	983	300	116	59	2,086	4,611
Kalimantan	151	130	123	173	862	588	539	868	5,172	8,606
Other islands	271	158	119	197	591	196	118	190	3,819	5,659
Total	3,591	2,596	2,052	3,219	9,117	3,667	2,387	2,451	36,587	65,667
Percent of Total Villages										
Java	8.2	5.3	4.3	7.2	14.4	3.3	1.4	9.4	55.0	100.0
Sumatra	4.1	3.3	2.4	3.6	14.2	7.9	5.7	4.9	59.0	100.0
Sulawesi	5.7	6.2	4.6	6.7	21.3	6.5	2.5	1.3	45.2	100.0
Kalimantan	1.8	1.5	1.4	2.0	10.0	6.8	6.3	10.1	60.1	100.0
Other islands	4.8	2.8	2.1	3.5	10.4	3.5	2.1	3.4	67.5	100.0
Total	5.5	4.0	3.1	4.9	13.9	5.6	3.6	3.7	55.7	100.0

Source: Statistik Potensi Desa, Sensus Pertanian 1983, Biro Pusat Statistik, Jakarta, 1985.

INDONESIA

RURAL ELECTRIFICATION REVIEW

700-Household, Average-Income, Grid-Supplied Village - Economic Costs (Base Case)
(Rp'000)

Year	Cost category					
	Infrastructure /a	Connections/b	O&M/c	Private/d	Energy/e	Total
1	39,408	0	0	0	0	39,408
2	39,407	10,263	2,673	6,606	7,900	66,849
3	0	10,098	2,975	5,490	14,276	32,839
4	0	993	3,005	540	15,347	19,885
5	0	827	3,030	450	16,594	20,901
6	0	827	3,055	450	17,501	21,833
7	0	827	3,080	450	18,446	22,803
8	0	910	3,107	495	19,958	24,470
9	0	827	3,132	450	20,979	25,388
10	18,182/f	827	3,157	450	22,478	45,094
11	0	827	3,182	450	24,041	28,500
12	0	1,165	3,214	1,611	27,128	33,118
13	0	827	3,239	450	28,791	33,307
14	0	993	3,269	540	30,757	35,559
15	0	827	3,294	450	32,546	37,117
16	0	827	3,319	450	34,398	38,994
17	0	827	3,344	450	36,301	40,922
18	0	910	3,371	495	38,405	43,181
19	0	827	3,396	450	40,433	45,106
20	0	827	3,421	450	43,130	47,828
21	0	827	3,446	450	45,297	50,020
22	0	827	3,471	450	48,182	52,930

/a Consists of 3-km MV line at \$15,400/km, 3-km LV line at \$9,100/km, and one 100 KVA transformer at \$5,040. All costs converted to local currency border prices by multiplying the dollar cost times the product of the exchange rate (US\$1 = Rp 1,110) times the standard conversion factor (0.9).

/b Border cost of connection = Rp 82,770 per household, commercial, or industrial consumer; for rice mill, connection cost = Rp 165,500.

/c Three percent of cumulative cost of infrastructure plus connections.

/d Border cost of wiring at Rp 45,000/consumer plus electric motor cost of Rp 1.026 million per rice mill.

/e Equals kWh load forecast for the village times estimated LRMC per kWh consumed. Estimated LRMC = Rp 126/kWh. This estimate include energy cost down to (and including) LV level and capacity cost down to (and including) MV level. LRMC estimate based on Electricity Pricing Based on LRMC Approach, PLN, September 1985.

/f Two km of LV line added in Year 10.

Source: Mission estimates.

INDONESIA

RURAL ELECTRIFICATION REVIEW

700-Household, Average-Income Village - Economic Benefits (Base Case)
(Rp'000)

Year	Households CS/a	Households WTP/b	Commercial/c	Industrial/d	Rice mill/e	Total
1	0	0	0	0	0	0
2	5,635	5,716	2,422	791	2,044	16,608
3	11,772	11,940	4,844	1,186	2,044	31,786
4	12,754	12,936	5,328	1,581	2,044	34,643
5	13,775	13,972	5,328	1,581	2,044	36,700
6	14,963	15,177	5,328	1,581	2,044	39,093
7	16,200	16,432	5,328	1,581	2,044	41,585
8	17,487	17,736	5,813	1,581	2,044	44,651
9	18,822	19,091	5,813	1,581	2,044	47,341
10	20,206	20,495	5,813	1,581	2,044	50,129
11	21,639	21,949	5,813	1,581	2,044	53,016
12	23,279	23,611	6,297	1,581	4,088	58,856
13	24,977	25,334	6,297	1,581	4,088	62,277
14	26,734	27,116	6,782	1,976	4,088	66,696
15	28,722	29,133	6,782	1,976	4,088	70,701
16	30,602	31,039	6,782	1,976	4,088	74,487
17	32,722	33,190	6,782	1,976	4,088	78,758
18	34,911	35,410	7,266	1,976	4,088	84,651
19	37,360	37,894	7,266	1,976	4,088	88,584
20	39,887	40,457	7,266	1,976	4,088	93,674
21	42,493	43,100	7,266	1,976	4,088	98,923
22	45,070	45,714	7,750	1,976	4,088	104,598

/a Cost savings per consumer equal Rp 49,000/year per consumer (equivalent to 180 liters of kerosene per year); is assumed to increase at 4% p.a. beginning in year 3.

/b Willingness-to-pay equals Rp 49,700/year per consumer (based on a standard conversion factor of 0.9); is assumed to increase at 4% p.a. beginning in year 3.

/c Benefits equal cost savings at Rp 484,400/year per consumer, equivalent to 87 kWh/month or 1,775 liters of kerosene per year.

/d Benefits equal cost savings at Rp 395,300/year per consumer, equivalent to 71 kWh/month or 1,448 liters of kerosene per year.

/e Benefits equal cost savings at Rp 2,044,000/year per consumer, based on annual cost of operating a 22-hp diesel rice mill.

Source: Mission estimates.

INDONESIA

RURAL ELECTRIFICATION REVIEW

700-Household, Above-Average Income, Grid-Supplied Village - Economic Costs (Base Case) /a
(Rp'000)

Year	Cost category					
	Infra-structure	Connec-tions	O&M	Private	Energy	Total
1	39,408	0	0	0	0	39,408
2	39,407	15,250	2,821	9,238	12,738	79,454
3	0	15,024	3,270	8,090	24,620	51,004
4	0	913	3,297	491	25,943	30,644
5	0	747	3,220	402	27,619	31,988
6	0	747	3,242	402	28,778	33,169
7	0	830	3,267	447	30,605	35,149
8	0	830	3,290	447	32,558	37,125
9	0	747	3,314	402	34,436	38,899
10	18,182	747	3,337	402	36,364	59,032
11	0	830	3,362	477	38,443	43,112
12	0	996	3,392	1,562	42,437	48,387
13	0	747	3,415	402	44,528	49,092
14	0	913	3,442	491	47,603	52,449
15	0	747	3,466	402	49,833	54,449
16	0	830	3,490	477	52,907	57,704
17	0	747	3,514	402	55,264	59,927
18	0	913	3,541	492	58,640	63,586
19	0	747	3,565	402	61,866	66,580
20	0	747	3,588	402	65,180	69,917
21	0	747	3,612	402	68,443	73,204
22	0	830	3,636	447	72,160	77,073

/a Cost assumptions are the same as for Annex 2, Table 1.

Source: Mission estimates.

INDONESIA

RURAL ELECTRIFICATION REVIEW

700-Household, Above-Average-Income Village - Economic Benefits (Base Case)
(Rp'000)

Year	Benefits category: Households CS/a	Households WTP/b	Commer-cial	Indus-trial	Rice mill	Total
1	0	0	0	0	0	0
2	11,401	10,762	2,422	791	2,044	27,420
3	23,715	22,386	4,844	1,186	2,044	54,175
4	25,260	23,845	5,328	1,581	2,044	58,058
5	26,852	25,348	5,328	1,581	2,044	61,153
6	28,737	27,127	5,328	1,581	2,044	64,817
7	30,760	29,039	5,328	1,581	2,044	68,752
8	32,765	30,930	5,813	1,581	2,044	73,123
9	34,829	32,878	5,813	1,581	2,044	77,135
10	36,952	34,882	5,813	1,581	2,044	81,257
11	39,226	37,028	5,813	1,581	2,044	85,682
12	41,751	39,412	6,297	1,581	2,044	93,129
13	44,346	41,862	6,297	1,581	4,088	98,172
14	47,012	44,378	6,782	1,976	4,088	104,236
15	50,048	47,244	6,782	1,976	4,088	110,138
16	52,973	50,006	6,782	1,976	4,088	115,825
17	56,172	53,025	6,782	1,976	4,088	122,043
18	59,575	56,237	7,266	1,976	4,088	129,142
19	63,267	59,723	7,266	1,976	4,088	136,320
20	67,053	63,296	7,266	1,976	4,088	143,679
21	70,933	66,959	7,266	1,976	4,088	151,222
22	74,906	70,710	7,550	1,914	4,088	159,430

/a Cost savings equal Rp 65,150/year per consumer; 4% annual growth is assumed starting in year 3.

/b Willingness-to-pay equals Rp 61,500/year per consumer; 4% annual growth in cost savings is assumed starting in year 3.

Note: Other benefit assumptions are the same as in Annex 2, Table 2.

Source: Mission estimates.

INDONESIA

RURAL ELECTRIFICATION REVIEW

300-Household, Average-Income, Grid-Supplied Village - Economic Costs (Base Case)
(Rp'000)

Year	Infrastructure /a	Connections	O&M	Private	Energy	Total
	Cost category					
1	31,233	0	0	0	0	31,233
2	31,234	4,327	2,004	2,295	2,596	42,456
3	0	4,327	2,134	2,476	5,342	14,278
4	0	426	2,147	135	5,796	8,504
5	0	354	2,158	225	6,338	9,075
6	0	519	2,173	1,296	8,543	12,531
7	0	354	2,184	180	8,946	11,664
8	0	390	2,196	225	9,601	12,412
9	0	354	2,207	225	10,042	12,828
10	13,636/b	354	2,218	180	10,685	27,073
11	0	354	2,229	180	11,353	14,116
12	0	390	2,241	225	11,882	14,738
13	0	354	2,252	180	12,600	15,386
14	0	426	2,252	180	13,444	16,315
15	0	354	2,276	315	14,200	17,145
16	0	354	2,287	180	14,994	17,815
17	0	354	2,298	180	15,813	18,645
18	0	390	2,310	180	16,708	19,588
19	0	354	2,321	225	17,577	20,477
20	0	354	2,332	180	18,736	21,602
21	0	354	2,343	180	19,656	22,533
22	0	354	2,354	180	20,903	23,791

/a Includes 3-km MV line, 1.5-km LV line and one 50 KVA transformer at $2,400.

/b Additional 1.5 km LV line added in year 10.

Note: Other cost assumptions are the same as for Annex 2, Table 1

Source: Mission estimates.

INDONESIA

RURAL ELECTRIFICATION REVIEW

300-Household, Average-Income, Diesel-Supplied Village - Economic Costs (Base Case)
(Rp'000)

Year	Cost category					
	Infrastructure /a	Connections	O&M/b	Private	Energy /c	Total
1	8,053	0	0	0	0	8,053
2	40,566	4,327	6,413	2,295	2,975	56,576
3	0	4,327	6,543	2,475	6,124	19,469
4	0	426	6,556	135	6,643	13,760
5	0	354	6,567	225	7,264	14,410
6	0	519	6,581	1,296	9,792	18,188
7	0	354	6,592	180	10,254	17,380
8	0	390	6,604	225	11,004	18,223
9	0	354	6,615	225	11,510	18,704
10	13,636	354	6,626	180	12,247	33,043
11	0	354	6,637	180	13,013	20,184
12	0	390	6,649	225	13,619	20,883
13	32,513	354	6,660	180	14,442	54,149
14	0	426	6,673	180	15,410	22,689
15	0	354	6,684	315	16,276	23,629
16	0	354	6,695	180	17,186	24,415
17	0	354	6,706	180	18,126	25,366
18	0	390	6,718	180	19,150	26,438
19	0	354	6,729	225	20,147	27,455
20	0	354	6,741	180	21,480	28,755
21	0	354	6,752	180	22,530	29,816
22	0	354	6,763	180	23,959	31,256

/a Includes 1.5-km LV line, one 50 KVA transformer, and one 40-kW diesel generator at $32,400, which is replaced after 12 years. All costs converted to local border prices by using a standard conversion factor of 0.9.

/b Equals 3% of cumulative investment in infrastructure (excluding diesel) and connections plus Rp 5,800,000/year, which is the average annual non-energy cost of maintaining and operating the diesel.

/c Long-run marginal energy cost estimated to be Rp 87/kWh (excluding personnel and maintenance). Estimate based on 0.5 liter diesel/kWh at Rp 253/liter, 0.0035 liter lube oil/kWh at Rp 844/liter and 10% losses.

Note: Other costs assumptions as the same as for Annex 2, Table 1.

Source: Mission estimates.

INDONESIA

RURAL ELECTRIFICATION REVIEW

300-Household, Average-Income Village - Economic Benefits (Base Case)
(Rp'000)

Year	Benefits category: Households CS/a	Households WTP/a	Commer-cial/a	Indus-trial/a	Rice mill/b	Total
1	0	0	0	0	0	0
2	2,415	2,435	1,019	333	0	6,202
3	5,044	5,169	2,038	499	0	12,750
4	5,465	5,529	2,242	665	0	13,901
5	5,903	6,012	2,242	665	0	14,822
6	6,412	6,513	2,242	665	2,044	17,876
7	6,942	7,034	2,242	665	2,044	18,937
8	7,494	7,574	2,445	665	2,044	20,222
9	8,065	8,201	2,445	665	2,044	21,420
10	8,658	8,783	2,445	665	2,044	22,595
11	9,272	9,386	2,445	665	2,044	23,812
12	9,975	10,151	2,649	665	2,044	25,484
13	10,703	10,868	2,649	665	2,044	26,929
14	11,456	11,610	2,853	832	2,044	28,795
15	12,307	12,533	2,853	832	2,044	30,569
16	13,113	13,327	2,853	832	2,044	32,169
17	14,021	14,224	2,853	832	2,044	33,974
18	14,959	15,149	3,057	832	2,044	36,041
19	16,009	16,282	3,057	832	2,044	38,224
20	17,092	17,353	3,057	832	2,044	40,378
21	18,209	18,456	3,057	832	2,044	42,597
22	19,312	19,592	3,261	832	2,044	45,041

/a Benefits estimates based on prorating benefits in Annex 2, Table 2.

/b Benefits based on one rice mill connecting in year 6.

Source: Mission estimates.

INDONESIA

RURAL ELECTRIFICATION REVIEW

Load Forecast

Average Income - 700 Household Village
(MWh)

Year	Residential	Commercial	Industrial	Rice mill	Total
1	0.0	0.0	0.0	0.0	0.0
2	41.4	5.2	1.7	14.4	62.7
3	85.9	10.4	2.6	14.4	113.3
4	92.5	11.5	3.4	14.4	121.8
5	102.4	11.5	3.4	14.4	131.7
6	109.6	11.5	3.4	14.4	138.9
7	117.1	11.5	3.4	14.4	146.4
8	128.1	12.5	3.4	14.4	158.4
9	136.2	12.5	3.4	14.4	166.5
10	148.1	12.5	3.4	14.4	178.4
11	160.5	12.5	3.4	14.4	190.8
12	169.5	13.6	3.4	28.8	215.3
13	182.7	13.6	3.4	28.8	228.5
14	196.4	14.6	4.3	28.8	244.1
15	210.6	14.6	4.3	28.8	258.3
16	225.3	14.6	4.3	28.8	273.0
17	240.4	14.6	4.3	28.8	288.1
18	256.0	15.7	4.3	28.8	304.8
19	272.1	15.7	4.3	28.8	320.9
20	293.5	15.7	4.3	28.8	342.3
21	310.7	15.7	4.3	28.8	359.5
22	332.6	16.7	4.3	28.8	382.4

INDONESIA

RURAL ELECTRIFICATION REVIEW

Load Forecast

Above Average Income - 700 Household Village
(MWh)

Year	Residential	Commercial	Industrial	Rice mill	Total
1	0.0	0.0	0.0	0.0	0.0
2	74.8	5.2	1.7	14.4	101.1
3	168.0	10.4	2.6	14.4	195.4
4	176.6	11.5	3.4	14.4	205.9
5	189.9	11.5	3.4	14.4	219.2
6	199.1	11.5	3.4	14.4	228.4
7	213.6	11.5	3.4	14.4	242.9
8	228.1	12.5	3.4	14.4	258.4
9	243.0	12.5	3.4	14.4	273.3
10	258.3	12.5	3.4	14.4	288.6
11	274.8	12.5	3.4	14.4	305.1
12	291.0	13.6	3.4	28.8	336.8
13	307.6	13.6	3.4	28.8	353.4
14	330.1	14.6	4.3	28.8	377.8
15	347.8	14.6	4.3	28.8	395.5
16	372.2	14.6	4.3	28.8	419.9
17	390.9	14.6	4.3	28.8	438.6
18	416.6	15.7	4.3	28.8	465.4
19	442.2	15.7	4.3	28.8	491.0
20	468.5	15.7	4.3	28.8	517.3
21	495.4	15.7	4.3	28.8	543.2
22	522.9	16.7	4.3	28.8	572.7

INDONESIA

RURAL ELECTRIFICATION REVIEW

Load Forecast

Average Income - 300 Household Village
(MWh)

Year	Residential	Commercial	Industrial	Rice mill	Total
1	0.0	0.0	0.0	0.0	0.0
2	17.7	2.2	0.7	0.0	20.6
3	36.8	4.5	1.1	0.0	42.4
4	39.6	4.9	1.5	0.0	46.0
5	43.9	4.9	1.5	0.0	50.3
6	47.0	4.9	1.5	14.4	67.8
7	50.2	4.9	1.5	14.4	71.0
8	54.9	5.4	1.5	14.4	76.2
9	58.4	5.4	1.5	14.4	79.7
10	63.5	5.4	1.5	14.4	84.8
11	68.8	5.4	1.5	14.4	90.1
12	72.6	5.8	1.5	14.4	94.3
13	78.3	5.8	1.5	14.4	100.0
14	84.2	6.3	1.8	14.4	106.7
15	90.2	6.3	1.8	14.4	112.7
16	96.5	6.3	1.8	14.4	119.0
17	103.0	6.3	1.8	14.4	125.5
18	109.7	6.7	1.8	14.4	132.6
19	116.6	6.7	1.8	14.4	139.5
20	125.8	6.7	1.8	14.4	148.7
21	133.1	6.7	1.8	14.4	156.0
22	142.5	7.2	1.8	14.4	165.9

INDONESIA

RURAL ELECTRIFICATION REVIEW

PLN Tariff Schedule /a

Category	Code of Tariff	Contracted power	Demand charge Rp/kVA	Energy charge Rp/kWH	Projected Av. revenue Rp/kWH
S: Social Institutions	S1	Up to /200 VA	/b		50.50/b
	S2	250 VA/200 kVA	2,100	43.50	60.57
R: Residential	R1	250 VA/500 VA	2,100	70.50	85.19
	R2	501 VA/2200 VA	2,100	84.50	98.41
	R3	2201 VA/6600 VA	3,680	126.50	156.42
	R4	6601 VA & Over	3,680	158.00	184.10
U: Comercial	U1	250 VA/2200 VA	3,680	134	160.10
	U2	2201 VA/200 kVA	3,680	150	185.73
	U3/MV	201 KvA & Over	2,300	P=158 OP=99	123.17
	U4			307	307
I: Industrial	I1	Up to 99 kVA	2,300	P=106 OP=66	93.97
	I2	100 kVA/200 kVA	2,300	P=100 OP=62.50	85.51
	I3/MV	201 kVA & Over	2,100	P=96.50 OP=60.50	75.88
	I4/HV	5000 kVA & Over	1,970	P=81.50 OP=52	61.13
G: Offices	G1	250 VA/200 kVA	3,680	96	120.86
	G2/MV	201 kVA & Over	1,970	P=99 OP=65	84.92
J: Street Lighting	J			76.50	76.50
Average					98.32

/a Effective: March 1984.

/b Tariff S1: 100 VA = Rp 2,510/month
150 VA = Rp 3,765/month
200 VA = Rp 5,025/month

Note: P = Peak Hours (18.00 - 22.00)
OP = Off Peak Hours (22.00 - 18.00)

Source: PLN Finance Directorate

INDONESIA

RURAL ELECTRIFICATION REVIEW

Estimation of Financial Operations of Rural Electrification Schemes /a (September 1985)

Ranting Sedayu	
Electricity sales (MWh)	1,007
Of which S and R1 /a	889
Of % total	89
No. of customers	21,734
Of which S and R1 /b	21,238
% of total	98
Average revenue (Rp/kWh)	96
Average for S and R1 customers	93
Operating Expenses Before Financing (Rp/kWh)	
Direct costs /c	30
Grid costs /d	75
Total	105

/a Ranting Sedayu in Central Java distribution district. Project financed under USAID. Interconnected with the Java main grid system.
/b PLN tariff categories: S = Social and R1 = simple residential.
/c USAID preliminary estimates including 6 Rp/kWh for meter reading and bill collection, 6 Rp/kWh for O&M and about 18 Rp/kWh for general overhead and administration.
/d Based on PLN's medium voltage (MV) tariff.

Source: PLN Finance Directorate and USAID.

INDONESIA

RURAL ELECTRIFICATION REVIEW

Estimation of Financial Operations of Rural Electrification Schemes /a

Ranting/subranting	No. of villages	Capacity (kW)	Units of diesel set	Lines (km) MV	Lines (km) LV	Substation No.	Substation kVA	Production (kWh)	Sales (MWh) Total	Sales (MWh) S+RI /b	Revenues (Rp'000) Total	Revenues (Rp'000) S+RI /b	Customers Total	Customers S+RI /b	Average revenue (Rp/kWh) Total	Average revenue (Rp/kWh) S+RI /b	Cash expenses (Rp'000) Fuel	Cash expenses (Rp'000) Other	Average cash expenses (Rp/kWh)	Estimated fuel cost with efficiency /c (Rp'000)	Average cash expenses with efficient fuel use (Rp/kWh)
Talang Padang (R)	35	1,080	4	53.3	79.0	36	3,130	314,999	117	99	10,973	8,852	2,444	2,295	94	89	22,058	1,402	201	14,040	132
Kalianda (R)	13	540	2	13.7	18.2	16	1,010	132,430	102	69	10,298	6,216	1,918	1,714	101	90	9,534	1,386	107	12,280	136
Kota Agung (S)	4	200	2	3.2	5.6	6	300	43,300	31	28	3,535	2,414	674	576	114	86	4,363	1,067	175	3,720	154
Bandar Jaya (S)	5	440	2	7.4	16.0	8	400	107,840	80	65	7,308	5,519	1,316	1,179	91	85	8,516	468	112	9,600	126
Bukit Kemuning (S)	4	300	2	4.4	2.4	4	400	89,690	62	51	6,133	4,632	1,385	1,274	99	91	6,897	328	120	7,440	129
Menggala (S)	8	350	3	3.2	15.5	5	730	42,510.	31	27	3,123	2,566	910	841	101	95	4,108	472	148	3,720	135
Sidomulyo (S)	3	265	2	2.5	4	1	-	31,453	20	15	1,966	1,320	405	337	98	88	2,898	402	165	2,400	140
Banjarrejo (S)	1	100	2	-	3	-	-	8,790	8	7	723	624	209	196	90	89	1,210	420	204	980	173
Sekampung (S)	3	100/220	1	8.2	4.1	2	320	14,715	13	12	1,136	991	209	196	87	83	1,513	502	155	1,560	159
Average															97	88			154		142

/a Operating statistics and financial data of a representative Cabang (Tanjungkarang) in Wilaya IV, Sumatra, with isolated diesel generation.
/b Refers to PLN tariff categories: S = Social; R1 = Simple residential.
/c Assuming a fuel efficiency factor of 0.3 liter/kWh.

Source: PLN, Finance Directorate

INDONESIA

RURAL ELECTRIFICATION SECTOR STUDY

Estimation of Financial Operations of Rural Electrification Schemes /a (August 1985)

	Lampung	Lombok	Luwu
Operating Statistics			
Average number of customers	4,384	3,043	3,553
Average monthly revenue (Rp)	4,281	4,409	2,030
Average kWh/customer	28	32	15
Average revenue/kWh	153	140	179
Total Sales (MWh)	119	114	79
Residential (MWh)	105	103	65
(%)	88	90	82
Assets and Depreciation		(Rp '000)	
Fixed Assets in Operation	1,365,682	1,542,888	362,378
Composition			
General	30	37	44
Distribution	59	48	37
Generation	10	14	17
Miscellaneous	1	1	2
Work in progress	1,180,966	807,338	1,238,040
Materials	1,127,576	488,567	835,608
Monthly Depreciation	3,055	4,440	543
Allocated to residential customer	2,688	3,996	445
Per kWh sold (Rp)	26	38	7
Avg. loan amount by end of project	6,514,126	4,890,218	4,710,388
Monthly interest	38,605	17,794	21,330
Allocated to residential customer	33,972	16,015	17,490
Per kWh sold	23	22	25

/a Representative RE schemes under Ministry of Cooperatives financed by USAID.

Source: Ministry of Cooperatives.

INDONESIA

RURAL ELECTRIFICATION REVIEW

PLN - Rural Electrification Connection Program, Repelita IV
(In 1985 prices)

	1984/85	1985/86	1986/87	1987/88	1988/89	1984/85-88/89 Total	%
Villages (no.)	8,995	10,215	11,615	13,215	15,015		
Java	4,449	5,058	5,754	6,529	7,375		
Outside Java	4,546	5,157	5,861	6,686	7,640		
Percentages (%)	100	100	100	100	100		
Java	49	50	50	49	49		
Outside Java	51	50	50	51	51		
Additions (no.)	980	1,220	1,400	1,600	1,800	7,000	100
Java	499	609	696	775	846	3,425	49
Outside Java	481	611	704	825	954	3,575	51
Customers ('000)	1,688	1,953	2,268	2,638	3,068		
Java	1,065	1,242	1,454	1,702	1,991		
Outside Java	623	711	814	936	1,077		
Percentages (%)	100	100	100	100	100		
Java	63	64	64	65	65		
Outside Java	37	36	36	35	35		
Additions ('000)	220	265	315	370	430	1,600	100
Java	148	177	212	248	289	1,074	67
Outside Java	72	88	103	122	141	526	33
Accumulated Sales (GWh)							
Java	511	620	755	919	1,118		
Outside Java	280	333	397	476	570		
Total	792	953	1,152	1,395	1,688		
Estimated Operation Results (10^9 million)							
Operating revenues	78	93	113	137	165	586	
Cash Operating costs	97	116	140	170	205	729	
Operating profit/deficit	-19	-23	-28	-33	-40	-143	
Java Operation							
Operating revenues	50	61	74	90	110	384	
Cash operating costs	54	65	79	96	117	412	
Operating profits/deficits	-4	-4	-5	-6	-8	-27	
Out Java Operation							
Operating revenues	27	33	39	47	56	202	
Cash operating costs	43	51	61	73	88	317	
Operating profit/deficit	-16	-19	-22	-27	-32	-115	

Existing Consumers (1983/84)	Conn	Sales	Op rev	Op cost	Op def
Java	917	440	43	46	-3
Out Java	551	248	24	38	-14
Total	1,468	688	67	84	-17

Assumptions: (in 1985 prices)	1984/85	1985/86	1986/87	1987/88	
Java: Ave. rev/kWh	98	98	98	98	98
kWh/conn/yr	480	499	519	540	562
Outside Java: Ave. rev/kWh	98	98	98	98	98
kWh/conn/year	420	437	454	472	491

INDONESIA

RURAL ELECTRIFICATION REVIEW

PLN - Rural Electrification Investment Program and Financing Plan, Repelita IV
(In 1985 prices)

	1984/85	1985/86	1986/87	1987/88	1988/89	1984/85-88/89 Total	%
Diesel Capacity (kW)							
Java	0	0	0	0	0	0	0
Outside Java	18,000	22,000	28,000	30,000	34,000	132,000	100
Subtotal	18,000	22,000	28,000	30,000	34,000	132,000	100
Microhydro (kW)							
Java	320	630	200	2,400	750	4,300	9
Outside Java	980	1,370	13,800	16,200	13,350	45,700	91
Subtotal	1,300	2,000	14,000	18,600	14,100	50,000	100
Transformers (kVA)							
Java	77,865	95,988	115,455	136,935	162,442	588,685	67
Outside Java	38,135	47,012	56,545	67,065	79,558	288,315	33
Subtotal	116,000	143,000	172,000	204,000	242,000	877,000	100
Med. Volt. Networks (km)							
Java	1,497	1,827	2,088	2,325	2,538	10,275	49
Outside Java	1,503	1,773	2,112	2,475	2,862	10,725	51
Subtotal	3,000	3,600	4,200	4,800	5,400	21,000	100
Low Volt. Networks (km)							
Java	1,497	1,827	2,088	2,325	2,538	10,275	49
Outside Java	1,503	1,773	2,112	2,475	2,862	10,725	51
Subtotal	3,000	3,600	4,200	4,800	5,400	21,000	100
House Connections (no.)							
Java	147,675	177,880	211,443	248,362	288,637	1,073,997	67
Outside Java	72,325	87,120	103,557	121,638	141,363	526,003	33
Subtotal	220,000	265,000	315,000	370,000	430,000	1,600,000	100

Assumptions:

	1984/85	1985/86	1986/87	1987/88	1988/89
In 1984 Prices (in millions)					
Disel gen (Rp/kW)	0.9981	0.9981	0.9981	0.9981	0.9981
Microhydro gen (Rp/kW)	1.6000	1.6000	1.6000	1.6000	1.6000
Transformers (Rp/kV)	0.0297	0.0297	0.0297	0.0297	0.0297
Med. volt. networks (Rp/kms)	15.5000	15.5000	15.5000	15.5000	15.5000
Low volt. netowrks (kms)	7.9327	7.9327	7.9327	7.9327	7.9327
House conn (Rp/conn)	0.1106	0.1106	0.1106	0.1106	0.1106
In 1985 Prices					
Disel gen	1.0650	1.0650	1.0650	1.0650	1.0650
Microhydro gen	1.7072	1.7072	1.7072	1.7072	1.7072
Transformers	0.0317	0.0317	0.0317	0.0317	0.0317
Med. volt. networks	16.5385	16.5385	16.5385	16.5385	16.5385
Low volt. netowrks	8.4642	8.4642	8.4642	8.4642	8.4642
House conn	0.1180	0.1180	0.1180	0.1180	0.1180

	1984/85	1985/86	1986/87	1987/88	1988/89	1984/85-88/89 Total	%
Estimated Expenditures (Rp mln)							
Diesel Capacity							
Java	0	0	0	0	0	0	0
Outside Java	19,170	23,429	29,819	31,949	36,209	140,576	100
Subtotal	19,170	23,429	29,819	31,949	36,209	140,576	100
Microhydro							
Java	436	2,271	2,071	1,865	382	7,025	8
Outside Java	10,040	20,438	23,817	16,787	7,252	78,335	92
Subtotal	10,477	22,709	25,888	18,652	7,634	85,360	100
Transformers							
Java	2,468	3,042	3,659	4,339	5,148	18,655	67
Outside Java	1,208	1,490	1,792	2,125	2,521	9,137	33
Subtotal	3,676	4,532	5,451	6,465	7,669	27,792	100
Med. Volt. Networks							
Java	24,758	30,216	34,532	38,452	41,975	169,933	49
Outside Java	24,857	29,323	34,929	40,933	47,333	177,375	51
Subtotal	49,616	59,539	69,462	79,385	89,308	347,309	100
Low Volt. Networks							
Java	12,671	15,464	17,673	19,679	21,482	86,970	49
Outside Java	12,722	15,007	17,876	20,949	24,225	90,778	51
Subtotal	25,393	30,471	35,550	40,628	45,707	177,748	100
House Connections							
Java	17,427	20,992	24,952	29,309	34,062	126,743	67
Outside Java	8,535	10,281	12,221	14,355	16,682	62,074	33
Subtotal	25,962	31,273	37,173	43,664	50,744	188,816	100
Total Estimated Expenditures							
Java	57,760	71,984	82,888	93,645	103,049	409,326	42
Outside Java	76,533	99,968	120,454	127,098	134,223	558,276	58
GRAND TOTAL	134,293	171,952	203,342	220,743	237,271	967,601	100
Conversion factor 1984 to 1985	1.067	1.067	1.067	1.067	1.067		

INDONESIA

RURAL ELECTRIFICATION REVIEW

Financial Implications of Repelita IV Rural Electrification Program

Base Case - With Government Grant Contribution

Fiscal year:	1	2	3	4	5	6	7	8	9	10	Total, Yrs 1-10
	(Rp million)										(Rp billion)
Incremental sales (GWh)	103	130	160	196	237	0	0	0	0	0	
Accumulated sales (GWh)	103	233	393	589	826	859	894	929	967	1,005	
Average tariff (Rp/kWh sold)	98	98	98	98	98	98	98	98	98	98	
% increase from previous year	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Sale of electricity	10,137	22,838	38,550	57,749	80,966	84,204	87,572	91,075	94,718	98,507	
Operating cost (before depreciation)	12,449	28,077	47,375	70,983	99,515	103,495	107,635	111,941	116,418	121,075	
Operating Profit/Deficit	-2,312	-5,240	-8,825	-13,234	-18,549	-19,291	-20,063	-20,865	-21,700	-22,568	
Financing Plan											
Sources											
Internal cash generation	-2,312	-5,240	-8,825	-13,234	-18,549	-19,291	-20,063	-20,865	-21,700	-22,568	-153
Consumers' contributions	5,372	6,478	7,534	8,830	10,491	0	0	0	0	0	39
Borrowings	0	0	0	0	0	0	0	0	0	0	0
Grants	128,921	155,474	180,808	211,913	251,780	0	0	0	0	0	929
Total Sources	131,981	156,713	179,517	207,508	243,722	-19,291	-20,063	-20,865	-21,700	-22,568	815
Uses											
Capital expenditures (including increments in working capital and credit programs)	134,293	161,952	188,342	220,743	262,271	0	0	0	0	0	968
Debt service											
Interest expenses	0	0	0	0	0	0	0	0	0	0	0
Principal repayments	0	0	0	0	0	0	0	0	0	0	0
Subtotal	0	0	0	0	0	0	0	0	0	0	0
Total Uses	134,293	161,952	188,342	220,743	262,271	0	0	0	0	0	968
Surplus or Deficit	-2,312	-5,240	-8,825	-13,234	-18,549	-19,291	-20,063	-20,865	-21,700	-22,568	-153

Memo Items (Over 10-year period; in Rp bln)	
Total capital expenditure	968
Total internal cash generation	-153
Total debt service	0
Total surplus/deficit	-153

INDONESIA

RURAL ELECTRIFICATION REVIEW

Financial Implications of Repelita IV Rural Electrification Program

Base Case - With Borrowing at 6% p.a.

Fiscal year:	1	2	3	4	5	6	7	8	9	10	Total, Yrs 1-10 (Rp billion)
	(Rp million)										
Incremental sales (GWh)	103	130	160	196	237	0	0	0	0	0	
Accumulated sales (GWh)	103	233	393	589	826	859	894	929	967	1,005	
Average tariff (Rp/kWh sold)	98	98	98	98	98	98	98	98	98	98	
% increase from previous year	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Sale of electricity	10,137	22,838	38,550	57,749	80,966	84,204	87,572	91,075	94,718	98,507	
Operating cost (before depreciation)	12,449	28,077	47,375	70,983	99,515	103,495	107,635	111,941	116,418	121,075	
Operating Profit/Deficit	-2,312	-5,240	-8,825	-13,234	-18,549	-19,291	-20,063	-20,865	-21,700	-22,568	
Financing Plan											
Sources											
Internal cash generation	-2,312	-5,240	-8,825	-13,234	-18,549	-19,291	-20,063	-20,865	-21,700	-22,568	-153
Consumers' contributions	5,372	6,478	7,534	8,830	10,491	0	0	0	0	0	39
Borrowings	128,921	155,474	180,808	211,913	251,780	0	0	0	0	0	929
Grants	0	0	0	0	0	0	0	0	0	0	0
Total Sources	131,981	156,713	179,517	207,508	243,722	-19,291	-20,063	-20,865	-21,700	-22,568	815
Uses											
Capital expenditures (including increments in working capital and credit programs)	134,293	161,952	188,342	220,743	262,271	0	0	0	0	0	968
Debt service											
Interest expenses	4,035	9,120	15,377	23,048	32,309	33,601	34,945	36,343	37,797	39,309	266
Principal repayments	0	0	19,284	28,905	40,519	42,140	43,826	45,579	47,402	49,298	317
Subtotal	4,035	9,120	34,661	51,954	72,828	75,741	78,771	81,922	85,199	88,607	1,550
Total Uses	138,328	171,073	223,003	272,696	335,099	75,741	78,771	81,922	85,199	88,607	1,550
Surplus or Deficit	-6,347	-14,360	-43,485	-65,188	-91,377	-95,032	-98,834	-102,787	-106,899	-111,175	-735
Memo Items (Over 10-year period; in Rp bln)											
Total capital expenditure	968										
Total internal cash generation	-153										
Total debt service	583										
Total surplus/deficit	-735										

INDONESIA

RURAL ELECTRIFICATION REVIEW

Financial Implications of Repelita IV Rural Electrification Program

Resource Mobilization Case - With Government Grant Contribution

Fiscal year:	1	2	3	4	5	6	7	8	9	10	Total, Yrs 1-10
	(Rp million)										(Rp billion)
Incremental sales (GWh)	182	228	282	345	417	0	0	0	0	0	
Accumulated sales (GWh)	182	410	692	1,037	1,454	1,512	1,573	1,636	1,701	1,769	
Average tariff (Rp/kWh sold)	98	98	98	98	98	98	98	98	98	98	
% increase from previous year	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Sale of electricity	17,841	40,194	67,848	101,638	142,499	148,199	154,127	160,292	166,704	173,372	
Operating cost (before depreciation)	19,296	43,510	73,421	110,003	154,221	160,390	166,806	173,478	180,417	187,634	
Operating Profit/Deficit	-1,455	-3,315	-5,573	-8,366	-11,722	-12,191	-12,679	-13,186	-13,713	-14,262	
Financing Plan											
Sources											
Internal cash generation	-1,455	-3,315	-5,573	-8,366	-11,722	-12,191	-12,679	-13,186	-13,713	-14,262	-96
Consumers' contributions	33,003	39,831	46,037	54,531	65,930	0	0	0	0	0	239
Borrowings	0	0	0	0	0	0	0	0	0	0	0
Grants	99,009	119,492	138,112	163,593	197,790	0	0	0	0	0	718
Total Sources	130,557	156,007	178,576	209,758	251,998	-12,191	-12,679	-13,186	-13,713	-14,262	861
Uses											
Capital expenditures (including increments in working capital and credit programs)	132,011	159,322	184,149	218,124	263,720	0	0	0	0	0	957
Debt service											
Interest expenses	0	0	0	0	0	0	0	0	0	0	0
Principal repayments	0	0	0	0	0	0	0	0	0	0	0
Subtotal	0	0	0	0	0	0	0	0	0	0	0
Total Uses	132,011	159,322	184,149	218,124	263,720	0	0	0	0	0	957
Surplus or Deficit	-1,455	-3,315	-5,573	-8,366	-11,722	-12,191	-12,679	-13,186	-13,713	-14,262	-96
Memo Items (Over 10-year period; in Rp bln)											
Total capital expenditure	957										
Total internal cash generation	-96										
Total debt service	0										
Total surplus/deficit	-96										

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RURAL ELECTRIFICATION REVIEW

Financial Implications of Repelita IV Rural Electrification Program

Resource Mobilization Case - With Borrowings at 6% p.a.

Fiscal year:	1	2	3	4	5	6	7	8	9	10	Total, Yrs 1-10
	(Rp million)										(Rp billion)
Incremental sales (GWh)	182	228	282	345	417	0	0	0	0	0	
	0	0	0	0							
Accumulated sales (GWh)	182	410	692	1,037	1,454	1,512	1,573	1,636	1,701	1,769	
Average tariff (Rp/kWh sold)	98	98	98	98	98	98	98	98	98	98	
% increase from previous year	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Sale of electricity	17,841	40,194	67,848	101,638	142,499	148,199	154,127	160,292	166,704	173,372	
Operating cost (before depreciation)	19,296	43,510	73,421	110,003	154,221	160,390	166,806	173,478	180,417	187,634	
Operating Profit/Deficit	-1,455	-3,315	-5,573	-8,366	-11,722	-12,191	-12,679	-13,186	-13,713	-14,262	
Financing Plan											
Sources											
Internal cash generation	-1,455	-3,315	-5,573	-8,366	-11,722	-12,191	-12,679	-13,186	-13,713	-14,262	-96
Consumers' contributions	33,003	39,831	46,037	54,531	65,930	0	0	0	0	0	239
Borrowings	99,009	119,492	138,112	163,593	197,790	0	0	0	0	0	718
Grants	0	0	0	0	0	0	0	0	0	0	0
Total Sources	130,557	156,007	178,576	209,758	251,998	-12,191	-12,679	-13,186	-13,713	-14,262	861
Uses											
Capital expenditures (including increments in working capital and credit programs)	132,011	159,322	184,149	218,124	263,720	0	0	0	0	0	957
Debt service											
Interest expenses	3,114	7,041	11,870	17,792	24,941	25,939	26,976	28,055	29,178	30,345	205
Principal repayments	0	0	14,897	22,331	31,303	32,555	33,857	35,212	36,620	38,085	245
Subtotal	3,114	7,041	26,767	40,123	56,244	58,494	60,834	63,267	65,798	68,430	450
Total Uses	135,126	166,363	210,916	258,247	319,964	58,494	60,834	63,267	65,798	68,430	1,407
Surplus or Deficit	-4,569	-10,356	-32,340	-48,489	-67,966	-70,685	-73,512	-76,453	-79,511	-82,691	-547

Memo Items (Over 10-year period; in Rp bln)	
Total capital expenditure	957
Total internal cash generation	-96
Total debt service	450
Total surplus/deficit	-547

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RURAL ELECTRIFICATION REVIEW

Financial Implications of Repelita IV Rural Electrification Program

Breakeven Tariff Case - With Government Grant Contribution

Fiscal year:	1	2	3	4	5	6	7	8	9	10	Total, Yrs 1-10 (Rp billion)
	(Rp million)										
Incremental sales (GWh)	182	228	282	345	417	0	0	0	0	0	
Accumulated sales (GWh)	182	410	692	1,037	1,454	1,512	1,573	1,636	1,701	1,769	
Average tariff (Rp/kWh sold)	98	98	117	117	117	117	117	117	117	117	
% increase from previous year	0.0	0.0	19.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Sale of electricity	17,841	40,194	80,763	121,004	169,644	176,429	183,486	190,826	198,459	206,397	
Operating cost (before depreciation)	19,296	43,510	73,421	110,003	154,221	160,390	166,806	173,478	180,417	187,634	
Operating Profit/Deficit	-1,455	-3,315	7,342	11,000	15,422	16,039	16,681	17,348	18,042	18,763	
Financing Plan											
Sources											
Internal cash generation	0	0	0	0	0	0	0	0	0	0	0
Consumers' contributions	33,003	39,831	46,037	54,531	65,930	0	0	0	0	0	239
Borrowings	0	0	0	0	0	0	0	0	0	0	0
Grants	99,009	119,492	138,112	163,593	197,790	0	0	0	0	0	718
Total Sources	132,011	159,322	184,149	218,124	263,720	0	0	0	0	0	957
Uses											
Capital expenditures (including increments in working capital and credit programs)	132,011	159,322	184,149	218,124	263,720	0	0	0	0	0	957
Debt service											
Interest expenses	0	0	0	0	0	0	0	0	0	0	0
Principal repayments	0	0	0	0	0	0	0	0	0	0	0
Subtotal	0	0	0	0	0	0	0	0	0	0	0
Total Uses	132,011	159,322	184,149	218,124	263,720	0	0	0	0	0	957
Surplus or Deficit	0	0	0	0	0	0	0	0	0	0	0
Memo Items (Over 10-year period; in Rp bln)											
Total capital expenditure	957										
Total internal cash generation	0										
Total debt service	0										
Total surplus/deficit	0										

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RURAL ELECTRIFICATION REVIEW

Financial Implications of Repelita IV Rural Electrification Program

Breakeven Tariff Case - With Borrowings at 6% p.a.

Fiscal year:	1	2	3	4	5	6	7	8	9	10	Total, Yrs 1-10
	(Rp million)										(Rp billion)
Incremental sales (GWh)	182	228	282	345	417	0	0	0	0	0	
Accumulated sales (GWh)	182	410	692	1,037	1,454	1,512	1,573	1,636	1,701	1,769	
Average tariff (Rp/kWh sold)	98	98	117	117	117	142	142	142	167	167	
% increase from previous year	0.0	0.0	19.0	0.0	0.0	21.5	0.0	0.0	17.7	0.0	
Sale of electricity	17,841	40,194	80,763	121,004	169,644	214,278	222,849	231,763	283,609	294,953	
Operating cost (before depreciation)	19,296	43,510	73,421	110,003	154,221	160,806	166,806	173,478	180,417	187,634	
Operating Profit/Deficit	-1,455	-3,315	7,342	11,000	15,422	53,888	56,044	58,285	103,192	107,319	
Financing Plan											
Sources											
Internal cash generation	0	0	26,767	40,123	56,244	58,494	60,834	63,267	65,798	68,430	440
Consumers' contributions	33,003	39,831	46,037	54,531	65,930	0	0	0	0	0	239
Borrowings	99,009	119,492	138,112	163,593	197,790	0	0	0	0	0	718
Grants	0	0	0	0	0	0	0	0	0	0	0
Total Sources	132,011	159,322	210,916	258,247	319,964	58,494	60,834	63,267	65,798	68,430	1,397
Uses											
Capital expenditures (including increments in working capital and credit programs)	132,011	159,322	184,149	218,124	263,720	0	0	0	0	0	957
Debt service											
Interest expenses	0	0	11,870	17,792	24,941	25,939	26,976	28,055	29,178	30,345	195
Principal repayments	0	0	14,897	22,331	31,303	32,555	33,857	35,212	36,620	38,085	245
Subtotal	0	0	26,767	40,123	56,244	58,494	60,834	63,267	65,798	68,430	440
Total Uses	132,011	159,322	210,916	258,247	319,964	58,494	60,834	63,267	65,798	68,430	1,397
Surplus or Deficit	0	0	0	0	0	0	0	0	0	0	0
Memo Items (Over 10-year period; in Rp bln)											
Total capital expenditure	957										
Total internal cash generation	440										
Total debt service	440										
Total surplus/deficit	0										

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RURAL ELECTRIFICATION REVIEW

Equivalence of Kerosene and Electric Lighting

In order to estimate cost savings benefits in existing markets and willingness-to-pay benefits in new markets, one must establish an equivalence between electric energy and energy derived from the alternative source used before RE. The most important such equivalence in the case of Indonesia is between electric lighting and kerosene lighting.

The analysis presented in this report assumes that 1.7 liters of kerosene must be burned in a lamp in order to provide the equivalent of 1 kWh of electric lighting. This, in turn, reflects the following assumptions: (a) most kerosene lighting in households which connect to RE when it becomes available is derived from petromax lamps; (b) the light from the petromax lamp is equivalent to the light from a 60 watt light bulb, and (c) petromax lamps consume kerosene at a rate of 0.1 liter/hour.1/

It should be clear that estimates of RE benefits using the methodology described above are very sensitive to the assumed equivalence between kerosene and electric lighting. Specifically, if the light from the petromax is postulated to be equivalent to the light from a 30-watt fluorescent light, which represents a more efficient technology to produce light from electricity, the equivalence factor would be about 3.4 liter/kWh. Also, if most RE consumers used wick lamps prior to electrification, the equivalence factor would be even higher, since they produce much less light per unit of kerosene than a petromax lamp.2/ On the other hand, if more efficient pressure lamps than the petromax lamps become widely used, then a lower equivalence factor would become appropriate. Because of its importance, a careful effort has been made to determine an appropriate equivalence factor.

1/ All of these assumptions are consistent with the results of a rural energy survey for Indonesia conducted by W. Paul Weatherly *et. al.* in 1979.

2/ However, survey data indicates that households in the upper half of the rural income distribution own, on average, at least one petromax lamp.

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RURAL ELECTRIFICATION REVIEW

Cost Estimate of Grid Substations
(US$ 1985 prices)

	Based on: Actual cost of substation in East Java 70 kV sub-station	Reference cost data in PLN Pusat 70 kV substation	Reference cost data in PLN Pusat 150 kV substation
2 HV line bays	170,000	490,000	744,000
HV bus work	72,000	72,000	144,000
1 HV transformer bay	60,000	270,000	400,000
10 MVA transformer	130,000	186,000	186,000
20 kV switchgear (6 circuts)	94,000	134,000	134,000
Control and protection	180,000	180,000/b	180,000/b
Civil works	50,000	50,000/b	50,000/b
Land /a	110,000	110,000	220,000
Total	866,000	1,492,000	2,058,000
Cost per kVA for 1 x 10 MVA station	87	149	206
Cost per kVA for 1 x 20 MVA station	50	81	112

/a Based on assumption of 1 hectare of land for 70 kV and 2 hectares of land for 150 kV substations (information obtained from East Java).

/b Assumed values.

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RURAL ELECTRIFICATION REVIEW

Comparative Costs of Single Phase Versus Three Phase Distribution

Type of distribution system		Relative cost	Relative losses	Final kW demand 500	750	1,000
				--- (Present worth of costs, US$/km) ---		
Single phase	(Phase to Neutral)	1.2/a + 1 = 2.2	6.00	3,601	5,768	6,438
Two phase	(Phase/Phase to Neutral)	1.2 + 1.2 + 1 = 3.2	3.75	3,187	4,541	6,438
Single phase	(Phase to phase)	1.2 + 1.2 = 2.4	2.00	2,488	3,211	4,222
Three phase	(3 wire)	1.2 + 1.2 + 1.2 = 3.6	1.00	2,488	2,849	3,555

/a Assumes 1.0 conductor cost and 0.2 insulation cost.

Note:
- Voltage: 20 kV
- Conductor size: 35 mm^2
- Load factor: 30%
- Years to reach (maximum demand): 15

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RURAL ELECTRIFICATION REVIEW

PLN's Standard Prestressed Concrete Poles

	Pole height (m)	Strength (daN) /a	Cost (US$) /b	Area where used
20 kV Lines				
	11	200	150	E Java
		350	196	"
		500	223	"
	12	200	180	C & E Java
		350	230	"
		500	240	"
	13	350	270	E Java
	13	500	300	"
	14	350	305	"
400 V LV Lines				
	9	200	110	Universal

/a 1 daN = 1 kg (approximately).

/b Includes cost of transport and erection which is estimated by PLN to be about 15% of the pole cost; however, actual break up of cost is nowhere specifically shown.

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RURAL ELECTRIFICATION REVIEW

Cost Estimates of Distribution Lines
(US$/km, 1985 prices) /a

Item	20 kV lines				400 v lines			
	East Java		Central Java		East Java		Central Java	
	Type	Cost	Type	Cost	Type	Cost	Type	Cost
Concrete poles (Incl. erection)	20, 14 m 2, 12 m	6,650	20, 11-14 m	5,910	24, 9 m	2,618	20, 9 m	2,540
Insulators	String 15 Pin 75	477 1,909	String 24 Pin 60	2,182	String 48 Pin 84	120 191		
Accessories								
Cross arms		627				718		
Strut pole and guy wire		378				410		
Grounding		140				152		
Hardware		518				181		
Pole foundations	5	772				-		
Subtotal		2,435		3,300		1,461		1,454
Conductors								
Phase	3,300 m A 3C 150 mm^2	3,600		4,727	70 mm^2	2,800	70 mm^2	1,818
Neutral	Nil	-		-				-
Shield	1,100 m GS 22 mm^2	400		-				-
Subtotal		4,000		4,727		2,800		1,818
Total Material		15,471		16,119		7,190		5,812
Labor		1,013		1,700		939		728
Transport		272		-		180		-
Total Cost of Line		16,756		17,819		8,309		6,540

/a Conversion rate US$1 = Rp 1,100.

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RURAL ELECTRIFICATION REVIEW

Design Basis for Distribution Line Poles /a

	MV						MV + LV		LV	
Conductor size (mm^2)	240	150	70	240	150	70	150 +	70	70	35
Pole height (m)	9	9	9	10	10	10	10		8	8
Maximum span (m)	65	65	65	80	80	80	85		50	50
Maximum sag (m)	1.5	1.5	1.5	2.3	2.3	2.3	1.5	1.5	1.5	1.5
Minimun tension (kg)	350	220	105	350	220	105	160	75	62	31
Approx. maximum tension (kg)	490	310	150	490	310	150	225	105	87	43
Force due to 5^{o} line angle (kg)	128	81	39	128	81	39	59	53	48	34
Force due to wind on conductors (kg)	117	92	63	144	113	77	78	53	48	34
Force due to wind on pole (kg)	50	50	50	60	60	50	60		35	35
Total Force on Pole	295	223	152	332	254	176	277		105	80
Pole class (kg)	300	200	150	350	250	200	300		100	100
Comparative cost (approx) for given conductor for MV	100	100	100	100	103	105	-	-	-	-

Suggested standard pole classes

9 M 300 kg for MV 240 mm^2 conductor up to 65 M span
9 M 200 kg for MV 150 mm^2 and below conductor up to 65 M span
10 M 300 kg for MV + LV (150 + 70) mm^2 or MV 240 mm^2 or MV 240 mm^2 up to 75 M span
8 M 100 kg for LV 70 mm^2 and below

Basis AAC conductor
Wind velocity 80 km/hr
Ground clearance MV 6m, LV 5m
Conductor temperature maximum 65^{o} C
minumum 20^{o} C

/a Approximate analysis which should be refined.

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RURAL ELECTRIFICATION REVIEW

Costs Estimates of Line Insulators and Hardware
(US$/km, 1985 prices)

	East Java				Suggested /a			
	MV line		LV line		MV line		LV line	
	Nos	Cost	Nos	Cost	Nos	Cost	Nos	Cost
Insulators								
Pin	75	2,000	84	200	45	810	-	-
String	15	600	48	200	12	360	-	-
Spool with brackets	-	-	-	-	-	-	48	240
Cross arms	31	650	33	400	16	325	-	-
Shield wire	-	280	-	-	-	-	-	-
Guy Wire	-	350	-	360	-	180	-	180
Ground rod	10	90	-	-	-	90	-	-
Clamps and misc. hardware	-	500	-	890	-	400	-	200
Total		4,470		2,050		2,165		620

/a Suggested cost takes into account:

a. Longer spans and hence less number of supports
b. Elimination of shield wire.
c. Use of standard pin insulators and 1-1/2 shackle points per km.
d. Spool type LV insulators with D shackle supports, instead of expensive cross arms.

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RURAL ELECTRIFICATION REVIEW

Economic Analysis for Sizing of Line Conductors

Basis for Evaluation

Life cycle costs are evaluated as present worth of capital costs (only variable portion) and costs of losses using the following assumtions:

(a) Period for evaluation	15 years	
(b) Discount factor	12%	

	Rural	Urban
(c) Load growth pattern (sinusoid curve) Final demand attained in year	15	5
(d) Load factor	30%	60%
(e) Daily load curve (rectangular blocks)		
Hours of peak demand	18-21	
Hours of 80% peak demand	17-18	21-22
Hours of off peak demand	0-17	22-24

(f) Long-run marginal costs /a	Capacity ($/kW/yr)	Energy ($/kWhr) Peak	Off-peak
For MV line sizing	106	0.09	0.06
For distribution transformer sizing	163	0.09	0.06
For LV line sizing	272	0.10	0.07

(g) Costs of (AAC) conductors 240 mm^2 (other conductor costs pro-rated)	$6,000/km (3 phase)
(h) Variation in pole cost	Proportional to $(\text{conductor area})^{1/3}$
(i) Power factor	0.8 lag

/a These are extrapolated from recent study (October 1985) furnished by PLN.

Results of Analysis

Medium Voltage Lines

	Final Demand (kW)						
	500	1,000	1,500	2,000	3,000	4,000	5,000
(a) Urban Loadings:	---------- Present value of costs (US$) ----------						
Conductor (mm^2)							
(240)	8,621	8,987	9,596	10,045	12,887	16,300	20,688
(150)	6,085	6,670	7,645	9,010	12,911	18,371	25,390
(70)	3,832	5,086	7,175	10,100	18,458	30,158	45,202
(35)	3,035	5,542	9,721	-	-	-	-
(170)	-	-	-	-	12,675	17,493	-
(b) Rural Loadings:							
Conductor (mm^2)							
(240)	-	-	-	9,174	10,017	11,197	12,715
(150)	-	-	-	6,969	8,318	10,207	12,635
(70)	3,559	3,992	4,715	5,727	8,617	12,664	17,867
(35)	2,488	3,355	4,800	6,824	-	-	-

Low Voltage Lines

	Final Demand (kW)					
	5	10	15	25	50	100
(a) Urban Loadings	---------- Present value of costs (US$) ----------					
Conductor (mm^2)						
(70)	1,912	2,401	3,216	5,824	-	6,937
(35)	1,200	2,178	3,808	9,023		
(10)	1,390	4,813				
(b) Rural Loadings						
Conductor (mm^2)						
(70)	1,812	1,998	2,308	3,302	7,961	26,594
(35)	999	1,371	1,992	3,980	-	-
(25)	798	1,320	2,190	4,972	-	-
(10)	684	1,989	-	-	-	-

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RURAL ELECTRIFICATION REVIEW

Costs of Distribution Transformer Stations
(US$ 1985 prices)

	1-Phase 50 kVA transformer		3-Phase 150 kVA transformer	
	Present cost /a	Suggested cost	Present cost /a	Suggested cost
Transformer	1,600	1,600	2,700	2,700
MV Fuse, LA, cross arm and insulators	260	260	420	420
MV - Cables	50	-	180	-
LV - Panel	25	-	250	-
LV - Cross arms	28	-	28	-
LV - Cables	125	-	250	-
Concrete pole	190	140	400	250
Miscellaneous items	70	70	110	110
Labor	170	40	300	80
Transport and overheads	60	60	80	80
Total	2,578	2,170	4,718	3,640
Percentage reduction	16%		23%	

/a Source: PLN Wilayah Ujung -Padang.

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RURAL ELECTRIFICATION REVIEW

Sizing of Transformers and Their Losses

Transformer Data	kVA	Cost US$	Iron loss W	Copper loss W	Replacement cost US$
	100	2,500	320	175	200
	200	4,000	460	285	-

	Present value of costs (US$)	
	Rural	Urban
100 kVA transformer replaced by a 200 kVA unit in Year 5	8,013	14,908
200 kVA transformers at start	8,562	12,502

Increase in present value of costs (or penalty) due to:

(a)	1 kW increase in iron loss	US$5,070
(b)	1 kW increase in copper loss - Rural loading	US$790
	- Urban loading	US$2,160

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RURAL ELECTRIFICATION REVIEW

Typical Costs of LV lines
(US$/km, 1985 prices)

	Bundled /a 3x70 + 1x50 mm^2 All insulated	Vertical 3x70 + 1x50 mm^2 All bare	Suggested cost for all bare conductors
Cost Analysis			
Conductor	2,839	2,010	1,800
Poles	1,250	1,450	1,250
Hardware	217	640	440
Stay materials	382	382	382
Labor	1,203	1,312	1,312
Total	5,891	5,794	5,184
Load transfer capability			
Load Moment:			
kVA.km	25.6	22.9	
$/(kVA.km)	230	253	

/a Costs are based on 1 km of construction comprising:

10 Intermediate/small angle pole assemblies.
5 Large angle pole assemblies.
9 Tee off intermediate pole assemblies.
1 Double dead end sectional pole assembly.
10 Single pole stays.
Earthing materials are excluded, since they are common to all alternatives.

INDONESIA

RURAL ELECTRIFICATION REVIEW

Cost of Diesel Generating Station
(US$, 1985 prices)

	Actual	Suggested
40 kW diesel generator set complete with panel, dry tank switchgear, etc.	16,363	16,363
Storage fuel tank (10 kl)	2,727	1,500
Civil works		
Power house and engine foundation	7,272	5,000
Site furnishing, fence, wood, etc.	6,818	4,000
Maintenance tools	909	500
Installation cost of equipment including transport	5,455	2,500
Total	42,271	30,863

INDONESIA

RURAL ELECTRIFICATION REVIEW

Application of Capacitors
(240 mm^2 MV line)

		Final demand (kW) 4,000	Final demand (kW) 5,000
		---- Present value of costs (US$) ----	
Power factor 0.8 lag		16,300	20,688
Power factor 0.9 lag		14,663	18,130
Saving per km of line		1,637	2,558
Load factor	0.6		
Year of final demand	5		

ORGANIZATIONAL STRUCTURE OF VILLAGE ELECTRIC ORGANIZATIONS

Figure 1 and Table 1 depict the recommended organization and staffing requirements for a decentralized managed system serving 10,000 consumers with 41 employees, including officers and staff. This is a ratio of 250 consumers per employee and is equally applicable to either a private company or an electric cooperative that is grid connected. In the case of isolated systems, positions must be added to operate and maintain the generating plant.

Table 1: STAFF REQUIREMENTS FOR 10,000 CONSUMER DISTRIBUTION SYSTEM

Position	No. of Employees
Manager	1
Department manager	4
Customer service representative	2
Accountant	2
Cashier	2
Billing clerk	4
Clerk-General	1
Work order clerk	1
Row chief	1
Storekeeper	1
Stores helper	1
Stenographer-typist	2
Line foreman	1
Lineman	5
Assistant lineman	5
Wiring Inspector	1
Mechanic	1
Driver	2
Security	2
Laborers	2
Total	41

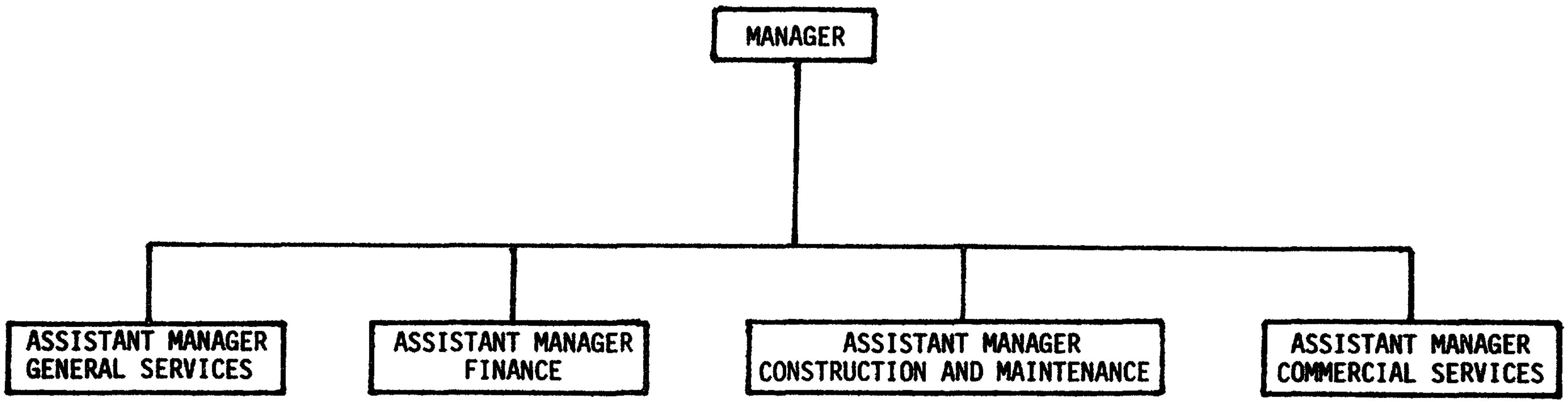
Isolated Systems

The cost of service to small isolated systems will be substantially higher than grid connected systems. Where geography, distance and road conditions permit, two or more small VEOs should work together to provide management, major maintenance, purchasing and warehousing, billing and consumer connections in their areas. This type of organization is illustrated in Figure 2.

Figure 1.

ORGANIZATION FOR 10,000 CONSUMER

DISTRIBUTION SYSTEM



Assistant Manager General Services

Functions

General Service Administration
Personnel Management

Assistant Manager Finance

Functions

Accounting
Billing
Collecting
Reports
Records

Assistant Manager Construction and Maintenance

Functions

Minor Construction
Maintenance
Operations
Stores
Meter Maintenance
Motor Pool

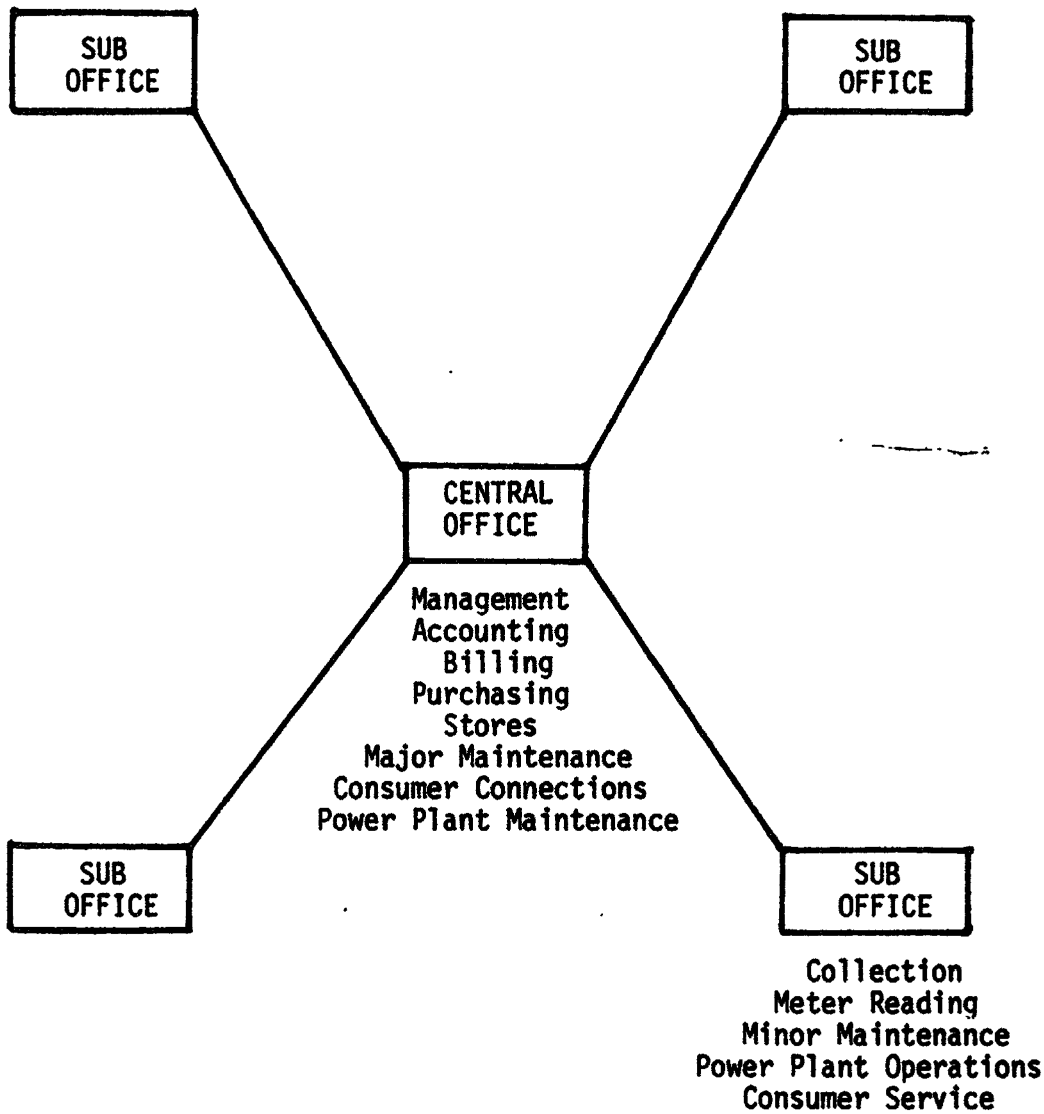
Assistant Manager Commercial Services

Functions

Consumer Services
Power Use
Complaints
Wiring Inspection

Figure 2.

ORGANIZATION FOR TWO OR MORE ISOLATED SYSTEMS



FINANCIAL PRINCIPLES AND ARRANGEMENTS FOR THE RURAL ELECTRIFICATION AGENCY

1. During the early stage of its existence, REA would have to raise necessary funds from GOI either in the forms of grant contribution or soft term credit facilities at an interest rate of, say 3% p.a., with a repayment period of 15 years after two-year grace. On handing over the completed schemes to VEO's, their total costs can then be transferred as a long-term loan financing from REA to VEOs, at an interest rate of say 6% p.a. Although these rates are significantly lower than commercial rates, this lending arrangement would be acceptable considering GOI's policy to promote rural electrification for social welfare purposes.

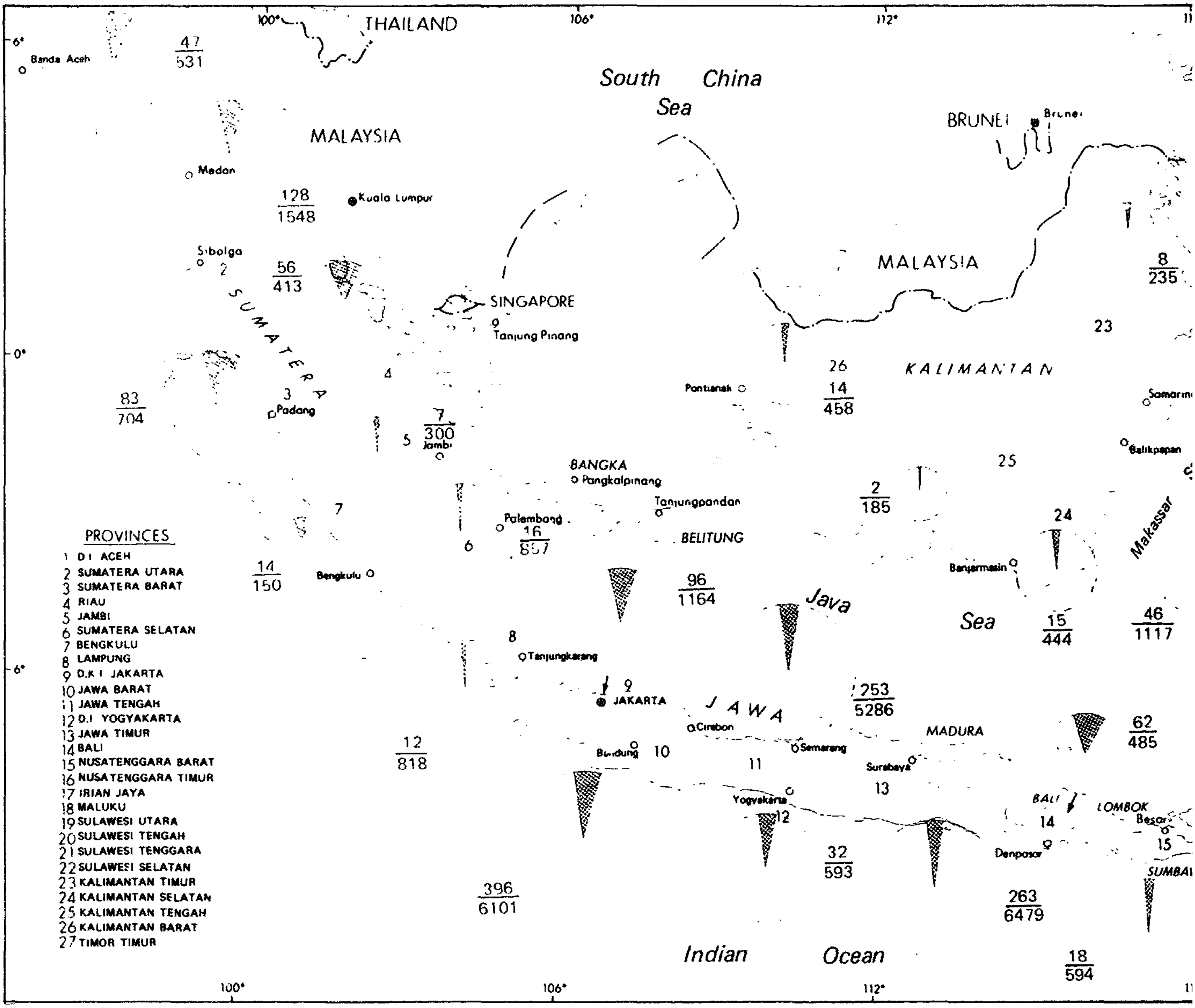
2. Recognizing the fact that affordability may vary among VEOs, the interest rates charged for RE programs may have to be determined according to the status of development a particular VEO. However, the interest spread between REA and VEOs should be set at a level sufficient to cover REA's administrative expenses and debt service payments on its own borrowings.

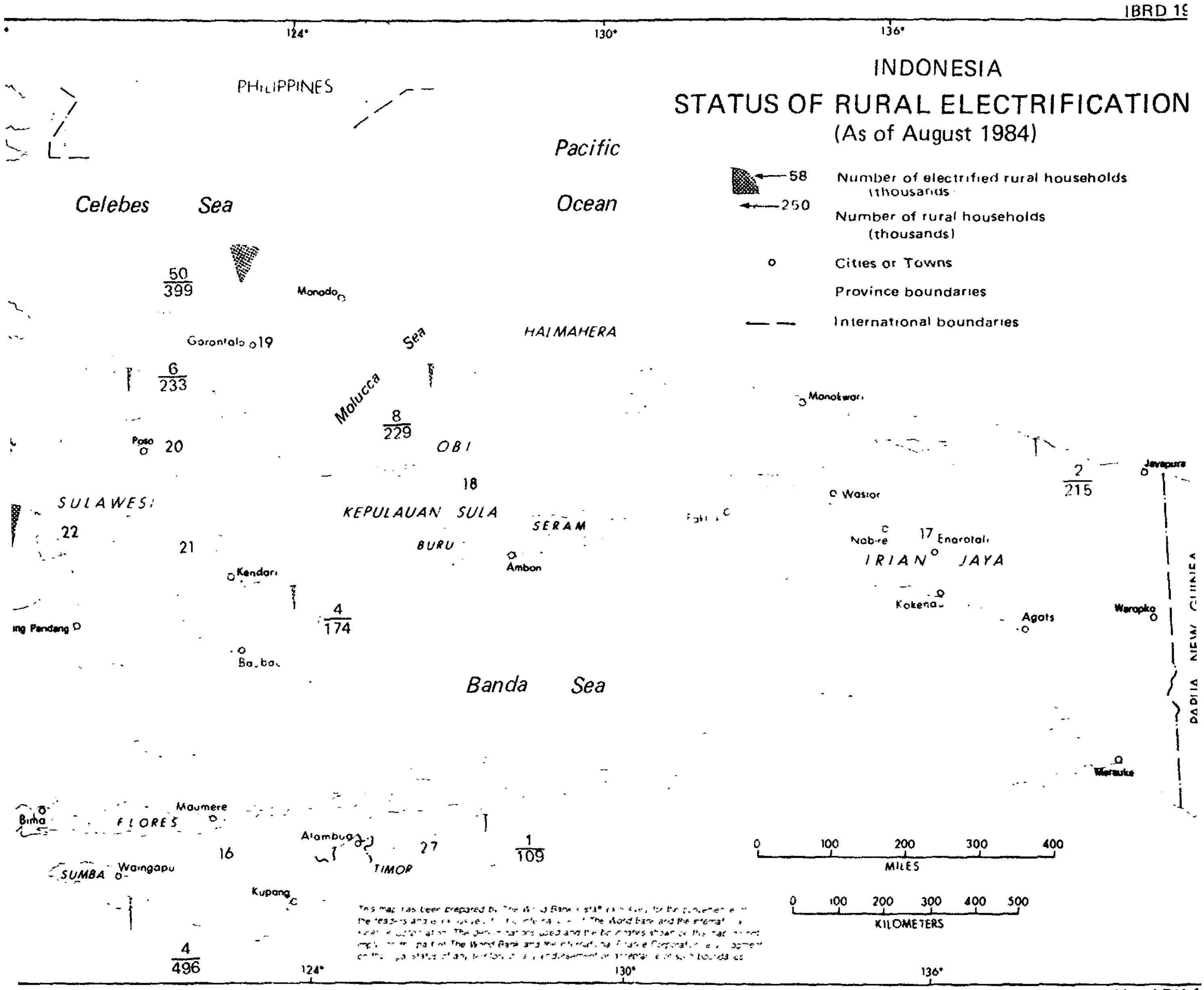
3. Since REA will be able to enjoy a spread on the interest rate and receive part of its capital as grant contribution, it can be expected that REA's financial position will improve as VEOs start servicing their debt. For VEOs to be able to meet their debt obligations, the mission has recommended that a reasonable framework for tariff regulation that would gradually reduce the subsidies and strengthen VEO's financial viability (paras. 4.29 and 5.26-27). Before this debt servicing by VEO begins, the GOI's commitment to cover REA's deficit arising from its operation will be required.

4. In order to ensure efficient operation, it would be necessary to establish certain monitoring criteria to measure REA's performance. Two financial indicators are recommended for this purpose. The first is REA's ability to generate revenues to cover its administrative and interest expenses and to provide a reasonable margin of net income. It can be stipulated that REA's administrative and interest expenses in a year shall not exceed a maximum of say 70-80% of its aggregate interest and other revenues.

5. The second is the ratio of internal sources of funds, including the VEO's loan repayments, to REA's own debt service requirements. This indicator will measure REA's ability to generate sufficient funds to meet its debt service requirement and also to provide for a surplus of funds necessary for future expansion and operation. By including VEO's loan repayments in the calculation of internal funds, this indicator can be used to monitor the effectiveness of REA as the central pool of funds for financing RE development. Since REA will be able to enjoy an interest spread in its lending to VEOs, the minimum level of this ratio can be set initially at 1.0 times progressing to say 1.5 times, which is a reasonable level commonly used in other countries for similar lending arrangements.

NOTES


THAILAND
South China Sea
MALAYSIA
BRUNEI
Brunei
Banda Aceh
Medan
Kuala Lumpur
Sibolga
SUMATERA
SINGAPORE
Tanjung Pinang
Padang
Jambi
Pontianak
KALIMANTAN
Samarinda
Balikpapan
BANGKA
Pangkalpinang
Tanjungpandan
BELITUNG
Palembang
Bengkulu
Banjarmasin
Makassar
Java Sea
Tanjungkarang
JAKARTA
JAWA
Cirebon
Semarang
MADURA
Surabaya
Bandung
Yogyakarta
BALI
LOMBOK
Denpasar
Besar
SUMBA
Indian Ocean
47/531
128/1548
56/413
83/704
7/300
16/857
14/150
96/1164
12/818
396/6101
14/458
2/185
253/5286
32/593
263/6479
15/444
46/1117
62/485
18/594
8/235
PROVINCES
1 D.I. ACEH
2 SUMATERA UTARA
3 SUMATERA BARAT
4 RIAU
5 JAMBI
6 SUMATERA SELATAN
7 BENGKULU
8 LAMPUNG
9 D.K.I. JAKARTA
10 JAWA BARAT
11 JAWA TENGAH
12 D.I. YOGYAKARTA
13 JAWA TIMUR
14 BALI
15 NUSATENGGARA BARAT
16 NUSATENGGARA TIMUR
17 IRIAN JAYA
18 MALUKU
19 SULAWESI UTARA
20 SULAWESI TENGAH
21 SULAWESI TENGGARA
22 SULAWESI SELATAN
23 KALIMANTAN TIMUR
24 KALIMANTAN SELATAN
25 KALIMANTAN TENGAH
26 KALIMANTAN BARAT
27 TIMOR TIMUR


INDONESIA
STATUS OF RURAL ELECTRIFICATION
(As of August 1984)
58 Number of electrified rural households (thousands)
250 Number of rural households (thousands)
Cities or Towns
Province boundaries
International boundaries
124°
130°
136°
PHILIPPINES
Pacific Ocean
Celebes Sea
Molucca Sea
Banda Sea
50/399
Monado
Gorontalo 19
HALMAHERA
6/233
8/229
Poso 20
OBI
18
SULAWESI
KEPULAUAN SULA
SERAM
22
21
BURU
Ambon
Kendari
4/174
Ujung Pandang
Baubau
Manokwari
2/215
Jayapura
Wasior
Nabire
17 Enarotali
IRIAN JAYA
Kokenau
Agats
Waropko
PAPUA NEW GUINEA
Merauke
Bima
Maumere
FLORES
16
Alambuga
27
1/109
TIMOR
SUMBA
Waingapu
Kupang
4/496
0 100 200 300 400
MILES
0 100 200 300 400 500
KILOMETERS