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Rural Electrification and the Commercial Sector in Indonesia

Janice Brodman

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CONTENTS

	Page
INTRODUCTORY NOTE	vii
Chapter 1. INTRODUCTION	1
Chapter 2. PROFILE OF THE PROJECT AREA	8
Chapter 3. ACCESS TO ELECTRICITY	12
Chapter 4. IMPACT ON BUSINESSES Potential for Electrical Equipment Use by Businesses Policy Implications	18
Chapter 5. IMPACT ON HOUSEHOLDS	54
Chapter 6. PERCEIVED IMPACT ON VILLAGE-AS-A-WHOLE	67
Chapter 7. ECONOMIC COSTS AND BENEFITS	74
Chapter 8. SUMMARY AND CONCLUSIONS	80
APPENDICES	86
LIST OF DISCUSSION PAPERS	92

INTRODUCTORY NOTE

Resources for the Future has, with the cooperation of the Agency for International Development, undertaken a series of studies known collectively as the ARDEN (AID-RFF-Development and ENergy) program to learn more about economic and social aspects of energy in developing countries. A major focus of this work has been to identify the costs, benefits, and obstacles to successful implementation of rural electrification programs.

Although the technological aspects of rural electrification are well established, the economic viability of a given project hinges largely on site-specific factors such as average family income, population density, crops and mix of industrial and business activities in the area. Even in those cases where the economics are clearly favorable, other factors, some of them cultural and institutional, may play important roles in determining whether or not the project reaches its full potential as a development tool.

Janis Brodman expands on these observations, adding considerable rigor and richness of detail, in her paper "Rural Electrification: Lessons from Java." The work is based on her survey conducted in central Java, Indonesia one and a half years after electricity was made available to the region.

The survey examined decisions by households with respect to the adoption of electricity, subsequent changes in energy consumption, and views of local residents as to the advantages and drawbacks of electrification. For the business sector, the emphasis was placed on determining how the adoption decision was affected by access to credit, and by such other factors as business size and type. The impact of electricity on business expansion and profitabiilty was investigated as well. While many of the impacts of typical rural electrification projects do not become apparent for at least several years, Brodman.s work indicates that, under the right circumstances, some project objectives can be achieved much sooner.

Because of the importance of rural electrification in the budgets of developing countries and national and multilateral aid and lending agencies, Resources for the Future has made a major commitment to addressing many of the issues presented in this Discussion Paper. Socioeconomic impacts are examined in two other major projects, one being carried out in India and the other in Colombia. Costs and some specific economic benefits of rural electrification are examined in other studies in the same two countries. Discussion Papers reporting on this research will soon be available.

We issue this report on work in progress with the multiple purposes of informing the policy and research communities of these results, of stimulating research elsewhere, and of eliciting comments on our own efforts.

Milton Russell
Director
Center for Energy
Policy Research

I. INTRODUCTION

Investments in rural electrification (RE) by developing countries are substantial and growing. Concomitant with the rise in investment has been controversy over the actual realization of returns, both economic and social. There has been no lack of suggestions regarding potential benefits. What has been noticeably rare is careful assessment of the changes which in fact occurred in rural areas due to electrification. There exists little quantitative information about changes in production, income, employment, and fuel use which are directly attributable to RE.

Complicating the task of evaluating RE are the independent effects of environmental factors. As is true for all development projects, the outcome of a RE project is not solely (some would say not even primarily) a function of project characteristics. A positive village environment can generate benefits from poorly designed projects; well formulated projects can be doomed by intractible village conditions. Generally, there are no absolutes on either side, and outcomes derive from complex interactive processes between project and environment.

The objective of this study is to address both those informational and analytical issues. In response to the former, determination was made of the quantitative changes directly attributable to electrification in one model RE area. Analysis of factors associated with development of those changes considers project characteristics and environmental conditions. While the multiple impacts of RE were investigated, the research emphasis was on the development of productive uses of electricity.

Because the project under examination had been in place for only one and a half years before the advent of this study, the findings refer to the short-term effects of electrification. Generally, the bulk of benefits from an infrastructure project such as RE would be expected to emerge in the long term. However, it will be demonstrated that substantial economic and social

impacts are feasible, even in the short term, given certain conditions associated with RE project design and village environment. Furthermore, findings provide evidence that realization of longer term gains can be impeded by the project design itself. Without complementary inputs and responsiveness to the needs of the recipient population, project investments are likely to forego a substantial portion of potential development returns.

Preliminary to analysis of the project, Part II provides a description of the socio-economic environment in which the project was implemented. Particular attention is paid to conditions associated with development of productive uses of electricity by businesses and home enterprises. Other important characteristics of the social and political environment are also considered; however, complete examination of those aspects must await future reports.

The balance of the paper is concerned with analysis of the impact of the project and its wider policy implications. Part III considers the basic determinant of the breadth of impacts: rate of connection among households and businesses. Factors affecting the decision to install electricity, and consequent differential access to electricity are examined.

Part IV analyzes the effects of electrification on businesses of different sizes and types. Outcomes related to business development, employment and employee income, and energy consumption are discussed. The section considers the extent to which productive uses developed, and the factors which stimulated or inhibited that development. Characteristics of the model area are demonstrated to be critical factors associated with the use of electricity to develop businesses. Certain aspects of project design prove to discourage productive uses of electricity. Although the assessment is of short-term effects, implications for longer term consequences are also drawn.

Part V discusses the direct and indirect economic effects of electrification among households. The extent to which households successfully used electricity to increase income and the factors associated with that success are analyzed, as are impacts on education, health facilities, and security. Certain project features which constrained development of productive uses among businesses are also found to inhibit realization of indirect economic benefits among households.

Part VI focuses on the impact of electrification on the village as a whole, as perceived by survey respondents. It demonstrates the way in which village

electrification can affect all villagers, whether or not they themselves install electricity. Among the topics considered in this section are the ways in which villagers perceived the distribution of benefits and extent of losses due to village electrification.

The issue of social costs and savings related to electrification is broad and complex. Part VII examines two aspects of that issue: resource costs/savings related to changes in energy consumption, and the issue of subsidies. For the project in question, electricity is provided by a central grid system primarily powered by petroleum products. There is substantial opportunity cost to the nation for petroleum products consumed domestically, while provision of heavy subsidies for petroleum products has placed a tremendous burden on the government.[1] Of concern, then, is RE's effect on the area's petroleum consumption, given relative efficiences of pre- and post-electrification energy use and changes in levels of consumption.

The issue of subsidies for RE has been a continuing source of controversy among those involved in RE planning. Since needs in LDC's far outrun the resources available, the form and extent of subsidies to RE customers must be carefully scrutinized. While an assessment of the quantitative returns to various subsidies is beyond the scope of this paper, the Klaten experience does permit the framing of alternative subsidy strategies and consideration of their implications for different RE goals.

The final section applies the study findings to the wider context of Indonesia and other LDC's. Particular environmental conditions contributing to the model project's ultimate impact will be placed in the perspective of the larger arena. Conclusions regarding the effects of project design on the attainment of project goals will be related to the structure of RE projects generally.

Methodology

The data on which this study is based were developed through a series of surveys conducted between October 1980 and February 1981, in Central Java, Indonesia. The survey area consisted of villages and sections of villages in

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[1] In January 1982, the government announced a reduction of petroleum products subsidies, according to "Indonesia Bites the Bullet On Subsidies After Years of Inaction, Lender Pressure," by Joseph P. Manguno, The Wall Street Journal, January 20, 1982, p. 28. While the immediate effect of that action will be to raise electricity's competitiveness, the ultimate consequences for electricity rates are as yet unknown. The prices for petroleum products used in this report are those in effect between June 1980 and December 1981.

which electricity had been made available one and a half years previously by a "model" RE project. Survey instruments were designed to obtain quantitative information regarding impacts which were directly attributable to electrification.[2] In accord with characteristics of the area (see pages 12-13) and research interest in productive uses, conditions related to off-farm income-generating activities were examined with particular rigor.

The major survey of the electrified area utilized a census of the village businesses and a random sample of electrified households (Adopters) and of non-electrified households (Non-adopters) in the electrified area.[3] Responses from all of the electrified businesses, representing 94% of the business population, are included in the present analysis. Data on home enterprises were gathered in the course of the household survey. Interviews were also conducted with National Electric Company (PLN) officials, government and bank officials, and village leaders. Participant observation of the villages was conducted continuously for five months.

Definition of Terms

Distinctions between businesses and home enterprises, and categorization of business size and household class, vary among researchers. For this study the following definitions and categories were utilized.

The term "business" refers to manufacturing, commercial, service-providing, and agricultural produce processing operations which met one of four requirements. They either operated in a structure physically detached from the family home, and/or had an annual net income of Rp. 200,000 or more, and/or had an annual net income of Rp. 100,000 to Rp. 200,000 and hired at least one non-family employee, and/or had an annual net income of less than Rp. 100,000 and hired at least five non-family employees. Operations which did not meet those criteria are considered to be home enterprises.

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[2] See Appendix A for further discussion of the survey instruments, data checks, and sampling techniques.

[3] The attempt was to survey all businesses in the survey area. Identification of businesses was hindered, however, by the absence of official records for all except the largest businesses (see Appendix A for further discussion of information sources). It is possible that there were some commercial operations which fit the study definition of "business" but were not included in the survey.

For the sample of electrified households, total N=217; for the sample of non-electrified households, total N=118 (see Appendix A). Because unequal intervals were utilized to draw from the two populations, electrified households were weighted twice in calculations in which electrified and non-electrified households were added together.

Categorization of businesses by size utilized annual net income as the criterion, as did classification of home enterprises by size. Table 1 presents net income categories and average workforce size for "small," "medium," and "large" businesses and home enterprises. Note that since the criterion utilized to determine size was net income, total workforce varied considerably within size categories.

Total household monthly expenditures was the criterion used to group households by income class. Table 2 presents expenditure data for the categories utilized. Households with the lowest level of expenditures can be considered to be "below poverty;" households in group 2 can be considered "poor;" those in group 3 can be considered "low income;" group 4 can be considered "medium income;" households in group 5 are considered to be "high income." The five categories presented in Table 2 were utilized for examinations of the total household sample. However, when Adopters and Non-adopters were analyzed separately, categories were adjusted in order to avoid sparce cells. For Adopters, the two poorest categories were merged; for Non-adopters, the two wealthiest categories were merged.

Table 1. Size Categories as Measured by Net Income (population: census of electrified businesses and survey sample of electrified home enterprises)

	Size categories			
	Small	Medium	Large	Unrecorded
Businesses				
Net income/year[a] (1,000s Rs.)[a]	0-300	300.001-1200	1200+	--
Average number of participants	4	10	25	--
Percentage distribution (N=123)	37% (46)	32% (39)	28% (34)	3% (4)
Home enterprises				
Net income/year (1,000s Rs.)	0-39	40-150	151+	--
Average number of participants	2	2	3	--
Percentage distribution (N=74)	30% (22)	28% (21)	31% (23)	11% (8)

Note: Unrecorded means missing cases in this and following tables.

Source: Present study.

[a]Rs. 625=U.S.$1.00.

Table 2. Household Expenditure Categories
(includes market value of food produced and consumed by the household--1,000s Rs.[a])

	Expenditure categories					
	Below poverty	Poor	Low	Medium	High	Not recorded
Total household expenditures/month	0-10	10.001-20	20.001-30	30.001-40	40.0+	--
Average per capita expenditures/month	2.7	4.9	5.4	6.3	9.6	--
Percentage distribution (N=552)[b]	8% (42)	23% (124)	26% (142)	21% (113)	19% (103)	5% (28)

Source: Present study.

[a]Rs. 625 = U.S.$1.00

[b]Electrified households, N=217, weighted twice; non-electrified households, N=118. Percentages sum to greater than 100 percent due to rounding.

II. PROFILE OF THE PROJECT AREA

In comparison with other developing nations in Asia and Latin America, Indonesia's investment in rural electrification has been limited.[4] In recent years, however, the government has expressed its commitment to extending public electricity services in rural areas. In accordance with that objective, experimentation with several different types of RE projects has begun. A major project, begun in 1977, was undertaken by the Government with substantial financial and technical support from USAID.[5] The project anticipates providing electricity to 600 villages in Indonesia, approximately 400 of which are on Java. Those villages are to be connected to the central grid and served by PLN. An additional 200 villages on Outer Islands are to be served by electricity cooperatives under the administration of the Directorate General of Cooperatives (DGC).

The project examined by this study is a small-scale "model" of the central grid project for Java. The pilot project provided electricity at subsidized rates in part of District Klaten, Central Java. Electricity was made available throughout three villages, and in small sections of five additional villages.

The Indonesian Government's RE policy is to target the early stages of RE toward villages which are relatively well developed ("desa swasembada"). Villages in District Klaten certainly met that requirement. In addition to a productive agricultural base, Klaten can claim a dynamic household enterprise sector and strong small-scale industry and business sector. Lying between two major cities, each about 60 kilometers away the district capital is a moderate sized rural town which serves as a marketing center for the surrounding agricultural community. An all-weather paved road links the town to both cities.

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[4] "Rural Electrification In Indonesia - Is It Time?" by Peter McCawley, Bulletin of Indonesian Economic Studies, Vol. XIV, No. 2, 1978. Mr. McCawley points out that private autogeneration supplies a large proportion of Indonesia's electricity production, perhaps as much as one-third of the total.

[5] The project received assistance from three foreign donors. USAID is the largest, with committed assistance of $30 million in loans and $6 million in grants. USAID has also been closely involved with project design. The Canadian International Development Agency (CIDA) committed a loan of $21 million and a grant of $1.8 million. The Government of Netherlands committed $5 million.

The villages included in the model RE area are all within 10 kilometers of the district capital, and are therefore advantageously situated. The three "area-covered" villages each have a boundary within four kilometers of the central electricity grid. Good roads link all of the electrified villages to the district capital, and beyond to the cities.

As Table 3 demonstrates, the RE area is quite prosperous when compared with the rest of rural Java. However, there is substantial income inequality. Median incomes are considerably lower than mean incomes, and incomes of one-fifth of the sample households were at levels considered "below poverty" by one Indonesian analyst.[6]

Like the rest of the district, the RE villages represent one of the most densely populated agricultural areas of the world. Agriculture is dominated by intensive rice production on land endowed with year-round gravity-fed irrigation systems. As is the case for the rest of District Klaten, the RE villages are highly industrialized relative to the rest of rural Java. There were 131 businesses in the electrified area - one for every 17 households.[7] Approximately a third of the businesses were manufacturers, one-quarter were commercial outlets, one-quarter were agricultural processing operations, and about a fifth were service providers.[8] Most of the operations defined as "businesses" in this paper were "small businesses" or "cottage industries" by national standards.[9] In addition, survey results indicated that 34% of village households operated some kind of home enterprise. Of those home enterprises, four-fifths were goods-producing, agricultural processing, or service-providing operations; the rest were stores or warungs (tea shops). Survey findings also suggest that less than half of the village households had a family member who worked as a farmer or farm laborer.

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[6] See "Basic Energy Budgets of Rural Households in Indonesia," by Hadi Soesastro, The Indonesian Quarterly, Vol. VIII, No. 1, January 1980, p. 34.

[7] The definitions of "business" and "home enterprise" were presented on page 6.

[8] Appendix B presents the kinds of businesses included in each of these categories.

[9] The Industrial Census utilizes the following categories for manufacturing operations: Household or cottage industries - engage fewer than 5 workers; Small manufacturing - engage 5-19 workers; Medium manufacturing - engage 20-99 workers; Large manufacturing - engage 100 or more workers;

Applying these criteria to all types of electrified businesses in the RE area provides the distribution: 55% (67) cottage industry-size; 33% (41) small; 11% (13) medium; 2% (2) large.

Table 3. Comparative Household Income/Expenditures in the Klaten Rural Electrification Area and Rural Java, 1980 (1,000s Rs.)[a]

	Klaten RE area[b]	Rural Java
Mean household expenditures/month	28.5	19.9[c]
Median household expenditures/month	21.1	n.a.
Mean per capita expenditures/month	6.1	4.4[c]
Mean household income/month	31.8	d
Proportion below poverty[e]	20%	45%

Note: n.a. means data not available.

Source: Present study.

[a]Rs. 625=U.S.$1.00

[b]Based on reports from household survey respondents, N=552 (28 unrecorded).

[c]Source: Indonesia Survai Sosial Ekonomi Nasional (SUSENAS) 1978. Inflated at a high estimate of 5 percent per year in order not to overstate the Klaten area.s relative wealth.

[d]Although SUSENAS figures are based on expenditures, they are generally utilized as a proxy for income.

[e]Definition of "at poverty" from Hadi Soesastro, "Basic Energy Budgets of Rural Households in Indonesia": per capita income of Rs. 3,000/month in 1976 Rupiah is the poverty level. Inflated at a low estimate of 3%/year, in order not to overstate Klaten.s relative poverty, provides a poverty level for Klaten in 1980 of Rs. 3,360/capita/month; for rural Java in 1978, Rs. 3,180/capita/month. The proportion of "below poverty" given above for rural Java is understated since it excludes households with per capita incomes of Rs. 3,000-3,180/capita/month.

Businesses and home industries take advantage of their access to markets external to the villages. Three-quarters of the survey respondents from manufacturing and agricultural processing businesses reported that they regularly sell their products at outlets outside their villages; 18% reported regularly marketing products in one of the nearest cities or beyond. A smaller, but nonetheless substantial 60% of the respondents with home industries reported selling their goods in market outlets outside their villages; however, none sold goods in the cities or beyond. The highly developed business/industrial sector, and adequate gravity-fed irrigation for agriculture, created a situation in which prospects for the development of productive uses of electricity were concentrated among off-farm activities.

The formal village political institutions, the village head (Lurah) and other village office officials, provided a vehicle by which information about the project could be introduced to villagers and their participation elicited. Although their personal influence varies, the village officials could utilize both their prestige and such mechanisms as village and neighborhood meetings to encourage villagers to participate in the RE project. Operating through formal and informal structures, village officials were also able to organize cooperative efforts by which electricity could benefit the entire community.

Before electrification, the ample demand for energy by businesses and households was served by two major types of fuels, petroleum products and firewood/agricultural waste. Kerosene was virtually the only fuel used for lighting by households and most businesses, although a few businesses used small generators, supplemented by kerosene lamps. Firewood and agricultural wastes were major cooking fuels for most households. Wealthier households also relied on kerosene for cooking, as did various businesses, e.g., tobacco curing operations. Approximately 15% of the businesses used diesel engines for shaft power.

The two types of fuels offer highly competitive alternatives to electricity. The source of petroleum products' attractiveness is the substantial subsidy provided by the Indonesian Government.[10] The non-commercial fuels, firewood and agricultural wastes, are generally gathered by family members, at low opportunity cost. Thus, while the dynamism and relative wealth of the RE area implied considerable potential demand for electricity, the competitive posture of alternative fuels set limits on development of that potential.

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[10] Those subsidies were reduced as of January 1982, see Note 1.

III. ACCESS TO ELECTRICITY

A primary objective of the Klaten RE project was a high rate of connection among households and businesses. Before operations had even begun, however, conditions on both the supply and demand sides appeared to mitigate against attainment of that goal. Installation and tariff rates, while continuing to be subsidized, rose far above early estimates. At the projected household consumption level of 22 kWh/month, actual monthly electricity expenses became Rp. 2,349 ($3.76), twice the original estimate.[11] Also, the required down-payment of Rp. 4,000 was twice the amount considered to be the "upper limit" for a majority of the target population.[12]

On the demand side, estimated rates of connection were based on higher levels of income than actually existed in the electrified area. These conditions were addressed by researchers who warned that calculations based on more realistic income figures reduced expected rates of connection substantially. Project forecasts of serving 50% of the households and 90% of the small commercial enterprises by the third year of system operation were clearly placed in doubt. Nor were those analysts unduly pessimistic. Based on average expenditures for kerosene lighting in rural Java, and on the experience of other Asian nations, only a very small percentage of the Klaten project households could have been expected to hook up. In a context where the average allocation for kerosene is approximately 3% of household expenditures, it would have been extravagent to propose that Klaten villagers would allocate, on average, nearly four times that rate to electricity. But that was what, in fact, they did.

Rates of Connection

Because villagers were willing to spend considerably more than expected for electricity, connection rates were extremely high. Of 2,225 households in the electrified area, 79% (1,748) installed electricity. In the survey sample,

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[11] Project Paper: Proposals and Recommendations, Indonesia - Rural Electrification I, AID, Department of State, Washington D.C. 1977, Annex G-1, p.1.

Note that these costs include charges for installation and wiring, an expense which will elapse after 4 years (1983). After paying a down payment of Rp. 4,000, RE customers paid Rp. 50,000 ($80) for installation and wiring (ref. PLN). To ease the burden, villagers were offered an installation package which spread payments across 48 monthly installments. The electricity "use" charge was Rp. 27 ($.04) per kWh. In addition, RE customers paid a "demand charge" of Rp. 720 ($1.16) per month for an installed capacity of 1.25 KW.

[12] Ibid.

the distribution of installation among income groups offered no surprises. The relationship between household connection and household expenditures[13] was significant and positive (see Table 4). However, the power of household expenditure as an indicator of installation was far weaker than expected (λ =.15).[14] That outcome reflected the fact that high connection rates cut across income groups, with more then half of the households in all but the poorest group installing electricity. Even more impressive was the finding that half of the households with incomes "at or below poverty," i.e., below Rp. 3,500/capita/month, installed electricity.[15] However, despite the survey's efforts to obtain accurate expenditure data, this outcome also suggests possible underestimation of household expenditures.[16]

Furthermore, 27% (32) of the officially "non-electrified" households in the sample actually had the use of electricity in their homes. Ties between family members and neighbors induced some households to "share" electricity. Wires from the officially electrified homes were connected to "non-electrified" houses, and provided lighting in the latter. Thus, 84% of the households in the electrified area were actually being served by the RE project.

The response among businesses was even stronger. Of 131 businesses in the electrified area, 87% (114) installed electricity during the first year of the RE project. An additional 7% (9) either installed electricity before the RE program began, or after the RE package became unavailable, and therefore paid higher rates for electricity service. Thus, 94% (123) of all businesses in the electrified area installed electricity.

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[13] Household expenditure is generally used as a proxy for household income in the literature on Indonesia.

[14] Simply stated, the coefficient lamda (λ) reflects how well variable A can be predicted from variable B. Thus, in the case presented above, 15% of the variance in installation can be predicted by household expenditure. Note the difference, then, between λ and χ^2. The latter is a test of the likelihood that the relationship between A and B occurs merely by chance. Thus, in the case above (χ^2=52, p=.0001), there is less than one chance in a thousand than the relationship between household expenditure and installation occurs only by chance.

[15] The definition of "poverty" is from "Basic Energy Budgets of Rural Households in Indonesia," by Hadi Soesastro, pp. 31 and 34. Soesastro defines Rp. 3,000-3,999/capita/month in 1976 levels as "at poverty."

[16] It should be noted, alternatively, that the findings regarding mean expenditures are comparable to those of another survey conducted in the area by PLN and the United States Census Bureau.

Table 4. Distribution of Connection by Household Expenditures (percent)

	Household expenditures/month (1,000s Rs.)				
Connection status	0-10	10,001-20	20,001-30	30,001-40	40,001
Installed electricity	27	53	71	83	94
Did not install electricity	73	47	29	17	6
Total	100	100	100	100	100
N:	33	81	83	81	35

Statistics: x^2=52, df=4, p=.0001. λ asymmetric, connection dependent on expenditures=.15. Total N=335, 22 unrecorded: 6 electrified, 16 non-electrified.

Source: Present study.

Factors Influencing Installation

The RE program was introduced to villagers through the Lurah and other village officials. Although they did not explicitly elicit villager participation, the Lurahs presented the RE project as a subsidized opportunity to gain a valuable improvement in village life.[17] Since the project required a substantial down payment, an increase in monthly lighting expense, and the loss of trees without compensation to make way for electricity lines, the Lurahs' credibility was a crucial initial factor in villagers' response.[18] Ultimately, of course, the individual decision to install electricity was dependent upon individual budget constraints.

For nearly all businesses, income did not impede the purchase of what they perceived to be a superior form of lighting. Furthermore, as will be discussed in the next section, electricity presented opportunities to increase production and sales for some businesses. Those businesses which operated out of the family home or a nearby structure enjoyed the additional advantage of service to both business and home with a single hookup. Of the few businesses which did not install electricity, all but one used little or no kerosene lighting and considered electricity to be unnecessary or unaffordable.

Financial constraints were potentially more serious for households. Average monthly kerosene lighting expenditure among Adopters before electrification was only about Rp. 600/family for 14 kWh equivalents.[19] At the projected consumption rate of 22 kWh/month, then, electricity expenses represented a considerable increase in lighting expenditure (see page 82). However, for a majority of villagers, considerations of cost were outweighed by other factors (see Table 5). For three-quarters of the Adopters, the additional expense was worth the attainment of better, cleaner, and more convenient lighting. The (incorrect) perception that electricity is more economical than kerosene, pursuaded about 15% of the Adopters to install electricity. The need for better lighting for nighttime activities was a primary motivation for 22% of the Adopters. Other inducements operated for small numbers of Adopters.

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[17] To the deliberately leading question, "Who urged you to install electricity in your home?" 94% (203) of the Adopters reported that no one had urged them to install electricity. However, all information on electricity which villagers presented as fact were based on the Lurahs' explanations.

[18] In discussions with villagers, it became clear that without alternative credible sources of information, lack of confidence in the Lurah would dissuade many villagers from accepting the program.

[19] Conversion of kerosene to kWh equivalents is based on the rate of consumption in a petromax lamp, see Note 24.

Table 5. Advantages of Electricity Perceived by Household Respondents

Kinds of advantages	Adopters: reasons for installing electricity	Non-adopters: perceived advantages of electricity
Better, cleaner, more convenient light	77%[a]	60%[a]
More economical	16%	21%
Nighttime activities require better light	22%	b
Makes you "happier"	b	49%
Neighbors were getting it	8%	b
To install television	7%	b
Safety/security	2%	1%
Other	5%	6%
No advantages/ Don.t know	b	2%
N:	(217)	(118)

Source: Present study.

[a]Sum to greater than 100% due to multiple responses.

[b]Open-ended question and this response was not given by any respondent.

As Table 5 shows, the benefits perceived by Adopters were also widely acknowledged by Non-adopters. Only one Non-adopter felt that electricity offered no advantage over alternative energy sources. Why, then, did Non-adopters choose not to install electricity? Electricity expense was the major constraint reported by 72% (85) of the Non-adopters. Although cost was an obstacle for almost all Non-adopters at the lower end of the household income scale, about half of the moderately and very well-off Non-adopters also found electricity too expensive an alternative.

For 11% (13) of the Non-adopters, expense was not a problem. They had not installed electricity only because they had been away from the village during the "sign-up" period. They were waiting until the special RE package was again available. Other dissuasive factors which operated for small numbers of Non-adopters were the condition of their houses, or the fact that they rented the house in which they lived.

Reports by Non-adopters indicated that 13% (15) could afford to pay Rp. 2,500, an amount approximately equivalent to the average bill received by Adopters. Another 10% (12) reported that they could afford Rp. 2,000/month, which would enable them to pay the RE fixed costs and use about 9 kWh/month, considerably less than the average 20 kWh/month consumption of Adopters using electricity for lighting alone. For 75% (88) of the Non-adopters, current RE rates placed electricity entirely beyond their means.[20] Of the Non-adopters, only 22% (26) anticipated installing electricity within a year.

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[20] Of the Non-adopters, 3% (3) did not know how much they could afford.

IV. IMPACT ON BUSINESSES

Consideration of RE impact begins with an overview of business response to the new technology, and the general benefits which ensued. The specific consequences related to business development and the factors associated with income and employment effects are then discussed. Subsequently, it will be shown that substantial potential for productive uses of electricity remains unexploited, while the constraints impeding realization of that potential persist.

Changes in Consumption

Preliminary to analysis of the kinds of uses the surveyed businesses made of electricity and the resulting impacts, it is useful to consider the absolute level of electricity use by businesses. This is particularly important because low load factor is generally the Achille's heel of RE programs.

The average kWh consumption of electrified businesses, based on the month of December 1980, was 69 kWh/month.[21] This was considerably below the anticipated average consumption level of 132 kWh/month for "small commercial" operations.[22] Consumption by business customers accounted for 57% of the total kWh consumption in the "RE" area.

Variance was great, however. The smallest amount of electricity used was 9 kWh/month, the greatest, 685 kWh/month. There proved to be a significant difference in the average level of electricity use by different types of businesses (Kruskal-Wallis=8.00, significant at the .05 level, see Table 6).[23] Services had an average use rate of 153 kWh/month, considerably higher than that of other types of businesses, and 16% greater than the expected average "small commercial" levels of use.[24] The next highest users were commercial establishments. Manufacturers and agricultural/food enterprises were

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[21] N=103, due to incomplete reports.

[22] See Project Paper: Proposals and Recommendations, Indonesia - Rural Electrification I, AID, Annex K, p.7 and p. 12. Also, Rural Electrification Preliminary Engineering and Feasibility Study Report, NRECA, March 1977, p. 35 and Table 18.

[23] Unless noted, relationships described as "significant" are significant at least at the .05 level.

[24] It should be noted that rice hullers were included in the services category, not the agricultural/food category. However, rice hullers represent only 17% (3) of the services, and they did not "bring up" the services' average electricity use rate. Rather, hullers had a considerably lower average use rate than the overall services' average. The average kWh use by rice hullers was 25 per month, compared with an average of 153 per month for services as a group.

comparatively small consumers. It is interesting to observe the relatively higher level of consumption by services, since in anticipating the load factor, many RE studies concentrate on manufacturing and agricultural processing operations, while ignoring or glossing over potential electricity use by service providers.[25]

Among services, there was a strong positive correlation (r=.89) between business size (as measured by net income/year) and the amount of electricity used (see Table 7). Among manufacturers, the association between size and electricity consumption was also significant but a good deal weaker (r=.39). Commercial establishments and agricultural/food businesses gave no evidence of a relationship between size and amount of electricity used. As will be discussed below, the differences in kWh consumption by type of business are associated with the use of electrical equipment. Services reported the greatest use of electrical equipment, with manufacturers being second. There was little electrical equipment use among commercial businesses, and none among agricultural/food enterprises. Differences between large and small manufacturers and services were associated with advantages enjoyed by large enterprises which enabled them to use electricity profitably.

Assessment of changes in kWh consumption was only possible for the 76 businesses which had been established before electrification, used electricity for lighting alone, and for which reports were complete. Among those businesses, kWh consumption, averaged over individual businesses, was 240% greater than pre-electrification levels.[26] Consumption of and expense allocations to

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[25] See, for example: Project Paper: Proposals and Recommendations, Indonesia - Rural Electrification I, AID, Annex K, p. 17. "Since grain mills are assumed to account for most of the demand for electricity by agricultural and productive consumers..."; also, Rural Electrification, World Bank, October 1975, p. 49; Issues in Rural Electrification, IBRD, July 24, 1974, pp. 20-21.

[26] This calculation is based on conversion rates established in an AID survey of energy use conducted in Klaten villages in 1979. According to the survey report, "Environmental Assessment of the RE Project," by Paul Weatherly and John Arnold, 1.7 liters of kerosene in a petromax lamp provides 1 kWh. All comparisons of kerosene and electricity consumption will utilize this conversion ratio.

The formula for calculating the change in consumption presented above was:

$$\text{AVERAGE} = \left(\sum_{i=1}^{N} \frac{KWH_i}{KEROKWH_i} \right) \Big/ N$$

Where KWH=The level of kWh consumption with electricity by the ith consumer

KEROKWH = The kWh equivalent of kerosene consumed for lighting before electrification by the ith consumer

Businesses which had used electric generators for lighting before RE were

Table 6. kWh Use, By Business Type

Business type	Number of cases[a]	Mean	Sum of rankings	Expected under H_0
Services	15	153	966	780
Commercial	25	76	1529	1300
Manufacturing	37	47	1684	1924
Agricultural/food	26	45	1178	1352

Statistics: Kruskal-Wallis = 8.00, df=3, p=.05

Source: Present study.

[a]20 businesses unrecorded: 3 services, 5 commercial, 8 manufacturers, 4 agricultural/food.

Table 7. Correlations of Net Income/Year and kWh Use, By Business Type

Business type	r	Number of cases[a]
Services	.89[b]	13
Manufacturing	.39[c]	35
Commercial	.10	23
Agricultural/food	.05	25
All Types	.03	96

Source: Present study.

[a]Twenty-seven businesses unrecorded: 5 services, 10 manufacturing, 7 commercial, 5 agricultural/food.

[b]Significant at .01.

[c]Significant at .05.

lighting were, on average, twice as great as they would have been with kerosene lighting (assuming an annual increase in kerosene consumption of 9% per year).[27] Businesses which increased consumption did so either by extending workhours or by increasing the use of light during regular workhours.

General Benefits to Electricity-Using Businesses

Satisfaction with electricity service was nearly universal.[28] Those reports suggest that with very few exceptions, the respondents feel they are "getting their money's worth," and that the benefits provided by electricity are at least equivalent to the rupiah value of their monthly bill. According to most business respondents, the major advantage provided by electrification was better and more convenient lighting (see Table 8). About a quarter of the business respondents reported that electricity was more economical than alternative fuels. Other advantages, e.g., ability to use new equipment, better security, and more reliable lighting, were each mentioned by a small number of respondents. Only 10% (12) of the business respondents reported that electrification had provided no advantage compared with alternative energy sources.

Because fixed costs constitute a substantial part of electricity expense, total cost per kWh varies with the level of consumption. At consumption levels greater than 53 kWh/month, the financial cost of electric lighting was

not included in this calculation. In fact, only one of those businesses met requirements for inclusion, and its addition would not have altered the statistic presented above.

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For this paper, data on pre-electrification kerosene consumption for lighting was based on memory-recall reports by business owners. That source would seem to be reliable for two reasons: kerosene for lighting was a staple good, bought regularly over the years, and not changing much throughout the year; also, kerosene had been purchased until only one-and-a-half years before the survey.

Estimates of the rate of increase in kerosene consumption vary widely in the literature. The inflation of kerosene kWh-equivalents by 9% per year is based on national trends in past consumption (1970-1976) presented in "Basic Energy Budgets of Rural Households In Indonesia," Hadi Soesastro, The Indonesian Quarterly, Vol VIII, No. 1, January 1980, p. 35. Since kerosene is used for both lighting and cooking in the Soesastro estimates, the use here of the 9% rate of increase assumes that the rate of change in kerosene use is the same for lighting and for cooking. To this author's knowledge, there is no comparable estimate for changes in kerosene use for lighting by small businesses and industry.

28 Only 3% (4) of the business respondents reported being less than satisfied with electricity service.

Note that for questions regarding business conditions, total N=123. For questions regarding respondent attitudes, total N=122. Total N varies thusly because one respondent owned two separate businesses. Business conditions were different for the two businesses, but the respondent's attitudes were the same.

Table 8. Advantages of Electricity Experienced by Businesses

Types of advantages	Level of response
Better/more convenient lighting	71%[a]
Cheaper than other fuels would have used	24%
Enables business to use new machinery	16%
Extended workhours	19%
Improved security	9%
Works faster during regular workhours	3%
Other	2%
There are no advantages	10%
N:	(123)

Source: Present study.

[a]Sum to greater than 100 percent due to multiple responses.

Table 9. "Productive Use of Electricity" by Business Type

	Services	Manufacturing	Commercial	Agricultural/ food
Uses electricity "productively"[a]	56%	33%	30%	10%
Does not use electricity "productively"	44%	67%	70%	90%
Total	100%	100%	100%	100%
N:	18	45	30	30

Statistics: X^2=11.2, df=3, p=.01. λ asymmetric, "productive use" dependent on business type=.05. Total N=123.

Source: Present study.

[a]See text for definition of "productive use."

below that of kerosene lighting, thereby providing a cost savings to electricity users.[29] The mean business consumption level of 69 kWh/month implied an average per kWh expense of Rp. 60, representing a 12% cost savings related to electric lighting as compared with kerosene lighting. Of 102 businesses which paid RE rates[30] and used electricity only for lighting, 31% (32) enjoyed a cost savings. Of the 12 businesses paying RE rates and using electrical equipment, 42% (5) used more than 53 kWh/month, and therefore experienced a cost savings related to the lighting component of their electricity use.

The RE system also provided cost savings to the four businesses using private electricity generators for lighting alone.[31] Alan Strout estimated that the latter system can provide electricity for about Rp. 56/kWh.[32] At that rate for private generation, the RE system offered cost savings to 3 of the 4 businesses (based on their levels of PLN kWh consumption). Furthermore, reports from the businesses suggested that actual overall expenses for the generators had been considerably higher than Rp. 56/kWh. In fact, the business respondent who paid more than Rp. 56/kWh for RE reported one advantage of PLN electricity to be its greater economy.

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[29] Calculation of comparative prices of electricity and petroleum products utilize prices as of December 1981. The government's reduction of petroleum subsidies in January 1982, will serve to raise electricity's competitiveness in the short run. However, it must be expected that electricity will follow kerosene's upward price trend, so that eventual comparative prices cannot be accurately foreseen.

To compare kerosene with electricity use, kerosene was converted to kWh equivalents at the rate of 1.7 liters of kerosene to 1 kWh (see Note 24). Thus, if they used petromax lamps, businesses would have to spend Rp. 68 (the price for kerosene in Klaten being approximately Rp. 40/liter) to obtain 1 kWh. Total electricity costs are Rp. 68/kWh when consumption is 53 kWh/month. When more than 53 kWh/month are used, per kWh charges are less than they would be with kerosene. A cost savings then exists equivalent to the difference in cost.

Note that calculations of electricity costs include expenses for installation and wiring, an expense which will elapse 4 years after installation (1983). Estimated expense for lightbulbs is also included. Since the cost of kerosene lamps has been excluded, the results are biased against electricity. For businesses which had used wick kerosene lamps, electricity installation costs are sufficiently greater than costs for kerosene lamps to render the bias negligible. For businesses which had used pressure (petromax) lamps, however, the bias will be somewhat greater since costs for installation and wiring may in the long run (15 years) be equivalent to, or even lower than, those of petromax lamps (depending on the number of lamps used).

The assumed cost for incandescent light bulbs used in the calculation is Rp. 8/kWh. This cost is based on AID Report for flourescent lights, which biases the cost calculation in favor of electricity, since florescent bulbs last longer than incandescent bulbs, However, since florescent bulbs cost more than incandescent bulbs, it is hoped that the foregoing bias is therefore cancelled out.

RE did not, however, offer similar advantages to businesses using diesel engines directly for shaft power. All diesel engines being used for shaft power were 6 HP or larger. Since the RE program provided a single phase system of 1250 watts, it did not permit substitution of those diesel engines by electric motors. For sufficient electricity capacity to accomodate motors of 6 HP or more, installation charges were Rp. 1,000,000, a sum far beyond the resources of village businesses.[33] Furthermore, installation of greater load capacity than that provided by the RE system would transfer village businesses from the RE category of tariff rates into a regular, more expensive customer category. As will be discussed below, business owners responded to these constraints by preferring diesel engines for shaft power.

Productive Uses and "Development" of Businesses

It is apparent that electricity provided a range of benefits to the businesses in Klaten. However, one crucial issue is the extent to which those were "productive" impacts, i.e., the extent to which electricity was used to increase production, sales, income and/or employment. It should be noted that because our concern is a rigorous test of the benefits of RE, "productive use" is being defined very narrowly to include only that use which altered business hours or production techniques.

There are two important ways in which businesses can use electricity to increase productivity. Electric lighting can be used to extend workhours, and electric energy can be used for rotary power or appliances. Of the

[30] As explained above, 9 businesses installed electricity before the RE project began, or after the RE package was no longer available, and paid higher rates.

[31] Before RE, five businesses used electricity generators. Four used small generators for lights. One used a larger, 125 KVA generator for lights and machinery.

[32] From a 1978 discussion paper, "Benefits and Costs of Rural Electrification in Indonesia:" "At an installed cost of US $690/KV for a 25 horsepower diesel generating unit plus a second standby unit, a 12% interest rate, a 15% load factor, a diesel fuel cost of Rp. 56/liter, and maintenance costs equal to one-fifth of the fuel costs, a residential consumer could generate his own electricity for about Rp. 56/kWh."

[33] Based on information received in interviews with officials in PLN, sufficient capacity for 6 HP motors on a single phase system would entail installation expenses of more than Rp. 815,000. However, PLN considers electric motors of 6 HP or more to require 3 phase electricity. Village businesses installing 3 phase electricity would incur expenses of Rp. one million or more. Note that the village business which had used a private electricity generator for large mechanical equipment installed PLN electricity for lighting and continues to use his 125 KVA generator for the machinery.

Further discussion of other components of cost for diesel and electric motors are presented in Appendix C.

electrified businesses, 19% (23) used electricity to increase workhours; 15% (18) used electricity for equipment (excluding two businesses with televisions); 70% (86) of the businesses did not fall into either of these "productive user" categories.[34]

As Table 9 demonstrates, "productive use" was not undertaken equally by different types of businesses. Services, with more than half using electricity "productively," had a relatively high level of "productive user activity". Commercial and manufacturing businesses, with about a third using electricity "productively," showed moderate "productive user activity." Agricultural/food enterprises, with only 10% using electricity "productively," displayed relatively low "productive user activity." While it is important to make a distinction between types of businesses and the extent of productive use, it is also worth noting that "business type" is not a powerful predictor of whether or not businesses will use electricity productively (λ =.05).

"Productive use" by almost one-third of the village enterprises represents a sizeable short-term response to electrification. However, such use does not necessarily result in business improvement. Nor does it encompass all means by which electricity can contribute to business conditions. In order to understand the extent to which "productive use" actually improved the economic situation of businesses, respondents were asked whether their businesses had "developed due to the use of electricity."[35] The responses of 31% (38) were affirmative; an additional 4% (5) reported that they had established electricity-dependent businesses after village electrification; 59% (73) reported that electricity use had not "developed" their businesses; 6% (7) were businesses for which owners could not say whether electricity use had "developed" their businesses because the businesses have always had electricity.

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[34] These groups sum to greater than 100% (123) because four businesses used electricity both for equipment and to extend workhours.

In addition to the 23 businesses which increased workhours due to electric lighting, 40 businesses used electric lights for "productive activity" (including restaurant lighting), but merely substituted electric lights for kerosene lights. Altogether, 51% (63) of the businesses used electric lights, on average 111 hours per month, for "productive activity." Electric lights were also used by 95% (116) of the businesses for nightly "security."

We have not considered substitution of electricity for fuels used to produce heat for processing or cooking, as such substitution would not generally be economical in the village industries surveyed. In some cases, electric rice cookers might be a profitable alternative to kerosene stoves; however, their role would be limited, and is not examined here.

[35] "Mengembangkan" is the root word in Indonesia. The connotation of the word is stronger than "developed" in English, implying to expand, to promote, "to bring prosperity to."

In considering the factors related to whether or not a business "developed," we will combine the new electricity-dependent businesses with those businesses which were reported to have "developed due to electricity use," whether they were established before or after electrification.[36] We will exclude from consideration the 7 businesses for which owners could not say whether the business had developed with the use of electricity.

Respondents who perceived their businesses to have "developed due to electrification" attributed that "development" to three types of electricity use. Use of electric lights either to extend workhours or to work faster and better at night was cited as the primary means of development by 58% (25) of the 43 businesses which developed.[37] For 30% (13) of the "developed" businesses, the improvement in business conditions was due to use of electrical equipment.[38] 12% (5) of the respondents whose businesses "developed due to electricity use" attributed increased sales to the indirect effects of "community changes," e.g., greater nighttime activity in the area.[39]

As would be expected, most of the business respondents who used electricity "productively," i.e., to extend workhours or for electrical equipment, reported that their businesses "developed" due to that electricity use. However, the pattern of "development" is somewhat different from that of "productive use." The occurrence of "development" was not significantly different between types of businesses (see Table 10). Thus, although services did have significantly higher rates of "productive use" than did other types of businesses, they did not "develop due to electricity use" at a significantly higher rate than other types of businesses. This phenomenon is primarily a consequence of development which occurred among some businesses without their actively undertaking "productive use." It was evident in commercial businesses which developed due to community changes, and in agricultural/food businesses (tobacco-curing operations) which improved the quality of

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[36] Twenty-one businesses in Klaten began with electricity. Six installed the regular service before the RE program began. Fifteen began after the RE program. Some respondents whose businesses have always had electricity reported that their businesses "developed" with the use of electricity, e.g., if the owner felt that he/she kept longer workhours due to the use of electric lights. Some reported that electricity had not developed their businesses, e.g., if they would have begun a business without electricity anyway, and used kerosene lighting for the same hours as electrical lighting. Respondents from some reported that they could not say whether the business had "developed" with the use of electricity.

[37] The 25 represent 20% of all electrified businesses.

[38] The 13 represent 11% of all electrified businesses.

[39] The 5 represent 4% of all electrified businesses.

Table 10. "Development Due to Electricity Use" by Business Type

	Services	Manufacturing	Commercial	Agricultural/ food
"Developed" or new electricity-dependent	56%	37%	40%	24%
Did not "develop"	44%	63%	60%	76%
Total	100%	100%	100%	100%
N:	16	30	41	29

Statistics: X^2=4.7, df=3, p=.19. Total N=123, 7 are excluded because began after electrification and owner did not know whether it developed due to electricity: 2 services, 4 manufacturers, 1 agricultural/food.

Source: Present study.

Table 11. Use of Electricity to Develop, By Business Type (population: businesses which "developed due to electricity use")

Kind of use	Services	Manufacturing	Commercial	Agricultural/ food
Electric lighting	33%	53%	58%	100%
Electrical equipment	67%	47%	0%	0%
Indirect effects of community change	0%	0%	42%	0%
Total	100%	100%	100%	100%
N:	9	15	12	7

Statistics: X^2=27, df=6, p=.0001. λ asymmetric, kind of use to develop dependent on business type=.17. Total N=43.

Source: Present study.

production during regular nighttime workhours. It was also true, to a far lesser extent, that not all "productive use" engendered "development" for the user. Five respondents reported that use of electrical equipment had not contributed to "development" of their businesses; one reported that extension of workhours with electric lights had not developed his business.[40]

The ways in which electricity was used for development did differ among types of businesses (see Table 11). Services developed primarily with the use of electrical equipment, secondarily with the use of electric lights to extend workhours. Manufacturers displayed a similar pattern, although among them electric lights and electrical equipment were about equally common sources of development. None of the commercial businesses developed with the use of electrical equipment; rather, they used electric lights to extend workhours, or experienced increased sales as an indirect effect of increased community activity at night. Agricultural/ food operations developed only by using electric lights to extend workhours or to improve work quality at night.

Factors Contributing to "Development"

Three factors appeared to be important in determining whether or not businesses developed due to electricity use: the size of the business (measured by net income/year); access to formal capital sources; and, for manufacturers and agricultural/food businesses, the kinds of market outlets available to them.

Size of Business. Business size, as measured by annual net income, had a positive association with "development due to electricity use," with size a moderately strong determinant of "development" (λ =.14, see Table 12).[41] This distinction between large and small businesses did not, however, hold across all types of businesses (see Table 13). Commercial and agricultural/food businesses, groups in which there was little or no use of electrical equipment, showed little difference in the mean net income of "developed" and "non-developed" operations. For manufacturers and services, the groups in which electrical equipment was used, there was a striking difference in the mean net income of businesses which developed with the use of electricity and

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[40] None of the four commercial establishment respondents who used refrigerators reported that that equipment had "developed" his/her business. One furniture maker reported that an electric drill had not "developed" his business.

[41] A t test using number of working participants in the business - a standard measure of size for rural businesses in LDC's - also disclosed a significant difference in size between businesses which developed with electricity use and those which did not.

Table 12. Relationship Between "Development Due to Electricity Use" and Business Size

	Business size		
	Small	Medium	Large
"Developed" or new electricity-dependent	27%	32%	60%
Did not "develop"	73%	68%	40%
Total	100%	100%	100%
N:	45	37	30

Statistics: X^2=9, df=2, p=.01. λ asymmetric, "development" dependent on size=.14. Total N=123, 11 business unrecorded: 1 small, 2 medium, 4 large, 4 size unrecorded.

Source: Present study.

Table 13. Difference in Size Between "Developed" and "Non-developed" Businesses By Business Type

Business type	Number of cases	Mean net income "developed" businesses (1,000s Rs./yr)	Mean net income "undeveloped" businesses (1,000s Rs./yr)	t statis-tic	Signi-ficance level
Services	13	7,610.0	209.6	1.03	.34
Manufacturing	40	9,489.7	520.7	2.70	.02
Commercial	27	483.5	680.0	-.96	.35
Agricultural/ food	28	4,609.6	4014.1	-.60	.55

Statistics: Total N=123, 15 unrecorded: 5 services, 5 manufacturing, 3 commercial, 2 agricultural/food.

Source: Present study.

those which did not. For manufacturers, this difference was significant, ($t=2.7$, $p=.02$). For services, it was not. However, the mean net income of "developed" services was 36 times as great as that of "nondeveloped" services.[42]

The greater proportion of development among large businesses appears to be related to the comparative advantage they enjoy with regard to two key factors: access to formal capital, and reliable market outlets.[43]

Access to Formal Credit Sources. Access to loans through banks and/or government loan programs, was strongly associated with development due to electricity use (symmetrical $\lambda=.53$, see Table 14). An association was also demonstrated between access to formal capital and business size (see Table 15). The question then arises as to the actual relationship between size, access to formal capital, and development due to electricity use. Unfortunately, the paucity of small and medium businesses with access to formal capital precludes testing the effect of that factor within those groups. However, as the discussion below will demonstrate, small businesses are more often constrained from use of electrical equipment by limited market demand than by access to formal capital. In contrast, access to formal capital will be shown to be quite important in influencing whether medium sized businesses use electricity productively. Among large businesses, a greater number of which had access to formal capital, that access was a powerful indicator of development (λ =.50, see Table 16).

Based on experience in other nations, it was expected that female business owners would have less access to formal capital than would male business owners, with consequent differential effects on business development. However, access to formal capital occurred in equal proportions among female and male business owners. Incidence of "development due to electricity use" was also proportionate, occurring in about one-third of men- and one third of

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[42] The small size of the t statistic is related to the great variances in net income for both "developed" and "nondeveloped" services.

[43] It is theoretically possible that the association between size and development reflects a situation in which businesses had been approximately the same size before electrification, and electricity use caused some to become larger than others. However, further examination of the data substantiated field impressions that that hypothesis is incorrect. Thirty business respondents reported that profits had increased with electricity use. For the 23 which reported the level of increase, examination was made of their net income, deflated to the level which presumably would have occurred had the business not been electrified. Of the 23, only one had a smaller size classification with the deflated net income. For the 7 businesses which increased profits but did not report the level of increase, all had incomes more than 20% greater than the minimum for their size category.

Table 14. Relationship Between Access to Formal Credit and "Development Due to Electricity Use"

	Credit access	
	Has access to formal credit	Does not have access to formal credit
"Developed" or new electricity-dependent	60%	31%
Did not "develop"	40%	69%
Total	100%	100%
N:	25	91

Statistics: X^2=7.2, df=1, p=.01. λ symmetric=.53, λ asymmetric, "development" dependent on access to formal capital=.12. Total N=123, 7 unreported: 2 with access, 5 without access.

Source: Present study.

Table 15. Relationship Between Access to Formal Credit and Business Size

	Business size		
Credit access	Small	Medium	Large
Has access to formal credit	11%	15%	47%
Does not have access to formal credit	89%	85%	53%
Total	100%	100%	100%
N:	46	39	34

Statistics: X^2=16.4, df=2, p =.0003. λ asymmetric, size dependent on access to formal capital=.15. Total N-123, 4 size unrecorded.

Source: Present study.

Table 16. Relationship Between Access to Formal Credit and "Development Due to Electricity Use" Among Large Businesses (population: large electrified businesses)

	Credit access	
	Has access to formal credit	Does not have access to formal credit
"Developed" or new electricity-dependent	80%	40%
Did not "develop"	20%	60%
Totals	100%	100%
N:	15	15

Statistics: X^2=5, df=1, p=.03. λ asymmetric, "development" dependent on access to formal credit=.50. Total N-34, 4 unrecorded: 1 with access, 3 without access.

Source: Present study.

Table 17. Relationship Between "Development Due to Electricity Use" and Sex of Business Owner

	Sex of business owner		
	Female owner	Male owner	Male-female partnership
"Developed" or new electricity-dependent	33%	36%	56%
Did not "develop"	67%	64%	44%
Totals	100%	100%	100%
N:	24	81	9

Statistics: X^2=1.5, df=2, p=.47. Total N=123, 9 unrecorded: 1 female, 6 male, 2 sex unrecorded.

Source: Present study.

women-owned businesses (see Table 17).

Market Outlets. For manufacturing and agricultural/food businesses, market outlets were also related to "development" (see Table 18). (Of course, services and commercial establishments sell "on site" and do not vary in terms of the kind of market outlets available to them.) Those manufacturing and agricultural/food operations with the very reliable market outlets of the Government of Indonesia's INPRES programs or the British American Tobacco Company, had a higher rate of "development due to electricity use" than did those which sold primarily to stores and/or provided regular orders to traders; businesses which sold products only in the marketplace (pasar) and/or irregularly to traveling traders had the lowest rate of "development due to electricity use."[44]

Impact of Electricity Use on Production

Findings regarding changes in production were limited by the small number of observations for each type of electrical equipment. However, since sewing machines were used continually by manufacturers which owned them, and since some of those businesses still used some footpedal machines, the reported changes in production for those machines do merit attention. Although these data can only be suggestive, it is interesting to observe the substantial increases in production cited, particularly since those reports were very consistent. The reported average increase in output of electric sewing machines over pedal machines was 58% per standardized day.[45]

Impact of Electricity Use on Profits

Respondents from 24% (30) of all businesses reported an increase in profits due to electricity use.[46] Based on reports of 23 of those businesses, the average increase in profits was 11%.[47] In addition, 4% (5) of all businesses

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[44] None of the 3 manufacturers which sold only "on site" developed with the use of electricity.

[45] For each business, the production change was calculated on the basis of the number of similar pieces produced during a "regular workday," which was standardized for each business. The reports were from four businesses using electric sewing machines. On the basis of their reports, increases in production of electrical sewing machines over footpedal machines were calculated to be: 60%, 60%, 58% and 54%.

[46] Businesses which increased profits constituted 80% of the 38 businesses which "developed due to electricity use." Five respondents whose businesses "developed" reported that their profits had not increased with that development. Some cited the cost of electricity as having eroded increases in revenue. Others felt that "development" had not yet served to increase profits. Three respondents whose businesses "developed" did not know if profits had increased.

Table 18. Relationship Between "Development Due to Electricity Use" and Type of Market Outlet
(population: manufacturing and agricultural/food businesses)

	Type of market outlet		
	Marketplace/ traveling traders	Stores/regular orders to traders	INPRES or BAT[a]
"Developed or new electricity-dependent	8%	41%	67%
Did not "develop"	92%	59%	33%
Total	100%	100%	100%
N:	13	37	9

Statistics: X^2=8.3, df=2, p=.02. λ asymmetric, "development" dependent on market outlet type=.14. Total N=75, 13 type of market outlet unrecorded, 3 sell only "on site." None of the latter "developed due to electricity use."

Source: Present study.

[a]INPRES is a Government of Indonesia-sponsored marketing program and BAT is a marketing plan of the British American Tobacco Company.

were electricity-dependent operations established after the advent of RE.[48]

Several factors were examined with regard to the rate of profit increase among businesses which raised profits using electricity (excluding the new electricity-dependent businesses). As the regression results presented in Table 19 demonstrate type of business and size of business proved to be insignificant as explanatory factors of the rate of profit increase due to electricity use. A simple t test also disclosed insignificant variance in average rates of increase across men- and women-owned businesses ($t=.44$, $p=.67$).[49]

The findings regarding business size are surprising since it might be anticipated that economies of scale would enable large businesses to utilize electrical equipment to a greater extent than could small businesses, and therefore achieve higher rates of profit increase. The outcome may be related to the fact that electricity was not used to power any large-scale (greater than 5 HP) equipment. The reasons for this limitation are discussed below. The consequence of the limitation is that only small electrical equipment and appliances were utilized. Since the types of small electrical equipment currently used are relatively divisible, small and medium businesses could profit from their use as well as could large businesses.[50] The same is true for electric lighting. It was also the case for virtually all of the electrical equipment which respondents did not yet use, but reported would be advantageous to their businesses. Thus, for businesses in the surveyed villages, appropriate productive uses of electricity have been, broadly speaking, neutral to scale.

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[47] Respondents were very reluctant to discuss profits. For 21 of the 30 respondents who reported that profits increased, the rate of profit change was calculated on the basis of reports regarding changes in production due to electrical equipment or due to changes in workhours with electric lights. For two additional businesses, which increased profits due to electrification but did not change workhours or use electrical equipment, respondents were able to state the percent change in profits they experienced. The other 7 respondents did not want to report the rate of change in their profits. This experience with attitudes toward reporting profits suggests that the data on profits may be downwardly biased.

[48] The 5 electricity-dependent businesses were: battery-charging services, an ice producer, a plastic bag manufacturer, and an "obras" tailoring service. The plastic bag manufacturer relied on an electric plastic welder. The obras service relied on an electric cross-stitch machine, since footpedal machines cannot produce saleable quality and are not used for this type of production for sale.

[49] For the t test N=20, since 3 male-female partnerships were excluded. When sex of business owner was included in the equation presented in Table 19, the marginal explanatory value added was negligible.

[50] This statement refers to the groups of small and of medium businesses. Of course, some businesses within these groups are not able to utilize even small electrical equipment profitably.

One factor which proved to be an important determinant of the percent of profit increase was use of electrical equipment. Businesses which utilized electrical equipment had significantly higher rates of profit increase than did those which raised profits through other forms of electricity use (see Table 19).

A second important explanatory variable was access to formal capital, which was again associated with more advantageous use of electricity. Levels of profit increase among businesses having that access were greater than levels of increase among businesses without such access (significant at .07). Table 19 shows that to be the case, even after the effects of electrical equipment use have been brought into account.

Labor Effects

Use of electric lights led to an extension of the hours of operation in 19% (23) of the electrified businesses.[51] The extension was, on average, 11%/month, and in most of those businesses entailed increased workhours for paid or unpaid workers.

Table 20 summarizes the impact on labor related to changes in workhours and salary due to electrification. Primarily affected were full-time workers, 16% (123) of whom experienced a regular increase in their workhours, and 14% (106) of whom received increases in salary.[52] Based on reports for 90 of those workers, the average increase in salary was 11%. Five new workers were also hired full-time due to one business' electricity use. Among part-time workers, only a very small number increased workhours and salary.[53]

As Table 20 demonstrates, paid workers who experienced workhour increases almost invariably obtained wage increases. In contrast, of nine paid workers who used new electrical equipment, none received an increase in salary due to increases in productivity. Although the latter group is small, these findings

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[51] See Appendix A for a discussion of the methodology used to determine changes in workhours.

[52] The term "workers" is used to indicate all who work in the businesses, excluding business owners. "Full-time" workers were those working 36 hours per week or more during the seasons the businesses were operating. "Part-time" connotes workers working less than 36 hours per week during the seasons the business was operating.

[53] 497 women worked part-time in the 123 businesses. Only 1% (5) increased their workhours, and only one of those 5 were salaried labor and experienced an increase in salary; however, the amount of salary increase was not recorded. 2% (2) of the 94 part-time men had an increase in workhours. Those men were unsalaried family workers.

Table 19. Factors Explaining Percent of Profit Increase (dependent variable: percent of profit increase due to electricity use; population: businesses which increased profits)

	Parameter estimates				
Income	Capital access[a]	Electrical equipment[b]	Services dummy	Manufacturers dummy	Agricultural food dummy
.01	6.17	7.23	-1.52	3.15	-.98
(t=.63)	(t=1.96)	(t=2.26)	(t=-.39)	(t=.84)	(t=.23)
(p=.54)	(p=.07)	(p=.04)	(p=.70)	(p=.41)	(p=.82)

Statistics: R^2=.55, F=3.27, p=.03, N=23.

Source: Present study.

[a]Dummy variable equals 1 when has access to formal capital.

[b]Dummy variable equals 1 when uses electrical equipment to increase profits. Measured against businesses which raised profits through increased workhours with electric lights or due to indirect effects of increased community activity at night as a result of electrification.

Table 20. Impact on Labor
(percent)

Worker population	Change due to electrification of business			
	Increased hours	Increased salary	New jobs (salaried or unsalaried)	Increased salary or new salaried job
All workers (N=1354)	10% (130)[a]	8% (107)	2% (21)	9% (119)
All paid workers (N=1248)	10% (118)	9% (107)	1% (12)	10% (119)
All full-time workers (N=763)	16% (123)	14% (106)	2% (13)	16% (118)
All part-time workers (N=591)	1% (7)	b (1)	1% (8)	b (1)
Paid workers who increased workhours (N=118)	100%	91% (107)	n.a.	n.a.
All women workers (N=700)	3% (21)	2% (11)	2% (13)	3% (20)
All men workers (N=654)	17% (109)	15% (96)	1% (8)	15% (99)

Note: n.a. = Estimator not applicable.

Source: Present study.

[a]Absolute number in parentheses.

[b]Less than 1 percent.

do suggest that workers benefited more from extensions in workhours, while businesses profited most from electrical equipment usage.

In addition to the foregoing changes in employment and wages, income generation accompanied the establishment with RE of five electricity-dependent businesses. These businesses cumulatively employed 9 full-time and 8 part-time participants, of whom 7 were salaried workers, 9 were unpaid family workers, and one was a working owner.

Benefits from increased wages or new employment were not distributed equally among men and women, however. The majority of women worked part-time, and part-time workers were almost entirely excluded from the benefits of increased hours and salary. Only 3% (20) of all paid women workers were hired or experienced increases in salary due to electrification of the businesses in which they worked. In contrast, the majority of men were full-time workers, the group in which most of the benefit to workers was concentrated. A significantly higher proportion, 16% (99), of paid male workers were hired or experienced an increase in salary due to electrification of the businesses in which they worked (see Table 21). Yet even among full-time workers, men benefitted disproportionately. A significantly larger proportion of full-time paid men received higher wages or new jobs than the proportion of full-time paid women who obtained those benefits (see Table 22).

All women and most men who obtained increased salaries or new jobs worked for manufacturers.[54] The proportion of all full-time women working in manufacturing operations was the same as the proportion of all full-time men in manufacturing (47%). Consequently, it appears that the disproportionate benefit to male workers cannot be explained by differences in the proportion of men and women working full-time in manufacturing. These findings are, of course, only indicative. The small number of full-time women increasing workhours and salary precluded statistical testing of factors differentially affecting men and women. Further research is required to understand the nature of and reasons for these differences.

Another phenomenon which merits further study is the fact that increased business hours implied increased workhours for those already employed by the business, rather than new jobs for others. Field impressions indicate that

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[54] 68% (67) of the 99 men who experienced increased salaries or obtained new jobs worked in manufacturing operations; 16% (16) worked in agricultural/food operations; 16% (16) worked in services.

Table 21. Difference in Economic Benefit to Paid Male and Female Workers Due to Electrification of Business (population: paid employees)

Economic impact	Female employees	Male employees
Increased salary or salaried new job	3%	16%
No income effect	97%	84%
Total	100%	100%
N:	632	616

Statistics: X^2=60, df=1, p=.0001. λ asymmetric, increased income dependent on sex=.90. Total N=1248.

Source: Present study.

Table 22. Difference in Economic Benefit to Full-time Paid Male and Female Workers Due to Electrification of Businesses (population: full-time paid employees)

Economic impact	Female employees	Male employees
Increased salary or salaried new job	11%	18%
No income effect	89%	82%
Total	100%	100%
N:	174	545

Statistics: X^2=5.1, df=1, p=.03. λ asymmetric, increased income dependent on sex=.81. Total N=719.

Source: Present study.

workers are willing to extend their workhours substantially, as long as salaries also increase. For example, one business increased workhours from 8 to 12 hours per day but added no new employees. This situation seems to be related both to workers' desire for additional income, and to the worker-employer relationship.

Employer-employee relations in these villages involve a number of informal ties. When an employee or member of his/her family is ill, the employer is expected to lend financial assistance. Employers give clothes and other "presents" to employees on appropriate holidays. Employers often seek new employees through current employees, so that employees within a business have ties external to the workplace. Their multiple roles within the business often require business owners to be absent from the workplace. Consequently, investments in employee training and confidence in employee honesty and reliability, become particularly important. Such conditions make it preferable for the employer to increase the workhours of current employees rather than to increase the number of people for whom he/she has responsibilities, or to generate any ill feelings among employees who wish to work longer hours.

Those informal ties may also be related to another phenomenon worth noting: the absence of any job-loss due to use of electrical equipment. This phenomenon does not appear to be merely a short-term effect. Of the 14 respondents who reported they would use loans for electrical equipment, only one anticipated that use of electrical equipment would result in a decrease in his labor force. Eight of the 14 reported that electrical equipment would not affect their labor force, while 5 said that it would stimulate an increase in workforce. The extent to which these expectations would be fulfilled cannot, of course, be calculated. However, the pattern of responses suggests that respondents consider electrical equipment primarily as a means to increase or accelerate production, or improve product quality, rather than as an instrument for reducing labor costs. While obligations of employers to employees may deter reduction of the current workforce, however, the use of electrical equipment may limit new hiring. These and other questions concerning formal and informal employer-employee relationships in rural small businesses and industries require further research. They are an important element affecting not only RE but all policies related to rural industrialization and off-farm employment.

Thus, after one and a half years of electrification, 11% (151) of all workers (family and non-family) experienced increased workhours or new employment directly attributable to electrification. 10% (119) of all paid employees experienced increased salaries or obtained new jobs due to electrification. 29% (35) of the electrified businesses experienced an increase in profits, or were newly established, due to electrification.

POTENTIAL FOR ELECTRICAL EQUIPMENT USE BY BUSINESSES

As important as examination of electricity use and consequent impacts is assessment of prospects for future use. In considering that issue we will first examine conditions which appear to have limited the use of electrical equipment by businesses. Implications of those findings for future productive use of electricity will then be discussed. Two groups will be examined: one consisting of respondents who reported that there is electrical equipment which would be advantageous to their businesses but which is not yet used; one containing businesses which currently use diesel engines for shaft power.

According to 54% (66) of all business respondents, there was no electrical equipment which would be advantageous to their businesses. Reports from 39% (48) stated that there is electrical equipment which would be advantageous to their businesses, but is not yet used. An additional 7% (9) of the respondents reported that they already own electrical equipment sufficient for their needs. There proved to be a significant difference between business types with regard to owners' perception of the utility of electrical equipment. Respondents from services and manufacturers, among whom electricity use was already concentrated, were far more likely to perceive electrical equipment as potentially beneficial than were respondents from commercial or agricultural/food businesses (see Table 23).

Obstacles to Productive Use: Marketing and Credit

The obstacles to use of "advantageous" electrical equipment were primarily related to demand and cost.[55] Expense of either electricity or electrical equipment was the major constraint cited by 46% (22) of the 48 respondents who

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[55] Differentiating between responses related to cost and those related to marketing was not a straightforward task. With respondents who cited "cost," it was important to ascertain whether the equipment was "too expensive" because market demand did not justify expenditures for more productive equipment, or whether sufficient market demand existed, but the respondent lacked capital for the purchase of more productive equipment.

did not use electrical equipment they considered "advantageous" to their businesses. Another 42% (20) cited problems with limited market demand. Lack of information was the major constraint reported by 10% (5). Only one respondent reported being dissuaded from using advantageous electrical equipment due to his perception that "electricity is unreliable."[56]

Despite sparse cells, there was a significant difference between small, medium and large businesses with regard to the factors which reportedly obstructed use of electrical equipment (see Table 24). For small businesses, marketing problems were the most common obstacle to using "advantageous" electrical equipment, while the expense of electricity/electrical equipment was the second most important factor. Most medium sized firms which did not use "advantageous" electrical equipment were constrained from doing so by the expense of electricity/electrical equipment; among those businesses, marketing was a far less frequent problem. Among large businesses, insufficient demand, electricity/electrical equipment expense, and lack of information were about equally common obstacles.

In considering the policy implications of these findings, it is important to recognize that responses citing "expense" actually refer to three distinct situations. The first was one in which businesses lacked sufficient capital to purchase electrical equipment they felt would improve their businesses. However, were capital available to them, the cost of electricity would not be a deterrent; they could use the "advantageous" equipment with the low load system already installed and electricity rates did not appear to be binding.[57] Most of the businesses citing expense were in that situation, and they represented the overwhelming majority of the small and medium businesses who cited cost as the major constraint.

In the second situation, business respondents felt that they could afford to purchase the "advantageous" electrical equipment, but high installation costs for the additional capacity which that equipment required made electricity an undesirable option. The third situation was one in which both

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[56] The "RE" system operated very reliably. 67% (81) of the business respondents reported having no problems with electricity service. Although 26% (32) reported that they had a problem with service interruptions, the average number of interruptions reported were three per year. Only 12 respondents reported as many as one per month, and only 2 reported a higher rate than that. Compare that rate of "breakdown" with the average of one "breakdown" per week reported by those who used diesel motors.

[57] Of course, this presumes that electricity rates would remain the same, i.e., that upon using more electricity these businesses would not be transferred into a more expensive user category.

Table 23. Differences Between Business Types in the Perceived Utility of Electrical Equipment

Perceived utility of electrical equipment	Business type: Services	Manufacturing	Commercial	Agricultural/ food
Electrical equipment would be "advantageous"	67%	51%	30%	10%
No electrical equipment would be "advantageous"	33%	49%	70%	90%
Total	100%	100%	100%	100%
N:	18	45	30	30

Statistics: X^2=20.3, df=3, p=0.0001. λ asymmetric, perceived utility dependent upon business type=0.15. Total N=123.

Source: Present study.

Table 24. Relationship Between Business Size and Reasons for Not Using Electrical Equipment Perceived as "Advantageous" (population: businesses for which there is electrical equipment perceived as advantageous)

Reasons	Business size: Small	Medium	Large
Lack of market demand	60%	22%	31%
Expense of electricity or electrical equipment	40%	64%	38%
Lack of information	0%	14%	23%
Electricity unreliable	0%	0%	8%
Total	100%	100%	100%
N:	20[a]	14[b]	13[c]

Statistics: Likelihood ratio X^2 (used due to sparce cells)=13.1,p=.04. λ asymmetric, type of reason dependent on size=.16. Total N=48, 1 size unrecorded (reason: market demand).

Source: Present study.

[a]Represents 44 percent of all 46 small businesses.

[b]Represents 36 percent of all 39 medium businesses.

[c]Represents 38 percent of all 34 large businesses.

problems existed, electricity costs were too high, and respondents lacked necessary capital. The latter two situations occurred primarily among large businesses.

These responses must be viewed in the overall context in which Klaten businesspeople find themselves. Like small businesspeople in other villages, the Klaten respondents face a binding capital constraint. Asked to name the greatest obstacle to increasing production and sales, almost half of the business respondents reported it to be lack of capital. Marketing/demand was the major constraint to increasing production and sales for about one fifth. A variety of other problems were also mentioned, each by about 2% of the businesses. Approximately one-third reported that they had no problems limiting sales and production. Thus, capital is a constraint not only to the use of electrical equipment but to meeting other business needs as well. Clearly, availability of loans would not automatically result in purchase of electrical equipment by all business operators who felt electrical equipment would be advantageous to their businesses. In order to gain a better understanding of the consequences which might arise were capital made available, additional questions were asked of respondents from manufacturing, service and agricultural/food operations. Those respondents were first asked how the Government of Indonesia could best help their businesses to develop. Of those 93 respondents, 52% (48) reported that the government could best help their businesses with low interest, long-term loans. The 48 respondents reporting the need for capital were then asked how they would use the capital were it made available. Of the 48, 29% (14) said that they would use the loans for electrical equipment. Thus, for 11% (14) of the businesses in the overall sample, lack of capital appears to be the sole constraint to purchasing electrical equipment.[58] As we have seen, that difficulty is particularly strongly felt among medium-sized businesses.

The findings indicate that assistance can be tailored to address the most pressing needs for particular size groups. Small businesses would benefit most from assistance with marketing. Credit would also be important to businesses in that group, and will become more critical if marketing constraints are eased. Medium businesses would be most helped by greater access to capital. For the businesses in those two groups, the current RE installation and

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[58] Note that owners of commercial businesses were excluded from this subset of the survey. Therefore, the percentage cited above is likely to understate the true percentage of owners in the overall sample who are constrained from using electrical equipment due to lack of capital.

use rates are not a constraint to use of electrical equipment. Although large businesses would benefit to some extent from both credit and marketing assistance, electricity installation and use rates are also an important constraint for these businesses. The greater sensitivity to electricity costs among large businesses may reflect greater anticipated levels of electricity use, making installation costs and marginal use costs more important to them.

Obstacles to Productive Use: Cost of Electricity

Another important group of businesses which would seem to have a strong underlying demand for electrical equipment are those which use diesel engines for shaft power. In fact, feasibility studies for RE in Klaten and other areas cite diesel engine users as the population likely to use electric motors and thereby raise the load factor.[59] The evidence from Klaten indicates that this group of potential "high users" does not readily switch from diesel to electric rotary power, nor even adopt electric motors when purchasing new motors. The reasons for the preference for diesel engines appears to be primarily related to two factors: cost of electricity, particularly installation expense, and lack of information about electric motor capabilities.

Installation costs for businesses with relatively high levels of power consumption, such as those using diesel engines for shaft power, made electricity uncompetitive as a source for that power (see page 37). Installation of greater load capacity than the RE program offers would also transfer village businesses from the subsidized "RE" customer category into the regular, more expensive "small business" category of tariff rates. In fact, tariff rates for small businesses are higher than those charged large businesses (See Table 25). For a general service utility program this type of tariff structure makes sense. Supplying electricity to a few large businesses demands fewer resources of the electric power company than does supplying small amounts of electricity to a great many consumers. However, if one important goal of RE is the development of productive uses, high installation and use rates inhibit achievement of that goal.

These conditions were reflected in the survey results. Of the electrified businesses, 17% (21) use petroleum fuel for shaft power. Perhaps most crucially, 24% (5) of the businesses which use diesel engines had installed electricity before they bought their diesel engine. Nevertheless they chose to

[59] See Project Paper: Proposal and Recommendations, Indonesia - Rural Electrification I, AID, Vol. II, pp. 155-156.

Table 25. Tariff Rates for Some Types of Commercial Operations Effective May 1, 1980[a]

Tariff category	Contracted power	Total average Rs./kWh
Small commercial service (low voltage)	250 VA to 2200 VA	64.50
Medium commercial service (low voltage)	2201 VA to 200 kVA	70.50
Big commercial service (medium voltage)	201 kVA & over	47.00
Small industrial service (low voltage)	3.8 kVA to 99 kVA	38.5
Medium industrial service (low voltage)	100 kVA to 200 kVA	40.5
Big industrial service (medium voltage)	201 kVA & over	31.0
Big industrial service (high voltage)	5000 kVA & over	26.0

Source: Central Office, PLN, Jakarta.

[a]Note that these are the regular PLN rates, not the rates utilized in the RE model program. The structure of RE rates is presented in note 11.

use diesel engines rather than electric motors. All five cited installation costs as the reason for using diesel rather than electric motors. Of the 16 business respondents who had already had diesel motors before electrification, 15 expected to purchase another diesel engine when their current engines required replacement. Eight cited installation costs as the reason for continuing to use diesel power; four said they do not know enough about electric motors to purchase one, or demonstrated by their statements that they were ill-informed; three respondents felt that electricity was unreliable. Only one felt that he might purchase an electric motor when his current diesel motor required replacement (although he also felt he required further information about electric motors).

In addition, 6 business respondents who do not presently have diesel motors stated that they need shaft power. Five of the six reported that were they able to get loans for equipment, they would purchase diesel motors. The sixth reported he would use a loan for a very small (under 1 HP) electric motor.

Thus, 20% (25) of the electrified businesses indicated a preference for diesel motors either by buying diesel motors after installing electricity (4%), or by reporting that they anticipate replacing their current diesel motors with new diesel motors or would purchase diesel motors rather then electric motors were capital made available for machinery (16%).

POLICY IMPLICATIONS

Many Klaten businesses did take advantage of the attractive RE rates to use the new technology to increase their production ano sales. However, closer examination of businesses' use of electricity reveals that development of potential productive uses was limited by the RE program's unresponsiveness as a development program. It must be reiterated here that this examination of the Klaten project was conducted after only one and a half years of electrification. However, the negative consequences of the inhibiting conditions are likely to persist unless the program becomes more responsive to the needs of village businesses.

Two important conditions hindered development of productive uses of electricity. The first concerns installation and tariff rates. Installation costs were prohibitive for the village businesses which might have used electric motors rather than diesel engines for direct shaft power. As the data

examined above demonstrates, of 27 businesses which could use either diesel engines or electric motors for direct shaft power, 67% (18) reported that high installation costs made diesel motors preferable to electric motors.[60] Only two of the 27 considered an electric motor to be preferable to a diesel motor. While those disincentives were particularly critical for diesel engine users, installation expenses deterred "productive use" among all businesses which might have used loads greater than that provided by the RE system. Thus, a substantial part of the potential productive uses of electricity remains unfulfilled, while use of electrical equipment has been entirely limited to small hand tools and appliances. Without change in electricity costs, particularly installation expenses, the situation is likely to remain so.

With a tariff structure and installation costs more responsive to village business conditions, eventual progress toward development of productive uses would be expected. Indeed, as has been shown, some productive uses did develop where villagers could use the single phase low load system "productively." Lack of complementary inputs, however, slowed the response time to the new technology considerably.

Three forms of "complementary inputs" appear to be important in assisting businesses to use electricity advantageously. The most important input is capital, and its availability, or lack thereof, has equity implications.

Complementary Input: Capital. As has been demonstrated, "development" among large manufacturers was disproportionately greater than among smaller manufacturers. If large manufacturers are better able than medium and small operations to utilize electricity to expand, there is a distinct danger that introduction of rural electrification into such a nascent industrializing economy could skew opportunities in favor of the largest manufacturers. A similar situation is also likely to exist for services. If a strong, viable small-scale sector is deemed desirable, care must be taken to help maintain the competitiveness of small and medium enterprises in rural areas which are electrified.

In the village context, electricity use appears to be largely neutral to scale. That is to say, smaller businesses appear to be capable of increasing profits at rates comparable to those of large businesses, where the small businesses can use the electricity in ways which are advantageous to the busi-

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[60] These 18 represent 15% of all electrified businesses surveyed.

ness. A crucial comparative advantage enjoyed by larger businesses, which enables them to use electricity profitably, is access to formal credit. Difficulty acquiring investment capital was the dominant constraint to use of "advantageous electrical equipment" by medium sized businesses. It was also a major obstacle to use of electrical equipment by small businesses. Thus, although electrical equipment is generally neutral to scale, access to capital (which would otherwise enable medium and small firms to purchase equipment) is not. Credit programs would thus appear to be the most useful facilities for assisting the development of "productive uses" of electricity by small and medium businesses. It would also seem to be the most feasible option, particularly since there are loan programs already established and operating at or near the village level.

Two "small credit" programs were operating in the villages at the time of the survey. Discussions with bank officials and with business respondents disclosed two important conditions which discourage businesses from using those programs for the finance of electrical equipment. The first problem relates to program structure. Both credit facilities were established before village electrification and each has structural disadvantages as a credit program for electrical equipment.

The "Village Credit" program (Sektor Kredit Desa) offers very small loans with very fast turn-around time. It is ideally designed for small traders, or for businesses requiring goods or raw materials which will be sold fairly quickly. The "Small Credit" program (Kredit Mini) offers larger loans which are adequate for purchase of small electrical equipment. However, a "land certificate" (certifikat tanah) is required as collateral against all loans. Bank officials reported that requirement to be the major obstacle for most business owners inquiring about loans.[61] A third type of credit program, offering "medium sized loans" (Kredit Midi) did not yet operate, but was expected to begin by the latter part of 1981. Loans through this program are larger than necessary for small electrical equipment and appliances. They would be appropriate for 6 HP motors, the size used by most medium sized businesses using diesel engines directly for shaft power. This program, like the "Small Credit" program, requires a land certificate as collateral.

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[61] The difficulties presented by these programs for businesses which have bought electrical equipment will be discussed at length in forth-coming work.

The second difficulty with the credit programs relates to misinformation. Business owners complained that not only a land certificate, but also a "business permit" (usaha izin) is required for all government loans. Only a handful of large businesses have such a permit. Actually, although other government credit programs for businesses do require a business permit, the credit programs described above do not.

Using the administrative structure which is already in place, a loan program could be designed specifically for equipment. If the programs are to assist small and medium businesses, loan sizes should remain small - no larger than the "Medium Loan" program. For most of those businesses, acceptance of collateral other than a land certificate will be necessary if they are to use the program. Programs which maintain the land certificate requirement, particularly the "Medium Loan" program, are likely to serve primarily large village businesses. One alternative would be for loans to provide only part of the equipment cost, while using the equipment itself as collateral. Whatever the structure, a small loan, long-term credit program will be important in assisting small and medium businesses to use electricity advangeously. Without such a program, the subsidized electricity use rates lose much of their effectiveness as an incentive for "productive use."

Complementary Input: Marketing. The second type of complementary input for which there was a demonstrated need was marketing assistance. This was especially important to small businesses. Limitations of marketing and demand are, however, complicated problems for an assistance program to address. Improvement in marketing for services and commercial operations may have to await more general village development. For small manufacturers, however, two forms of assistance may be possible.

One alternative would be a marketing co-operative. District Klaten is the focus of a special effort to develop village cooperatives. The organization, PUSPETA (Center for Assistance to Cooperatives and to Farmers), could undertake a program specifically designed to assist small and medium manufacturers in establishing such a co-op. Two co-ops, established independently by participants, already operate in the surveyed villages. One is a furniture-makers' co-op which was formed to obtain wood at competitive prices. The other co-op was organized to obtain credit through a few members who have access to formal credit sources. The development of such independent co-ops indicates that a marketing co-op could be a viable assistance mechanism for small manu-

facturers. However, development of a co-operative, particularly one designed to assist with the complicated task of marketing, would be a complex venture. Administrative skills, necessary to the success of such an effort, are in limited supply in rural areas. Such a program would require the investment of considerable human and capital resources.

Another alternative might be a marketing program conducted by the Department of Small Industries which has a branch in the District capital. This branch has limited its focus to the largest village industries (still primarily "small industries" by national standards). The activities of the office appear oriented toward record- keeping rather than assistance. It would require considerable change of focus and scale for this office to carry out a marketing assistance program. Given the difficulties with which bureaucracies usually change focus, and the limited experience and resources of this office, it would seem to be the less viable alternative.

Complementary Input: Information. The third type of complementary input necessary to support the goals of the RE program, information dissemination, has less immediate importance but great potential impact. It is especially relevant to businesses which require shaft power. Some comparative aspects of diesel engine vs. electric motor use are rather subtle, e.g., relative complexity of use, reliability, relative discounted value (where capital costs differ), etc. If installation rates are brought within village business capabilities, and use rates are competitive, businesspeople will require information about such factors in order to make optimum choices. At the time of the survey, businesspeople had received no information on comparative costs, maintenance requirements, etc. for electric as compared with diesel motors.[62] Nor was there an outlet to which businesspeople could go for more information on electricity use.[63] While they might have been able to obtain information from businesses in the city which sell electric motors, they were wary of the objectivity of such information sources. Furthermore, they had not, as yet,

[62] This is true as of February 1981. In that month a "productive uses consultant" was posted in Klaten by USAID. Presumably he included an information component in his program to assist development of productive uses. However, resources, jurisdictional competition, and "contacts" limitations may prevent that consultant from developing the administrative mechanisms which would be necessary to ameliorate the problems of program unresponsiveness, at least in the near future.

[63] 71% (86) of 122 business respondents said that if they needed information on electrical equipment use, they would go to PLN. But the Klaten and Solo PLN offices did not have that information, according to officials there. A variety of other information sources were each mentioned by less than 10% of the respondents: neighbors, the village head, stores, and others. 6% (7) said they did not know where to go for information.

any reason to go to such lengths for information on electric motors. Some were completely uninformed, or misinformed (e.g., those who think electric engines come only in small sizes because they have only seen those sizes, or those who believe that electric motors are not as "strong" as diesel engines and that they would have to buy much larger motors for equivalent power). Diesel motors were generally the only source of shaft power most village businesspeople had ever seen, and the only kind of motor (other than for small appliances), with which they had any experience.

The "information gap" extends to the amount of power available to the businesses. Although for administrative reasons, PLN bills show the installed load capacity to be 450 watts, all RE consumers actually have 1250 watts available. Almost every respondent believes he/she is limited to 450 watts, and behaves accordingly.[64] One businessman had installed three meter systems in his business because he felt he needed 1300 watts. He was having difficulty because his electricity bills were high and he had to continue to use his diesel motor which was larger than 5 horsepower.

The billing system was a mystery to a large number of respondents, who did not understand how much of their bill reflected use, and how much fixed costs.[65] Consequently, they did not know the marginal costs incurred for using higher wattage light bulbs or small electrical equipment.

Thus, lack of responsiveness and absence of complementary inputs severely limits the development of a significant portion of readily realizable productive uses: use by business owners who are using or plan to use diesel engines for shaft power, and use by business owners who feel that electrical equipment would improve their businesses, but are prevented from buying the equipment due to lack of capital. Perhaps most importantly, it indicates how lack of responsiveness can actually build obstacles to achievement of project goals into the program design. It makes clear the need for a coordinated RE program addressing the related needs of potential productive users. Heretofore, the costs to the government for subsidized RE use rates have foregone much of the potential development "payoff" because related needs of businesses were ignored.

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[64] 96% (109) of the 114 business respondents who had the "RE" system reported that they had 450 watts installed. The 8 respondents with the regular PLN system knew the amount of load installed.

[65] 48% (59) did not know what portion of their bill was fixed cost and which reflected use.

V. IMPACT ON HOUSEHOLDS

In this section, changes in energy consumption as a consequence of household electrification are first examined, with particular attention to identifying indicators of levels of electricity consumption. General benefits to Adopters are then reviewed, with a subsequent focus on direct economic impacts. Finally, the potential for further positive impact is assessed in view of existing constraints.

Changes in Consumption

Average electricity consumption by electrified households in the survey sample (Adopters) was 28 kWh/month, 25% higher than had been anticipated by project planners.[66] Electricity substituted primarily for kerosene lighting, with no Adopter reporting use of kerosene for lighting other than during electricity service interruptions. Since the average number of interruptions reported was only 4 per year, it was evident that electricity had substituted for virtually all kerosene previously used by Adopters for lighting.[67] A small proportion of Adopters also substituted PLN electricity for accumulators which had powered electrical appliances. There was no substitution of electricity for cooking fuels.

Like business respondents, Adopters demonstrated a strong underlying demand for electric lighting. By converting pre-electrification consumption of kerosene for lighting into "kWh equivalents," changes in kWh consumption can be directly compared for the 109 households which used electricity only for lights. Among those households, kWh consumption, averaged over individual households, was 230% greater than pre-electrification levels.[68] Hence, those households used, on average, about twice as much as light as they would have with kerosene lighting.[69] Increases in consumption were accompanied by increases in expenditure. The average cost per kWh for households using electricity only for lights was Rp. 118, about 70% more than the expense for kerosene burned in a petromax lamp.[70] Of the households using electricity for

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[66] Project Paper: Proposals and Recommendations, Indonesia - Rural Electrification I, AID, Annex K, p. 7.

[67] Only 21% (46) of the Adopters reported higher rates of interruptions than 4/year; only 2 reported as many as one per month. According to reports of Adopters, the average length of interruptions was 1-2 hours.

[68] See Note 24 for discussion of conversion rates and presentation of the formula used to calculate the average change in consumption.

[69] Assuming yearly increases in kerosene consumption of 0% (see Note 25).

lighting alone, 96% (105) increased the proportion of their expenditures allocated to lighting.[71]

The unexpectedly great change in kWh consumption with the advent of electrification highlighted a ubiquitous problem in RE planning: accurate prediction of consumption by households. To gain a better understanding of factors which may be useful predictors of consumption, examination was made of household characteristics which are measurable before electrification. Four such characteristics emerged as important explanatory variables of kWh consumption. Not surprisingly, one of the most powerful was household expenditures. As the regression results in Table 26 show, there was a strong positive association between household expenditures and household consumption of electricity. Mean kWh consumption in the poorest groups was 20 kWh/month, slightly less than project designers had anticipated for the electrified area as a whole. For low and middle income households, it was approximately 25 kWh/month, slightly greater than anticipated levels. The wealthiest group, however, had an average consumption of 43 kWh/month, twice that of the poor.

Even after household expenditures have been taken into account, the level of kerosene use at the time of electrification proved to be a powerful indicator of electricity consumption. Apparently, despite increased costs for electric lighting, levels of lighting were maintained or increased even among poorer households. In the context of Klaten, such factors as proximity to urban influences, and numerous home enterprises, may create a strong demand for lighting even among poor households.[72]

The third important explanatory variable of consumption was the presence of a store or tea shop within the household premises. However, presence of a home industry was not a significant factor. Identification of the reasons for this difference between the two types of enterprises is beyond the scope of this paper. What the data on household enterprises do make clear is that the

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[70] Note that this calculation is based on electricity costs which include installation and wiring, and kerosene prices in 1981 (see Note 27).

[71] This statement assumes that before electrification Adopters had allocated about 4% of their household budgets to kerosene lighting. This was the average rate allocated to kerosene lighting by Non-adopters in the Klaten survey. The rate is also comparable to the rest of rural Central Java (source: Survey Sosial Ekonomi Nasional, 1976 and 1978).

[72] Expenditure level was not a strong indicator of pre-electrification kerosene use, r=.29. The report by Weatherly, examining use of kerosene for lighting among non-electrified households in Klaten, noted the "above average" consumption of kerosene for lighting by a number of households in the lowest income group.

Table 26. Factors Explaining Level of kWh Consumption by Households (dependent variable: kWh consumption per month)

	Parameter estimates					
Expenditures	Liters kerosine*	Size household	Home industry[a]	Store/warung[b]	"Farm family"[c]	Has school-children[d]
.52	.53	1.34	1.65	8.24	-7.9	-2.02
(t=6.2)	(t=6.0)	(t=.49)	(t=.58)	(t=2.03)	(t=-2.2)	(t=-.61)
(p=.0001)	(p=.0001)	(p=.62)	(p=.56)	(p=.04)	(p=.03)	(p=.54)

*Pre-electrification kerosine consumption for lighting.

Statistics: R^2=.45, F=20, p=.0001, N=183.

Source: Present study.

[a]Dummy variable equals 1 when has home industry.

[b]Dummy variable equals 1 when has store or warung.

[c]Dummy variable equals 1 when is a "farm family" (see text for definition).

[d]Dummy variable equals 1 when has schoolchildren in the home.

disparity is not related to changes in workhours after electrification; stores and tea shops did not increase their workhours significantly more than did home industries (see Table 27). One hypothesis suggested by the data, therefore, is that stores and warungs took advantage of electricity to increase their lighting significantly during regular nighttime workhours, in order to attract customers.

The fourth important determinant of kWh consumption was whether or not the household was a "farm family," i.e., whether a family member farmed land owned by the household. There was a significant difference in the level of consumption by "farm families" and "non-farm families," with average kWh consumption of the former about one-third less than that of the latter.[73] The lower consumption levels of "farm families" may be an important consideration when RE projects are being planned for areas in which the predominant source of family income is own-account farming.

The regression equation in Table 26 includes a dummy variable for households with schoolchildren. It was presented for purposes of illustration, since presence of schoolchildren was expected to be an important indicator of electricity consumption. It proved, however, ceteris paribus to be without significance. The same was true of the number of people in the household. The lack of explanatory power by these two variables is likely to be related to the living situation found in villages. Homes have few rooms, and family members - adults and children - generally use one "living room" for their activities. While households apparently used electricity to increase the level of lighting in the main family room, that level is not likely to vary with the number of people being served by the lights.

General Benefits to Electrified Households

As we have seen, the basic benefit of electric lighting was disproportionately skewed toward wealthier village households. However, substantial proportions of all income groups were enjoying the use of electric lighting after one and a half years of RE project operations.

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[73] Note that the lower levels of consumption were tested only for households which farmed their own land. Further research is necessary to distinguish the ways in which electricity use differs for families whose major source of income is farming land they rent in and operate themselves.

Table 27. Difference Between Types of Home Enterprises in Their Use of Electric Lights to Increase Workhours (population: electrified home enterprises)

Effect of electric lights on workhours[b]	Type of home enterprise[a]	
	Home industry	Store/warung
Increased workhours	15%	13%
No change	85%	87%
Total	100%	100%
N:	54	16

Statistics: X^2=.05, df=1, p=.82. Total N=70.

Source: Present study.

[a]Three households with both a home industry and a warung are excluded.

[b]One home industry excluded; owner decreased workhours with electric lights.

Table 28. Association Between Kind of Electricity Use and Household Expenditures

Kind of use	Household expenditures/month (1,000s Rs.)			
	20 or less	20.001-30	30.001-40	40.001+
Large appliances (with or without small appliances)	4%	17%	20%	56%
Small appliances	25%	34%	34%	14%
Lights alone	71%	49%	46%	30%
Total	100%	100%	100%	100%
N:	51	59	50	50

Statistics: For association: large appliances, small appliances or lights, with expenditures. X^2=45, df=6, p=.0001. λ asymmetric, kind of use dependent on expenditures=.12. N=217, 7 unrecorded.

For association: appliances or lights alone, with expenditures. X^2=16.9, df=3, p=.001. λ asymmetric, whether uses appliances dependent on expenditures=.20. N=217, 7 unrecorded.

Source: Present study.

Distribution of the benefits from electrical appliances showed a similar pattern. Use of appliances was surprisingly widespread, with 48% (105) of the Adopters owning some type of PLN-powered electrical equipment.[74] Small equipment, radios, tape recorders, and irons, were owned by 41% (89) of the Adopters. Almost a quarter of the Adopters owned large appliances, TV's, refrigerators, electric sewing machines, and/or water pumps, with televisions being by far the most prevalent. As expected, there were significant positive relationships between level of household expenditures and the use of both large and small appliances (see Table 28). Household expenditures proved to be a moderately strong indicator of whether Adopters used electricity for appliances or for lighting alone (λ = .20). Again, the extent of appliance use in the lowest income group was unexpectedly great. More than one quarter of the Adopters with household incomes of less than Rp. 20,000 ($32)/month reported owning some kind of appliance in addition to electric lights. In addition, extensive "sharing" of some appliances, particularly televisions, enabled more households to enjoy the benefits of appliances than owned them.[75]

The fact that Adopters were willing to commit an increased proportion of their expenditures to electricity and to electrical appliances indicates that they were receiving substantial benefit. This inference is supported by the fact that "satisfaction" with electricity services was nearly unanimous.[76] Furthermore, four-fifths of the Adopters reported that their lives had been improved by electricity use.

For most Adopters, the benefits gained from electricity use were clearly not financial. The cost savings which occurred when RE customers used more than 53 kWh/month was enjoyed by only 8% (18) of all Adopters.[77] Of Adopters using electricity for lighting alone, all but one were spending more for each kWh; all were using more kWh's per month. However, relative cost of electricity and kerosene was apparently not of primary importance to most Adopters.

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[74] This figure includes only electrical equipment which was powered by PLN; thus, it excludes battery-powered radios, etc.

[75] 10% (22) of the Adopters reported that they regularly borrow irons. Of 50 television-owners, 86% (43) reported sharing their TV's with people from outside the household at least once a week. Other major appliances, however, were not shared.

[76] Only 1% (3) of the Adopters reported being less than satisfied with electricity service.

[77] Of those Adopters, 17 used electrical appliances and their cost saving related only to the lighting component of their electricity use. One of the 18 used electricity only for lights. See page 23 for discussion of the calculation of cost savings.

Rather, as Table 29 demonstrates, the benefits most frequently cited by Adopters were intangible in nature, and could be measured with difficulty, if at all. Although conclusions regarding those benefits must therefore be formulated with caution, the frequency with which they were reported makes them an important component of the impact of RE.

The benefit most widely reported by Adopters was an increase in home security. Almost two-thirds of the Adopters reported experiencing improved home safety. Although respondents spoke of security as it related to theft, the concept in Klaten implied protection from spiritual forces as well. Insofar as petty theft was reduced, there would have been some indirect economic improvement.

The second most widely perceived benefit was an increase in children's study time. Almost three-quarters of the Adopters with school children in the home reported an increase in children's study time at night.[78] There was no report of a decrease. The increase in study time was not measured, however, and the magnitude of change is not known. To the extent that the change occurred, the increased investment in human capital should eventually yield economic rewards. A variety of other intangible benefits, e.g., healthier environment, greater satisfaction with life, higher status, were also reported.

Direct Economic Impacts

For 11% (24) of the Adopters, the benefits of electrification included an increase in income.[79] All income increases were directly or indirectly a consequence of electric lighting.[80] Half of those who increased their incomes did

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[78] The question asked of Adopters was: "If there are school children in the home, did their study time change since electrification of your home?"

[79] Of the 24, three Adopters were also included in the group of employees who increased workhours and income (see page 36).

Field impressions indicate that the data on income effects are downwardly biased. Not only were Adopters reluctant to discuss increases in income, but participant observation revealed income-generating activities which were not reported during the survey. For example, one family which used electric lights for a hatchery which they operated for profit, and one Adopter who borrowed an iron and took in ironing for a fee, did not report those activities. When asked about them, the respondents reported that the income from those activities was minimal, and they did not wish to report it. Activities such as these were not included in the findings regarding income changes.

[80] Of the 58 home industries owned by Adopters, only one, a tailor, used electrical equipment. The owner of that enterprise reported that her electric cross-stitch machine had not generated increased income, because machine repair costs and electricity expense eroded increased revenues.

Table 29. Benefits to Electrified Households from Electricity Use

Kind of benefit	Proportion of adopters[a]
Economic benefit:	
Income increased	11% (24)
Indirect economic benefit:	
Increased safety	64% (139)
Children study longer (of households with school children N=162)	73% (118)
Higher status	40% (87)
Healthier environment	9% (19)
Happier/life generally more pleasant	22% (47)
Other	3% (7)
Electricity did not change quality of life	21% (46)
Total N:	100% (217)

Source: Present study.

[a]Sums to greater than total N because of multiple responses.

Table 30. Association Between Income Increase Due to Electricity Use and Ownership of Home Enterprise

Income effect	Owns home enterprise		No home enterprise		Totals	Number of cases
	Percent	Number	Percent	Number		
Increased income with electricity	26%	(19)	4%	(5)	100%	24
No income effect	74%	(55)	96%	(137)	100%	192
Total	100%		100%			
N:	74		142			

Statistics: X^2=24, df=1, p=.0001. λ asymmetric, income effect dependent on ownership home enterprise=.88. Total N=217, 1 unrecorded.

Source: Present study.

so by increasing their workhours either in home enterprises or in other employment.[81] Electric lighting also enabled some owners to increase production in their home industries by working more efficiently. Some warung and store owners experienced increased sales due to increased village nighttime activity.

As Table 30 demonstrates, the factor of overwhelming importance to whether Adopters increased their income with the use of electricity was presence of a home industry or warung (λ =.88). More than three-quarters of Adopters who used electricity to increase their incomes, did so through their home industries/warungs. While 26% (19) of Adopters with home enterprises raised their incomes, only 4% (5) of Adopters without them did so.

Unlike other reported benefits, income-related benefits did not disproportionately favor the wealthy (see Table 31). Poorer households utilized electricity to increase income as often as did their wealthier neighbors. Size of the home enterprise, measured by net income, also proved to be unimportant as a distinguishing factor between those enterprises which used electricity to increase revenues and those which did not (Table 32).[82] Thus, home enterprises proved to be the critical vehicle through which poor households were able to use electricity to obtain increased income.

Although a substantial 26% (15) of home industry owners and 22% (4) of warung owners increased their incomes with the use of electricity, home industries and warungs were in a far more precarious financial position than were businesses. Half of the electrified home enterprises had intervals during which production stopped completely, as compared with only 6% (7) of the businesses.[83] Furthermore, for 38% (21) of electrified home industries, production stoppages were a consequence of insufficent demand. Demand compelled stoppages in only 2% (3) of the businesses.

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[81] Average reported level of increase in home enterprise workhours was 19%. However, those reports were not subject to multiple checks as were business responses regarding workhour changes.

[82] Size measured by the number of participants involved in the home enterprise also proved to be insignificant as an indicator of use of electricity to increase income.

Data was not collected from owners of home enterprises regarding the <u>degree</u> of revenue increase. Therefore, comparisons of the extent of increase among small and large home enterprises can not be made.

[83] Excluding businesses which are intentionally seasonal: rice mills and tobacco curers.

Table 31. Association Between Income Increase Due to Electricity Use and Household Expenditures

Income effect	Household expenditures/month (1,000s Rs.)			
	20 or less	20.001-30	30.001-40	40.001+
Increased income with electricity	10%	10%	10%	14%
No income effect	90%	90%	90%	86%
Total	100%	100%	100%	100%
N:	52	59	50	49

Statistics: X^2=.74, df=3, p=.86. Total N=217, 6 expenditures unrecorded, 1 expenditure more than. Rs. 40,000 income effect unrecorded.

Source: Present study.

Table 32. Association Between Revenue Increase Due to Electricity Use and Size of Home Enterprise (population: adopters with home enterprises)

Effect on revenues	Size of home enterprise		
	Small	Medium	Large
Raised revenues using electricity	17%	38%	26%
No effect on revenues	83%	62%	74%
Total	100%	100%	100%
N:	30	21	23

Statistics: X^2=3.0, df=2, p=.23. Total N=74.

Source: Present study.

Limited demand was not equally constraining for all home industries. As was true for manufacturing businesses, access to different types of market outlets was a powerful indicator of whether home industries used electricity to increase revenues (λ =.60, see Table 33). Goods-producing home enterprises with access to the "better" market outlets of stores and regular orders were more often able to use electricity to increase revenues than were producers which sold their product only in a marketplace or irregularly to traveling traders.[84]

For all home enterprises, however, demand constraints made further financial advancement with electricity use problematic. As has been discussed with regard to small businesses, limited demand is a particularly intransigent problem for assistance programs to address. The difficulties would be even more intractable with regard to home industries. Improvement in the overall village economy would seem to be the essential prerequisite to further financial development by home enterprises.

Obstacles To Development Of Benefits To Households

The Klaten RE project was outstandingly successful with regard to one of its primary objectives, that of widespread connection. The project provided solid evidence that electricity could be provided to rural Indonesia at a price affordable even by the poor. Installation of electricity was, however, only one of the project goals. Electricity was also expected to provide a variety of direct health and education benefits, including expanded educational opportunities at night, and improved health services through the use of sterilization, refrigeration, and water supply equipment. As was the case for development of productive uses among businesses, however, absence of complementary inputs inhibited the development of education and health related benefits among households.

No effort was made on the part of the RE program, or other government offices, to encourage the use of electricity for child or adult evening education programs. Adult education classes imparting marketable skills would certainly have filled a need. Lack of skilled labor was reported to be a major problem limiting production by 11% (5) of the manufacturers. Other manufacturers, particularly among furniture makers and tailors, also reported experi-

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[84] No home industry had the most dependable market outlets: INPRES or BAT.

Table 33. Association Between Revenue Increase Due to Electricity Use and Type of Market Outlet
(population: adopters with home industries[a])

Effect on revenues	Type of market outlet[b]	
	Marketplace/ traveling traders	Stores/regular orders
Raised revenues using electricity	18%	50%
No effect on revenues	82%	50%
Total	100%	100%
N:	34	18

Statistics: $X^2=6$, df=1, p=.01. λ asymmetric, raised revenues dependent on market access=.60. Total N=52.

Source: Present study.

[a]Excludes commercial home enterprises, that is, stores and warungs.

[b]Excludes 6 home industries which only sell "on site": 5 did not increase revenues using electricity, 1 did increase revenues using electricity.

encing the problem to a lesser degree.

Although three-quarters of Adopters with schoolchildren reported that electrification had stimulated increased studying at night, the benefits appear to have been limited. To an earlier, more general question regarding changes electricity had made in the family's life, only 20% (42) of the Adopters with schoolchildren reported changes in children's studying. The latter response rate indicates that the change in study time may be widespread but shallow, without much effect for individual children. The three village teachers who were interviewed reported that although they perceived some improvement in children's studying since electrification, no attempt had been made to encourage greater educational activity by children at night.

Similarly, no effort had been made to assist health clinics in using electricity to provide improved services. Neither funds nor information were made available to aid clinics in the purchase of electrical equipment. As a result, clinics limited their use of electricity to lighting.

To the extent that educational and health related benefits are considered to be important, arrangements to provide complementary inputs will be necessary. Without organizational, informational, and/or financial inputs being incorporated into the RE program, changes in education and health will be a function of independent villager response. The result is likely to be limited.

VI. PERCEIVED IMPACT ON VILLAGE-AS-A-WHOLE

Villagers' experience with electricity did not end at their doorsteps. Electrification had impacts on the village as a corporate entity, thereby affecting all villagers, whether or not they themselves had installed electricity in their homes. There were also perceptions of change which reflected villagers' experience as members of the village, rather than their personal experiences alone. In order to ascertain those effects, respondents were queried regarding their perceptions of the effects of electrification on the village community, as distinct from their own experiences.

Economic Impacts

Electrification culminated in increased income for 10% (119) of all paid business employees, 10% (21) of electrified households which were not affected by the changes in village businesses, and 29% (35) of the village businesses. There is a threshold in community life at which individual experiences with a phenomenon are common enough to generate a shared experience. We were interested in ascertaining whether the employment and income changes experienced by individuals had generated a wider sense of economic change due to electrification. Respondents were asked whether employment opportunities or income for the village generally, had changed due to village electrification. Of the household respondents, 53% (294) reported that there had been no change in economic conditions due to electrification (see Table 34).[85] According to 43% (236), employment opportunities or income had increased due to electrification. No household respondent reported that employment opportunities or income had decreased. 4% (22) did not know whether there had been any change.

Perceptions of improved economic conditions due to electrification were somewhat more widespread among business than among household respondents. An increase in employment opportunities or income in the village was perceived by 53% (65) of the business respondents.[86] The perception that electricity had not effected economic change was reported by 43% (53) of the business respondents. As was the case for household respondents, no business respondent perceived a decrease in village employment or income due to electrification.

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[85] Electrified households are weighted twice for all statistics measuring overall village household response (see Note 3). Therefore, N=552 for those types of statistics.

[86] Note that total N=122 since the questions relate to perceptions on the part of the respondent, rather than conditions with respect to particular businesses (see Note 26).

Table 34. Perceived Impacts on the Village-as-a-whole (percent)

Kind of impact	Proportion of households			Proportion of businesses
	Adopters	Non-adopters	Total[a]	
Economic benefits				
Employment opportunities/ income increased	45% (98)[b]	34% (40)	43% (236)	53% (65)
Employment opportunities/ income decreased	0	0	0	0
No change	52% (112)	59% (70)	53% (294)	43% (53)
Don.t know	3% (7)	7% (8)	4% (22)	3% (4)
Indirect economic benefits				
Improved security/safety	92% (199)	87% (103)	91% (501)	94%(115)
Increased nighttime activity/more lively	76% (164)	76% (90)	76% (418)	28% (34)
Village is more attractive/more like a town/higher status	36% (77)	25% (30)	33% (184)	33% (41)
More sports activities for children	12% (25)	20% (24)	13% (74)	5% (6)
Other	1% (2)	2% (2)	1% (6)	5% (6)
Don.t know	1% (1)	1% (1)	1% (3)	2% (3)
There are no advantages	2% (4)	1% (3)	2% (11)	1% (1)
Losses				
People whose trees felled and damage or other negative consequences	16% (34)	20% (23)	17% (91)	24% (29)
People who can.t pay bill	0	0	0	4% (5)
Other	0	0	0	2% (2)
No one had losses	83% (179)	75% (89)	81% (447)	64% (78)
Don.t know	2% (4)	5% (6)	3% (14)	5% (6)
Total N[c]	100% (217)	100% (118)	100% (552)	100%(122)[d]

Source: Present study.

[a]Statistics representing total households weight Adopters twice.

[b]Absolute numbers in parentheses.

[c]Proportions sum to greater than 100 percent due to multiple responses.

[d]N=122 because refers to respondent attitudes rather than business conditions (see Note 26).

Conditions for the village, as distinct from their own business experience, were not known by 3% (4) of the business respondents.

Reflecting the actual types of changes which occurred, increased overtime was the example of economic change most frequently cited by business and by household respondents. Other types of economic effects, cited by a smaller number of business and household respondents, were the establishment of new businesses, increased productivity with the use of electrical equipment, and more efficient production due to better lighting.

Indirect Economic Impacts

As Table 34 demonstrates, a variety of indirect economic benefits to the village as a whole were widely perceived by respondents. Chief among them was an increase in village security. More than 90% of the household respondents cited improved security as a benefit of electrification enjoyed by the entire village.[87] It was a benefit widely perceived by Non-adopters as well as Adopters. Improved village security was also cited by nearly all business respondents.

Another improvement in village life widely reported by household respondents, was increased activity at night. That benefit was cited in equally high proportions by both Adopters and Non-adopters. The change was far less widely perceived by business respondents. However, owners of commercial enterprises, who were most directly affected by the change, noted increased activity more often than did other business owners. Of the 30 commercial enterprise owners, one-third cited increased nighttime activity as an example of village-wide benefits.

The perception that electrification had provided some sort of benefit to the village as a whole was extremely widespread. Only 2% (11) of all household respondents, and 1% (1) of the business respondents felt that electrification had not improved village living conditions. Clearly, even households which did not themselves install electricity felt that they, too, had received some benefit.

The two most widely perceived benefits to the village generally - improved security and increased nighttime activity - were a consequence of efforts of the village headmen. The Lurahs considered street lighting of major

[87] The survey question was: "[Other than changes in employment or income] were there any other benefits which electrification brought to this village?"

importance, and they had hoped to get some assistance for street lighting from PLN. When none was forthcoming, they urged Adopters to put a lightbulb on the path outside their homes. Almost all complied. The system of private contribution for street lighting was highly effective. It exemplifies a benefit which can accrue to RE without inputs other than a promotive tariff schedule.

Perceived Distribution of Benefits

As has been shown, wealthier households experienced disproportionately more of the overall benefits from RE than did poor households. Although district and local PLN officials, and village officials, felt that RE was primarily a "household lighting program," businesses obtained greater economic benefits than did households. Did villagers' perceptions of the distribution of benefits reflect that situation? Survey responses indicate that they did - in part.

More than half of the household respondents, and half of the business respondents reported that "wealthy" households benefited more from village electrification then either "middle income" or "poor" households (see Table 35). A much smaller proportion felt that all three groups had benefited equally. Very few respondents felt that "middle-income" or "poor" households had benefited most from village electrification. Most business and household respondents who felt that the wealthy had received the greatest benefit ascribed that benefit to greater use of home applicances, i.e., to non-economic advantages. About 10% of those household and business respondents, however, attributed the greater benefit obtained by the wealthy to business-related conditions.

In considering the relative distribution of benefits to government, businesses, and households, approximately one-quarter of household respondents believed that all three groups had benefited equally (see Table 35). One-quarter felt that households had gained most, primarily due to the better and more convenient lighting households enjoyed. Businesses were perceived to be the major beneficiary by 17%, with increased workhours and greater productivity cited as benefits.

The pattern of responses by business respondents was very similiar. Most considered businesses, households, and government to have benefited equally. Approximately one-fifth considered households to have benefited most, again due to improved lighting. According to 10%, businesses had received the

Table 35. Perceptions of Distribution of Benefits from Rural Electrification (percent)

Groups perceived to have benefited most	Adopters	Non-adopters	Total[a]	Proportion of businesses
Of the 3 groups:				
Wealthy, middle-income, and poor households				
Wealthy	62% (134)[b]	55% (65)	60% (333)	49% (60)
Middle income	4% (9)	6% (7)	5% (25)	4% (5)
Poor	2% (5)	3% (3)	2% (13)	2% (3)
All benefited equally	23% (50)	14% (17)	21% (117)	33% (41)
Don.t know	9% (19)	22% (26)	12% (64)	9% (11)
Of the three groups:				
Government, businesses, households				
Government	3% (6)	4% (5)	3% (17)	5% (6)
Businesses	18% (40)	14% (16)	17% (96)	10% (12)
Households	26% (56)	25% (30)	26% (142)	19% (23)
All benefited equally	26% (57)	30% (35)	27% (149)	58% (71)
Don.t know	26% (57)	27% (32)	27% (146)	7% (9)
Response not recorded	1% (1)	0	0	2% (2)
Total N	100% (217)	100% (118)	100% (552)	100% (122)[c]

Source: Present study.

[a]Total N=552 for statistics representing total village because Adopters weighted twice.

[b]Absolute numbers in parentheses.

[c]Total N=122 for questions regarding respondent perceptions rather than business conditions.

greatest benefit, due to increased workhours and greater productivity, as well as other gains.

A very small percentage of household and business respondents believed government to have gained most. Almost all who did so cited "increased taxes" as the advantage obtained. One household respondent, who was a village official, felt that the village government had gained most because "people were easier to organize." His response reflected observations made by two of the village headmen. Village cohesiveness, those officials reported, had declined during recent years. Consequently, it had become increasingly difficult to induce villagers to forego other daytime commitments in order to participate in traditional mutual-assistance (gotong-royong) activities. With the advent of village electrification, and street lighting, the Lurahs found villagers amenable to fulfilling their community commitments at night. They have organized evening gotong-royong groups to repair roads, and maintain village infrastructure.

What the Lurahs did not mention, and may not yet have realized, is that electrification - like other "modernizing" influences - is double-edged. While enhancing one aspect of village cohesiveness, electrification also stimulates changes which erode cohesiveness. Expanded economic opportunities, and with them heightened time commitments, increased numbers of newcomers who might otherwise have moved to local towns, a general sense that the village is more "town-like" - all these effects of electrification serve to undermine feelings of mutual commitment and corporate membership. Simultaneously, new, more profitable alternatives raise the opportunity cost of villagers' time, and reduce the relative value of community participation.

Perceptions of Loss

There has been little investigation by RE studies of losses incurred by villagers due to electrification. To ascertain whether there had been any general perception of negative impacts, Klaten respondents were asked whether anyone in the village had suffered loss due to electrification of the village. The prevailing perception by household and business respondents was that no one had experienced such a loss (see Table 34).

There were, however, reports by 17% of the household respondents and 30% of the business respondents that losses had been incurred. The problem almost all cited concerned program administration rather than the introduction of

electricity itself. The situation was related to the fact that villagers had agreed to allow trees to be removed for the right-of-way, without compensation. Because of limited communication between the village and PLN, no one in the village was notified when trees were to be felled. Consequently some trees and gardens were damaged; trees were sometimes stolen before owners returned home. The Lurahs also reported that the lack of communication resulted in a variety of service problems. The most important of those was lack of preventive maintenance around electricity lines, with potentially dangerous consequences. These problems derive from several factors, and full discussion of the issues involved must await future reports. It can be said, however, that lack of responsiveness to village conditions and limited manpower resources in the local PLN office were both contributing factors.

VII. ECONOMIC COSTS AND BENEFITS

Resource Costs/Savings

Discussion of comparative costs of electricity and petroleum products has thus far considered only financial cost. Relating all fixed costs to lighting expense, RE has been shown to offer cost savings at certain levels of consumption, compared with kerosene lamps and private electricity generators.[88] Approximately one-third of the businesses with the RE system, and 8% of the household Adopters enjoyed that savings.

However, because energy prices in Indonesia are subsidized in varying degree, the economic costs and savings related to RE are quite different from the financial costs. While analysis of the full social costs and savings of the Klaten project must be deferred to forthcoming reports, a first approximation can be presented based solely on the benefit/cost ratio associated with the substitution of electricity for kerosene. This limited evaluation is thus an assessment of the minimum net value of the project. Other than foregone costs of kerosene, the only benefit included in the calculation was the minimum economic benefit which could be ascribed to household appliances.[89] Increased income to businesses, workers, and households, the establishment of new businesses due to electrification, and other direct and indirect economic benefits have been excluded. The results are further biased against RE by the exclusion of the following data: levels of petroleum consumption related to accumulators used before RE; all petroleum and electricity consumption by the five businesses which used generators before RE; forward and backward linkages. Thus, the results indicate the level of returns possible in a context in which electricity substitutes only for kerosene, or is used to power electrical equipment which provide no economic return.[90]

As is often true for estimates of future value, the findings are dependent on assumptions which are themselves subject to debate. The attempt has been made to utilize assumptions, presented in Table 36, which will be

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[88] Calculations assume the use of petromax lamps, see Note 27.

[89] The minimum economic benefit from electrical appliances is assumed to be the amount households are paying for the use of those appliances. Appendix D discusses in further detail the assumptions and methodology utilized in the calculations.

[90] It should be noted that costs for electrical equipment have been overstated relative to benefits since consumption by 5 businesses for electrical equipment has been included on the "cost" side, while benefits from that use have been excluded. Presumably those businesses would not have used that equipment had there been no economic benefit.

Table 36. Project Benefit/Cost Ratio

Assumptions[a]
Discount rate = 18%
Rate increase in kerosene consumption = 4%/year
Rate increase in electricity consumption = 12%/year
Economic cost of kerosine = Rs. 231 (U.S.$0.37)/liter
Economic cost of electricity = Rs. 94 (U.S.$0.14)/kWh
Electricity installation costs = U.S.$250/connection
Benefits included in the calculations
Foregone costs of kerosine for lighting
Minimum economic benefit of household appliances[b]
Costs included in the calculation
Installation costs per connection
Electricity consumed
Population
Electrified businesses (N=97)[c]
Electrified households (N=1748)[d]

Note: Benefit:Cost = 1.05:1.00

Source: Present study.

[a]Appendix D discusses in further detail the assumptions, formulae, and conversion procedures used in the calculation.

[b]Assumed to be equivalent to the financial cost to households for using the appliances (see appendix D).

[c]Excludes businesses with the non-RE system, businesses which began with electricity, and businesses which had used generators before RE.

[d]Derived from the household sample (N=217) and expanded by a factor of 1/0.124 for aggregate household consumption.

comparatively restrictive of electricity (see Appendix D for further discussion). Given those assumptions, the benefit/cost ratio of the Klaten project after 15 years is 1.05:1.00.

From this outcome it can be inferred that the substitution effect of electricity provided economic benefits approximately equivalent to economic costs, with positive rates of return dependent on the economic benefits to businesses and households which were excluded from the calculation. This limited assessment thus demonstrates the importance of productive uses to the Klaten project's net economic value. Broader implications for RE suggest that without productive uses and consequent economic returns, RE may only manage to pay for itself, while even equivalency may eventually be jeopardized where electricity consumption expands rapidly without culminating in productive uses. As has been shown, incorporation of complementary inputs can be crucial to the development of such uses. Their inclusion may therefore determine whether RE will merely "break even" or achieve positive net value.

Subsidies: Gift To The Rich Or Development Tool?

Within all developing nations, competitive needs for limited national resources make RE subsidies a controversial issue. The very magnitude of the Klaten project's success in achieving high rates of connection brought into question the legitimacy of government subsidies to RE customers. With connection and use rates running far higher than anticipated, PLN became increasingly reluctant to continue providing subsidized electricity to villages. Within PLN, proposals were made to raise rates and to shorten the installation repayment period. In response, officials from USAID argued that such changes would have a negative impact on connection rates in other, less wealthy villages.

Within the differing perspectives lay several complex issues: the distinctive roles and responsibilities of a RE agency in contrast to a commercial electricity company; the proper purpose and extent of subsidies; the primary goals of RE. Although full discussion of these issues is beyond the scope of this paper, the data which have been presented do permit the framing of alternatives as they relate to RE charges.

As the discussion of household access to electricity made clear, current RE rates have approached the limit of affordability for poor rural households. In Klaten those households are allocating, on average, 16% of their expendi-

tures to electricity. In villages which have yet to be electrified, higher charges would remove electricity as a viable option for poor households.[91] A larger down payment requirement would accelerate that effect. For poor villagers in Klaten, who have already made substantial investments in installation, increased use rates would make disconnection inevitable, with concomitant loss of their investment. The village Lurahs reported having received numerous complaints from villagers who wanted to disconnect service after rate increases in May 1980.[92] Clearly, across-the-board rate hikes would seriously jeopardize the project's goal of serving the poor.

Yet by subsidizing electricity to the poor, the RE program also subsidizes use by wealthy households. In Klaten, the latter allocated only about 5% of their income to electricity, while their average consumption was twice that of poor households. Wealthy households would certainly be able to absorb higher electricity costs, thereby reducing the government's burden.

In considering this problem, it is useful to examine the three components of electricity charges separately: installation charges, demand charges, and use charges. If the poor are to be served, down payment requirements for installation must be low and a long-term installment payment plan made available. For the poor, low monthly charges are essential, while the ultimate cost for installation is less important. If the choice must be between lower monthly costs and lower total costs, the former conform more closely to the needs of the poor. Subsidies for installation also offer the advantage to government of being a limited rather than open-ended commitment, in contrast to subsidies on use rates.

Two considerations argue for low "demand" charges. First, as fixed costs, demand charges tend to penalize the poor, who are small consumers. Due to fixed demand charges, poorer households in Klaten, with low levels of consumption, paid well over the cost to PLN for producing one kWh.[93] Wealthier households and businesses, which consumed relatively high levels of electricity, paid much lower per kWh costs. In a sense, then, the poor partially subsidized use by the rich, a rather undesirable situation. The second

[91] As noted on page 7, we are considering "poor" households to be those with household expenditures of Rp. 20,000/month or less.

[92] Rates were reduced shortly thereafter, although not to previous levels, and there were few, if any, disconnections.

[93] PLN's cost to produce one kWh was Rp. 36, according to PLN officials. At consumption levels of 20 kWh/month, Klaten households paid Rp. 63/kWh, excluding costs for installation/wiring.

consideration related to demand charges is the effect on business use. Investment in electricity for productive uses is a highly experimental undertaking for most village businesses and home enterprises. To the extent that there is an increasing block rate for levels of contracted power, businesses will be discouraged from using electricity productively. Low demand charges providing fairly high levels of contracted power reduce the consequences of risk and encourage experimentation.

With regard to "use" rates, one strategy for serving the poor without unduly subsidizing use by the rich would be to utilize increasing block rates. For example, the first 10 kWh of consumption per month could be offered very cheaply, or even without charge.[94] Consumption greater than 10 kWh per month would be charged at increasing rates.

That alternative, however, runs afoul the goal of stimulating productive uses. Applying high charges to all relatively large consumers may discourage much productive use, while targeting rates and price incentives specifically toward businesses is far more complicated than orienting RE toward a specific kind of use, e.g., irrigation. Distinguishing between village businesses, home enterprises and households for the purpose of rate-setting would be exceedingly difficult since owners, wary of tax liabilities, are reluctant to register their enterprises as "businesses." In Klaten, almost all businesses are considered to be houscholds by PLN, and even large businesses often operate out of a section of the family dwelling. Thus, increasing block rates for consumption greater than a minimum level per month could strongly discourage productive uses, while limiting RE to a highly subsidized household lighting program.

One approach is suggested by the evidence from Klaten. Mean and median levels of consumption by wealthy households were 43 kWh/month and 34 kWh/month, respectively; for businesses the levels were 69 kWh/month and 43 kWh/month, respectively. Although the consumption distributions overlap considerably, it seems possible that rate structures could be designed to assist the poor while encouraging business use by taking account of the difference between business and wealthy household consumption. For example, the first 10 kWh's could be offered at very low rates or free of charge; consumption between 11 and 40 kWh/month could be charged at a higher rate than the costs

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[94] Peter McCawley suggests one way to assist the poor would be to provide a very small capacity, e.g., 30 watts, free of a "demand" charge, while larger amounts would be charged at full cost.

to PLN for delivering one kWh; charges for consumption above 40 kWh/month could again be subsidized. Complementary inputs, e.g., loan programs for electrical equipment and a well-designed information component, would to some extent offset the negative effects of higher electricity charges. With cross-subsidies from the more affluent sectors, the burden on government would thus be minimized, while stimulus for development impacts would be reduced only slightly. Furthermore, the government would be less deeply involved in ever-expanding subsidies, or the equally unpleasant situation of having to suddenly raise rates to villagers whose investment decisions had reflected unrealistic marginal costs.

VIII. SUMMARY AND CONCLUSIONS

After one and a half years of operation, the Klaten model RE project was providing a number of benefits to the recipient area. An important contributing factor was the promotional nature of the RE rates, to which households and businesses responded by installing electricity in large numbers. Although income was clearly an important factor determining whether households installed electricity, high connection rates cut across income groups. More than half of the households in all but the poorest group installed electricity. Even more impressive was the finding that half of the households with incomes "at or below poverty" installed electricity. Among businesses, connection rates approached 100%.

Direct and indirect economic impacts devolving from the villagers' electricity use were unexpectedly widespread. More than one-third of the businesses "developed due to electricity use," either by extending workhours, using electrical equipment, or otherwise increasing sales as a result of village electrification. A slightly smaller proportion, 29%, experienced increased profits or were newly established due to electrification. Of paid employees, 10% obtained increased wages due to electrification of the businesses in which they worked. No workers lost jobs due to business adoption of electrical equipment. For households the benefits were primarily intangible in nature - higher status, longer study-time for children, more pleasant living conditions. However, 11% of the electrified households also increased their incomes due to electrification, primarily by using electricity in home enterprises. Improved security was a benefit widely cited by both household and business respondents.

For the creation of most RE benefits, the promotional rate structure was a necessary but not sufficient condition. Economic returns to electricity use were closely associated with supportive features of the socio-economic environment, e.g., the presence of external marketing outlets and institutions providing access to formal capital. Less tangible but nonetheless effective village conditions such as cohesiveness and concern for education also proved to be associated with the development of economic and social returns.

Impressive as those impacts were, analysis of the project revealed that the absence of complementary inputs inhibited the development of economic and indirect economic benefits. More than one-third of the business respondents

reported that they did not use electrical equipment which would be advantageous to their businesses. The major obstacles they cited were lack of capital, marketing problems, and insufficient information about electrical equipment. Complementary inputs addressing those needs are essential to further development of productive uses. Educational and health benefits of RE were also limited by the absence of administrative and financial support.

Electricity use which would have raised the project's net economic value and contributed to the load factor was discouraged because the entire range of installation and tariff rates were not responsive to the needs of village businesses. Installation costs for businesses with relatively high levels of power consumption, such as those using diesel engines for shaft power, made electricity uncompetitive. Costs to government for subsidized RE rates have therefore foregone much of the potential development "payoff" because related needs of businesses were ignored.

The experience in Klaten thus discloses not only the benefits which RE can provide under highly propitious circumstances, but also the development effects foregone even under the best of circumstances due to limitations in project design. As the findings demonstrate, to maximize returns from what are inevitably substantial government investments, RE programs must be formulated as comprehensive development projects rather than solely electricity-delivering services. Incorporation of the means to stimulate productive uses will be an essential factor in the achievement of positive project net returns. In this regard, complementary inputs and competitive rates for all relevant tariff and installation costs will make vital constributions to project success.

It was also clear that benefits from RE are not distributed equally among subsets of the population, making explicit consideration of differential effects an important part of program planning. Tariff structure and installation charges most directly affect access to electricity. In Klaten, a much smaller proportion of the poorest 10% of the population installed electricity than of other income groups. Furthermore, poor electrified households paid more per kWh, and a larger proportion of their household expenditures for electricity, than did wealthy households.

The presence and nature of complementary inputs to the RE program were also shown to have equity implications. Although the types of electrical equipment

being used by Klaten businesses were broadly neutral to scale, differential access to formal capital sources and to market outlets enabled large businesses to benefit disproportionately from village electrification. Depending on their design, inclusion of complementary inputs will differentially assist subsets of the community. In Klaten, assistance with installation costs for large capacity would primarily help large businesses to use electrical equipment, while loan programs would address the most binding constraint among medium businesses, and marketing assistance meet the foremost needs of small businesses. The extent to which development of productive uses among businesses will benefit workers is unclear. Although there were notable gains in employee salaries due to increased workhours with electric lights, short term evidence was inconclusive regarding the employment consequences of electrical equipment use by businesses. The complementary inputs of greatest direct benefit to workers may be those related to evening education and skills training programs.

In sum, four factors have emerged with apparent relevance for all RE projects: goal formulation, project responsiveness, project resources, and the village socio-economic environment.

Goals. Since few development projects can fully achieve all the impacts theoretically possible, goal priorities must be explicitly formulated and utilized as the guide for project design. In order for RE projects to generate positive development returns, goals must be designed with regard to the ways in which electricity will be used as well as installation itself. Furthermore, since introduction of electricity may have equity implications, such effects should be explicitly considered in the formulation of project goals. In the case of Klaten, the only goal which served as an operational guide for project design was achievement of a high rate of installation. Other project objectives were less goals than hopes, and their realization suffered from lack of attention in the project design.

Project Responsiveness. To maximize the rate of development returns and minimize response time, a project must be responsive to a variety of conditions in the project area in addition to the one ordinarily considered by a commercial electricity company, i.e., the ability of the recipient community to pay for electricity service. There are two components of responsiveness. A program must be able to gather information about the particular needs of the target area in a timely manner, and respond to that information in the origi-

nal project design and in ongoing modifications as needs change. This relates to the "technical" content, e.g., tariff schedules, load capacity, use of meters, etc., as well as administrative design and complementary inputs to support achievement of project goals.

Project Resources. The financial and human resources available to the program will delimit its potential achievements. Allocation of sufficient resources to fulfill the mundane task of ensuring proper installation and continuing maintenance has important ramifications for development goals. Without confidence in reliability, businesses are averse to investing in electrical equipment, and once confidence has been eroded it is difficult to reestablish. In Klaten, RE service was reliable, thereby preventing one deterrent to productive uses often associated with RE in LDC's.

The sizeable capital investment for installation and maintenance of the electricity system does not conclude the resource requirements. As discussed above, resources for complementary inputs such as loan facilities or information dissemination programs must be considered an integral part of RE without which overall project returns are likely to be delayed or foregone entirely.

Village Environment. The socio-economic conditions, physical infrastructure, and nature of village energy use in areas where RE is introduced strongly affect the achievement of project goals. Certain economic conditions, e.g., levels of income and costs of alternative fuels, will be fairly obvious contextual factors to be considered. Social and political conditions, while more subtle and difficult to assess, will be equally important in determining project outcomes.

The Klaten site was advantageous in several regards. Densely settled, economically dynamic, and close to the central grid, it required relatively low per connection investment costs in comparison with most RE projects. The area's prosperity, the comparative development of its small industries, proximity to wide market outlets and credit facilities stimulated relatively high levels of consumption as well as uses which provided direct and indirect economic returns. Formal village political institutions also contributed to the achievement of high levels of connection, as village officials, in disseminating information about the RE program, lent the weight of their influence to the putative value of the service being offered. Village leaders also organized use of electricity for the benefit of the community as a whole.

These kinds of advantages are also likely to obtain in other "advanced villages" of Java, of which there are some 4,700. Although many are less favorably endowed industrially and financially than Klaten, conditions are likely to support the creation of positive RE impacts. Those impacts will be more difficult to realize in less advanced and less advantageously situated villages which are more typical of Indonesia and the developing world. Greater distances from the grid, sparcer populations, and lower incomes with concomitant lower levels of consumption will entail more costly investment. Fewer opportunities will exist for the development of productive uses by businesses, industry, and home enterprises, although the potential for initiating new kinds of production should not be overlooked. Where efficient market outlets are available or can be developed, improved quality and speed of production with electrical equipment may enable villages to compete with urban producers. Conditions in such areas may also support alternative productive uses of electricity, e.g., for irrigation. Whatever their potential, such areas are likely to require greater complementary input support than did Klaten.

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Appendix A. Survey Methodology

Data for this study were collected in four surveys: (1) a village survey; (2) interviews with officials of the National Electric Company (PLN); (3) interviews with village leaders; (4) interviews with government officials (including bank officials) at district and subdistrict levels. The surveys were conducted over the course of five months, October 1980-February 1981. Discussions were also held with USAID officers and consultants. Participant observation of the villages was conducted for five months.

The village survey was conducted only in the areas of eight villages where electricity had been made available by the Klaten model RE project. The "village survey" was in fact a series of surveys of households and businesses. A census of all households was first conducted to obtain an initial estimate of household income. Based on those data a stratified random sample of electrified and of non-electrified households was drawn in the proportions presented in Table A.[95] A census of the 131 businesses was conducted (Appendix B). Since only the very largest businesses were identified by official records, the survey initially identified businesses with the use of PLN maps of the village. The maps were then reviewed with village officials, who added businesses which did not appear on the maps. Additional businesses were identified during the course of the survey and participant observation. It is possible that there are operations in the villages which meet the study definition of "business" but were not included in the survey. Data regarding home enterprises were collected as part of the household survey.

Survey instruments were designed to collect detailed quantitative information regarding RE effects on economic, social and energy use conditions. Because baseline data were not available, respondent recall was an important source of information about actual changes in productivity, income, workhours, energy use and community activity. Memory-recall data is always frought with uncertainty. Multiple surveys of businesses were therefore conducted with alternative formulations of questions regarding workhour, productivity, and income changes due to electricity use. Thus, for example, in the first survey, business respondents were asked whether, <u>due to electricity use</u>, workhours in their businesses had changed. If they replied in the affirmative

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[95] According to maps from PLN, which were used to draw the sample, the total number of electrified households was 1748. However, according to figures from USAID, the total number of electrified households was 1780 at the outset of the survey period, September 1980.

Table A. Samples as Proportions of Total Populations

Population	N	Survey sample (Absolute numbers in paranetheses)
Electified households	1,748	12.4% (217)*
Non-electrified households	484	24.4% (118)**
Electrified businesses	123	100% (123)
Non-electrified businesses	8	88% (7)

*Survey design called for 219 electrified households; however, 2 electrified household respondents were unavailable for interview.

**Survey design called for 121 non-electrified households; however, 3 non-electrificed household respondents were unavailable for interview.

they were asked what form the changes took, how many hours were added or subtracted, on average, each day, and the number of days per month for which the change applied. Several weeks later a second survey was conducted of businesses for which workhour changes had been reported. Respondents were asked what hours (from what hour to what hour) they had ordinarily worked before electrification and the hours they kept after electrification. The responses from the first survey questions and the second were later compared. A third interview was conducted one month later, again including all businesses which reported workhour changes due to electricity use. Information regarding the specific individuals affected by workhour changes was gathered. Where there had been inconsistencies in the first two interviews, further discussion was conducted to clarify the changes which had actually occurred. (The results of that third interview illuminated certain aspects of businesses for which hours vary greatly during rainy and dry seasons.) Discussions regarding workhour changes were also held with workers.

Appendix B. Distribution of Business Types in the RE Area

Types and kinds of businesses	Electrified	Non-electrified
Manufacturers	37% (45)[a]	38% (3)
furniture (wood or metal)[b]		
tailors/ready-made clothing[b]		
building materials		
ice makers		
pottery		
bamboo mats		
nets		
printer		
plastic bags		
jeweler		
Services	15% (18)	38% (3)
sawmill[b]		
rice huller[b]		
battery charger		
builder		
radio repair		
car repair		
bicycle repair		
tailoring services		
Agricultural/food	24% (30)	13% (1)
food (bread, tofu, etc.)		
tofu refiner		
milk producer		
tobacco curer[b]		
Commercial	24% (30)	0%
wood store		
restaurant/tea shop		
general store		
private savings and loan company		
outlet for purchasing tobacco leaves		
Unrecorded	0%	13% (1)
Total	100% (123)	100%[c] (8)

Source: Present study.

[a]Absolute number in parentheses.

[b]Non-electrified businesses included only these kinds of businesses.

[c]Sum to greater than 100 percent due to rounding.

Appendix C. Comparative Costs: Diesel Engines and Electric Motors

Although full discussion of comparative costs electric motors and diesel engines will be deferred to forthcoming work, a brief overview of those costs can be made. In comparing the two forms of power, all installatio and wiring costs for electricity have been excluded, i.e., have been allocated to the lighting portion of electricity use. Since field impressions strongly suggest that business respondents would have installed electricity even if they had not been able to use electrical equipment, it seems reasonable to make that allocation.

It is interesting to note that with respect to the energy component of RE expense alone, electric motors would have been competitive with diesel engines. Calculations of the comparative energy expense of diesel and electric motors are based on formulae developed for small (less than 100 HP) diesel engines generally. Small engines have a specific fuel consumption of .33 liters of diesel fuel per kWh. A factor of inefficiency can be conservatively assumed to be .50. At Rp. 55/liter, then, the diesel engine energy cost is approximately Rp. 27/kWh (.33*1.5*55=27). If a 6 HP electric motor were used 4 hours/day, 20 days/month, energy costs would be Rp. 29/kWh or less. If we assume a rather high inefficiency factor of .04 for electric motors, energy expense for electric motors would therefore be Rp. 30/kWh, delivered (29*1.04=30). Note, however, that respondents generally reported paying more than Rp. 55/liter of diesel, with prices cited as high as Rp. 70 per liter, depending on the place of purchase. At the latter price, the diesel engine energy expense is Rp. 35/kWh (.33*1.5*70=35). Thus, the costs of running a small diesel motor range from being 11%/kWh less expensive than an electric motor, to being 17% more than an electric motor. (My appreciation to Mr. Larry Weick, of the Stanford University cogeneration project, and Dr. Lewis London, Department of Mechanical Engineering, Stanford University, for information on conversion rates and small motor efficiency.)

Although prices for motors and maintenance varied, even for the same business, the survey on which this report is based, and an informal survey of prices in Yogyakarta, indicated that 6-10 HP electric motors (the sizes most often used by surveyed businesses) generally were about 35% more expensive than diesel engines of the same power. Alternatively, transportation costs for diesel fuel and maintenance for diesel engines would be likely to weigh in favor of electricity.

Appendix D. Methodology for Calculating Benefit/Cost Ratio

In calculating the Klaten project economic benefit/cost ratio, the following formulae, assumptions, and conversion procedures were used. The basic formula utilized was:

$$\frac{8.07\left[\sum_{i=1}^{15} BH_i/(1+R)^i\right] + \sum_{i=1}^{15} BB_i/(1+R)^i}{8.07\left[\sum_{i=1}^{15} CH_i/(1+R)^i\right] + \sum_{i=1}^{15} CB_i/(1+R)^i} = \frac{B}{C}$$

Where,

BH_i = Economic benefits, summed over individual sample electrified households, N=217
CH_i = Economic costs, summed over individual sample electrified households, N=217
BB_i = Economic benefits, summed over individual businesses, N=97
CB_i = Economic costs, summed over individual businesses, N=97
R = Discount rate of 18%
i = Number of years of operation
B = Total discounted economic benefit
C = Total discounted economic cost

Thus, the ratio is calculated on the basis of consumption changes by the total electrified household sample, expanded by a factor of 8.07 to represent the aggregate electrified household consumption for the area, and consumption by all electrified businesses, excluding businesses with the non-RE system, businesses which began operation with electricity, and businesses which used generators before RE.

Installation investment. This cost is based on the overall total investment expense of $500/connection for all villages in the project, including those on Outer Islands requiring construction of autogeneration facilities. According to project consultants at NRECA, the greater population density, proximity to the central grid, and other factors, make the Klaten project investment/connection considerably lower than that for the overall program, probably less than $200/connection. To estimate conservatively, the expense was assumed to be $250/connection.

Cost of electricity consumption. The economic cost of electricity was assumed to be Rp. 87.5 (US$ .14)/kWh, to include all direct an indirect costs of providing electricity to the villages.[96] The rate of expansion in electricity

[96] Based on personal communication with a World Bank researcher. His estimate for RE generally is US$.15/kWh, which includes all direct and indirect economic costs, including installation, at a discount rate of 12%. Since installation costs are included separately for benefit/cost calculations

consumption has been assumed to be, on average, 12%/year. No adjustment was made for decline in electricity cost due to increases in load factor.

Cost of household wiring/installation. These costs were excluded from the calculation for two reasons. First, charges to customers were expected to cover the total cost of wiring/installation, including interest for the four year installment plan. Second, studies by the World Bank in India and NRECA in the Phillipines indicate that for an overall project area, the long-term (15 year) cost for purchase and maintenance of housewiring/installation is approximately equivalent to the cost of purchase and maintenance of kerosene lamps. Any effect of excluding these costs for either source would appear to be minimal.

Benefits related to foregone costs of kerosene. The economic price of kerosene was assumed to be Rp. 231 (US$ .37)/liter, based on an international price of $59/barrel (source: personal communication with World Bank researcher). Foregone kerosene consumption was based on respondent reports of the amount of kerosene used for lighting before electrification, expanded at a rate of 4%/year. Estimates in the literature of the rate of expansion in kerosene consumption in Indonesia have ranged from 3%-9% (Strout and Soesastro, respectively). The former estimate was derived specifically for rural Java. In areas like Klaten, which are relatively prosperous and dynamic, a somewhat higher rate can be assumed, hence the rate utilized herein of 4%/year.

Benefits related to use of electrical appliances. For the five businesses which used electrical equipment and were inclued in the calculation, benefits from that equipment use were excluded. For households, it was assumed that the minimum economic benefit of appliances was the amount households paid for using those appliances. That amount was estimated to be:

$$\sum_{i=1}^{4}\left[(\bar{X}_2 - \bar{X}_1)\ N\ C\right]_i = B$$

Where,

$\bar{X}_1$ = Mean kWh consumption of households which used electricity only for lights

$\bar{X}_2$ = Mean kWh consumption of households which used electricity for lights and appliances

N = Number of households using electricity for appliances

C = Cost per kWh, based on the average kWh consumption of households using electricity for appliances

i = Expenditure group

B = Proxy for economic benefit of appliances used by households

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made here, the economic cost of electricity consumption has been assumed to be US$.14/kWh.

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