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New Light on Rural Electrification:

The Evidence from Bolivia

Background paper for an evaluation sponsored by the Bureau of Program and Policy Coordination of the U.S. Agency for International Development

by

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Preface

The attached report started as a background paper for an evaluation--one of a number of project impact evaluations sponsored by the U.S. Agency for International Development. This particular evaluation, a team undertaking, concerned an AID-financed rural electrification project in Bolivia. Because of the press of time, I was not able to fully incorporate into the background paper the information and data gathered during my field trip--or to write an introduction, summary and conclusions--until after the deadline for the team evaluation had passed.

The evaluation team, composed of myself and two AID staff members, spent the month of May in 1980 in Bolivia, visiting four of the seven systems built by the project--Cochabamba, Santa Cruz, Chuquisaca, and the Altiplano. I had the pleasure of working in close cooperation throughout the field investigation with Ed Butler and Karen Poe of AID. Their independent observations of project impact were very important to the verification or questioning of my own impressions. Their careful comments on an earlier draft of the background paper were greatly appreciated. Since they did not always agree with my emphases and conclusions, my thanking them does not imply their endorsement of what I have written.

I am most appreciative of the time spent with me by AID staff members and persons in the Bolivian power sector whom I sought out for information and interpretations. I thank, in particular, two persons who took much of their time to talk with me about matters of electric power and from whom I learned very much. They are M. Charles Moseley, Chief Engineer of the Engineering and Energy Division of the AID/Bolivia Mission--and Federico Lucero, Director for Distribution of the state power enterprise, ENDE. I also thank those of AID in Bolivia and Washington whose comments at meetings on the evaluation results set me thinking about rural electrification in new ways. Finally, I thank Albert O. Hirschman for his criticisms of the summary and conclusions--and for encouraging me, in the first place, to explore matters of electric power and economic development many years ago.

Introduction, Summary and Conclusions*

In 1973 and 1974, AID lent US$24.5 million to Bolivia for a US$29.5 million program to create seven rural electric systems in six of Bolivia's nine departments. The new systems would be added onto those of already-existing municipal utilities in the departmental capitals (with the exception of La Paz department, where the two completely new systems were to be exclusively rural). The new rural power was expected to serve 48,000 consumers in the first year after construction and almost double that number ten years later, when the systems would be working at full capacity. The new rural consumers would account for 25% of the consumers and 10% of the consumption and revenues of the expanded systems, the rest representing urban consumption (except for the two La Paz systems). The expanded urban-rural systems would not be interconnected with each other, and would buy their bulk power as they had done in the past, from hydroelectric or gas thermal plants owned by the government power enterprise, ENDE. ENDE would be the executing agency for the loan with full responsibility for all phases of implementation.

At the time of this evaluation, three of the systems had been completed and in operation for one or two years (Santa Cruz, Cochabamba and Chuquisaca); two more were partially energized (Tarija and Potosí), and the two La Paz systems were just being energized. The number of connections made by the time of project completion was close to that anticipated--except for the La Paz system, where various problems and delays resulted in about 30%-40% less connections than planned. Given the number of consumers connected at the time of the evaluation, or projected for connection by the time of project completion some months hence, unit investment costs were US$400-$900 per household connection, depending on the system.

The new rural electric systems, of course, were newer than one would have liked in order to do an evaluation of project impact and in order to separate out startup problems and hopes from longer-term phenomena. Partly for this reason, considerable time was spent checking impressions in certain towns that had had electric power for several years prior to the project. Impressions were also checked against the reports coming in from other evaluations of AID's rural electrification projects. Because of the brief post-project history, then, the findings on impact presented below may well be overturned by subsequent years of experience with the new systems.

Installing seven rural electric systems and connecting them up to 81,000 consumers over ten years was meant to serve three broad

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*The Bolivian peso was devalued from 20 to 25 pesos to the U.S. dollar at the end of November 1979. All current cost figures in this report were converted to U.S. dollars at the 25-peso rate (mainly, current electric-power rates and costs of household connections); and all pre-1980 costs were converted at 20 pesos (mainly, project costs and household-connection costs under the project).

and interrelated objectives: improvement in the condition of the rural poor, stimulation of economic growth in the countryside through the use of power for production, and creation of viable electric utilities. These three objectives are the subject of my report.

The distributional consequences of electrification were of central importance to this evaluation effort not only because the Bolivia project was expected to bring significant benefits to the rural poor. In addition, and contrarily, recent evaluations have suggested that rural infrastructure projects are not particularly suited to reaching the rural poor. Because the electric systems and the roads are available to everybody, and because the rich are often more in a position than the poor to take advantage of them, the new facilities often turn out to benefit the rich more than the poor. Though this latter view of rural electrification, as well as the New-Directions' concern for targeting projects on the poor, postdates the conceptualization of the Bolivia project, the project still provides an excellent opportunity to collect evidence on this important question.

Much of the support for rural electrification arises from the belief that the provision of adequate and cheap electric power to rural areas will "release" productive potential lying dormant there. This new production, it is also expected, will help to decentralize the pattern of economic growth typical of countries like Bolivia, where production and infrastructural capacity are concentrated in and around large cities, with attendant problems of urban congestion and large settlements of the poor. Many of the new rural producers, it is also assumed, will be "small" and therefore poor--or poorer, at least, than the urban industrial users of electric power. These assumptions about the interaction between rural electrification and growth were reflected in the justifications for the Bolivia project.

Finally, it was central to the realization of the above two objectives that viable electric utilities be in place after the completion of construction. Viable organizations would be necessary not only to run the new systems, with their capacity to handle at least ten years' worth of demand growth, but also so that demand for new connections could be vigorously met. In this latter sense, electrification projects are quite different from some other projects because what the electrification entity does after construction will be crucial to the realization of the economic and financial benefits of the project. Though post-construction operations are typically neglected in the design of many infrastructure projects, the implications of neglecting this phase are more serious for electrification. If roads are left unmaintained by an inadequate highway department, for example, this

will not prevent their being used in the years immediately following construction, or their economic benefits from being realized. With electrification, as will be seen, the case is quite different.

Rural electrification and the rural poor

Contrary to the new wisdom about rural electrification, the Bolivia project showed that certain qualities of electrification projects, if handled properly, actually suit them for having a uniquely favorable impact on the rural poor. In certain ways, the technology of rural electrification makes it easier to benefit the poor than with projects in health, agricultural credit and agricultural inputs--the projects currently thought of as more suited than rural infrastructure for targeting on the poor.

One of the major problems of projects that are considered appropriate for targeting on the poor is that the subsidized services--the health clinics, the subsidized credit, the subsidized inputs--often end up in the hands of the rich. Rural electrification does not have this problem, because of the highly arbitrary way of determining who gets access to the service--namely, those houses that happen to be within reach of the distribution lines. The poor get connected, then, simply because they live mixed in with the better off in the rural communities, because they are more numerous, and because it is in the utility's interest to connect as many houses as possible under the net. This gives little opportunity for the rich to shoulder out the poor.

The city subsidizes the countryside. The Bolivia project also demonstrated another potential of rural electrification for benefiting the rural poor: through the rate charged for electricity, some types of consumers can be made to subsidize other types, and consumers of power in general can be made to subsidize non-consumers--all with very little political visibility. Grid-system electrification facilitates this use of the power rate for distributive ends because it tends to centralize and unify-rate-setting policies. In the case of the Bolivia project, AID and the Bolivian power sector agreed to a rate policy whereby rural consumers were charged the same kilowatthour rate as urban consumers in the same system, despite the fact that the costs of providing rural power were, as is typical, three to four times higher than urban power. (This is because the unit costs of power increase substantially as population density decreases.) The subsidy to rural power users by urban users represented an unusual reversal of the more common bias in the other direction--i.e., the food-price and exchange-rate policies that result in the much-criticized

subsidization of the city by the countryside. To the extent that the poor were more represented among rural as opposed to urban consumers, the subsidy also amounted to a transfer of funds from the rich to the poor.

The subsidization of the country by the city through the uniform power rate, though of favorable distributional significance, was somewhat misplaced in terms of where the greatest payoff from subsidization is to be found. The financial implications of the urban-rural subsidy for the utilities, moreover, may ultimately undermine the subsidy's positive distributional impacts: that the urban-based Bolivian utilities were required to charge the same rate for their rural service as for their considerably less costly urban service gave them a financial incentive to pay greater attention to the urban part of their service--and thus to give preference to urban requests for new connections. The subsidization of poor consumers of household electricity through the power rate may also have been misplaced in that the Bolivian poor were more than willing and able to pay their monthly light bills (minimum monthly charges under the project systems varied between US$.90 and $2.00). Those without electric power were often paying three and four times that amount for candles and kerosene; household electricity costs, moreover, represented a small portion of total household expenditures of poor families, so that subsidization of the rural poor through the power rate might not have had a significant impact on their incomes.[1] A greater impact might be had on the access of the poor to electricity through subsidization of the capital rather than running costs of household electricity. This was also done in the Bolivia project.

The hookup costs of the simplest household connections (one or two lightbulbs) in the AID-financed systems are far beyond the reach of the Bolivian poor--about US$120, including the cost of the internal house wiring. The AID project included credit for these capital costs, reducing the down payment and subsequent monthly installments to about US$2.50-$5.00, or 2%-5% of the total capital costs. But unlike the subsidized power rate, this connection credit ran out when construction was completed, and in some cases before that. Since the loading up of rural

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[1]Expenditures for cooking with kerosene, wood and dung were considerably greater than those for lighting. Cooking with electricity is almost non-existent in Bolivia, partly because of the availability of cheap bottled gas, and partly because electric stoves are approximately three to four times as costly as gas stoves.

distribution systems takes ten to twenty years, and since the poor tend to apply for connections last, this termination of connection funding limited the distributional impact of the project significantly.

A last note of caution about using the electric-power rate for reversing the rural-urban bias of third-world economic policies. Adding new rural systems to existing urban ones makes it politically more difficult to raise power rates than would be the case in an exclusively rural system. Protests over increases in electric power are not the problem in rural areas that they are in cities; rural consumers are used to spending more money for traditional sources of energy, or to paying high rates for the autogenerated power systems that often precede grid electrification. Because of the political difficulty of raising urban rates in Bolivia as well as other countries, therefore, a unified urban-rural rate is already a low one, from the point of view of the financial viability of the utilities. When a rural area is brought together in a grid with an urban system, therefore, the advantage that rural areas have in being able to charge more adequate rates is lost. The urban-rural subsidy may thus lead to the financial inability of utilities to add the new consumers for which the rural system was built.

The social uses of electric power. The Bolivia case illustrated another distributive potential of rural electrification, through the development of certain other public services that can use power--health, education, potable water, street lighting. The impact of these public services on the poor is potentially greater than that of electricity for household use because these other services reach those households without electricity, among which the poor are more than proportionately represented. In a few instances, the Bolivia systems financed street lighting and potable water through the rate charged to household consumers of electricity; in this way, consumers were paying the costs of water and public lighting for non-consumers, as well as for themselves. One attraction of using the electric-power rate for this form of distributive "taxation" is that it is not politically conspicuous--in comparison to progressive taxes and other redistributive policy instruments.

Though the justification for the Bolivia project placed great emphasis on the benefits to result from the social uses of power--health services, potable water, night classes--these uses usually did not materialize. A partial exception was potable water, where several diesel-powered systems were converted to electric power with the advent of project power. The expected social services did not appear partly

because electricity was not necessary to their functioning, or because other missing inputs represented more of an impediment. In mountainous countries like Bolivia, many village water systems can function on gravity alone and do not need electric power. Refrigerators in health clinics were problematic usually because of the lack of spare parts for power-using equipment. Where health and night education services were not operating, this had mainly to do with the lack of programs in these areas rather than with a lack of power. The coming of electricity in most of these cases, then, made no difference.

The only strong potential linkage between electrification and social services seemed to be that of potable water, in cases where gravity flow was not available. A disadvantage of forging this linkage in an electrification project is that it requires complicating the project with a separate program in a separate agency. At the same time, the relatively simple management demands of village water systems mean that the installation part of the water program might be entrusted to the electric utility itself as part of the construction task. Forcing the linkage between electrification and potable water in this way would not only heighten the distributional impact of the electrification project; it would also hitch the cause of a significant social investment to the state electric-power sector, which is usually among the most powerful in the public sector. Except in a few instances, the Bolivia project did not take advantage of the potential of rural electrification for introducing social services and financing them progressively.

Electrification and economic growth

Given the prevailing assumptions about the importance of cheap and adequate power supply for the growth of rural production, it was striking to find that productive uses of the new supply of electric power were negligible in the three systems already fully functioning. Irrigation, which had been singled out in particular in quantifying project benefits (accounting for 10%-30% of benefit flows), also seemed unlikely to materialize to any significant degree.

Central to AID's design standards, and to its justification for introducing central-system rural electrification, was that the new systems would provide 24-hour service, as opposed to the nighttime-only service characteristic of the smaller isolated utilities usually found in rural areas. Nighttime service was said to be insufficient for the productive uses of power that central-system projects would facilitate.

Thus the paltry response of Bolivian rural producers to the new power, despite its excellent quality and low prices, requires some explanation. Most of the reasons for this outcome fall into two categories--project design, and the economics of production and of electric-power use in the electrified areas. I will take up the latter topic first.

The economics of rural production and power use. The use of electric power for production was not occurring in the electrified areas because it was not particularly profitable, for the following reasons: (1) power-based equipment was not competitive with labor-based techniques of production; (2) the seasonal production patterns of agro-processing operations made central-system power uneconomic, as compared to user-owned generators; (3) opportunities for profitable production in the electrified areas were limited; and (4) in the case of irrigation, project designers had not looked into the question of whether irrigation was economically worthwhile, nor was the system designed to pass through irrigable areas (with two exceptions) or to accommodate potential users.

That all the above factors were operating was attested to by the many producers who were using electric power only to extend the work day into the night, with electric light, while continuing to use manual techniques; by the many small agro-processors who preferred to continue using their own diesel motors because with the new public power supply they would have to pay minimum monthly charges for power whether or not they used it, and by the paucity of power-using production in some towns that had had 24-hour service for several years prior to the project. In the communities receiving power for the first time, moreover, there was little previous production based on user-owned power-generating equipment. The only exception was the Santa Cruz system, where substantial economic growth had occurred prior to the AID project. Not coincidentally, Santa Cruz was also the only system where productive use of power after the AID project was significant.

That the Bolivia project did not bear out the assumption that new, cheap and 24-hour power would be sufficient to elicit previously "repressed" production is not surprising. The literature on central-system rural electrification suggests that it becomes economic only after a certain stage of economic growth, and thus is not a precursor of growth. This particular stage occurs when previous economic growth, accompanied by the acquisition of user-owned power units, has demonstrated that profitable opportunities for production and for the

use of central-system power actually do exist. This prior stage had not occurred in the Bolivian case, except for the Santa Cruz system.

The expectation that rural electrification would contribute to more decentralized economic growth and a reversal of rural-urban migration flows also seemed not to be borne out by this particular project. The Bolivia project involved the expansion into the countryside of the urban systems of five departmental capitals. This meant that the new rural transmission lines extended out from the city along the major road arteries, connecting up towns and communities along the way. This approach to electrification had various implications for decentralized growth. Most obviously, because of their location near Bolivia's major cities, the new distribution systems would no doubt enhance rather than offer alternatives to the infrastructural endowment of the greater urban areas. This seemed particularly the case in Santa Cruz, where almost half of the household connections went to the poor suburban areas of the city of Santa Cruz.

The placement of transmission and distribution lines along arterial roads leading out from cities is, of course, the most logical way to build such an urban-based system. At the same time, however, this form of expansion may also have contributed to the lack of profitable production opportunities in the rural electrified communities. Highways that connect rural communities to urban centers will lower transport costs drastically and, in may cases, remove the competitive edge that small producers hold over cheap mass-produced goods from the cities or abroad. The urban-based expansion of rural systems in Bolivia, in sum, may have contributed more to urban than to rural growth--or, at the least, may have had no contrary impact at all on centralizing growth patterns.

Making it possible to produce with power. When small rural producers did have some interest in using the new rural power, that interest was in many cases not realized for reasons more within the control of project designers than those discussed above. Two types of potential productive users, it seemed, were not being connected up: those without capital for the high connection costs, and those who had capital and were somewhat beyond the reach of existing lines, but who were willing to pay the costs of the additional lines and/or transformers necessary to service their place of production. For the small rural producers without capital for connecting up to the system, the project offered no credit--though such credit was provided for household connections, as mentioned above. For the opposite

type of producer--proffering his own capital to finance the additional costs of his connection to the system--neither the project designers nor the utilities seemed alert to the possibility for gaining additional capital and revenues in this way. Though rural electrification was supposed to break the "bottleneck" to the growth of rural production, then, the project missed the opportunity to accommodate a significant potential for such growth.

The small and unsophisticated rural producer envisioned in project justifications experienced various other impediments to connecting up to the system--impediments that could be partly removed through project design. Most important, small rural producers did not have the access to credit and technical assistance that larger and urban-based producers did--not only for the capital costs of the power connection but, more important, for the purchase of appropriate electric motors. In many of the electrified communities, small producers had acquired inappropriate motors; or they did not know that it would be possible for them to use the system's power without considerable investment; or they did not know where the appropriate motors could be acquired. The utilities had no program for responding to the inquiries of such users; only one or two staff members spent any share of their time in the electrified areas.

Whether or not rural producers had the capital to purchase the power connection and the electric motors turned out be be considerably more significant than the price of power in their decision to connect up to the system. All producers, whether small or large, seemed to base their decisions to use public power on the capital cost of the connection and the electric motors, rather than on the expected cost of monthly power bills. The availability of "cheap" electric power, in other words, did not have much significance for locational and production decisions. In these cases where rural electrification might actually have had the potential for "releasing" economic growth, in sum, this potential might have been realized more by reducing the costs of the conversion and connection, and of obtaining information about it, than by offering cheap central-system power. Such a capital-cost subsidy, of course, would not have the adverse consequences on the financial viability of the utilities that the rate subsidy does.

That the Bolivia project included arrangements to finance household but not productive connections reflected a certain lack of interest in productive use by AID and Bolivian project designers themselves. AID's rural electrification projects in general have followed

the U.S., household-oriented model of rural electrification. The Bolivian government, in turn, saw rural electrification as having a primarily social purpose--i.e., of placing light in as many poor rural households as possible--an objective that is attested to by the large share of connections that reached truly poor households. The fact that the electric utilities were primarily urban systems also contributed to the lack of interest in productive use and its promotion; the utilities could count on their urban load for productive uses, since the urban load represented an overwhelming share of consumption and revenues anyway (about 90%).

The lack of interest by Bolivia project's designers in productive use also reflects the inherent nature of electrification projects which, like other infrastructure projects, are focused almost exclusively on the large and demanding task of construction; they tend to neglect what has to happen after construction is completed, a subject that will be discussed further below.

So far, in conclusion, various ways of trying to make the productive uses of power materialize have been suggested. An alternative approach to the lack of productive use would be to simply abandon the hope of linking electrification to economic growth, rather than trying to make it come true. Trying to force the linkage between electrification and production may not only bring limited results; it also requires a greater organizational complexity that may burden excessively the already fragile institutions entrusted with such projects. Or, a bigger distributional payoff might occur, for a given complication of the project, from forcing the linkage to potable water rather than to production.

Designing for low-productive use and high social objectives

It is perfectly reasonable to ask what was wrong with the lack of productive use if, indeed, household consumption was what project designers and policymakers cared about most and if that goal was realized. The answer is, in part, that productive users in grid systems, by consuming power during the otherwise unused daytime hours, bring down the unit cost of electric power to a more reasonable level. A 24-hour central-system facility like that installed in Bolivia, in other words, makes more economic sense when there is significant use of capacity during a good number of hours of the day--in contrast to the predominantly four-hour nighttime consumption for lighting that occurred.

The rest of the answer to the question posed above lies in the answer to another question: given the implicit goal of bringing rural electrification to as many households as possible, how did the Bolivia project do? For an investment of US$29.5 million, the project reached between 12% and 22% of the households in the electrified cantons (equivalent to U.S. counties), representing only about 7% of Bolivia's rural families. As seen above, the project reached fewer households than was possible partly because of the investment that went into providing unnecessarily high-quality service. In addition, grid systems have economies of scale that do not start to operate at the small size of communities characteristic of those electrified under the Bolivia project--about 85% of the electrified communities had less than 200 families.

There were less costly alternatives to grid-system power that might have brought many more households into the system for the same investment--for example, independent systems supplying individual towns with diesel or microhydro generating units. Yet one of the principal justifications AID used for the Bolivia project, as well as for other electrification projects, was that it replaced the "inadequate" service of such systems, which provided power "only" at night. This brings the argument full circle: the allegedly "inadequate" independent systems, that is, might have been considerably more appropriate than a grid-system if the goal of the Bolivia project was to provide light to as many poor rural households as possible.

The question of cost is no more important than that of whether a decentralized approach, and its many small independent utilities, would have been as institutionally effective as the small number of centralized urban utilities of the Bolivia project--especially after construction. Experience with local public services in small rural towns in some countries suggests that whereas concern for cost might lead to one choice--the decentralized approach--the concern for post-construction continuity and effectiveness might lead to the more costly, centralized choice. Unfortunately, the time constraints of this evaluation did not permit a more adequate investigation of this question through an evaluation of the many small independent utilities in Bolivia financed outside the AID project.

If one agreed from the start that a central-system electrification project were being designed for household use, technical specifications could be such as to result in considerably lower unit costs. For example, standards for the quality of service--the maximum acceptable number and length of power cuts and of variations in voltage--could be considerably lower than those followed in the Bolivia project; this is because the main economic justification for the large additional investment in high-quality service is that power cuts and variations in voltage would result in significant losses of production, which is not the case when electricity is used mainly for lighting and only at night.

With an explicitly social purpose, a rural electrification project would also have to be designed so as to maximize the number of household connections. The Bolivia project was designed for an average monthly household consumption that was considerably larger than could be expected--namely, 30-35 kwh per month immediately after project completion and 50-70 kwh by the tenth year, as opposed to the more typical 10-20 kwh actually registered in the first years after completion. The result was that whereas the number of consumers was roughly the same as projected, the amount of power sold was considerably less--by 36%, for example, in the Cochabamba system. Fewer consumers were connected than was possible or socially desirable, in sum, while at the same time the utilities were without funds to make up for, by adding new consumers, the shortfall in average consumption.

In assessing the impact of the Bolivia project as a mainly social project, finally, it is important to compare its cost to other social projects valued highly by the rural poor: health, potable water, education. In making future decisions as to how to best benefit the rural poor, AID should seek to determine how rural-electrification costs--US$400-$900 per family in the Bolivia case--compare to the costs and post-construction effectiveness of similar investments in these other sectors.

There is one important argument in favor of the use of grid-system electrification for social purposes--as opposed to making social investments in other sectors or to using more economic approaches than grid systems to rural lighting. Large-scale electrification projects generate considerable political support--from contractors, consultants, engineering professionals, equipment-supply firms, utilities, donors and, most important, political leaders. Investments in other social sectors, or in less capital-intensive and less centralized approaches to rural electrification, are usually less in the interests of these particular groups and therefore receive less support. This is one reason why rural electrification projects are so prevalent, despite the fact that many of them are not economic or appropriate; one sees less expenditure and extravagence in rural potable water or health, for example, where the groups listed above have less to gain. If the grid approach to rural electrification is rejected for other sectors or for less centralized technologies, in other words, the poor may simply end up with considerably less investment going their way.

Creating viable electric utilities

The attempt to create viable electric utilities seemed to be undercut in some ways by the very design of the project itself. The result could be seen in a post-construction "letdown" by the utilities. One or two years after construction, they were not able to keep up with the requests for new house connections and line extensions.

Grid-system projects put capacity into place that is meant to serve between ten and twenty years of demand growth. For this reason, aggressiveness in making new connections is crucial to the utility's earning of an adequate return, as well as to realizing the project's economic and social benefits. The high unit costs and excess capacity of rural electrification projects in the years immediately following construction mean that the marginal costs of adding new consumers are extremely low; bringing in new consumers during this period is essential to lowering these high average costs of rural electric power and, hence, to assuring financial viability for the utility. Actually, the importance of loading up the system and making sure the utilities are fit to do so is one of the rare cases where distributional objectives coincide with economic and financial ones: the inability to load up the system limits the distributional impact of the project, especially because the poor tend to connect later rather than in the first wave of connections undertaken during the construction period.

The reasons for the lack of vigor by the Bolivian utilities in bringing more consumers into the grid fall into four categories: (1) there was no concern for this post-construction phase in the design of the project; (2) technical specifications were set without concern for their burden on operating costs after construction; (3) unrealistic assumptions were made about the ability and the willingness of the utilities and the power sector to seek rate increases that would finance expansion; and (4) a major alternative source of financing for line extensions and new hookups was neglected--i.e., the willingness of many productive and household consumers to themselves pay at least a part of the utility's cost of extending the lines or putting in transformers for them.

Overdesign: its origins and consequences. A lack of concern for costs in project design has burdened the Bolivian utilities with higher operating and amortization costs than necessary, as well as system capacity for twenty years rather than the ten projected. The overdesign of the system grew out of a project-design environment where cost constraints were not present. This happened for various reasons. AID and the design consultants, for one, insisted on technical standards used by the United States Rural Electrification Administration. The international design consultants typically used for such projects, moreover, have everything to lose from using the more appropriate, less internationally familiar standards: if something goes wrong, they are more likely to be held accountable for the design standards than when international standards have been used, in which case failings can be more readily attributed to others--e.g., manufacturers of construction materials, construction contractors, etc.

Another reason for overdesign is that design consultants on rural electrification projects are given a task that does not elicit cost consciousness: instead of being asked how one would design a system for a given cost that would serve a specified and unusually large (for U.S. standards) number of consumers, they are given only the cost or the number of consumers as constraints, or are allowed to use their own experience as guides for determining how many consumers can be served for a given cost. Finally, the project-design process leads to overdesign because, in making technical choices, it does not sufficiently involve and pay attention to those persons who will have to bear the higher administrative costs and complications resulting from overdesign; project design, that is, is dominated by design engineers, rather than those involved in utility operation and responsible for financial performance.

Mixing city rates into rural systems. When rural-electrification systems are added onto urban systems, as in the Bolivia project, it is unrealistic to expect that utilities will be able to charge rates compatible with a vigorous expansion policy--loan agreement commitments notwithstanding. The political problems of raising rates for urban public services are a well-known feature of the political economy of third-world countries. It is not only that policymakers fear the political repercussions of raising the price of urban services used by the poor. In addition, they are often deliberately pursuing a policy of keeping down the price of urban "wage goods" like food and public services; this is one reason for the bias against the countryside in the form of food-price controls. The pursuit of electric power rates that are high enough to finance a vigorous loading up of the system, then, will usually conflict with another common, and more politically compelling, policy objective. In countries that are more politically open or have a tradition of being politically sensitive to working-class demands, the problem of allowing electric-power rates to keep pace with inflation will be more acute.

The tendency of rates to lag behind inflation, contributing to the difficulty that the Bolivian utilities had in loading up the system after construction, was also caused by the fact that the utilities and the power policymakers themselves did not pursue adequate rates as vigorously as they might have. This happened because: (1) the long grace period under the AID loan (ten years) provided a time of freedom from amortization which, though financially desirable, also gave the utilities a false sense of relief from concern about rates; and (2) even before project construction had terminated, AID

and the Inter-American Development Bank entered into discussions with Bolivian power officials about large follow-on loans for rural electrification; this also created a sense that there was no need to worry about rates as a source of funds for future expansion.

Willing and neglected financiers. The Bolivian utilities, finally, were not alerted by the project to the possibilities for mobilizing the kind of financing that private utilities have long resorted to when confronted with similar situations of high demand for new connections and inadequate revenues to meet that demand; a "forced" financing from the consumers desiring connection. Households and producers with sufficient capital are often willing to pay or finance the additional costs necessary to connect them up to the system--costs that the utility would normally bear. This practice, which had also been used in the city of La Paz, has not always been looked upon positively, because of its association with large foreign utilities in third-world countries and their alleged attempt to get the most revenue out of their system while putting in the least funds of their own. The circumstances in the Bolivian public power sector, however, are similar in some ways to those of the private utilities; because of inadequate rates, the public utilities will also have little of their own funds to put into expansion in the future.

There are other reasons for taking advantage of the opportunity for consumer financing of the loading up of rural electrification systems. Resort to this source of financing represents a charging of close to the full value of a service to its users, in a situation where charging that value through the rate is politically impossible. The willingness of individuals and firms to put up these funds, moreover, represents a rare opportunity to "tax" the users of public infrastructure investments according to their willingness and ability to pay, as revealed by the large extra investment they are willing to make to get the connection. Accepting the financing of these better-off applicants for connections also addresses the concern that the better-off benefit disproportionately from public investments in rural infrastructure. Finally and most important, this way of accommodating some of the unattended requests for connections is a way of keeping the utility out of its post-construction financial doldrums, by bringing in capital and subsequent revenues from power use at a greater pace than can otherwise occur.

The problems noted in this section have serious implications for the financial viability of the Bolivian electrification project, and for its potential distributional impact. In contrast to many such problems and to the investment made in the facility itself, these

problems require little funding for their resolution. They would require technical assistance and some budgetary support to the utilities during the immediate post-project years--as well as costless changes, such as attentiveness to the technical choices in project design that minimize operating costs, or involvement of the operational staff of utilities in this design.

Conclusion: bringing out the social objective

The Bolivia electrification project has shown that the ability of electrification to touch the lives of the rural poor may be greater than was thought. The rural poor themselves placed great value on receiving household light, often ranking it as important a "purely" social investment as potable water, health care, and education. The coming of electric light to their towns gave the poor a sense of optimism about the future, and made them much happier about the quality of their life at night. Bolivian policymakers and power managers, moreover, wanted an electrification project with a mainly social goal--to put light into as many poor rural households as possible.

What was wrong with the Bolivian project was that the strong social objective did not sufficiently guide the technical design of the project. Though the Bolivians and AID were comfortable with an exclusively social objective, the project was also designed to meet a production objective that was unrealistic. There was little evidence in the towns to receive electric power that opportunities for use by small producers existed; where such opportunities did exist, the project did nothing to help them be realized. Two other aspects of the project worked against its ability to fulfill the social objective: overdesign, and the assumption that any alternative to central-system electrification was inadequate. Together, all of these factors worked toward minimizing rather than maximizing the number of rural households reached by the project.

If project designers had been able to follow their social preferences openly, it would have been easier for them to come up with a more technically appropriate and financially viable project. Admitting to purely social objectives, of course, would have been difficult. Rural electrification projects were supposed to have "hard" economic justifications--how else could one justify such heavy investment?--and engineers were more familiar and comfortable with capital-intensive and centralized design, whether or not it was appropriate or made for financial viability.

The Bolivia project has taught us, in sum, that the pursuit of social objectives partially clothed in other guises can do ill to electrification projects: it leaves the project without its anticipated economic returns, creates an operation of questionable financial viability and, most important, undercuts the realization of the social objective itself.

I - Rural Electrification and the Rural Poor*

The rural electric systems built by the AID project reached many poor as well as better-off households, and many small communities as well as larger ones.[1] In most villages and towns, approximately 60% of the houses within reach of the distribution lines had been connected by the time of the evaluation, which was one or two years after the towns had been energized. Further connections of those within reach of the lines seemed to be constrained by supply problems rather than by lack of demand; all the utilities had a backlog of applications which they had not been able to attend to, for lack of funding and staff following termination of the AID project. This problem, along with its distributional aspects is discussed below.

That the poor were as included in the project as they were was, to a certain extent, a byproduct of the dictates of distribution technology and the fact that, in Bolivian villages, the poor live

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*The Bolivian peso was devalued from 20 to 25 pesos to the U.S. dollar at the end of November 1979. All current cost figures in this report were converted to U.S. dollars at the 25-peso rate (mainly current electric-power rates and costs of household connections); and all pre-1980 costs were converted at 20 pesos (mainly, project costs and household-connection costs under the project).

[1]For example, in the Santa Cruz system, 66% of the 80 electrified communities had less than 100 houses and 84% had less than 200 houses. In the Cochabamba system, 60% of the 158 electrified communities had less than 100 houses and 90% had less than 200.

The only exception to the truly rural nature of the beneficiaries was the largest subproject in Santa Cruz, where almost half the household connections made with project funds (6,255 of 14,053) were in the poor suburban areas of the city of Santa Cruz. Consumers in rural areas represented 12% of total consumers, as opposed to 25% in the other systems.

mixed in with the better off. From a technical and financial point of view, it is desirable for a utility to connect as many houses as possible within reach of the lines. This determinism of distribution technology and economics in keeping the poor from being excluded is significant, given the fact that the very presence of the rich in the areas of projects providing services like agricultural credit, subsidized inputs, or health supplies has often enabled them to monopolize these services, resulting in exclusion of the poor from project benefits.

Despite the reasonably high rates of connection of houses within reach of the distribution lines (60%), the percentage of Bolivia's rural population that was reached with the AID project was still low: between 12% and 22% of the families of the electrified towns and their rural hinterlands (i.e., the canton, roughly equivalent to the U.S. county); between 4% and 10% of the rural households of the six departments where the new electric systems were located; and roughly 7% of the total rural population of Bolivia.[1] Dividing the total project cost for each system by the number of connections gave an average investment cost of from US$400 to $900 per connection. Whether

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[1]These percentages, of course, will be somewhat higher as further connections are made, given that the number of consumers projected for ten years after project completion is almost double the current figure--86,000 vs. 48,000. The data on connections as a percent of rural population was developed by Karen Poe.

this degree of residential impact on the rural poor was reasonable, given the level of investment, or whether equal investments in other sectors might have had a greater impact on development and the poor are questions that were not taken up in this evaluation.[1]

The rural poor placed a high priority on electricity, often ranking it as important as potable water, education or health care. They wanted electricity only for lighting uses, however, typically one or two lightbulbs in a house; electric power, in fact, is always referred to as "light." The high priority placed on electricity seemed, to a certain extent, to be a result of the fact that electrification projects were under way in the general vicinity; construction activity and lines going up had been visible for some time, and people felt that this put electrification within close reach. Since rural households were not visited in areas outside the reach of the rural electrification projects, it was not clear to what extent the high priority placed on electricity was a result of its seemingly "easy" availability.

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[1]One Bolivian power manager asked if, with the accomplishment of the rural electrification project, he had really done a disservice rather than a favor for those in the rural areas. "Have we simply provided 3% or 4% of the rural population with electricity and, in so doing, falsely raised the hopes of the remaining 95% of the population that they too would receive electricity?"

The preference of the rural poor for electricity was also revealed by their willingness to undergo considerable sacrifice and cost to obtain it. Many were willing to pay significant capital costs for obtaining a household connection--between US$75 and $120. Many rural households with fields and huts outside the villages, moreover, made expenditures for land and house construction in the villages in order to be within reach of the new electric lines. Some communities, upon learning that they would not be connected up to the system even though the primary distribution lines passed nearby, cut the lines or tore down or burned the poles. One community, at a considerable distance from the new distribution net, blocked roads and threatened to cut off supplies of gas produced in the area and transported by the pipeline to the rest of the country.

Most people repeated the same reasons for their desire for electricity: (1) they could stay up later at night and socialize more; (2) their children could do homework at night (reading by kerosene lamps made them dizzy); (3) they could work at night with electric light--tailoring, weaving, sorting seeds; they were not interested, however, in acquiring electric motors for work, but wanted the light so as to extend their non-electrified productive activities into the night; (4) their towns, they felt, would become "modern and progressive" with the new electric power, and would result in new small industries and increased government services (visits to towns that had been

electrified for several years did not seem to bear out this association of electrification in rural people's minds with "guaranteed" progress); (5) partly related to the latter expectation, people were convinced that the advent of electric power would do away with stagnation and the rural-urban migration flows from their towns (little evidence was found that this expectation was being borne out).

Power lines, roads and nucleation

Rural electrification, or the prospect of it, seemed to be contributing to a trend toward nucleation of previously dispersed rural inhabitants in small villages and towns. Since the utility lines usually followed existing roads, it was difficult to determine to what extent the nucleation was a previous response to the road, or to the possibility of obtaining electricity, or to the combination of both. Nucleation of rural populations, moreover, had been occurring in Bolivia ever since the agrarian reform of 1952, which had broken up the pattern of dispersed rural populations living on and attached to large estates. The nucleation induced by the roads and the electric lines seemed to hold the potential for positive impacts on the rural poor, bringing them closer to other services like health, education and potable water; these new population groupings, in turn, made the supply of such services by public agencies more economic and, therefore, perhaps more likely. Finally, the coming together of rural

inhabitants into villages and towns seemed to make it more likely that they would organize to provide themselves with services, or more effectively pressure government agencies for resources and assistance.

Clearly, nucleation also carries with it adverse distributional consequences: (1) deterioration of health and water conditions resulting from denser living; and (2) the fact that nucleation around roads and electricity usually causes increased land prices near the facilities. The poor will be the least able to afford the lands close to the facilities, and thus may have to live beyond their reach.

City subsidies to the countryside

The rural electrification systems financed under the project amounted to expansions of urban systems out into their rural hinterlands--with the exception of the Altiplano and Yungas systems in La Paz department, which will be exclusively rural. In each of these systems, rural consumers are being charged the same rates as urban consumers, a policy required by AID and supported by most Bolivian power managers.[1] Since the unit costs of supplying electric power to rural areas are about three to four times those for cities--mainly

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[1]The minimum monthly consumption billed for, in contrast, was considerably higher in some of the systems for rural as opposed to urban consumers--20 kwh vs. 10 kwh, for example, in the Cochabamba system, and 25 kwh vs. 16 kwh in the Chuquisaca system. The reasons for this difference, despite the fact that average rural consumption is much lower than urban, are discussed in the subsection on rates.

because of the dispersion of rural households and the lack of industrial loads--the equal-rate policy signifies a substantial subsidy by urban users to their rural counterparts.

The subsidization of the countryside by the city through the rate charged for electric power represents an unusual reversal of the typically contrary phenomenon: the "forced" subsidization of the city by the countryside in the form of price controls on food, overvalued exchange rates, etc. The urban-rural subsidy implicit in the rate structure, of course, had less favorable implications for utility management and future service to rural areas, as discussed below. Though the urban-rural rate structure favored the countryside over the city, some of the utilities follow the traditional practice of charging residential consumers lower unit rates if they consume larger blocks of electricity.[1] This practice, of course, represents a subsidization of the larger consumer by the small one, particularly in a system like Bolivia's, where a large proportion of residential consumers consume small amounts of electricity.

Hooking up the poor

One of the most significant distributional impacts of project design was the financing provided for the capital costs of house

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[1]In December 1979, the Santa Cruz system not only ended the declining block rate for household users, but replaced it with an ascending rate; all consumers using more than 150 kwh monthly now pay 27% more per kwh. The Chuquisaca and Potosi systems do not use block rates at all, leaving only the Cochabamba and Tarija systems with declining block rates.

connections. In brief, households were able to make an initial payment, and subsequent monthly ones, ranging from US$2.50 to $5.00--representing approximately 2%-5% of the total cost of the house connection, meter, internal house wiring and, in the case of cooperatives, the membership fee. This financing, a small proportion of AID project costs,[1] ran out before all the connections to be made under the project were completed, partly because of cost overruns; such financing was not available, moreover, for further applicants for connections after the system was in place. This meant that those who wanted to connect up to the system after the hookup financing ran out had to come up with 15 to 30 times as much cash as did those with access to the early financing. By the end of the project, hookup costs had more than doubled--not only because of the intervening inflation, but because equipment for house connections purchased in larger quantity at low unit cost in the early years of the project had been used up. In the first year after the systems were energized, therefore, those who wanted household connections had to pay approximately US$75-$120 in cash, depending on the system.

The premature termination of financing for household connections had consequences that fell most heavily on the poor. The poor tended to connect last because (1) they frequently migrated to obtain

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[1]The cost of household connections, meters and inside house wiring amounted to roughly 10% of project costs. It is not clear what proportion of this amount represented financing to the consumer.

seasonal work and therefore were often not at home when collections were being made for the new system; (2) those that remained home were frequently women, who were monolingual in Aymara or Quechua and had difficulty communicating with the monolingual/Spanish representatives of the utility; or social custom proscribed their communicating with males (women-headed households were predominant among the unconnected houses in many of the communities visited); (3) the poor did not want to part with their cash until they were more certain that electric power was actually going to be brought in; since collections were made many months before signs of construction appeared, there was no concrete evidence for a long time that such payments were not being made in vain (many of the rural poor felt they had been the victims of previous collections and unfulfilled promises of politicians).

Two related aspects of project design limited the positive distributional impacts of the new electric systems. One was the fact that AID and the U.S. design consultants designed the systems for a fewer number of consumers and a level of household consumption that was roughly double that which corresponded to Bolivian reality. Whereas average monthly consumption levels were projected at 30-35 kwh immediately after project completion and 50-70 kwh by the tenth year, levels actually registered in the first years were between 10-20 kwh. Most Bolivian rural households, moreover, were meticulously careful about not exceeding the minimum amount of electricity charged for by the utility--usually around 25 kwh.

The overdesign for average household consumption meant that when the new rural systems were put into place, the amount of electricity sold and revenues earned were less than projected. In Cochabamba, for example, in the second year after project termination, the number of consumers was approximately as predicted, but power sold was 36% less. This was one reason why installed capacity in relation to demand was approximately double that planned--twenty years instead of ten years. At the same time, however, the utilities did not have the funds or the staff after AID project termination to compensate for the lower average consumption by attending to the considerable unattended demand for hookups. The significantly higher consumption standards projected by the consultants were based not only on U.S. rural electrification experience, but on the unfulfilled assumption of aggressive campaigns by the utilities promoting the use of electricity.

In addition to the overestimation of average residential consumption levels, the degree of nucleation of the rural population in Bolivia was considerably underestimated. In the La Paz system, for example, the consultants used a rule of thumb of one connection per 20 households in any area through which primary distribution lines would be passing; the actual ratio, however, was closer to one to six. This underestimate resulted in part from reliance by the consultant on old census data (an updated estimate of a census undertaken 20 years previously), without adequate field checks to determine the growth of

population and population centers in the intervening years.[1] As a result, several eligible communities were not connected, while several stagnant communities of dwindling size were connected.[2] The overall effect of these two misestimates--the overestimated average consumption per individual consumer and the underestimated population density--was that (1) the system had considerably more capacity than projected in terms of transmission and primary distribution, while (2) it was unable to load up that excess capacity once construction was completed, for lack of additional secondary transmission and distribution lines, transformers, and personnel.

The situation described above had serious adverse impacts in distributional, economic and financial terms. Distributionally, of course, the impasse meant that significantly few consumers could be connected to the line than were willing to pay for electricity. Since the poor were more than proportionately represented among the unattended requests, this meant that they were not as benefited by electricity as they could have been. Financially, the impasse meant that the utilities were endowed with a brand new and costly power

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[1]Another result of this inadequate field checking was that in the Chuquisaca system, the demand for house connections was overestimated by 100%; 5,200 houses were provided with service drops but only 2,600 completed the internal wiring that was necessary to connect up to the system. The utility estimated that the remaining 2,600 houses would be connected by 1982.

[2]One unfortunate consequence of this in the Altiplano was that pure Aymara Indian communities were left out more than mestizo communities, because the former communities were of more recent origin, having developed as a result of the 1952 agrarian reform. This outcome reconfirmed the feelings by the Indian communities that they were constantly being neglected by government authorities in contrast to the mestizo communities. "Why them?" those from the unconnected Indian communities asked about smaller or same-size mestizo communities that were connected, "and not us?"

system but were unable to fully realize the capacity of that system to generate revenues for debt service and expansion. Economically, the impasse meant that, for lack of ability to forge the final link between installed capacity and the consumer, the project was not able to produce its projected benefits. Interestingly, this problem represents one of the few situations in the electric power sector where there was a convergence--rather than a divergence--between social, economic and financial objectives.

Compounding the inability of the utilities to connect up a larger number of users was the lack of attention in project design to possibilities for allowing would-be users to finance their own connections to the system--or extensions of the secondary distribution lines that would allow such connections. Many households in electrified communities desired electricity and were willing to contribute to the extension of the secondary distribution line and, if necessary, a transformer.[1] Though the utilities were not against this practice, they were not set up to handle it, let alone promote it. In the city of La Paz, this practice had been common in the rapidly

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[1]The Santa Cruz system had 15 isolated cases of this nature, whereby the household consumer "financed" the line extensions to the utility. The utility repaid the consumer by deducting 10% from the monthly electricity bill, without interest; this meant that the more electricity consumed, the sooner the financing could be repaid. The total amount of such consumer financing was US$24,000, for an average investment of $1,600 per connection.

growing poor neighborhoods that were inadequately serviced by the private utility, which encouraged groups of neighbors to band together and themselves finance the extension of the line to their area. Neither the AID project design nor technical assistance prepared the utilities for operating this way.

Though there was considerable potential for local organization and participation in the loading up of the new power system, in sum, this potential was not used, resulting in a more limited realization of project benefits thus far, particularly for the poor. Just as significant, one of the rare opportunities for mobilization of private savings for infrastructure projects was neglected. Given the political difficulty of raising the rates charged for electric power in Bolivia and other third-world countries, as discussed further below, this neglect takes on more significance; the chronic lowness of rates, that is, means that utilities can be expected to generate little funds of their own for expansion.[1] Finally, the lack of a mechanism to bring electricity to those who were able and willing to finance the

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[1]Possibilities for mobilization of private resources and local participation were also not taken advantage of in the construction phase, except for a few cases where communities volunteered to help dig holes and place the poles; this participatory approach has been used with considerable success by a private utility in El Salvador, which resorted to it out of an interest in profits rather than local participation--i.e., because it wanted to gain additional sources of revenue but, as in the Bolivian case, was constrained by rates not high enough to finance expansion.

extension of the line meant that project benefits were being kept from some consumers who valued electricity most, as measured by their willingness to pay significant capital costs to gain these benefits.[1]

Bolivia's regional inequalities: the lure of Santa Cruz

A final observation on the distributional impact of the Bolivia rural electrification project is that the distribution of AID investments between the various systems may have tended to exacerbate regional income inequalities--mainly, that between the Altiplano and the intermontane valleys, where the majority of Bolivia's poor are concentrated, and the eastern Santa Cruz lowlands, where population densities are lower and per capita incomes are higher.[2] The largest share of the rural electrification investment went to the Santa Cruz area, and was almost double that of the next largest share, which went to Cochabamba.[3] The Santa Cruz provinces that received

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[1]A remarkable case of "forced" consumer financing occurred in the Santa Cruz system, whose new rural lines were to pass near three large Japanese-Bolivian colonies with 1,000 families, which had been founded by the Japanese government. After the colonists appealed to the utility without success to extend the new system to their colonies, they then took their case to the Japanese government, which provided US$1.5 million in financing to the utility through the Banco Agrícola for the necessary transformers and extension of the lines.

[2]Densities of rural population per square kilometer in the electrified provinces were 6.8 for Santa Cruz, as opposed to 18.8 for La Paz, 14.9 for Cochabamba, and 9.6 for Chuquisaca.

[3]US$10.9 million for Santa Cruz and $5.7 million for Cochabamba of total project costs of $29.5 million. La Paz department accounted for the largest single share (30%) of the rural labor force and received 15% of project investments, while Santa Cruz accounted for 10% of the labor force and 37% of the project investment.

electrification, however, had only one-third the population density of those provinces electrified in the Altiplano and only one-fourth the density of the Cochabamba area. Since the cost of rural electrification increases with the dispersion of the population to be served, it will be more economic to electrify the more densely populated regions first if, as in the Bolivian case, household consumption is the principal use.

Of the areas electrified under the Bolivian project, the Santa Cruz area was also the most capable of coming up with at least part of the financing itself. The department is unique in that it has large petroleum and gas reserves, earning a 11% royalty on all production; the royalty currently yields the department a revenue of US$12 to $36 million a year, which amounts to about 50% of the total revenues of all decentralized agencies in Bolivia (the AID loan for the Santa Cruz system was US$9.9 million). Evidence of this strong local funding capacity is the fact that the oil royalties were mobilized to pay all the local counterpart on the Santa Cruz sub-project (US$769,000) and, when there was a large cost overrun, to grant loan financing for that as well (US$369,000); during the 1976-1980 period, moreover, the Departmental Development Corporation committed a further US$2.6 million of oil and gas royalties to the Santa Cruz utility for electrification of a new industrial park at the edge of the city. The relative abundance of local funding in Santa Cruz

is also witnessed by the utility's tendency to use equipment and design standards that are considerably higher than for the other systems.[1] Finally, the lesser relative need of the Santa Cruz area in terms of rural population density for large outside loans for rural electrification may explain why more than half the projected household connections were made in the suburban, albeit poor, area of the city of Santa Cruz. Santa Cruz, then, may not have merited its large proportion of the project's investment funds--for reasons of distributional equity, population density, and demonstrated ability to finance infrastructure investments.

AID has had various reasons for investing so heavily in Santa Cruz--in other sectors as well as in electrification. Santa Cruz was considered to be a rapidly growing, frontier-like area, based mainly on the processing of agricultural products--lumber, beef, cotton, sugar and cocaine; contraband has also been significant in the area's growth.[2] The Santa Cruz area, it was hoped, would be a receptor of

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[1]The Santa Cruz utility, for example, wanted to include US$3 million for undergrounding of lines in the city of Santa Cruz as part of a proposal for financing to the Inter-American Development Bank. It also wanted three additional substations in order to achieve a standard of maximum permissible service interruptions that was equal to that of the United States.

[2]Because of the significance of cocaine and contraband in the Santa Cruz economy, the U.S. dollar can be sold in that area only for less than the official rate. Cocaine production, which uses kerosene, has also resulted in severe shortages of kerosene and increases in its price--despite Santa Cruz' primacy in Bolivia as a petroleum producer. This has had particularly unfortunate distributional consequences for the poor, who rely on kerosene for cooking and lighting.

spontaneous migration from the intermontane valleys and the Altiplano and was thus looked upon as the solution to the intractible problems of poverty in those other areas. Santa Cruz was considered to be free of the social and "cultural" problems of the Altiplano, with its Aymara and Quechua inhabitants, many of whom are not fluent in Spanish. Santa Cruz, finally, was felt to have more of an "American" spirit of entrepreneurial vigor and efficiency; it was where you could "get something done."

The Santa Cruz electric utility is the largest electric cooperative in Latin America and was a going and successful enterprise by the time of the 1974 loan, mainly becuase of a previous AID loan of US$4.7 million in 1966 for the creation of the urban system; the Santa Cruz utility, therefore, seemed more able to absorb such a large investment. In the Altiplano, in contrast, the foreign utility supplying La Paz (Bolivian Power Company) had no interest in undertaking rural electrification, and there was no obvious institutional alternative. Though Santa Cruz had much lower population densities than elsewhere, moreover, rural electrification was thought to have more productive potential there than in the other areas, and was looked at as an obvious need for the area's burgeoning growth. Finally, the Bolivian government had considerable political interest in directing more public-sector investment toward Santa Cruz ever since the 1950s, out of a concern that this area was developing closer links to Brazil and Argentina than to the rest of Bolivia; the U.S. government shared that concern.

The large infrastructural investments of AID in the Santa Cruz area, finally, were not without implications for political developments in Bolivia, as well as for regional inequalities and public-sector neglect of the Altiplano. Santa Cruz, that is, has long been a center of separatist sentiment in Bolivia, and has tended to be the source of more conservative political movements and coup actions by the military; the Altiplano and the valleys have seen the growth of strong labor and peasant organizations, associated with more reformist political platforms. The disproportionate investments of AID in Santa Cruz may well have contributed to a strengthening of these particular political forces in Bolivia. Given this background, it would seem that AID's current interest in investing proportionately more in Santa Cruz than in the Altiplano should be re-evaluated in light of the U.S. government's interest in supporting Bolivian moves toward civilian government and democracy.

Broadening the impact: the social uses of electric power

The use of electric power for programs in potable water, health and education was considered one of the significant benefits to result from the rural electrification project. These benefits are also among the most significant in distributional terms because (1) they also accrue to non-users of household electricity, among whom the poor are disproportionately represented; and (2) because they are financed, to

a certain extent, progressively--i.e., they are made possible by the availability of electric systems that obtain their income from consumers of electric power.

The expected social uses of the new systems usually did not materialize, with a few incipient exceptions in the area of potable water.[1] The reasons for this lack of linkage between electrification and social usages were various: (1) most importantly, the project included no mechanism, either financial or administrative, through which the linkage between electric power and its social uses could be made to take place; (2) because the electricity-using services are administered by agencies outside the electric-power sector, any project linkage between electricity supply and social use would require bringing these other agencies into the project, with all the attendant problems of coordination; (3) the public agencies responsible for health, education and potable water are typically among the weakest, in terms of bureaucratic power and financing; electric-power

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[1] In Cochabamba, a separate AID project for potable water projected for 1982 new potable water systems in 60 of the 202 communities electrified under the AID project. The convergence of the two AID projects in the same area seems to have been coincidental. In Santa Cruz, of the 82 communities electrified under the AID project, 44 already had their own diesel-power potable water systems and the rest were gravity flow. Of the diesel systems, most are projected to be converted to electric motors by the end of 1981, through a program of the Departmental Development Corporation. Many of the diesel systems had been working poorly or not at all.

entities, in contrast, are usually among the strongest, given the appeal of the large capital projects they construct and manage, and the fact that sales of electric power give them a source of income that is independent from central-government budgets; this disparity in strength between electric-power and social-sector entities makes it unlikely that the latter entities, on their own, can come up with the funds and the organization to take advantage of the new availability of electricity; (4) because of the weakness of the social-sector entities, they often do not have the funds to pay their electric-power bills or to pay for the installation; in some cases, this tends to cause the utilities to be unenthusiastic about facilitating service to them (the consumption of power by these social-service entities rarely amounts to more than 5-10% of a utility's total sales).[1]

A fifth and final reason for the weak linkage between electricity and social usage is that electricity is not as essential an input into these usages as it is portrayed in project justifications. In many cases, these services do not materialize or function well for reasons that are unrelated to the availability of electric power. Health

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[1]There were some cases where health clinics were built for electricity but did not get the connection because the Ministry of Health was considered a poor customer. A contrary example comes from the Santa Cruz utility, which went out of its way to choose its sites for stepping down power to a community near the school, so the school would not have to buy a transformer.

clinics frequently function without refrigerators, for example, because they break down and spare parts are not available, even though electricity may be at hand. Potable water based on gravity flow may be readily available, as is the case in Bolivia, where a large portion of the potable water systems for small towns can function on gravity flow, without electricity. Finally, the vaunted advantage of electricity for education, allowing night classes and vocational classes with machinery, seems to be the least likely to materialize. Most rural schoolteachers in Bolivia do not live in the towns where they teach, or are not interested in extending their work day; the projected night or literacy classes, moreover, depend on the mounting and funding of a program quite different and distinct from that which uses the school during the day for primary education.

The strongest case for building the linkage between electric power and social usage into project design might be that of potable water, where gravity flow systems are not feasible. These are cases where water supply is totally dependent on power if it is to function at all, unlike the case of health clinics and schools. Where diesel-based potable water systems are already in place, the substitution of electric pumps can bring considerable improvement; electric pumps require less maintenance and operating expenditures than diesel, a significant advantage given that inadequate maintenance of local systems and funding for operating costs are usually a serious problem (the

diesel-powered potable water systems in many of the towns visited were experiencing serious problems or had fallen into disuse). Finally, it might be desirable to force the linkage between electric power and potable water in project design because potable water is among the highest priorities expressed by the rural poor. New evidence from AID studies, moreover, suggests that there is an improvement in health conditions subsequent to the introduction of potable water regardless of whether the supply is accompanied by complementary health and education programs.[1]

Electrification projects might be "exploited" to generate financing for potable water. A surcharge might be attached to the electric-power rate to finance the capital and running costs of such systems. Again, such a financing mechanism would be progressive, since the better-off electric-power users would be subsidizing the poorer non-users. Integrating potable-water financing into electrification projects, finally, would be a way of linking a bureaucratically weak sector with a strong potential for impact on the poor to a bureaucratically powerful entity with little natural inclination for targeting its benefits on the poor.

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[1] E.g., "Water Supply and Diarrhea: Guatemala Revisited," by Daniel and Judith Dworkin, Evaluation Special Studies No. 2, U.S. Agency for International Development, 1980.

II - Electrification and Economic Growth: The Productive Uses of Power

One of the surprising findings of the evaluation was the paucity of productive uses of electric power in the rural areas supplied by the project. A partial exception to this finding was the Santa Cruz system, where productive users were more numerous; part of these users represented more an expansion of urban-type industry out from the city of Santa Cruz along the road and the new power lines, rather than the kind of dispersed rural industry depicted in project justifications.[1] In addition, the seasonal nature of many of the Santa Cruz industries--mainly, cotton gins and sugar mills--made central-system power supply uneconomic: the utility had to have capacity available that would be left unused for several months of the year, and the gins and mills would have to pay minimum monthly charges whether or not they used the electric power.[2] Some of these operations, therefore, found it more desirable to continue using their own generators.

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[1] Unfortunately, the Santa Cruz system is the only one where monthly power consumption data do not distinguish between rural and urban users, nor do the load projections in the AID loan paper. In 1979, large and small industrial consumers accounted for 40% of the power sold in the Santa Cruz system. Most of this industrial consumption, utility staff say, is located in and around the city of Santa Cruz.

[2] The seasonality problem, at the time of the evaluation, had caused the Santa Cruz utility to try to force the cotton gins to use power only during off-peak hours.

The reasons for the relative scarcity of productive uses of electric power fall into four categories: (1) the technical and organizational design of the project; (2) promotion policies; (3) costs to users; and (4) broader economic and policy factors.

Productive use and project design

Despite the concern for productive uses and benefits expressed in project justifications, the rural electrification project was designed almost exclusively with residential consumption in mind. Urban systems were expanded out into their hinterlands, along existing roads, connecting up all the communities above a minimum size along the road.[1] Even though irrigation was projected to play an important role in project benefits (representing 10% to 30% of the benefit flows in the cost-benefit analysis, depending on the system), no plans were made in the project, nor funds included, that would increase the probability that the irrigation potential would materialize.

No evidence was gathered for project justification as to whether irrigation was profitable, given existing cropping practices, the capital costs of irrigation, and local availabilities of complementary

[1] In the Santa Cruz system, for example, the minimum-size criterion for stepping down to a community along the route of a line was 10-15 houses. Of the 80 communities connected under the project, 66% had less than 100 households. In the Cochabamba system, 60% of the 158 communities connected under the project had less than 100 houses.

inputs and services. For example, though irrigation was projected to account for 14% of the benefit flows from electrification in the Altiplano by the third year after construction, and 27% after the system was fully loaded, there is considerable doubt as to whether irrigation there even makes economic sense--mainly because of the harsh winters and salinity problems. In Santa Cruz, irrigation was to contribute 26% of benefit flows as soon as construction was terminated. Only two farmers were using system electricity for irrigation, however, and utility staff said that irrigation did not make sense in the region: land was plentiful, cultivation was extensive, rainfall was high, and irrigation equipment was too costly.

Partial exceptions to the lack of irrigation design in the project were the Alto Valley in Cochabamba and the Yacuíba Valley in Tarija. These area were considered irrigable by pumping subterranean water through electric pumps; about 20 such systems already existed in the Alto Valley, run on diesel pumps and managed by indigenous water-user associations (about 40-50 members apiece, each pump irrigating about 25 hectares). The distribution lines for these valleys were designed to accommodate the expected irrigation load, though exploitation of the opportunity for irrigation would be dependent on the programs of other agencies; studies of irrigation potential, experimental drilling, water-use technology, etc., were not the responsibility of the utilities. The utilities, moreover, were

not prepared to facilitate coordination with these agencies, nor to handle requests for organizational, financial, and technical assistance for hookups by water-user associations.[1] In the Alto Valley of Cochabamba, small programs of the Ministry of Agriculture (jointly with FAO) and the Departmental Development Corporation were projecting installation of 30 electric irrigation pumps by the end of 1981, each with a command area of about 25 hectares. Though a good start, this rate seemed inadequate given the importance of irrigation to the realization of the electrification project's benefits.

The lack of development of the project's irrigation objectives not only meant underutilization of the investment in electricity; it also represented an underutilization of the ability of Bolivian farmers to organize themselves in small groups around the possible attainment and utilization of pumps for irrigation water. The few groups visited by the team in the Cochabamba area had been quite capable of forming informal organizations for obtaining and managing pump-irrigation systems, and of contributing financially to the undertaking. Again, this grouping potential represented an untapped

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[1] In the system encompassing the Alto Valley (Cochabamba), project materials designated for irrigation connections were used, for lack of demand, for other purposes--mainly, for long-line extensions to a normal school and an agricultural center. The utility, moreover, had not yet decided upon a rate for irrigation users, 1½ years after project completion; it was thinking of charging the commercial rate, which was the highest. The utility had also not yet decided on farmer requests to lower or finance the capital cost of the irrigation-pump connection.

source of private-sector financing for productive uses of electricity, let alone for increased agricultural productivity and output. Finally, the technological characteristics of such small irrigation systems--with simple equipment and small command areas--were highly compatible with traditions of intra-community cooperation among Bolivian peasants, and did not require the complex management of larger, more centralized irrigation systems.

A few interesting attempts by the utilities to encourage productive use were taking place. The Altiplano system, as noted above, is exclusively rural and thus will not be able to rely on urban industrial use for its non-residential load. In planning this system, the state power enterprise ENDE has vigorously pursued the possibility of distribution-line extensions of several kilometers apiece to five small and medium mines in the area, hoping that consumption by these mines will constitute an adequate industrial load.[1] ENDE has not

[1]Productive use of electric power is desirable not only from the economic point of view of contributing to increased output; it is also desirable in terms of maximizing the return on the investment in installed capacity and bringing down the cost to the utility of supplying power. This is because productive users consume a fairly constant level of energy for at least eight hours of the day, whereas residential use has peaks and troughs (two peaks a day in the urban area, and one in the countryside). Capacity must be installed to meet the peak load, even though it will not be used during the trough, during which time capacity will be idle and thus not paying itself off. Industrial load, by filling up the troughs, results in a better utilization of installed capacity, and hence lower costs per kilowatt-hour generated. Exclusively residential rural loads are even more undesirable than exclusively residential urban loads, since rural areas tend to have only one peak rather than two, leaving capacity idle the rest of the time.

only sought out these potential productive users, but has also attempted to draw out their capital in financing the transformers and the line extensions (which will average about US$2,000 apiece). The mines, that is, will "finance" the line extension to the utility, which will pay them back through a 12% discount on the monthly power bill. This repayment arrangement is in itself promotional, since the more kilowatt-hours consumed, the quicker the financing is paid back by the utility. There were 15 similar cases of financing by productive users to the Santa Cruz utility, like the residential-consumer financing to that utility noted above; this financing amounted to US$65,030, for an average of $2,740 per connection.

A less well-conceived attempt to facilitate productive use was the extension of secondary lines from the road to 692 farmhouses in the Santa Cruz area. The utility paid for part of the lines and financed the farmer for the other part and the transformers; since distances to the farmhouses were as high as two or three kilometers from the road, such extensions were costly (about US$2,750 per km).[1] Visits to some of these farms suggested that most of them were using

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[1]The total cost of these extensions was US$956,250--$406,250 for the transformers and $550,000 for 200 km of single-phase line extensions. The project paid for part of the line extension (up to 100 meters for a 5-kVA transformer, 200 m. for 10 kVA, 300 m. for 15 kVA, and 500 m. for 25 kVA) and financed the rest (8 years at 6%); it also financed 40% of the cost of the transformers (2 years at 6% interest), equivalent to a total value of $162,500. Together with total line costs, this amounted to roughly 6% of total project costs for Santa Cruz.

their new electric power for household purposes--only lighting and refrigeration; the small size of many of the transformers installed with this financing (60% were 5-kVA transformers) also suggests that only household use was intended. (There was some use of electricity on the newly-connected farms for lighting of poultry operations.) Because of the proximity of the city of Santa Cruz to these newly connected farms, and the lure of the city's services and educational facilities, many of these farm owners were absentee. This may explain to a certain extent why their new electric power was used only for household purposes, since electricity-using productive activities on the farm are usually management-intensive, requiring full-time managerial presence. It was difficult to determine, only one or two years after connection of these farms, whether productive uses would later materialize.

Though the connection of farmhouses to the distribution lines approximated most the concept of rural electrification in the U.S., the result seemed economically "perverse": project financing was provided to individuals for investments in transformers and line extensions that resulted in residential use only. If financing had been required of the line owners for such extensions (as in the case of the mines), the willingness to invest such resources might have been a more reliable prediction of the existence of profitable opportunities for productive uses on these farms.

Will the small producer use power?

The productive enterprises using rural electricity, as depicted in project justifications, were to be manned by small, dispersed rural producers. A combination of rate structures, utility policies, and structural factors, however, seemed to work together against the use of electric power by these producers. Some attention to this question in project design might have turned this bias around, or at least neutralized it. The problem resulted from the fact that (1) financing of the capital costs of connection was available only to residential users and to some larger farm owners, as noted above, but not to those who would be using power productively; (2) large industrial users had access to official and commercial bank credit for expansion of their activities in general, and frequent contact with supply firms for technical assistance in buying electrical equipment; small users did not have such access, partly because of their economic level and partly because of their dispersion in the countryside, where such firms were not represented; (3) rates charged for small industrial users were higher than for large industrial users and even, in the case of

Cochabamba, higher than those for residential use.[1] To a certain extent, these higher rates reflect the higher costs of serving smaller users.

A fourth and final reason for the paucity of productive users in the new electric systems is that many potential productive uses of rural electric power are seasonal--such as fruit and vegetable processing, cotton gins, sugar and flour mills. Seasonal loads are unprofitable for the utility because it has to supply a certain level of installed capacity that goes unused for a good part of the year (unless there exists, by chance, a complementary load of equal proportions during the off-season, an unlikely occurrence in the Bolivian rural systems). Likewise, the use of central-system electricity can be unprofitable for seasonal producers themselves because rate structures impose a minimum monthly charge, independent of usage. Even with the high price of diesel, then, total annual outlays for

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[1] It is not clear to what extent these higher costs actually inhibit the connection and use of electricity by small users, since electricity tends to account for only a small share of the costs of production in most industries; also, producers were more sensitive to the capital costs than to the running costs of using electricity.

In the Cochabamba and Tarija systems, rates for kilowatt-hours consumed were higher for productive users with less than 50 kw of installed capacity while capacity charges were the same; there were also four declining blocks within each small and large category. Santa Cruz charged a declining kwh rate, but an ascending kw rate; the average rate was 27% higher for small industrial users with less than 50 kVA of capacity in 1979; that is, large users paid an average of 3.73 cents (U.S.) per kwh and small consumers were billed for an average 4.76 cents per kwh. The Chuquisaca and Potosí systems charged a single rate to all industrial users.

power by seasonal users could easily be less with their own diesel-run motors, despite their higher operating costs during a few months of the year. Since much of the projected productive load of rural electric systems is based on activities related to the agricultural cycle, this aspect of the comparative economics of central-system electricity vs. self-owned diesel motors is a significant one. The mere installation of central-system electricity, then, may not elicit agorindustrial consumers and production, even in cases where some such production already exists in the area to be electrified on the basis of self-owned motors.

Misdirected promotion

To the extent that promotion policies existed in the rural electrification project--either as part of the project, or as utility policy--they tended to be somewhat misdirected, at least with respect to the objectives of the project. The declining block rates for industrial or larger users are questionable promotional devices, for the following reasons:[1]

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[1]The Cochabamba, Santa Cruz and Tarija systems charged declining block rates to industrial users. Cochabamba was intending to move to a single rate, and Santa Cruz used an ascending rate for the capacity charge to industrial users. Chuquisaca and Potosí charged a single rate to industrial as well as residential consumers.

(1) These rates represent a regressive structure of charges, since they subsidize better-off users who are also the most willing and able to pay for high consumption levels.

(2) Because electric power accounts for a small percent of most industrial costs, the price elasticity of demand for power by industrial users is thought to be low (except for electricity-intensive industries, of which there were none in the area electrified under the project);[1] that is, users will not significantly reduce or increase production in response to increases or decreases in power rates. If responsiveness of production to changes in power rates is indeed low, then utilities are unnecessarily giving away the extra income that they might earn on the large blocks of consumption if they were not to give bulk discounts.[2]

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[1]International data show that electric power bills do not exceed 4% of the costs of industrial production for all industries except hydrocarbon and metal mining, metal and steel manufacture and products, synthetic fibers, paper, pharmaceutical products and ceramics; for the latter industries, the share is between 4% and 8% of production costs.

[2]One industrial user complained vociferously to the utility when he found that though he had consumed less energy in a particular month, his bill was not correspondingly less. The utility had to explain to him that he was being charged a declining block rate, and therefore his bill for less consumption in one month might be the same as his bill for more consumption in another month. This particular user, then, was not even aware of the declining block rate.

(3) It is not necessarily economic for producers to respond to the declining rates with increased production; one way to take advantage of block rates is to add another production shift or two at night; when the Chuquisaca utility polled its industrial users on the possibility of changing from a single rate to a declining block rate, the producers said they were not interested because of the sharply increased expenditures for payroll taxes and overtime that they would incur.

(4) To the extent that productive users were responsive to the costs of electric power in their decisionmaking, they seemed to be influenced more by the capital costs of the hookup and the purchase of electric motors than by the operating costs of electric power. Various productive users were interviewed who did not know what their monthly electricity bills represented as a proportion of their total production costs.

The practice of charging unnecessarily promotional rates to large industrial users is, of course, not unique to Bolivia. To the extent that it is a result of the political power of large industrial users rather than genuinely promotional objectives, it is not a problem of easy resolution. Whatever the case, the lack of political and economic power of small productive users provides a partial explanation of why the rates charged them tend to be higher, and why the attention paid to them by the utility and other entities providing

capital and assistance is lower. A rural electrification project that relies on productive use to realize a significant share of its economic benefits, then, requires active planning to turn around this natural bias against the small productive user.[1]

Other instances of "misdirected" promotion are: (1) a tendency in the exceptional case where utilities did have promotional programs (CESSA in Chuquisaca), to promote the use of domestic household appliances rather thon productive equipment; this type of promotion not only ignores productive use but also has regressive distributional implications, since it is only the higher-income families that can afford the electric showers, the electric stoves, the hair dryers and the blenders that appear in the promotional literature; and (2) the Santa Cruz utility partially financed the extension of distribution lines to individual farmhouses and the purchase of the transformer, as noted above, for uses that turned out to be mainly residential.

Many of the small productive users or would-be users interviewed were confused and uninformed about what they had to do and how much they had to pay in order to connect up to the new grid;

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[1]Though the Bolivia electrification projects did not take the small productive user into account, the AID/Bolivia Mission is now aware of this problem and has just approved a US$200,000 grant for the promotion of productive uses of the new rural power.

and about what kinds of motors they needed to buy and where they could be obtained. The latter confusion resulted, in some cases, in the purchase of inappropriate motors because of the availability of only single-phase (as opposed to three-phase) lines in many of the communities electrified. Many potential productive users did not know (1) that they would be able to use single-phase rather than three-phase motors (up to about 5 hp) for the level of activity they wanted to engage in; (2) that three-phase motors could not be used with the single-phase lines; (3) whether the utility could or would extend a three-phase power line to their location and, in the case that three-phase power were necessary, what such an extension might cost and what the financing arrangements might be; and (4) where they could buy single-phase motors.[1] Finally, small potential users of electric power for productive purposes tended to be against using single-phase motors because (1) they are about 20%-30% more expensive than three-phase motors; (2) they are economic only up to 3-5 hp capacity, beyond which point it is more economic to use a three-phase motor; and (3) because although 5-hp motors are perfectly adequate for most small producers, they tend to overestimate their needs and the level of production they can sustain.

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[1]This problem was particularly acute in Chuquisaca, where single-phase motors were said to be not available for purchase in the departmental capital of Sucre. The problem of single-phase power might have been alleviated by recourse to the phase converter, a small generator made to produce three-phase power from a single-phase line. Such converters are usually a fraction of the cost of extending a three-phase line to the producer. The AID Mission has recently brought these converters to the attention of the Bolivian utilities, which would have to arrange for their importation and sale to small producers.

A final observation on the lack of productive use is that the possibility of mobilizing private-sector resources by those who were willing to contribute at least part of the costs of obtaining line extensions and transformers was not taken advantage of in project design, as discussed further below. Cases where there was private-sector willingness to finance the line extension or the transformer would seem to represent the most obvious cases of potentially profitable productive use.

Taken together, all these considerations suggest that a small technical assistance and promotion effort by the utilities could have resulted in significantly more productive use, could have reduced wasted investment in inappropriate motors by potential users, and could have elicited the mobilization of private funds by potential users for extensions of the line and purchase of transformers.[1]

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[1] An interesting exception to this lack of promotional interest, funding and activity by the utilities is the self-initiated promotion activity of the Chuquisaca utility, CESSA. CESSA is attempting to negotiate a US$100,000 credit with the Banco Agrícola, through which it would purchase a group of single-phase motors and then retail them through sublending arrangements to productive users. CESSA would repass the credit to purchasers for a one-year amortization period, charging an interest rate 1% greater than the bank's, which would cover its financing and expenses and contribute to the formation of a rotating fund. Amortization payments would be made through the monthly power bill. CESSA's idea represents a clever institutional mechanism for extending credit to small rural enterprises in an environment where credit is not available and where the monthly bill collector of the utility represents one of the few extensions of the city's activities into the countryside.

The utilities, in sum, had to rely on either public-sector financing (mainly foreign) or rate revenues to finance extensions of their service and to load up the excess capacity in the system. Yet rates were barely adequate to cover costs, let alone expansion, and outside financing was not available after expenditure of AID project funds on putting the system into place. At the same time, productive users were getting electric power for less than they were willing to pay, and opportunities for private-sector financing from these users was being ignored in a situation where other sources of financing for growth of the system were not forthcoming. Potential productive uses of electric power were not being realized to the extent possible, therefore, while at the same time the utilities were unnecessarily foregoing additional income.

The economics and politics of productive use

There are a few other reasons that the rural electrification system did not lead to productive use. (1) Despite the concern for productive use expressed in project justifications, the Bolivians seemed to see the rural systems as having exclusively social and political justifications--i.e., that these investments were meant to carry light, not production, to the rural population. The Bolivians viewed rural electrification as redressing the past imbalance of public-sector attention in favor of the cities. Actually, this

conception of rural electrification was not that divergent from that of AID and its consultants. As noted above, the technical and organizational design of the project concentrated almost exclusively on residential use.

(2) Complementing the Bolivian concern for carrying light to its rural peasants was the fact that one could count on the urban base of the rural systems to provide the industrial load and its desirable characteristics. The new rural systems represented a small fraction of the existing urban ones (about 10% of revenues and power sold and 25% of consumers), which already had built up a reasonable industrial load (with load factors between 50% and 60%); there was no pressing need to seek out productive users in the rural areas, therefore, from the point of view of gaining desirable load characteristics.

(3) Another possible reason that productive use was less than expected was that machine-based technologies of production may in many cases have not been competitive with existing labor-based techniques, in which case the adoption of electric power would not have been profitable. In some market towns that had had power for seven or eight years, electric power was being used for productive purposes only in the sense of extending the number of working hours

in a day.[1] Tailors and weavers, for example, were now working into the night by electric light, but were not using electric power for machine work; tailors had switched from coal to electric irons, but only a few were using electric machines. Similarly, many artisans who expressed great interest in receiving electricity wanted it so they could work at night by light, but not for mechanizing their operations. The lack of productive rural uses of electricity, then, may have been partly a function of the relative price advantage of labor over capital, and the inability of equipment-based techniques to compete with labor-based techniques in some rural areas.

(4) The central-system electrification provided by the project seemed more a response to economic growth than the cause of it. In some towns where electric power had been available for several years, the lack of development of productive activity was striking; there were even various instances where there had been no switchover of small operations like flour mills from their own diesel motors to

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[1]After having 24-hour electric power for eight years, the Altiplano town of Achacachi--a market town and provincial capital with a population of 4,000--had the following productive establishments as electricity consumers: 4 repair shops, 10 tailors, 4 ice-cream makers, and 30 bakeries. (The bakeries and tailors were using electricity mainly for light and not for machines.) Ironically, Achacachi was the town that forced the large foreign utility supplying La Paz (BPC) to provide it with power eight years previously; BPC had built a long transmission line from the city to a large mine, with no plans to supply any towns along the way. Achacachi sabotaged the line until BPC provided it with power.

central utility supply. In the Santa Cruz region, at the other extreme, it seemed that other economic factors had played the dominant role as engines of that region's growth--booms in cotton, beef, sugar cane, lumber, cocaine, contraband; most rural-based users had installed their own motors before the advent of central-system electricity. The lack of electric power prior to the AID project, in other words, had not seemed to have constrained Santa Cruz growth. Though the possibility for productive use of power in the Santa Cruz area had seemed more apparent than in the other areas, the fact that many of the industrial users of the new power in Santa Cruz were urban-based industries, oriented toward urban markets, suggests that the industrial growth associated with the Santa Cruz grid was not completely of a rural nature.[1] The provision of rural electric power to this area, in sum, did not seem to play a catalytic role in economic development or to be a precondition of it.

(5) Finally, the lack of productive use of rural electric power may have been related to the fact that the systems represented the expansion of urban systems out from the city along existing road networks.[2] Roads radiating out from cities cause a decrease in urban-

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[1]As noted above, the Santa Cruz data do not distinguish between urban and rural consumers. These impressions were based on talks with utility staff, field visits, and a list of the industrial consumers of the utility.

[2]The Altiplano system is the only exception to this pattern, being exclusively rural; since the system was just about to be energized at the time of this evaluation, it was not possible to evaluate its impact on production.

rural transport costs and thus facilitate the supply to rural areas of cheap, mass-produced articles with which small rural industries are often unable to compete in price and quality. The installation of road infrastructure, then, will often result in the destruction of small-scale dispersed rural industry. Unfortunately, it was not possible to assess the net impact of expansion of the Bolivian rural systems out from the cities along existing roads in terms of displacement or creation of opportunities for small-scale rural production.

III - After AID: The Electric Utilities as Viable Entities

Once AID project funds were disbursed and the new systems were in place, the utilities seemed to experience a post-project "letdown" during which they were unable to carry through with the ongoing task of connecting up new consumers. Thus there was a backlog of unattended requests for house connections and line extensions soon after the system went on stream, a backlog that seemed to result from financial and personnel constraints. Clearly, the inability to facilitate productive uses was, in part, a result of the financially lean character of these post-construction years.

It is important to point out the significance of this problematic transitional period before going into the reasons for it. The unit costs of rural electrification are very high--about three to four times those of urban electrification in Bolivia--which means that rate charges based on full-cost recovery would make the price of electricity prohibitive. Rural electricity rates, therefore, usually involve some degree of subsidization, at least in the early years when the system has considerable excess capacity. Along with the fact that unit costs of rural electrification are high, capacity is usually installed to handle projected growth in demand for up to about ten years. (In the Bolivian case, the overdesign of equipment and the overestimation of average residential consumption resulted in

capacity for closer to 20 years rather than ten years of load growth.) The high unit costs and excess capacity that characterize rural electric systems immediately following construction mean that it is essential to load up the system as rapidly as possible. The marginal costs of adding the new consumers, in other words, are extremely low as compared to the high initial average costs. The ability of the utility to meet demand for new connections in the early years, then, is crucial to the realization of the system's economic benefits and to the channeling of adequate revenues to the utility.

The difficulties of the Bolivian utilities in bringing new consumers into the system can be attributed to two sets of considerations--those regarding the rate problem, and those related to the nature of donor involvement. The latter set of considerations will be taken up first.

Construction vs. operation

As designed by donors, rural electrification projects are treated as discrete construction tasks, with a beginning and an ending when donor funds are completely disbursed. The connection of new consumers, in contrast, is an ongoing activity, requiring more action and aggressive behavior by the utility itself--in contrast to the contracted-out nature of the construction task. The thinking out of electrification projects is done mainly by design and construction

engineers, both on the donor and the recipient side, whose task is to get the structure built; that the managers of a utility's ongoing operations are usually little involved in this design process reinforces the tendency to treat the project as a discrete task.

The neglect of the transition from construction to operation is common to many infrastructure projects--roads being an obvious example, where the post-construction activity of maintenance is frequently neglected in the design of the project. The neglect of future ongoing activities in roads, however, is far less damaging to the project than in the case of rural electrification: the neglect of road maintenance, that is, will not prevent the economic and financial benefits of the road from being realized, at least in the crucial early years after completion of the construction task. In electrification, the neglect of the ongoing activity constrains the realization of the project's benefits immediately after construction; by depriving the utility of early potential revenues, this problem initiates a process right after construction by which the utilities become less and less able to grow independent and strong. The perception by Bolivian power authorities and utilities that donor funding for further investment will be necessary and available contributes to the neglect of the post-construction phase; in the face of their difficulties in loading up the new AID-financed systems, for example, Bolivian power authorities and utilities seem to be

focusing most of their concern on the prospects for negotiating another rural electrification loan (Phase III), this time from the Inter-American Development Bank.

The political economy of rates

As in many third-world countries, the Bolivian utilities have political difficulties in charging rates that will cover their costs and allow an adequate margin for expansion.[1] The two larger and older systems--Santa Cruz and Cochabamba--have been earning about a 7% return on their assets--somewhat short of the allowable 9%. The current year is an exception, partly because of a 25% foreign exchange devaluation in late 1979 that resulted in large cost increases to the utilities, combined with an election year that made it difficult to adjust rates accordingly.[2] Santa Cruz had been earning only 1.5%-1.8% in the first five months of 1980, and both Cochabamba and Santa Cruz were expected to earn only around 3% in 1980. The three smaller southern systems are considerably worse off and will probably end the year in the red. As is common in such systems,

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[1] In the project systems, rates vary between three and seven cents (U.S.) per kwh, depending on the type of consumer and the system; additional capacity charges for industrial users are US$1.00-2.00 per KW.

Data did not allow for an analysis of the adequacy of rates and rate increases in recent years. Between 1976 and 1980, rates paid for bulk power increased by approximately 77% (bulk power constitutes 50% of the Bolivian utilities' costs). Rates charged by the utilities increased by an average of 82% during the same period. A relevant series on inflation during the same period was not available.

[2] In December 1979, the utilities received approval from the federal rate-making authority (DINE) to increase rates by 30%.

they are spending their depreciation funds for operating costs, and thus are already setting themselves up, even before their systems are fully energized, to have difficulties in meeting requests for new services. The fact that the southern systems may be too small to reap the economies of scale inherent in electric power systems--along with their lower population densities as compared to Cochabamba and the Altiplano--raises some question about the economic wisdom of having added rural systems to these urban utilities at this early stage of their growth.[1]

Another consequence of the inadequate rate return is that the utilities are considerably delinquent in their payments for purchased power to the state power enterprise, ENDE; delays in payment of five to six months are not unusual. Delinquency, it should be noted, can be a sign of power as well as of weakness: the financially better-off Santa Cruz system is as delinquent as the weaker systems. The strength of the Santa Cruz utility (CRE), added to the anti-central-government stance of that region, makes it difficult for ENDE to force

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[1]In terms of total power sold in 1979, Chuquisaca and Tarija are one-fifth the size of the Cochabamba and Santa Cruz systems and Potosí is one-tenth.

payment or to enforce sanctions.[1] The implications of this delinquency to ENDE in payments for bulk power are that the utilities are forcing ENDE to provide them with interest-free operating capital. (ENDE charges a small fine for late payment, but it is lower than the prevailing rate of interest and the utilities tend not to pay the fine anyway.)

The difficulties of raising electric power rates have various causes. Policymakers, for one, are interested in keeping down the price of urban wage goods. One of the disadvantages of mixing a rural system with an urban system, therefore, is that the difficulty of raising urban rates gets conveyed to the rural system, where increases in rates usually cause little protest and hence are less politically difficult. It should be noted that if Bolivia moves toward a civilian government and democracy, and hence is more

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[1]The political strength of CRE vis-a-vis ENDE is also a result of its being the only utility in the system that is independent of ENDE participation as shareholder and member of the Board of Directors (which varies from 3% to 20% of shares of the other utilities). Thus although ENDE has de facto power to strongly influence electric-power policy--as the country's only state company in the power-generation business, and as the executing agency for donor lending--it often is unable to influence what CRE does.

Ironically, AID partly contributed to this difficult situation for ENDE when, in negotiating the first loan for the creation of the Santa Cruz system in the 1960s, it insisted as a condition of the loan, on the advice of NRECA, that CRE be an independent cooperative--rather than a municipal utility like the rest, with ENDE participation in shareholding and management.

responsive to popular pressures, the difficulty of raising electric power rates is likely to increase. A continuation of the rate problem, in other words, may be a concomitant of success in the broader political field.

A political understanding of the rate problem reveals one of the disadvantages of the central-system approach to rural electrification, as opposed to independent units for individual towns or exclusively rural systems. The latter type of unit is now being contemplated under the AID Mission's proposed micro-hydro program. Central-system electricity magnifies the political problem of raising rates because it brings major cities into the rural system, with their more vocal and effective protests against rate increases. The more interconnected the system, that is, the more consumers and cities that are affected by, and vocal against, a rate increase. The first concern of the federal rate-making authority (DINE), for example, when it receives a request for a rate increase from a utility, is what the implications of such an increase would be for rates in the city of La Paz. La Paz, of course, has the greatest urban population concentration in Bolivia, and is also the most politicized city with respect to rate increases and other

matters.[1] When the electric utility serving only one town or area raises its rate, in contrast, consumer discontent does not reverberate through all the towns and cities in the region or country. Perhaps this is one reason why independent or exclusively rural systems in Bolivia are able to get away with charging rates that are three to four times those of the central system.[2]

Finally, higher rates are sometimes not pursued as aggressively as they might be by the Bolivian utilities themselves, partly

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[1] Residential rates in La Paz are less than half the rates charged by utilities in the other departmental capitals of the AID project (i.e., between 31% and 44% of these other capitals). (This difference would also be partially attributable to lower costs in La Paz resulting from economies of scale.)

One of the few occasions on which it was possible to gain prior acquiescence from industrial consumers for increases in their rates involved the fear of the political repercussions of a proposed residential rate increase in the La Paz system. On this occasion, the rate-setting authorities called the Chamber of Commerce and various large industrialists to a meeting in order to persuade them to accept more than their share of the next round of rate increases, on the grounds that a proportionate increase in residential rates would result in a major threat to the country's political stability--and that the industrial users ought to accept more than their share of the rate increase because of the importance to them of political stability. (The differential between current industrial rates in La Paz and other departmental capitals is not as great as that for residential rates.)

[2] The Altiplano and Yungas systems, in the rural hinterlands of the city of La Paz, are the only exclusively rural systems among the seven of the project. It is probably no coincidence that their rates will not only be the highest of the project, but that they will be three times those of the city of La Paz for residential use--6 cents (U.S.) per kwh vs. 2 cents. This contrasts with the lower, and uniform rural-urban rates of the other systems.

because of a false sense of security inspired by the generous terms of loans from donor organizations.[1] The long initial grace period (ten years) coincides with the time when the utility should be pursuing new customers and greater revenues through vigorous service and expansion. To the extent that the lack of concern about rates in this initial period is a result of the "easiness" of the grace period, the loan terms contribute to the problem.[2] Correspondingly, the willingness of donor organizations to enter into discussions about large subsequent loans immediately after completion of previous projects no doubt contributes to the utilities' sense of security about being able to find funds for expansion outside the rates.[3] An

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[1]After the December 1979 approval of a 30% rate increase by the federal rate-making authority (DINE), the Santa Cruz utility increased its residential rates by only 15%, partly out of fear of political reaction and even though it had requested a 35% increase. (The utility said it was waiting until after the elections or the expected coup to raise rates the remaining 15%.) The Potosí utility also did not charge the approved increase. Three other utilities, moreover, had asked for only half of the rate increase that DINE granted them. (This discrepancy, it should be noted, is attributable not only to utility laxness in pursuing adequate rates but to a high political decision to grant the same percentage rate increase to all the utilities at one time regardless of their differing costs and intial rate levels. The rate-making authority [DINE] had asked for an equal absolute increase for all the utilities; since La Paz rates were less than half those of the other utilities, this would imply a considerably large percentage increase for La Paz [about 50%]; for this reason, DINE's recommendation was turned down and substituted for an equal percentage increase of 30%. That this uniform percentage increase would result in some utilities receiving more than they requested was secondary to the political considerations.)

[2]One utility manager actually cited this reason for not worrying about raising the rates.

[3]Though adequate rates are usually the subject of convenants to or conditions of donor loan agreements, these conditions are often not met, or looked after by the donor--partly because of the donor recognition of the political difficulty of raising rates at any particular moment.

example is the current discussions of the IDB (and, previously, AID) with Bolivia--before the new systems are completely energized--about financing part of a US$85 million follow-on project of rural electrification.

Given the tenacity of the rate problem, the neglect of opportunities to facilitate private contributions to the extension of lines for new consumers, as discussed above, is particularly damaging. In future electrification projects, then, more attention should be paid to funding and organizational design for the period immediately after a system is energized.

Mixing cities and countrysides in electric systems

The new rural systems of the AID project represent fairly small additions, in terms of the number of consumers and kilowatt-hours sold, to existing urban systems. In most of the systems, rural consumers account for no more than 25% of the total number of consumers and 10% of the kilowatt-hours consumed.[1] All the systems started as municipal utilities serving departmental capitals. The urban preponderance in the new rural systems--in Bolivia as well as

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[1]The Altiplano and Yungas systems are exceptions; they are exclusively rural because the utility supplying the city of La Paz, a foreign power company, was not interested in expanding into the rural areas.

in some other Latin American countries with AID-financed rural electrification projects--has been the subject of some criticism.[1] Though it is true that the systems are preponderantly urban and therefore do not fit the U.S. model of rural electrification, there were found to be some distinct advantages, as well as disadvantages, to the urban-rural mix.

When rural systems are added onto an existing urban base, this provides a good initial source of revenue and industrial load to the utility. Given the difficulties in developing productive rural uses and their desirable load characteristics, the urban base represents an important contribution to the financial viability of the utility.[2] The preponderance of urban consumption in the system, moreover, allows the high costs of rural service--about three to four times that of urban--to be spread over and diluted in the much larger, less costly urban load--which accounted for about 90% of power sold in the project systems.[3] Building rural electrification systems onto

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[1] E.g., Robert R. Nathan Associates, Inc., "Evaluating AID Rural Electrification Projects," Contract No. AID/afr-c-1380, U.S. Agency for International Development, 1979.

[2] The Chuquisaca system had only 24 industrial users but, in compensation, a state cement factory at the edge of the capital city accounted for 50% of total energy sold. "Without the cement plant," utility officials said, "we couldn't exist."

[3] In the Cochabamba system, it was estimated that the new rural system could be accommodated with only a 3% increase in the existing urban rate.

existing urban utilities was also the only way that the AID project could attach its investments to established entities with some history in the field of electric power distribution. The extreme difficulties encountered under the project in creating cooperative utilities from scratch for the exclusively rural systems of the Altiplano and Yungas areas are good illustrations of the problem of working where there is no established utility. Finally, when a utility supplies power to an urban area, this seems to give it a strength and political power that exclusively rural suppliers do not have.

One example of the institutional difference between rural and urban utilities is the comparison between ENDE, the state-owned power-generating enterprise and INER, the more recently-created rural electrification institute that has worked in the area of supplying independent diesel units to towns beyond the central-system grids. INER was also meant to play an important role in the AID rural electrification project, at least with respect to the Altiplano and Yungas systems. Without getting into the details of this story, suffice it to say here that ENDE ended up taking over INER's role in the project, mainly because of INER's weakness and inadequacy vis-a-vis ENDE.

ENDE has been wholesaling power to the urban systems expanded under the AID project, and thus has an independent source of income;

INER, in contrast, is dependent on central government budgets. Though AID has tried to strengthen INER through the project, and plans to try again with the micro-hydro project, it will continue to be difficult to overcome the basic structural problem--i.e., that the electric power field is already occupied by a more powerful entity, ENDE, whose strength is based on earning its own revenues from urban systems.[1] In such a situation, it seemed foreordained that INER, with its exclusively rural mandate and no independent source of revenue, would not be able to do as adequate a job as ENDE, or to keep ENDE from invading its domain.[2]

AID's actions with respect to the urban-rural question, in light of this analysis, might be interpreted as somewhat contradictory. AID insisted that rural rates not be higher than urban rates, that is,

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[1]In the 1960s, ENDE, which was created out of an electric-power department of the Bolivian Development Corporation, was central to the construction and expansion of the Santa Cruz and Cochabamba urban distribution systems. It then handed these systems over to the respective municipal utilities, partly because of pressure by the World Bank, which was lending to it for generation facilities, for the new entity to restrict its activities to generation. Also as a result of the Bank's concern, rural electrification responsibilities were removed from ENDE and placed in the newly created INER.

[2]Similarly, INER's turf in the Altiplano and Yungas projects, where it had direct responsibility, was inevitably challenged by another existing and powerful entity in the electric power sector--the foreign-owned Bolivian Power Company, supplier of the city of La Paz. BPC's actions throughout the history of the La Paz rural projects had a dog-in-the-manger quality: the utility was not interested itself, but at the same time made it difficult for INER and, later, ENDE to carry out the projects themselves.

while at the same time it tried to create an electrification entity that would deal exclusively with rural power. Yet if urban rates were to subsidize the costs of rural electrification, then it might deprive the rural system of its strength if one divorced its management from that of the more power-conferring urban systems. There seems to be no logical reason, in sum, why an entity like ENDE or the urban distribution utilities, which have built their strength on urban systems, would not be qualified or interested in taking on rural electrification. All this is not to say that it would be best for an urban-based entity to take on a new rural system, as indicated by the following discussion of the disadvantages of such a mixed system. It is only to say, rather, that entities starting out in urban electric power will confer a certain strength on the rural electrification effort that may not be available to exclusively rural entities.

Another advantage of the expansion of urban utilities into rural electrification is that this mechanism offers a unique opportunity to tax one sector in favor of another in a way that is consistent with some important development and AID objectives. The urban-rural combination, along with the single rate charged for both types of consumers, represents a "tax" (1) on the cities in favor of the countryside, in a situation where such "forced" subsidization is usually in the opposite direction, with adverse consequences for rural

development; (2) on industry, to the extent that it is mainly located in and around cities, in favor of agriculture and rural development; (3) on better-off residential consumers, who are more than proportionately located in cities, in favor of poorer consumers who are concentrated in rural areas;[1] and (4) on urban commerce in favor of rural areas, in that rates for commercial use are the highest in both urban and rural areas.[2] Where redistributive tax policies are difficult, the accomplishment of such a transfer through the rate charged for electric power is a significant achievement. It is notable, moreover, that this transfer could have been made through one of the most public and politicized prices that exists--the electric-power rate. This is because the urban-rural subsidy was never explicitly set forth as a rationale for the uniform urban-rural rate,

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[1]This transfer is not realized to the extent possible, because of the declining block rates for increased residential consumption that were used by some of the utilities.

[2]The oft-repeated justification that one hears in Bolivia for the fact that rates charged to commercial users are the highest is that these users usually evade taxes; that they are not subject to price controls to the extent that industry and agriculture are (and thus are able to pass on increased electricity costs to their consumers); and that the commercial sector, in contrast to industry or agriculture, does not produce "output." To the extent that small commercial establishments in fact do evade taxes, then the higher rate for commercial users may represent a good proxy for a tax on commerce the proceeds of which are transferred to the rural sector. As noted above, the urban-rural transfer is an unusual one; most of the prices and policies in countries like Bolivia cause transfers to go in the opposite direction.

and because the rural component of the system is so small that the increase it contributes to the urban power rate is minimal.[1]

There are also distinct disadvantages to building a rural system on top of an existing urban system, especially in the Bolivian case. Though there is logic to spreading the higher costs of rural service over the larger urban service, it should be remembered that the urban rate is already inadequate, because of the political difficulties of raising it. Thus the addition of the more costly rural system to the urban one, with the same rate, puts the utility one step further away from earning an adequate return.[2] As noted previously, the urban component of the urban-rural system will make rate increases more politically difficult than in the exclusively rural system, given the population density and political character of cities. In a new and exclusively rural system, moreover, it is easier to start out with a relatively high rate since monthly electricity bills will typically be lower than previous costs to consumers of lighting with kerosene and candles, or of charges by previously existing independent systems. Rural consumers, finally, are said by the utilities to be

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[1] A proposal for further use of the power rate as a transfer mechanism from city to countryside is being discussed now in the Bolivian power sector. The proposal would involve a small surcharge on all power consumers in the country, whose proceeds would support the budget of the National Rural Electrification Institute (INER).

[2] In the Chuquisaca system, for example, utility data on costs and rates for January 1979 suggested that urban rates were 70% of real costs, whereas rural rates were only 9% of real costs.

better at paying their bills than urban consumers.[1]

There are two illustrations of the greater ease of charging higher rates in rural areas. One is that the highest rate in the AID-financed project will be that of the only exclusively rural system (CORELPAZ in the Altiplano), which will charge six cents (U.S.) per kilowatt-hour and a minimum monthly consumption of 33 kwh for US$2.00--as compared to 4.6-4.9 cents per kwh in the other systems and a monthly minimum of between 20 and 25 kwh for US$0.96-1.31; as noted above, moreover, the Altiplano rate is three times that charged in the departmental capital, La Paz.[2] A second illustration of the greater ease of charging higher rates in rural areas is that the minimum monthly consumption charged by the utilities is higher in the AID-financed rural systems than in their urban components--e.g., 10 kwh vs. 20 kwh in Cochabamba--even though average consumption levels are lower in rural areas than in cities; this difference in the minimum consumption charged for resulted from the utilities' reluctance to raise the urban minimum charge on the occasion of

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[1] One utility told of many rural consumers who try to pay off their household-connection financing in advance if they can--because they fear that the amounts owed will be increased. Frequently, such consumers pay six months' worth of amortization in advance right after the harvest.

[2] It is interesting that though the CORELPAZ rate to the consumer is the highest, this utility will be the most subsidized one in the system, because it is being created from scratch. ENDE will charge about one cent (U.S.) per kwh for the power CORELPAZ retails at six cents. This ENDE rate to CORELPAZ is about 30% less than that charged to the rest of the utilities (purchased power accounts for 50%-60% of the distribution utility's costs). ENDE will also allow CORELPAZ to treat the amounts owed ENDE for purchased power as a loan.

introducing the higher new rural minimum, out of fear that urban consumers would react to the higher minimum charge as if it were a rate increase. (A large majority of urban, as well as rural, consumers use less than the monthly minimum charged for, and thus are used to paying the same amount for electricity each month.)

Another disadvantage of the urban-rural mix and the equal rate is that the utilities know that they can count on the urban market for the good characteristics of industrial load and for steady growth. As a result, they tend to feel less aggressive about the growth of the rural market and about developing a productive load there. It is interesting that the one utility in the project that started a rural promotion program on its own--CESSA in Chuquisaca--is based on an urban system that has grown more slowly than the other systems over the last ten years (annual rates of roughly 10% vs. the 20%-25% rates of the Cochabamba and Santa Cruz systems).

Perhaps the most serious disadvantage of the urban-rural mixed utility, combined with the uniform rate, is that the rural service is perceived by utility management as less profitable than the urban service.[1] This means that utilities may give priority to urban maintenance, service and expansion. The tendency to neglect the

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[1]The Cochabamba utility had actually been against the uniform urban-rural rate, worrying that it would result in a worsening of the utility's financial situation.

rural service for the urban, of course, will be even more pronounced in times of inflation, credit contraction, and difficulty in gaining rate increases--precisely the kinds of times through which the Bolivian utilities are now passing. This type of neglect of the rural service seemed to be apparent in the ELFEC system in Cochabamba, which was delaying on plans to set up offices to service the rural system, even though it had been energized for two years. The utility had also kept consumption growth rates in the new rural system equal to those in the urban system, it said, because of the losses involved in rural services.

The final and most obvious problem of adding a rural system onto an existing urban one is the "fungibility" problem. When a utility receives large injections of outside capital for a rural system that represents a small fraction of its service and revenues--during a period when it has almost no other funds for expanding the urban and major part of its service--it will be difficult to keep this injection of funds from "leaking" into the other, more important side of the service. Or, utilities will spend the AID funds for "rural" expansion immediately adjacent to the city--expansion that they might have undertaken anyway--and invest the freed-up funds of their own into further urban service. This is probably an accurate description of what happened in the Santa Cruz system, where it was planned that almost half the household connections would go into the suburban areas on the fringe of the

city.[1] The adding on of the new rural systems to the established urban ones, in sum, means that the rural system may not get the attention and the funds it would if it were not combined with the more attention-getting urban counterpart.

Overdesign and the search for a cost-constrained environment

A further reason for the problematic transition of the AID-financed utilities from the construction to the operation phase was a certain lack of concern for cost in the project's technical design. This was, in part, a result of instructions by AID to adhere to specifications used by the Rural Electrification Administration of the United States. This meant that technical specifications were consistent with capital costs, load characteristics, per capita incomes, and transport conditions of the United States rather than Bolivia.

Some examples of inappropriate or excessive design standards, as attested to by AID and Bolivian engineers, were:

(1) The requirement of a distance not to exceed 66 meters between utility poles, as opposed to the 100-130 meters between poles that is acceptable in less developed economies. The longer distance

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[1] In addition, the annual rate of connection of these suburban consumers under the AID project (2,085) was almost 40% greater than the annual rate of connection of urban consumers during the previous five-year period (1,520).

between poles exposes the lines to somewhat higher probabilities of damage from wind, but the costs of interrupted service in a Bolivian rural system are much lower than in the United States, with its larger and more sophisticated industrial loads. In the Bolivian case, not only is the country's output considerably less vulnerable to electric power cuts or changes in voltage, but the rural systems have almost no productive load. Given that estimated costs for poles and their fixtures accounted for 35% of the AID loan, the use of a U.S. standard for pole spacing that required almost double the number of poles could not help but have had a significant impact on costs.[2]

(2) Because of the U.S. standards employed to estimate average residential consumption, as discussed above, transformer size was often considerably larger than necessary. Transformers of 50-kVA capacity were used in several instances where 25 kVA would have been sufficient.

(3) Individual house meters were used, rather than charging flat monthly rates, despite the wishes of some Bolivian power technicians. Since a large number of rural households consume no more than the minimum monthly charge, a flat monthly rate would have been

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[1]After project approval, a large cost overrun caused the specified distance between poles to be increased to 100 meters. This change is discussed below. In the La Paz and three southern systems, pole distances were set at 100 meters from the start (these projects accounted for 44% of total project investment).

reasonably equitable and accurate.[1] The costs of reading meters with the current system are significant, given the dispersion of the rural communities and the fact that many of them can only be reached by unpaved roads that are often impassable in the rainy season. Finally, meters accounted for roughly one-third of the cost of house connections and inside house wiring, thus burdening considerably the connection costs for poor households. (Meters accounted for roughly 3% of total project costs.)

(4) The capacity of the household meters was higher than the typical consumption levels of the rural users (15 amperes vs. 3 amperes). This meant that the meters were not accurate at registering the low consumption levels in Bolivia and that this inadequacy had to be taken into account in setting the minimum consumption levels to be charged for. (There was no significant cost difference in this particular choice.)

(5) In many cases, three-phase lines were installed rather than single-phase, where there was no indication that industrial loads would be forthcoming. Three-phase lines are roughly 50% more

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[1] Of the rural consumers of the Santa Cruz area, where per capita incomes are highest, between 40% and 75% consumed less than 25 kwh per month in 1979. (The minimum charged for in Santa Cruz is 20 kwh.) Data by kwh consumed are not available for the other systems, but average consumption figures are revealing: in Chuquisaca, even average monthly rural consumption (11 kwh) was considerably below the minimum of 25 kwh; in Cochabamba, average consumption (16 kwh) was also below the minimum (20 kwh).

costly than single-phase lines; they also can be added later to the single-phase system if demand warrants.[1]

(6) Voltage regulators were used to insure a fine tuning of voltage that was way beyond the needs of the system--i.e., 32-step regulators, which were three times as costly as the less sophisticated 4-step regulators. The latter were more than adequate for a system where changes in voltage would have little deleterious effect on output.

(7) Substations were said to be considerably more sophisticated than necessary; one substation in the Cochabamba system, for example, was built with 40 MW of capacity when demand was approximately 2 MW.

(8) There were too many medium-tension lines in relation to low-tension lines; thus medium-tension lines were used in cases where low-tension lines would have been adequate. This meant higher costs not only in lines, but in the costs of stepping down the power to communities along the way.

(9) A final contributant to costs was the practice of requiring the use of a single large foreign consulting firm to design and supervise the whole project, and of single construction contractors for each complete system. When one contractor is responsible for construction of a complete system, it is to his convenience to work

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[1]The cost overrun noted above also resulted in the reduction of many of the three-phase lines to single-phase; some felt that there were still many three-phase lines built in areas without the loads to justify them. As noted in note 1 on p. 34, the phase converter is a possible alternative for three-phase production in areas with only single-phase lines.

on the whole system at once in stages--all the staking at once, all the meters at once, etc. This meant that, in some of the systems, no one part of the system was energized until the last piece was in place--instead of the system being energized community by community, or sub-area by sub-area. In the Altiplano system, for example, meters were installed in user houses up to two years before the system was energized. This "indivisible" approach to constructing and energizing the system, though the most logistically and financially convenient for the contractor, was costly for the system in both economic and financial terms: (a) realization of the benefits of the investment were being delayed for one or more years, a costly delay in countries where capital costs are high; and (b) the companies were foregoing revenues that they might be earning if the system were energized community by community or area by area. Finally, management of the new system would have been easier for the utilities to absorb if it were energized gradually, instead of all at once.

The examples of overdesign illustrate not only the extent to which the project costs were greater than necessary. They also illustrate how the lack of concern for cost in design placed a burden on the administrative and financial viability of the utilities, once construction was over and operations begun. Not only would the inappropriate design standards result in a greater future burden of amortization payments for the utility, but they would also lead to

higher operating costs--the costs of reading meters being one example. These higher operating costs, in turn, contribute to the problems discussed above of the transition from construction to operation, and the inability of the utilities to connect up new customers as rapidly as they should.

Overdesign results, in part, from the structure of the project design process itself: the designers--AID and the consultants--are not those who will have to bear the burden of higher operating costs associated with inappropriate design. Indeed, there is a distinct disincentive for the consultant to use less sophisticated standards. If he strays from international standards, he may be held accountable for any inadequacies in the system; if he follows internationally accepted standards, inadequacies can always be blamed on the quality of materials and construction.

The lack of cost constraints, then, results from project design being directed by those whose business is to build things, rather than to make them yield a return. The engineer's task is completed when a structure if finished; what happens afterward is somebody else's concern. For this reason, the problem of overdesign is not an easy one to solve; it results not so much from people consciously making inappropriate choices as it does from the absence of certain cost constraints in the environment of project design, and from the lack of sufficient involvement in design of those who will have to pay the costs of overdesign.

It is interesting to note that more appropriate design standards were rapidly forthcoming on two occasions when cost constraints unexpectedly appeared on the scene. The first and most dramatic instance was completely fortuitous: the petroleum crisis of 1973 and 1974, and the resulting large overrun in estimated project costs (US$8.7 million), causing the AID Mission in Bolivia to request a project amendment to cover the new costs. Because AID/Washington agreed to finance only part of the overrun (US$4 million), something had to give. Since the Bolivians had insisted strongly on their social objectives of maximizing the number of residential connections--and since this approach was consistent with AID's New Directions--the Bolivian maximand prevailed. The projected number of household connections was considered sacrosanct and thus the only thing that could give way was the design standards. Distances between poles were readily increased to 100 meters and many of the three-phase lines were cut back to single-phase.

Another sudden appearance of cost constraints, and their effect on the choice of equipment standards, could be seen after the utilities used up the equipment and materials for house connections acquired with AID funding. Left to their own resources to finance the acquisition of such materials, the utilities reverted to simpler and less costly materials, some having felt all along that AID-designed connections were unnecessarily extravagent. This "reversion" to

less costly and sophisticated equipment, after AID's departure, could also be seen in other areas.[1]

The overdesign problem, then, requires two forms of attention: (1) a direct attempt to require standards that are more appropriate to the reality and costs of the project environment; and (2) an understanding of how project design, contracting and institutional arrangements might be altered so as to introduce more forcible cost constraints into the design environment. One way to achieve the latter would be to give more voice in the design process to those actors who will be involved in the operation of the system, and thus will be more concerned about cost implications of design choices; another way is to allow more voice to those actors from the host country who object to design choices on the grounds of cost and appropriateness. A review of the history of the technical choices made for the project showed that Bolivian engineers and project managers who had objected to certain technical choices on the grounds of inappropriateness and cost ultimately gave in, as they said, to AID and the U.S. consultant; there was no chance of winning a disagreement with a large U.S. contractor, they said, because AID "would go along with" the contractor's judgment and because it was important "to keep in the good graces" of the donor.

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[1]For example, one of the smaller utilities stated that if a community that used electricity only for lighting suffered a power failure, the utility felt it could allow up to two days to pass before repairing the failure. Yet the systems were designed so as to be compatible with a much higher standard of service reliability, which therefore turned out to be an unnecessary additional investment.

An antidote to overdesign and other problems

One approach to some of the problems discussed here is a more piecemeal pattern of design and construction. Some have suggested that part of the post-AID problems could be diminished if the system were not so completely specified beforehand. In contrast to the usual practice of having a single large foreign consultant design the whole system, down to the specification of each community to be connected, this alternative approach would specify beforehand only the primary distribution lines and the areas to be connected, leaving it up to the commercial department of the utility, after the basic system was in place, to connect up communities as it became fit. The advantages of this more piecemeal approach to design are considered to be:

(1) The process of selecting communities to connect up is placed under the charge of the commercial department of the utility, which represents those who are most preoccupied with the revenue-earning capacity of the system, and thus more subject to the otherwise elusive cost constraints. (2) The piecemeal approach allows for a public specification of the criteria for connecting communities, and a consequent placing of the burden on the community to seek out the utility, to show that it meets the criteria and, if appropriate, to come up with some of the connection costs. (3) By deciding which communities to connect only later on in the construction process, one

avoids the pitfalls described above of (a) connecting communities that do not turn out to have the population or production potential that they seemed to several years previous, and (b) leaving out communities that have turned out to be dynamic and more populated in the many years intervening between traditional project design and termination of construction. (4) The piecemeal approach to design facilitates the mobilization of community organization and resources in connecting up to the system, thus tapping the private-sector capital that is available for expansion of the system, capital that lies unused under the present approach. (5) The proposed approach allows the system to be energized as one goes along, making for a more rapid realization of economic and financial returns on the investment, and breaking up the expansion process into more "digestible" pieces for the utility.

(6) The piecemeal approach allows the company to contract out much smaller pieces for construction than the traditional approach to contracting out the whole system to one construction firm. The latter approach not only requires adapting to the contractor's convenience of energizing the whole system only at the last minute; it also makes it quite difficult to get rid of a contractor for unsatisfactory performance, and to start with a new one, because of the high cost involved in stopping construction on the whole project until a new contractor is found. More than one AID or Bolivian

technician spoke of how contractor performance was woefully inadequate in some cases, warranting termination of the contract and letting of new bids. But because the contractor was responsible for the whole system, they were loathe to undergo the high cost of stopping construction on everything. Smaller construction tasks let out to several contractors, they felt, would make it less costly to replace an inadequate contractor, since the replacement process would not jeopardize the pace of construction on the rest of the system. The ability to replace contractors when performance was inadequate, in turn, would contribute to a more competitive environment between contractors and, hence, better performance.

(7) The letting out of small construction tasks to many contractors, it was felt, would result in better control by the executing entity and better contractor performance because a contractor would be bidding for a small geographic area that was more comprehensible, and the demands of the task would be more concretely understood. The single large construction task, it was felt, was much more difficult in terms of eliciting realistic commitments; contractors often made serious misjudgments about their ability to get equipment into the area, about labor practices, etc. (8) Dividing construction and community selection into smaller discrete tasks, it was also felt, would make it easier for local contractors, with more limited capacity than large foreign contractors,

to participate in construction. It was also felt that local contractors, by virtue of their more limited equipment and capital resources, were accustomed to using more appropriate and labor-intensive construction techniques. The large equipment used by the single foreign contractor, it was felt, was often associated with long delays for importation and serious difficulites and delays in transporting equipment to the site, given the accidented terrain of much of Bolivia and the relative absence of paved roads.

This suggested approach has been elaborated in some detail here as a way of illustrating possible ways of thinking about problems discussed in this evaluation--namely, the lack of cost constraints in the design of AID rural electrification projects, the overemphasis on the construction task in contrast to a certain neglect of the ensuing operations and revenue-earning task, and the making of technical choices by those who will not have to concern themselves with the financial viability of the system, once it is in place. Talks with project designers in AID and recipient countires would probably turn up myriad other suggestions for dealing with these problems. The importance of facing up to these problems lies in the fact that they inhibit the ability of AID's electrification projects to realize their intended impacts.