

OED Précis



Operations Evaluation Department

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Rural Electrification: A Hard Look at Costs and Benefits

In a study of rural electrification (RE) in Asia, OED notes that while RE projects supported by the World Bank have had a satisfactory record overall, their economic returns have been considerably lower than projected and a wide range of expected indirect and external benefits have not materialized. In India RE has had a crucial role to play in the spread of irrigated farming, in conjunction with other agriculture development programs. But experience in general shows that RE does not provide a primary stimulus for regional development through industrial growth. The study recommends more rigorous economic and financial analysis and improved tariff and demand management policies.*

The introduction of electricity often profoundly affects village life. Electric lighting expands the productive and social hours in the day. Radios and television provide accessible, affordable entertainment and education. Power machinery can raise productivity and improve working conditions. Most important, electrification brings with it expectations for progress and a better future.

Yet in many countries, where other infrastructure such as roads, drinking water, and sanitation is also needed, village electrification does not receive the priority allocations for subsidized funding that its advocates would wish to see. Expe-

rience in Asia suggests that the main reason is that most RE programs have cost more and yielded fewer benefits than expected. (Box 1.)

Costs

It costs more to provide electricity to rural than to urban communities. Economic and financial appraisals of RE projects have consistently ignored the financial implications of this difference for the supplying utility.

Investment costs

The higher rural investment costs—measured as capital infrastructure costs per kilowatt hour consumed—partly reflect the lower density of rural connections and the smaller amounts consumed by those connected. These costs depend on the community's distance from the existing medium voltage grid, and on the community's size and potential demand pattern. Since RE programs can easily overextend themselves, project appraisal needs to focus more attention on identifying the economic limits of extensions to the grid and on the economic potential of alternative energy sources, particularly solar energy.

Investment costs per unit of demand are higher in rural areas

because the bulk of demand in rural areas is for lighting during the early evening. Thus the ratio of average demand (which determines financial and economic benefits) to peak demand (which determines investment cost) is much lower in rural systems than in urban, where there is considerable daytime electricity use.

Generation costs

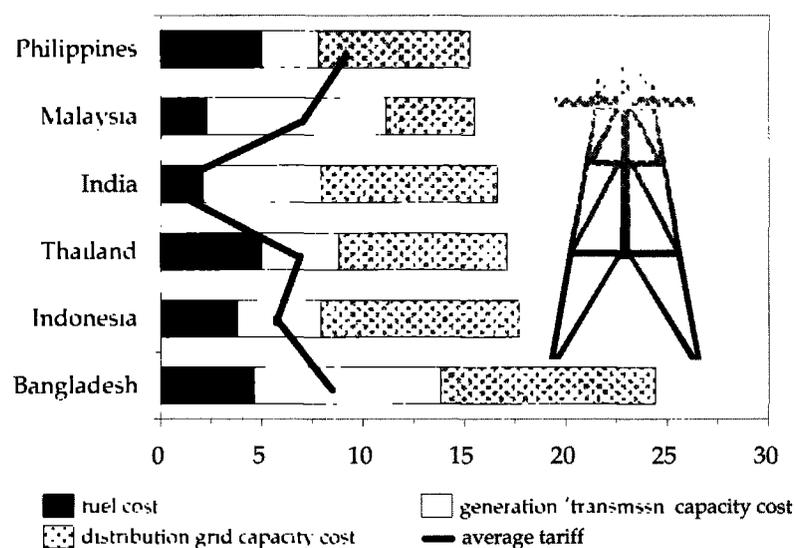
Largely because rural demand is concentrated at the time of the national system's peak load, generation costs are higher for rural than for urban consumption. The cost of generating electricity to meet peak load demand is often more than double the long-run marginal cost (LRMC) averaged over the entire day (or year).

Benefits

Many of the benefits claimed for RE have not materialized, or

* "Rural Electrification in Asia: A Review of Bank Experience", Report No. 13291, June 30, 1994, by Richard Berney, Alvaro Covarrubias, and Alain Barbu. This report is available to Bank Executive Directors and staff from the Internal Documents Unit and from Regional Information Services Centers.

Rural electricity: supply costs vs. tariffs
(low voltage use; 1993 US cents per kilowatt-hour^a)



a. Load factor 35 percent, including peak periods.

have been much smaller than expected. One of the most persistent claims for RE is that it can induce industrial growth in otherwise lagging low-income rural economies. The evidence from developing countries does not support this claim; RE has not, by itself, triggered industrial growth or regional development. In certain circumstances, however, it has supported growth led by a dynamic agricultural sector.

The study found that where other prerequisites of sustained development were absent, demand for electricity for productive uses did not grow. (An important exception is demand for electricity for water pumping to spread irrigated farming.) Without agricultural growth, the use of electricity in rural areas has remained low, and many of the expected economic benefits of electrification have not been realized.

OED's findings support that of the World Bank's 1975 Rural Electrification Policy Paper: investment in RE is economically justified only when the emerging uses of electricity are strong enough to ensure suf-

ficient growth in demand to produce a reasonable economic rate of return on the investment. The Bank has not fully applied this criterion in appraising its RE projects in Asia.

Although RE in Asia may not have been an engine for economic growth, it has provided significant benefits. Many of these benefits have been underestimated, for three reasons:

- Where tariffs are far below economic costs, and demand is constrained by non-price factors, conventional rules of thumb for establishing the demand curve often underestimate the benefits that consumers derive from electricity. The most common error is to assume that the observed consumption level represents a point on the demand curve, when in fact it may be far below the demand curve because consumption is being held down by inadequate supply.
- The economic benefits of electricity may be difficult to measure on the basis of the cost of substitutes. For instance, because electric lighting provides an order of mag-

nitude improvement over lighting from candles and kerosene, electric light is much more than a simple replacement for kerosene.

- Even if a substitute is deemed to exist for electricity (as with the use of diesel pumps in irrigation, for example), microeconomic rate of return calculations may be flawed for two reasons. First, observed consumer behavior and underlying prices are often distorted by taxes, subsidies, and lack of information about access to rural credit. Second, assumptions that may be valid for a small project, taken in isolation, do not necessarily apply to a massive RE program; on that scale, diesel fuel may not be available, and prices and benefits may differ.

When this happens, RE may be in a unique position to promote a paradigm shift in agricultural production, by making possible irrigation and associated modern technology and practices. This occurred in the Indo-Gangetic plain of the Indian subcontinent and in some areas of China. Project analyses have failed to evaluate the alternatives and to account for the indirect benefits of national and regional food security and the accompanying low and stable food prices that may flow from RE.

Box 1: Scope of study

The study focused on Asia because of the substantial experience gained through Bank-financed projects in this region over many years. It examined ten completed RE projects in Bangladesh, India, Malaysia, the Philippines, and Thailand, drawing on OED performance audits, World Bank country sector studies, and recent evaluations of RE investments in Asia undertaken by national, bilateral, and international sources

Cost recovery

All the evidence to date, including that from Bank-financed RE projects in Asia, shows that RE does not directly reduce poverty by helping the poorest rural people. Most of the direct benefits from rural electricity go to wealthier people. Even when tariffs are low, potential consumers cannot always afford the initial connection and household wiring. Once connected, the amount of electricity consumed, and therefore the benefits obtained, depend on the ability to buy electrical equipment, whether light fixtures, televisions, fans, water pumps, or motor-driven machines. Evidence from Indonesia suggests that the poorest 25–50 percent of the population could not afford electricity, even if connections were to be financed through power company loans. Direct observation tends to support this supposition for most countries with per capita rural incomes of less than \$200 a year.

RE reduces rural poverty only through a general rise in rural income obtained by productive uses. And—again with the exception of irrigation pumping—these productive uses of electricity appear to come about only when other factors are already raising rural and national per capital income, as has been the case, most noticeably, in Malaysia and Thailand.

Hence the justification for investing in and subsidizing RE programs needs to be based on their ability, after a start up-phase, to elicit a sufficient level of consumption at an economic price. All proposed projects should therefore provide estimates of expected consumption growth.

Although most RE schemes in Asia have generated substantial economic benefits, they have had a dismal cost recovery record, even without taking account of peak load generation costs. While the capital and operating costs of generation,

Box 2: Recommendations for the Bank

Strengthen economic and financial analysis of RE projects during appraisal.

- The rationale for supporting projects should be based on the real economic benefits they create, a rigorous quantitative analysis is needed to reflect the specific benefits expected from the project, including, most importantly, a projection of the expected growth in electricity consumption in the project area.
- Calculations of the cost of providing electricity to the RE distribution grid should be based on the cost of meeting the anticipated load curves, including providing peak load power for rural consumers.
- The Bank should carry out detailed financial analysis of ultimate beneficiary utilities. It should include a calculation of the financial returns from future projects and a full analysis of the implicit and explicit subsidies required.

On tariff policy, lending for RE should be subject to the same rules as lending for other power projects.

- Tariffs should be set high enough to avoid the need for ongoing operating subsidies to RE programs. They should cover, at a minimum, the full cost of generation and transmission to the medium voltage transformer station, plus operating and maintenance costs.

- Subsidies should be limited to a portion of the distribution system's initial capital investment costs, which can be controlled by the funds available at the time of the investment

- Low lifeline tariffs are an exception to the above rule, justified on income distribution grounds, but they should cover only a small block of electricity related to a minimum use level.

- To implement these recommendations and promote conservation all consumption should be metered.

Utilities should be requested to maintain separate monitoring systems, including separate financial accounts, for RE systems, so that individual RE loans, real costs, and monetary implications can be identified and analyzed.

transmission, and distribution are significantly higher for rural communities than they are for urban, rural tariffs have been at best equal to, and in many cases much lower than, urban tariffs. Only 10 to 50 percent of the economic cost is generally recovered. Thus RE has usually been highly subsidized, either indirectly by urban industrial users or directly by government allocations.

Implications

Implicit subsidies of RE programs can significantly depress a utility's financial performance. Unfortunately, many of the Bank's appraisals of power projects have failed to analyze the financial implications of

subsidies to RE, particularly where apex institutions are used to onlend to utilities.

Where cross-subsidization from urban/industrial consumers has been inadequate, power companies have suffered debilitating financial losses—often with serious national economic consequences.

Where struggling power utilities cut service at the national or regional level, the impact on the country's economic growth can be serious. In India and the Philippines, for example, financial difficulties have made utilities less willing and less able to support the growth of rural networks.

More important from a national economic development perspective, revenue shortfalls have also made it difficult to maintain acceptable power supplies for urban/industrial consumers. And the subsidized bulk supply of grid electricity to RE systems can stifle the emergence of alternative energy supply that would make economic sense in an undistorted market.

As with other power sector projects, a rational system of cost recovery is a key policy ingredient of any RE project. (Box 2.)

Conclusions

Rural electrification may be economically justified after all the benefits are accounted for and given the value that is appropriate. However, before starting a RE investment program those in charge must consider the following:

- rural electrification rarely supports itself financially, at least in the first years;
- government resources available to support RE are very scarce;
- these resources could be used in alternative ways to enhance living standards in rural communities.

Policy implications

- Strictly screen RE investments on the basis of quantifiable benefits;
- recognize the need for rational cost recovery policies;
- analyze the project's financial impact and return;
- carefully review subsidization policies;
- monitor growth in electricity consumption, to be able to judge project success.

Bank management, responding to the recommendations of the study, noted that many are already incorporated in ongoing operations. However, while acknowledging OED's justifiable concerns about financial accountability, management expressed strong reservations about the practicality of requiring a financial rate of return estimate for borrower utilities or for RE initiatives. It is difficult for utilities to maintain separate financial accounts for RE systems, especially since rural areas become urban over time. And in some countries, preparation of a complete financial appraisal of each beneficiary may be too burdensome for project

preparation. Instead, management proposed to continue its practice of concentrating on economic costs and benefits and the financial health of the utility as a whole.

The Joint Audit Committee of the Bank's board of executive directors noted that the study raised the standard against which the board would need to justify approving new RE operations. For further attention by the directors, it highlighted OED's recommendations for strengthening the economic and financial analysis of projects during appraisal. On tariff policy, the committee noted the need for further research, to assess the results of various tariff options. It noted that if tariffs are high enough to ensure the utility's financial health, and cross subsidies do not greatly distort demand or worsen the access of poor people to electricity, then the Bank should not preclude the consideration of technically and economically justifiable RE projects. Since governments have limited resources available for redistribution to rural communities, rural electrification needs to compete with other worthwhile projects for these resources. This competition should be based on guidelines that are as rational and transparent as possible. Most importantly, they should allow for local participation in the decision making on local infrastructure investment.

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