

The Economics of Rural Electrification

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With today's increasing demand for electricity and the massive rural electrification programme being carried out in Sri Lanka this discussion by R. Ramanathar of the Plan Implementation Ministry's Regional Development Division raises many topical issues.

Rural electrification in this paper is referred to as the electrification of rural areas using the Grid system. Electrification of rural areas is a modernising factor in the social and economic facets of human life. It is often claimed that rural areas need to be supplied with electricity if economic development is to occur. But the scarcity of resources with alternative investment needs raises the economic aspects of electrification vis-a-vis other investments needs. World Bank studies revealed that in a number of countries the experience with rural electrification has not been satisfactory. This might be due to poor identification, preparation and approval of projects in areas with a low economic activity. But in Sri Lanka in the context of integrated rural Development Projects, electrification is not the only investment, but is accompanied by complementary investments on irrigation, water management, extension services, credit, roads, industries etc., needed to increase output and income in the area. Further, the demand for electricity has increased as a substitute for other sources of energy in view of the price-hike in fuels. Hence there is a strong likelihood, in achieving the intended economic performance of rural electrification in Sri Lanka.

Capsule Background

In this article a capsule background of the present status of rural electrification in Sri Lanka is given. Attention is focused on certain vital economic characteristics of rural electrification. Further, the economic approach that is specially applicable to rural electrification vis-a-vis urban electrification is also discussed. It would appear from the discussion that the producer

surplus approach and not the consumer surplus approach is most appropriate in analysing rural electrification projects especially when this is viewed in a production context. This has to be so when an investment in electrification is integrated with complementary investments in rural areas to bring about an increase in production and income.

In the early 1950s there was hardly any rural electrification in the true sense of the term in Sri Lanka. Small village communities in rural areas have developed small electricity schemes of their own. Electricity was available only in Municipal and Urban Council towns. Financial provision for rural electricity schemes was first made by the government in 1955/56. The qualifying criterion then applied was 20 percent annual return if funds were obtained through loans and 12 percent if funds were generated. Very few projects satisfied this criterion. Rural electrification was first taken up in an organised manner in 1916.

Annual return was fixed at 5 percent with the formulation of a "50-village scheme". The Cabinet paper of February 1967 launched a "500 village" rural electrification project. The Ceylon Electricity Board was established in 1969. The following are the figures of rural electrification schemes created:

Upto	1971	..	287
	1972	..	59
	1973	..	66
	1974	..	65
	1975	..	129
	1976	..	178
	1977	..	161
	1978	..	280
	30-6-1979	..	211
	Total	..	1436

Apart from these schemes, the village committees supply electricity to a number of villages from bulk supplies given to them by the SLEB. As these schemes cover roughly about 2000 villages which constitute nearly 10 percent of the total number of villages in Sri Lanka, it has been estimated that 5% of the rural population (households) have received electricity upto the end of June 1979. From 1971-1977 there had been a growth rate of nearly 8.7 per cent per annum in the domestic consumers of electricity in rural areas whereas the growth rate in commercial and industrial consumers during the same period was only 6.8 percent per annum. With the liberalised economy and the removal of restrictions on the import of electrical appliances etc., coupled with rural development programmes the demand for rural electricity is expected to have a sharp growth rate. The number of rural households coming up per year is around 20,000. The S.L.E.B. has a programme to execute 200-250 village schemes a year and the result would be about 10,000 rural households getting electricity annually. The government proposes to increase the rate of electrification to 500 villages a year. The potential for rural electrification is high and the task is formidable.

Economic Characteristics

- (a) The initial investment cost tends to be more than double than that for urban areas, because of the distance of the demand centres from the Grid network and the relatively low population densities compared with urban centres. The high costs are

TABLE I

Population range	No. of villages	Percentage of total villages
0 - 599	.. 14,551	78.6
600 - 999	.. 1,913	10.3
1000 - 2999	.. 1,773	9.6
3000 & Over	.. 265	1.5
	18,502	100.0

mainly attributed to 33 the KV lines involved. The low population density in the rural areas in Sri Lanka could be seen in Table I.

It is observed that costs decline with the increase in consumer density, especially when the demand for electricity in rural areas is limited as at present mainly to domestic uses. The Kenya Light and Power Company reports that for a rural centre with 500 persons per square mile, the initial investment costs are \$1,777 per KW, whereas for a centre of 3 times this population density, investment costs per KW was only \$250 (1971 prices).

(b) Costs increase sharply with the distance of the demand centre from the Grid. Also equipment costs per unit capacity increase with reduction in size. This gives rise to heavy initial investment and at the same time to poor economic viability of the project. In such cases the economic viability of using diesel operating sets vis-a-vis the Grid System could be considered.

(c) Low level of consumption especially in the early years of the project is another characteristic of the rural electrification projection. In the initial stages the probability of an increase in electricity adoptors occurring is also slight. In between these stages, the increasing rate in electricity adoptors is followed by a decreasing rate. This could be illustrated by a bell-shaped time distribution of consumers and S shaped Logistic CUMULATIVE distribution as seen in Figures I and II.

(d) Associated with (C) are low-load factors in the early years. "The load factor is the rate of the number of K.W. hours supplied during a given period to the number that would have been supplied, had the maximum demand been maintained throughout the period"—UN publication on Rural Electrification. There is a strong co-ordination between the costs of supplying electricity and load factors. The World Bank has reported that load factors typically improve from about 30 or 40 percent over a period of 10 years. Annual load factors of 50-60 percent are considered very satisfactory. It is observed that in Sri Lanka the potential for domestic load is high due to high literacy rate which is around 87 percent and to other favourable factors like proximity to motorable roads to villages. There is a great potential in the Agricultural sector for Electric Power. The pattern of electricity consumption in electrified villages is indicated as follows.

60 percent	..	domestic purposes
28.5 percent	..	commercial purposes
11.5 percent	..	industrial purposes

The demand load can be improved by:—

- (a) Standardised low-cost wiring, for poor sectors.
- (b) Organising agencies for wiring work and standardising hardware.

(c) Providing loan facilities on easy terms to meet the cost of service connections.

There appears to be a good potential for productive load. This can be exploited by:—

(a) Providing incentives to entrepreneurs in rural areas. In UK the Regional Development Policies provide a variety of incentives to manufacturing firms to move into the regions. Assistance in the form of grants are given to firms for modernisation of factories as well as for projects likely to provide extra employment.

(b) Conversion of existing diesel-kerosene driven machinery and equipment to electricity.

(c) Provision of loans facilities on easy terms for conversion to electricity.

Since the peak load is determined by domestic lighting, it is considered desirable to have a higher proportion of industrial to domestic load in these schemes. Financial performance of rural electrification projects is generally poor.

The initial investments are bulky and initial returns are poor. When electricity is made available from the Grid to small units scattered over long distances, the concentration or load per unit area is much less and the growth of the load could be slow. The construction costs have increased by nearly 2.5 times in 1977 as against 1973 and they are still escalating. The cost of generation, transmission and distribution per KWH ranges from 25-60 cts. The tariff rates have not undergone necessary changes. Under these circumstances financing of rural electrification schemes cannot be subjected to the normal tests of return on investment. The economic picture is somewhat more optimistic than the financial one. In the economic analysis, shadow price adjustments for labour, etc. and savings derived by government and private sector on fuel costs and other economic benefits generated would be generally favourable to rural electrification projects. For example, in the case of Sri Lanka's

CLASSICAL MODEL OF ELECTRICITY DIFFUSION

Fig. 1. Time Distribution

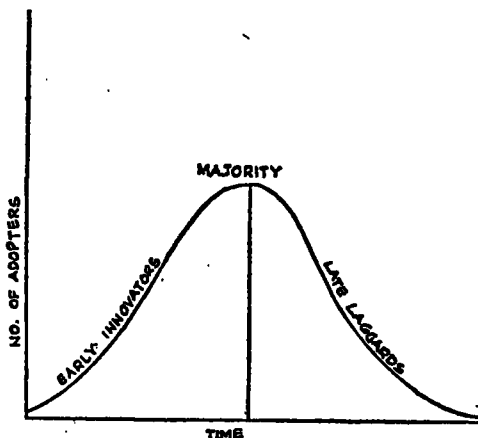
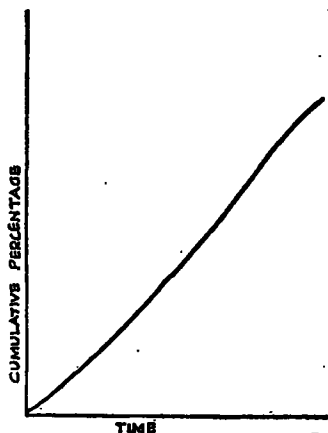


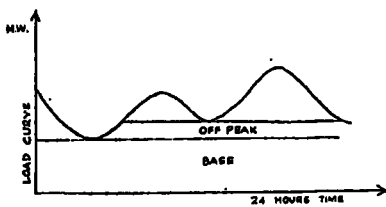
Fig. 2. Cumulative Distribution



rural electrification projects undertaken by the S.L.E.B. the internal rate of return calculated districtwise could vary from negative to plus and the average economic rate of return would be as high as 15% (leaving out producers' surplus and externalities). However, the significance of the financial analysis in terms of commercial profitability brings out certain implications for suitable policy decisions regarding subsidisation by the government.

Invariably, the financial performance is a consequence of poorly designed tariffs. The designing and implementation of a tariff system based on marginal costs theory is a complex one due to various factors. The demand for electricity varies throughout the day due to its different uses which can be explained by consumers' behaviour. A typical load curve is shown in Figure 3.

Fig. 3 - Load Curve



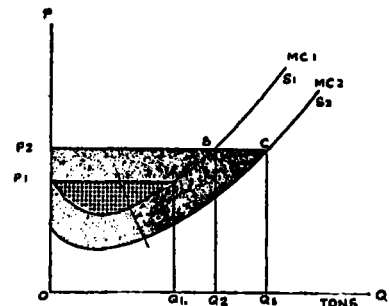
Different products are produced depending on the time of the day, and the marginal cost of production is obviously different. Therefore if one wants to calculate or design a marginal cost based tariff the demand in the future and how it would be satisfied must be known. The characteristics of the demand and the shape of the load curve are subject to variations. The complexity of the tariff system is also brought about by the different modes of generation, transmission and distribution of electricity and the marginal costs connected with them. But from the consumers' point of view the tariff system should be simple and easy to understand. In Sri Lanka the uniform tariff system provided for both urban and rural supply of electricity and the uniform rates for both day and night are subject to criticism. On the one hand, costs of energy supply to

rural areas is higher than for urban areas and on the other hand, the value of services to the consumer may be low. Therefore tariff for rural areas presents special problems. The substantial portion of the costs of electricity consists of depreciation and interest charges. Generally the fixed cost is determined by the kilowatt supply and the variable cost by KW hours supply. There is also the consumer costs that is relative to the number of consumers. From the cost point of view the best structure of tariff appears to be that which contains: (a) KW charge, (b) KWH charge, (c) Consumer charge. Also the government has social and economic aims in rural electrification. The tariff structure should be designed to achieve these objectives. Presently the domestic tariff is based on a block system. The first block of 50 units has a higher rate than the balance units consumed. The domestic consumer constitutes nearly 60%. The declining block tariff system to all consumers has several defects and its application to the rural areas is questionable. It does not take advantage of the "ability to pay" principle, and therefore keeps financial returns down and has no economic merit. Further, it goes against the fairness principle to the small consumers. In order to raise financial return and to take care of efficiency and fairness appropriate tariff charges appear to be necessary.

Rural electrification needs to be viewed in a productive context, because of its wide range of uses for productive purposes in both agricultural and small industrial sectors in rural areas. It is a new good opening up the areas for development. There are direct effects on development and output and effects related to avoidable costs to the economy. It will be increasingly possible to have small scale that are technologies and produce items competitive in prices and quality in the rural sector. The consumer surplus approach defined as the difference between what they might be willing to pay for a good or service and what they actually pay applicable to urban electrification is inadequate to consider the mechanism through which "savings" are translated into a new output and

income. Also it does not take into account other constraints on development. These are better considered by the producer surplus approach which assumes that rural electrification is integrated with complementary investments. The producer surplus approach is illustrated in Figure 4.

Fig. 4 - Producer Surplus



This figure illustrates the production situation say, for a commodity. Without electrification the quantity is Q_1 at price P_1 . Without project producer surplus is equal to the area below P_1 and above S_1 curves. The charges due to electrification and other complementary investments are reflected in a higher price P_2 due to savings in cost by way of electricity. At P_2 farmers produce Q_2 . The MC shifts from MC_1 to MC_2 again increasing net income at P_2 . Output increases from Q_2 to Q_3 at lower costs and use of new technology. Thus rural electrification and complementary investments have induced the change from Q_1 to Q_3 and the producer surplus becomes the area between P_2 and S_2 with and without electricity and other complementary investments.

It is assumed in the analysis that electricity cost savings are fully passed on to the producer. This approach emphasises the importance of integrated area development planning and the perfect co-ordination of the various components in implementing the development programmes of the government. In this article I have briefly discussed the salient economic implications of rural electrification in Sri Lanka. This is of topical interest in view of the massive programme launched by the government in expanding electricity supplies to the villages.