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amounts may be sanctioned on a guarantee by the State Government. In order to reduce their own financial liability, the State Governments may extend the guarantee only to small farmers as the large farmers can find alternative sources of finance.

The panchayats can also help in the extension of rural electrification and the utilization of electricity by the small farmer. The panchayats can give the electricity deposit to the State Electricity Boards and also purchase the pump sets. These pump sets may then be given on hire to the cultivators who have wells, and the cultivators who hire the pump sets may be given the right to sell water at fixed rates to the other cultivators. The finances of the panchayats, however, are not likely to be adequate for the electricity deposits and the purchase of pump sets. The panchayats may, therefore, either be financed by the commercial banks on a State guarantee or they may be given specific grants or loans by the *Panchayat Samitis*.

While the methods suggested above help the small farmer, the problem of the small village still remains. The small village can be covered by rural electrification if the village approach is given up in favour of an 'area' or 'cluster' approach.

The methods suggested above will help in the expansion of the programme of rural electrification, and substantially extend the benefits of the programme to the small village and the small cultivator.

INVESTMENT: REVENUE RATIO OF RURAL ELECTRIFICATION VERSUS AGRICULTURAL ELECTRIFICATION*

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Introduction

To the Indian farmers electricity is by no chance a luxury; it is a vital necessity—a life-giving energy for increasing agricultural production and productivity through lift irrigation, more efficient processing of farm production, establishment of cottage industries and what is more, for giving them a source of security and developing a forward outlook. Throughout the country, there is huge demand for electricity in the villages. Until the start of the Third Plan, rural electrification programme in India was mainly conceived for electrifying villages for lighting purposes but not for energizing pump sets. The programme for energizing pump sets has been given priority since 1966-67.

* This paper is written under the guidance of Dr. S. M. Patel, Professor, Indian Institute of Management, Ahmedabad for which the author expresses his deep sense of gratitude.

The Planning Commission and Government of India have urged the States from time to time for bestowing special attention to rural as well as agricultural electrification. It is expected that during the Fourth Plan about 7.3 lakh pump sets would be energized against the achievement of only 4.5 lakh pump sets during the first three Five-Year Plans.

In India, the biggest hurdle faced by the State Electricity Boards for extending their services in rural areas is inadequacy of funds for distribution network which hampers the growth of rural/agricultural electrification. The State Electricity Boards have to procure funds for development work from other agencies as they do not have their own savings for ploughing back in the business. The State Electricity Boards have therefore to prepare economically viable plans for rural/agricultural electrification so as to meet with the requirements of the lending agencies. In such a situation, investment: revenue ratios for extension plans should be oriented towards better utilization of the investments rather than considering electrification as merely a subsidized activity.

Rural Electrification in Gujarat State

The Gujarat Electricity Board (GEB) also had gradually accepted rural orientation in its electrification plans. The progress of rural electrification during the Five-Year Plan periods was as follows:

TABLE I—PROGRESS OF RURAL ELECTRIFICATION IN GUJARAT

Period	Number of villages and rural areas electrified	Percentage to total villages
End of First Plan	105	0.05
End of Second Plan	828	4.29
End of Third Plan	1,840	9.58
End of 1968	2,665	13.88

Looking to the total number of villages to be covered under electrification the coverage is not very significant even though the growth rate is phenomenal. Moreover, the benefit of electrification is not evenly distributed over different sizes of villages, as the bigger villages are electrified to a greater extent than the smaller villages. Up to the end of Third Five-Year Plan, rural electrification under normal scheme was mainly for lighting purposes in the village and selection of a village for electrification was based on population of the village rather than the number of agricultural connections. In such normal electrification scheme the LT lines passed through the village streets for domestic, street lighting and industrial purposes. Along with such electrification a few convenient agricultural connections were also granted. Thus an electrified village under normal scheme would have many wells (located at distant places from the transformer centres) not electrified.

In the meeting of the National Development Council in September, 1965, it was decided to give higher priority to agricultural electrification with a view to enhancing agricultural production. The electrification plans of GEB were, therefore, oriented towards electrification of wells rather than electrifying the entire village for all purposes from 1966-67 onwards.

Agricultural Electrification in Gujarat State

The GEB took a keen initiative in such agricultural electrification programme and accorded the top most priority to well electrification rather than all purpose rural electrification. Confronted with the limitations of resources, both in terms of electricity to be supplied and finance to lay out distribution network, the GEB reallocated priorities and decided to concentrate on electrification of wells without releasing power for other purposes, viz., home lights, street lights and domestic uses in the rural areas. Thus, under the new scheme the farms got electrified even though the village-site was not electrified, as the transmission lines were drawn for the consuming points in the outskirts of the villages. In such agricultural electrification, the planning of distribution network was oriented towards well electrification which provided three phase motive load connections for motors operating pumps. Along with agricultural connections, a few motive load connections for non-agricultural purposes were also granted if the consumers shared the cost of LT lines. The shift from rural electrification (general purpose) to agricultural electrification (specialization) seems to be production-oriented even though it was initially brought in on account of change in sources of funds for electrification.

The impact of such a shift in policy is exhibited in the total number of agricultural connections granted after 1965-66 as indicated in Table II.

TABLE II—PROGRESS OF AGRICULTURAL ELECTRIFICATION IN GUJARAT STATE

Year	Number of agricultural connections at the end of the year	Year	Number of agricultural connections at the end of the year
Prior to 1951	.. 500	1964-65	.. 10,316
1955-56	.. 2,000	1965-66	.. 15,240
1960-61	.. 5,401	1966-67	.. 26,261(Big leap)
1961-62	.. 6,483	1967-68	.. 37,662
1962-63	.. 7,548	1968-69	.. 50,000(Estimated)
1963-64	.. 8,807	1969-70	.. 65,000(Proposed)

The data indicate that during the year 1966-67 electrification of wells has taken a big leap. The rate of growth per year has surpassed even the total of previous five years. In the later years also the high rate of progress has been maintained.

Electrification of wells involves a huge financial investment, for distribution of electricity in rural areas where connections per unit length of transmission line are lesser as compared to those of urban areas for industrial/motive loads. Thus, the finance for distribution network constitutes a huge bottleneck in the rapid growth on agricultural front. Such a tight situation demands rational utilization of the available resources, especially finance.

In this context, it becomes pertinent to see whether the new policy of GEB (*viz.*, giving priority to agricultural electrification instead of rural electrification in general) is economically worthwhile or not. When the resources available are less than the required quantity, it becomes imperative to devise a policy that gives priority to only that activity which is financially sound and gives adequate returns for ploughing them back in extending the services for achieving other socio-economic objectives.

Empirical Study

With the objective of examining the economic justification of the new policy of GEB, a study was taken up in eight selected villages of the two sub-divisions of GEB, *viz.*, Rampur and Vijayanagar. From each sub-division four villages were selected with the following criteria :

- (a) Two villages were selected from the villages covered by normal electrification scheme where both agricultural as well as non-agricultural loads were granted.
- (b) Remaining two villages were selected from the villages covered by only agricultural electrification scheme where three phase motive load connections were granted for electrifying pump sets, besides a few industrial connections for processing and rural industries.
- (c) While selecting the villages care was taken to see that one village of normal scheme was comparable with one village of agricultural scheme in terms of distance from main HT line, number of motive load connections, etc.

Based on these considerations the following villages were selected :

Sub-division	Normal scheme	Agricultural scheme
Rampur	1. Duttal	5. Amargarh
	2. Kothwal	6. Mangalpura
Vijayanagar	3. Petsar	7. Chadiad
	4. Laxmipur	8. Mitral

The number and type of connections in these villages are given in Table III.

TABLE III—CONNECTED LOAD FOR DIFFERENT PURPOSES IN SELECTED VILLAGES (JUNE, 1968)

Village	Connected load (actual) kW				Total connected load (kW)
	Agricultural*	Industrial*	Domestic**	Street light**	
A. Rural/normal scheme					
1. Duttal	148.12 (12)	22.5 (3)	28.5 (57)	1.05 (36)	200.17
2. Kothwal	71.25 (7)	22.5 (3)	39.0 (78)	1.45 (58)	133.75
3. Petsar	215.62 (36)	52.5 (7)	60.0 (120)	1.70 (67)	329.82
4. Laxmipur	88.12 (14)	78.75(12)	93.5 (187)	2.00 (79)	262.37
B. Agricultural scheme					
5. Amargarh	121.87 (10)	—	—	—	121.87
6. Mangalpura	39.37 (5)	7.5 (1)	—	—	46.87
7. Chadiad	151.87 (20)	15.0 (2)	—	—	166.87
8. Mitral	65.62 (9)	—	—	—	65.62
Total	901.84 (113)	198.75 (28)	221.0 (442)	6.20 (249)	1,327.79

Note: The figures in brackets indicate the number of connections.

* Motive load connections.

** Non-motive load connections.

Investment for Electrification

The investment for electrification of a village here denotes the total investment for the distribution system¹ for supply of electricity. It starts with 11 kV tapping from existing pole on HT line and includes intermediary items of distribution till the power reaches the consuming point, *i.e.*, upto the energy meter.

The total investment for electrification per village differs both in terms of amount and contents. For the villages covered under rural/normal electrification scheme, it is composed of two types of costs, *viz.*, cost of HT line and LT line, etc., for motive load used for three phase, electric motors and non-motive single phase loads used for fans, radios, lights, etc., in the village. For villages under agricultural scheme it is composed of the distribution system for motive load connections—mainly for agricultural purposes.

All the villages were not electrified during the same period and therefore the actual cost incurred on their electrification would not become comparable simply

1. Investments for generating capacity and distribution lines up to 11 kV tapping point are not considered as cost of electrification at this stage.

because of the differences in the rates for material and labour used at different times. To take care of this difficulty, the actual inventory of all GEB assets on June 30, 1968 in the respective villages was taken and was evaluated by GEB's standardized price pattern for 1968. The resultant figures showing the investment for electrification of the selected villages are shown in Table IV.

TABLE IV—INVESTMENT BY GEB IN DISTRIBUTION NETWORK FOR THE SELECTED VILLAGES

Sr. No.	Villages	Motive load			Non-motive load (Rs.)	Total (Rs.)
		Agricultural (Rs.)	Industrial (Rs.)	Total (Rs.)		
A. Normal scheme						
1.	Duttal	91,375	14,209	1,05,584	38,567	1,44,151
2.	Kothwal	77,714	24,762	1,02,476	54,031	1,56,507
3.	Petsar	1,16,327	27,831	1,44,158	62,311	2,06,469
4.	Laxmipur	33,624	29,908	63,532	76,748	1,40,280
	Sub-total	3,19,040	96,710	4,15,750	2,31,657	6,47,407
B. Agricultural electrification scheme						
5.	Amargarh	77,825	—	77,825	—	77,825
6.	Mangalpura	50,108	9,546	59,654	—	59,654
7.	Chadiad	1,44,042	14,230	1,58,272	—	1,58,272
8.	Mitral	85,441	—	85,441	—	85,441
	Sub-total	3,57,416	23,776	3,81,192	—	3,81,192
	Grand total	6,76,456	1,20,486	7,96,942	2,31,657	10,28,599

The investment in distribution network per village varies to a large extent, *i.e.*, from a low figure of Rs. 59,654 for Mangalpura (agricultural electrification) to as high as Rs. 206,469 for Petsar (rural/normal scheme). Such a variation is caused by many factors such as total length of HT line and LT line, types and numbers of connections, type and quantum of total connected load, etc.

Revenue to the GEB from the Sale of Electricity

The gross annual revenue from electrification here means sales proceeds or the energy charges paid by the customers of electricity for one year during the period from November, 1967 to October, 1968. Details on the same for different villages are given in Table V.

TABLE V—GROSS REVENUE TO THE GEB FROM THE SALE OF ELECTRICITY TO THE DIFFERENT TYPES OF CONSUMERS

Sr. No.	Village	Revenue* (Rs./year) to the GEB from				
		Motive load			Non-motive load	Total
		Agricultural	Industrial	Total		
A. Rural/normal scheme						
1.	Duttal	39,949	3,493	43,442	4,036	47,478
2.	Kothwal	16,139	3,370	19,509	4,065	23,574
3.	Petsar	45,696	6,789	52,485	7,082	59,567
4.	Laxmipur ..	15,788	14,361	30,149	9,840	39,989
	Sub-total ..	1,17,572	28,013	1,45,585	25,023	1,70,608
B. Agricultural scheme						
5.	Amargarh ..	31,270	—	31,270	—	31,270
6.	Mangalpura ..	9,052	776	9,828	—	9,828
7.	Chadiad	27,393	3,938	31,331	—	31,331
8.	Mitral	12,461	—	12,461	—	12,461
	Sub-total ..	80,176	4,714	84,890	—	84,890
	Grand total ..	1,97,748	32,727	2,30,475	25,023	2,55,498

* Rates of electricity for different types of loads were as follows :

Type of load	Rate in paise/kWh
Non-motive	31 for lights and fans. 15 for heat and small power.
Motive	14 for agriculture. 16 for industrial.

As in the case of investment, there is a wide variation in Annual gross revenue also. The maximum total revenue is from Petsar (Rs. 59,567) and minimum is from Mangalpura (Rs. 9,828). In the case of revenue for motive load connections also, the highest and the least are covered by the same villages. Having seen the investment as well as the revenue aspect of the electrified villages, it would be possible to examine their relationship.

The gross revenue: investment, *i.e.*, GR/I ratios of different categories of loads are worked out and presented in Table VI.

TABLE VI—INVESTMENT : GROSS REVENUE RATIOS OF ELECTRIC CONNECTIONS GRANTED FOR MOTIVE AND NON-MOTIVE LOADS IN SELECTED VILLAGES

Sr. No.	Villages	GR/I for motive load (%)			GR/I for Non-motive load (%)	Overall GR/I (%)
		Agricultural	Industrial	Total		
A. Rural/normal scheme						
1.	Duttal	43.72	24.58	41.14	10.46	32.94
2.	Kothwal	20.77	13.61	19.04	7.52	15.06
3.	Petsar	39.28	24.39	36.41	11.37	28.85
4.	Laxmipur	46.95	48.02	47.45	12.82	28.51
	Ratio for A	36.85	28.97	35.02	10.80	26.35
B. Agricultural scheme						
1.	Amargarh	40.18	—	40.18	—	40.18
2.	Mangalpura	18.06	8.13	16.48	—	16.48
3.	Chadiad	19.02	27.67	19.80	—	19.80
7.	Mitral	14.58	—	14.58	—	14.58
	Ratio for B	22.43	19.83	22.27	—	22.27
	Overall ratio	29.23	27.16	28.92	10.80	24.84

The data reveal a very striking feature. The gross annual revenue per rupee invested for motive load connections in all the villages is much higher than that of non-motive load connections. Since the rate for different categories of the loads were different, the net revenues to the GEB would be different and hence the ratio of gross revenue: investment does not indicate the true picture. Therefore, the net revenue realised by the GEB per rupee invested in distribution network was worked out for finer comparison. The same is given in Table VII.

Table VII indicates that the net revenue to the GEB was hardly 7.24 per cent from the consumers of non-motive load, as against 15.52 per cent from the consumers of motive load in the normal scheme villages and 8.74 per cent from the consumers of motive load in the agricultural scheme villages. This indicates that the shift from general purpose electrification to special purpose electrification for the small villages is not a wrong move.

In Gujarat, most of the villages having a population of more than 5,000 are already electrified. Therefore, the GEB will have to cover the small villages (with population of less than 5,000) in the future rural electrification plan. As the small villages are scattered, the cost of distribution network per kW for such villages would be higher than that of the big villages already electrified, as indicated in Table VII

TABLE VII—NET REVENUE RETURNS TO THE GEB (FROM DIFFERENT CATEGORIES OF LOADS)
ON INVESTMENT FOR DISTRIBUTION NETWORK

(in Rs.)

Item	Normal scheme villages			Agricultural scheme villages	
	Non-motive consumers	Motive load consumers		Motive load consumers	
		Agricultural	Industrial	Agricultural	Industrial
(a) Connected load in kW ..	227.20	523.11	176.25	378.73	22.5
(b) Investment in distribution network	2,31,657	3,19,040	96,710	3,57,416	22,776
(c) Investment/kW	1,018	610	549	944	1,057
(d) Gross revenue to GEB (sales proceeds) ..	25,023	1,17,572	28,013	80,176	4,174
(e) Consumption of electricity (kWh/year)	68,366	9,01,904	1,66,901	6,23,102	31,711
(f) Cost of electricity supplied by GEB at 7 paise/kWh* up to the supply point	4,786	63,133	11,683	43,617	2,220
(g) Operation and maintenance expenses at 1.5 per cent of (b)—GEB norm ..	3,475	4,786	1,451	5,361	357
(h) Net revenue to the GEB for payment of interest, depreciation, etc. (d)—(f)—(g)	16,762	49,653	14,879	31,198	2,137
(i) Item (h) as a percentage of (b)	7.24	15.56	15.38	8.73	8.99
		15.52%		8.74%	

*This takes care of generation cost as well as capital recovery factor for the investment in generation and distribution lines upto 11 kV tapping point.

As a result of such high investment the net revenue to the GEB per rupee invested in electrification of the small villages would be lower than that of the big villages. This fact is brought out in the table, which indicates that the net revenue to the GEB from the motive load consumers of normal scheme villages was 15.52 per cent as against 8.74 per cent in the case of the motive load consumers of the agricultural scheme villages.

The net revenue returns per rupee invested in distribution network to the GEB from the non-motive load consumers even in the big villages were much less than that from the motive load consumers. From this trend, one can infer that the general purpose electrification of small villages would have yielded lower net revenue than that could be achieved from special purpose electrification.

The net revenue returns for the villages covered under the special scheme are observed to be 8.74 per cent of the investment in distribution network which

is sufficient to cover depreciation (say 2 per cent) and interest on the borrowed capital (say 6 per cent). This indicates that agricultural electrification in rural areas can also stand on its economic merits. This, at the same time, belies the common apprehension about the economic justification of agricultural electrification even though the load centres are scattered and the cost of electrification is higher than that of motive load connections in urban areas.

Utilization of Installed Capacity

The performance of rural electrification and agricultural electrification can be compared in terms of utilization of installed capacity. From the data on connected load and annual consumption of electricity in different categories of loads, the utilization of installed capacity was worked out as shown in Table VIII.

TABLE VIII—UTILIZATION OF CONNECTED LOAD IN DIFFERENT CATEGORIES OF BOTH TYPES OF VILLAGES

Type of electrification	Consumption of electricity in kWh/kW of connected load per year			Remarks
	Non-motive load	Motive load		
		Industrial	Agricultural	
1. Rural	301	947	1,724	These figures also indicate the use of electricity in hours/year
2. Agricultural	—	1,409	1,645	
Overall average ..	301	999	1,691	

It can be seen from the table that the maximum utilization of the installed capacity (*i.e.*, the maximum load factor) was achieved by the consumers of agricultural load in both the types of electrification and the least utilization of installed capacity was in the category of non-motive load. This indicates that for the maximum utilization of installed capacity (apart from the considerations of cost of electrification and revenue returns to the GEB), the order of priority for different categories of rural electrification should be (1) agricultural load, (2) industrial load and (3) non-motive load, *i.e.*, domestic and street lighting. Moreover, agricultural electrification is an income generating factor (through increase in agricultural production and productivity) which deserves preferential treatment over the other conveniences like domestic and street lighting. Thus, the change over from all purpose electrification to agricultural electrification is a desirable shift in policy as income has to be generated before planning to spend it.