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EVALUATION OF THE PROJECT OF ENERGISATION OF WELLS FOR LIFT IRRIGATION IN POONA DISTRICT

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The paper deals with the evaluation of the project of energisation of wells in a compact rural region in Poona district, Maharashtra. The financial analysis part of the evaluation is from the point of view of the State Electricity Board and the other part of the evaluation dealing with the economic analysis is from the point of view of the society. Indeed, part of the total investment on providing high tension (H.T.) lines, distribution transformers and accessories and the low tension (L.T.) lines in bringing electricity to the area should be apportioned to the categories of agricultural consumers (energised wells), but since there is no conceivable manner in which it can be done we consider those investment as investment on providing overheads. We then make an attempt to analyse if the return from the investment in giving extensions to the wells to be energised from the already existing network of distribution lines, and operating and maintaining those extensions, is enough to account for a part of the investment made in overheads in providing electricity to the villages.

THE STUDY AND ITS OBJECTIVES

The scheme under consideration was implemented during the year 1971-72 by the Maharashtra State Electricity Board covering 42 villages from Poona district. It was expected that energisation of 500 wells would be completed within a period of five years from then (*i.e.*, by 1975-76) and a total load of 15 lakh kWh would develop as a result of that.

We undertook a study of assessing the economic benefit of this scheme over its entire life period. The specific objective of the study was two-fold: (*i*) to analyse the investment and return in respect of the scheme of energisation of wells strictly from the financial viewpoint; and (*ii*) to assess the costs and benefits, both direct and indirect of energisation of wells from the point of view of the society.

Since the study involved the estimation of the total benefits and total cost over the entire life of the project, estimation of the potential power consumption was an essential and crucial part of the whole study. Therefore, another objective of the study which was implied in the two mentioned above was to identify the factors influencing the spread of the electricity and the development of load in the rural areas.

ESTIMATION OF THE POTENTIAL LOAD

The field survey was undertaken in 1976-77 with a view to examine the progress with the energisation programme vis-a-vis the target set in the beginning and also with a view to examine and estimate the future load develop-

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ment and its phasing during the entire life of the project. We assumed a 25-year life period of the project because, on an average, the use value of most of the capital structure created comes to an end by the end of 25 to 30 years. The data and other information about the actual number of energised wells and total power consumption for the first five years of the scheme (*i.e.*, from 1971-72 to 1975-76) were made available to us from the records of the State Electricity Board's divisional office. Based on our field survey, we examined the factors responsible for the development of load in a region and estimated the future load. Assuming that the entire potential load was most likely to develop within a period of ten years, the phasing of the potential load development was made in two five-year periods beginning from the sixth year of the scheme.

The consumption of power (electricity) for agricultural use, *i.e.*, irrigation, may increase in future on account of increase in the number of consumers and increase in the consumption of the existing consumers. The number of energised wells (consumers) may increase in future on account of the following: (*i*) construction of new wells and old wells brought to use, (*ii*) electrification of wells using oil engines, (*iii*) electrification of wells using *mhots*, and (*iv*) installation of electric pumps on rivers and streams.

Our estimate of sinking new wells is based on the relevant information provided by the Groundwater Survey and Development Agency for the area under investigation. The estimate of the number of wells to be energised out of the new wells sunk is based on the past trend of energisation of newly sunk wells in the post-electrification period. We investigated a sizable sample of wells with oil engines and with *mhot* and on the basis of the sample investigation we estimated the number of such wells likely to be energised in the two five-year periods. Similarly, we also estimated the number of electric motors that may be used on rivers and streams and other lift irrigation schemes. It is likely that the additional number of energised wells estimated for the two five-year periods in future may get distributed in any manner during the period. In the absence of any precise criterion in this regard, we assume that the additional number of consumers get distributed in equal number in each year of the two five-year periods.

For estimating total consumption of the energised wells, some average consumption level per energised well was arrived at taking into consideration the following factors: (*i*) annual average consumption of the past few years from which data were available, (*ii*) the proportion of new consumers in the total number of consumers in each of the past years, (*iii*) the average depth of the wells and (*iv*) the average standard area irrigated per energised well. The actual number of energised wells and actual power consumption at the end of the fifth year as well as the estimated number of energised wells and estimated power consumption at the end of the tenth and fifteenth years are presented in Table I.

TABLE I—ENERGISED WELLS AND POWER CONSUMPTION AT THE END OF EACH FIVE-YEAR PERIOD

	At the end of		
	Fifth year	Tenth year	Fifteenth year
Number of energised wells	260	582	840
Amount of power consumption in kWh (lakhs)	5·00	9·84	13·39

METHODS OF ESTIMATION OF COSTS AND RETURNS

All the computations of estimated capital cost and operating cost and of estimated revenue to the State Electricity Board were done at 1975-76 prices on the assumption that the relative price structure would by and large remain unchanged.

The capital cost estimated was on account of providing L.T. line extension to the consumers from the nearest electric pole in and around the village site, as well as on account of the service erection charges. On the basis of the field investigation we considered, on an average, four agricultural connections per kilometre of L.T. line.

As per the information provided by the State Electricty Board, the price of L.T. line per kilometre used in our computation was Rs. 7,200 and the charges for service erection was Rs. 250 per consumer. Further, the L.T. lines and service connections were considered to have life periods of 25 years and 15 years respectively. The service connection and accessories therefore needed to be replaced at the end of 15 years.

The operating cost comprised the cost of energy provided to the consumers and the operation and maintenance expenditure of the extensions provided. As per the information provided by the State Electricity Board, the rate of cost per unit of power used in the computation was 10.62 paise. Similarly, 3 per cent of the capital expenditure was considered as operation and maintenance expenditure of the scheme. It is to be noted that in computing the cost of energy, 10 per cent of the actual power supplied was considered as loss of power in transmission and distribution and was thus added to the actual power consumed to account for the line losses.

The revenue side comprised (*i*) service connection charges realised from the consumers, (*ii*) energy charges and meter rent against the sale of electricity and (*iii*) salvage value of the remaining unused life of the assets and equipments. The rates of service connection charges and energy charges and meter rent obtained from the State Electricity Board were Rs. 350 per consumer, 20 paise per unit and Rs. 24 per year per consumer respectively. The salvage value was computed by considering the scrap value of the equipment which exhausted their life periods plus the unused values for the remaining life of the equipments at the end of the project period. As per Section 68 of the Electricity Supply Act, 1948, 10 per cent of the book value of the asset is considered as the scrap value of the equipments.

METHODOLOGY OF FINANCIAL ANALYSIS

For assessing the financial profit or loss from the project to the State Electricity Board the discounted cash flow technique was followed. The prime aspect of the technique is to compare the costs and returns over time. When we look at a project we can see it earning a stream of gross returns from which we must deduct the capital investment and pay the other operating cost. What is left over is residual (which will be negative in the early years of the project) and which is available (*i*) to recover the investment made in the project—the return of capital and (*ii*) to compensate for the use of money involved in the project, the return to capital (or *on* capital). This residual is termed cash flow.[1]

The most straight forward discounted cash flow measure of the project that was computed was the net present worth (NPW). Symbolically, it can be expressed as follows:

$$\text{Net Present Worth (NPW)} = \sum_{t=1}^{n} \frac{R_t - C_t}{(1+i)^t}$$

where R_t = returns in each year,
C_t = costs in each year,
n = number of year (life of the project),
i = discount rate.

The discount rate used in the computation of the NPW is 6 per cent, primarily because that is the average borrowing rate of capital to the State Electricity Board for rural electrification programme.

The internal rate of return (IRR) of the project was also computed in order to know the rate of return on the capital investment. The discount rate at which the NPW of the project becomes zero, is the IRR of the project.

THE RESULT OF THE FINANCIAL ANALYSIS

The NPW of the project at 6 per cent turns out to be negative (Rs. —25,208). This shows that the project is financially not profitable from the point of view of the State Electricity Board.

Present worth of the returns (Rs. lakhs)	Present worth of the costs (Rs. lakhs)	Net present worth (Rs. lakhs)
25.61	25.86	—0.25

1. J. Price Gittinger: Economic Analysis of Agricultural Projects, The International Bank for Reconstruction and Development, Washington, D. C., U.S.A.; The Johns Hopkins University Press, London, 1976.

The negative NPW of the project indicates that the return from the project is not sufficient to account for the cost incurred in energising the wells. This situation arises mainly because of poor load development and the delay in the development of load. For the first five years of the scheme the average consumption was of the order of 1,000 kWh per year per energised well. It is only during the second five-year period that the average consumption level was estimated to come up to around 1,800 kWh per year and get stabilized around that for the entire life of the project. Further, the number of energised wells during the first five years of the project was only 260. As against these, at the time of formulation of the project proposal the State Electricity Board expected a target of 500 wells to be energised during the first five years of the project itself and it also expected an average consumption of 5,000 kWh per year per consumer. Our field investigation brought out very sharply that the lack of finance and inadequate water in the wells were the two main reasons for slow response to energisation and low consumption of power. It is clear from this observation that not only timely completion of the energisation programme but also a fairly high level of consumption (around 2,000 kWh) per energised well per year is necessary for the financial profitability of the project. For the completion of the energisation programme within a reasonable short period a proper co-ordination between different rural development agencies is of utmost importance. At the same time, for ascertaining a minimum level of consumption for the viability of the project a proper assessment of the groundwater potentialities of the region under consideration is also an essential pre-requisite.

The IRR computed for the project turns out to be around 5½ per cent. Since the average rate at which the State Electricity Board borrows capital for rural electrification programme is 6 per cent, an IRR of 5½ per cent from the project shows a financial loss to the Board. Thus the result of the financial analysis shows that the return from the project of energisation of wells is not enough even to account for the cost incurred in providing extension lines to the wells and supplying power to them, let alone recovering a part of the cost on the network of H. T. lines and distribution transformer erected for bringing electricity to the region.

METHODOLOGY OF ECONOMIC ANALYSIS

Having analysed the financial profitability of the project from the point of view of the State Electricity Board, we now attempt to examine the economic viability of the project from the point of view of the society. Commercial consideration measured in terms of profit or loss is generally a fair indicator of the desirability of undertaking any investment. However, it proves to be a necessary but not a sufficient criterion when a project to be selected is a public utility involving large investment.

The computation of social cost of electrification involves the cost incurred by the State Electricity Board in generation, transmission and distribution of electricity and those incurred by the farmers in using the electricity supplied.

However, for the computation of benefits we consider the cost of the most economic alternative source of energy for the purpose for which the electricity is being used as the benefit from electricity. In other words, we ask how much it would cost to obtain the same amount of motive power through alternate source of energy. The alternative cost of generating the same amount of motive power then can be considered as the social benefit of electrification. This follows from the argument that the same amount of output can be produced in agriculture with the help of either of the two alternative sources of power, but presumably there will be net benefit to the society through saving of productive resources which comes about through the discontinuation of the alternative method of getting motive power.

The alternative to electric motor for lifting water is either oil engines or *mhots*. The same amount of water can be lifted for irrigating the same area by using oil engines to the wells in lieu of electric motors, the total agricultural produce remaining unchanged. The benefits of electrification in such cases are the cost of using oil engine. The difficulty arises in the case of *mhots* used as alternative for electric motor. However, in the case of *mhot* also we consider the cost of using the *mhot* for lifting the same amount of water as is done with electric motor, everything else remaining unchanged, as the benefit of electrification. In case the depth of the well is increased to strike more water after energisation, it may cost much more if the *mhots* were to be used to draw the same amount of water from the increased depth and to that extent the benefit of electrification is over-estimated. However, it is a moot point whether the farmers would at all increase the depth of wells further, if they were to continue with *mhot*, and to that extent increased water availability for irrigation leading to increased agricultural production due to electrification is a net benefit of electrification which would otherwise not get included in the benefit stream.

Following this methodology, we computed the social benefit and social cost of the project. On the basis of our field investigation, we were able to estimate the proportion of the energised wells that shifted from each of the alternative sources, *i.e.*, oil engine and *mhot* during different periods. The social cost of electrification comprised the cost of providing and maintaining the extension lines to wells, cost of supplying power, and the cost of installing and operating electric motors on the wells. The social benefits of electricity, on the other hand, comprised the cost of installation of oil engines and *mhots* and operating and maintaining them. The prices used in the computation of social cost and benefits are net of taxes and duties and are also adjusted for any subsidy operating on any item. These along with cost data and other information used in the computation of social benefit-cost are presented in Table II. A social discount rate of 15 per cent was used to compute the benefit-cost ratio which was the ratio of present worth of the benefits to the

TABLE II—PRICES AND COSTS AND OTHER DATA USED IN COMPUTATION OF SOCIAL COSTS AND BENEFITS

(*Rs.*)

	Electric motor (3HP)	Oil engine (5HP)	*Mhot*	Pipe line
1. Price	1,705	4,155	810	600
2. Installation cost	100	250	—	—
3. Operating cost per consumer	40	410	250	—
4. Cost of energy per kWh	10·62 paise	—	—	—
5. Life in years	15	10	5	10

present worth of the costs. Symbolically, the benefit-cost ratio may be represented as

$$\frac{\sum_{t=1}^{n} \frac{B_t}{(1+S)^t}}{\sum_{t=1}^{n} \frac{C_t}{(1+S)^t}}$$

where B_t = benefit in the tth year,
C_t = cost in the tth year,
S = social rate of discount,
n = project period.

THE RESULT OF THE ECONOMIC ANALYSIS

The social benefit-cost ratio of the project at 15 per cent turns out to be more than 1 (1.08). In other words, the result shows that the present worth of the benefit stream (measured in terms of the cost of alternative source of power) is larger than the present worth of the cost stream for the project from the point of view of the society. It would cost more to the society to provide the same amounts of motive power with the alternative source as compared to that with electricity.

The total cost consists of the capital cost and the operating cost. It may be then noted that even though the capital cost for providing electrification is much higher (on account of L. T. lines and accessories), since the operating cost in the case of alternative source is very high and more than compensates for the differences in the capital costs between the two sources, the total cost of alternative source of energy turns out to be larger than that of electricity. This is a clear case of saving of productive resources of the society which comes about through using electricity instead of alternative sources of energy. In view of this, it can be inferred that the project of energisation of wells is economically viable from the point of view of the society.

CONCLUSION

Evaluation of the project of energisation of wells over its life period, both from the point of view of the financing entity, *i.e.*, the State Electricity Board and from the point of view of the society, shows that though the project is financially not profitable to the State Electricity Board, from the point of view of the society, it is economically viable. A project, particularly for the agricultural sector, having a great deal of public utility in terms of creating infrastructural facilities, need not only be assessed from the angle of financial criterion. There is the wider question of costs and benefits to the society of such projects, which too needs to be taken into consideration. Further, any scheme to be feasible and operative must take into consideration the benefits accruing to the sections of the population directly affected by the project. In this case it is clear that the farmers affected by the energisation project stand to gain. Once the wells are energised, the operating cost of using electric power for irrigating a standard acre is much smaller than the operating cost of using oil engines and *mhots*. In view of this, the farmers actually would not increase their economic activity of irrigating larger area if there were to be no electricity. To that extent there would be reduction in the total social product. These are thus some of the considerations which need to be kept in mind in evaluating a project.

KANDI WATERSHED AND AREA DEVELOPMENT PROJECT OF THE PUNJAB STATE : AN *EX ANTE* APPRAISAL OF THE FORESTRY COMPONENT

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The Kandi area of the Punjab comprises parts of Hoshiarpur, Gurdaspur and Ropar districts of the State. The peculiar characteristics of this area such as undulating topography, heavy precipitation, steep land gradients, loose nature of the soil, low man-land ratio, over-grazing, illicit felling of trees and the like, have caused denudation of vegetative cover and gully erosion of the Shiwaliks. This has ultimately resulted in the formation of flashy torrents (choes) which cause havoc down the hills during the rainy seasons. The flashy flows in the choes erode adjoining agricultural lands and spread sterile sands over the fertile fields rendering them unsuitable for agricultural purposes. Besides, they cause considerable damage to human and animal life and public property year after year. The frequent changes in the courses and the profiles of the choes aggravate the situation further. Realising the gravity of the matter, the State Government has, in consultation with the Punjab Agricultural University, formulated the Kandi Watershed and Area Development Project[1] for the integrated development of land and water resources in five selected choe catchments, *viz.*, Dholbaha, Janauri, Chohal,

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1. A. C. Sharma, R. K. Sabharwal and Y. P. Chowdhary: Kandi Watershed and Area Development Project, Punjab, submitted by the Punjab Government to the World Bank for financial assistance, February 1978.