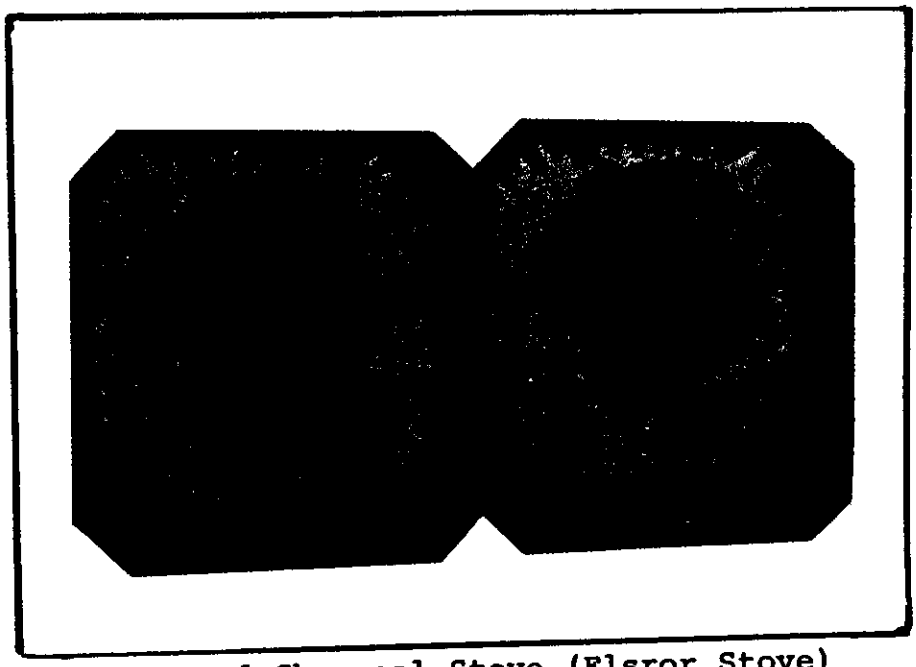
SUDAN Energy news



Improved Charcoal Stove (Elsror Stove)

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ELECTRICTY SUPPLY IN EASTERN SUDAN
PRACTICES AND DEVELOPMENT PROSPECTS

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7. Financial evaluation

For the purposes of the evaluation it was necessary to collect a significant quantity of data - or to estimate it - concerning costs and returns. In the first place, a (provisional) estimate was made of all the investment costs involved in the different alternatives. These are not just the costs of the diesel engines themselves but all kinds of other costs related to installation of the machines, such as the costs of transport, building costs, engineering works, oil storage facilities, electrical facilities, etc. In our view, the costs involved in familiarizing the operators with the new equipment and the costs of parts (which recur annually) are also indissolubly linked with the project in question. Practice has shown that expenses of this kind are substantial, not incidental in nature, to the extent that they must be considered as part of the investment costs. Among the factors that played an important role here were the available space in the power stations, the operators familiarity with engines of this kind, the ease with which the engines could be transported, the type of engines (/1/), etc. The total investment costs of the various alternatives are summarized in Table 1. It should be noted that the great majority of these costs (94%) should be financed with foreign currency. In the second place, we drew up an estimate of the annual production costs. These costs are made up of the variable operating costs: chiefly the costs of fuel and lubricants, the fixed operating cost primarily the (additional) costs of operators and maintenance personnel, and the additional overhead: the costs involved in distribution, sales, management, etc. The total annual production costs, about two-thirds of which consist of fuel costs, are also given in Table 1. These are the costs which occur every year and which may therefore not be included in the total investment costs. Unlike the investment costs, the major part (about 98%) can be financed with local currency (Sudanese pounds). For the figures in Table 1, we used the 1987 rate of exchange of 0.94 guilders to the Sudanese pound. The table shows that the estimates are based on the specific characteristics of the alternatives, such as the facilities already available at the two locations (for example. oil storage facilities, buildings, etc., already on the sites), the costs of parts, the output of electricity, etc. It appeared, for example, that in Kassala an extension of the building was necessary, but in Khashm el Girba the existing powerhouse was big enough to house also the projected new diesel engines. Thirdly, an estimate had to be made of the expected annual returns to the electricity company. Various factors were taken into account in the estimate, including the rates to be charged (specified by customer category) (/2/), the quantity of electricity bought at these rates, transport losses and the large "unexplained" losses (which can largely be ascribed to illegal consumption and billing problems). Total losses are estimated about 20% of production. It was moreover assumed that the preparatory work would start in 1988 and that the engines would be put into service in

1990. The first returns can therefore be expected in 1990. It is assumed that the engines will be taken out of operation in 2000 and replaced with new ones. It can be calculated that the average return per KWh sold is about 22.2 cents. the return averages are 17.7 cents per generated kwh, calculated with 20% average losses. This return should cover the production costs and the investments costs.

TABLE (3)
OVERVIEW OF EXAMINED ALTERNATIVES

Alternatives	1	2	3	4
Expansion (in MWs)				
Kassala	1x2,5	1x4,0	1x3,0	1x2,5
Khashm el Girba	2x4,0	2x2,5	2x3,0	2x2,5
Total	10,5	9,0	9,0	7,5
Financial figures (in million guilders)				
Total investment Costs a)	30,3	27,4	26,6	23,1
Annual production costs	7,4	6,4	6,4	5,7
Annual return	13,0	11,1	11,1	9,6
Gross annual profit	5,6	4,7	4,7	3,6
(in cts/kwhe)				
Average return	22,2	22,2	22,2	22,2
Average production costs	12,6	12,7	12,7	13,5
Gross profit	9,6	9,5	9,5	8,7
Economic figures				
Net cash value b) (in million guilders)				
- average	12,0	9,2	9,7	5,7
- minimum	2,1	0,6	1,1	1,4
Internal Rate of Return (in %)				
Financial analysis	17,6	15,5	16,3	12,2
Economic analysis				
- average value	35,5	16,2	17,2	11,8

a) Including all associated works, spare parts and contingencies; excluding possible residual value in 2000.

b) Using the discount rate of 15% (opportunity costs of capital) recommended by the World Bank.

The average production costs, depending on the alternative, are 12.6 - 13.5 cents, In all cases the result is a gross profit (from 8.7 to 9.6 cents per KWh). Since the present production costs for the existing diesel sets, excluding the investment costs, amount on average to more than 25 cents per KWh sold, it is easy to see that operating these existing units is not a paying proposition (even when investment costs are not taken into account). In this context, we should note the potential opportunity to generate electricity at significantly lower average production

costs offered by the large sugar factory nearby (in New Halfa). This large sugar factory -of which there are several in the Sudan - is faced with a major waste product problem. The surplus of "bagasse" (the dry pulp left after the sugar cane is processed) amounts to no less than 70,000 tones a year. The storage of the bagasse-there are already about three-quarters of a million tones at the factory - not only takes up a lot of space, but can also be viewed as an environmental problem. However, bagasse is a potential source of fuel for boilers if additional steam turbines were to be installed. Although it was not a specific part of the researchers' brief, we made a rough calculation which indicated that the electricity could be generated for a total cost price - including investment costs - of less than 11 cents per KWh sold. The calculation was based on an additional capacity of 4 MWe steam turbine power. The specific investment costs per KWe installed power are approximately at the same level as of the projected diesel engines. The cost-difference is caused mainly by the saving on fuel costs (the maximum average variable production costs are less than 4 cents per KWhe, instead of cerca 13 cents per KWhe at diesel engines). Furthermore, it would solve the problems of storage space and environmental hazards. In view of the significant difference compared with the production costs (excluding investments) of the projected diesels (circa 13 cents per KWhe), and the very high level of sugar consumption in the Sudan, a more detailed technical and economic investigation is strongly recommended. Returning to the new diesel engines that may be in-stalled, it can be said on the basis of the data in Table 1 that they would produce a gross profit of several million guilders a year in the period 1990-2000. It may be asked how this profitability relates to the investment costs that would be incurred. A measure of the profitability of the alternative projects is the Internal Rate of Return (IRR). The IRR is the discount rate at which the (net) present value of the project becomes zero. The net present value of a project is equal to the sum of the discounted annual outgoings and income during the lifetime of the project. The higher the internal rate of return, the more profitable the project. The size of the IRR for the alternatives is shown in table 1. The IRR in the financial analysis we carried out is highest for alternative 1, followed by alternatives 3,2 and 4. (This order does not change if the return or the production costs are increased or decreased by 10%.)

8. Economic analysis

In the financial analysis, the costs and returns were considered from the point of view of the electricity company. The economic analysis approaches the question from a national and economical viewpoint. The social implications of the availability or lack of electricity are not easy to measure. This is inherent in the intermediary character of electricity, which is used in all kinds of consumption and production processes. Without electricity, many of these activities would be done in a different way and probably also at a different level. For this reason it is extremely difficult to compare situations in which (sufficient) electricity is or is not available. Quantifying the social consequences of the lack of electricity in monetary terms is likewise extremely complicated. It is sometimes said that the lack of (sufficient) electricity causes production losses or makes it impossible to take advantage of opportunities for development. Although this assertion certainly contains a darnel of truth, it must be borne in mind that production is often hampered by a complex of interrelated factors: the lack of water, raw materials, technical knowl-

edge and spare parts, difficult climatic conditions, etc. To mention one factor in this complex as being solely responsible would be incorrect. For this reason, we have made no attempt to estimate the possible economic losses or wasted production opportunities as a consequence of the lack of electricity. The same is true of the service sector (for example, health care, where health and possibly even human lives are at stake) or the valuation of standard of living in households. Instead, we adopted a different approach. As the return on the project in question we took not the Bills paid to the electricity company, but the (avoided) costs which those connected could have incurred by providing for their own electricity needs using private generators. We are talking about the so-called "opportunity costs" which would have to be incurred to meet the demand. It is possible to come up with a minimum and a maximum estimate of these costs. The minimum estimate relates to the (avoided) variable costs, which consist primarily of fuel costs. The maximum estimate relates to the (avoided) integral costs of private generation. Regarding the projected increase of the discrepantion between demand and production of electricity, and already high share of private electricity generation in the total electricity supply, it is plausible that here will be sufficient potential consumers which are ready and willing to pay the integral costs of private generation. Nevertheless, in order to reduce this uncertainty in assumption a pessimistic evaluation has also been carried out, in which the result of the project is considerably lower, because then the income is based on the minimum estimate of the avoided private generation costs. An estimate of these costs was made for each customer category and incorporated in the economic analysis. As far as the costs are concerned, the same items as those in the financial analysis were taken into account. In contrast to the financial analysis, however, all costs and returns were valued at efficiency prices, which can for the most part be equated to free world market prices. This is necessary for a number of reasons, for example the fact that in a developing country like the Sudan, current prices do not always accurately reflect social scarcity. This is the result of, among other things, market disturbances and imperfections and the fact that the Sudanese pound is a non convertible currency. We therefore calculated a different set of cost and return data for each of the four alternatives. Based on these data the Internal Rate of Return was calculated in the same way as in the financial analysis. From this it appears that the order of preference of the alternatives does not differ from that of the financial analysis. In November 1986, the World Bank developed a comparative yardstick for the Internal Rate of Return in the economic analysis. This yardstick - known as "opportunity costs of capital" - is a discount rate of 15%. The average calculated value of the Internal Rate of Return in the economic analysis is well above this 15%. Even if one were to take a minimum estimate of this Internal Rate of Return, it still compares favorably with the World Bank figure. Only alternative 4 would then be eliminated. The same thing emerges when one calculates the net cash value of the project. The minimum estimate for this is negative for alternative 4. These results can be ascribed to a significant extent to the fact that the generation of electricity by means of private generators is a relatively costly affair, even if the investment costs are not taken into account. The explanation lies primarily in the relatively high fuel costs, caused by the relatively low electrical efficiency and the more expensive fuel. The aspects environment, safety and reliability are not regarded. It is likely that in

respect of these aspects central production of electricity must be chosen above private generation. Internalizing these effects would therefore lead to higher internal rates of return.

9. Conclusion

Despite the fact that the installation and operation of electricity facilities in a underdeveloped country like the Sudan are often fraught with problems, it is possible to design projects that are not only financially feasible, but can also be (very) profitable in socio-economic terms. Based on financial and economic criteria, the order of preference of the four alternative expansion options investigated was established. The technical and economic evaluation by NEI and KEMA not only proved to be useful in the development, consideration and assessment of the possibilities of expansion based on diesel engines; the investigation also brought to light the fact that there are potentially highly favorable possibilities of generating a part of the needed electricity at a relative low cost price using waste products from the sugar industry.

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