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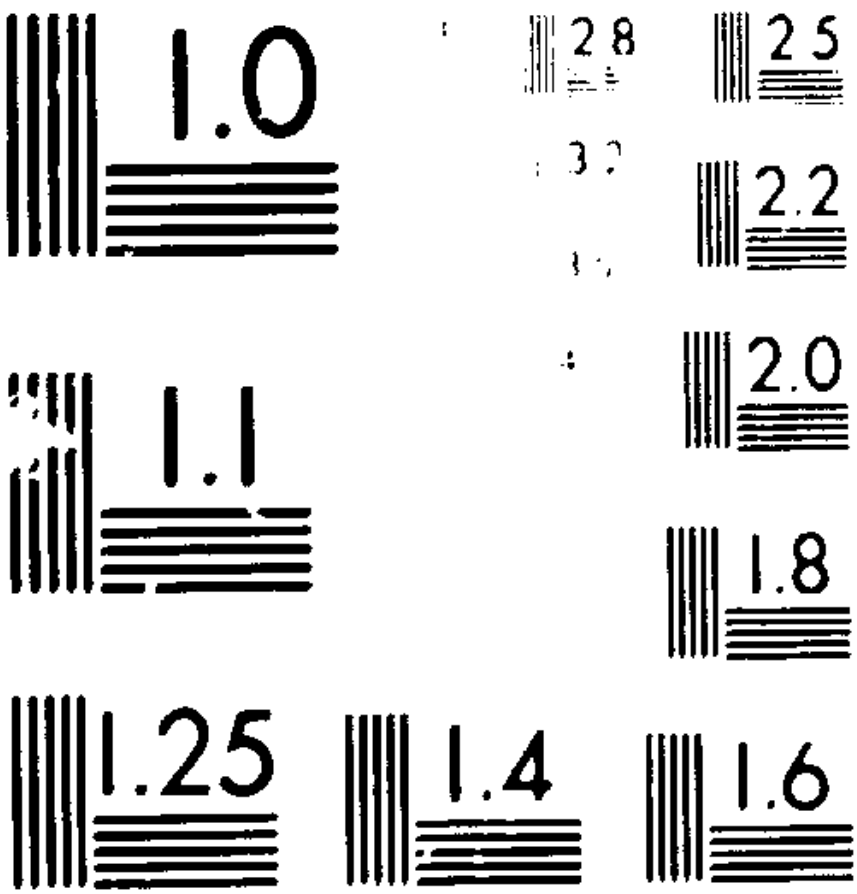
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THE NEED FOR AN INTEGRATED APPROACH IN RURAL ELECTRIFICATION IN NEPAL*

by

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Abreviations used

HMG	His Majesties Government of Nepal
SHDB	Small Hydel Development Board
SATA	Swiss Association for Technical Assistance
MHEGU/SHEGU	Mini- or Small Hydro Electric Generation Unit
RECAST	Research Centre for Applied Science and Technology
MFA	Ministry of Food and Agriculture
DA	Department of Agriculture
DFAMS	Department of Food and Agriculture Marketing Services
ADBN	Agriculture Development Bank Nepal
AIC	Agricultural Inputs Corporation
DI	Department of Irrigation
(D)WSS	(Department of) Water Supply and Sewerage
DF	Department of Forests
DMP	Department of Medicinal Plants
DM	Department of Mines
LDD	Local Development Department
DIn	Department of Industry
DCVSI	Department of Cottage, Village and Small Industry
ISC	Industrial Services Centre
TPC	Trade Promotion Centre
NIDC	National Industrial Development Corporation
NC	Rupees Nepalese Currency (1 NC = 12 U$)
kW	Kilo Watt
kWh	Kilo Watt hour

Headings

1. Introduction

Integrated approach is a word often heard and mentioned in the context of development programmes, though the meaning of it is not always clear, its need is widely accepted. As one local official told me once, "integrated approach" for the nepalese administration until recently meant, that the money for various different development activities comes from the same source.

Rural electrification in Nepal stands just at its beginning and some experience is being gathered actually. Gathering of experience however means as well making errors in the beginning and find better solutions through constant analysis of made errors. This paper tries to analyze some experiences, examples cited hereafter therefore should not be considered useless errors for which at the limit somebody could be blamed, but as important steps on the way towards a useful rural electrification in Nepal.

This paper does not pretend to proclaim any new revolutionary idea or findings for patented solutions but simply tries to analyze, what integrated approach could mean for rural electrification in Neapl and now an integrated approach to rural electrification could be achieved.

2. Traditional Approach

Nepal has a large energy deficit for which mainly cooking in rural areas account. In the search for alternative energy resources to replace the ecological harmful practice of cooking with firewood, one turned first towards the logical possibility of harnessing the plentiful available and so far very little used waterpower.

The topography of Nepal however and the state of transportation facilities available, make the electrification of the whc country from a centralized grid an almost utopic enterprise. As most of the energy in form of firewood is being consumed in the rural areas of Nepal, the only possibility to replace fire-

wood in these areas was reckoned to be electrification through Mini Hydro Electric Generation Units (MHEGU). definition of MHEGU's being units in the range of 30 to 500 kW approximatively.

The first small hydel plant thus was built in Dhankuta and commissioned in the year 1972 and the second in Surkhet and commissioned in 1978.

2.1. Dhankuta Small Hydel Plant

Dhankuta small hydel plant has a capacity of 240 kW, with two Pelton turbines of 120 kW output each and a head of 200m.

A glimpse inside the local houses shows, that the expectation, that people would switch from cooking with wood to cooking with electricity has not realised during the seven years of operation of the plant. The fact that the power consumption for industrial consumers has just doubled since the year of commissioning and that total yearly industrial consumption accounts for just about 10% of the total consumption, indicates that the availability of a new powersource in fact has not changed tremendously the local living and production habits, be it not the fact, that people can extend the length of their working day by the use of electric light. Thus one probably wouldn't go too far in saying that the Dhankuta samll hydel plant so far has not had a big influence on the local economy nor on the ecologic balance.

2.2. Surkhet Small Hydel Plant

Surkhet, headquarter of the far western development region is electrified by a 345 kW powerplant of 65m head with 3 Ossberger - Banki turbines of 115 kW output each.

The same observation as in Dhankuta can be made here: majority of the inhabitants go on cooking with firewood, so that domestic powerconsumption comes mainly from light loads.

Due to a too optimistic assumption of the river flow during the design period of the project, the actual firm output is only

40 kW. With a pondage of 6000 m^3 it is possible to satisfy the evening peak load of up to 100 kW made up for by extensive lighting mainly. The limited riverflow, however makes it impossible to supply electricity to all productive consumers during daytime as otherwise the average load demand would be higher than the firm output capacity. Thus so far only one rice mill and one welding shop count among the productive consumers, whereas three mills are still running on diesel and have no hope to be electrified unless the policy to supply electricity for excessive lighting and illumination to the detriment of productive uses is changed.

Thus both in Dhankuta and Surkhet, little contribution to the national energy balance comes from these powerstations. Instead of satisfying an existing demand (e.g. for cooking), a new demand (i.e. excessive lighting) has been created which has to be satisfied now.

2.3. First Surveys Carried Out Under SHDB (1977-79)

It was recognised soon that electricity from small hydro power stations is not feasible for replacing the waste of firewood for cooking. Nevertheless, rural electrification through MHEGU's is considered to be an important step to achieve a future goal of near to full electrification of the whole country for supplying electricity to large parts of the population. With this goal in mind a country wide survey programme was launched to study most feasible load centres and sites. The SHDB was created as coordinating agency for this purpose.

During a first batch of studies 19 districts were studied for implementation of SHEGU's. Based on the assumption that the district head quarters are usually the most densely populated areas and the places where the economic activity is highest, these studies were mainly concentrated on district head quarters. Due to lack of experience with this kind of study, the terms of reference for the private Nepalese consulting firms who were awarded the task of carrying out these studies, didn't emphasise enough the productive aspect of rural electrification. As a result, most of the studies proposed projects which were mainly sized on the domestic lighting demand due to lack of economic market analysis for productive uses of electricity. A typical pattern common of the

presumed load curves for these proposed projects is a high peak load in the evening and almost no load during day time. The projects thus have a very low load factor and are actually mere illuminating exercices for district head quarters.

5. Experiences Made so Far

As the examples Dhankuta and Surkhet show, installation of electricity in rural areas on the base of a free market system does not have the expected impact on the economic conditions nor on the ecological balance. As a matter of fact, electricity distributed on a free market bases generates an ever increasing demand for lighting which goes far beyond the satisfaction of a basic need for lighting. Thus the mere installation of electricity in rural areas without any accompagnying measures rather intends to create a new unproductive demand than to satisfy basic needs of the rural population.

Besides the fact that electricity from SHGEU's is not a viable substitute for wood for cooking from the technical and economic point of view, experiences show that even when electricity is available, it is seldom used for cooking. A glimpse in Kathmandu households shows that even among very well educated members of the local community, electricity for cooking is used at the utmost as standby in case no wood, gas or kerosine was available. This is rather a result of traditional cooking habits, than of a lack of accustoming to a new utility or even of the understanding that such a high grade energy as electricity should not be converted to low grade energy such as heat. - Dhaal bhaat is just not as tasteful if cooked on electricity or gas than when cooked on fire.

This however shows that one should not expect electricity installed in rural areas to act as a somehow magic solution for reinstalling an ecological balance in the deforested rural hills of Nepal without having any flanking activities.

The only project so far which hopefully will make a palpable contribution towards reinstallation of an ecological balance or at least in preventing further destruction of the forest, is the 80 kW Salleri-Chialsa project in Solu Kumbu district, actually under construction with joint efforts from HMG and GATA. This project

will provide 40 kW for the Tibetan refugee camp in Chialsa, to replace about 500 kg wood which are burnt actually daily in the dying process of the wool needed for the carpet industry which makes up for the livelihood of the whole camp.

The surveys carried out in 77/78 and 78/79 covering 35 districts, showed that too much emphasis has been laid on the purely technical point of view of rural electrification and that on the other hand socio-economic study, assessment of future cottage and small scale industry development on base of a market analysis, in short the whole productive aspect of rural electrification was neglected.

Unsatisfactory load curves with very high domestic peak were made up to improve the daily load factor, presuming that "some industry might come up", neither giving the reason why those industries should come up or which industries are most likely to come up. In some cases, where only sites with limited potential could be identified for a specific load centre, priority was given to domestic light load to the detriment of productive load as for example pumping drinking water or irrigation water.

Implementation of thus analysed projects without any further input would most likely lead to similar experiences as made in Dhankuta or Surkhet.

4. Improved Approach

With the aim to cover as many of the hilly districts of Nepal as possible (51 districts) a series of new surveys was started in 32 different districts in spring 79 and is actually still going on.

On the base of the so far made experiences new terms of reference have been worked out for the private consultants who are carrying out the work. These new surveys emphasise more the productive aspect of the use of electricity than the purely technical, since it was seen from the former surveys that the technical part of the studies in very few cases could meet the requirements. The consultants have to identify five most promising load centres in the district assigned to them, on the basis of the following list of the priority criterias for selection of load centres:

- cottage industries
- agro based industries
- farms
- irrigation
- densely populated areas
- bazaars
- administrative head quarters
- localities with more than 1000 inhabitants

After identification of five suitable load centres within the district, the consultants have to carry out a baseline survey with the local inhabitants with the help of a questionnaire prepared and handed over to them by the SHDB. From these baseline surveys we hope to get informations about the general attitude of local population towards a new utility such as electricity. Results from these interviews may as well help the consultants to make a realistic power demand forecast.

For each thus identified load centres, two technically feasible sites have to be proposed. The survey work on these sites is reduced to measuring head and canal length and to make informative photographs of the whole proposed scheme.

In short this new approach intends to gather more information about productive uses of electricity in rural areas and to size projects rather on the base of a reasonably expectable productive demand than on an ever growing demand for domestic light, which at the limit could never be satisfied by any size of SHEGU. In the sizing of the projects, light loads should be assumed in the range of 100 - 150 W per household as this is the average connected load which would be sufficient to satisfy basic lighting needs. In reality as soon as electricity is available, the load per household intends to be higher, at least in the households where they can afford it. This however must not been taken into consideration at any cost as with pricing policy or other restrictive measures lighting loads can easily be capted within the mentioned limits.

4.1. Some Preliminary Results From Village Interviews

It might be interesting in this contest to have a look into the so far returned and filled in forms of the village interviews (from 5 districts so far). In every district 100 persons have been interviewed.

- On the question whether they think that they are more important works to do in the village than electrification, 69% out of these 500 so far answered with yes. In one district all 100 interviewees answered with no. The percentage of the affirmative answers not counting this district comes to 86% !
- Among the development works mentioned on first or second priority out of a list of 15 possibilities, the most oftenly mentioned are : - irrigation
  - watersupply
  - healthpost
  - motorable roads

  Only in one district so far electricity for domestic use has been given first priority.
- The money spent on fuel for lighting per month on a average of 4 so far surveyed districts amounts to 21 rupees per household. One district an exeption as in this district the money spent on fuel for light is 83 rupees. Including this district in the calculation of an average of the 5 surveyed districts gives an average of 34 rupees per month.
- In all the districts except one lighting is done mainly with kerosine as fuel. Only in one district the ecologically armful practice of burning dialos (resine soaked wooden chips cut from living trees) for light is done extensively. In this district thus electrification would have a direct impact on the ecology even by only supplying electricity for domestic light.

4.2. Further Requirements

To passionates of rural electrification these preliminary results may sound disappointing. On a first glimpse it does of course not make much sense to install electricity in rural areas, when the majority of think that there are more important works to be done in the village before electricity should be introduced. However, these answers may only indicate that local people

cannot imagine what all can be done with electricity. Furthermore the works mentioned on first places to get priority over electricity are mainly works which can be implemented with the help of electricity.

Thus these preliminary results only indicate that electricity alone does not fulfill a basic need of the rural population of Nepal but that electricity in combination with other activities can play an important for rural development.

As experience shows, it is not sufficient to mention in prefeasibility reports other activities which would be most fruitful to be introduced in combination with electricity. As these prefeasibility reports usually find only a very limited readership and as especially those who would be in charge of such flanking activities never see such reports, so far no other activities in combination with electricity can be expected. Without an input from concerned offices nothing will happen. I think therefore that the need to involve other offices in rural electrification right from the beginning is very strong and that in addition to this, a kind of circulation key should be worked out according to which these prefeasibility studies would be distributed among offices of other departments and ministries.

5. The Possible Uses of Electricity in the Hills

The following shall but outline possible uses of electricity in combination with which electricity could become a valuable input in rural development, pointing out as well which offices should be involved right from the beginning.

5.1. Traditional Use

As stated earlier, the traditional use of electricity is only for domestic lighting. Thus in common Nepali language "batti" stands for light, lamp as well as for current, electricity. Though it was stated that electricity for lighting is an unproductive use, this is not fully true. Light can be used to extend the working day in manually operated industries, to allow studying and reading after sunset, to establish evening schools for adult literacy courses and as some pretend to curb the birth rate curve considerably.

Electricity for lighting however is considered unproductive if used extensively and in an exaggerated way as this can be observed in the two already electrified rural centres.

5.2. New, Alternative Uses

Based on the requirement that electricity either contribute to rural development or the reestablishment of an ecological balance, the following are but some possibilities which would help to fullfill it.

5.2.1. Community Hotwater Tanks

In places with very low demand during day time, the surplus capacity of a MHEGU could be used to heat water in electric boilers, placed on well frequented and centrally located places in a village. The use of water with 50 - 70°C temperature for cooking instead of cold water could reduce the demand for firewood by as much as half of the actual demand. Thus used electricity would make a palpable contribution to the conservation of forests and to the reestablishment of an ecological balance.

However to realise this way of using surplus electricity the RECAST and some local workshops for development and construction of cheap and appropriate boilers, the department of WSS as well as may be the LDD should be involved right from the beginning.

5.2.2. Community Gobar Gas

Gobar gas being a widely recognised and valuable alternative energy source is not easily applicable in the Nepalese hills due to unfavourable climatic conditions. Gobar gas plans are having an optimal gas output with an ambient temperature of 28°C. This temperature however is reached only during few month per year in large parts of the Nepalese hills.

SATA is actually building a cheese plant in the hills south of Kathmandu, which should depend completely on gobar gas for its

energy requirements. To make gobar gas production feasible in spite of unfavourable climatic conditions, a solar heat backing up system has been conceived and will be used for the first time in combination with gobar gas. A small trial plant has been put in operation satisfactorely about one year back. According to calculations made in this context, an average daily input of 50 kWh approximately would be sufficiant to keep the temperature of a well insulated 21m^3 pit on an optimum under average climatological conditions in the Nepalese hills.

One now could think of an electric backing up system as well, to operate alone or in combination with solar collectors, using surplus capacity of a MHEGU during daytime to keep the gobar gas plant at an optimal temperature. This indirect use of electricity would very clearly cut down the exclusive use of firewood for cooking.

Agencies and public bodies to be involved in the successful introduction of such plants would be for example local workshops with experience in manufacturing bio gas plants, RECAST for developing an appropriate heating system, LDD, Agriculture Training and Extension Section of the MFA etc.

5.2.3. Irrigation and Watersupply

A typical topographical feature of Nepal are the "Tars", high plateaus of alluvial and thus very pervious material, situated at 50 - 150 m above the riverbeds in the valleys of the major rivers of Nepal. These tars usually are extremely dry due to the lack of water retension capability of their soils and complete lack of irrigation facilities. Gravity irrigation schemes often are not feasible for these tars due to extremely long canals required.

Another typical feature of Nepal is the fact, that settlements usually are situated high on ridges above the rivervalleys. This often brings with it the fact, that no sources of drinking water are available above the settlement to allow a gravity watersupply scheme.

In both the mentioned features electricity could be used in a most productive way by supplying the energy to run pumps. This however

would require envolvement of DI and DWSS right from the beginning of the feasibilty study, in order to ensure a successful implementation of such a multipurpose project.

5.2.4. Agrobased Industries

Rice hullers, oil expellers and flour mills are the most trivial examples of agro based industries which can use electricity as motive power. Having a mill just near the settlements on top of the ridge can spare several hours of manpower actually used to bring the grain down to the river where the traditional "Ghattas" (water-wheel driven mills) are located. This manpower thus would be free for other productive development activities.

Many regions of Nepal have a favourable climate for horticulture and fruitplantations. The main problem so far hampering the development of such horticultural farms is the lack of transportation facilities which would allow to bring the perishable crops to the market within a useful laps of time. With the help of electricity fruit processing plants could be installed which would allow the marketing of the local cash crops in the big consumption centres of Nepal.

To give the needed input to this kind of development, the Fruit Development Section of the DA, the Marketing Service Division and the Economic Analysis Division of the DFAMS, the LDD, the DIn, the TPC, the DCVSI, the ADBN, the ISC and others should be involved in such programmes right from the beginning of the project study.

5.2.5. Small Scale and Cottage Industries

As the experiences from Dhankuta and Surkhet show, samll scale and cottage industries do not come up without any input from outside, simply because electricity is supplied.

To make sure that such industries really come up. close cooperation between LDD, TPC, DCVSI, DM, ISC, NIDC etc. has claiming priority.

5.2.6. Eucalyptus Oil Extraction

A more utopic utilisation of electricity would be the extraction of Eucalyptus oil. As was already pointed out by Mr. Malcolm Campbell at the Seminar on Management of Mountain Ecosystem held here in Kathmandu in November two years back, Eucalyptus canaldulensis of North-West Australian origin, would be a good, fast growing fuel-wood tree, capable of producing fuel of high calorific value.

With a little energy input, eucalyptus oil could be extracted from the smaller branches and leaves and form a valuable export good for Nepal. One 44 gallon barrel of Eucalyptus oil is worth 4000 $ approximately on the world market!

Thus an Eucalyptus tree plantation in combination with an electric Eucalyptus oil extraction plant would fullfill several aims at once: soil protection and erosion control, "energy plantation" to provide fuel to the local people and generation of a good cash income in rural areas.

However, to realise such plantations needs coordination and cooperation between different departments and ministries, namely LDD, DF, DMP, Afforestation Office, Dln, Fuel Corporation, ISC, NIDC, Timber Corporation and others.

5.2.7. Nitrogen Fertilizer Plants

Another even more utopic productive application of electricity in rural areas would be the already so often mentioned small scale electric nitrogen fertilizer plant. This plant works on the principle of separating the Nitrogen contended in the air by means of an electric arc. For an output of 1 ton of fixed Nitrogen about 50'000 kWh are required in this process.

To bring this application foreward, the cooperation and coordination of the following public bodies would be required: RECAST and local workshops to adapt the technology to be reproduceable locally, LDD, Soil Science Section in the DA, ADBN, AIC and others.

6. The Function of the SHDB

The function of the SHDB is to supervise feasibilty studies for rural electrification and to act as the executing agency in the construction of SHEGU's. SHDB already now is rather understaffed, especially in the field of civil engineering and it can by no means be the task of SHDB itself to carry out an integrated approach on its own forces. Its function within the outlined possibilities of applications of electricity in rural areas has to be confined to act as coordinating agency between the different mentioned offices and institutions in order to ensure an efficient integrated approach towards rural electrification.

7. Conclusion

If rural electrification is to contribute toward the economic output and rise incomes in rural areas, it must be placed in a productive context. Electricity from SHEGU's being rather an expensive energy, it is economically to feasible to supply it for domestic lighting only and at the limits would even not be feasible to supply energy for covering the local heat requirements for cooking. As experiences in Gujarat (India) have shown "energy plantations" i.e. plantations of forests with application of a regular cropping pattern for supplying wood for fuel, are cheaper than other sources of energy. If 1% solar energy conversion by photo synthesis of trees can be achieved, the land requirement for a 1 MW thermoelectric plant on base of wood would be 1 km^2 only. As for the fuel costs from energy plantations, studies in the USA and experiences in India put them in the range of 0.1 NC per kWh as compared to 1,0 to 2.0 NC economic price per kWh of small hydel plants.

The economic justification of SHEGU's thus is not self evident. The need to put rural electrification in a productive context can not be denied and in Nepal this can only be achieved through an integrated approach. Here one should make a strong request on the address of international and bilateral development agencies as well as development banks not to just consider implementations of isolated SHEGU's but take over "packages" for financing. It is only like this that rural electrification can play its important role in the development of the country.