REPORT OF THE TASK FORCE ON RURAL ELECTRIFICATION IMPACTS

VOLUME II

APPENDICES

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REPORT OF THE TASK FORCF ON RURAL ELECTRIFICATION IMPACTS IN NEPAL

SUMMARY

This is the final report of the Task Force on Rural Electrification Impacts in Nepal. The HMGN Task Force chaired by the Water and Energy Commission Secretariat (WECS) and with membership of the Nepal Electricity Authority (NEA), the Agricultural Development Bank of Nepal (ADBN) and the National Planning Commission (NPC), was set up to investigate impacts of rural electrification in order to both create a database for future forecasting and to provide policy direction for future development. The terms of reference of the work which spanned nearly 3 years called for the specification of a set of goals of rural electrification extracted from selected policy documents. These formed the basis for the current investigation.

Rural areas across Nepal served from a variety of generation sources were studied. These included NEA grid sites and those areas remote from the grid served by diesel, the Indian grid, NEA small hydro and private micro hydro. The study gathered and analyzed demand data from NEA billing units served from their grid, diesel, the Indian grid and small hydro sites. As well site investigations were made of small hydro and private micro hydro to determine operating characteristics. A local consultant was engaged to survey impacts of electricity in a sample of 28 rural communities amongst domestic, industrial, institutional and agricultural users. Details of this work are compiled in the two volumes of this report. The major conclusions of the Task Force are summarized below. Recommendations follow directly after the summarized conclusions.

The major overall conclusion of this report is that in the past the impacts of rural electrification have been minimal. For strong proponents of rural electrification this conclusion may be seen as a criticism that threatens the development aspirations of Nepal. This is not the case. The conclusion is based on a technical assessment of the past performance of RE. It does not mean there is no future for rural electrification. Rather it means that development of a rural grid must proceed in a planned, reasoned way that accounts in a systamic way for the broader development goals HMGN has set out for its rural areas. There are lessons in the past that can help the future particularily in the support RE will require if it is to succeed.

While the conclusions dwell on the impacts to date recommendations are geared to the pace and direction of rural electrification in the future. It is hoped that this document will provide a basis for future rural electrification development in Nepal.

1. CONCLUSION - Rural Electrification Meeting the Goals of HMGN

1. <u>To increase agricultural and industrial productivity</u>.

Rural electricity has not had the desired impact on agriculture. Although large central irrigation schemes use electric pumps these are arguably not served by the rural grid. Electrified shallow tube wells are served by the Nepal and Indian grids only. An estimated 1% of all shallow tube wells are operated by electricity. Based on experience in India further study is required before HMGN undertakes to promote electrified tubewells.

The impact of electricity on rural industry has been minimal. The primary need for electricity, other than lighting, has been found to be for motive power in industry. This means spinning motors in grinding, milling and perhaps cooling operations in small rural industrial applications provide the most productive use for electricity. These industrial uses are poorly developed in rural Nepal where other necessary industrial incentives are often lacking such as access to markets and raw materials. Electrified Panchayats on the Terai were found to have four times as many industries as in the hills. Average capacities of motors is about 6.5 kW with about 1.5 motors per industry. On average rural industries were found to consume relatively small amounts of energy in billing units (25% to 15% of total) and growth of consumption per customer was negligible (4%). Industrial growth in consumption appears to be particularly influenced by security of supply. Where supply is insecure (on the Indian grid) there is a decline in growth of consumption per customer. Where supply is seasonal or serves mainly domestic customers (diesel, small hydro, micro hydro) industrial customers are limited or nonexistent.

2. To Promote Tourism in Remote Areas

There is no evidence that electricity either promotes or hinders tourism in remote areas. It is evident that tourism provides a good base load for electricity project developments and that remote tourist centres can reasonably support rural electrification projects.

3. To Conserve Fuelwood and Petroleum Fuels

Surveys showed almost negligible savings of fuelwood due to electricity. Electricity was found to be too high cost to replace wood for cooking and heating. On average 5% to 15% of electrified households reported cooking 5 to 15 minutes per day with electricity. In households well over 50% of demand went for lighting. The displacement of kerosene here is obvious. Trends could not be observed, however, because kerosene is often replacing fuelwood as cooking fuel.

4. To Provide Regional Government Services By Electrifying Remote District Headquarters

It is evident that electricity is well used by HMGN institutions particularly in remote areas. For example on the Nepal grid at billing units in the hills the demand is 15% of the total for this tariff class which is equal to the industrial demand. At small hydro sites total demand of this class is at least twice the industrial demand. Major uses in offices appear to be for lighting, fans and heaters. In staff quarters attached to institutions higher use is made of appliances like fans and cookers/heaters than in average households.

5. <u>To Increase Productivity in Rural Households</u>

Productivity is not increased by electricity in rural households. From 50% to 75% of demand serves lighting while the remainder goes for appliance use such as fans and radios. Surveys showed less than 3% of the adult population report added income earning activities due directly or indirectly (lighting) to electricity.

6. <u>To Promote the Use of Social and Other Services in Remote Communities</u>

Electricity has brought social and economic community benefits generally in those communities served by the Nepal or Indian grids. Benefits included streetlights, electric water pumps, extension of closing time for the marketplace and industries. Electricity did not stimulate the provision X-ray services, photocopiers or night classes.

2. CONCLUSION - The Supply of Rural Electrification to the Remote Hills

This investigation suggests that electricity has limited productivity in remote, inaccessible areas. Except for HMGN services the major use is for social purposes. It is concluded that before electricity is provided the true <u>energy</u> demands and fuel needs are analyzed for a rural area and a reasonable forecast for development (or lack of development) is made. Electricity does not substitute easily for traditional fuels so that other energy supply programs may have higher priority.

Where it has been decided to provide electrification, such as in District Headquarters, small hydro is a costly option for supplying power. Annual operating costs have been found to be inordinately high although capital costs are not. At the same time revenue is low. The average estimated cost of electricity is estimated as NRs. 3.5/kWh for operating costs alone. Average revenue is NRs. 0.87/kWh. Based on these trends and the fact that there will likely be 29 sites in operation by 1990 yearly subsidy required to support only the cost of operation and maintenance would be NRs. 22 million. Efforts must obviously be made to decrease O&M costs and to increase revenue at these sites.

Preliminary analysis shows that grid extensions, possibly using low cost single wire earth return (SWER) systems, to accessible hill areas are more cost effective and may provide more secure supply (thus increased use of electricity) than small hydro.

Private microhydro may provide a cost effective alternative under certain conditions. Microhydro best serves a domestic demand. Economic systems have been found to be limited in size and service area to about 25 kW serving 250 households per installation. A multipurpose unit providing mechanical power during the day has been found to be more cost effective.

In the past the announcement of HMGN subsidy on the capital cost of equipment has had a significant impact in increasing the demand for installations. The withdrawal of the subsidy has had a similarly negative effect. Programs of subsidy if they are to be applied should be done so consistently and for a long enough period of say 5 years to have an extended impact.

3. CONCLUSION - Rural Electrification Tariffs

The lifeline rate (NRs. 0.44/kWh) is widely used in rural areas by about 50% to 75% of the customers. The long run marginal cost of power has been estimated at NRs. 1.30/kWh. The high implicit subsidy to the rural system has failed to induce some of the primary goals of HMGN such as increasing industrial, agricultural or household output. For productive purposes subsidy assistance may better be provided for up front capital purchases. Subsidizing the cost of energy should not be necessary since these costs can often be recovered by increased prices. For social lighting purposes as well there is some evidence of a willingness to pay an increased rate. Private micro hydro owners are able to charge rates from NRs. 1 to even 6 per kWh. Households should be willing to pay at least the marginal cost of kerosene lighting which has been calculated as NRs 0.94/kWh for the hills.

The cost of providing electricity in remote communities has been found to be high and the revenue low. Average ratios of revenue to annual operating costs at small hydro plants are about 19%. That is revenue covers only a fifth of annual operating costs. The tariff structure for remote hydro and diesel sites should be analyzed for possible changes such as a special increased tariff, a special tariff for government users, flat rate billing for lighting using load limiting fuses and other possible measures.

4. CONCLUSION - Planning and Institutional Support for Rural Electrification

A series of strengthening programs are being initiated by NEA and funded by the World Bank. Those that are relevant to future rural electrification policy are, 1) a rural electrification master plan, 2) a long run marginal cost and tariff study, 3) a ten year transmission and distribution plan. The data and findings of the Task Force on Rural Electrification Impacts should tie into these studies. Major conclusions related to planning and institutional support are;

- rural <u>energy</u> needs should be analyzed before rural electricity.
- ongoing plans to connect communities currently electrified by the Indian grid, diesel or small hydro are sound as are

plans to strengthen distribution from existing centres particularly on the Terai. Rather than an extensive rural grid extension program the above approach is likely appropriate for the coming two decades.

- political and institutional support must be given for the productive uses of electricity. To emphasize this load promotion groups are suggested for both NEA and ADBN.
- the Distribution and Customer Services Department of NEA are the most appropriate group to undertake a rural electrification program.
- ADBN are the most appropriate agency to promote private autogeneration for remote rural electrification.

RECOMMENDATIONS

The following recommendations have been keyed to the issues raised by the conclusions of Chapter 6. The recommendations have been made primarily for the organizations concerned with rural electrification in Nepal: The Ministry of Finance, The National Planning Commission (NPC), The Water and Energy Commission Secretariat (WECS) for analysis and policy issues; The Nepal Electricity Authority (NEA) for public rural electrification implementation issues; The Agriculture Development Bank (ADBN) for private rural electrification implementation issues.

It is noteworthy that these recommendations are being made at an important juncture for RE development. Several related studies are ongoing in NEA and several outside organizations are actively assisting the ADBN in private electrification development. NEA is contracting three related studies/programs through World Bank financing;

- a Rural Electrification Master Plan
- Long Run Marginal Cost and Tariff Study
- Institutional Strengthening and Twinning Program

The ADBN is actively pursuing private autogenerating options with outside agencies such as;

- GTZ (Germany) and ITDG (Britain) for micro hydro
- CNRS (France) for photovoltaics

These recommendations are also made to provide direction for the implementation of these inputs.

RECOMMENDATIONS

ISSUES	INSTITUTIONS	RECOMMENDATIONS
Rural Electrification Meeting the Goals of HMGN		
1. Nepal lacks a clearly defined set of goals for rural electrification that can help guide implementation of a long term programme. Based on the findings of the Impact Analysis a long list of potential goals can be reduced to three.	NPC WECS	The primary goals for rural electrification should be refined to three; 1. To strengthen important regional and district government centres through the provision of services. 2. Notwithstanding goal number one, to increase the financial viability of rural electrification systems by implementing projects on an economic priority basis. 3. To increase the productive output of industry, agriculture and households in rural Nepal.
Supply of Rural Electrification to the Remote Hills		
2. The provision of services at remote district headquarters with diesel and small hydro is not proving to be cost effective. O&M costs and unscheduled downtime are particularily high.	WECS	Immediately set up a programme to study management and operation/maintenance problems and issues at small hydro sites. The purpose of the programme will be to reorient the mandate of the Small Hydro Development Project.
	NEA/ SHDP	Anticipating the recommendations of the above-named programme, begin over the coming 5 years to reorient the mandate and workload of the Small Hydro Development Project. The focus of the Project should be to strengthen the operation and maintenance capability of NEA.
3. Remote small hydro and diesel have been found to be high cost, low dependability, generation modes for hill communities. SWER and other possible lower cost grid extension options may be available for more dependable service at these locations.	NEA / WECS	Based on the analysis of SWER, it and other grid extension options should be evaluated as alternatives for small hydro plant under study and as replacement for diesel and small hydro systems already operational.

ISSUES	INSTITUTIONS	RECOMMENDATIONS
Supply of Rural Electrification to the Remote Hills		
4. Private autogenerators play a significant but largely undetermined role in providing electricity to rural areas.	NEA / ADBN	The role of private autogenerators should be considered for use in off-grid remote locations as part of a rural electrification strategy. ADBN should be given primary responsibility for promoting the use of private microhydro, solar photovoltaics and small petrol-diesel engines. An electrification promotion unit is required within ADBN not only to promote the use of autogenerators but also to help develop the economic potential of rural areas. NEA should seriously consider the use of private autogenerators in decreasing public demand for electricity in remote locations. Their role should be determined by the Rural Electrification Master Plan through close coordination between ADBN and NEA.
5. To date electricity generated by photovoltaics has not seriously been considered for remote areas.	WECS / NEA/ ADBN	Although large scale centralized photovoltaic systems are uneconomic other options should be considered for economic comparison with conventional remote systems. Small decentralized lighting units or solar radios have been found to be currently competitive under certain conditions. The costs are expected to drop and efficiencies increase by the mid nineteen nineties. Nepal should be anticipating these changes and developing policy to move with these changes.
6. To date HMGN programs to encourage the deployment of private autogenerators has been sporadic.	WECS / Ministry of Finance	Technical and economic analysis has been made of microhydro. Similar analysis should be made for STW pumps, photovoltaic appliances, and diesel autogenerators. A coherent policy directive must be issued in line with the government's desire to encourage private autogenerators. Possible options for promotion of this equipment include capital subsidy, tariff relaxation, provision of foreign currency for parts purchase and so on. Whatever policy is developed this should be applied for a minimum of 5 years to ensure the proper signals to the private sector.

ISSUES	INSTITUTIONS	RECOMMENDATIONS
Rural Electrification Tariffs		
7. Revenues at small hydro and diesel sites are extremely low in proportion to the operating costs.	NEA	NEA should consider as part of its tariff study a special tariff for remote customers. Possible tariff options to be considered include; flat rate tariffs with load limiting fuses and the elimination of lifeline tariffs.
8. Rural electricity in remote areas serves a major demand from government institutions and attached quarters.	Ministry of Finance	HMGN must recognize the large burden the operation of diesel and small hydro plant places on NEA essentially to meet Government developed policy. Government should review its policy of financial assistance at these sites. Possible options include; straight subsidy to NEA for construction and operation of remote facilities, and a special inflated government tariff.
9. The NEA residential and agricultural tariff structure has not had its intended impact in rural areas of increasing electricity uses for productive purposes. Subsidy if it is applied should be available for the high capital cost items. Energy is generally a low cost item that can be absorbed in the price of the product.	NEA / Ministry of Finance	In its upcoming tariff study NEA should redesign its tariff levels primarily to meet economic criteria and to meet its financial committments. HMGN should consider other ways to meet social goals for the rural population with the benefits of electricity. These options might include; programmes that generate access to capital for purchase of electrical equipment and support of "load promotion" groups that teach productive uses of electricity.

ISSUES	INSTITUTIONS	RECOMMENDATIONS
Planning Implementation and Institutional Support for Rural Electrification		
10. Notwithstanding the goal to serve rural Government headquarters, planning for rural electricity should first account for the energy needs of rural people.	WECS	Rural electricitrification costs must first be compared on a least cost basis with other energy options as the initial step in developing a rural electrificationa programme. To do this an agency like WECS with a broad background in rural energy supply and demand should be responsible for reviewing and commenting on all rural electrification project proposals, particularily the Master Plan underway at NEA.
11. Once the primary step for a rural energy analysis is undertaken, methodologies to determine least cost alternatives for distribution grid extension will be undertaken in a Master Plan exercise. A goal of rural electrification programs is to connect on an economic priority basis.	NEA	Analysis of historical demand would suggest major distribution extensions from the NEA grid should be focussed on; o extension of the existing grid to semi rural and peri urban areas on the Terai and in the lower hills o those communities already served by the Indian grid, remote diesel, or where technically and economically feasible, remote small hydro. Current demand is clearly suppressed at these locations. These extensions can be adequately handled by the existing NEA Department of Distribution and Consumer Services (DCS).
12. The observed impacts of rural electrification have been minimal with respect to; o replacement of fuelwood o inducement of industry o increase in agricultural productivity o increases in home productivity Major uses have been for social and "comfort" with lights and fans.	NEA	Provision of service in the future should focus on increasing the productivity of industry, agriculture and homes by; a) ensuring to the extent possible firm power to productive users. b) remote site generation timed and sized to meet primarily industrial load. c) creating a "load promotion" project within Distribution and Consumer Service (DCS) to act as an extension agency operating through Billing Units in rural areas promoting productive uses of electricity.

ISSUES	INSTITUTIONS	RECOMMENDATIONS
Planning and Institutional Support for Rural Electrification		
13. Electrified shallow tube wells (STW) have been forecast by the Seventh Power Plan and promoted within HMGN as an end user of rural electricity.	WECS/ NEA	The electrification of STW is a policy issue that requires careful technical and economic analysis before it is promoted widely. Neither the financial benefits to the user nor the economic benefits to the nation of using grid electricity over diesel pumpsets has been adequately studied to justify the development of an extensive program in rural distribution extensions. This should be undertaken before such a program is developed.
14. Accurate load forecasting in rural areas is greatly hampered by the lack of data on demand by tariff class and supply characteristics by switching station or small hydro site.	NEA	A Technical Data Management System should be created to standardize, collect, process, summarize and distribute key technical information in the NEA system.
15. Single Wire Earth Return (SWER) systems have been identified in the ADB (Manila) Seventh Power Project as having great potential for cost savings both in construction and in operation/maintenance.	NEA	SWER should be analyzed further for its technical and economic viability in Nepal by the Master Plan study. A necessary further step would be the demonstration and analysis of SWER in a test location before its widespread use.

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Goals of Rural Electrification

Presented in the Sixth Power Project Document

EXTRACT FROM "A Policy for Rural Electrification" Appendix 3A, "Butwal-Nepalgunj Transmission Line Project-Rural Electrification Program-Final Report Volume 2" Preece Cardew and Rider Ltd., HMGN, June 1984

1. Objective of Rural Electrification Programme

Based on the economic and social development objectives stipulated in the Sixth Plan, a number of objectives are suggested for HMG/N's RE programme:

a) to promote increased agricultural and small scale industrial production in rural areas;
b) to promote tourism as well as save the scarce resources such as fuel wood and petroleum fuels by substituting them with electricity;
c) to promote inter fuel substitution through increased use of electricity for cooking and lighting purposes;
d) to electrify rural houses so that the rural inhabitants can spend their leisure hour in more productive way; and
e) to promote social services to rural areas in setting up of hospital with X ray and surgical operation theatre, night schools for adults, library and reading room, drinking water supply, etc.

2. Priority to the Electrification in the Vicinity of Project Sites

Priority should be given to the electrification of those rural areas which are in the vicinity of power project such as generating station or transmission line so that local people will realize the importance of project and co-operate in the implementation of the development projects in future.

3. Modality for RE

Rural Electrification programme shall be carried out by extending line from generating station or transmission line provided the programme proves to be the least cost alternative.

4. Selection of Areas for RE

To electrify area within the jurisdiction of RE technically best scheme will be formulated and they will be ranked according to the benefit cost ratio for implementation on the priority basis.

5. Use of Indegeneous production and Talents

Every effort shall be made in designing the programme so that maximum utilization of the available national resources, products and talents in the implementation of RE programmes, will be taken care of.

6. Training of Local People

Efforts shall be made to train and use local people for construction, operation and maintenance of RE Project.

7. Safe and Simple Wiring

Wiring practice to be adopted in the rural areas should be safe and simple.

8. Hook-up Charge

In order to make electricity supply available to more number of houses, study on the implication of financial assistance for the installation of house-wiring, shall be made.

Appendix 2

Listing of known Operating
Private Micro Hydro Sites

TABLE: A2.1

PRIVATE MICRO HYDROELECTRIC SCHEMES IN NEPAL

	OWNER'S NAME	PLANT LOCATION	REGION	NET HEAD (m)	FLOW (l/s)	RATED POWER (kW)	COST (lakh.Rs)	DATE ONLINE	NO.OF UNITS	TURBINE TYPE	TURBINE MAKER	GENERATOR TYPE Phase/rpm	GENERATOR MAKER	GENERATOR CAPACITY (kVA)	DESIGN BY	FINANCE BY
1	Shrestha,Pancha Krish	Benighat, Dhading	C	40	15	5		Dec-85	1	Pelton	KMI	3-ph.1800	Kholer, USA	6.25	KMI	ADB/N
2	Bhandari,Karta B.	Hatiya, Baglung	W	14	150	12	0.62	Feb-86	1	X/Flow	BEW	3-ph/1500	Markon,UK	15.00	DCS	ADB/N
3	Sherchan, Hem p.	Butiwang, Baglung	W	11	157	16	1.04	Mar-87	1	X/Flow	BEW	3-ph/1500	Kirlosker,In	20.00	DCS	ADB/N
4	Kalamagar, Indra Bdr.	Khaireni, Gulmi	W	8.9	100	12	0.70	Dec-83	1	X/Flow	BEW	1-ph/1500	Markon,UK	10.00	DCS	ADB/N
5	Sapkota, Laxmi N.	Kushmisera, Baglung	W	10.3	80	10	0.73	Jun-86	1	X/Flow	BEW	1-ph/1500	Markon,UK	12.50	DCS	
6	Singh, Min b.	Lueta, Bajhang	?	4.25	200	5.91	1.33	Apr-86	1	MPPU	NSE	3-ph/1500	NPP, Nepal	5.50	NSE	ADB/N
7	Sherpa Community	Lukla No.2, Solukhumbu	E	100	3	2		Jul-86	1	Pelton	KMI	3-ph/1600	Induction, N	2.00	KMI	GTZ/Commun
8	Sherpa Community	Lukla No.1, Solukhumbu	E	100	3	2		Jul-86	1	Pelton	KMI	3-ph/1600	Induction, N	2.00	KMI	GTZ/Commun
9	Naresh Bdr. G.C.	Okharkot, Pyuthan	MW	5	75	4	0.41	Jun-86	1	MPPU	NSE	1-ph/1500	Indian	4.00	DCS	ADB/N
10	Basnet,Thir Vikram	Gajun(Mohantar),Dhading	C	7.5	40	4	0.29	Apr-85	1	MPPU	KMI	3-ph/3000	Induction, N	2.00	KMI	ADB/N
11	Khatri, Ratna Kumar	Naubise No.1, Dhading	C	4	100	4	0.56	Aug-86	1	X/Flow	KMI	1-ph/1600	Induction, N	5.00	KMI	ADB/N
12	Kurma,Upreti Dip	Naubise No.2, Dhading	C	13	185	14	1.02	Jan-84	1	X/Flow	BYS	1-ph/1500	Newage, UK	13.40	BYS	ADB/N
13	Shrestha, Ram Bdr.	Naubise No.3, Dhading	C	4	200	7	0.35	Feb-82	1	X/Flow	NSE	3-ph/1500	Indian	5.00	NSE	self
14	Bhaukaji, Badri Das	Sangutar, Ramechhap	C	10.5	300	26	0.35	Dec-83	1	X/Flow	NYS	3-ph/1500	Kirlosker,In	10.00	NYS	ADB/N
15	Medicinal Plant	Manichour, Sankhu		20	25	7	0.75	Sep-82	1	X/Flow	NYS	3-ph/1500	Markon,UK	5.00	NYS	HMG
16	Sherpa,Kscherpa Doje	Solukhumbu	E			2		jan-86	1		NYS	1-ph/3000	Induction, N	2.00	KMI	
17	SFDP,Gov't	Taklung, Gorkha	W	14	50	9	0.48	Nov-85	1	X/Flow	KMI	3-ph/2200	Induction, N	3.00	KMI	ADB/UNICEF
18	Upadhaya, Dharma R.	Tamghas, Gulmi	C	106	35	27	6.64	Apr-86	1	Pelton	BEW	3-ph/	Kirlosker,In	40.00	AgroEng	ADB/N
19	Shrestha,Govinda Ram	Turture, Tanahun	W	20.5	37	8	0.38	Jun-83	1	X/Flow	BEW	1-ph/1500	Markon,UK	10.00	DCS	ADB/N
20	Nepal, Bal Bdr.	Bhumisthan, Dhading	C	4	50	1	0.10	Jul-86	1	MPPKIT	KMI	1-ph/1600	Induction, N	1.00	KMI	ADB/GTZ
21	District C'tte	Gajuri, Dhading	C	28	100	25	1.13	Dec-79	1	X/Flow	BYS	3-ph/1500	Elmot,India	31.25	BYS	HMG
22	Dept Nat Parks W'life	Namche Bazar	E	80	70	27	0.00	Oct-83	1	S/Flow	BYS	3-ph/1500	Markon,UK	37.50	BYS	Aid
23	FAO/Sheep & Goat Farm	Guthichaur	W	5.5	250	6	0.00	Aug-78	1	X/Flow	BYS	?	?	?	BYS	?
24	UMN Jumla Project	Jumla,(UMN)	MW	13	220	20		May-81	1	X/Flow	BEW	3-ph/1500	Markon,UK	25.00	DCS	KTS
25	Shrestha, Jagat Das	Okheldhunga, Pokhali		5	300	7.5	2.70	Sep-86	1	X/Flow	NYS	1-ph/1500	Kirlosker,In	1.00	NYS	ADB/N
26	Mukhiya, Uday Bdr.	Jasbire, Ilam	E	9	60	4.61	0.24	Dec-83	1	MPPU	NSE	1-ph/1500	Indian	1.00	NSE	ADB/N
27	Amatya, Gauri N.	Indrayani, Kathmandu	C	19.2	150	19	0.65	Oct-85	1	MPPU	NSE	1-ph/1500	Indian	1.00	NSE	ADB/N
28	Khatri, Dhir Bdr.	Melung, Dolakha	MW	9.64	82	7	0.44	Aug-85	1	MPPU	NSE	1-ph/1500	Indian	1.00	NSE	ADB/N
29	Bhatwal, Khem Nath	Terhathum	E	14	83	7	0.61	Dec-84	1	MPPU	NSE	1-ph/1500	Indian	1.00	NSE	ADB/N
30	Shah, Dambar Bdr.	Balekhu, Doti	FW	5.7	249	9	0.63	Mar-87	1	MPPU	NSE	1-ph/1500	Indian	1.00	NSE	ADB/N
31	Regmi,Dhan Bdr.	Charaundi, Dhading	C	20	60	8	0.61	Mar-86	1	MPPU	NSE	3-ph.3000	Induction, N	3.00	KMI	ADB/N
32	Shrestha,Pancha Krish	Benighat,2nd generator	C	40	15	3	0.35	Dec-85	1	Pelton	KMI	3-ph/3200	Induction, N	3.00	KMI	ADB/N
33	Sherpa, Chepal Dorji	Solukhumbu	E	20	120	20	1.13	Dec-84	1	X/Flow	NYS	1-ph/1500	Indian	3.00	NYS	ADB/N
34	Gautam, Puskar	Tallo Haluwar, Dang	MW	4.4	150	5.34	0.70	Jan-83	1	MPPU	NSE	3-ph/1500	Indian	3.00	NSE	ADB/ATU
35	Shahi, Dirgha Bir	Bhude Gaon, Doti	FW	7.5	200	12.68	0.85	May-85	1	MPPU	NSE	3-ph/1500	Indian	3.00	NSE	ADB/N
36	Adhika,Yub Raj	Surkhet,		40	15	5	0.9	Jul-86	1	Pelton	KMI	3-ph/1600	Induction, N	4.70	KMI	ADB/N
37	Komi, Siva Bdr.	Jiri Bazar,Dolakhar		6.5	100	7	0.63	Aug-86	1	X/Flow	KMI	1-ph/1600	Induction, N	7.00	KMI	ADB/N
38	Girelu, Dhan Bdr.	Jiri, Dolakha	C	6.29	160	7.46	0.41	Dec-82	1	MPPU	NSE	3-ph/1500	Indian	7.00	NSE	ADB/N
39	Dairy Dev. Corp.	Gatlang	C	44	45	8	0.98	Aug-81	1	X/Flow	BYS	1-ph/1500	Elmot,India	10.00	BYS	HMG
40	Regmi,Gopal Raj	Udaypur, Bhenighat	C	6	280	10	1.148	Mar-86	1	X/Flow	BYS	1-ph/1500	Newage, UK	10.00	BYS	ADB/N
41	Agric Input Corp	Sundar Bazar	W	7.5	125	5	1.61	Apr-84	1	X/Flow	BYS	3-ph/1500	Markon, UK	10.00	BYS	AIC
42	ADB	Nuwakot, Gaukharka		65	80	40	4.27	Oct-85	1	X/Flow	NYS	3-ph/1500	Kirlosker,In	30.00	NYS	ADB/N
43	NEA	Thansing	C	25	120	20	1.24	Dec-79	1	X/Flow	BYS	3-ph/1500	Elmot,India	30.00	BYS	HMG
44	Khatri,Ganesh Bahadur	Harichour Bazar,Baglung	W	11.2	153	12	1.06	Apr-87	1	X/Flow	BEW	1-ph/1500	Markon, UK	15.00	DCS	ADB/N

TABLE: A2.1

PRIVATE MICRO HYDROELECTRIC SCHEMES IN NEPAL

	OWNER'S NAME	PLANT LOCATION	REGION	NET HEAD (m)	FLOW (l/s)	RATED POWER (kW)	COST (lakh.Rs)	DATE ONLINE	TURBINE NO.OF UNITS	TURBINE TYPE	TURBINE MAKER	GENERATOR TYPE Phase/rpm	GENERATOR MAKER	GENERATOR CAPACITY (kVA)	DESIGN BY	FINANCE BY
45	Sajha,Issaneswar	Karaputar, Lamjung	W	22.5	5000	40	3.17	Sept-86	1	X/Flow	BEW	3-ph/1500	Kirlosker,In	47.5	DCS	ADB/N
46	Thapa. Chham B.	Goosmili, Baglung	W	13.7	170	4	0.32	Apr-87	1	X/Flow	BEW	3-ph/1500	Induction, N	4	DCS	ADB/N
47	Nepali, Moti R.	BIJAYANAGER,PYUTHAN	W	12	75	4	0.46	Aug-87	1	X/Flow	BEW	1-ph/1500	Kirlosker,In	8.00	DCS	ADB/N
48	Subedi,K.P.	Gorkhe, Illam	E	7.7	150	10	1.92	Jun-87	1	X/Flow	BEW	3-ph/1500	Kirlosker,In	12.50	DCS	ADB/N
49	Badajar,C.K.	Jogbudha,Dadeldhura	FW	6.6	200	6	0.6	Feb-87	1	X/Flow	BEW	1-ph/1500	Kirlosker,In	6.00	DCS	ADB/N
50	Awasthi,Prjapati	Lali, Daarchula	FW	15	70	10	1.47	Feb-87	1	X/Flow	BEW	3-ph/1500	Kirlosker,In	12.50	DCS	ADB/N
51	Malla, Dharmendra	Wamitar,Gulmi	W	8.8	200	10	1.77	Jul-87	1	X/Flow	BEW	1-ph/1500	Kirlosker,In	12.50	DCS	ADB/N
52	Pant,Mahadev	Bhartoal,Darchula	FW	17	112	12	1.45	Dec-87	1	X/Flow	BEW	3-ph/1500	Kirlosker,In	15.00	DCS	ADB/N
53	Shrestha,Jawahar Lal	Purtighat Bazar,Gulmi	W			12	1.26	Dec-87	1	X/Flow	BEW	1-ph/1500	Kirlosker,In	15.00	DCS	ADB/N
54	Sharma,Krishna Prasad	Khara Bazar, Baglung	W	7.5	125	12	0.87	DEC-87	1	X/Flow	BEW	1-ph/1500	Markon,UK	15.00	DCS	ADB/N
55		Malekhu, Dhading	C			5		?	1	X/Flow	?	?	?	?	?	ADB/N
56	Karna Bdr. Bhandari	Galkot, Baglung	W			12	0.48	?	1	?	?	1-ph.	Markon,UK	?	DCS	ADB/N
57	District Panchayat	Lete, Mustang	W	90	6	10	3.73	1988	1	X/Flow	BEW	1-ph/1500	Markon,UK	12.50	DCS	District
58	Khadka, N.B.	Surlichour,Rolpa	MW	6.5		6	0.53	1988	1	X/Flow	THAPA	1-ph/1500	Kirlosker,In	6.00	DCS	ADB/N
59	Dept Nat Parks W'life	Tengboche	E	90	40	20		not	1	X/Flow	BYS	?	?	?	BYS	-
60	Bhandari, Lok Narayar	Okheldhunga, Pokhali		10	150	8	1.10	U/C	1	X/Flow	NYS	1-ph/1500	Kirlosker,In	1.00	NYS	ADB/N
61		Tamghas, Gulmi	W	40	25	7		?	1	X/Flow	?	3-ph.1500	Shaktimaan,I	18.75	?	?
62	Khadka Khadga Bdr	Khimti, Ramechhap	C	15	150	10.0	0.46	U/C	1	X/Flow	NYS	3-ph/1500	Kirlosker,In	5.00	NYS	ADB/N
63		Rambu Khola, Nuwakot	C			25			1						NYS	
64		Sankhuwasawa	E			4			1						NYS	
65	Naresh Bdr. G.C.	Okharkot, Pyuthan	MW			4	0.35	?	1	MPPU	?	1-ph.	?	?	DCS	ADB/N
66	Sapkota,Laxmi Narayan	Kusmi Shera	?			8	0.51	?	1	?	BYS	1-ph.	?	?	DCS	ADB/N

TOTAL KNOWN ONLINE CAPACITY KW 557.

TOTAL ONLINE SITES 51

AVERAGE CAP/SITE 10.9 KW

Appendix 3

Committed Expansion of the NEA System

TABLE A3.1

HYDRO POWER SYSTEMS(SYNCHRONOUS) UNDER CONSTRUCTION
(1987)

REGION	LOCATION	SITE	NO. OF UNITS	UNIT SIZE MW	INSTALLED CAP. MW	FIRM CAP. MW	IN SERVICE DATE
WESTERN	PALPA	ANDHI KHOLA	3	1.7	5.1	5.1	1989
WESTERN	TANAHU	MARSHYANGDI	3	23.0	69.0	66.0	1989
		TOTAL			74.1	71.1	

TABLE A3.2

COMMITTED TRANSMISSION LINES IN NEPAL
132 KV AND 66 KV

S.NO.	FROM	TO	VOLTAGE KV	LENGTH KM	SIZE SQ. INCH	NO. OF CIRCUIT	TYPE OF TOWER	DUE IN SERVICE
1	BANESWAR LOOP		66	3	0.25	2	DC	1987
1	SHIVAPUR	LAMAHI	132	51	0.25	1	DC	1988
2	LAMAHI	NEPALGANJ	132	96	0.25	1	DC	1988
3	MARSHYANGDI	BALAJU	132	85	0.25	1	SC	1990
4	MARSHYANGDI	BHARATPUR	132	25	0.25	1	SC	1990
5	BALAJU	LAINCHOUR	66	1	0.25	1	SC	1990
6	BIRATNAGER	ANARMANI	132	78	0.25	1	SC	1991

DC = DOUBLE CIRCUIT

SC = SINGLE CIRCUIT

SOURCE: LEAST COST GENERATION PLAN 1987 (NEA)

TABLE A3.3

NEA COMMITTED SUBSTATIONS 66 AND 132 KV

S.NO.	LOCATION	VOLTAGE KV	NO. OF UNITS	UNIT CAP.MVA	SUBSTATION CAP.MVA	DUE IN SERVICE
1	BANESWAR	66/11	1	18	18	1987
2	SHIVPPUR	132/33/11	1	5	5	1988
3	LAMAHI	132/33/11	1	5	5	1988
4	NEPALGANJ	132/33/11	1	10	10	1988
5	BALAJU(EXT)	132/66	1	45	45	1990
6	BALAJU(EXT)	66/11	1	20	20	1990
7	LAINCHOUR(EXT)	66/11	1	20	20	1990
8	ANARMANI	132/33/11	2	6	12	1991
9	BIRGANJ(EXT)	66/33	2	5	10	1991
10	POKHARA(EXT)	132/11	1	6	6	1991
				TOTAL	151 MVA	

SOURCE: LEAST COST GENERATION PLAN 1987 (NEA)

TABLE: A-3.4

SMALL HYDRO UNDER CONSTRUCTION BY NEA (1987)

DISTRICT	SITE	INSTALLED CAPACITY KW	DATE IN SERVICE	EST. CAP. 1987 '000 US $	EST. CAP. '000 RS.	COST PER KW US $
TAPLEJUNG	TAPLEJUNG	125	7/1988	726.82	15990	5815
KHADBARI	SANKHUWASABHA	250	7/1988	1117.82	24592	4471
TERHATHUM	TERHATHUM	100	7/1988	808.86	17795	8089
BHOJPUR	BHOJPUR	250	7/1988	881.77	19399	3527
SALLERI	SOLUKHUMBU	200	7/1988	904.27	19894	4521
NAMCHE	SOLUKHUMBU	600	7/1989	1428.18	31420	2380
OKHALDHUNGA	OKHALDHUNGA	125	7/1988	750.14	16503	6001
RAMECHAP	RAMECHAP	75	7/1989	561.91	12362	7492
MAHANG	MAHANG	80	12/1987	459.73	10114	5747
TATOPANI	MYAGDI	1000	7/1990	5122.73	112700	5123
CHAUJHARI	RUKUM	150	7/1988	1130.32	24867	7535
SYARPUDAHA	RUKUM	200	7/1988	1567.09	34476	7835
BAJURA	BAJURA	200	7/1988	1447.73	31850	7239
BAJHANG	BAJHANG	200	7/1988	1137.27	25020	5686
ARUGHAT	GORKHA	150	7/1989	350.00	7700	2333
RUPALGAD	DADELDHURA	100	7/1989	581.82	12800	5818
SURNAYAGAD	BAITADI	200	7/1989	471.95	10383	2360
	TOTAL	4005		19448.41		4856

TABLE: A-3.5

SOLAR POWER PLANTS UNDER CONSTRUCTION BY NEA

SITE	DISTRICT	CAP. KW	CAPITAL '000 US $	CAPITAL '000 RS	
KODARI	SINDHUPALCHOK	10			
TATOPANI	SINDHUPALCHOK	20	763.82	16804	(1)
GANGADHI	MUGU	50	1116.41	24561	
SIMIKOT	HUMLA	50	1112.05	24465	
	TOTAL	130	2992.27	65830	
	AVG. COST/KW $		23017		

(1) (FOR BOTH TATOPANI & KODARI)

Appendix 4

Maps of Nepal's Electricity Systems

FIGURE – A-4.1
NEA SYSTEM

NEPAL

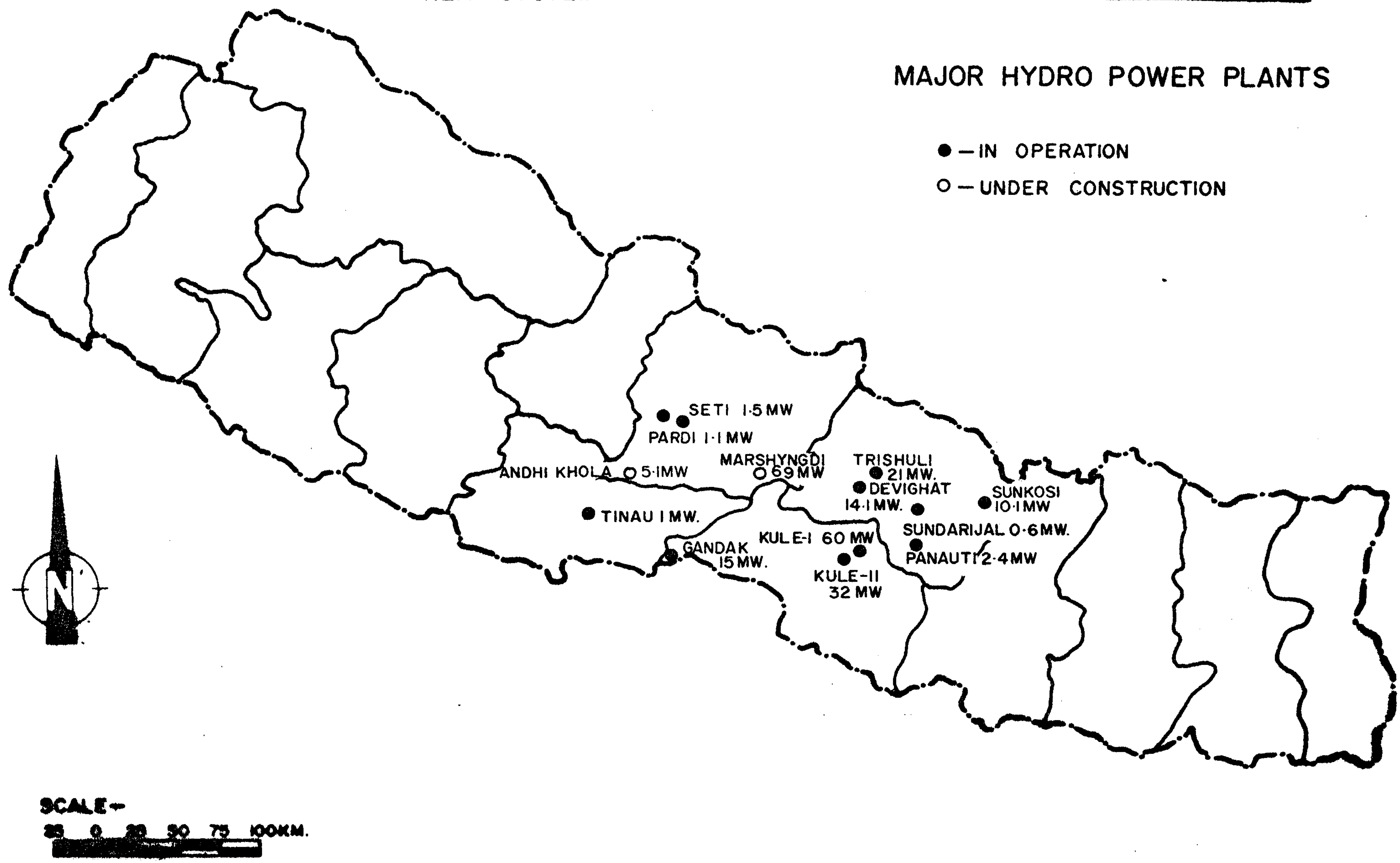
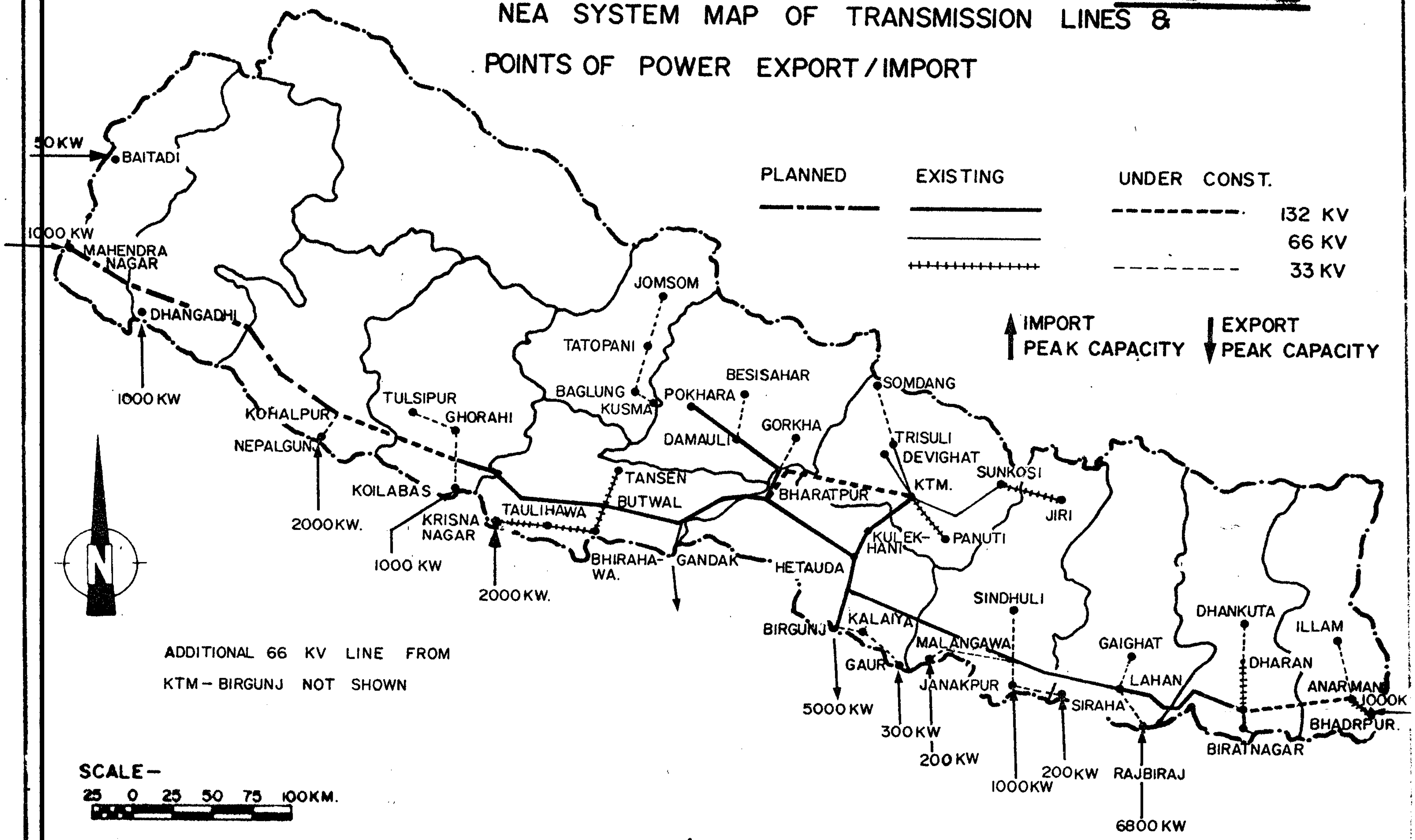


FIGURE – A – 4.2

NEA SYSTEM MAP OF TRANSMISSION LINES & POINTS OF POWER EXPORT / IMPORT



ADDITIONAL 66 KV LINE FROM KTM – BIRGUNJ NOT SHOWN

FIGURE - A-4·3

NEA SYSTEM

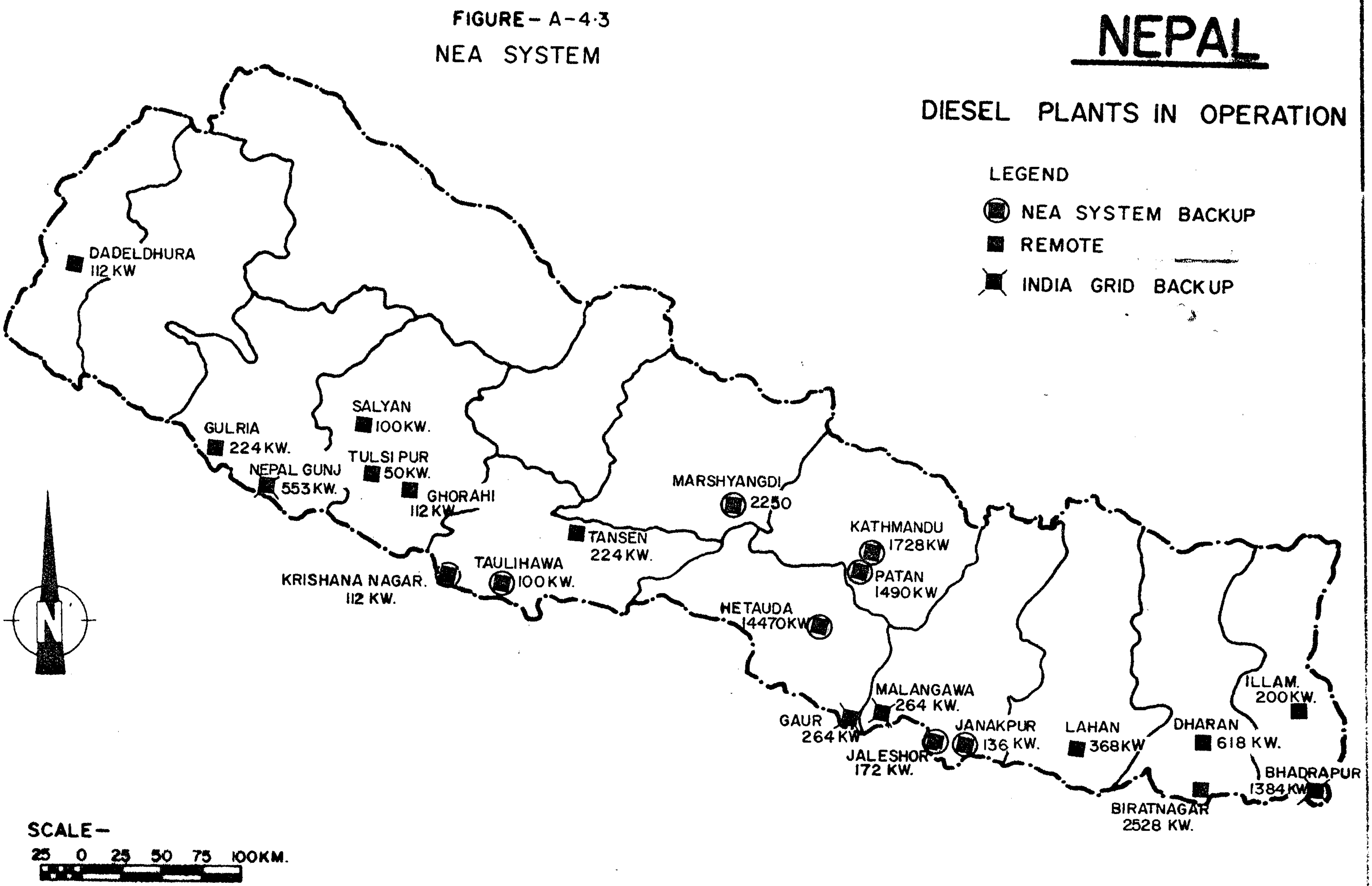


FIGURE – A 4.4

NEPAL

NEA OPERATED REMOTE SMALL HYDRO POWER UNITS, OPERATIONAL & UNDER CONSTRUCTION.

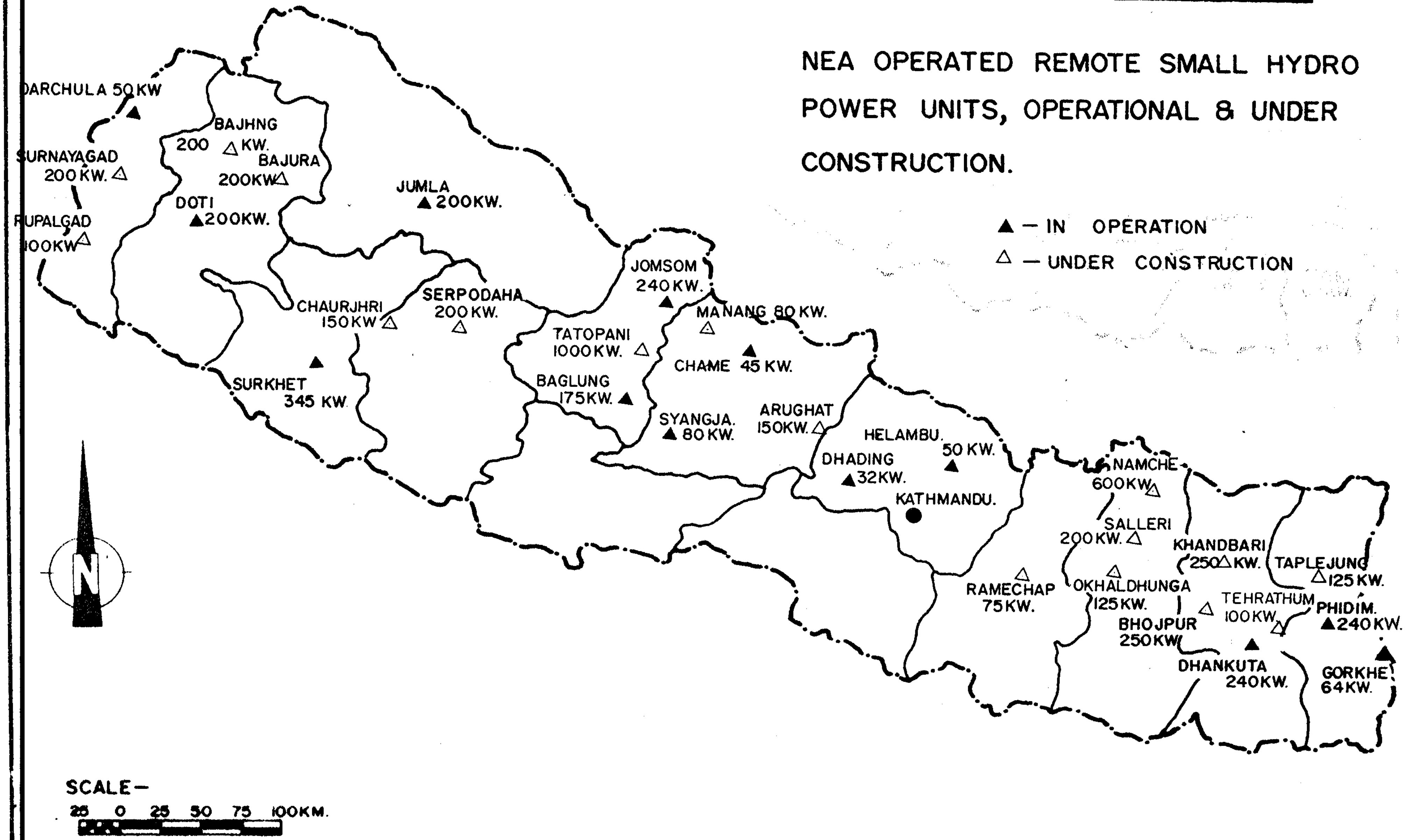
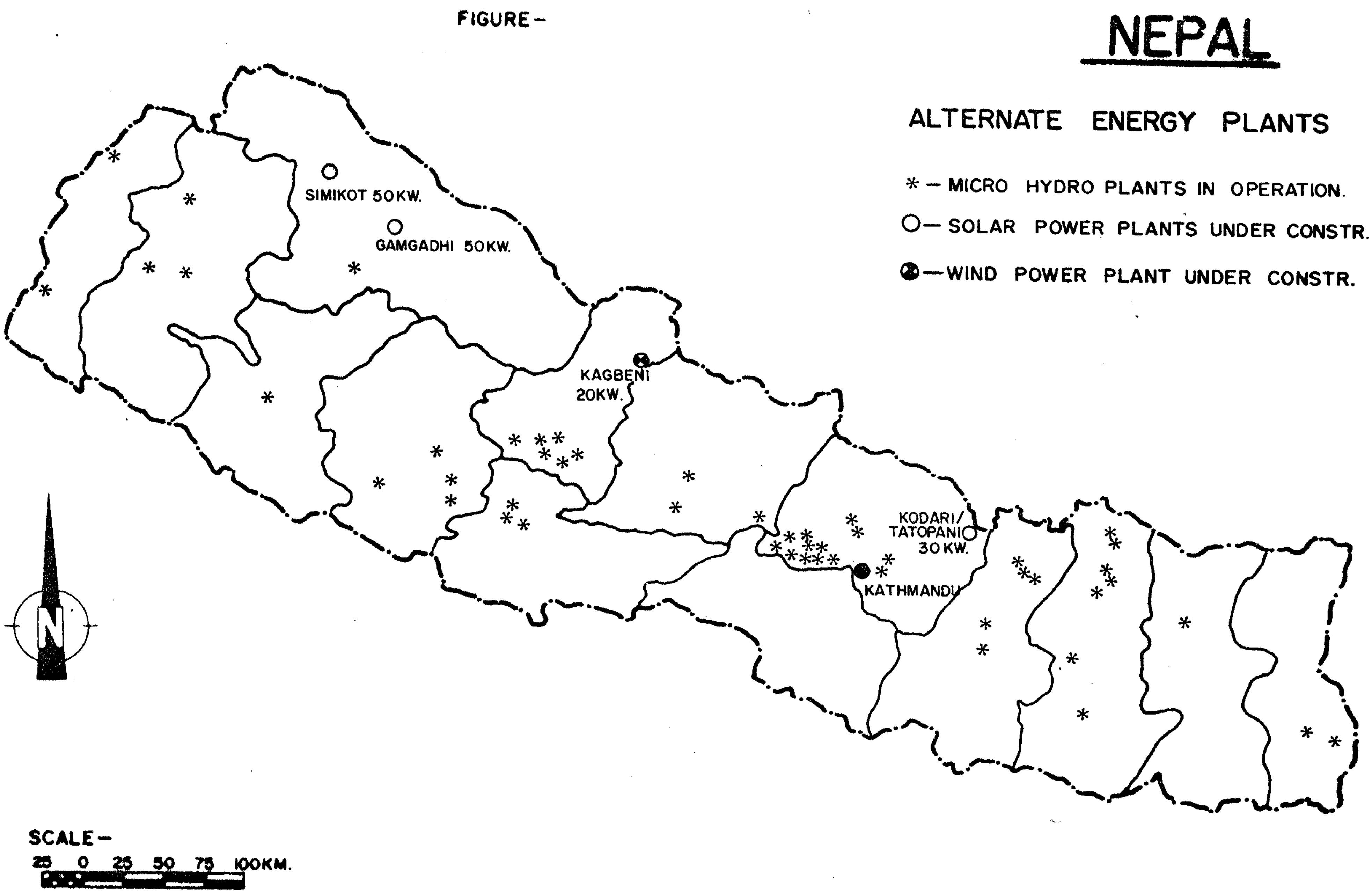


FIGURE-


NEPAL
ALTERNATE ENERGY PLANTS
* — MICRO HYDRO PLANTS IN OPERATION.
O — SOLAR POWER PLANTS UNDER CONSTR.
⊗ — WIND POWER PLANT UNDER CONSTR.
SIMIKOT 50 KW.
GAMGADHI 50 KW.
KAGBENI 20 KW.
KODARI/ TATOPANI 30 KW.
KATHMANDU
N
SCALE-
25 0 25 50 75 100 KM.

Appendix 5

Assumptions of the Sixth Power Plan in Calculating Feeder Loads.

APPENDIX 5

LOAD FORECAST ASSUMPTIONS USED IN THE SIXTH POWER PROJECT

1. Composition of Energy Demand in each Village.
   Domestic - 41%
   Industrial - 37% Commercial - 1.5%
   other (Irri., non-commercial etc.) 20.5%

2. For Domestic Consumption;
   100% of permanent and tiled houses are connected
   25% of thatched houses are connected
   Peak load contribution; permanent houses - .3 kVA, tiled houses - .2 kVA, thatched houses - .175 kVA.

3. Load Factor
   Domestic - 25%
   Industrial - 40% Commercial - 25%
   Other - 40%
   System - 40%

4. Coincidence Factors
   1 Transformer - 100%, 2/3 transformers - 90%,
   4-6 transformers 80%, 7-10 transformers 70%.

Appendix 6

Technical Description of Single Wire Earth Return (SWER) System

MINUTES OF MEETING

Time and Date

2 p.m. Tuesday, 17 March 1987

Place

N.E.A. Offices, Kathmandu

Present

Nepal Electricity Authority

Mr. L.M. Dixit,	Director-in-Chief, System Planning Directorate
Dr. M.R. Tuladhar,	Director, Technical Services Department, DCS
Mr. B.B. Malla,	Director, Project Monitoring Dept. System Planning Directorate
Mr. G.M. Kadariya,	Director Western Region, DCS
Mr. R.S. Pandey,	Director Eastern Region, DCS
Mr. R.K. Bajracharya,	Project Coordinator System Planning Directorate
Mr. T.D. Shrestha,	Manager, Planning Division Technical Services Dept., DCS
Mr. D.R. Bhattarai,	Manager, Design and Standards Division Technical Services Dept., DCS
Mr. B. Kayastha,	Project-in-Charge Pokhara Rehabilitation Project
Mr. B.M. Singh,	Deputy Manager Planning Division Technical Services Dept., DCS

Mr. J.M. Pradhan	Deputy Manager, Design and Standards Division Technical Services Dept., DCS
Mr. M. Shrestha	Deputy Manager, Pokhara 132 KV Substation

Asian Development Bank

Mr. J. Irving,	Distribution Expert
Mr. J. Dennis,	Economics Expert

Sixth Power Project Consultants

Mr. R. Stockton,	Resident Distribution Engineer

WERD Project

Mr. K. Davies,	Distribution Planning Advisor

Purpose of Meeting

To discuss the use of Single Wire Earth Return (S.W.E.R.) Systems for rural electrification in Nepal.

Discussion

Dr. M.R. Tuladhar initiated the discussion by introducing to the meeting mr. J. Irving and Mr. J. Dennis, Asian Development Bank Experts in power distribution and economics, who are assisting NEA in the preparation of the Seventh Power Project.

Mr. Irving outlined the Urban Distribution Rehabilitation and Rural Electrification (R.E.) schemes which NEA had requested be considered for financing by ADB under the Seventh Power Project.

With regard to the R.E. schemes Mr. Irving, noted that to date in Nepal distribution design has been based on traditional British practice with 3 phase 33 KV subtransmission and 3 phase 11 KV distributors. This is considered appropriate for R.E. schemes in the Terai where the terrain is flat and which is more densely populated than the hill areas. In the hill areas however, where the terrain is very rugged and where the loads are very small and widely scattered, considerable cost savings could be realized by adopting single phase distribution using the 19.8 KV Single Wire Earth Return (SWER) system in which a single phase wire derived from an isolating transformer is reticulated alone, the return current being directed through the earth.

Schemes using this system have been in operation successfully and safely for over 40 years in Australia and New Zealand. More recently it has been introduced in Mexico and India.

The main features of this type of distribution are described in a january 1983 paper by J.W. Wilson entitled "Single Wire Earth Return (SWER) for Rural Areas - An Introduction" copies of which were circulated to participants prior to the meeting. A much more detailed description of SWER Systems is given in a brochure entitled "High Voltage Earth Return Distribution for Rural Areas" produced by the Electricity Authority of New South Wales, Australia. This brochure also includes a complete set of drawings and data relevant to the erection and operation of the systems described.

The lower costs associated with the SWER System stem from the use of longer line spans (since conductor clashing is eliminated by the use of a single conductor) and cheaper, more efficient single phase transformers. The SWER System also provides higher reliability due to fewer wires exposed to failure causes (birds, trees, conductor clashing) and due to the reduced number of potential insulation failure points resulting from the use of longer spans. In New Zealand it has been found that on the basis of faults/year SWER Systems are about three times more reliable than conventional 3 phase distribution systems.

As an example of a SWER system for small widely scattered loads in hill areas Mr. Irving demonstrated a map and diagram which had been prepared for the Ilam R.E. scheme. (A copy of a similar diagram No. DCS-TS-RE01 is annexed to these minutes).

Ilam requires a 3-phase supply, but its load (at least initially) does not justify a conventional 3 phase 33 KV line. Instead it is proposed to take three 19.8 KV SWER lines to Ilam over different routes so as to pick up as many loads as possible. Each of these lines will be taken from a different pair of phases at the 33 KV isolating substation. In order to improve the reliability of the 3 phase supply at Ilam in the event of an outage on one of the SWER lines, Ilam will be fed via a transformer designed to provide a 3-phase output with an input derived from 2 phases and the earth return neutral. Any two of the three incoming phases can be selected to supply this transformer.

Mr. Irving stated that as previously indicated it was not proposed to apply the SWER system to Terai R.E. schemes except in the case of supplies to shallow tubewell pump sets. In this case a SWER conductor would be run as an additional conductor on conventional 33 KV or 11 KV lines supplying other loads. Mr. Irving illustrated this type of scheme by demonstrating a map and diagram which had been prepared for the Malangawa R.E. scheme in the Terai.

(A copy of a similar diagram No. DCS-TS-RE02 is annexed to these minutes.)

During the general discussion which followed Mr. Irving's presentation the following topics were covered:

1. Load Limit

This is governed by the upper limit set on earth return current and the extent to which load balance can be achieved between single phase SWER lines supplied from a 3 phase backbone feeder.

In general terms a total load of up to approximately 1 MW can be fed from such a system.

2. Reliability

On most overhead distribution lines a large proportion of non-transient faults are between phases. These are usually caused by conductors clashing, birds, animals or sticks causing short circuits. SWER systems are obviously not prone to such faults. In New Zealand it has been found that on a basis of faults/year SWER lines are about three times more reliable than "conventional" distribution lines.

3. Earthling

Because the current carrying earth connection is such an important part of the system, duplicate protected conductors are run down opposite ends of the earth electrode system. To prevent high voltage gradients in the vicinity of the earth connection the resistance is usually kept to less than 2.5 ohms. This would normally be achieved with 4-6 earthling rods at each location.

4. Telephone Interference

Requirements to minimise telephone interference are well documented in the relevant Australian and new Zealand standards. Provided normal clearances between telephone and power lines are maintained the SWER system is not usually associated with interference problems. Earth current is restricted to the SWER circuit and, unlike other systems, does not return to the substation transformer neutral.

5. Maintenance Problems in Hilly Areas

This should not be a great problem since in the schemes under consideration line routes are selected so as to follow roads, tracks etc. as much as possible. Whilst the line will not follow every twist and turn of a road it will be routed along the road's general axis.

6. Cost of Single Phase Motors

In the lower range of ratings most frequently encountered in SWER schemes single phase motors cost up to approximately 20% more than three phase motors.

However, this cost increase represents a very small part of the total cost of connecting a consumer to the electricity supply.

7. Operation of 3 Phase Motors from a Single Phase Supply

Since certain motor driven equipment, e.g., for rice mills, is supplied equipped with three phase motors, these have to be adapted for operation from a single phase supply. This can be done very simply using capacitors as illustrated in J.W. Wilson's paper on SWER systems. Consideration could be given to including such an 'adaptor package" in the service connection.

8. Reliability of 3-Phase Supply to Ilam

The transformer feeding Ilam will be of a type designed to given a three phase output when connected on its primary side to two phases and the earth return neutral.

Since a switching arrangement is envisaged which will permit the connection of any 2 of the 3 incoming phases to this transformer the loss of any one SWER line to Ilam will not affect the continuity of tbe 3-phase supply in Ilam.

9. Protection

A cheap high speed single phase auto recloser is usually employed with a SWER scheme especially in areas with a high incidence of lightening. Adequate protection of the transformers is provided by HV fuses.

10. Line Erection

Only one conductor is required. This eliminates any requirement to limit span lengths due to conductor clashing (as with multi conductor supply system). The use of smooth bodied aluminum coated steel wire permits high tensions to be used to facilitate long spans, thereby utilizing fewer pole support structures.

11. Voltage Regulation

LV capacitors connected in series with a power line cancel out a proportion of the line impedance. This significantly improves voltage regulation. (It is noted that series capacitors are rarely used on most HV systems because of the difficulty of insulating and protecting them particularly under fault conditions. On SWER system however series capacitors are a practical proposition because they use cheap low voltage capacitors connected into the earth circuit of the isolating transformers.)

12. Costs

The cost advantage of SWER lines compared with 3-phase 3 wire and single phase 2-wire construction is in part related to the use of long spans permitted by the single wire construction. It is for this reason that the SWER system is considered particularly suitable for R.E. schemes in hilly areas.

A cost comparison of 19.8 KV SWER type line construction with 33 KV 3 phase 3 wire and 33 KV single phase 2 wire construction is annexed to these minutes.

13. Subsidies for Connections to Shallow Tubewell Pumpsets

It was noted that the Indian Government encourages the electrification of shallow tubewell pumpset installations by paying Electric Utilities a subsidy for each such service connection made.

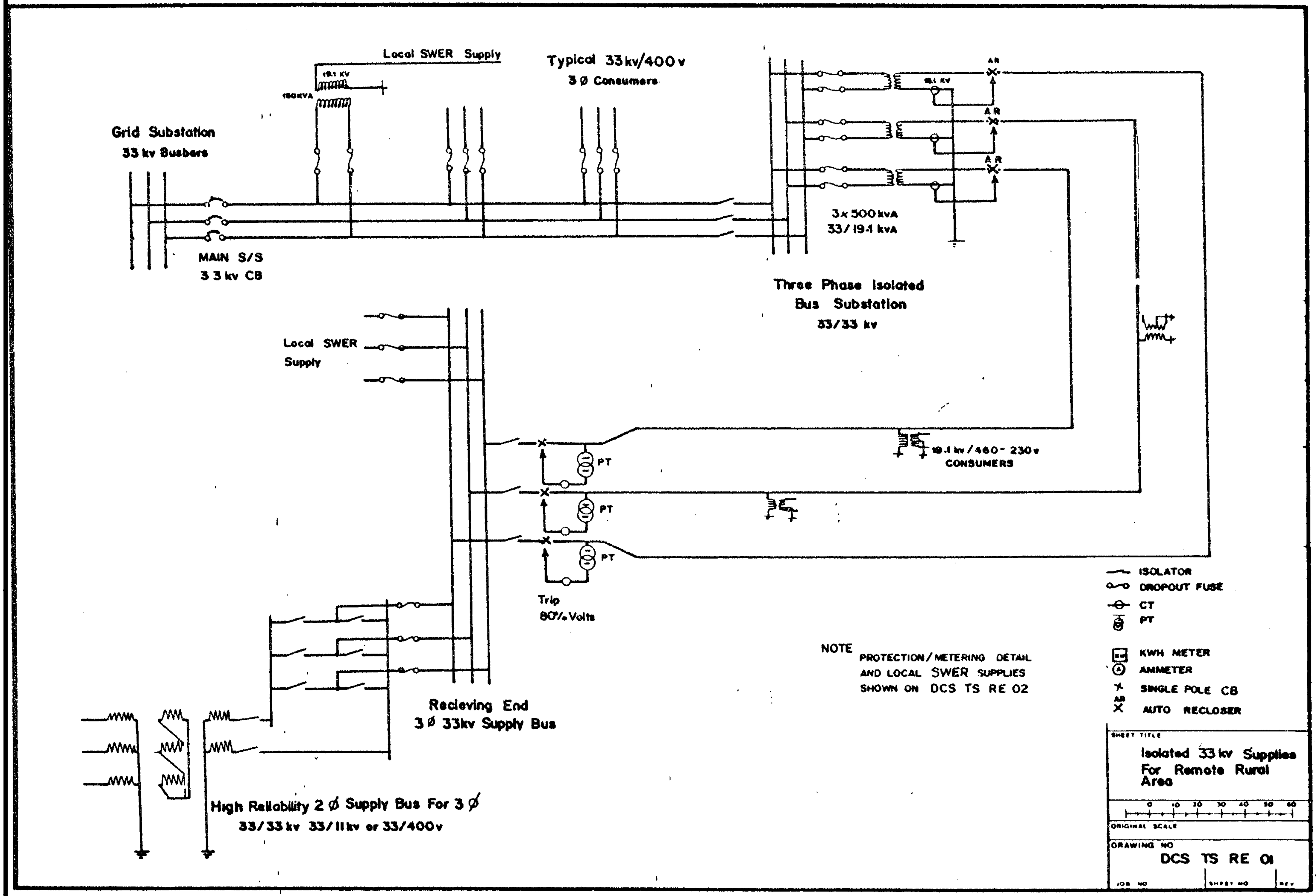
It was suggested that a similar arrangement was desirable in Nepal.

14. Use of SWER Systems in Nepal

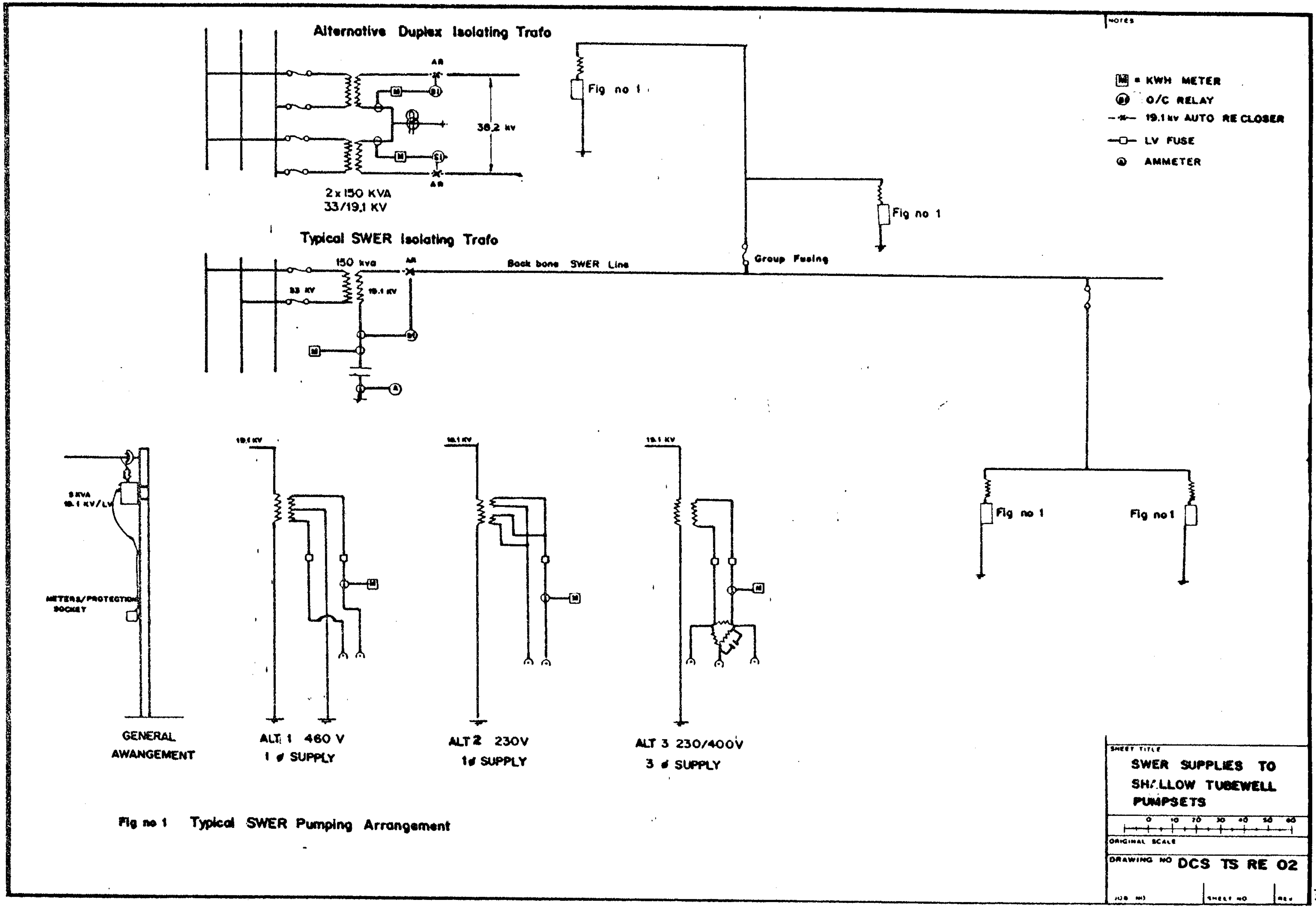
Dr. M.R. Tuladhar agreed to prepare a paper, for consideration by NEA management, setting out the advantages of the SWER system and proposing its adoption for use in rural electrification schemes in Nepal.

RURAL COST COMPARISON
STEEP/HILLY TERRAIN
35 SQ MM AAAC

ITEM	33 KV THREE PHASE 110 M SPANS				33 KV SINGLE PHASE 2 WIRE (OR EQUIVALENT CAPACITY DUPLEX SWER SYSTEM) 143 M SPANS				19.8 KV SINGLE PHASE 1 WIRE 200 M SPANS			
	QTY	UNIT COST $	SUB.T.	TOTAL	QTY	UNIT COST $	SUB.T.	TOTAL	QTY	UNIT COST $	SUB.T.	TOTAL
POLES - CONCRETE 12 M 350 da N	9	210		1890	7	210		1470	5	210		1050
INSULATORS - PIN	21	22	462		12	22	264		5	15	75	
- DISC	54	10.5	567	1029	24	10.5	252	516	8	10.5	84	159
CROSSARMS - HARDWOOD	12	8.4		101	9	7.0		63	-			
HARDWARE - CROSSARM BRACE	24	2.6	62.4		18	2.0	36		-	-		
TIES	21	1.6	33.6		12	1.6	19.2		5	1.6	8	
TERMINATIONS	18	1.6	23.8		8	1.6	12.8		4	1.6	6.4	
DISC INSUL. HDWARE(SET)	18	5.8	104.4		8	5.8	46.4		4	5.8	23.2	
POLE TOP INSUL. BRKT.	-	-	-		-	-	-		5	9.6	48	
BOLTS	45	1.1	49.5	279	34	1.1	37.4	152	12	1.1	13.2	99
GUYING - PER SET	4	38.7		155	3	38.7		116	3	38.7		116
CONDUCTORS	3.15KM	179		564	2.1KM	179		376	1.05KM	179		188
ERECTION/TRANSPORTATION												
POLES/CROSSARMS	9	55.5	499		7	53.0	371		5	49.0	245	
STRINGING	3KM	0.15/M	450		2KM	0.15/M	300		1KM	0.15/M	150	
GUYING	4	10.5	42	991	3	10.5	31.5	703	3	10.5	31.5	427
TOTAL COST/KM				5009				3396				2039
CONSTRUCTION BASED ON:	6 SINGLE CROSSARM INTERMEDIATES 3 SECTIONAL 4 GUYS				5 SINGLE CROSSARM INTERMEDIATES 2 SECTIONAL 3 GUYS				3 SINGLE INSULATOR INTERMEDIAT… 2 SECTIONAL 3 GUYS			



Local SWER Supply
19.1 KV
150 KVA
Typical 33kv/400v
3 Ø Consumers
Grid Substation
33 kv Busbars
MAIN S/S
33 kv CB
A R
19.1 KV
3x500 kvA
33/19.1 kvA
Three Phase Isolated
Bus Substation
33/33 kv
Local SWER
Supply
19.1 kv/460-230v
CONSUMERS
PT
PT
PT
Trip
80% Volts
Recieving End
3 Ø 33kv Supply Bus
High Reliability 2 Ø Supply Bus For 3 Ø
33/33 kv 33/11kv or 33/400v
NOTE
PROTECTION/METERING DETAIL
AND LOCAL SWER SUPPLIES
SHOWN ON DCS TS RE 02
ISOLATOR
DROPOUT FUSE
CT
PT
KWH METER
AMMETER
SINGLE POLE CB
AUTO RECLOSER
SHEET TITLE
Isolated 33kv Supplies
For Remote Rural
Area
0 10 20 30 40 50 60
ORIGINAL SCALE
DRAWING NO
DCS TS RE 01
JOB NO
SHEET NO
REV



Alternative Duplex Isolating Trafo
AR
38,2 kV
2 x 150 KVA
33/19,1 KV
Fig no 1
Typical SWER Isolating Trafo
150 kva
33 KV
19.1 KV
Back bone SWER Line
Group Fusing
NOTES
M = KWH METER
O/C RELAY
19.1 kV AUTO RE CLOSER
LV FUSE
AMMETER
19.1 KV
5 KVA
19.1 KV/LV
METERS/PROTECTION SOCKET
GENERAL AWANGEMENT
ALT 1 460 V
1 ø SUPPLY
ALT 2 230V
1ø SUPPLY
ALT 3 230/400V
3 ø SUPPLY
Fig no 1 Typical SWER Pumping Arrangement
SHEET TITLE
SWER SUPPLIES TO SH/LLOW TUBEWELL PUMPSETS
0 10 20 30 40 50 60
ORIGINAL SCALE
DRAWING NO DCS TS RE 02
JOB NO
SHEET NO
REV

Appendix 7

Assumptions about NEA Billing Units Used in Analyzing Demand Characteristics

TABLE: A-7.1

ASSUMPTIONS USED IN TABLE: 3.1 FOR ANALYZING DEMAND DATA FOR BILLING UNITS

DEVELOPMENT REGION	ZONE	BILLING UNIT	SUPPLY SOURCE NEA GRID - INDIA - DIESEL	ECON. STATUS Rural/Urban	PHISIO REGION	DIST. ADMIN
WESTERN	LUMBINI	BHAIRAHAWA	NEA	U	TERAI	HQ
		BUTWAL	NEA	U	TERAI	HQ
		LUMBINI	NEA	R	TERAI	HQ
		PALPA	NEA	R	HILLS	HQ
		PARASI	NEA	R	TERAI	HQ
		TAULIHAWA	NEA	R	TERAI	HQ
	GANDAKI	POKHARA	NEA	U	HILLS	HQ
CENTRAL	NARAYANI	BHARATPUR	NEA	U	TERAI	HQ
		BHIMPHEDI	NEA	R	HILLS	
		BIRGUNJ	NEA	U	TERAI	HQ
		HETAUDA	NEA	U	TERAI	HQ
	BAGMATI	KIRTIPUR	NEA	R	HILLS	
		PANAUTI	NEA	R	HILLS	
		SUNKOSI	NEA	R	HILLS	
		TRISULI	NEA	R	HILLS	HQ
	JANAKPUR	JALESHWAR	NEA	R	TERAI	HQ
		JANAKPUR	NEA	R	TERAI	HQ
EASTERN	KOSI	BIRATNAGAR	IND/DIES	U	TERAI	HQ
		DHARAN	DIESEL	U	TERAI	
	MECHI	BHADRAPUR	IND/DIES	U	TERAI	
	SAGARMATHA	LAHAN	DIESEL	R	TERAI	
		RAJBIRAJ	INDIA	U	TERAI	HQ
CENTRAL	JANAKPUR	MALANGWA	INDIA	R	TERAI	HQ
	NARAYANI	GAUR	INDIA	R	TERAI	HQ
		KALAIYA	DIESEL	R	TERAI	HQ
WESTERN	LUMBINI	NAYAMILL	INDIA	R	TERAI	
		KRISHNANAGA	INDIA	U	TERAI	
		BAHADURGUNJ	INDIA	U	TERAI	
		TRIBENI	INDIA	R	TERAI	
MID-WESTERN	BHERI	GULARIA	DIESEL	R	TERAI	HQ
		NEPALGUNJ	DIESEL	U	TERAI	HQ
	RAPTI	GHORAHI	DIESEL	R	TERAI	HQ
		TULSIPUR	DIESEL	R	TERAI	
		KOILABAS	INDIA	R	TERAI	
FAR-WESTERN	MAHAKALI	MAHENDRANAG	INDIA	U	TERAI	HQ
		DADELDHURA	DIESEL	R	HILLS	HQ
	SETI	DHANGARHI	INDIA	R	TERAI	HQ

NOTE: SITES SERVED BY INDIA WITH DIESEL BACKUP (IND/DIES) ARE CONSIDERED TO BE SERVED BY INDIA

Appendix 8

Demand Data for Billing Units of the NEA Interconnected System

TABLE: A-8.1

DEMAND CHARACTERISTICS SUMMARY - NEPAL GRID BILLING UNITS

DEVELOPMENT REGION	ZONE	BILLING UNIT	ECON. STATUS R/U	PHISIO REGION	DIST. ADMIN	YEAR OF ELEC	MODE	YEAR HOOKUP TO GRID	YEAR DATA CURRENT	YEARS ELEC-TRIFIED	YEARLY CONSUMPTION - MWH DOM	IND	COMM	NON-COM	IRR	STR-LT	SELF	TEMP	TOTAL
WESTERN	LUMBINI	BHATRAHAWA	U	TERAI	HQ	1972	DIESEL	1975	1985	13	2563.04	3468.25	47.60	383.24	1219.30	159.61	97.68		7938.72
		BUTWAL	U	TERAI	HQ	1971	HYDRO		1985	14	1580.71	1686.67	1185.06	456.59	78.35	188.86	13.31		5160.49
		LUMBINI	R	TERAI	HQ	1975		1975	1985	10	93.36	182.89	2.91	44.37	0.00	12.94	1.20		337.13
		PALPA	R	HILLS	HQ	1972	DIESEL	1975	1985	13	853.29	101.54	3.57	136.11	1052.20	48.47	26.71	0.54	2221.67
		PARASI	R	TERAI	HQ	1975		1975	1985	10	632.94	873.83	0.00	43.31	0.00	11.99	13.99		1576.06
		TAULIHAWA	R	TERAI	HQ	1973	DIESEL	1975	1985	12	315.91	465.86	11.53	145.85	38.24	17.96	2.93		997.95
	GANDAKI	POKHARA	U	HILLS	HQ	1967	HYDRO	1983	1985	18	5812.85	1519.48	541.85	1460.54	0.00	84.79	289.26	44.68	9588.16
CENTRAL	NARAYANI	BHARATPUR	U	TERAI	HQ	1972	DIESEL		1985	13	2290.57	2859.17	512.96	918.56	4197.08	12.40	58.90	247.45	10297.09
		BHIMPHEDI	R	HILLS					1985	1985	92.04	0.96	0.00	63.04	0.00	1.88	2.37		160.04
		BIRGUNJ	U	TERAI	HQ	1950	DIESEL	1969	1985	35	6397.99	24571.75	162.28	1618.62	352.43		46.80	6715 (*)	39865.32
		HETAUDA	U	TERAI	HQ	1966	DIESEL	1969	1985	19	2792.61	18963.25	0.00	470.93	5.48	106.88	85.33	3254.58	25679.06
	BAGMATI	KIRTIPUR	R	HILLS					1985	1985	1201.80	138.05	0.00	0.00	66.01	157.44	4.98		1566.02
		PANAUTI	R	HILLS		1965	HYDRO		1985	20	269.34	158.26	0.00	24.20	0.00	12.96			464.76
		SUNKOSI	R	HILLS		1972	HYDRO		1984	12	391.70	162.28	0.00	156.18	0.00	5.76	397.54	14.36	1120.63
		TRISULI	R	HILLS	HQ	1967	HYDRO		1985	18	838.85	332.23	11.96	137.75	621.18	4.03	1203.78		2210.71
	JANAKPUR	JALESHWAR	R	TERAI	HQ	1973		1973	1985	12	341.26	287.11	13.57	178.93	27.89	7.20	2.40		858.36
		JANAKPUR	R	TERAI	HQ	1972	DIESEL	1973	1985	13	1745.39	925.78	157.64	381.84	144.10	43.20	58.80		3456.75
	AVERAGE																		
	TOTALS										28213.65	55897.35	2650.93	6620.06	7802.27	876.37	2305.97	3561.61	113498.9

TABLE: A-8.1

DEMAND CHARACTERISTICS SUMMARY - (Cont'd)

DEVELOPMENT REGION	ZONE	BILLING UNIT	PERCENT OF TOTAL CONSUMPTION							NUMBER OF CUSTOMERS						YEARLY CONSUMPTION / CUSTOMER - KWH						MEASURED
			DOM	IND	COMM	NON-COM	IRR	STR-LT	SELF	DOM	IND	COMM	NON-COM	IRR	STR-LT	DOM	GROWTH IND	COMM	NON-COM	IRR	STR-LT	YEARS
WESTERN	LUMBINI	BHAIRAHAWA	32.3%	43.7%	0.6%	4.8%	15.4%	2.0%	1.2%	3309	184	3	14	56	1	756	18849	15867	27374	21773	159612	6
		BUTWAL	30.6%	32.7%	23.0%	8.8%	1.5%	3.7%	0.3%	2063	132	17	148	1	3	766	12778	69710	3005	78348	62953	
		LUMBINI	27.7%	54.2%	0.9%	13.2%	0.0%	3.8%	0.4%	315	21	1	17	0	1	296	8709	2913	2610	0	12936	
		PALPA	38.4%	4.6%	0.2%	6.1%	47.4%	2.2%	1.2%	1608	34	1	6	3	2	531	2986	3570	22685	350733	24237	
		PARASI	40.2%	55.4%	0.0%	2.7%	0.0%	0.8%	0.9%	1173	60	0	2	0	4	540	14564	0	21655	0	2998	6
		TAULIHAWA	31.7%	46.7%	1.2%	14.6%	3.8%	1.8%	0.3%	786	42	2	61	2	2	402	11092	5763	2391	19121	8979	6
	GANDAKI	POKHARA	60.6%	15.0%	5.7%	15.2%	0.0%	0.9%	3.0%	5795	148	17	25	0	1	1003	10267	31873	58421	0	84792	6
CENTRAL	NARAYANI	BHARATPUR	22.2%	20.0%	5.0%	8.9%	40.8%	0.1%	0.6%	3362	199	46	131	4	1	681	10348	11151	7012	1049271	12396	6
		BHIMPHEDI	57.5%	0.6%	0.0%	39.4%	0.0%	1.7%	1.5%	158	1	0	3	0	1	583	964	0	21013	0	1883	6
		BIRGUNJ	16.0%	61.6%	0.4%	4.1%	0.9%	0.0%	0.1%	5814	416	5	215	23	22	1100	59067	32456	7528	15323		6
		HETAUDA	10.9%	73.8%	0.0%	1.8%	0.0%	0.4%	0.3%	3245	115	0	16	2	3	861	164098	0	29433	2741	35625	6
	BAGMATI	KIRTIPUR	76.7%	8.8%	0.0%	0.0%	4.2%	10.1%	0.3%	4321	22	0	0	3	4	278	6275			22004	39360	6
		PANAUTI	58.0%	34.1%	0.0%	5.2%	0.0%	2.8%	0.0%	756	14	0	9	0	27	356	11305		2688		480	6
		SUNKOSI	35.0%	14.5%	0.0%	13.9%	0.0%	0.5%	35.5%	833	19	0	52	0	20	470	8541		3003		288	5
		TRISULI	37.9%	15.0%	0.5%	6.2%	28.1%	0.2%	54.5%	2059	48	3	0	6	2	407	6921	3986		103531	2016	6
	JANAKPUR	JALESHWAR	39.0%	33.4%	1.6%	20.8%	3.2%	0.8%	0.3%	3551	182	35	271	6	2	96	8203	50	29822	4648	3600	6
		JANAKPUR	50.5%	26.8%	4.6%	11.0%	4.2%	1.2%	1.7%	3551	182	35	271	6	2	497	5087	4504	1409	24016	21600	6
	AVERAGE TOTALS		24.9%	49.2%	2.3%	5.8%	6.9%	0.8%	2.0%	42779	1819	165	1241	112	98	660	30730	16066	5334	69463	0943	6

T BLE: A-8.1

AND CHARACTERISTICS SUMMARY - (Cont'd)

EVELOPMENT REGION	ZONE	BILLING UNIT	GROWTH CONSUMPTION ADJ-DOM	IND	IRR	TOTAL	GROWTH CUSTOMERS ADJ-DOM	IND	IRR	GROWTH CONS/CUST ADJ-DOM	IND	IRR
STERN	LUMBINI	BHAIRAHAWA	8.3%	15.2%	179.5%	5.1%	8.8%	8.9%	94.7%	-0.5%	5.8%	43.5%
		BUTWAL	17.5%	16.2%		15.5%	8.1%	9.7%	8.7%	5.9%	23.6%	
		LUMBINI	13.6%	-0.8%		3.9%	11.6%	11.8%	1.7%	-12.0%		
		PALPA	7.1%	-0.2%	11.6%	8.3%	8.2%	17.8%	0.0%	-1.0%	-15.3%	11.6%
		PARASI	26.8%	22.5%		24.1%	23.8%	23.4%	2.4%	-0.7%		
		TAULIHAWA	13.8%	12.9%	43.2%	14.1%	7.2%	16.0%	0.0%	6.2%	-8.9%	43.2%
	GANDAKI	POKHARA	44.8%	48.7%		32.3%	13.4%	17.2%	27.8%	26.9%		
CEN	NARAYANI	BHARATPUR	23.5%	32.4%	432.1%	40.1%	26.3%	28.9%	32.0%	-2.2%	2.7%	303.3%
		BHIMPHEDI	7.2%			7.3%	2.0%		5.1%			
		BIRGUNJ	15.7%	40.4%	1.8%	26.4%	10.6%	10.2%	8.9%	4.7%	27.4%	-6.6%
		HETAUDA	-22.0%	29.5%	-26.5%	16.9%	12.9%	10.4%	0.0%	-30.9%	17.2%	-26.5%
	BAGMATI	KIRTIPUR	15.9%	-0.9%		12.3%	7.3%	3.0%	8.1%	-3.8%	27.2%	
		PANAUTI	10.4%	6.7%		8.6%	6.0%	3.1%	4.1%	3.4%		
		SUNKOSI	10.7%	40.6%		11.3%	9.7%	20.5%	0.9%	16.6%		
		TRISULI	0.3%	15.4%	1.1%	-6.5%	19.6%	14.9%	3.7%	-16.2%	0.4%	-2.5%
	JANAKPUR	JALESHWAR	18.1%	11.5%	NA	15.8%	9.0%	6.2%	NA	8.4%	46.1%	NA
		JANAKPUR	30.4%	15.3%	24.9%	24.6%	9.0%	6.2%	0.0%	19.6%	8.6%	24.9%
	AVERAGE TOTALS		8.0%	30.0%	53.4%	20.8%	11.4%	11.5%	37.8%	-3.1%	16.6%	11.3%

SUMMARY -BHAIRAHAWA   === NEA INTERCONNECTED UNIT ===

	AVERAGE YEARLY CONSUMPTION '000 KWH									NUMBER OF CONSUMERS		
YEAR	DOM	IND	COMM	NON-COMM	IRR	STREET	SELF	TEMP	TOTAL	DOM	IND	COMM
2042	2563.04	3468.25	47.60	383.24	1219.30	159.61	97.68	ERR	7938.72	3389	184	3
2041	1950.84	3219.10	549.74	710.64	1481.11	158.92	29.26	ERR	7625.85	0	0	0
2040	1834.65	2316.25	168.48	663.44	1386.50	158.88	52.86	4.15	6465.00	2852	137	33
2039	2591.70	2029.72	77.87	ERR	272.92	26.51	19.48	6.20	5007.53	2393	120	2
2038	2168.02	1967.85	6.70	ERR	12.03	28.64	34.46	0.11	4212.12	2509	131	2
2037	2008.30	4076.64	0.00	0.00	7.15	46.94	40.44	0.00	6177.09	2232	124	0

				AVERAGE CONSUMPTION PER CONSUMER - KWH					
YEAR	NON-COMM	IRR	STREET	DOM	IND	COMM	NON-COMM	IRR	STREET
2042	14	56	1	756	18849	15867	27374	21773	159612
2041	0	0	0	ERR	ERR	ERR	ERR	ERR	ERR
2040	0	38	1	643	16907	5106	ERR	36487	158880
2039	2	21	1	1083	16914	38936	ERR	12996	26508
2038	3	4	8	864	15022	3351	ERR	3007	3579
2037	0	2	9	900	32876	0	0	3575	5216

SUMMARY -BUTWAL === NEA INTERCONNECTED UNIT ===

YEAR	AVERAGE YEARLY CONSUMPTION '000 KWH									NUMBER OF CONSUMERS		
	DOM	IND	COMM	NON-COMM	IRR	STREET	SELF	TEMP	TOTAL	DOM	IND	COMM
2042	1580.71	1686.67	1185.06	456.59	78.35	188.86	13.31	ERR	5160.49	2063	132	17
2041	1099.39	1254.42	379.16	413.76	117.97	3.38	7.00	ERR	2996.90	0	0	0
2040	1273.80	925.47	112.42	328.62	51.32	6.43	24.46	ERR	2691.82	1804	104	15
2039	1515.44	899.23	ERR	ERR	ERR	165.49	27.60	ERR	2605.25	1842	105	0
2038	1463.25	925.81	0.00	13.93	0.00	128.84	26.56	ERR	2549.11	1684	91	0
2037	1424.16	918.21	0.00	14.93	0.00	131.95	32.83	0.00	2510.88	1511	88	0

YEAR	(NUMBER OF CONSUMERS, cont.)			AVERAGE CONSUMPTION PER CONSUMER - KWH					
	NON-COMM	IRR	STREET	DOM	IND	COMM	NON-COMM	IRR	STREET
2042	148	1	3	766	12778	69710	3085	78348	62953
2041	0	0	0	ERR	ERR	ERR	ERR	ERR	ERR
2040	0	1	2	706	8899	7495	ERR	51324	3213
2039	0	0	1	823	8564	ERR	ERR	ERR	165490
2038	0	0	1	869	10174	ERR	ERR	ERR	128842
2037	0	0	1	943	10434	0	0	0	131946

SUMMARY -LUMBINI === NEA INTERCONNECTED UNIT ===

YEAR	AVERAGE YEARLY CONSUMPTION '000 KWH DOM	IND	COMM	NON-COMM	IRR	STREET	SELF	TEMP	TOTAL	NUMBER OF CONSUMERS DOM	IND	COMM
42	93.36	182.89	2.91	44.37	0.00	12.94	1.20	ERR	337.13	315	21	1
41	71.34	208.20	31.30	26.98	ERR	16.54	2.00	ERR	338.37	0	0	0
40	81.19	228.60	2.97	43.00	ERR	17.14	1.95	ERR	374.85	260	18	1
39	104.06	226.91	ERR	ERR	ERR	21.07	1.04	ERR	353.08	256	18	0
38	88.04	203.76	ERR	ERR	ERR	15.23	1.20	ERR	308.23	213	14	0
37	74.46	190.30	0.00	0.00	0.00	13.13	1.20	ERR	279.09	192	12	0

YEAR	NON-COMM	IRR	STREET	AVERAGE CONSUMPTION PER CONSUMER - KWH DOM	IND	COMM	NON-COMM	IRR	STREET
42	17	0	1	296	8709	2913	2610	0	12936
41	0	0	0	ERR	ERR	ERR	ERR	ERR	ERR
40	0	0	1	312	12700	2970	ERR	ERR	17142
39	0	0	1	406	12606	ERR	ERR	ERR	21072
38	0	0	1	413	14555	ERR	ERR	ERR	15230
37	0	0	1	388	15858	0	0	0	13128

SUMMARY -PALPA === NEA INTERCONNECTED UNIT

YEAR	AVERAGE YEARLY CONSUMPTION '000 KWH DOM	IND	COMM	NON-COMM	IRR	STREET	SELF	TEMP	TOTAL	NUMBER OF CONSUMERS DOM	IND	COMM
42	853.29	101.54	3.57	136.11	1052.20	48.47	26.71	0.54	2221.67	1608	34	1
41	459.97	160.60	160.74	240.30	825.80	48.02	16.53	6.66	1753.98	0	0	0
40	607.46	115.17	31.40	302.58	895.20	56.26	28.19	2.40	2053.06	1320	24	10
39	834.94	124.75	ERR	ERR	788.28	64.95	28.28	3.10	1844.30	1298	22	0
38	703.46	107.24	ERR	ERR	596.50	62.50	27.47	0.18	1497.35	1170	17	0
37	703.56	102.69	0.00	0.00	606.49	49.01	31.05	2.25	1489.60	1088	15	0
36												
35												
34	296.28	18.80	ERR	ERR	ERR	38.32	7.20	ERR	360.60	0	0	0
33	313.07	7.32	0.00	0.00	0.00	46.83	7.40	0.00	367.79	673	7	0

YEAR	NON-COMM	IRR	STREET	AVERAGE CONSUMPTION PER CONSUMER - KWH DOM	IND	COMM	NON-COMM	IRR	STREET
42	6	3	2	531	2986	3570	22685	350733	24237
41	0	0	0	ERR	ERR	ERR	ERR	ERR	ERR
40	0	3	2	460	4799	3140	ERR	298400	28130
39	0	3	1	643	5670	ERR	ERR	262761	64948
38	2	3	1	601	6308	ERR	ERR	198832	62503
37	1	3	1	647	6846	0	0	202162	49010
36									
35									
34	0	0	0	ERR	ERR	ERR	ERR	ERR	ERR
33	0	0	257	465	1045	0	0	0	182

SUMMARY -PARASI === NEA INTERCONNECTED UNIT ===

	AVERAGE YEARLY CONSUMPTION '000 KWH									NUMBER OF CONSUMERS		
YEAR	DOM	IND	COMM	NON-COMM	IRR	STREET	SELF	TEMP	TOTAL	DOM	IND	COMM
42	632.94	873.83	0.00	43.31	0.00	11.99	13.99	ERR	1576.06	1173	60	0
41	261.53	565.38	92.76	115.83	ERR	22.61	14.09	ERR	971.75	0	0	0
40	305.44	480.35	ERR	117.17	ERR	22.10	14.68	0.10	925.14	677	33	0
39	308.62	372.92	ERR	ERR	ERR	12.27	9.40	ERR	703.21	504	32	0
38	237.49	339.29	ERR	ERR	ERR	11.48	7.33	0.56	596.11	432	31	0
37	206.56	316.49	0.00	0.00	0.00	6.12	6.19	0.34	535.71	402	21	0
36												
35												
34	70.06	59.40	ERR	ERR	ERR	10.90	ERR	ERR	140.35	0	0	0
33	73.32	27.73	ERR	ERR	ERR	9.36	ERR	ERR	110.42	175	5	0

				AVERAGE CONSUMPTION PER CONSUMER - KWH					
YEAR	NON-COMM	IRR	STREET	DOM	IND	COMM	NON-COMM	IRR	STREET
42	2	0	4	540	14564	0	21655	0	2998
41	0	0	0	ERR	ERR	ERR	ERR	ERR	ERR
40	0	0	8	451	14556	ERR	ERR	ERR	2763
39	0	0	2	612	11654	ERR	ERR	ERR	6135
38	0	0	2	550	10945	ERR	ERR	ERR	5742
37	2	0	2	514	15071	0	0	0	3062
36									
35									
34	0	0	0	ERR	ERR	ERR	ERR	ERR	ERR
33	0	0	55	419	5547	ERR	ERR	ERR	170

SUMMARY -TAULIHAWA

=== NEA INTERCONNECTED UNIT ===

	AVERAGE YEARLY CONSUMPTION '000 KWH									NUMBER OF CONSUMERS		
YEAR	DOM	IND	COMM	NON-COMM	IRR	STREET	SELF	TEMP	TOTAL	DOM	IND	COMM
42	315.91	465.86	11.53	145.85	38.24	17.96	2.93	ERR	997.95	786	42	2
41	237.74	501.72	72.38	73.43	44.41	28.69	1.38	ERR	910.80	0	0	0
40	277.20	462.54	10.74	108.92	74.29	25.21	3.93	ERR	962.33	711	32	5
39	355.84	356.79	ERR	ERR	20.78	11.97	8.43	ERR	744.71	705	28	0
38	289.45	370.39	ERR	ERR	7.25	0.64	15.01	ERR	680.88	644	23	0
37	247.78	253.63	0.00	0.00	6.35	1.23	8.48	ERR	516.77	600	20	0
36												
35												
34	108.18	45.52	ERR	ERR	ERR	16.92	11.36	0.62	182.60	0	0	0
33	153.44	58.42	ERR	ERR	ERR	19.12	7.20	1.03	239.21	0	0	0

				AVERAGE CONSUMPTION PER CONSUMER - KWH					
YEAR	NON-COMM	IRR	STREET	DOM	IND	COMM	NON-COMM	IRR	STREET
42	61	2	2	402	11092	5763	2391	19121	8979
41	0	0	0	ERR	ERR	ERR	ERR	ERR	ERR
40	0	2	5	390	14454	2149	ERR	37145	5042
39	0	2	2	505	12742	ERR	ERR	10388	5984
38	0	2	1	449	16104	ERR	ERR	3625	641
37	0	2	1	413	12682	0	0	3174	1225
36									
35									
34	0	0	0	ERR	ERR	ERR	ERR	ERR	ERR
33	0	0	0	ERR	ERR	ERR	ERR	ERR	ERR

SJMMARY -POKHARA === NEA INTERCONNECTED UNIT

YEAR	AVERAGE YEARLY CONSUMPTION '000 KWH									NUMBER OF CONSUMERS		
	DOM	IND	COMM	NON-COMM	IRR	STREET	SELF	TEMP	TOTAL	DOM	IND	COMM
2042	5812.85	1519.48	541.85	1460.54	0.00	84.79	289.26	44.68	9588.16	5795	148	17
2041	2807.40	1045.87	617.99	1714.30	ERR	84.79	35.04	50.48	6355.87	4227	125	65
2040	2612.08	819.82	469.77	1441.11	ERR	84.79	39.83	135.48	5482.79	4035	0	0
2039	2493.84	485.05	162.30	ERR	93.84	84.79	308.44	27.27	3585.14	3799	87	3
2038	714.08	159.69	70.61	ERR	ERR	88.07	840.35	4.85	1667.57	3152	75	3
2037	1112.94	209.07	114.23	0.00	0.00	97.92	932.28	8.61	2368.59	3112	67	3

YEAR				AVERAGE CONSUMPTION PER CONSUMER - KWH					
	NON-COMM	IRR	STREET	DOM	IND	COMM	NON-COMM	IRR	STREET
2042	25	0	1	1003	10267	31873	58421	0	84792
2041	254	0	1	664	8367	9508	6749	ERR	84792
2040	0	0	0	647	ERR	ERR	ERR	ERR	ERR
2039	31	1	1	656	5575	54100	ERR	93840	84792
2038	25	0	1	227	2129	23538	ERR	ERR	88074
2037	4	0	1	358	3120	38076	0	0	97920

SUMMARY -BHARATPUR === NEA INTERCONNECTED UNIT ===

	AVERAGE YEARLY CONSUMPTION '000 KWH									NUMBER OF CONSUMERS		
YEAR	DOM	IND	COMM	NON-COMM	IRR	STREET	SELF	TEMP	TOTAL	DOM	IND	COMM
2042	2290.57	2059.17	512.96	918.56	4197.08	12.40	58.90	247.45	10297.09	3362	199	46
2041	1792.82	1620.02	263.75	796.23	222.90	4.84	123.88	114.66	4939.10			
2040	2332.95	1414.30	242.90	852.83	1089.27	4.84	89.37	119.41	6068.33	2257	122	56
2039	2060.76	1146.71	199.69	ERR	109.34	4.74	62.61	75.94	3696.23	1853	97	1
2038	1616.98	787.66	ERR	ERR	0.99	4.67	37.20	74.29	2521.78	1298	65	0
2037	1295.47	506.73	0.00	0.00	0.98	4.67	32.74	65.01	1905.60	1099	56	0

				AVERAGE CONSUMPTION PER CONSUMER - KWH					
YEAR	NON-COMM	IRR	STREET	DOM	IND	COMM	NON-COMM	IRR	STREET
2042	131	4	1	681	10348	11151	7012	1049271	12396
2041									
2040	116	3	1	1034	11593	4337	7352	363091	4836
2039	4	2	1	1112	11822	199694	ERR	54668	4738
2038	0	0	1	1246	12118	ERR	ERR	ERR	4668
2037	2	1	1	1179	9049	0	0	984	4668

SUMMARY -BHIMPHEDI   === NEA INTERCONNECTED UNIT ===

YEAR	DOM (Average yearly consumption '000 KWH)	IND	COMM	NON-COMM	IRR	STREET	SELF	TEMP	TOTAL	DOM (Number of consumers)	IND	COMM
2042	92.04	0.96	0.00	63.04	0.00	1.88	2.37	ERR	160.04	158	1	0
2041	52.22	ERR	4.85	123.78	ERR	2.26	1.19	ERR	184.29	0	0	0
2040	63.79	ERR	6.14	239.28	ERR	2.26	1.86	ERR	290.85	138	0	2
2039	155.03	ERR	ERR	ERR	0.52	2.26	2.28	ERR	160.02	172	0	0
2038	136.98	ERR	ERR	ERR	ERR	2.26	1.28	ERR	140.30	161	0	0
2037	109.64	0.00	0.00	0.00	0.00	2.26	0.88	ERR	112.78	146	0	0

YEAR	NON-COMM (Number of consumers, cont.)	IRR	STREET	DOM (Average consumption per consumer - KWH)	IND	COMM	NON-COMM	IRR	STREET
2042	3	0	1	583	964	0	21013	0	1883
2041	0	0	0	ERR	ERR	ERR	ERR	ERR	ERR
2040	29	0	1	462	ERR	3069	8251	ERR	2256
2039	0	0	1	901	ERR	ERR	ERR	ERR	2256
2038	0	0	1	851	ERR	ERR	ERR	ERR	2256
2037	0	0	1	751	0	0	0	0	2256

SUMMARY -BIRGUNJ === NEA INTERCONNECTED UNIT ===

YEAR	AVERAGE YEARLY CONSUMPTION '000 KWH DOM	IND	COMM	NON-COMM	IRR	STREET	SELF	TEMP	INDIA	TOTAL	NUMBER OF DOM	IND
2042	6397.99	24571.75	162.28	1618.62	352.43	ERR	46.80	ERR	6715.46	39865.32	5814	416
2041	5134.35	8529.87	387.77	1160.56	620.72	ERR	46.80	ERR	6533.46	22413.53	0	0
2040	5441.38	7284.72	990.61	1073.24	608.68	39.68	46.80	ERR	5866.80	21032.60	4500	329
2039	6258.70	5979.16	ERR	4.68	519.10	119.04	46.80	ERR	5847.36	18773.28	4334	308
2038	4793.50	5509.35	11792.40	ERR	312.51	119.04	42.90	12.04	4127.43	15555.52	3876	287
2037	3940.48	4503.36	0.00	0.00	322.73	119.04	30.47	5.87	3447.39	12358.00	3652	256

YEAR	CONSUMERS COMM	NON-COMM	IRR	STREET	AVERAGE CONSUMPTION PER CONSUMER - KWH DOM	IND	COMM	NON-COMM	IRR	STREET
2042	5	215	23	22	1100	59067	32456	7528	15323	ERR
2041	0	0	0	0	ERR	ERR	ERR	ERR	ERR	ERR
2040	45	174	27	21	1209	22142	22014	6168	22544	1890
2039	0	0	19	21	1444	19413	ERR	ERR	27321	5669
2038	0	1	18	21	1237	19196	ERR	ERR	17362	5669
2037	0	1	15	20	1079	17591	0	0	21515	5952

SUMMARY -HEATUDA

=== NEA INTERCONNECTED UNIT ===

YEAR	DOM	IND	COMM	NON-COMM	IRR	STREET	SELF	TEMP	TOTAL	DOM	IND	COMM
	AVERAGE YEARLY CONSUMPTION '000 KWH									NUMBER OF CONSUMERS		
2042	2792.61	18963.25	0.00	470.93	5.48	106.88	85.33	3254.58	25679.06	3245	115	0
2041	1790.83	11796.72	89.38	688.67	7.66	106.88	48.81	734.12	15263.08	0	0	0
2040	1812.07	11767.06	87.25	730.67	6.62	106.88	154.56	567.25	55218.71	2334	86	15
2039	2253.80	9840.94	ERR	ERR	1.66	104.04	199.95	288.96	13824.74	2286	80	0
2038	1928.35	10898.87	5612.53	ERR	78.89	102.00	145.40	110.82	14594.76	1969	75	0
2037	1718.78	5210.99	9602.64	0.00	14.15	102.00	82.64	95.30	11784.17	1776	70	1

YEAR	NON-COMM	IRR	STREET	DOM	IND	COMM	NON-COMM	IRR	STREET
				AVERAGE CONSUMPTION PER CONSUMER - KWH					
2042	16	2	3	861	164898	0	29433	2741	35625
2041	0	0	0	ERR	ERR	ERR	ERR	ERR	ERR
2040	116	1	4	776	136826	5817	6299	6617	26721
2039	1	2	4	986	123012	ERR	ERR	831	26009
2038	1	2	3	979	145318	ERR	ERR	39444	34000
2037	1	2	3	968	74443	9602642	0	7077	34000

SUMMARY -KIRTIPUR (KATHMANDU)   === NEA INTERCONNECTED UNIT ===

YEAR	AVERAGE YEARLY CONSUMPTION '000 KWH									NUMBER OF CONSUMERS		
	DOM	IND	COMM	NON-COMM	IRR	STREET	SELF	TEMP	TOTAL	DOM	IND	COMM
42	1201.80	138.05	0.00	0.00	66.01	157.44	4.98	ERR	1566.02	4321	22	0
41	1136.64	143.87	4.97	27.76	73.00	157.44	ERR	ERR	1543.68	3809	21	1
40	1069.76	132.78	5.11	27.56	40.80	157.44	0.91	ERR	1427.48	3292	17	1
39	875.09	170.50	ERR	ERR	ERR	157.44	ERR	ERR	1203.02	3483	17	0
38	677.26	159.38	ERR	ERR	ERR	157.44	ERR	0.00	994.08	3206	17	0
37	573.87	144.77	0.00	0.00	0.00	157.44	ERR	1.55	877.63	3042	19	0

YEAR	(NUMBER OF CONSUMERS, cont.)			AVERAGE CONSUMPTION PER CONSUMER - KWH					
	NON-COMM	IRR	STREET	DOM	IND	COMM	NON-COMM	IRR	STREET
42	0	3	4	278	6275	ERR	ERR	22004	39360
41	18	3	377	298	6851	4966	1542	24334	418
40	19	3	377	325	7811	5109	1451	13599	418
39	0	0	377	251	10029	ERR	ERR	ERR	418
38	0	0	377	211	9375	ERR	ERR	ERR	418
37	0	0	377	189	7619	ERR	ERR	ERR	418

SUMMARY -PANAUTI

=== NEA INTERCONNECTED UNIT ===

YEAR	AVERAGE YEARLY CONSUMPTION '000 KWH DOM	IND	COMM	NON-COMM	IRR	STREET	SELF	TEMP	TOTAL	NUMBER OF CONSUMERS DOM	IND	COMM	NON-COMM	IRR
42	269.34	158.26	0.00	24.20	0.00	12.96	ERR	ERR	464.76	756	14	0	9	0
41	282.94	151.33	ERR	26.05	ERR	12.96	ERR	ERR	473.29	756	14	0	9	0
40	234.56	130.88	ERR	19.19	ERR	12.96	171.54	ERR	438.87	635	13	0	8	0
39	238.90	125.20	ERR	ERR	ERR	12.96	ERR	ERR	377.05	602	13	0	0	0
38	196.44	128.46	ERR	ERR	ERR	12.96	ERR	ERR	337.86	588	13	0	0	0
37	179.36	114.66	0.00	0.00	0.00	12.96	ERR	ERR	306.98	572	12	0	0	0

YEAR	STREET	AVERAGE CONSUMPTION PER CONSUMER - KWH DOM	IND	COMM	NON-COMM	IRR	STREET
42	27	356	11305	ERR	2688	ERR	480
41	27	374	10810	ERR	2894	ERR	480
40	27	369	10068	ERR	2398	ERR	480
39	27	397	9631	ERR	ERR	ERR	480
38	27	334	9881	ERR	ERR	ERR	480
37	27	314	9555	ERR	ERR	ERR	480

SUMMARY -SUNKOSI

=== NEA INTERCONNECTED UNIT ===

YEAR	DOM	IND	COMM	NON-COMM	IRR	STREET	SELF	TEMP	TOTAL	DOM	IND	COMM
	AVERAGE YEARLY CONSUMPTION '000 KWH									NUMBER OF CONSUMERS		
42	404.34	181.71	4.87	144.39	ERR	5.76	274.94	8.81	841.53	1548	20	1
41	391.70	162.28	0.00	156.18	0.00	5.76	397.54	14.36	1120.63	833	19	0
40	396.41	139.33	ERR	128.76	ERR	4.71	323.85	0.00	960.48	833	18	0
39	478.26	96.34	ERR	ERR	ERR	3.69	325.09	0.20	876.49	798	14	0
38	337.50	51.47	ERR	ERR	ERR	7.74	316.97	0.72	714.39	694	11	0
37	365.33	41.58	0.00	0.00	ERR	7.20	316.80	0.66	731.57	612	9	0

YEAR	NON-COMM	IRR	STREET	DOM	IND	COMM	NON-COMM	IRR	STREET
				AVERAGE CONSUMPTION PER CONSUMER - KWH					
42	52	0	20	261	9086	4873	2777	ERR	288
41	52	0	20	470	8541	ERR	3003	ERR	288
40	50	0	0	476	7740	ERR	2575	ERR	ERR
39	0	0	1	599	6882	ERR	ERR	ERR	3694
38	0	0	0	486	4679	ERR	ERR	ERR	ERR
37	0	0	0	597	4620	ERR	ERR	ERR	ERR

SUMMARY -TRISHULI === NEA INTERCONECTED UNIT ===

YEAR	AVERAGE YEARLY CONSUMPTION '000 KWH									NUMBER OF CONSUMERS		
	DOM	IND	COMM	NON-COMM	IRR	STREET	SELF	TEMP	TOTAL	DOM	IND	COMM
42	838.85	332.23	11.96	137.75	621.18	4.03	1203.78	ERR	2210.71	2059	48	3
41	598.75	341.52	12.62	459.99	768.43	4.42	1203.78	ERR	3389.50	1736	47	4
40	505.76	300.36	303.51	1133.70	666.06	4.61	1203.78	0.00	3872.41	1522	41	7
39	679.72	280.88	2834.32	ERR	1130.46	4.61	1203.78	1.27	6134.72	1139	33	1
38	528.30	218.98	1387.24	ERR	2324.74	4.51	1129.89	ERR	5593.66	938	27	1
37	420.27	162.65	553.66	0.00	587.16	4.03	1357.85	ERR	3085.62	840	24	1

YEAR	NUMBER OF CONSUMERS (cont.)			AVERAGE CONSUMPTION PER CONSUMER - KWH					
	NON-COMM	IRR	STREET	DOM	IND	COMM	NON-COMM	IRR	STREET
42	0	6	2	407	6921	3986	ERR	103531	2016
41	105	5	2	345	7266	3156	4381	153685	2208
40	97	5	2	332	7326	43359	11688	133213	2304
39	0	5	2	597	8511	2834320	ERR	226091	2304
38	0	5	2	563	8110	1387235	ERR	464948	2256
37	0	5	1	500	6777	553659	ERR	117432	4032

SUMMARY -JALESHOR === NEA INTERCONNECTED UNIT ===

YEAR	AVERAGE YEARLY CONSUMPTION '000 KWH									NUMBER OF CONSUMERS		
	DOM	IND	COMM	NON-COMM	IRR	STREET	SELF	TEMP	TOTAL	DOM	IND	COMM
2042	341.26	287.11	13.57	178.93	27.89	7.20	2.40	ERR	858.36	3551	182	35
2041	210.99	315.20	6.15	122.53	ERR	7.20	2.40	ERR	664.47	3004	168	30
2040	236.07	243.26	6.00	131.88	ERR	7.20	2.40	ERR	613.02	2914	159	29
2039	219.18	151.10	ERR	ERR	ERR	7.20	2.40	ERR	373.28	2876	152	0
2038	206.68	141.50	0.00	0.00	ERR	0.00	2.40	ERR	350.58	2658	141	0
2037	232.33	166.52	0.00	0.00	0.01	21.60	8.67	ERR	412.32	2512	135	0

NO. OF CONSUMERS INCLUSIVE OF JANAKPUR & MALANGAWA

YEAR	NUMBER OF CONSUMERS (cont.)			AVERAGE CONSUMPTION PER CONSUMER - KWH				
	NON-COMM	IRR	STREET	DOM	IND	COMM	NON-COMM	IRR	STREET
2042	271	6	2	96	8203	50	29822	4648	3600
2041	263	6	2	70	1876	205	466	ERR	3600
2040	257	6	2	81	1530	207	513	ERR	3600
2039	0	0	2	76	994	ERR	ERR	ERR	3600
2038	0	0	1	78	1004	ERR	ERR	ERR	0
2037	0	0	1	92	1234	0	0	0	21600

SUMMARY -JANAKPUR

=== NEA INTERCONNECTED UNIT ===

YEAR	DOM	IND	COMM	NON-COMM	IRR	STREET	SELF	TEMP	TOTAL	DOM	IND	COMM
	AVERAGE YEARLY CONSUMPTION '000 KWH									NUMBER OF CONSUMERS		
2042	1745.39	925.78	157.64	381.84	144.10	43.20	58.80	ERR	3456.75	3551	182	35
2041	997.34	759.67	94.64	275.33	86.96	43.20	58.80	ERR	2315.95	3004	168	30
2040	991.34	625.41	81.77	319.48	92.40	43.20	58.80	ERR	2153.80	2914	159	29
2039	922.26	654.64	ERR	ERR	ERR	43.20	58.80	ERR	1678.91	2876	152	0
2038	900.65	668.25	ERR	ERR	ERR	36.00	58.80	ERR	1663.70	2658	141	0
2037	606.87	454.86	0.00	0.00	0.00	31.20	58.80	ERR	1151.73	2512	135	0

NO. OF CONSUMERS INCLUSIVE OF JALESWOR & MALANGAWA

YEAR	NON-COMM	IRR	STREET	DOM	IND	COMM	NON-COMM	IRR	STREET
				AVERAGE CONSUMPTION PER CONSUMER - KWH					
2042	271	6	2	492	5087	4504	1409	24016	21600
2041	263	6	2	332	4522	3155	1047	14493	21600
2040	257	6	2	340	3933	2820	1243	15400	21600
2039	0	0	2	321	4307	ERR	ERR	ERR	21600
2038	0	0	1	339	4739	ERR	ERR	ERR	36000
2037	0	0	1	242	3369	0	0	0	31200

Appendix 9

Demand Data for Billing Units of the NEA Remote Non-Hydro System

TABLE: A-9.1

DEMAND CHARACTERISTICS SUMMARY - REMOTE NON-HYDRO BILLING UNITS

DEVELOPMENT REGION	ZONE	BILLING UNIT	PHISIO REGION	DISTRICT ADMIN	ECON. STATUS R/U	ELEC-TRIFIED IN YEAR	YEAR DATA CURRENT	YEARS ELEC-TRIFIED	MODE	YEARLY CONSUMPTION - MWH DOM	IND	COMM	NON-COM	IRR	STR-LT	SELF	TEMP	TOTAL
EASTERN	KOST	BIRATNAGAR	TERAI	HQ	U	1939	1984	45	IND/DIES	4955.24	23747.68	352.06	913.17	192.68	331.39	168.99		30661.22
		DHARAN	TERAI		U		1985	1985	DIESEL	2807.79	1626.79	0.00	75.84	0.35	70.45	7.85		4589.06
	MECHI	BHADRAPUR	TERAI		U	1975	1985	10	IND/DIES	977.74	427.29	91.97	315.24	70.31	63.67	36.14	79.27	2008.78
	SAGARMATHA	LAHAN	TERAI		R	1979	1984	5	DIESEL	140.79						17.10		157.89
		RAJBIRAJ	TERAI	HQ	U	1968	1985	17	INDIA	1595.82	1228.03	24.42	420.74	132.31	59.56	16.23		3183.03
CENTRAL	JANAKPUR	MALANGWA	TERAI	HQ	R	1973	1985	12	INDIA	274.87	134.43	20.58	96.51	20.48		18.60		565.47
	NARAYANI	GAUR	TERAI	HQ	R	1973	1985	12	INDIA	226.56	53.07	7.18	62.15	20.87	2.83	3.62		360.05
		KALAIYA	TERAI	HQ	R		1985	1985	DIESEL	1045.86	937.48	31.64	171.38	310.47	16.96	9.95		2523.74
WESTERN	LUMBINI	NAYAMILL	TERAI		R		1985	1985	INDIA	423.04	320.02	0.00	31.63	0.78	7.55	2.74	5.28	789.17
		KRISHNANAGAR	TERAI		U	1973	1985	12	INDIA	556.74	162.95	0.00	3.38	42.01	33.89	20.72		809.98
		BAHADURGUNJ	TERAI		U	1973	1985	12	INDIA	209.04	468.08	0.00	39.97		4.06	6.11		727.25
		TRIBENI	TERAI		R	1975	1983	8	INDIA	135.93	163.24	4.71	13.88	0.00	3.64	3.76		325.16
MID-WESTERN	BHERI	GULARIA	TERAI	HQ	R	1982	1983	1	DIESEL	82.99		0.00	0.00		13.55	2.40		98.93
		NEPALGUNJ	TERAI	HQ	U	1965	1984	19	DIESEL	3523.97	1978.62	54.86	0.00	38.52	294.41	118.80	118.80	6077.20
	RAPTI	GHORAHI	TERAI	HQ	R	1979	1985	6	DIESEL	89.77	0.00	0.00	0.00	0.00	1.53	2.44		93.73
		TULSIPUR	TERAI		R	1978	1985	7	DIESEL	57.56		0.00	0.00		3.15	3.15		64.76
		KOILABAS	TERAI		R	1974	1984	10	INDIA	76.61	0.56	0.00	0.00		5.97	6.00	6.55	95.23
FAR-WESTERN	MAHAKALI	MAHENDRANAGAR	TERAI	HQ	U	1973	1984	11	INDIA	973.92	768.75	0.00	0.00	42.94	10.00	106.10	90.43	1992.94
		DADELDHURA	HILLS	HQ	R	1982	1983	1	DIESEL	37.05		0.00	0.00		1.62	6.88		45.56
	SETI	DHANGARHI	TERAI	HQ	R	1973	1984	11	INDIA	1148.43	1468.99	0.00	0.00		38.88	96.00	112.98	2865.28
	AVERAGE							11										
	TOTALS									19339.71	33485.96	587.43	2143.89	871.71	963.90	653.57	413.31	58034.42

BILLING STATUS

TABLE: A-9.1

DEMAND CHARACTERISTICS SUMMARY

DEVELOPMENT REGION	ZONE	BILLING UNIT	PERCENT CONSUMPTION OF TOTAL								NUMBER OF CUSTOMERS						YEARLY CONSUMPTION / CUSTOMER - KWH					
			DOM	IND	COMM	NON-COM	IRR	STR-LT	SELF	TEMP	DOM	IND	COMM	NON-COM	IRR	STR-LT	DOM	IND	COMM	NON-COM	IRR	STR-LT
EASTERN	KOSI	BIRATNAGAR	16.2%	77.5%	1.1%	3.0%	0.6%	1.1%	0.6%	0.0%	6846	387	4	17	10	45	724	61364	88016	53716	19268	7364
		DHARAN	61.2%	35.4%	0.0%	1.7%	0.0%	1.5%	0.2%	0.0%	5067	149	0	6	3	19	554	10918		12640	115	3708
	MECHI	BHADRAPUR	48.7%	21.3%	4.6%	15.7%	3.5%	3.2%	1.8%	3.9%	2092	88	69	251	2	11	467	4856	1333	1256	35153	5708
	SAGARMATHA	LAHAN	89.2%	0.0%	0.0%	0.0%	0.0%	0.0%	10.8%	0.0%	262	0	0	0	0	0	538					
		RAJBIRAJ	50.1%	38.6%	0.0%	13.2%	4.2%	1.9%	0.5%	0.0%	2722	145	1	0	14	1	586	8469	24417		9450	59559
CENTRAL	JANAKPUR	MALANGWA	48.6%	23.8%	3.6%	17.1%	3.6%	0.0%	3.3%	0.0%	3551	102	35	271	6	2	77	739	586	356	3414	
	NARAYANI	GAUR	62.9%	14.7%	2.0%	17.3%	5.8%	0.6%	1.0%	0.0%	500	13	3	40	1	1	453	4082	2394	1554	20865	2825
		KALAIYA	41.4%	37.1%	1.3%	6.8%	12.3%	0.7%	0.4%	0.0%	2011	88	5	57	16	6	520	10653	6328	3007	19404	2827
WESTERN	LUMBINI	NAYAMILL	53.6%	40.6%	0.0%	4.0%	0.1%	1.0%	0.3%	0.7%	1554	46	0	14	2	4	272	6957		2259	390	1888
		KRISHNANAGAR	68.7%	20.1%	0.0%	0.4%	5.2%	4.2%	2.6%	0.0%	678	21	0	1	1	1	821	7759		3381	42009	33891
		BAHADURGUNJ	28.7%	64.4%	0.0%	5.5%	0.0%	0.6%	0.8%	0.0%	572	47	0	2	0	2	365	9959		19984		2029
		TRIBENI	41.8%	50.2%	1.4%	4.3%	0.0%	1.1%	1.2%	0.0%	245	6	15	0	1	1	555	27206	314			3636
MID-WESTERN	BHERI	GULARIA	83.9%	0.0%	0.0%	0.0%	0.0%	13.7%	2.4%	0.0%	245	0	0	0	0	1	339					13547
		NEPALGUNJ	58.0%	32.6%	0.9%	0.0%	0.6%	4.8%	2.0%	2.0%	3866	159	0	0	0	0	912	12444				
	RAPTI	GHORAHI	95.8%	0.0%	0.0%	0.0%	0.0%	1.6%	2.6%	0.0%	469	1	0	0	0	1	191	0				1530
		TULSIPUR	88.9%	0.0%	0.0%	0.0%	0.0%	4.9%	4.9%	0.0%	126	0	0	0	0	0	457					
		KOILABAS	80.5%	0.6%	0.0%	0.0%	0.0%	6.3%	6.3%	6.9%	253	1	0	0	0	42	303	558				142
FAR-WESTERN	MAHAKALI	MAHENDRANAGAR	48.9%	38.6%	0.0%	0.0%	2.2%	0.5%	5.3%	4.5%	1570	55	0	0	57	0	620	13977			753	
		DADELDHURA	81.3%	0.0%	0.0%	0.0%	0.0%	3.6%	15.1%	0.0%	237	0	0	0	0	48	156					34
	SETI	DHANGARHI	40.1%	51.3%	0.0%	0.0%	0.0%	1.4%	3.4%	3.9%	1600	52	0	0	0	90	60	2354				
	AVERAGE TOTALS		33.3%	57.7%	1.0%	3.7%	1.5%	1.7%	1.1%	0.7%	34465	1440	132	659	113	275	561	23254	4450	3253	7714	3505

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TABLE: A-9.1

DEMAND CHARACTERISTICS SUMMARY - (Cont'd)

DEVELOPMENT REGION	ZONE	BILLING UNIT	GROWTH CONSUMPTION				GROWTH CUSTOMERS			GROWTH CONS/CUST		
			ADJ-DOM	IND	IRR	TOTAL	ADJ-DOM	IND	IRR	ADJ-DOM	IND	IRR
EASTERN	KOSI	BIRATNAGAR	8.2%	11.6%	13.2%	10.8%	9.0%	12.5%	8.9%	-0.8%	-0.8%	4.0%
		DHARAN	8.8%	10.3%	-11.9%	9.4%	11.8%	9.7%	20.1%	-2.7%	0.6%	-26.6%(2)
	MECHI	BHADRAPUR	12.4%	-4.4%	48.8%	5.4%	7.1%	8.1%	-10.9%	5.0%	-11.6%	67.0%
	SAGARMATHA	LAHAN	41.5%			38.4%	12.2%			26.1%		
		RAJBIRAJ	12.6%	10.4%	11.4%	10.4%	8.2%	10.5%	32.0%	4.0%	-0.1%	-15.7%
CENTRAL	JANAKPUR	MALANGWA	14.2%	0.2%		9.3%	33.3%	35.3%		-14.3%	-26.0%	
	NARAYANI	GAUR	5.3%	-4.5%	109.6%	3.0%	4.3%	0.9%	-30.1%	1.0%	-5.3%	199.9%
		KALAIYA	6.6%	-2.0%	9.0%	10.3%	9.5%	-3.4%	-9.6%	5.4%	1.4%	
WESTERN	LUMBINI	NAYAMILL	19.1%	7.3%		13.3%	40.5%	14.1%		-15.3%	-5.9%	
		KRISHNANAGAR	1.6%	0.4%	294.5%	1.6%	-2.7%	-2.8%	0.0%	4.4%	3.3%	294.5%(1)
		BAHADURGUNJ	7.9%	36.3%		18.1%	14.5%	18.8%		-5.8%	14.8%	
		TRIBENI	21.8%	22.8%		20.8%	12.9%	10.4%		7.8%	11.2%	
MID-WESTERN	BHERI	GULARIA	74.8%			56.3%	36.7%			27.9%		
		NEPALGUNJ	17.4%	8.6%	6.1%	13.7%	10.8%	16.8%		6.0%	-7.0%	
	RAPTI	GHORAHI	18.3%			16.6%	29.2%			-8.4%		
		TULSIPUR	20.9%			21.6%	5.8%			14.3%		
		KOILABAS	-5.6%	-56.7%		-9.2%	1.6%	-15.9%		-7.1%	-48.5%	
FAR-WESTERN	MAHAKALI	MAHENDRANAGAR	19.3%	17.0%	63.7%	19.8%	20.9%	17.6%	63.4%	-1.3%	-0.5%	0.2%(2)
		DADELDHURA	-11.2%			-13.1%	3.5%			-14.2%		
	SETI	DHANGARHI	21.0%	36.7%		27.9%	19.7%	26.4%		1.1%	8.2%	
	AVERAGE TOTALS		14.1%	13.0%	10.4%	13.2%	14.3%	16.4%	26.2%	-0.2%	-3.0%	-12.5%

NOTES: (1) IRR GROWTH FOR LAST 4 YEARS
(2) IRR GROWTH FOR LAST 7 YEARS

SUMMARY -BIRATNAGER   === NEA REMOTE NON HYDRO ===

YEAR	AVERAGE YEARLY CONSUMPTION '000 KWH DOM	IND	COMM	NON-COMM	IRR	STREET	SELF	OTHER	TOTAL	NUMBER OF CONSUMERS DOM	IND	COMM
2042	5983.88	15403.33	51.64	212.31	195.53	315.30	160.61	ERR	22322.62	7065	424	4
2041	4955.24	23747.68	352.06	913.17	192.68	331.39	168.99	ERR	30661.22	6846	387	4
2040	4733.71	18449.92	255.76	941.55	175.66	335.41	142.13	ERR	24934.34	5960	338	45
2039	5449.85	18574.76	ERR	ERR	107.53	370.55	153.93	ERR	24605.31	5399	290	44
2038	4774.17	16742.27	ERR	ERR	100.57	312.01	ERR	ERR	21929.02	5303	265	0
2037	3516.32	11224.35	ERR	ERR	90.74	270.56	ERR	ERR	15101.97	4820	232	0
2036	4035.10	12846.14	ERR	ERR	105.46	268.38	ERR	ERR	17255.08	4491	212	0
2035	3887.37	12270.25	0.00	0.00	91.38	315.96	ERR	ERR	16564.95	4094	191	0

YEAR	NON-COMM	IRR	STREET	OTHER	AVERAGE CONSUMPTION PER CONSUMER - KWH DOM	IND	COMM	NON-COMM	IRR	STREET	OTHER
2042	22	9	46	0	847	36329	12910	9651	21726	6854	ERR
2041	17	10	45	0	724	61364	88016	53716	19268	7364	ERR
2040	309	10	40	0	794	54586	5683	3047	17566	8385	ERR
2039	302	9	39	0	1009	64051	ERR	ERR	11948	9501	ERR
2038	0	11	38	0	900	63178	ERR	ERR	9143	8211	ERR
2037	0	9	36	0	730	48381	ERR	ERR	10082	7516	ERR
2036	0	9	34	0	898	60595	ERR	ERR	11717	7893	ERR
2035	0	6	27	0	950	64242	ERR	ERR	15230	11702	ERR

SUMMARY -DHARAN === NEA REMOTE NON HYDRO ===

YEAR	AVERAGE YEARLY CONSUMPTION '000 KWH DOM	IND	COMM	NON-COMM	IRR	STREET	SELF	OTHER	TOTAL	NUMBER OF CONSUMERS DOM	IND	COMM
2042	2807.79	1626.79	0.00	75.84	0.35	70.45	7.85	ERR	4589.06	5067	149	0
2041	2393.59	1502.83	203.73	413.55	0.35	80.15	7.73	ERR	4601.81	4856	133	0
2040	2255.89	1301.43	177.84	333.67	4.89	61.42	10.69	ERR	4102.39	4134	120	72
2039	2394.49	1296.49	ERR	ERR	5.47	69.88	14.80	ERR	3777.43	3809	120	54
2038	2037.45	1093.04	ERR	ERR	1.34	68.41	ERR	ERR	3200.25	3512	113	0
2037	1545.62	966.98	ERR	ERR	1.70	54.45	ERR	ERR	2568.75	2195	99	0
2036	1680.40	1042.34	ERR	ERR	0.74	44.35	ERR	ERR	2767.21	2622	88	0
2035	1595.53	818.30	0.00	0.00	ERR	25.83	ERR	ERR	2439.66	2317	78	0

YEAR	NON-COMM	IRR	STREET	OTHER	AVERAGE CONSUMPTION PER CONSUMER - KWH DOM	IND	COMM	NON-COMM	IRR	STREET	OTHER
2042	6	3	19	0	554	10918	ERR	12640	115	3708	ERR
2041	5	3	21	0	493	11299	ERR	82709	116	3817	ERR
2040	165	2	19	0	546	10845	2470	2022	2447	3233	ERR
2039	83	2	17	0	629	10804	ERR	ERR	2736	4111	ERR
2038	0	1	17	0	580	9673	ERR	ERR	1344	4024	ERR
2037	0	1	13	0	704	9768	ERR	ERR	1700	4188	ERR
2036	0	1	12	0	641	11845	ERR	ERR	738	3696	ERR
2035	0	0	11	0	689	10491	ERR	ERR	ERR	2348	ERR

SUMMARY -BHADRAPUR === NEA REMOTE NON HYDRO ===

YEAR	AVERAGE YEARLY CONSUMPTION '000 KWH									NUMBER OF CONSUMERS		
	DOM	IND	COMM	NON-COMM	IRR	STREET	SELF	OTHER	TOTAL	DOM	IND	COMM
2042	977.74	427.29	91.97	315.24	70.31	63.67	36.14	79.27	2008.78	2092	88	69
2041	905.75	653.30	136.46	ERR	0.59	75.43	32.44	104.41	1861.92	2010	97	59
2040	728.42	557.75	91.41	262.99	14.16	94.85	30.02	ERR	1750.05	1735	73	77
2039	1055.55	691.84	ERR	ERR	3.11	53.94	25.01	ERR	1823.21	1688	71	60
2038	769.96	608.89	ERR	ERR	5.42	58.92	ERR	ERR	1443.20	1637	60	0
2037	737.37	559.78	ERR	ERR	5.25	68.96	ERR	ERR	1371.36	1711	56	0
2036	686.73	559.26	0.00	0.00	6.49	251.22	ERR	ERR	1461.84	1599	55	0
2035	916.24	561.75	ERR	ERR	5.95	ERR	ERR	ERR	1483.93	0	0	0

YEAR	NON-COMM	IRR	STREET	OTHER	AVERAGE CONSUMPTION PER CONSUMER - KWH						
					DOM	IND	COMM	NON-COMM	IRR	STREET	OTHER
2042	251	2	11	0	467	4856	1333	1256	35153	5788	ERR
2041	0	4	13	0	451	6735	2313	ERR	148	5802	ERR
2040	328	3	5	0	420	7640	1187	802	4721	18969	ERR
2039	178	4	6	0	625	9744	ERR	ERR	779	8990	ERR
2038	0	5	1	0	470	10148	ERR	ERR	1084	58918	ERR
2037	0	5	4	0	431	9996	ERR	ERR	1049	17240	ERR
2036	0	4	6	0	429	10168	ERR	ERR	1622	41870	ERR
2035	0	0	0	0	ERR	ERR	ERR	ERR	ERR	ERR	ERR

SUMMARY -LAHAN === NEA REMOTE NON HYDRO ===

YEAR	AVERAGE YEARLY CONSUMPTION '000 KWH DOM	IND	COMM	NON-COMM	IRR	STREET	SELF	OTHER	TOTAL	NUMBER OF CONSUMERS DOM	IND	COMM
42												
41	140.79	ERR	0.00	0.00	ERR	ERR	17.10	ERR	157.89	262	ERR	0
40	111.28	ERR	ERR	ERR	ERR	ERR	9.23	ERR	120.50	0	ERR	ERR
39	101.20	ERR	ERR	ERR	ERR	ERR	13.50	ERR	114.70	188	0	0
38	47.62	ERR	ERR	ERR	ERR	4.32	4.42	ERR	56.36	0	ERR	ERR
37	35.15	ERR	0.00	0.00	ERR	4.32	3.55	ERR	43.02	165	0	0

YEAR	NON-COMM	IRR	STREET	OTHER	AVERAGE CONSUMPTION PER CONSUMER - KWH DOM	IND	COMM	NON-COMM	IRR	STREET	OTHER
42											
41	0	ERR	ERR	ERR	538	ERR	ERR	ERR	ERR	ERR	ERR
40	ERR	ERR	ERR	ERR	ERR	ERR	ERR	ERR	ERR	ERR	ERR
39	0	0	ERR	0	538	ERR	ERR	ERR	ERR	ERR	ERR
38	ERR	ERR	ERR	ERR	ERR	ERR	ERR	ERR	ERR	ERR	ERR
37	0	0	0	0	213	ERR	ERR	ERR	ERR	ERR	ERR

SUMMARY -RAJBIRAJ === NEA REMOTE NON HYDRO ===

YEAR	AVERAGE YEARLY CONSUMPTION '000 KWH									NUMBER OF CONSUMERS		
	DOM	IND	COMM	NON-COMM	IRR	STREET	SELF	OTHER	TOTAL	DOM	IND	COMM
2042	1595.82	1228.03	24.42	420.74	132.31	59.56	16.23	ERR	3183.03	2722	145	1
2041	1144.30	1345.87	67.76	367.50	137.58	55.17	17.42	ERR	3135.60	2397	138	0
2040	1053.63	1183.01	55.63	285.48	115.23	43.92	16.75	ERR	2725.21	2153	127	28
2039	1383.85	926.66	ERR	ERR	147.06	30.46	16.15	ERR	2500.13	2049	121	17
2038	1178.11	1020.53	ERR	ERR	117.47	27.50	ERR	ERR	2343.62	2026	112	0
2037	904.48	852.05	ERR	ERR	84.43	27.41	ERR	ERR	1868.37	1845	97	0
2036	929.11	869.35	ERR	ERR	63.66	26.10	ERR	ERR	1888.23	1710	83	0
2035	891.11	614.70	0.00	0.00	62.26	28.29	ERR	ERR	1596.35	1567	72	0

YEAR	NUMBER OF CONSUMERS (cont.)				AVERAGE CONSUMPTION PER CONSUMER - KWH						
	NON-COMM	IRR	STREET	OTHER	DOM	IND	COMM	NON-COMM	IRR	STREET	OTHER
2042	0	14	1	0	586	8469	24417	ERR	9450	59559	ERR
2041	144	13	1	0	477	9753	ERR	2552	10583	55167	ERR
2040	174	9	1	0	489	9315	1987	1641	12803	43920	ERR
2039	114	8	1	0	675	7658	ERR	ERR	18382	30456	ERR
2038	0	5	1	0	581	9112	ERR	ERR	23495	27504	ERR
2037	0	5	1	0	490	8784	ERR	ERR	16886	27408	ERR
2036	0	2	1	0	543	10474	ERR	ERR	31832	26099	ERR
2035	0	2	61	0	569	8538	ERR	ERR	31128	464	ERR

SUMMARY -MALANGWA === NEA REMOTE NON HYDRO ===

YEAR	AVERAGE YEARLY CONSUMPTION '000 KWH DOM	IND	COMM	NON-COMM	IRR	STREET	SELF	OTHER	TOTAL	NUMBER OF CONSUMERS DOM	IND	COMM
42	274.87	134.43	20.58	96.51	20.48	ERR	18.60	ERR	565.47	3551	182	35
41	196.69	144.31	16.79	57.22	9.74	0.00	18.60	ERR	443.35	3004	168	30
40	180.79	131.57	11.60	55.57	4.74	0.00	16.44	ERR	393.52	2914	159	29
39	185.84	132.63	ERR	ERR	ERR	ERR	14.25	ERR	332.72	2876	152	0
38	141.25	119.41	ERR	ERR	ERR	ERR	11.60	ERR	272.26	2658	141	0
37	24.43	65.01	ERR	ERR	ERR	ERR	0.51	ERR	89.95	2512	135	0
36												
35												
34	81.84	141.84	ERR	ERR	ERR	0.48	3.16	ERR	227.32	ERR	ERR	ERR
33	118.31	132.57	0.00	0.00	ERR	0.26	2.36	ERR	253.33	289	12	1

YEAR	NON-COMM	IRR	STREET	OTHER	AVERAGE YEARLY CONSUMPTION PER CONSUMER - KWH DOM	IND	COMM	NON-COMM	IRR	STREET	OTHER
42	271	6	2	0	77	739	588	356	3414	ERR	ERR
41	263	6	2	0	65	859	560	218	1623	0	ERR
40	257	6	2	0	62	827	400	216	789	0	ERR
39	0	0	2	0	65	873	ERR	ERR	ERR	ERR	ERR
38	0	0	1	0	53	847	ERR	ERR	ERR	ERR	ERR
37	0	0	1	0	10	482	ERR	ERR	ERR	ERR	ERR
36											
35											
34	ERR	ERR	ERR	ERR	ERR	ERR	ERR	ERR	ERR	ERR	ERR
33	0	0	2	2	409	11047	0	ERR	ERR	132	ERR

SUMMARY -GAUR === NEA REMOTE NON HYDRO ===

YEAR	AVERAGE YEARLY CONSUMPTION '000 KWH									NUMBER OF CONSUMERS		
	DOM	IND	COMM	NON-COMM	IRR	STREET	SELF	OTHER	TOTAL	DOM	IND	COMM
2042	226.56	53.07	7.18	62.15	20.87	2.83	3.62	ERR	360.05	500	13	3
2041	126.02	46.73	4.16	30.28	12.91	ERR	ERR	ERR	220.10	441	14	3
2040	120.63	47.69	3.49	34.70	3.37	ERR	0.24	0.70	206.74	430	14	3
2039	57.13	23.20	ERR	ERR	0.52	ERR	0.25	ERR	81.08	438	14	0
2038	38.16	23.26	ERR	ERR	0.52	ERR	0.11	ERR	62.04	414	13	
2037	27.69	25.41	ERR	ERR	0.52	0.00	9.44	ERR	58.86	405	13	0
2036												
2035												
2034	105.99	113.38	ERR	ERR	ERR	ERR	4.80	ERR	224.16	ERR	ERR	ERR
2033	185.57	80.29	0.00	0.00	0.00	ERR	4.80	4.80	275.46	373	12	0

YEAR	(NUMBER OF CONSUMERS, cont.)				AVERAGE YEARLY CONSUMPTION PER CONSUMER - KWH						
	NON-COMM	IRR	STREET	OTHER	DOM	IND	COMM	NON-COMM	IRR	STREET	OTHER
2042	40	1	1	0	453	4082	2394	1554	20865	2825	ERR
2041	40	1	0	0	286	3338	1388	757	12912	ERR	ERR
2040	36	2	0	0	281	3406	1164	964	1687	ERR	ERR
2039	0	6	0	0	130	1657	ERR	ERR	86	ERR	ERR
2038	0	6	0	0	92	1789	ERR	ERR	86	ERR	ERR
2037	0	6	0	0	68	1955	ERR	ERR	86	ERR	ERR
2036											
2035											
2034	ERR	ERR	ERR	ERR	ERR	ERR	ERR	ERR	ERR	ERR	ERR
2033	0	0	0	0	497	6691	ERR	ERR	ERR	ERR	ERR

SUMMARY -KALAIYA === NEA REMOTE NON HYDRO ===

YEAR	AVERAGE YEARLY CONSUMPTION '000 KWH DOM	IND	COMM	NON-COMM	IRR	STREET	SELF	TEMP	TOTAL	NUMBER OF CONSUMERS DOM	IND	COMM
2042	1045.86	937.48	31.64	171.38	310.47	16.96	9.95	ERR	2523.74	2011	88	5
2041	929.29	1254.39	31.52	142.31	199.12	15.66	8.82	ERR	2581.10	0	0	0
2040	901.90	1008.36	29.71	146.58	618.00	14.90	7.75	ERR	2711.16	1563	75	5
2039	1050.43	955.44	ERR	0.00	652.56	16.11	3.46	ERR	2677.99	1515	69	0
2038	1370.08	830.33	ERR	ERR	314.39	13.97	13.59	ERR	2542.34	1367	64	0
2037	588.95	681.99	0.00	0.00	343.62	20.36	4.06	ERR	1638.99	1272	56	0

YEAR	NON-COMM	IRR	STREET	AVERAGE CONSUMPTION PER CONSUMER - KWH DOM	IND	COMM	NON-COMM	IRR	STREET
2042	57	16	6	520	10653	6328	3007	19404	2827
2041	0	0	0	ERR	ERR	ERR	ERR	ERR	ERR
2040	50	23	7	577	13445	5941	2932	26869	2129
2039	0	21	7	693	13847	ERR	ERR	31074	2301
2038	0	17	6	1002	12974	ERR	ERR	18493	2329
2037	0	19	7	463	12178	ERR	ERR	18085	2909

SUMMARY -NAYAMILL   === NEA REMOTE NON HYDRO ===

	AVERAGE YEARLY CONSUMPTION '000 KWH									NUMBER OF CONSUMERS		
YEAR	DOM	IND	COMM	NON-COMM	IRR	STREET	SELF	TEMP	TOTAL	DOM	IND	COMM
2042	423.04	320.02	0.00	31.63	0.78	7.55	2.74	5.28	789.17	1554	46	0
2041	240.35	343.91	26.26	24.29	4.09	9.88	10.22	ERR	625.87	0	0	0
2040	284.73	265.57	ERR	24.99	ERR	20.17	ERR	ERR	595.46	707	33	0
2039	258.41	258.95	10.92	0.00	0.00	26.51	0.00	ERR	543.08	564	31	1

	(NUMBER OF CONSUMERS, continued)			AVERAGE CONSUMPTION PER CONSUMER - KWH					
YEAR	NON-COMM	IRR	STREET	DOM	IND	COMM	NON-COMM	IRR	STREET
2042	14	2	4	272	6957	0	2259	390	1888
2041	0	0	0	ERR	ERR	ERR	ERR	ERR	ERR
2040	0	0	7	403	8048	ERR	ERR	ERR	2881
2039	0	0	7	458	8353	10920	0	0	3787

SUMMARY -KRISNANAGER === NEA REMOTE NON HYDRO ===

YEAR	AVERAGE YEARLY CONSUMPTION '000 KWH DOM	IND	COMM	NON-COMM	IRR	STREET	SELF	OTHER	TOTAL	NUMBER OF CONSUMERS DOM	IND	COMM
42	556.74	162.95	0.00	3.38	42.01	33.89	20.72	ERR	809.98	678	21	0
41	484.80	199.20	45.11	28.08	55.82	26.34	28.59	ERR	849.23	573	18	39
40	442.99	155.35	15.61	32.22	28.37	25.98	35.09	ERR	723.02	572	18	11
39	444.62	178.07	ERR	ERR	0.68	32.26	26.48	ERR	681.50	567	16	0
38	396.44	134.57	ERR	1.92	ERR	26.39	19.61	ERR	577.98	537	13	0
37	341.26	82.08	ERR	0.59	ERR	25.83	18.59	ERR	467.89	491	13	0
36												
35												
34	353.19	192.57	ERR	ERR	ERR	51.16	13.36	2.51	612.79	0		
33	486.05	156.99	0.00	0.00	ERR	48.01	11.53	2.03	704.62	865	27	0

YEAR	NON-COMM	IRR	STREET	OTHER	AVERAGE YEARLY CONSUMPTION PER CONSUMER - KWH DOM	IND	COMM	NON-COMM	IRR	STREET	OTHER
42	1	1	1	0	821	7759	ERR	3381	42009	33891	ERR
41	0	1	1	0	846	11067	1157	ERR	55824	26344	ERR
40	0	1	1	0	774	8630	1419	ERR	28370	25983	ERR
39	0	1	5	0	784	11130	ERR	ERR	684	6451	ERR
38	0	0	2	0	738	10351	ERR	ERR	ERR	13197	ERR
37	0	0	3	0	695	6314	ERR	ERR	ERR	8610	ERR
36											
35											
34											
33	0	ERR	ERR	ERR	562	5814	ERR	ERR	ERR	ERR	ERR

SUMMARY -BAHADURGUNJ === NEA REMOTE NON HYDRO ===

YEAR	AVERAGE YEARLY CONSUMPTION '000 KWH DOM	IND	COMM	NON-COMM	IRR	STREET	SELF	OTHER	TOTAL	NUMBER OF CONSUMERS DOM	IND	COMM
42	209.04	468.08	0.00	39.97	ERR	4.06	6.11	ERR	727.25	572	47	0
41	148.21	467.76	63.02	98.21	ERR	4.91	4.73	5.50	723.20	458	38	22
40	151.33	445.21	2.12	106.27	2.47	10.17	3.54	ERR	718.67	457	35	3
39	218.19	369.33	ERR	ERR	ERR	16.67	5.48	ERR	609.67	416	32	0
38	177.28	280.52	ERR	24.53	ERR	16.20	7.63	ERR	483.67	371	31	0
37	141.57	249.39	ERR	1.74	ERR	17.83	5.93	ERR	415.10	324	28	0
36												
35												
34	66.23	55.56	ERR	ERR	ERR	10.16	ERR	ERR	131.95	ERR	ERR	ERR
33	125.73	28.75	0.00	0.00	ERR	8.05	0.00	1.94	162.75	170	10	0

YEAR	NON-COMM	IRR	STREET	OTHER	AVERAGE YEARLY CONSUMPTION PER CONSUMER - KWH DOM	IND	COMM	NON-COMM	IRR	STREET	OTHER
42	2	0	2	0	365	9959	ERR	19984	ERR	2029	ERR
41	0	0	5	0	324	12309	2865	ERR	ERR	982	ERR
40	0	0	6	0	331	12720	705	ERR	ERR	1695	ERR
39	0	0	10	0	524	11542	ERR	ERR	ERR	1667	ERR
38	0	0	10	0	478	9049	ERR	ERR	ERR	1620	ERR
37	0	0	10	0	437	8907	ERR	ERR	ERR	1783	ERR
36											
35											
34	ERR	ERR	ERR	ERR	ERR	ERR	ERR	ERR	ERR	ERR	ERR
33	0	0	6	0	740	2875	0	0	ERR	1341	ERR

SUMMARY -TRIBENI === NEA REMOTE NON HYDRO ===

YEAR	AVERAGE YEARLY CONSUMPTION '000 KWH									NUMBER OF CONSUMERS		
	DOM	IND	COMM	NON-COMM	IRR	STREET	SELF	TEMP	TOTAL	DOM	IND	COMM
42												
41	117.18	112.70	14.41	15.84	ERR	3.63	2.83	ERR	256.03	0	0	0
40	135.93	163.24	4.71	13.88	0.00	3.64	3.76	ERR	325.16	245	6	15
39	132.58	149.62	ERR	ERR	ERR	4.61	3.12	ERR	289.09	213	5	0
38	108.08	222.76	ERR	ERR	ERR	5.78	1.50	ERR	338.12	197	5	0
37	103.95	151.60	ERR	ERR	ERR	6.60	1.47	ERR	263.61	166	4	0
36												
35												
34	44.64	62.72	ERR	ERR	ERR	7.10	ERR	1.82	116.28	0	0	0
33	38.92	38.82	0.00	0.00	0.00	7.10	ERR	1.82	86.67	111	3	0

YEAR				AVERAGE CONSUMPTION PER CONSUMER - KWH					
	NON-COMM	IRR	STREET	DOM	IND	COMM	NON-COMM	IRR	STREET
42									
41	0	0	0	ERR	ERR	ERR	ERR	ERR	ERR
40	0	1	1	555	27206	314	ERR	0	3636
39	0	0	1	622	29924	ERR	ERR	ERR	4607
38	0	0	2	549	44552	ERR	ERR	ERR	2889
37		0	2	626	37899	ERR	ERR	ERR	3298
36									
35									
34	0	0	0	ERR	ERR	ERR	ERR	ERR	ERR
33	0	0	41	351	12941	ERR	ERR	ERR	173

SUMMARY -GULRIA === NEA REOMTE NON HYDRO ===

YEAR	AVERAGE YEARLY CONSUMPTION '000 KWH									NUMBER OF CONSUMERS		
	DOM	IND	COMM	NON-COMM	IRR	STREET	SELF	OTH	TOTAL	DOM	IND	COMM
42												
41	58.04	ERR	ERR	ERR	ERR	11.09	2.60	ERR	71.73	ERR	ERR	ERR
40	82.99	ERR	0.00	0.00	ERR	13.55	2.40	ERR	98.93	245	0	0
39	53.97	ERR	ERR	ERR	ERR	17.88	1.20	0.32	72.28	194	0	0
38	14.02	ERR	ERR	ERR	ERR	2.50	1.12	ERR	17.64	ERR	ERR	ERR
37	15.53	ERR	0.00	0.00	ERR	9.33	1.02	0.20	25.92	96	0	0

YEAR					AVERAGE CONSUMPTION PER CONSUMER - KWH							
	NON-COMM	IRR	STREET	OTHER	DOM	IND	COMM	NON-COMM	IRR	STREET	SELF	OTHER
42												
41	ERR	ERR	ERR	ERR	ERR	ERR	ERR	ERR	ERR	ERR	2600	ERR
40	0	0	1	0	339	ERR	ERR	ERR	ERR	13547	2400	ERR
39	0	0	1	1	278	ERR	ERR	ERR	ERR	17881	1200	324
38	ERR	ERR	ERR	ERR	ERR	ERR	ERR	ERR	ERR	ERR	1116	ERR
37	0	0	41	2	162	ERR	ERR	ERR	ERR	228	1016	99

SUMMARY -NEPALGUNJ === NEA REMOTE NON HYDRO ===

YEAR	AVERAGE YEARLY CONSUMPTION '000 KWH									NUMBER OF CONSUMERS		
	DOM	IND	COMM	NON-COMM	IRR	STREET	SELF	OTH	TOTAL	DOM	IND	COMM
2042	3316.44	2864.96	ERR	ERR	62.74	360.54	120.00	120.00	6844.68	4075	172	0
2041	3523.97	1978.62	54.86	0.00	38.52	294.41	118.80	118.80	6077.20	3866	159	0
2040	3481.70	2033.20	55.90	ERR	ERR	96.00	104.40	72.00	5843.20	3656	146	0
2039	3419.33	1948.79	71.55	ERR	ERR	96.00	72.00	72.00	5679.66	3346	136 X	
2038	2147.64	1559.38	ERR	ERR	37.37	165.62	6.00	6.00	3922.02	ERR	ERR	ERR
2037	2261.94	1350.64	ERR	ERR	36.77	165.62	6.00	60.00	3880.98	2659	98	566
2036	2569.26	1470.59	ERR	ERR	43.18	63.24	60.00	66.94	4273.21	ERR	ERR	ERR
2035	1939.34	1227.02	ERR	ERR	27.02	62.01	51.20	80.21	3367.24	2205	67	0
2034	2317.02	1067.31	ERR	ERR	ERR	58.32	ERR	124.68	3567.33	1906	51	0
2033	988.71	1026.14	0.00	0.00	ERR	58.32	ERR	103.33	2176.50	1699	46	0

YEAR					AVERAGE CONSUMPTION PER CONSUMER - KWH							
	NON-COMM	IRR	STREET	OTHER	DOM	IND	COMM	NON-COMM	IRR	STREET	SELF	OTHER
2042	0	3 X	X		814	16657	ERR	ERR	20913	ERR	120000	ERR
2041	0	ERR	ERR	ERR	912	12444	ERR	ERR	ERR	ERR	118800	ERR
2040	0	20	0	0	952	13926	ERR	ERR	ERR	ERR	104400	ERR
2039	0	0 X	X		1022	14329	ERR	ERR	ERR	ERR	72000	ERR
2038	ERR	ERR	ERR	ERR	ERR	ERR	ERR	ERR	ERR	ERR	6000	ERR
2037	0	0	0	0	851	13782	ERR	ERR	ERR	ERR	6000	ERR
2036	ERR	ERR	ERR	ERR	ERR	ERR	ERR	ERR	ERR	ERR	60000	ERR
2035	0	7	296	0	880	18314	ERR	ERR	3859	209	51200	ERR
2034	0	0	296	0	1216	20928	ERR	ERR	ERR	197	ERR	ERR
2033	0	0	296	2	582	22307	ERR	ERR	ERR	197	ERR	51664

	AVERAGE YEARLY CONSUMPTION '000 KWH									NUMBER OF CONSUMERS		
YEAR	DOM	IND	COMM	NON-COMM	IRR	STREET	SELF	OTHER	TOTAL	DOM	IND	COMM
42	57.56	ERR	0.00	0.00	ERR	3.15	3.15	ERR	64.76	126	0	0
41	46.81	ERR	ERR	ERR	ERR	3.60	3.60	ERR	54.01	122	0	0
40	45.91	ERR	ERR	ERR	ERR	3.00	3.60	ERR	52.51	121	0	0
39	32.18	ERR	ERR	ERR	ERR	3.60	3.60	ERR	37.58	114	0	0
38	22.14	ERR	ERR	ERR	ERR	ERR	2.10	ERR	24.24	105	ERR	ERR
37	22.28	ERR	0.00	0.00	ERR	ERR	2.09	ERR	24.37	95	0	0

					AVERAGE YEARLY CONSUMPTION PER CONSUMER - KWH						
YEAR	NON-COMM	IRR	STREET	OTHER	DOM	IND	COMM	NON-COMM	IRR	STREET	OTHER
42	0	0	0	5	457	ERR	ERR	ERR	ERR	ERR	ERR
41	0	0	0	5	384	ERR	ERR	ERR	ERR	ERR	ERR
40	0	0	0	5	379	ERR	ERR	ERR	ERR	ERR	ERR
39	0	0	0	0	282	ERR	ERR	ERR	ERR	ERR	ERR
38	ERR	ERR	ERR	ERR	212	ERR	ERR	ERR	ERR	ERR	ERR
37	0	0	0	0	235	ERR	ERR	ERR	ERR	ERR	ERR

SUMMARY -GHORAHI === NEA REMOTE NON HYDRO ===

	AVERAGE YEARLY CONSUMPTION '000 KWH									NUMBER OF CONSUMERS		
YEAR	DOM	IND	COMM	NON-COMM	IRR	STREET	SELF	OTHER	TOTAL	DOM	IND	COMM
2042	89.77	0.00	0.00	0.00	0.00	1.53	2.44	ERR	93.73	469	1	0
2041	69.68	ERR	ERR	ERR	ERR	1.09	1.71	1.02	72.55	302	0	0
2040	64.16	ERR	0.00	0.00	ERR	2.01	1.73	1.31	68.92	281	0	0

					AVERAGE YEARLY CONSUMPTION PER CONSUMER - KWH						
YEAR	NON-COMM	IRR	STREET	OTHER	DOM	IND	COMM	NON-COMM	IRR	STREET	OTHER
2042	0	0	1	0	191	0	ERR	ERR	ERR	1530	ERR
2041	0	0	1	1	231	ERR	ERR	ERR	ERR	1085	1020
2040	0	0	1	1	228	ERR	ERR	ERR	ERR	2007	1315

SUMMARY- KOILABAS

=== NEA REMOTE NON HYDRO ====

YEAR	AVERAGE YEARLY CONSUMPTION '000 KWH: DOM	IND	COMM	NON-COMM	IRR	STREET	SELF	OTHER	TOTAL	NUMBER OF CONSUMERS: DOM	IND	COMM
42	59.25	0.00	ERR	ERR	ERR	1.61	1.08	1.08	63.02	254	1	0
41	76.61	0.56	0.00	0.00	ERR	5.97	6.00	6.55	95.23	253	1	0
40	91.26	1.51	ERR	ERR	ERR	8.26	7.97	9.00	112.74	252	2	0
39	116.76	16.20	ERR	ERR	ERR	17.73	11.27	0.00	156.56	242	2	0
38	78.91	11.64	ERR	ERR	ERR	21.60	9.30	ERR	121.45	240	2	ERR
37	96.32	15.88	0.00	0.00	ERR	21.60	6.31	ERR	140.11	237	2	0

YEAR	NON-COMM	IRR	STREET	OTHER	AVERAGE YEARLY CONSUMPTION PER CONSUMER - KWH: DOM	IND	COMM	NON-COMM	IRR	STREET	OTHER
42	0	0	0	42	233	0	ERR	ERR	ERR	ERR	26
41	0	0	42	0	303	558	ERR	ERR	ERR	142	ERR
40	0	0	42	0	362	753	ERR	ERR	ERR	197	ERR
39	0	0	42	0	482	8100	ERR	ERR	ERR	422	ERR
38	ERR	ERR	42	ERR	329	5820	ERR	ERR	ERR	514	ERR
37	0	0	45	0	406	7940	ERR	ERR	ERR	480	ERR

SUMMARY -MAHENDRANAGER === NEA REOMTE NON HYDRO ===

YEAR	AVERAGE YEARLY CONSUMPTION '000 KWH									NUMBER OF CONSUMERS		
	DOM	IND	COMM	NON-COMM	IRR	STREET	SELF	OTH	TOTAL	DOM	IND	COMM
42	1052.78	883.33	0.00	0.00	61.09	10.80	130.80	120.00	2258.80	0	ERR	ERR
41	973.92	768.75	0.00	0.00	42.94	10.80	106.10	90.43	1992.94	1570	55	0
40	865.60	671.78	ERR	ERR	32.77	10.80	36.00	6.44	1623.39	1235	52	0
39	721.98	525.52	ERR	ERR	21.21	10.80	36.00	7.98	1321.72	1058	43	0
38	594.18	522.52	9.41	ERR	ERR	10.80	36.00	19.20	1192.11	881	39	0
37	447.08	529.17	6.30	ERR	ERR	10.80	36.00	2.41	1031.15	731	38	9
36	359.36	436.92	2.38	ERR	1.31	10.80	36.00	ERR	845.19	600	31	5
35	328.06	440.19	2.12	ERR	2.23	9.38	13.60	ERR	792.60	519	28	0
34	282.14	231.65	ERR	ERR	1.48	9.60	4.80	4.80	521.97	414	21	3
33	237.41	218.82	0.00	0.00	ERR	9.24	ERR	4.33	468.77	345	15	0

YEAR					AVERAGE CONSUMPTION PER CONSUMER - KWH							
	NON-COMM	IRR	STREET	OTHER	DOM	IND	COMM	NON-COMM	IRR	STREET	SELF	OTHER
42	ERR	ERR	ERR	ERR	ERR	ERR	ERR	ERR	ERR	ERR	130800	ERR
41	0	57	0	18	620	13977	ERR	ERR	753	ERR	106100	5024
40	0	38	20	8	701	12919	ERR	ERR	862	540	36000	805
39	0	32	20	14	682	12221	ERR	ERR	663	540	36000	570
38	0	14	20	12	674	13398	ERR	ERR	ERR	540	36000	1600
37	0	0	20	3	612	13926	700	ERR	ERR	540	36000	804
36	0	0	20	2	599	14094	476	ERR	ERR	540	36000	ERR
35	0	3	20	0	632	15721	ERR	ERR	744	469	13600	ERR
34	0	0	20	0	681	11031	ERR	ERR	ERR	480	4800	ERR
33	0	0	50	3	688	14588	ERR	ERR	ERR	185	ERR	1444

SUMMARY -DADELDHURA === NEA REMOTE NON HYDRO ===

YEAR	AVERAGE YEARLY CONSUMPTION '000 KWH									NUMBER OF CONSUMERS		
	DOM	IND	COMM	NON-COMM	IRR	STREET	SELF	OTH	TOTAL	DOM	IND	COMM
2042												
2041												
2040	37.05	ERR	0.00	0.00	ERR	1.62	6.88	ERR	45.56	237	0	0
2039	41.71	ERR	0.00	0.00	ERR	1.70	9.00	ERR	52.42	229	0	0
2038												

YEAR	(NUMBER OF CONSUMERS, cont.)				AVERAGE CONSUMPTION PER CONSUMER - KWH							
	NON-COMM	IRR	STREET	OTHER	DOM	IND	COMM	NON-COMM	IRR	STREET	SELF	OTHER
2042												
2041												
2040	0	0	48	0	156	ERR	ERR	ERR	ERR	34	6879	ERR
2039	0	0	48	0	182	ERR	ERR	ERR	ERR	35	9000	ERR
2038												

SUMMARY -DHANGADI === NEA REMOTE NON HYDRO ===

YEAR	AVERAGE YEARLY CONSUMPTION '000 KWH									NUMBER OF CONSUMERS		
	DOM	IND	COMM	NON-COMM	IRR	STREET	SELF	OTH	TOTAL	DOM	IND	COMM
42	1131.39	1572.17				38.88	96.00	28.25	2951.42			
41	1148.43	1468.99				38.88	96.00	112.98	2865.28	1600	52	
40	669.14	862.95				38.88	72.00	14.40	1657.37	0	0	
39	702.47	1355.84				35.46	66.00	12.93	2172.69	1174	42	
38	601.09	1257.00				25.20	37.00	6.70	1926.99	1038	35	
37	466.87	347.73				52.20	19.00	8.95	894.76	919	31	
36	414.66	151.11				65.70	8.09	172.98	812.54	752	19	
35	386.47	147.43				43.20	10.94	6.56	594.60	697	16	
34	303.39	109.56				8.38	12.00	12.00	436.33	536	15	
33	249.16	120.32				6.00	12.00	12.00	399.48	380	8	

YEAR	(NUMBER OF CONSUMERS, continued)				AVERAGE CONSUMPTION PER CONSUMER - KWH							
	NON-COMM	IRR	STREET	OTHER	DOM	IND	COMM	NON-COMM	IRR	STREET	SELF	OTHER
42												
41			90	30	60	2354					96000	3766
40			0	0	ERR	ERR					72000	ERR
39			92	80	50	2690					66000	162
38			99	45	48	2993					37000	149
37			99	37	42	935					19000	242
36			168	0	46	663					8094	ERR
35			168	8	46	768					10937	820
34			68	5	47	609					12000	2400
33			17	2	55	1253					12000	6000

Appendix 10

Demand Data for 10 NEA Small Hydro Sites

TABLE: A-10.1

DEMAND CHARACTERISTICS SUMMARY - NEA OPERATED REMOTE HYDRO SITES

REMOTE HYDRO SITE	CAPACITY KW		DISTRICT ADMIN HQ	YEAR OF ROAD ACCESS	YEAR OF OPERATION	YEAR DATA CURRENT	PERIOD OF GRWTH-YRS	1985 YEARLY CONSUMPTION - MWH: DOM	IND	COMM.	NON COMM.	PUB	TEMP	SELF	TOTAL	1985 YEARLY CONSUMPTION PERCENT OF TOTAL: DOM	IND	COMM	NON-COMM	SELF
DHANKUTA	2*120=	240	HQ	1981	1971	1985	14	337993	38228	14750	262417		7393	14626	660782	51%	6%	2%	40%	2%
PHIDIM	2*130=	260	HQ	1983	1981	1985	4	99367	6973						106340	93%	7%	0%	0%	0%
JOMSOM	2*120=	240	HQ	NO	1982	1985	3	193913	1432					7500	202845	96%	1%	0%	0%	4%
BAGLUNG	1*175=	175	HQ	NO	1981	1985	4	166564	8146					4742	179452	93%	5%	0%	0%	3%
SURKHET	3*115=	345	HQ	1977	1977	1985	8	390126	40077			3600		115604	549407	71%	7%	0%	0%	21%
JUMLA	2*100=	200	HQ	NO	1983	1985	2	105854	15123		8555			6450	135981	78%	11%	0%	6%	5%
DOTI	2*100=	200	HQ	1983	1982	1985	3	155650	11921					9600	177171	88%	7%	0%	0%	5%
GORKHE	2*32=	64	HQ	1985	1982	1985	3	30713						727	31440	98%	0%	0%	0%	2%
DHADING	1*32=	32	HQ	1982	1983	1985	2	32018	6344					870	39232	82%	16%	0%	0%	2%
SYANGJA	2*40=	80	HQ	1970	1983	1985	2	55157	1241			22009		10428	88835	62%	1%	0%	0%	12%
TOTAL		1836						1567355	129485	14750	270972	25609	7393	170547	2171485	72%	6%	1%	12%	8%
AVERAGE																				

REMOTE HYDRO SITE	CAPACITY KW		1985 NUMBER OF CUSTOMERS: DOM	IND	COMM	NON COMM.	PUB	TEMP	SELF	1985 AVERAGE YEARLY CONSUMPTION PER CONSUMER: DOM	IND	COMM.	NON COMM	PUB	TEMP	SELF	PERIOD COMPOUND GROWTH - %: CONSUMPTION ADJ-DOM	CONSUMPTION IND	CONSUMPTION TOTAL	CUSTOMERS ADJ-DOM	CUSTOMERS IND	CONS/CUST ADJ-DOM	CONS/CUST IND
DHANKUTA	2*120=	240	685	10	13	120	2	13	2	493	3823	1135	2187		569	7313	23.2%	9.9%	21.6%	10.3%	19.4%	11.7%	-7.9%
PHIDIM	2*130=	260	267	2					1	372	3487						35.6%	41.5%	100.0%	43.2%	26.0%	5.3%	12.3%
JOMSOM	2*120=	240	662	5					1	293	286					7500	124.4%	672.4%	115.9%	110.5%	123.6%	6.6%	245.4%
BAGLUNG	1*175=	175	549	3					1	303	2715					4742	33.4%	65.6%	32.5%	3.3%	0.0%	29.1%	65.6%
SURKHET	3*115=	345	548	8			142		1	712	5010			25		115604	11.0%	8.2%	13.4%	12.4%	13.0%	-0.5%	4.3%
JUMLA	2*100=	200	224	3		2			1	473	5041		4277			6450	-19.6%	453.8%	-13.7%	16.5%	200.0%	-30.9%	84.6%
DOTI	2*100=	200	409	5				2	1	381	2384					9600	11.0%	5.7%	9.1%	13.2%	7.7%	1.9%	-1.9%
GORKHE	2*32=	64	143	0					1	215						727	61.1%		50.0%	61.4%		-0.2%	
DHADING	1*32=	32	230	3					1	139	2115						6.3%	47.6%	10.7%	10.8%	73.2%	-3.9%	-14.8%
SYANGJA	2*40=	80	223	7			1		1	247	177			22009		10428	74.1%	3082.1%	67.2%	7.7%	600.0%	61.6%	354.6%
TOTAL		1836	3940	46	13	122	145	15	11														
AVERAGE																							

SITE: DHANKUTA
CAPACITY: 240 KW BEG-OPER:2028/

YEAR	AVERAGE YEARLY CONSUMPTION - KWH DOM	IND	COMM.	NON COMM.	PUB	TEMP	SELF	TOTAL	GENERA. TOTAL	SOLD UNIT	OPERATE TIME HOURS	YRLY PEAK KW
2026												
2027												
2028									61000			
2029	40819	11220	0	0	0	0	0	52039	73000	39029		100
2030	67519	16255	0	0	0	0	0	83774	104000	83774		118
2031	98382	16473	0	0	0	0	0	114855	143750	114855		85
2032	124238	9641	0	0	0	0	8137	133879	166147	133879		126
2033	214529	30332	0	0	9157	198	6841	254216	279355	254216		147
2034	208932	37922	0	0	19697	1109	3600	267660	82614	111525		142
2035	276460	47251	0	0	15820	528		340059	338865	340059		202
2036	345592	45804	0	0	2940	528		394864	363935	394864	7689	207
2037	433407	47402	0	0	2940	1080		484829	488876	484829	7145	229
2038	481132	47307	0	0	2925	1054	23341	532418	533355	532418	7721	265
2039	612093	51999	0	0	2860	878	12144	667830	716070	667830	9922	274
2040	323184	53326	20609	240640	478	5857	18240	644094	696958	644094	11302	274
2041	235159	46725	21734	291691	0	12818	16860	608127	647308	608127	10774	298
2042	337993	38228	14750	262417	0	7393	14626	660782	591906	550652	8783	257

YEAR	REV TOTAL RS	AV.REV. PER MON RS	CAPITAL COST RS	O&M&A TOT RS	AVE. MNTHLY O&M RS	NUMBER OF CONSUMERS DOM	IND	COMM	NON COMM.	PUB	TEMP	SELF	YEARLY LOAD FACTOR	YEARLY PLANT FACTOR
2026														
2027														
2028			3000000											
2029	14331	1592				228	1	0	0	0	0	1	8%	3%
2030	28548	2379		697500	58125	295	1	0	0	0	0	1	10%	5%
2031	42392	3533		822500	68542	398	1	0	0	0	0	1	19%	7%
2032	49171	4098		584000	48667	502	1	0	0	1	0	1	15%	8%
2033	82000	6833		336500	28042	544	3	0	0	1	1	1	22%	13%
2034	50709	4226		216250	18021	574	5	0	0	2	2	1	22%	13%
2035	105197	8766		252311	21026	609	8	0	0	2	2	1	19%	16%
2036	136725	11394		342170	28514	629	9	0	0	2	2	1	22%	19%
2037	160703	13392		342471	28539	641	9	0	0	2	3	1	24%	23%
2038	179832	14986		476303	39692	655	9	0	0	2	3	1	23%	25%
2039	244632	20386		713616	59468	713	9	0	0	2	2	1	30%	34%
2040	456654	38055		1045849	87154	713	9	12	115	2	7	2	29%	33%
2041	530110	44176		1087456	90621	610	10	13	120	2	14	2	25%	31%
2042	503389	50339				685	10	13	120	2	13	2	29%	31%

YEAR	LOSSES /GEN	AVERAGE REV/O&M	AVERAGE YEARLY CONSUMPTION PER CONSUMER							SELF/ SOLD	O&M / CAPITAL
			DOM	IND	COMM.	NON COMM	PUB	TEMP	SELF		
2026											
2027											
2028											
2029	47%		179	11220							7.1%
2030	19%	4%	229	16255							19.0%
2031	20%	5%	247	16473							16.9%
2032	15%	8%	247	9641			0		8137	6.1%	9.5%
2033	7%	24%	394	10111			9157	198	6841	2.7%	4.8%
2034	-39%	23%	364	7584			9848	554	3600	1.3%	3.0%
2035	-0%	42%	454	5906			7910	264			3.8%
2036	-8%	40%	549	5089			1470	264			4.7%
2037	1%	47%	676	5267			1470	360			3.9%
2038	-4%	38%	735	5256			1463	351	23341	4.4%	5.6%
2039	5%	34%	858	5778			1430	439	12144	1.8%	7.5%
2040	5%	44%	453	5925	1717	2093	239	837	9120	2.8%	10.0%
2041	3%	49%	386	4673	1672	2431	0	916	8430	2.8%	8.5%
2042	4%		493	3823	1135	2187	0	569	7313	2.2%	

SMALL HYDRO DATA SUMMARY

SITE: PHIDIM BEG-CONS: 2034
CAP: 260 KW BEG-OPER: 2038/11

YEAR	AVERAGE YEARLY CONSUMPTION KWH DOM	IND	OTH	SELF	TOTAL	TOTAL GENER-ATED	TOTAL SOLD	OPERATE UNTOTAL TIME HRS	CAPITAL COST RS	YRLY PEAK KW	REVENUE TOTAL RS	AVERAGE MNTHLY REVENUE	O&M&A TOTAL RS
2034									2014967				
2035									1648723				
2036									999562				
2037									1250123				
2038									1047962				
2039	39896	2460	0	0	13299	NA	42356	2049		51.1	32737	2728	736125
2040	46055	2846	0	0	48901	NA	48901	2178.5		58.7	64187	5349	1144670
2041	63862	6292	0	0	70154	NA	70154	2486		80.5	89541	7462	1627461
2042	99367	6973	0	0	106340	NA	106340	3068		100.4	110369	9197	680843

YEAR	AV.O/M PER MON. RS	NO. OF CONSUMERS DOM	IND	OTH	SELF	YEARLY LOAD FACTOR	YEARLY PLANT FACTOR	REV/EXP.	AVE YEARLY CONSUMPTION PER CONSUMER KWH DOM	IND	OTH	SELF	SELF /SOLD	O&M RS/ CAP. COST
2034														
2035														
2036														
2037														
2038		12	1	0	1									5.2%
2039	61344	91	1	0	1	3%	1%	4%	438.4	2460.0	ERR	0.0	N.A.	6.9%
2040	95389	161	1	0	1	10%	2%	6%	286.1	2846.0	ERR	0.0	N.A.	13.0%
2041	135622	213	2	0	1	10%	3%	6%	299.8	3146.0	ERR	0.0	N.A.	15.6%
2042	68084	267	2	0	1	12%	5%	14%	372.2	3486.5	ERR	0.0	N.A.	3.5%

SMALL HYDRO DATA SUMMARY

SITE: JONSOM
CAPACITY: 240 KW BEG-OPER: 2034/11

YEAR	AVERAGE YEARLY CONS. KWH DOM	IND	PUB	SELF	TOTAL	TOTAL GENER-ATED	TOTAL SOLD UNIT TOTAL	OPERATE TOTAL TIME HRS	CAPITAL COST RS	YRLY PEAK KW	REVENUE TOTAL RS	AVERAGE MNTHLY REVENUE	O&M&A TOTAL RS
2034									276043				
2035									2109528				
2036									3671997				
2037									1891429				
2038									2609501				
2039									668690				
2039	17160	0	0	3000	20160		17160	168.5		59	2860	1430	214009
2040	53787	24	0	7648	61460		53811	1739.6		122	62366	5670	953696
2041	164838	354	0	7342	172534		165192	6052.4		149	168632	14053	1033395
2042	193913	1432	0	7500	202845		195345	7502.3		149	222334	18528	591277

TECHNICAL PERFORMANCE TABLE

YEAR	AV.O/M PER MON. RS	NO. OF CONSUMERS DOM NUMBER OF CONSUMERS	IND	OTH	SELF	YEARLY LOAD FACTOR	YEARL PLANT FACTOR	AVERAGE REV/EXP	AVE YEARLY CONSUMPTION PER CONSUMER KWH DOM	IND	PUB	SELF	SELF / SOLD	O&M/CAP
2034														
2035														
2036														
2037														
2038														
2039														
2039	107005	71	0	0	1	4%	1%	1%	242	0	ERR	3000	17.5%	4.0%
2040	79475	558	1	0	1	6%	3%	7%	96	24	ERR	7648	14.2%	5.1%
2041	86116	612	3	0	1	13%	8%	16%	269	118	ERR	7342	4.4%	6.5%
2042	49273	662	5	0	1	16%	10%	38%	293	286	ERR	7500	3.8%	2.2%

SMALL HYDRO DATA SUMMARY

SITE: BAGLUNG
CAPACITY: 175 KW BEG-OPER: 2038/9

YEAR	|- AVERAGE YEARLY CONSUMPTION DOM	IND	PUB	SELF	KWH -| TOTAL	TOTAL GENER- ATED	TOTAL SOLD TOTAL	OPERATE UNTOTAL TIME HRS	CAPITAL COST RS	YRLY PEAK KW	REVENUE TOTAL RS	AVERAGE MNTHLY REVENUE	O&M&A TOTAL RS	AV.O/M PER MON. RS
2034									1498014					
2035									1080938					
2036									564527					
2037									1414045					
2038								1216.3	825905	111			236197	59049
2039								4505.8		123	138615	11551	960430	80036
2040	93553	2971	0	5746	102270		96524.2	2095.3		110	141151	14858	905166	75431
2041	126012	6351	0	5755	138119		132363.	2241.2		158	157103	16196	660504	55042
2042	166564	8146	0	4742	179452	146736	174710.	2817.8		158	149754	13614	472567	47257

TECHNICAL PERFORMANCE TABLE

YEAR	|- NO. OF CONSUMERS -| DOM	IND	OTH	SELF	YEARLY LOAD FACTOR	YEARL PLANT FACTOR	AVERAGE REV/EXP	AVE YEARLY CONSUMPTION |--PER CONSUMER KWH DOM	IND	PUB	SELF ----------|	SELF /SOLD	O&M/CAP
	NUMBER OF CONSUMERS												
2034													
2035													
2036													
2037													
2038	385	0	0	1									7%
2039	512	3	0	1			14%						16%
2040	514	3	0	1	11%	7%	20%	182.0	990.3	ERR	5746.1	6.0%	12%
2041	549	3	0	1	10%	9%	29%	229.5	2117.1	ERR	5755.1	4.3%	8%
2042	549	3	0	1	13%	12%	29%	303.4	2715.3	ERR	4742.2	2.7%	6%

SMALL HYDRO DATA SUMMARY

SITE: SURKHET
CAP: 345 KW BEG-OPER: 2034/10

YEAR	DOM (AVERAGE YEARLY CONSUMPTION KWH)	IND	PUB	SELF	TOTAL	TOTAL GENER-ATED	TOTAL SOLD UNTOTAL	OPERATE TOTAL TIME HRS	CAPITAL COST RS	YRLY PEAK KW	REVENUE TOTAL RS	AVERAGE MNTHLY REVENUE	O&M&A TOTAL RS
72/73 2030									70000	700			
2031									1971000	16675			
2032									5858000	42449			
2033									2865000	20912			
2034	148000	15000	0	0	163000	61755	163000	1913	1797000	12836 57	18500	6167	
2035	159283	21365	3110	17352	201110	215604	183758	7914		88	86043	7170	
2036	160804	44022	4147	36461	245434	279019	208973	8771		140	86220	7185	
2037	162683	67841	2342	16385	249251	312772	232866	8108		134	118677	9890	
2038	226309	77343	750	32027	336429	381671	304402	10150		180	149533	12461	751165
2039	315357	66189	3330	43000	427876	502143	384876	11127		185	357228	29769	1115311.5
2040	333026	84216	3571	48000	468813	556687	420813	10767		220	435363	36280	1731686.2
2041	384544	97214	17358	63551	562667	532305	499116	11227		225	280264	28026	1329493.5
2042	390126	40077	3600	115604	549407	664399	433803	9752		222	442753	36896	918671

92572

+7

F.R. CONSUMERS ARE INCLUDED IN PUB

TECHNICAL PERFORMANCE TABLE

YEAR	AV.O/M PER MON. RS	DOM (NO. OF CONSUMERS) NUMBER OF CONSUMERS	IND	OTH	SELF	YEARLY LOAD FACTOR	YEARL PLANT FACTOR	AVERA REV/E	DOM (AVE YEARLY CONSUMPTION PER CONSUMER KWH)	IND	PUB	SELF	SELF / SOLD	O&M/CAP
2030														
2031														
2032														
2033														
2034		152	2	1	1									
2035		215	3	1	1	28%	7%		741	7122	3110	17352	10.6%	
2036		263	5	1	1	23%	9%		611	8804	4147	36461	19.8%	
2037		290	6	1	1	27%	10%		561	11307	2342	16385	7.8%	3.0%
2038	62597	374	6	1	1	24%	13%	20%	605	12891	750	32027	13.8%	3.7%
2039	92943	424	6	21	1	31%	17%	32%	744	11032	159	43000	14.1%	5.1%
2040	144307	433	7	58	1	29%	18%	25%	769	12031	62	48000	12.5%	7.3%
2041	110791	530	8	71	1	27%	18%	25%	726	12152	244	63551	15.1%	4.0%
2042	83516	548	8	142	1	34%	22%	44%	712	5010	25	115604	23.2%	3.0%

SMALL HYDRO DATA SUMMARY

SITE: JUMLA BEG-CONST: 2034/
CAP: 200 KW BEG-OPER: 2040/2

YEAR	!--- AVERAGE YEARLY CONSUMPTION KWH ---! DOM AVERAGE	IND MONTHLY	NON.COMM. CONSUMPTION	SELF	TOTAL	TOTAL GENER-ATED	TOTAL SOLD TOTAL	OPERATE UNTOTAL TIME HRS	CAPITAL COST RS	YRLY PEAK KW	REVENUE TOTAL RS	AVERAGE MNTHLY REVENUE	O&M&A TOTAL RS	AV.O/M PER MON. RS
2034									2158669					
2035									2604372					
2036									2414029					
2037									2618937					
2038									1989917					
2039									1246041					
2040						64160		2895.9		51	72000	8000	1038351	115372
2041	135353	2731	12592	6867	157543	0	150676	4523		55	136763	11397	1030535	85878
2042	105854	15123	8555	6450	135981	41805	129531	5145		67	87393	10924	622632	51886

(FOR 2042 REVENUE ONLY FIRST 8 MONTHS ARE EVALUATED)

TECHNICAL PERFORMANCE TABLE

YEAR	!-- NO. OF CONSUMERS --! DOM	IND	NON.COM	SELF	YEARLY LOAD FACTOR	YEARLY PLANT FACTOR	AVERAGE REV/EXP	!--PER CONSUMER KWH AVE YEARLY CONSUMPTION DOM	IND	NON.COMM	SELF	SELF / SOLD	O&M/CAP
2034													
2035													
2036													
2037													
2038													
2039													
2040	161	1	2	1			7%						12.7%
2041	193	1	2	1	33%	9%	13%	701.3	2730.7	6296.0	6866.7	4.6%	2.8%
2042	224	3	2	1	23%	8%	21%	472.6	5041.0	4277.3	6450.0	5.0%	2.8%

SMALL HYDRO DATA SUMMARY

SITE: DOTI
CAPACITY: 200 KW BEG-OPER: 2039/9

YEAR	|--- AVERAGE YEARLY CONSUMPTION KWH ---| DOM	IND	PUB	SELF	TOTAL	TOTAL GENER-ATED	TOTAL SOLD TOTAL	OPERATE UNTOTAL TIME HRS	CAPITAL COST RS	YRLY PEAK KW	REVENUE TOTAL RS	AVERAGE MNTHLY REVENUE	O&M&A TOTAL RS	AV.O/M PER MON. RS
2033									429105					
2034									698372					
2035									1235388					
2036									1552671					
2037									5905904					
2038									1564669					
2039	113716	10096	6624	6000	136436		130436	2046		90	35909	11970	282425	70606
2040	140398	20323	9655	10322	180698		170376	3107		93	70603	14121	1825504	152125
2041				3750	47522		43772	2248		100	43772	8754	1212895	101075
2042	155650	11921	0	9600	177171		167571	4122		110	140872	14087	565728	47144

TECHNICAL PERFORMANCE TABLE

YEAR	|-- NO. OF CONSUMERS --| DOM (NUMBER OF CONSUMERS)	IND	OTH	SELF	YEARLY LOAD FACTOR	YEARLY PLANT FACTOR	AVERAGE REV/EXP	AVE YEARLY CONSUMPTION |--PER CONSUMER KWH ----------| DOM	IND	PUB	SELF	SELF/ SOLD	O&M/CAP
2033													
2034													
2035													
2036													
2037													
2038													
2039	282	4	1	1	17%	8%	17%	403.2	2524.0	6624.0	6000.0	4.6%	2.8%
2040	317	5	1	1	22%	10%	9%	442.9	4064.6	9655.2	10322.4	6.1%	13.1%
2041	392	5	2	1	5%	3%	9%				3750.0	8.6%	5.0%
2042	409	5	2	1	18%	10%	30%	380.6	2384.2	0.0	9600.0	5.7%	2.3%

SMALL HYDRO DATA SUMMARY

SITE: GORKHE
CAP: 64 KW BEG-OPER: 2039/6

YEAR	AVERAGE YEARLY CONSUMPTION DOM	IND	OTH	SELF	TOTAL	TOTAL GENER-ATED	TOTAL SOLD	OPERATE TOTAL TIME HRS	CAPITAL COST RS	YRLY PEAK KW	REVENUE TOTAL RS	AVERAGE MNTHLY REVENUE	O&M&A TOTAL RS	AV.O/M PER MON. RS
2034														
2035														
2036														
2037														
2038														
2039	7341	0	1209	771	9321	NA	2850	525	2230000	13	2871	718	220369	36728
2040	16697	0	1083	1680	19460	NA	17780	1717.5		29	17635	1470	285933	23828
2041	27721	0	696	767	29184	NA	28417	1695.5		38	28056	2338	368394	30700
2042	30713	0	0	727	31440	NA	25594	1466.5		46	29884	2988	275621	27562

TECHNICAL PERFORMANCE TABLE

YEAR	NUMBER OF CONSUMERS DOM	IND	OTH	SELF	YEARLY LOAD FACTOR	YEARLY PLANT FACTOR	AV.MON. REV/EXP.	AVE YEARLY CONSUMPTION PER CONSUMER KWH DOM	IND	OTH	SELF CON. / TOTAL CON. %	O&M / CAP.COST %
2034												
2035												
2036												
2037												
2038												
2039	34	0	1	1	8%	2%	2%	215.9	NA	1209.0	8%	9.9%
2040	107	0	1	1	8%	3%	6%	156.0	NA	1083.0	9%	10.7%
2041	116	0	1	1	9%	5%	8%	239.0	NA	696.0	3%	11.8%
2042	143	0	0	1	8%	6%	11%	214.8	NA	ERR	2%	8.6%

SMALL HYDRO DATA SUMMARY

SITE: DHADING
CAP: 32 KW BEG-OPER: 2040/2

YEAR	¦--- AVERAGE YEARLY CONSUMPTION KWH ---¦ DOM	IND	OTH	SELF	TOTAL	TOTAL GENER-ATED	TOTAL SOLD UNIT	OPERATE TOTAL TIME HRS	CAPITAL COST RS	YRLY PEAK KW	REVENUE TOTAL RS	AVERAGE MNTHLY REVENUE	O&M&A TOTAL RS
2035									59000				
2036									167000				
2037									540209				
2038									471515				
2039									377557				
2040	28342	2911	0	785	32038	31417	28659	1969.5		28	27695	3077	408620
2041	29740	5242	0	740	35722	32606	34994	3158.2		29.8	53261	4438	306201
2042	32018	6344	0	870	39232	36717	38374	3182		29	44459	3705	252911

YEAR	AV.O/M PER MON. RS	¦--- NUMBER OF CONSUMERS ----¦ DOM	IND	OTH	SELF	YEARLY LOAD FACTOR	YEARLY PLANT FACTOR	AVERAGE REV/EXP.	AVE YEARLY CONSUMPTION ¦--PER CONSUMER KWH ---¦ DOM	IND	OTH	SELF CON. / TOTAL CON. %	O&M RS./ CAP.COST %
2035													
2036													
2037													
2038													
2039													
2040	34052	188	1	0	1	13%	11%	9%	150.8	2910.5	NA	2%	20.5%
2041	25517	213	2	0	1	14%	13%	17%	139.6	2621.0	NA	2%	11.9%
2042	21076	230	3	0	1	15%	14%	18%	139.2	2114.7	NA	2%	10.0%

SMALL HYDRO DATA SUMMARY

SITE: SYANGJA
CAP: 80 KW BEG-OPER: 2041/5

YEAR	AVERAGE YEARLY CONSUMPTION -KWH DOM	IND	OTH	SELF	TOTAL	TOTAL GENER-ATED	TOTAL SOLD	OPERATE TOTAL TIME HRS	CAPITAL COST RS	YRLY PEAK KW	REVENUE TOTAL RS	AVERAGE MNTHLY REVENUE	O&M&A TOTAL RS	AV.O/M PER MON. RS
2036														
2037									520393					
2038									731918					
2039									1940541					
2040									1465042					
2041	31683	39	13160	8250	53132		29921	2024		54	22055	2757	621042	77630
2042	55157	1241	22009	10428	88835		78407	5402		52	58403	4867	547606	45634

TECHNICAL PERFORMANCE TABLE

YEAR	NUMBER OF CONSUMERS DOM	IND	OTH	SELF	YEARLY LOAD FACTOR	YEARLY PLANT FACTOR	AV.MON. REV/EXP.	AVE YEARLY CONSUMPTION PER CONSUMER KWH DOM	IND	OTH	SELF CON. / TOTAL CON. %	O&M RS./ CAP.COST %
2036												
2037												
2038												
2039												
2040												
2041	207	1	1	1	11%	8%	4%	153	39	13160	16%	15%
2042	223	7	1	1	20%	13%	11%	247	177	22009	12%	5%

Appendix 11

Economic Comparison of Small Hydro and Grid Extensions in Hill Areas

APPENDIX 11

ASSUMPTIONS USED FOR ECONOMIC EVALUATION OF SMALL HYDRO

ECONOMIC ASSUMPTIONS

1. Costs and benefits are evaluated over a 25 year lifecycle with a discount rate of 10%.
2. Capital is equally distributed over 5 years of expenditure.
3. Capital and O & M for Small Hydro Costs is assumed as that for Dhankuta and taken from Table 5.1 (i.e. US $ 641,149 Capital, 6.0% of capital/year O & M).
4. Capital and Annual benefits for the grid extension option are taken from costs given in the ADB Seventh Power Project for Ilam.
5. Capital benefits include all Costs for Subtransmission, 33/11 kV Substation and the spine Distribution system. Half of the service connection costs were included in Capital. These included distribution transformers and service distribution lines.
6. Annual benefits include grid (transmission and generation) capacity costs, LRMC energy charges from the grid, 2% O & M costs for the grid extension to Ilam and the extra cost of adding new service connections.
7. Incremental grid capacity charges for the yearly increment of peak felt at the substation were calculated from WECS document "Costs of Grid Capacity and Energy for Use in Planning Rural Electrification and Transmission Extensions"[12] and were taken as [$140 + ($0.18 * d)] where d is distance from Hetauda S/S to the point of subtransmission.
8. Grid LRMC energy charges were taken as $0.058/kWh and were obtained from the NEA Generation Expansion Plan [13].

LOAD ASSUMPTIONS

1. For Dhankuta it was assumed peak and load factor for the first and tenth year of operation are as given by the research data. It was assumed the Plant reached capacity at year 10 and thereafter load factor and energy sold remained constant.
2. For Ilam it was assumed peak at year 10 of operation was as given by the Seventh Power Project multiplied by a coincidence factor of 1.0. Peak at the first year of operation was found from the ratio of first to ten year peaks in Dhankuta. Load factors were assumed identical to Dhankuta. It was assumed that loads reached capacity at year 10 and thereafter remained constant.

TABLE: A-11.1

ECONOMIC COMPARISON OF SMALL HYDRO AND GRID EXTENSION IN THE HILLS

COSTS - SMALL HYDRO

YEAR	PEAK KW	LOAD FACTOR	ENERGY CONSUMPTION MWH	CAPITAL US $ 1985	O & M US $ 1985	TOTAL ANNUAL COSTS
0				128.2		128.2
1				128.2		128.2
2				128.2		128.2
3				128.2		128.2
4				128.2		128.2
5	100.0	0.1	70.1		7.7	7.7
6	110.2	0.1	89.5		7.7	7.7
7	121.5	0.1	114.2		7.7	7.7
8	133.9	0.1	145.8		7.7	7.7
9	147.6	0.1	186.1		7.7	7.7
10	162.6	0.2	237.5		7.7	7.7
11	179.3	0.2	303.2		7.7	7.7
12	197.6	0.2	387.1		7.7	7.7
13	217.8	0.3	494.1		7.7	7.7
14	240.0	0.3	630.7		7.7	7.7
15	240.0	0.3	630.7		7.7	7.7
16	240.0	0.3	630.7		7.7	7.7
17	240.0	0.3	630.7		7.7	7.7
18	240.0	0.3	630.7		7.7	7.7
19	240.0	0.3	630.7		7.7	7.7
20	240.0	0.3	630.7		7.7	7.7
21	240.0	0.3	630.7		7.7	7.7
22	240.0	0.3	630.7		7.7	7.7
23	240.0	0.3	630.7		7.7	7.7
24	240.0	0.3	630.7		7.7	7.7
25	240.0	0.3	630.7		7.7	7.7
DISCOUNTED VALUE			1826.1			527.4
LEVELLIZED COST ($/KWH)			0.289			

BENEFITS - GRID EXTENSION

YEAR	PEAK KW	LOAD FACTOR	ENERGY CONSUMPTION MWH	CAPITAL US $ 1985	GRID CAPACITY COST	GRID ENERGY COST	ANNUAL SERVICE COST	O & M US $ 1985	TOTAL ANNUAL COSTS
0				253.7					253.7
1				253.7					253.7
2				253.7					253.7
3				253.7					253.7
4				253.7					253.7
5	1422.1	0.1	996.6		292.5	57.8	23.1	25.8	399.3
6	1567.4	0.1	1272.2		29.9	73.8	23.1	26.3	153.1
7	1727.5	0.1	1624.0		32.9	94.2	23.1	26.8	177.0
8	1904.0	0.1	2073.0		36.3	120.2	23.1	27.2	206.9
9	2098.5	0.1	2646.2		40.0	153.5	23.1	27.7	244.3
10	2312.9	0.2	3378.0		44.1	195.9	23.1	28.1	291.3
11	2549.2	0.2	4312.0		48.6	250.1	23.1	28.6	350.4
12	2809.6	0.2	5504.4		53.6	319.3	23.1	29.1	425.0
13	3096.6	0.3	7026.4		59.0	407.5	23.1	29.5	519.2
14	3413.0	0.3	8969.4		65.1	520.2	23.1	30.0	638.4
15	3413.0	0.3	8969.4		0.0	520.2		30.0	550.2
16	3413.0	0.3	8969.4		0.0	520.2		30.0	550.2
17	3413.0	0.3	8969.4		0.0	520.2		30.0	550.2
18	3413.0	0.3	8969.4		0.0	520.2		30.0	550.2
19	3413.0	0.3	8969.4		0.0	520.2		30.0	550.2
20	3413.0	0.3	8969.4		0.0	520.2		30.0	550.2
21	3413.0	0.3	8969.4		0.0	520.2		30.0	550.2
22	3413.0	0.3	8969.4		0.0	520.2		30.0	550.2
23	3413.0	0.3	8969.4		0.0	520.2		30.0	550.2
24	3413.0	0.3	8969.4		0.0	520.2		30.0	550.2
25	3413.0	0.3	8969.4		0.0	520.2		30.0	550.2
DISCOUNTED VALUE			25968.3						3012.1
LEVELLIZED COST ($/KWH)			0.116						

APPENDIX 12

Site Assessments of NEA Small Hydro Sites

- M. SHAKYA

SUMMARY OF SMALL HYDRO SITES IN OPERATION

- M. Shakya

Load Demand

Load demand is at present in excess of the supply in the following places 1) Gorkhe (64 kW) 2) Dhankuta (240 kW) 3) Dhading (32 kW) 4) Syangja (80 kW) 5) Baglung (175 kW) 6) Surkhet (345 kW) and 7) Doti (200 kW). Out of these seven sites, Dhankuta is planned to be connected with the national grid in the near future by 33 kV transmission line. Load shedding is practised in all of these sites except Surkhet where it will likely take place this winter. In the case of the three Micro Hydro sites (Gorkha, Dhading and Syangja) and Dhankuta, the actual demand is estimated at more than twice that of the installed capacity. There is suppressed load demand in Jumla. In the domestic consumption sector, if cooking with electricity is to be permitted (thus replacing the present mandatory 2.5 kVA household fuse with high capacity ones) the demand would be much higher. Industrial demand in most of the sites is also suppressed at present likely due to uncertain supply.

Maintenance Backlog :
Waterway & Forebay daily Pondage Basin

In the power canal at Baglung there is much seepage and offtakes for irrigational water use. The balancing reservoir is yet to be commissioned. The canal needs an impervious lining and the desilting basin needs repair.

The breaching of the power canal at Jomsom is a serious hindrance in smooth running of the power plant and hence needs to be repaired immediately.

Powerhouse

Problems at the powerhouses of the various sites can be summarized in the following way:

Problem	Powerhouse	Comments
Butterflyvalvedoes not operate in automatic mode	Phidim Jomsom Jumla Baglung	Mech-ElecEquip- Jyoti (Same) (Same) (Same)
Governors are out of commission most of the time or not functioning efficiently.	Phidim Jomsom Jumla Baglung Gorkhe Dhading Syangja	(Same) (Same) (Same)
Most of the meters in the control panel are disfunctional.	Phidim Jumla Baglung Doti	(Same) (Same) (Same)
Turbine runners are performed	Baglung	Inadequate discharge is major cause and has led to low voltage supply.
One generator out of operation	Phidim Jumla Jomsom Surkhet	M/E supply by Jyoti Ltd (Same) (Same) Insufficient discharge & snag in the geared Power Coupling
Rotor alignment improper	Doti	
One 150 kVA transformer not operating.	Doti	

In all a lack of spare parts and proper maintenance has been reported as the major problem facing the plants. Inadequate communication with the Kathmandu office and insufficient responsibility at the sites coupled with a lack of incentives are further causes of inefficiency.

JUMLA SMALL HYDRO POWER PROJECT

Capacity operated : 200 KW

M. Shakya
Field Visit: 21-28 May 1986

Since : 2040/2 i.e. 1983 May

No. of consumers:

Domestic : 224 Industrial: 3

Non-commercial: 2

Jumla Small Hydro Power Plant is the most remotely located unit in operation at present. It caters the Zonal Headquarter which has a population of approximately 6500. The township is at a trekking distance of 5 days from Surkhet which is the nearest roadhead. The power plant/office is located about 4 KM from the township.

At present the peak load is roughly 70 KW, out of the two 100 KW - turbo generators, unit No. 1 is out of operation. Panel board of the power plant also needs some spare parts. Governor of unit No.1 is KWH meter & frequency meter are also out of operation. Butterfly value of both the units do not operate in auto mode. Running the damaged unit would require a repair costing roughly 50,000 Rs. including the essential spares in the panel board. At present the demand is suppressed due to unavailability of household energymeters and malfunctioning of the unit No. 1. Prospective consumers include a 25 KW capacity refrigeration plant. The nearby villages are yet to be electrified. A transmission line of 4-5 km if constructed would push the load demand to nearly 150 KW instantly. At present about 4-5 new consumers are added very month, most of them procure the energymeter from Nepalgunj at their own cost. (The project has so far been unable to obtain the energymeter from the consumer services HQ at Kathmandu) Industrial demand is also considerably high (chiefly grinding, saw mill).

The powerhouse is normally run from 5 AM to 11 PM (only no. 2 unit is operated). The balancing reservoir which was completed in mid 1985 is so far unprotected, so it is creating a safety hazard in the area.

The powerhouse/office is manned by a staff of 17 persons which is the average figure for other Small Hydro plants too. The plant efficiency can be significantly increased provided the spares parts & budget for new transmission line are allocated in due time.

One striking feature of the project is that although every commodity/services at Jumla costs atleast twice than that at Surkhet, tariff is same irrespective of remoteness. This results income vs expenditure ratio of the plant to be very low. Local consumers are eager to have a connection even if they have to pay considerably higher than the present tariff rate, for the nearest alternative (kerosene for lighting) costs far more. So far electricity is not used for cooking purpose at Jumla. The largest chunk of revenue comes from government/semi government offices (numbering about 58) located in this zonal HQ.

In some peak winter months the demand has been significantly lower than in the nearby months as there is population migration (mostly office staff & families) to the warmer south or even Kathmandu. Connection with road network which would imply drastic increase in load is not possible in near future although the 200 km road from Surkhet is targeted to be complete in 2046 (1989). However, commissioning of the proposed electrification scheme in the nearby villages (in the fiscal year 2043/44) would result the peak load to approach the plant capacity within two/three years provided the supply situation increases simultaneously.

SURKHET SMALL HYDRO PROJECT

Capacity operated : 345 KW

M. Shakya

Field Visit : 17-18 Apr. 1986

Since : 2034 i.e. 1977

No. of Consumers: 548 (Domestic), 8 (Industrial)

Surkhet is the second district HQ in Nepal which was electrified by Small Hydro Power Plant (the first being Dhankuta commissioned in 1971).

The power house is situated at Jhupra Khola about 6 KM from the Surkhet township. Due to inadequate run-off in the river and malfunction in unit No. 3, only two of the three 115 KW turbo-generators are being operated at a time. The decline in river discharge is attributed to water diversion for irrigation purposes upstream of the intake as well as deforestation in the catchment area. Load demand is restrained within 230 KW by means of following austere methods like installing low Ampere fusewires (2.5A) to prevent cooking with electricity, disconnecting flat rate consumers and so on. For the last two years the demand has been much higher. Surkhet being the regional headquarter of western development region, it has many government or semi-government offices. It was connected with Nepalgunj by a fair weather road in 1977.

Surkhet serves as a transition between the plains sparsely populated but widespread mountainous areas. It will develop as an transportation hub, as there are plans to build road to Dailekh & Jumla in the further North. This would mean an increase in load demand in the future.

At present the electricity generated from the plant is barely sufficient to meet the increasing demand. By 1990 peak load would be in excess of 500 KW. Connection with the National Electricity Grid (from Nepalgunj the distance would be about 35-40 km) seems the only practical solution to cater the energy requirement. As regards to the condition of the powerhouse at present, it seems to be the most well maintained unit in operation under small hydro category. The only major problem with its smooth operation is the inability to run the third unit turbo-generator.

DOTI SMALL HYDRO POWER PROJECT

M. Shakya

Capacity :	200 kW
Field Visit:	12 to 16 April, 1986
Operated since:	2039/9/ i.e. January, 1983
Number of Consumers:	409 (Domestic), 5 (Industrial)

Doti Small Hydro Power plant is located about 4Km from Dipayal which is regional headquarter of far western development region. It caters the demand of three communities, Silgadhi (5 Km from Dipayal), Dipayal and Rajpur (2 Km from the powerhouse). Although the power plant was commissioned in early 1983, a high flood in mid 1983 caused the plant to be out of operation for 14 months. Normal tailwater level rose by more than 12 m inundating the tailrace channel and powerhouse. The turbo-generators were completely buried by silt and a portion of the penstock was also seriously damaged. After extensive repair the plant was reopened in October 1984.

At present only one of the two units is being operated, the second unit has the problem of overheating. The shaft of Unit No. 2 not being horizontal, causes excessive stress in the bearings, thus resulting in overheating. Unit No. 1 being in constant use is susceptible to breakdown inevitably. Most of the meters in the panel board are out of order and require immediate replacement. Out of the two step up transformers at the power-house, one is not in working condition. Any breakdown in the working transformer would result in power blackout. Shortage of spareparts is a major hindrance in the smooth functioning of the plant, even small items like carbon brush was in short supply.

There are over 400 applicants for power connection (roughly equivalent to 120 kW) which are yet to be served. As only 100 kW is being produced, load shedding is being practiced. For any feeder area, load shedding is in every alternate day. A seasonal road from Dadeldhura (Mahakali Zone) linking the right bank of western Seti River (just to the opposite of Dipayal) was operational since 1985. Vehicular traffic to Silgadhi will start in early 1987, which would imply sudden increase in electricity demand in that area. Dipayal is a rapidly growing township and power demand is very high in Dipayal as well as Silgadhi. Since the power project is not giving any new connections in the past few months, number of new applicants have dwindled. In fact, actual demand at present is much greater than 200 kW and is suppressed to the capacity that can be produced from a single generator. There are a number of prospective industrial consumers (saw mill, oil mill) at Dipayal. Regarding personnel manning the plant, there seems to be a mismanagement regarding their working hours and overtime allowances.

BAGLUNG SMALL HYDRO POWER PROJECT

M. Shakya

Capacity: 175 kW

Site Visit: April 1-5, 1986

Operated since: 2038/9/ (1981 December)

No. of consumers: 549 (Domestic), 3 (Industrial)

Baglung Small Hydro Powerhouse is located about 2 Km from the township and the river intake at Kathe Khola River is further 2 Km upstream. The canal is unlined and there is much visible sediment load throughout the waterway. The diversion weir is of temporary rubble stone masonry which is about 1 m high and 30 m in length. Seepage as well as irrigational outlets from the power canal is widespread. In fact, the power canal prior to the construction of this project was an irrigational canal made with local technology. Through the canal stretch, the waterway dimensions (breadth, depth) vary significantly. Stream discharge was 360 l/sec a few days earlier which is less than the 470 l/sec required for the power plant. Actual canal discharge near the forebay is reduced by about 1/3 due to seepage and irrigation outlet losses. A balancing reservoir being made near the forebay (capacity 1550 m^3) is yet to be lined. So far the powerhouse is being operated as a run of the river plant without any pondage.

Although rated capacity of the single installed unit is 175 KW, it could produce only 159 KW and that too momentarily and machine overheated during the instant. Due to cavitation in turbine, the runners were perforated and hence actual power it could produce was even less.

The Francis turbine runners were replaced in 1984 July but since the major problem of cavitation in the turbine was not tackled, the later installed runner has the same problems.

Meters at panel board are more/or less completely out of order (HZ, Cos ø, KWh, excitation voltmeter, ammeter of output, over voltage relay, etc.). RPM meter of the governor is also not in working condition. The governor has to be operated manually. The turbine-generator itself, has very little headroom and side tolerances within the powerhouse is barely passable. Replacement of major parts is a problem as there is difficulty in using the outsized gantry crane. (Even the smaller crane can hardly be moved throughout the length of powerhouse). The butterfly valve is not in working condition and bearing of the turbine shaft needs frequent replacement as there is excessive wear. Transmission line poles (of log wood) are needing replacement as many of them have rot and other defects.

Power demand at present is of the order of 400 kW which is far in excess of the power supply. Baglung once linked with highway to Pokhara (in next 4 years), will be a bustling city and hence the demand will increase tremendously in near future. Moreover, Kusma (District headquarter of Parbat) which is about 8 Km east of Baglung is yet to be electrified. Population of Kusma is about half of Baglung.

At present load shedding is being followed in Baglung. Electricity consumption being much higher, and water supply deficit being acute in the dry season compounds the problem with electricity supply. During the visit, voltage of the power supply was as low as 100 V. Only when there was a rain, the voltage surged to 210 V. Kerosene lamps are widespread in the market area. The problem of low voltage will be reduced once the work in the balancing reservoir is completed which will enable the generator to run at peak load for about 3 hours at a stretch. As a long term solution to meet the demand of this sector, linking Tatopani project under construction (1000 kW) at about 20 km north with a 33 kV transmission line is planned to be completed in 1990.

DHADING SMALL HYDRO POWER PROJECT

M. Shakya

Capacity : 32 kW Site Visit on: 5 June 1986

Operated Since : 2040/2/ i.e May 1983

Number of consumer: 230 (Domestic), 3 (Industrial)

System Manufacture, Balaju Uantra Shala - Crossflow

Dhading small Hydro Power Project although commissioned in 2037 (1980) with a capacity of 16 kW could not be smoothly operated for a long period. After a series of modifications, the plant with a installed capacity of 32 kW was recommissioned in early 2040. The power plant caters the demand of 233 customers (including three industries) at the district headquarter of Dhading. The single unit of generator although rated at 32 kW, normally does not operate beyond 30 kW. While running around the peak load, the machine has a speed of about 1,000 RPM (instead of normal 1,550 RPM) and this induces a drop in frequency as well as voltage of the output. The power system supplies the load at 400 V through a 3.6 kM long distribution line; there is no high tension transmission line. Since the powerhouse is located at the far end of distribution line itself and there is no transformer in the supply area, there is significate drop in voltage by the time it reaches the other end.

Dhading township being linked with Kathmandu-Pokhara highway at Malekhu through a 20 kM feeder road, it has about 350 households and is increasing at a fast pace. Currently power demand is around 70 kW and would increase tremendously once the feeder road is completed in the near future. Currently power demand is suppressed by means of installing low Ampere (2.5A) fuses and denying any new connection since the past eight months. Two rice mills (15 HP each), one oil mill and a saw mill are planned to be established if the power supply can be guaranteed. Revenue collection for the energy sold was initiated only from 2040/2. Prior to this power was being utilized free of cost for a few months.

At present power is supplied to cater the industrial demand during the day and domestic demand during the evening. During the dry season for about 4 months the problem of inadequate run off requires the power plant to run for relatively short periods in each day and requires load shedding in the town. Capacity of the balancing reservoir (which is 1580 m^3) if increased would enable the plant to supply for the growing industrial demand.

There are plans for installation of a 3.3 kv transmission line to reinforce the distribution system but this is yet to materialize.

Water from the tailrace and reservoir overflow is used in an irrigation scheme and cascaded to a mechanical grinding mill after 0.75 km of canal. There is no charge for irrigation. The power plant has been out of operation from 1986 June 20 to the present date (1986 Sept. 6) due to problems with electro-mechanical equipment.

GORKHE SMALL HYDRO POWER PROJECT

M. Shakya

Capacity: 64 kW Site Visit: 13 March 1986

Operated Since: 2039/6/ (October 1982)

No. of Consumers: 143 (Domestic)

System Manufacture and Installation: Balaju Yantra Shala

Gorkhe Small Hydro-Power Project caters the power demand of Pasupatinagar (border town in Ilam District) and Gorkhe which is a small market near the powerhouse. The distance between Pasupatinagar and Gorkhe is about 3.5 km. The former town is linked with Jhapa-Ilam highway by a fair weather road. At present the power demand is much in excess of power output, thus load shedding is being practiced. Pasupatinagar has roughly twice the number of customers in comparison to Gorkhe and the present power output is sufficient only for the latter community. For nearly five months in the dry season inadequate water renders the plant to be operated with only one unit for about five hours a day. Lack of sufficient discharge is the major hindrance in smooth running of the power plant. Although there is a balancing reservoir, its capacity is limited. The governor of the unit, which is of water pressure type does not function properly.

Phikkal on the way to Pasupatinagar (about 11 km away) is a sizable community yet to be electrified. Industrial power demand in this area is also considerable. There is a large sized tea processing factory running with its own diesel unit. A subsidiary line from the proposed Bhadrapur (Jhapa District) to Ilam 33 kV line may be feasible as a long term solution for power demand in this area as a whole.

DHANKUTA SMALL HYDRO POWER PROJECT

M. Shakya

Capacity: 240 kW Site Visit: 12 March 1986

Operated Since: 2024/ (1967)

No. of Consumers: 685 (Domestic), 9 (Industrial), 55 (non-commercial), 6 (Commercial

The local utility office reports a potential peak demand of 600 kW. Whether or not this demand is real it is apparent that the load exceeds the capacity of the plant. Load shedding is required at night when sections of the grid are displaced on alternate days. A 33 kV line is being installed from the Terai to relieve the hydro system and to take excess demand. Service is currently provided only in the evening for about 5 hours but runs 24 hrs with adequate water. It is reported that demand began to exceed supply at the time the road was extended to Dhankuta. The increase in demand should be checked with road access to see if there is correspondence. Intermittent and poor supply may be attributed to a number of factors:

- In the dry season, January to June, severe water shortages are felt. Daily poundage is available yet there is sufficient water for only one of the two turbines.
- Severe flooding has destroyed previous intakes. The current intake is temporary and is frequently washed out in the rainy season.
- One of the two units has been in operational for an extended period because O&M funds were not available.

It is likely that wide discrepancies will be found between generation and consumption data. Metres at the site are inoperative or in poor repair. Thus consumption data is to be trusted before generation data. System losses cannot be calculated accurately.

PHIDIM SMALL HYDRO POWER PROJECT

M. Shakya

Capacity: 2 x 130 kW Site Visit: 14 March 1986

Operated Since: 2038/11 (1981 Feb.)

Two Jyoti units have been installed. This site is experiencing severe unresolved maintenance problems. One generating unit has been down for the last year. Both governors are not working and must be operated manually according to voltage levels. Ammeters and energy meters were not working so energy generated went unrecorded. This is unfortunate since unmetered loads included 2 housing compounds (12 houses) and 12 street-lights. One transformer was also inoperable. The butterfly valve has also out of operation since a long period.

The unit generally runs 3 hours in the morning and 5-6 hours at night. The load is small requiring no load shedding for one 130 kW unit. A 15 km feeder line is being built to the next village but the added load is expected to be only 15-20 kW. Dry season flow is expected to provide 110 kW. The classification "domestic" is misleading. Domestic customers include 1 police post, 1 nurse's residence, 1 hospital) under construction, 1 District Office, 1 prison, several small tea shops/restaurants and 2 hotels. The loads at these locations are almost all lighting.

JOMSOM SMALL HYDRO POWER PROJECT

Capacity: 240 kW

M. Shakya

Operated since: 2039/11/ (1983 Feb)

Field Visit: 9 to 11 August 1986

No. of Consumers: 662 (Domestic), 4 (Industrial)

The power project at present faces the following problems.

(1) Erosion at the 0.2 km section of the power channel in the early June 1986 caused complete breaching of about 35 meter length of the canal. This rendered total shutdown of the power plant for half a month. It was recommissioned on 18th June 1986 by making an improvised aqueduct comprising seven 6 inch diameter polythene pipes supported on timber scaffolding. The pipes are borrowed from a local irrigation scheme and will have to be returned in the near future. Estimated cost for the repair work including a stone-masonry retaining wall is Rs. 0.7 million and needs to be sanctioned immediately in order to run the power plant smoothly.

(2) R. P. M. meter of the governor and pressure tapping are not in working condition. Butterfly valve near the turbine does not work in auto mode. Governor of Machine No. 1 also needs repair. The rubber bush at power coupling (between the turbine and generator) needs frequent replacement. A new energy meter for the station feeder is essential.

(3) There is frequent blockages at the trashrack at the intake by boulders of up to 0.2 m diameter. To solve this problem, the gabion weir needs repair work.

(4) Jomsom being a very windy area, the logwood poles (used as transmission and distribution towers) are susceptible to overturning, creating power blackouts. These need to be replaced by telescope tubular poles.

Regarding the power supply at present, the peak demand is yet below the plant capacity. At the present rate of increase of the energy consumption, load shedding will be essential after three years in 2045/46 until the grid from Tatopani Project (1000 kW under construction) is completed around 2048/49.

SYANGJA SMALL HYDRO POWER PROJECT

Capacity: 80 kW

M. Shakya

Operated since: 2041/2 (1984 May) Field Visit: 12 August 1986

No. of Consumers: 223 (Domestic), 7 (Industrial)

The powerhouse is located at 4 km North of Syangja near the confluence of Seti river. It caters power to three communities Seti Dovan (confluence), Naudanda - 2 km from the powerhouse and Syangja - 4 km further downstream. The installed capacity of 80 kw falls far below the present power demand which is well above 200 kw. Consequently, load shedding is being practiced in the supply area.

The powerhouse comprises two 40 kw units manufactured by B.Y.S. The hydraulic governors used in the plant have poor sensitivity; this is common in similar governors at Gorkhe and Dhading Small Hydropower sites. When both the machines are run there is a problem with synchronization of the units, thus resulting in tripping of the output system. It seems the machine foundation is not properly designed as the whole base frame (including the turbine) vibrates while running at peak load. The V belt drives between the turbine and generator have expanded into different lengths. This has created a problem in synchronising power transmission with the two machines.

As a long-term solution to the power demand in this area a 33 kV transmission line either from Pokhara (about 15 km) or from Andhi Khola Power Project in the south is necessary. At present there are a couple of small industries running with their own diesel power units.

MICRO HYDRO EQUIPMENT MANUFACTURERS

S.NO.	NAME	ADDRESS		MANUFACTURE TURBINE & HYDRAULIC GOVERNER	SUPPLY GENERATOR	SITE INSTALL.
1	BALAJU YANTRA SHALA	BALAJU IND. STATE	KATHMANDU	*	*	*
2	KATHMANDU METAL WORKS	CHETRAPATI	KATHMANDU	*	*	*
3	NEPAL YANTRASHALA	PATAN IND. STATE	LALITPUR	*	*	*
4	NATIONAL STRUCTURE & ENGINEERING	PATAN IND. STATE	LALITPUR	*	*	*
5	BUTWAL ENGINEERING WORKS	BUTWAL IND. STATE	BUTWAL	*	*	*
6	NEPAL HYDRO & ELECTRIC LTD.	P.O.B. 1	BUTWAL	*		*
7	THAPA ENGINEERING INDUSTRIES		BUTWAL	*		*
8	TECHNICA ENGINEERING	BUTWAL IND. STATE	BUTWAL	*	*	*
9	AGRICULTURAL ENGINEERING		BUTWAL	*		*

c). Batchelors quarters - 4 per service station.

bedroom	1no x 13w x 5 hours/night		5.5 AH
kitchen	1 x 8w x 3	"	2.25
toilet	1 x 8w x ½	"	0.38

average daily load demand per quarter 8.2 AH
1 no. 13 watt light per quarter
2 no. 8 watt lights "

Total number of lights per service station:

10 number 13 watt lights
24 number 8 watt lights

2. Computer in the main office in Dipayal:

computer	6 hours/day	48 AH
printer	2 "	3
inverter	6 "	18

average daily load demand 69 AH

System Sizing

There is no site specific radiation data available for the project area. To account for this, the lowest recorded figure in the Kingdom is used which is a monthly average of 3.5 kWh/m2/day. The panel output is then derated to 90% of specified output and the batteries are generously sized to account for both the inadequate data and for a 3-5 day autonomy period i.e. no sun at all for 3-5 days.

a). Divisional Engineers house:

average daily load demand	28.3 AH
solar panels	3 no. M75 ARCO
battery	1 no. 100AH Absolyte
charge controller	1 no.

b). Guest house:

as per Divisional Engineers house.

It is presumed that the guest house will have maximum usage in the months when the apparent radiation is at it's lowest and hence the reasoning behind the similar installation as in a).

c). Batchelor quarters:

average daily load demand	8.2 AH
solar panels	1 no. M75 ARCO
battery	1 no. 100AH Absolyte
charge controller	1 no.

d). Computer:

average daily load demand	70 AH
solar panels	6 no. M75 ARCO
battery	3 no. 100AH Absolyte
inverter	1 no.
charge controllers	1 no.
mains battery charger	1 no.

System Components.

Wherever possible the system components are the same. Note that all the panels are the M75 model and that the batteries are the same Absolyte type even for the computer power supply; the charge controllers are of one type except for the computer system which controls a greater load. Please find attached the technical specifications for the solar panels and the batteries together with the warranties. The charge controllers, of proven local design and manufacture, will avoid both deep discharge and overcharge of the batteries, ensuring long life. As they are the only part of the system which can be repaired, the importance of local manufacture cannot be overstressed. The controllers are an important safeguard against abuse of the system - if the lights are constantly on and the lights drawing far more power than is being supplied by the panels then the system shuts down until the battery has an adequate charge. The battery is designed for deep discharge but it is of course preferable that this does not happen.

System Maintenance.

The system is essentially maintenance free.

The solar panels require cleaning with a damp cloth once a week; if there is a lot of seasonal dust in the air more frequent cleaning will give better performance.

The batteries are sealed and require absolutely no maintenance.

Normal wear and tear of the lights and wiring is to be expected and is the reason why training and installation of and by area staff members is essential in the long term.

System Installation.

The divisional engineers house, guest house, each of the batchelors quarters and the computer are all entirely separate systems. Each system has the panel(s) mounted either on the roof of that particular building or on a support structure (of local manufacture) as close as possible to that building to avoid wiring losses. The power out lead runs to the charge controller, wall mounted, and then to the battery which is housed in a padlocked box (to avoid tampering). The keys to the battery box are held by the person responsible for maintenance who will make periodic checks of the installations.
The wiring is standard except that the circuits are d.c. rather than a.c.
The lights are of the high efficient flourescent type.

System Costs.

The costs given below are the costs pertaining to date and are for evaluation.

a). Typical service centre equipment costs:

	US Dollars	NRs.
10 no. ARCO M75 solar modules	2880	
6 no. Absolyte 5000 batteries	864	
10 no. 13 watt lights, complete	200	
24 no. 8 watt lights, complete	500	
6 no. Charge controllers		12,600
6 no. support strucures		12,000
6 no. complete wiring circuits		6,800
Freight and insurance to Kathmandu	1100 (estimate)	
Freight to Dipayal		10,000 (estimate)
Equipment totals landed Dipayal	5544	41,400
or total cost of US dollars	7434.	

Note that these figures assume duty free status and that clearing of the items through the customs will be the responsibility of the project.

b). Computer power:

6 no. ARCO M75 solar modules	1728	
3 no. Absolyte	360	
1 no. Inverter		4,000
1 no. charge controllers		4,500
1 no. support structure		3,000
1 no. wiring circuit		1,500
1 no. mains charger		2,000
Freight and insurance to Kathmandu	550 (estimate)	
Freight and insurance to Dipayal		7,500
Equipment totals landed Dipayal	2638 USD	22,500
or total cost of US dollars	3665 USD.	

c). Installation and training at the Dipayal site:

Note that for this to be effective the project will nominate a minimum of 3 persons of a suitable category but with some qualification or proven ability in electrical wiring.
The installation and training is expected to last one week which coincides with the weekly flight schedule. The 100% contingencies in this section are to safeguard the installers against loss of time in the event of plane cancellation or overbookings. It would be appreciated if every consideration be given to the team in terms of possible transport difficulties.

Costs:	NRs
Installation team of electronics engineer, electrician and civil engineer for 7 days	16,800
3 return flights to Dipayal	3,900
3 subsistence for 1 week	4,200
Hire of local labour and materials	2,000
100% contingency on time of the team members	16,800
Total	43,700

Note that in the event of there being no problems with the flights and that the project provides the team with board and lodging the total for the installation and training is:

23,000 NRs

Project Cost Summary:

All figures are in US dollars at an exchange rate of 1 USD = 21.90 NRs

a). Equipment costs for the lighting and computer power system at Dipayal	11,100
b). Installation and training on the Dipayal system:	1,050
c). Equipment costs for a further 5 sites at 7500/site	37,500
Project implementation cost total:	49,650 USD

Economic comparison and justification

The power output of the solar module is warranted for 10 years with an expected life span of 20 years. The battery is warranted for 5 years. For a valid economic comparison it is justified to take the life cycle system costs over a 10 year period with no module replacement and with one replacement battery

The solar system provides a flexibility which cannot be met by a generator in terms of lighting; it is a fair assumption to cost the generator system against what the solar can provide - that is lighting for up to 5 hours per night. The other great advantage is the modularity of the solar system; that is if more hours of lighting are required an extra solar module is hooked into the system.

In the solar option there are 6 completely separate systems for each service centre. A malfunction in one of the systems does not in any way affect the other systems and abuse of any of the sytems is penalised simply by no light. In the generator system, however, a malfunction or fuel shortage means that the whole system is down and there is no light in that service station. This simplicity and convenience cannot be quantified but should be borne in mind for the wellbeing of staff who are perhaps used to the greater facilities of the capital.

In the comparison, the cost of wiring and installation is ignored as this would be approximately the same for both systems. Wear and tear of wiring and lights is also ignored for the same reason.

For the generator system the minimum size is taken as that which would light the 34 lights (the number of lights in the solar system per service centre) with a minimum of a 60 watt bulb; it is a fair assumption that all the lights would be on. Hence the comparison is made against the HONDA 3600 kerosene generator (rated output of 2800 VA) which would be working at near maximum loading. The generator is expected to last for 5 years before replacement is necessary (about 10,000 hours).

Fuel porterage charges are not included in the analysis as this would vary from centre to centre; however this could add up to some 20% of the fuel costs and should be evaluated by the project. The cost of kerosene is hence assumed as that of Dipayal.

The holding of spares and trained maintenance engineer for all the service stations is not included but a generator shed and an operators salary are included.

Generator costs:

HONDA 3600 kerosene generator c.i.f. Calcutta	20,900
transport to Dipayal	1,500
Generator shed	10,000
Capital costs	32,400 NRs
or USD 1480	

Annual running costs:

a). fuel - 2 litres/hour kerosene at 10 NRs/litre	
0.15 lt /hour petrol at 14 NRs/litre	
5 hours/night, 365days/year, the annual fuel cost	40,332
b). operators salary	8,400
Annual costs	48,732 NRs
or USD 2225	

Present Worth analysis:

A discount factor of 10% is used.
The capital cost of the generator system is USD 1480 with a replacement cost of USD 1000 in 5 years time. The annual running costs of USD 2225 are taken for the smallest unit that would be appropriate. Note that this does not include wiring, installation, portering of the fuel, oil and oil filters, holding of spares or the services of a trained mechanic.
The capital cost of the solar system is USD 7434 (including freight estimate) which accounts for everything except for installation. The battery replacement cost of USD 1650 (freight of USD 800) is taken at year 5.

	Generator system	Solar system
Year 1	1480 + 2023 (3503)	7434 (7434)
2	1839 (5342)	- (7434)
3	1672 (7014)	- (7434)
4	1520 (8534)	- (7434)
5	621 + 1381 (10536)	1024 (8458)
6	1256 (11792)	- (8458)
7	1142 (12934)	- (8458)
8	1038 (13972)	- (8458)
9	944 (14916)	- (8458)
10	858 (15774)	- (8458)
Total:	15774 USD	8458 USD

Comment on the analysis:

1. The solar system pays for itself, with battery replacement included in the 5th year, by the end of the 4th year. The generator needs replacing at the end of the 5th year by which time the solar system has completely new batteries and paid for itself and the project is saving on both generator replacement costs and the annual o and m costs.
2. If the battery life is taken as only 3 years then the payback period is in the 5th year, before the generator needs replacing.
3. Fuel costs are those of today and no guesses are made on the price of fuel in the future.
4. Similar evaluation with a diesel powered generator with a fuel cost per litre of 10 NRs works out at about the same; the capital cost for this size diesel is somewhat higher than for the kerosene model but the running costs are less. However the uncertainty of diesel fuel supply in Dipayal has precluded inclusion in this evaluation.
5. It is interesting to note that it is the annual costs of the generator system that make these generator systems so expensive if the long term analysis is taken.

James Goodman
Kathmandu

12 August 1987

RADIO EDUCATION TEACHER TRAINING

THE COST CASE FOR A SOLAR POWERED RADIO

INTRODUCTION

The merits of the radio medium in disseminating both information and training programmes are enormous, and there is now widespread attention focused on using this medium in national development. The infrastructure is essentially in place with national radio services well established, programme development underway and an eager audience willing to participate. The success of these projects depends to a large extent on the radio receiver, its power supply, and the cost to the user of that power. In situations where all these costs are borne by the project then these costs are internalized and evaluated on a cost-effective basis. However, a more usual situation is for the project to provide the receivers at a resonably subsidised price to the participants and then for the latter to be responsible for providing the power. If the proramme is community orientated then this cost can easily be borne but if it is personally orientated e.g. teacher training, then will the users be willing to bear this operating cost for a programme which may make them better teachers but will not necessarily increase their salaries ?

One of the goals for basic minimum needs by the year 2000 is the attainment of universal primary education and literacy (UPEL). The backlog of untrained present teachers is estimated to be at least 30,000. Current targets call for the training of some 2,700 each year; an ambitious goal considering the shortage of infrastructure and training institutes.

The advantage of radio education programmes is that the infrastructure, apart from the individual receivers, is already in place.

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This brief looks at the cost comparison of a solar powered receiver, which has been specifically developed for these national development projects, and an ordinary dry cell radio which has been used in a teacher training project in Nepal.

RADIO SPECIFICATION SUMMARY

	Philips Commander	Noack Solar
1. Output power	700mW rms 1400mW peak	700mW rms 1800mW peak
2. Power Supply	6V dc 4 no R20(D cells)	12V dc 1 no 1.2AH sealed lead acid battery with automatic disconnect at 20% rest capacity. Solar charged.
3. Battery drain	74mA for 50mW output	60mA for 50mV output (16 hours) 90mA for 700mV (10 hours) c 200mA for peak output (4-6 hours)
4. Recharge time	none - new batteries required	1-1½ sun days
5. Warranty	1 year	3 years

NOTES ON THE ANALYSIS

1. All consumer type batteries of the R20 or D cell type are rated at a capacity of 1.1 - 1.2AH. This figure, in ampere-hours, gives the current drain multiplied by the number of hours which the cell can sustain that current drain.

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6. In the strict sense, the figures for a) and b) are the financial costs of the user in buying the radio and providing power for 6 years. The figures for the solar radio, however, are the economic costs of providing a unit. The payback mechanisms are discussed later.

3. Sensitivity :

a) The above analysis is based on a battery life of 3 weeks and it shows that the present worth annual costs are :

Philips radio and minimum battery price ....440 NRs/year
" " " maximum " " ....797 NRs/year
Solar radio ....301 NRs/year

b) The sensitivity is of course battery life dependent and using the most favourable battery price, that of Kathmandu, this is calculated for a life span of 2 and 4 weeks.

2 weeks life at NRs.7/cell, present worth annual costs.....616 NRs/year
4 " " " " " " " " ......352 NRs/year

This shows,that even with a 4 week life span at the minimum battery price, it is cheaper for the user to have a solar radio.

At the maximum battery price and a 4 week battery life, the present worth annual cost is : NRs.621/year.

c) If only the warranty period (3 years) of the solar unit is considered then the figures are (with reference to the PW table) :

Philips radio with minimum battery price.............578 NRs/year
" " " maximum " " ....989 NRs/year
Solar radio ....525 NRs/year

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With a life span of 6 years and a 3 week battery life, the present worth total financial cost to the user is :

at the minimum battery price	NRs. 2,640.-
at the maximum battery price	NRs. 4,782.-

Note that even at the most favourable battery price the user is paying NRs.485/year or NRs.40/month for batteries alone.

If we consider an initial investment of 5000 units, which is not unreasonable with goals of training 2700 teachers a year and with 30,000 untrained teachers, then the cost of providing those unit at $3.15/unit is $15,750. Although the cost to the agency is not great, the financial cost to the user is substantial.

b) Solar Radio at a monthly charge of NRs.25 :

Over a 6 year life span, including replacement battery in the third year, the PW annualised costs are NRs.301/year or NRs.25/month. A discount factor of 10% is used which should allow for inflation; however, salaries do not rise at 10% p.a. and a realistic approach is to sustain that present worth monthly figure over the full period of the radio life i.e. if user pays NRS.25/month in the first year he should also pay it in the sixth year . The shortfall in returns will be considered as a subsidy. However, any salary increases in the 6 year period could be accompanied by an equivalent percentage rise in the monthly charge.

Consider the present worth values of the returns of a constant NRs.25/month over a 6 year period.

Year 1	273
Year 2	248
Year 3	225
Year 4	205
Year 5	186
Year 6	169
Total :	1,306

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PW total cost over 6 years..........................1,806

PW of returns of a constant NRs.25/month over 6 years 1,306

Effective subsidy/unit ....500 NRs.

Hence costs for an investment in 5000 units are :

PW cost for 5000 solar radios $362,500

PW cost for 5000 replacement batteries in third year ....$ 51,184

PW implementation cost $413,684

PW of returns of constant NRs.25/month............$299,528

Total cost of providing 5000 radios..............$114,155

<u>OR</u> $27.40 per unit

If the donor agency purchased the units then either :

a) they receive NRs.25/unit/month and their total implementing costs are $114,155, or

b) the agency paid the total implementation costs as a direct grant and the HMG radio education project is credited (by docking salaries at source) with $299,528 over 6 years to develop proramnes, material and administer a truly national education project with a network of 5000 receivers established. This substantial sum also allows the possibility of establishing a revolving fund; the surplus over programme development is used to purchase more radios to capture a wider audience.

c) The users pay NRs.500 on receipt of the radio as they now do with the Philips radio. Then in a) the implementing costs are zero and in b) HMG would gain the whole grant for programme development.

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SENSITIVITY OF THE MONTHLY CHARGE

It is shown earlier that, with the Philips radio and the cheapest battery price, the user is now paying NRs.40/month. If that monthly figure is taken as the charge then an effective surplus of NRs.285/unit would result over the 6 year period or $65,000 PW value for 5000 units. Although the figure of NRs.40/month may seem high consider that, for those users who are paying up to NRs.14/battery, their monthly battery costs are up to NRs.76, almost double.

It is worth noting that, if there is some concern about the assumption of a 6 year life span of the unit (with one replacement battery allowed for in the third year), then at this monthly charge of NRs.40 the solar unit would be paid for, at present worth values, in just under 4 years. Over a 6 year life span, a monthly charge of NRs.34 would cover the costs of the solar unit at present worth values (this figure is what the user would pay monthly for batteries if his/her batteries lasted 3½ weeks AND were available at the cheapest price). This is of interest if the donor or funding agency is not in a position to make a grant but is willing to make the foreign exchange available.

SUMMARY

The analysis clearly shows that adopting solar radios for a national radio education programme is more cost-effective than the dry cell powered radio. In all cases the financial cost to the user is cheaper and in some situations barely a third of the monthly cost. The section on radio usage show s that with the Philips radio, or any dry cell radio, there is very little room for expansion of the daily broadcasting of education programmes without increasing the financial burden to the user. The expansion of radio education to direct class broadcasting would be prohibitively expensive purely from an energy outlook . The most interesting point is that the users themselves, apart from enjoying a greatly extended listing time, would be paying for the

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development of more and better eduaction programmes at a cost to themselves of less than half what they would be paying on batteries. If a direct grant was made to HMG the project material development would be self financing over the 6 year period with a substantial network in place and the power capacity to expand. This option is surely cheaper than the establishment of teacher training courses and also keeps the education system carefully controlled and monitored.