ELECTRICITY SUPPLY AND PROSPECTS FOR FUTURE EXPANSION

Electricity Supply Situation

The first power plant was installed in Bhutan in the early sixties with the commissioning of a 360 kW power station in Thimpu. With the rapid growth of Thimpu, this plant was not able to meet the demand after a few years, and a 1,250 kW hydropower station was constructed at Gidakom in 1973. Even this addition could not keep up with the demand in Thimpu and the surrounding rural areas.

A series of diesel generators were installed from 1977 onwards with a total capacity of 3,755 kW. A 66 kV line supplements the energy requirement via Chukha Hydel Project from the Indian grid. The supply of power in Thimpu is now much more reliable after the commissioning of the first two units of the Chukha Hydel Project (336 MW). A 30 kW micro-hydropower station has been recently commissioned under the Japanese grant aid.

A few photovoltaic units have been installed by the Department of Power to tap solar energy for lighting. Some such units have also been installed by the Swiss Aid Agency, Helvetas. A few experimental water heating systems have been installed for the monasteries around Thimpu.

Thimpu District is presently supplied by a network of 84.6 km of LT line and 77 km of 11 kV line. A 66 kV line feeds the system and a 220 kV line is under construction. Twenty one villages and one town of the district have so far been electrified. The per capita consumption of electricity in Thimpu is 136.6 units compared to only 45.8 for Bhutan as a whole. Tables 1 and 2 show data on electricity use in Thimpu and Bhutan respectively from 1980/81 to 1986/87.

Table 1 : Electricity Supply in Thimpu District, 1980/81 to 1986/87

Particulars	80/81	81/82	82/83	83/84	84/85	85/86	86/87
Installed Capacity (in MW)							
a) Hydro	1.610	1.610	1.610	1.610	1.610	1.610	1.610
b) Diesel	1.296	1.296	1.805	3.155	3.155	3.755	3.755
Total:	2.906	2.906	3.415	4.765	4.765	5.365	5.365
Energy Generated (in MU)							
a) Hydro							
i) Gidakom	4.057	5.003	5.140	4.866	4.341	4.136	2.420
ii) Thimpu	1.047	0.773	0.714	0.839	0.868	0.780	0.731
b) Diesel	0.900	0.960	1.096	1.649	2.532	3.206	1.295
Total:	6.004	6.816	6.950	7.354	7.741	8.122	4.446
Percentage growth over previous year	14.6	13.5	2.0	5.8	5.3	4.9	-45.3
Auxiliary consumption (MU)	0.150	0.170	0.174	0.176	0.148	0.141	0.130
Export (if any in MU)	0.000	0.000	0.094	0.096	0.028	0.751	0.809
Import - do -	0.000	0.000	1.090	1.355	1.013	2.995	9.440
Energy Requirement (MU)	5.854	6.646	7.772	8.437	8.578	10.225	12.947
Percentage growth over previous year	14.6	12.5	16.9	8.6	1.7	19.2	26.6
Energy sales (in MU)	4.059	4.287	4.550	5.348	5.768	7.838	8.079
Percentage growth over previous year	6.3	4.4	7.4	17.5	7.9	35.9	3.1
Energy Loss (in MU)	4.795	2.409	3.222	3.089	2.810	2.387	4.868
Loss in % of E. Requirement	30.663	36.247	41.457	36.613	32.758	23.345	37.599
Load factor (in %)	40.998	41.010	44.922	36.747	33.883	23.387	26.630
Peak load (in MW)	1.630	1.850	1.975	2.621	2.890	4.991	5.550
Length of H.T. Lines (km)	-	63.500	75.500	76.800	76.800	77.300	77.300
Length of L.T. Lines (km)	-	70.000	70.500	80.600	80.600	84.600	84.600
No. of consumers	-	2100	3116	3132	3325	3596	3902
Connected load (in MU)	-	-	8.906	9.070	9.773	11.837	14.565
No. of villages electrified	-18	18	18	18	21	21	
No. of towns electrified	-	1	1	1	1	1	1

Source: Department of Power, RGB.

Note: MU denotes million units of electricity consumption where 1 unit = 1kWh.

Table 2: Electricity Supply in Bhutan, 1980/81 to 1986/87

Particulars	80/81	81/82	82/83	83/84	84/85	85/86	86/87
Installed Capacity (in MW)							
a) Hydro	3.450	3.450	3.450	3.450	3.450	3.460	3.46
b) Diesel	2.328	2.972	3.052	4.442	4.442	5.442	5.44
Total:	5.778	6.422	6.502	7.892	7.892	8.902	8.90
Energy Generated (in MW)							
a) Hydro	7.314	7.577	8.283	7.946	7.864	6.940	5.45
b) Diesel	1.529	1.573	1.587	2.326	3.152	3.708	1.54
Total:	8.843	9.150	9.870	10.272	10.516	10.648	6.99
Percentage gorwth over previous year	-	3.5	7.9	4.1	2.4	1.3	-34.3
Auxiliary consumption (MU)	0.245	0.267	0.318	0.350	0.286	0.253	0.24
Export (if any in MU)**	0.000	0.000	0.000	0.000	0.280	0.751	0.80
Import - do -	2.464	3.196	4.510	4.890	5.151	8.137	17.50
Energy Requirement (MU)	11.062	12.079	14.062	14.812	15.101	17.781	24.25
Percentage growth over previous year	-	9.2	16.4	5.3	2.0	17.7	36.4
Energy sales (in MU)	7.900	8.471	9.389	10.750	12.218	14.630	17.20
Percentage growth over previous year	-	7.228	10.837	14.496	13.656	19.741	17.62
Energy Loss (in MU)	3.162	3.608	4.673	4.062	2.883	3.151	7.04
Loss in % of E. Requirement	28.584	29.870	33.231	27.424	19.091	17.721	29.05
Load factor (in %)	34.721	33.689	35.180	31.658	26.644	24.820	30.54
Peak load (in MW)	3.637	4.093	4.563	5.341	6.470	8.178	9.06
Percentage growth over previous year	-	12.5	11.5	17.1	21.1	26.4	10.9
Length of H.T. Lines (km)	-	282.8	285.78	288.4	291.6	303.0	353.9
Length of L.T. Lines (km)	-	297.6	318.0	342.7	342.2	347.7	349.1
No. of consumers	-	6482	8695	9262	9751	10583	11360
Connected load (in MW)	-		23.806	27.887	29.382	31.795	37.12
No. of villages electrified	-	87	92	93	95	98	98
No. of towns electrified	-	14	15	16	16	17	17

Source: Department of Power, RGB.

Electricity Supply Trend

The demand for electricity in Thimpu is not constant but varies tremendously at different times of the day. To meet the peak requirements for power, the Department of Power has installed oversized machines.

The demand for electricity is constantly on the rise with the use of power for space heating, cooking, water heating, and industrialisation in addition to the traditional use of electricity for domestic lighting. While urban areas in the district have economic activities which can both use and pay for electricity, a few electrified rural areas use electrical energy only as a substitute for kerosene for lighting.

Table 3 shows sectoral demand for electricity and growth rates for the district. After the construction of a 66 kV line and the commissioning of a sub-station, electricity will be supplied to additional rural areas.

For the efficient use of the power supply from Chukha Hydel Project, existing sub-stations around Thimpu are being upgraded. At the same time, the overhead lines in Thimpu are being laid underground. When the upgrading of existing sub-stations is completed, the older hydropower stations can be overhauled. Since plenty of power supply is now available from Chukha, there are no plans for future construction of hydropower stations in Thimpu Valley.

Table 3 : Volume and Growth Rate of Electricity Sales by Sector in Thimpu District, 1986

Sector	Average % Growth Rate Per Annum in Electricity Sales to Sector	Proportionate Share of the Sector	Units Sold to Sector in 1986 (MU)
Domestic	8.18	0.31	2.5
Commerce and Government	28.48	0.39	3.14
Industries	11.23	0.05	0.404
Bulk	6.33	0.24	1.97
Public Lighting	32.45	0.01	0.065

Source: Department of Power, RGB.

Constraints to Grid Extension

There are two major constraints to grid extension in Thimpu. First, the network of motorable roads is limited in Thimpu District and most blocks can only be reached by trails and mule tracks. The transportation of the materials required for grid extension is very costly and tedious. Second, the villages

and households are scattered and this limits grid extension because of high transmission costs and low load factors. In 1986/87 line losses were estimated to be 37.6 per cent. With the increase in line length, line losses would further increase. Outdated transmission and distribution lines add to line losses.

Alternatives to Grid Extension

There are several possibilities that could be considered as alternatives to grid extension for electricity supply. Important alternatives in Thimpu are as outlined in the following passages.

Types

Micro-hydels. Like the rest of the country, Thimpu District is also endowed with plenty of natural streams which have huge hydropower potentials. Micro-hydels are ideal for rural electrification as they can be set up in user localities reducing transmission costs. Also, they can cater to small-scale industries.

However, micro-hydels have some inherent problems associated with their installation and maintenance. Most areas with potential for micro-hydels are not accessible by vehicle, thus making the transportation of equipment difficult. Micro-hydels installed with Japanese aid involve a relatively high level of technology. Spare parts for these cannot be manufactured indigenously, thus making their maintenance very difficult.

Solar Photovoltaics. An experimental photovoltaic system for lighting has been installed in one location recently. Although the plan was to expand the use of solar energy on a larger scale for lighting and heating, the cost factor has so far deterred the implementation of this plan. At 1985 prices, Helvetas was paying Nu. 221,000 per kWP of solar electricity generation. However, the cost of solar panels has been continuously declining with the rapid advances made in technology. At current prices, it would cost about Nu. 130,000 per kWP generation.

Experimental photovoltaic systems installed across the country show that the solar energy intensity is sufficient to charge batteries capable of meeting the domestic lighting requirements. A large-scale solar power unit needs a huge amount of capital investment and occupies plenty of space.

Although an individual unit solar photovoltaic system for a single household (assumed to use 4 outlets of 20 W each) costs only Nu. 10,000, in terms of energy costs per kW these systems are the most expensive. More specifically, the cost/kW for photovoltaics, grid extension, and micro-hydel are Nu. 130,000, Nu. 50,000, and Nu. 7,000 respectively.

Biogas Plants. Almost all households in Thimpu District own some animals. Although no quantitative data are available, most households have enough animal waste which can be converted into cooking fuel to meet the demand for cooking or into electricity for lighting. But most biogas plants available in the market are designed for areas that lie in the subtropical zone. In Thimpu District only two blocks have temperatures suitable for methane gas production as the production of this gas decreases drastically below 10 degrees celsius.

Diesel Generating Sets. Diesel sets were originally used in Thimpu District to supplement power supply but are now used as back-up units in cases of power failure in Chukha Hydel Project. Diesel generating sets are highly unsuitable for rural electrification. Although installation works are easily accomplished, the costs of operating and maintaining these sets are invariably very high. Transportation difficulties add to these costs.

Prospects for the Expansion of Electricity Supply

The extension of the electricity supply system in Thimpu faces different problems and constraints in two different ecological environments. As soon as the new 66 kV line is completed, the grid system along the Thimpu Valley can be extended to both sides of the valley to cover wider areas of the temperate and subtropical blocks.

Four blocks in the alpine zone are not designated to revive grid supply as these blocks neither have the population concentration nor do they have a sizeable energy demand to justify grid extension. However, electricity can be used in this area both in the domestic sector for cooking, heating, and lighting and in the industrial sector for yak wool weaving. Moreover, the pressure from increasing human and yak populations on the fragile environment further justifies an alternative source of electricity supply.

Micro hydels can meet all the domestic energy needs while the solar photovoltaic system is suitable for lighting and limited weaving applications. However, the cost and technical feasibility of the solar photovoltaic system are well known but the technical feasibility of micro hydels is not known. In view of the current plans of the Department of Power to install photovoltaic systems in the service centres in the first part of the Sixth Five Year Plan, the feasibility of micro hydels for the electrification of the alpine blocks should be explored.