

RRP:BHU 27260

ASIAN DEVELOPMENT BANK

REPORT AND RECOMMENDATION
OF THE
PRESIDENT
TO THE
BOARD OF DIRECTORS
ON A
PROPOSED LOAN AND TECHNICAL ASSISTANCE GRANT
TO THE
KINGDOM OF BHUTAN
FOR THE
RURAL ELECTRIFICATION PROJECT

August 1995

CURRENCY EQUIVALENTS

as of 31 July 1995

Currency Unit	-	Ngultrum (Nu)
Nu1.00	-	\$0.032
\$1.00	-	Nu31

For the purpose of calculations in this Report, an exchange rate of \$1.00 = Nu31 has been used.

ABBREVIATIONS

ASEB	-	Assam State Electricity Board
BCCL	-	Bhutan Calcium and Carbide Ltd.
CHPC	-	Chhuka Hydro Power Corporation
DOP	-	Division of Power
EIA	-	Environmental Impact Assessment
EIRR	-	Economic Internal Rate of Return
ESU	-	Electric Supply Unit
ESSU	-	Electric Supply Subunit
FIRR	-	Financial Internal Rate of Return
GDP	-	Gross Domestic Product
ICB	-	International Competitive Bidding
IMF	-	International Monetary Fund
LPG	-	Liquified Petroleum Gas
LRMC	-	Long-Run Marginal Cost
MTI	-	Ministry of Trade and Industry
MOF	-	Ministry of Finance
O & M	-	Operation and Maintenance
PIU	-	Project Implementation Unit
PSMP	-	Power System Master Plan
SEB	-	State Electricity Board
SIEE	-	Summary Initial Environmental Examination
WBSEB	-	West Bengal State Electricity Board

WEIGHTS AND MEASURES

V	(volt)	Unit of electrical voltage
kV	(kilovolt)	1,000 V
kVA	(kilovolt-ampere)	1,000 VA
Wh	(watt-hour)	Unit of energy
kWh	(kilowatt-hour)	1,000 Wh
MWh	(megawatt-hour)	1,000,000 Wh
GWh	(gigawatt-hour)	1,000,000 kWh
W	(watt)	Unit of active power
kW	(kilowatt)	1,000 W
MW	(megawatt)	1,000,000 W

NOTES

- (i) The Fiscal Year (FY) of the Government and its agencies ends on 30 June. In this Report, "FY" before a calendar year denotes the year in which the fiscal year ends, e.g. FY1994 ends on 30 June 1994.
- (ii) In this Report, "\$" refers to the US dollar.

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BHUTAN
RURAL ELECTRIFICATION PROJECT
LOAN AND PROJECT SUMMARY

Borrower	:	Kingdom of Bhutan
Project Description	:	The Project will provide electricity to seven districts in Bhutan and serve about 3,100 consumers.
Classification	:	The primary objective is economic growth. The secondary objective is poverty reduction by providing electricity to poor households, enabling them to increase their cash incomes. The Project is classified in environmental category "B", a limited environmental impact.
Rationale	:	Although Bhutan has substantial sources of clean, renewable hydropower energy, the distribution of this form of energy throughout the country is very limited, and the electrification ratio is accordingly low. This increases the pressure on deforestation as fuelwood accounts for more than three-quarters of the country's energy consumption. The proposed Project will improve access to electricity by electrifying rural areas in seven districts that are not served at present. Through its involvement in Bhutan's power sector, the Bank will be able to assist the Government in restructuring and commercializing the sector.
Objectives and Scope	:	The proposed Project will provide indigenously generated hydropower to the domestic market in Bhutan to promote economic development, reduce the use of fuelwood for cooking and heating, and save foreign exchange by reducing expenditure on imported kerosene. The Project will extend the 33 kilovolt (kV) and 11 kV distribution systems from the nearest power source to transformers located in the designated villages in seven districts and will establish the associated low-voltage networks and consumer service connections within the villages. The Project will supply electricity to about 3,100 new customers, and provide tools, plant, vehicles and regional maintenance centers to assist in operation and maintenance of the distribution facilities.
Cost Estimates	:	The Project is estimated to cost \$9.5 million of which \$7.3 million (77 percent) is the foreign exchange cost and \$2.2 million (23 percent) is the local currency cost.

Financing Plan

(\$ million)

Source	Foreign Cost	Local Cost	Total Cost	Total (%)
Bank Loan	7.3	0.2	7.5	78.9
Government	-	2.0	2.0	21.1
Total	7.3	2.2	9.5	100.0

Loan Amount and Terms

The equivalent in various currencies of Special Drawing Rights 4.809 million (\$7.5 million equivalent) from the Bank's Special Fund resources, with an amortization period of 40 years including a grace period of 10 years and with a service charge of 1 percent per annum.

Period of Utilization

Until 31 December 1998.

Implementation Arrangements

All rural electrification construction and erection of distribution lines will be carried out by the Division of Power (DOP) of the Borrower, supplemented by local contract laborers. Given the current manpower resources of DOP and that DOP has already completed more than 30 rural electrification schemes, the Project can be satisfactorily implemented with limited assistance from international consultants for procurement (because this is the first Bank loan for the power sector in Bhutan) and for design of 66/33 kV interconnections. Because DOP has limited material resources, particularly distribution materials and operational support facilities, the proposed Project includes the necessary funds for tools and other materials required for operation and maintenance.

Executing Agency

Division of Power (DOP) under the Ministry of Trade and Industry (MTI).

Procurement

Procurement for the proposed Project will be undertaken using international competitive bidding (ICB) and international shopping (IS) procedures, in accordance with the Bank's *Guidelines for Procurement*.

Consulting Services

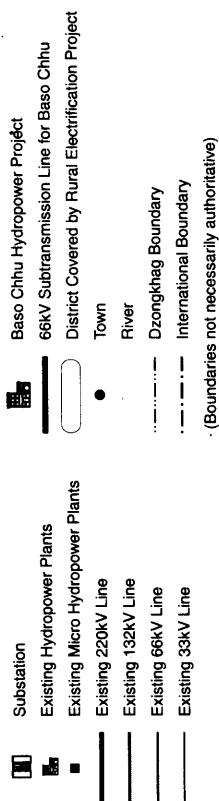
A total of 12 person-months of international consulting services will be required for Project implementation to assist with the design and implementation of 66/33 kV interconnections, and with Bank-financed procurement. Consultants will be selected in accordance with the Bank's *Guidelines on the Use of Consultants*.

Estimated Project Completion Date : 30 June 1998.

Project Benefits and Beneficiaries : The Project will provide reliable electricity supply to about 3,100 new consumers in seven districts in Bhutan, thus reducing the use of fuelwood. The financial internal rate of return (FIRR) is estimated at 1.1 percent, and the economic internal rate of return (EIRR) at 11.9 percent.

Technical Assistance : A technical assistance grant of \$400,000 is processed in conjunction with the Project to provide consulting services for the introduction of a public utility accounting system in DOP and the establishment of an appropriate tariff structure to ensure the financial viability of DOP.

BHUTAN



I. THE PROPOSAL

I submit for your approval the following Report and Recommendation on a proposed loan to the Kingdom of Bhutan for the Rural Electrification Project. The Report also describes proposed technical assistance for the Institutional and Financial Development of the Division of Power, and if the proposed loan is approved by the Board, I, acting under the authority delegated to me by the Bank, shall approve the technical assistance.

II. INTRODUCTION

1. On 29 December 1993, the Bank approved a technical assistance (TA) for the Power System Development in Bhutan.¹ The final feasibility report prepared under the TA was submitted in December 1994. On the basis of that report and discussions with the Bank, the Royal Government of Bhutan requested assistance from the Bank to finance the entire foreign exchange cost and part of the local currency cost of a rural electrification project covering seven districts in the country.

2. Fact-finding for the Project was undertaken in March 1995, followed by appraisal in May 1995.² This Report is based on the feasibility report and the findings of the Bank Missions.

3. The proposed loan will be the first from a multilateral financing institution for the power sector in Bhutan. The Bank has used this opportunity to play a pioneering role in restructuring the sector by changing the role of the Government from being the main operator in the sector to being the regulator of the sector.

III. BACKGROUND

A. The Economy

4. The economy of Bhutan has strong economic linkages with India. Because Bhutan's currency, the ngultrum, is pegged to the Indian rupee at par, local prices generally reflect the inflationary movements in India. In 1993, 87 percent of Bhutanese exports went to India, while 77 percent of imports came from India.³ The Government of India is the largest bilateral donor to Bhutan.

¹ TA No. 2043-BHU for \$245,000, executed by Worley International of New Zealand.

² The Appraisal Mission comprised of R.J. Kay, Mission Leader and Senior Financial Analyst; E. Haugh, Sr. Programs Officer; H. Nakajima, Project Engineer; S. Nanwani, Counsel; and S. Jarvenpaa, Young Professional/Project Economist.

³ International Monetary Fund (IMF) estimates for 1993/94 from Bhutan - Recent Economic Developments, of 27 September 1994.

5. Structural changes in the 1980s, particularly the development of hydropower for export and the expansion of energy-intensive industries, led to higher growth, which averaged nearly 7 percent per annum over the decade. As a result of these changes, the agriculture sector contributes only 44 percent to the gross domestic product (GDP), albeit 78 percent of the population is engaged in agricultural activities. The service sector accounts for 32 percent of GDP and the industrial sector for 24 percent. Because no new hydropower projects have become operational since 1990, GDP growth has slowed to about 4 percent in the 1990s.

6. Imports to Bhutan consist of petroleum products, transport equipment, and manufactured goods, while electricity, cement, timber, veneer, block boards, and agricultural products are the main exports. Since 1987, electricity exports have constituted the single most significant export item earning \$13.7 million per annum, or nearly 20 percent of the total export receipts. With external aid, the overall budget deficit has been contained at less than 2 percent of GDP, while reserves stand at a comfortable level of 13 months of imports. The national debt amounts to over 50 percent of GDP. The debt service ratio, as a percentage of total exports, has risen from 7 percent in 1992 to 20 percent in 1994.

7. With the absence of any significant private sector activities, the momentum for the growth in the early 1990s emanated from large self-financed, high-yielding, public industrial ventures, such as Bhutan Calcium Carbide Limited (BCCL), Bhutan Board Products, and the Army Welfare Project. In the second half of the 1990s, growth is expected to be based on the construction of the Baso Chhu and Kurichu hydropower projects, and the expansion of energy intensive industries such as the Pendem Cement plant and the construction of a ferro-silicon plant. The Government has implemented reforms to create a favorable environment for the private sector. Industrial licenses are administered in an increasingly liberal manner, a number of public enterprises have been privatized, and programs to improve infrastructure, provide social services, and develop human resources have been initiated. Future reforms will cover revisions in trade and fiscal policies and reforms in the financial sector.

8. Fiscal revenues benefited substantially from the hydropower development in the 1980s, and enabled the Government to make substantial investments in infrastructure, primary health care, and the education system. These investments provided the basis for advances made in social development during the 1980s, which are reflected in the improvements in the social indicators: during the period, the life expectancy at birth increased from one of the lowest in the world, at 48 years, to 66 years; infant mortality was reduced from 134 to 70 per 1,000 births;¹ maternal mortality declined from 7.7 to 3.7 per 1,000; and participation in primary education improved. In the 1990s, the increase in current expenditures emanating from the new social programs, combined with the increases in civil service salaries and in interest payments, have exerted pressure on the fiscal budget and caused a delay in some of the new projects and a slowdown in the expansion of social services.

¹ World Bank. 1994. "Country Economic Memorandum." Report No. 13495-BHU. Washington, DC.

B. Energy Sector

9. Despite Bhutan's low level of economic development, its per capita energy consumption is relatively high because its forest resources provide an abundant and readily available source of energy. Per capita energy consumption amounts to about 0.8 ton of oil equivalent, which is twice as high as Nepal's. Similarly, the electrification ratio at 20 percent is higher than Nepal's 10 percent.¹

10. Fuelwood accounts for about 77 percent of total energy consumption and virtually all noncommercial energy consumption. The household sector consumes 95 percent of the fuelwood, the Government and commercial establishments use 3 percent, and the agriculture sector and industry use about 1 percent each. The annual consumption of fuelwood by a typical household is estimated at 14 cubic meters (m³). Of this quantity, 7-9 m³ is used for cooking and the balance for heating.

11. The mountainous terrain and the abundance of rivers make hydropower a viable option for energy generation. The country's hydropower potential has been estimated at 20,000 megawatts (MW), of which 50 percent is considered to be economically viable. However, there are 22 run-of-river hydropower stations with a total installed capacity of only 342 MW at present. They consist of the Chhuka hydropower station with an installed capacity of 336 MW, 7 minihydro plants with capacities ranging from 300 kW to 1,500 kW, and 14 microhydros with capacities ranging from 20 kW to 200 kW. Power exports to India are a major foreign exchange earner for Bhutan, and in view of an increasingly large export market for power in the subregion, present a significant opportunity for future expansion.

12. Bhutan has no known reserves of oil, or gas, and all petroleum products are imported. In 1989, petroleum products accounted for 8 percent of the total energy consumption. The petroleum products are mostly used in the transport sector. The demand for diesel oil and motor gasoline has been increasing in proportion to the rise in the number of vehicles. The use of liquified petroleum gas (LPG) is also increasing, at an annual rate of 15 percent. Kerosene is used for cooking and lighting in the household sector. In the industrial sector, 2,500 metric tons (t) of furnace oil is used by BCCL in Pasakha. Petroleum products are imported and distributed by two companies, Bhutan Oil Distribution and Druk Petroleum Company. There are 18 fuel depots in the country, with subdepots for the distribution of kerosene. Domestic prices are aligned with Indian domestic prices.

13. A total of 18,000 t of coal and coke were used in 1989. The main customers were industries such as food processing units, lime kilns, and candle and brick factories. Coal and coke imports are channeled through the State Trading Corporation of Bhutan as well as private agencies.

14. BCCL is the only user of charcoal in the country, with an annual consumption of 20,000 t. Charcoal is used as a raw material in production and not as fuel. Ninety percent of the charcoal is imported from India.

¹ Electrification ratios in some other countries in the region: Bangladesh, 13 percent; Cambodia, 3 percent; India, 80 percent; Lao PDR, 13 percent; and Myanmar, 6 percent (Key Indicators 1994: EDRC).

15. The production from about 60 biogas plants in Bhutan is used for lighting purposes. Solar panels, numbering some 271, exist in remote areas to charge batteries, particularly in monasteries, Government institutes, and basic health units. Experiments with wind energy are also being carried out on a pilot basis, mainly to charge batteries.

C. Power Subsector

16. Electricity was first introduced in Bhutan in 1960 when diesel generating sets were installed. It was not until 1967 that the first minihydro plant was commissioned in the capital, Thimphu. This was quickly followed by the commissioning of another minihydro plant in Paro, where the country's only airport is located. Between 1972-1976, further minihydro plants were constructed at Tashigang, Wandiphodrang, Gidakom, Thimphu, and Mongar, while during 1987-1988, such plants were commissioned at Khaling and Gyetsa. All of this minihydro development was undertaken with assistance from the Government of India. During 1969-1970, the Sarbang, Geylegphug, and Samdrup Jongkhar districts in the southern part of Bhutan were electrified through connection to the grid of the Assam State Electricity Board of India (ASEB). Similarly, the commissioning in 1972 of the Jadakha hydropower plant in West Bengal led to the electrification of the neighboring districts of Samchi, Sibsoo, and Phuntsholing in Bhutan through the West Bengal State Electricity Board of India (WBSEB).

17. The country achieved a major development objective in 1986 when the first unit at the Chhuka hydropower station was commissioned with assistance from the Government of India. By 1988, three further units had been commissioned at Chhuka, increasing its total installed capacity to 336 MW. This led to a rapid increase in rural electrification in the western regions of Bhutan, as well as to the establishment of several energy-intensive industries.

18. Since commissioning of the first unit at Chhuka in 1986, nearly 90 percent of generated electricity has been exported to India, and Chhuka is playing a key role in the economy as the largest single foreign exchange earner. Bhutan was not in a position to finance Chhuka's high investment costs and because the cash flows were in Indian rupees, which were not convertible at that time, the project was developed on a grant and loan basis by the Government of India. In return, India receives Chhuka's excess electricity for 99 years at a tariff that is effectively a royalty on power generated.

19. During 1986-1987, 11 microhydro plants were commissioned with aid from Japan for the benefit of isolated areas of the country. In 1991-1992, an additional three microhydro plants were commissioned in Chirang, Dagana, and Shemgang with assistance from Japan. With these plants, the total installed hydropower capacity of the country is 342 MW, while the diesel generating capacity totals 13 MW (see Appendix 1). The Government continues to electrify isolated rural areas. Construction of the 2.4 MW Rangjung scheme in the Tashigang District with assistance from the Government of Austria is nearing completion while another 1 MW minihydro project is currently under study, with assistance from the Government of India, at Wangla, one of the most remote areas of Bhutan.

20. The Government's future plans for the sector include: commissioning of the Baso Chhu hydropower project in the Sankosh basin with an installed capacity of 61 MW, designed to increase the reliability of power supply in the western grid and to allow further surplus to be

exported to India from Chhuka; completing the Chhuka tailrace tunnel to allow the plant to operate at its full rated capacity of 336 MW,¹ instead of the present 325 MW; and commissioning of the Kurichu hydropower project in eastern Bhutan with an initial capacity of 45 MW to supply the eastern districts and to support industrial activities, particularly the Dungsum cement project. The Government also has under consideration proposals from the Government of India to construct two new large hydropower projects downstream of the Chhuka power plant: Chhuka II (1,020 MW) and Chhuka III (900 MW). A description of the hydropower projects under implementation and under study is in Appendix 2.

21. The power transmission and distribution system in Bhutan comprises three components:

- (i) an interconnected grid supplying the Thimphu and Phuntsholing areas, fed from Chhuka and other power plants in these areas, and connected to the Indian grid for power exports from Chhuka;
- (ii) local networks supplied from India such as the Samdrupjongkhar and Geylegphug Electric Supply Units (ESUs) served by ASEB and the Samchi area of the Phuntsholing ESU served by WBSEB; and
- (iii) isolated local networks such as the Bumthang and Tashigang ESUs.

22. Transmission of power from the Chhuka hydropower plant is at 220 kilovolt (kV) and 66 kV. The main subtransmission and distribution voltage throughout the areas served in the country is 33 kV and 11 kV, while distribution is at 11 kV and low voltage. A list of the major transmission and subtransmission lines together with the approximate lengths of distribution lines in service and the number of customer connections is in Appendix 3.

23. Electricity supply in Bhutan is the responsibility of the Division of Power (DOP), which is part of the Ministry of Trade and Industry (MTI). DOP distributes electricity at the district (*dzongkhas*) and village level through ESUs and Electric Supply Subunits (ESSUs). In a policy directive issued in late 1993, the Government decentralized responsibilities for power supply to the district level in an attempt to improve its effectiveness. In compliance with the new policy, DOP has started turning over assets and transferring staff to several of the *dzongkhas* for operation and maintenance (O&M) purposes. The Chhuka Hydro Power Corporation (CHPC), which operates as a wholly owned Government company, registered under the Bhutan Companies Act, is also an important institution in the power subsector. In FY1994, DOP purchased 187 gigawatt-hours (GWh) or 97 percent of its requirements from CHPC. That same year, CHPC exported 1,328 GWh or 87 percent of the energy generated to India. The activities of CHPC are controlled by a Board of Directors and the price of Chhuka power sold to DOP is set by the Government.

24. At the end of FY1994, 37 towns and 282 villages were electrified and the total number of DOP consumers was 19,901, of which approximately 16,500 were households. Total electricity sales increased by an average 33.7 percent per annum in the 1980s, with largest increases in the industrial sector following the commissioning of Chhuka in 1986. In the early 1990s, total sales continued to increase at an annual rate of 10 percent, as a result of both an

¹ Chhuka tailrace was completed on 22 June 1995.

increase in the number of consumers from expansion of transmission and distribution networks and an increase in consumption by existing consumers.

D. Government Development Strategies

25. The Government's development policy is outlined in broad terms in the Seventh Plan (FY1993-FY1997), which has among its main objectives, the conservation of natural resources and the development of water resources.

26. The Seventh Plan recognizes the need to reduce the present rate of forest depletion, especially in the more densely populated areas, and includes as an important long-term strategy, the replacement of fuelwood by hydroelectricity. Extending power supplies to rural areas and improving the efficiency of fuelwood use are components of the Seventh Plan; other components include better forest management, the banning of logging and extraction by the private sector, restrictions on the export of logs and sawn timber, and forest plantation programs.

27. Given the absence of other conventional energy resources, the plan recognizes the need to develop the country's hydropower resources. The main aims of the Government for the energy sector under the Seventh Plan are summarized below.

1. Revenue Generation

28. The Government views the power sector as one of its main sources of revenue from both the export and the internal sale of power. The development of further hydropower schemes for power export is under active investigation by the Government, as is the development of small hydropower projects for communities in mountainous regions.

2. Countrywide Provision of Electricity

29. Eighty percent of the population does not have access to electricity. It is the long-term goal of the Government to provide electricity to all the population through an efficient, safe and reliable system. A gradual establishment of the national grid will be the main approach to increasing the electrification ratio throughout Bhutan. In the more remote areas, where grid supply is not viable, solar panels and microhydro plants will be provided.

3. Balanced Regional Growth

30. Hydropower development is also seen as a key to the progress of the manufacturing sector, which depends on a reliable supply of electricity. To ensure balanced growth, the Government envisages that most of the country will eventually be served by an interconnected high-voltage grid in which the main generation plants will supply domestic consumers and provide for regional industrial growth.

4. Sustainable Development of Energy Resources

31. The provision of electricity will encourage the rural population to reduce their fuelwood consumption, although these changes are likely to take a long time before people adapt to the use of the new form of energy. The Government also wishes to ensure that adverse environmental impacts of power projects are mitigated to the maximum extent possible.

E. External Assistance to the Energy Sector

32. The Bank's involvement in Bhutan's energy sector has been limited to the provision of two TA grants.¹ The most significant investment in the energy sector, the 336 MW Chhuka hydropower station, was financed by the Government of India on a concessional basis. Similarly, the 45 MW Kurichu hydropower project and several other minihydro plants have been fully funded by the Government of India on a grant and loan basis.² The Government of Japan has provided grant financing for 13 remote microhydro plants with a total capacity of 980 kW. These plants were constructed under a self-help scheme in which the villagers provided free labor and the consumers paid for wiring of their homes. A World Bank-executed project funded by the United Nations Development Programme (UNDP) and Government of Norway provided for a Power Sector Master Plan (PSMP), hydrometeorological measurement stations and the preparation of feasibility studies for priority projects selected under the PSMP.

33. The Government of Austria has been another major donor to the energy sector by funding about \$30.0 million for the first phase of the Baso Chhu hydropower project (22 MW), which is expected to be commissioned in 1998. It is also considering to fund, or arrange bilateral cofinancing for \$26 million for the second phase of the Baso Chhu project (39 MW), scheduled to be on stream by 2001. In addition, it provided assistance for the 2.4 MW hydropower plant at Rangjung in the eastern district of Tashigang, which will be the source of electricity for two of the villages to be electrified under the proposed Bank-financed Project.

F. The Bank's Strategy

34. The Bank's current operational strategy for Bhutan concentrates on (i) improving the capacity of the development administration, which is severely constrained by the lack of trained manpower, (ii) assisting Bhutan in structural transformation from a subsistence to a more diversified economy, (iii) enhancing the country's convertible currency earning capacity, and (iv) developing basic physical and social infrastructure. The Bank's strategy broadly supports the Government's development objectives outlined in the Seventh Plan. The strategy envisages

¹ TA No. 1729-BHU: Power Sector Institutional and Financial Development for \$500,000, approved on 9 July 1992 and TA No. 2043-BHU: Power System Development for \$245,000, approved on 29 December 1993.

² For example, the total cost of Kurichu is \$83 million, of which 60 per cent is financed by a grant and 40 per cent by a loan with an interest of 10.75 per cent per annum. The construction began in May 1994, and the project is expected to be commissioned in 1999.

relatively low lending levels combined with a substantial TA program for a systematic, long-term institutional strengthening of the Government.

35. The Bank's strategy for the energy sector in Bhutan supports the Government's objectives for the sector, particularly the development of hydropower resources for export and the expansion of the power transmission and distribution systems for balanced regional development. The proposed Project addresses the latter by providing reliable power supply to parts of the country not currently served and establishing the basic infrastructure to support the transformation of a subsistence economy.

G. Policy Dialogue

36. During the processing of the Project, a policy dialogue was initiated with the Government about the power subsector that has addressed three main issues: (i) institutional development and corporatization of DOP to make it a commercially oriented body; (ii) revision of domestic and export electricity tariffs to bring them closer to the economic cost of supply, and thereby improve the revenue flows to DOP and the Government, and ensure the efficient use of electricity; and (iii) the role of the private sector in future hydropower development.

1. Institutional Development of the Division of Power

37. Discussions were held with DOP and other concerned Government departments about a program for institutional development of DOP to allow it to operate as an autonomous public utility. A two-phase approach is envisaged. The first phase, which will be implemented with the TA processed in conjunction with the Project, will aim at ensuring the financial viability of DOP. The work will be undertaken in two parts. The first part will include the development and installation of a commercially based accrual accounting system within DOP that will accurately reflect the revenues and costs associated with operating the system. The second part will prepare a revised tariff structure, reflecting the cost of supplying electricity at different voltage and consumption levels.

38. The second phase of the institutional development will include the restructuring of the power subsector and will commence after the successful completion of the first phase. This phase, which will consist of the conversion of DOP into an autonomous corporate body, will include: (i) drafting legislative documents prescribing the powers, functions and authority of the corporate entity and establishing a regulatory section within MTI, (ii) defining the relationship between MTI and the corporate entity as well as the terms and conditions under which other entities can engage in power distribution, (iii) establishing the corporate entity under the Companies Act of 1989, and (iv) preparing a formal proposition including the draft legislation for the reorganization of MTI to be submitted to the Cabinet for its consideration and approval.

2. Power Pricing

a. Domestic Tariff

39. The electricity tariff in Bhutan is set well below the economic cost of supply for most consumers. There is a single uniform rate for all districts and consumer categories. On

1 April 1987, after the first unit at Chhuka had been commissioned, the rate was reduced from Nu0.70 per kWh to Nu0.40 per kWh. On 1 April 1995, the rate was increased to Nu0.50 per kWh, the same level as the export price paid by India. In its policy dialogue with the Government, the Bank pointed out that a tariff that was set below the economic cost of supply and ignored the voltage level did not necessarily increase living standards or productivity but actually lead to inefficient usage of electricity that otherwise could be exported. The discussions emphasized the importance of maintaining a sound domestic tariff to cover operating expenses and to finance the future expansion of the system. At a time when the availability of concessional funds for Bhutan is limited, it is essential for DOP to achieve an adequate level of self-financing for future investment projects.

40. The PSMP, completed by consultants in 1993,¹ established the long-run marginal cost (LRMC) of supply to domestic consumers based on the assumption that the Chhuka investment was a sunk cost and that the export price paid by India represented the economic benchmark or opportunity cost, at the generation level, for electricity consumed within Bhutan. The question is whether the export price is relevant for consumption in the whole country or only in the western region that is directly supplied from Chhuka. It can be argued that the export price is relevant for the whole country because (i) the major electricity consuming centers in the central and eastern regions are supplied from India; and (ii) according to the Chhuka agreement between Bhutan and India, the latter's rate for consumption in the central and eastern regions is the same rate that it pays for imported Chhuka power, plus a wheeling charge.² Thus, all present consumption in Bhutan has an implicit cost of Nu0.50 per kWh before adding wheeling charges and transmission and distribution costs. Adding these charges and costs as determined by the PSMP, the total cost at the low-voltage level is Nu 1.55 per kWh in the western region and Nu5.22 per kWh in the central and eastern regions.

41. An analysis of the disaggregated power system data prepared by DOP for the three year interval, 1992-1994, shows that average power generated by DOP during this period was 11.5 GWh per annum, while the power drawn from Chhuka averaged 192 GWh per annum, giving a total annual availability for the domestic market of 203.5 GWh. System losses averaged about 16 percent resulting in total sales of 170 GWh per annum. Sales to high-voltage industrial consumers accounted for about 80 percent of total sales, while Government offices and residential consumers supplied at the low-voltage level represented the balance. On the basis of this disaggregation and the analysis in Table 1, the overall recovery of LRMC is about 53 percent and the annual subsidy amounts to about \$2.4 million, with the major part going to low-voltage consumers, particularly in the central and eastern regions.

¹ Norconsult International of Norway.

² Wheeling charge is the cost of transporting electricity through the grid and typically comprises operation, maintenance, and capital cost of the transmission system plus a service charge.

Table 1: Tariffs versus LRMC by Consumer Category

Consumer Category	Voltage Level	Region	Sales (GWh)	Share (%)	Tariff (Nu/kWh)	LRMC (Nu/kWh)	Cost Recovery (%)	Subsidy (\$ million/a)
Industrial	High	Western	136	80	0.50	0.53	94	0.1
Residential	Low	Western	24	14	0.50	1.55	32	0.8
Residential	Low	Central and Eastern	10	6	0.50	5.22	10	1.5
Total/Weighted Ave.			170	100	0.50	0.95	53	2.4

42. The Bank pointed out to the Government that while it understood the objective of providing subsidies to low income consumers, these subsidies should be transparent. A public utility should respond to the needs of both its customers and its owners. Normally, this does not include fulfilling social objectives. If the Government's policy is to develop hydropower resources further as a source of revenue and to attract private sector investors to participate in the development of the hydropower sector in Bhutan, it is important to demonstrate that the Government agency responsible for the development is operated as a strictly commercial venture. Therefore, it would run counter to this objective if DOP were required to provide, as a regular function, subsidies on behalf of the Government. Subsidies to the power sector, if any, should be explicit and come from sources other than DOP.

43. The Government's initial view was that given the stage of socioeconomic development in the country, it was not possible to recover the full economic cost of an essential service such as electricity from the consumers. In particular, the Government considered it difficult to increase the domestic price beyond the export price. Their argument was that because the transmission network within the country was very small and the domestic consumer base was not large, the increment in the revenue obtained from increasing the domestic tariffs would be negligible compared with the overall revenue earnings of the power sector.¹

44. After considerable discussion, the Government accepted the need to reduce subsidies and increased the uniform rate to Nu0.50 per kWh effective 1 April 1995. The Government also acknowledged the rationale for further tariff increases in line with the time-bound plan shown in Appendix 4, which envisages average annual rates of increase of about 23 percent in nominal terms and 17 percent in real terms during the next five years. To address the tariff issue in a comprehensive manner (i.e., to revise not only the tariff level, but also the tariff structure), it was agreed that the scope of the TA for institutional and financial development of DOP in conjunction with the loan would cover two phases (see para. 71). The first part would focus on establishing a commercial accounting system and collecting baseline data on power sector operations. This data would form the basis for the second part, a tariff study to

¹ If the exports from Chhuka are added to the domestic consumption, the subsidized low-voltage consumers account only for about 2 percent of total sales and the cost recovery in the power sector increases to 91 percent.

determine an appropriate tariff structure differentiated by voltage levels and consumption categories. The tariff study may also result in adjustments to the time-bound plan for overall tariff increases shown in Appendix 4.

b. Export Pricing

45. Chhuka, completed in 1988, was built with the assistance from the Government of India consisting of a grant that covered 60 percent of the cost and a loan with an interest rate of 5 percent that covered the balance. The planning and investment costs of the Chhuka project over the period 1973-1988 were approximately Nu2,445 million in nominal prices. This figure is a mix of historical prices and does not reflect the capital cost of a similar plant at present price levels.¹ The contract between Bhutan and India provides for a revision of the export price every four years but in reality, the adjustments have been made more frequently. The latest one was in April 1995 when the export price was increased from Nu0.37 per kWh to Nu0.50 per kWh. The low export price reflects the grant and concessionary financing, and basically represents a royalty on the power generated at Chhuka.²

3. Private Sector Participation

46. The Government, in its efforts to expand hydropower generation to increase export earnings, is fully aware that (i) the financial requirements for the development of larger scale projects are beyond the capability of the Bhutanese economy even with bilateral and/or multilateral financial assistance, and (ii) DOP's institutional capabilities to develop such projects are limited. The Bank pointed out that private sector participation should eventually be a source of additional resources to develop such projects provided that a reasonable proportion of the financial benefits was captured by the Government. The participation of the private sector would also facilitate the commercialization of the power subsector because a pricing structure would be required that allows an attractive rate of return on investment. The Government's view was that it had adequate resources for development of the sector from bilateral and multilateral sources for the medium term. However, the Government agreed on the need to enhance the commercialization of the power subsector. As a first step in this process, the Government needs to reach an agreement with the Government of India to purchase power at a predetermined price. The Bank is willing to provide the Government with a TA to develop an export pricing framework. The Government must also prepare a prefeasibility level inventory of potential hydropower sites, for which private developers would be invited to bid on a joint venture basis with the Government. This issue has been addressed by the PSMP, which identified a number of suitable sites, and by the preparation of detailed studies for several of these sites with bilateral assistance.

¹ In 1988 dollar terms, the total capital expenditure was only \$188 million or about \$550 per kW.

² Assuming an average annual generation of 1,500 GWh during the 50-year lifetime of Chhuka, an interest rate of 10 percent, and annual operation and maintenance costs of Nu70 million, the Nu2,445 million capital cost results in a unit generation cost of only Nu0.21 per kWh.

IV. THE PROJECT

A. The Rationale

47. Although Bhutan has substantial sources of clean, renewable hydropower energy, the distribution of this type of energy throughout the country is very limited, and the electrification ratio is low. This increases the pressure on deforestation as fuelwood accounts for more than three-quarters of the country's energy consumption. The proposed Project will improve the access to electricity by electrifying rural areas in seven districts that are not served at present. The number of consumers will increase by about 16 percent, and the electrification ratio will go up to about 24 percent. The Project is expected to contribute to poverty reduction because most of the new consumers will be low-income rural households.

48. The Project is the first one in the power sector to be financed by a multilateral financing institution. This has allowed the Bank to play a pioneering role and to provide an impetus for reforms in the sector. The reforms are related to electricity pricing, both for domestic consumption and exports, and institutional development. Through commercialization, corporatization, and, at a later stage, partial or full privatization, DOP will be transformed from a Government department into an autonomous and financially viable corporate entity, and the Government's role will be reduced to that of a regulator.

B. Objective and Scope

49. The primary objective of the Project is to provide indigenously generated hydropower to the domestic market in Bhutan to promote economic development, reduce the extraction of fuelwood for cooking and heating, and save foreign exchange by reducing expenditure on imported kerosene. A secondary objective is poverty reduction by providing electricity to poor households, and enabling them to increase their cash incomes (see para. 83). The Project will extend the 33 kV and 11 kV distribution systems from the nearest power source to transformers located in the designated villages in the seven districts¹ and will establish the associated low-voltage networks and consumer service connections within the villages. The Project will supply electricity to about 3,100 new customers, and provide tools, plant, vehicles, and regional maintenance centers to assist in operation and maintenance of the distribution facilities. The Project consists of the following components:

- (i) civil works and installation of 140 circuit kilometers (cct-km) of feeder and 33 cct-km of spur 33 kilovolt (kV) overhead lines;
- (ii) civil works and installation of 33 kV pole-mounted load break switches and auto-reclosers;
- (iii) installation of 66/33 kV network interconnections;
- (iv) installation of 25 cct-km of feeder and 5 cct-km of spur 11 kV overhead lines;
- (v) installation of 11 kV load break switches;

¹ The seven districts included in the proposed Project are: Chhuka, Paro, Thimphu, Punakha, Tashiyangtse, Tashigang, and Wangdiphodrang (see Map on page v).

- (vi) installation of 8,090 kVA of 33/.4 kV and 1,170 kVA of 11 kV/.4 pole-mounted distribution transformers;
- (vii) installation of 206 km of low-voltage bundled conductors;
- (viii) service connections for about 3,100 new customers;
- (ix) supply of vehicles, office equipment, and a warehouse;
- (x) consulting services to assist DOP with the implementation of the Project, including procurement, and the design and commissioning of the 66/33 kV interconnections.

C. Technical Justification

50. The Project represents the least-cost solution for providing electricity in the selected districts of Bhutan in a reliable manner and with sufficient supply to meet the forecast load (see para 75). The design for the distribution networks is in accordance with international practice, and standardized in terms of insulation coordination, safety requirements, and clearances. Supply to the rural areas of Chhuka, Paro, Punakha, Thimphu, and Wangdiphodrang districts will come from the main Bhutan-India grid fed by the Chhuka hydropower station. The districts of Tashigang and Tashiyangtse will be supplied from the 2.4 MW Rangjung hydropower scheme scheduled for completion in 1995.

51. The design for the Project has considered both current distribution practices in Bhutan and cost-effective construction in accord with international practices. The design includes (i) adoption of the International Electrotechnical Commission standards for all electrical equipment to facilitate international competitive bidding; (ii) introduction of low-voltage bundled conductors; and (iii) introduction of a simple village electrification kit¹ for low-income groups of consumers.

D. Cost Estimates

52. The total cost of the proposed Project, including physical and price contingencies and service and other charges during construction, is estimated at \$ 9.5 million, of which \$7.3 million (77 percent) are foreign currency costs. The Project will be exempt from all direct taxes and duties in accordance with Government procedures for development projects. A summary of the cost estimate is in Table 2 and the detailed cost estimate is in Appendix 5.

¹ The kit is a simple unmetered household connection that is fitted with a switched incandescent light, and a few power outlets which can be used for lighting and a small appliance. The kits will be offered at a fixed monthly charge.

**Table 2. Summary of Project Costs
(\$ million)**

Item	Foreign Exchange	Local Currency	Total
A. Base Cost			
1. Civil Works and Equipment	5.7	1.3	7.1
2. Consulting Services	0.3	0.1	0.4
3. DOP Administration and Overhead	---	<u>0.2</u>	<u>0.2</u>
Subtotal (A)	6.0	1.7	7.7
B. Contingencies			
1. Physical Contingencies	0.6	0.2	0.8
2. Price Contingencies	<u>0.5</u>	<u>0.3</u>	<u>0.8</u>
Subtotal (B)	1.1	0.5	1.6
C. Service Charge on Bank Loan	0.2	---	0.2
Total (A+B+C)	<u>7.3</u>	<u>2.2</u>	<u>9.5</u>
Percent	77	23	100

E. Financing Plan

53. The financing plan is shown in Table 3. It is proposed that the entire foreign exchange cost of \$7.3 million, including service charge during construction of \$0.2 million, and a portion of the local currency cost amounting to \$0.2 million, or 79 percent of the total cost of the Project, be covered by the proposed Bank loan. The balance of the local currency cost will be borne by the Government.

**Table 3. Proposed Financing Plan
(\$ million)**

Source	Foreign Exchange	Local Currency	Total Costs	Percent
Bank	7.3	0.2	7.5	78.9
Government	---	<u>2.0</u>	<u>2.0</u>	<u>21.1</u>
Total	<u>7.3</u>	<u>2.2</u>	<u>9.5</u>	<u>100.0</u>

54. The proposed Bank loan of \$7.5 million equivalent will be from the Bank's Special Funds resources on standard terms with a repayment period of 40 years, including a grace period of 10 years, and a service charge of 1 percent per annum. The borrower will be the Kingdom of Bhutan.

F. Implementation Arrangements

1. Executing Agency

55. The Executing Agency for the Project will be DOP. All rural electrification construction and erection of distribution lines will be carried out using DOP staff, supplemented by local contract laborers as required. A Project Implementation Unit, headed by a senior engineer, will be established within the O&M wing of DOP to ensure timely implementation of the Project and to liaise with the Bank and the consultants during the implementation period. It has been determined that given the current manpower resources of DOP and that more than 30 rural electrification schemes have been successfully completed by DOP, the Project can be satisfactorily implemented by DOP with only limited assistance for design and procurement from international consultants. Because DOP does not have adequate material resources, particularly distribution materials and operational support facilities, the Project includes the necessary allowances for tools and other materials required for its O & M.

2. Project Implementation Schedule

56. The Project will be implemented over a two-and-a-half-year period (see Appendix 6). The implementation will commence in early 1996 and will be completed by mid-1998. The schedule is considered realistic, given the experience of DOP in implementing such rural electrification schemes, as well as the assistance to be provided by consultants for design and procurement.

3. Procurement

57. Procurement of the rural electrification equipment and materials needed for the Project will be undertaken in accordance with the Bank's *Guidelines for Procurement*. Tentative contract packages are shown in Appendix 7. Five packages with an estimated value of \$0.1-\$0.2 million will be procured through international shopping (IS) procedures. Four packages with an estimated contract value of \$0.5 million or more will be procured on an international competitive bidding (ICB) basis. Bid documents prepared by the consultants engaged under TA No. 2043-BHU, will be finalized by DOP based on detailed field surveys. Installation of the equipment and erection of the lines are not attractive for international contractors because of their low value and dispersed character. Therefore, DOP will do the work on a force account basis by using local contract labor.

4. Consulting Services

58. Consulting services will be required during implementation of the Project to assist DOP in the design and installation of the 66/33 kV interconnections, the training in the use of new equipment, and the procurement because this is the first Bank-financed loan to the power sector. The terms of reference for the consulting services are in Appendix 8. An international consulting firm will be recruited in accordance with the Bank's *Guidelines on the Use of*

*Consultants.*¹ It is estimated that a total of about 12 person-months will be required for this purpose.

5. Reports, Accounts, and Audit

59. Regular progress reports will be prepared for the Project and submitted to the Bank on a quarterly basis. The reports will include a description of physical progress and a summary of financial accounts for the Project, which will consist of expenditures during the period, year to date, and total expenditure to date. A project completion report will be submitted to the Bank within three months after completion of the Project.

60. Separate accounts will be maintained for the Project by the Government. Within nine months of the close of the financial year, detailed annual accounts audited by an auditor acceptable to the Bank, will be submitted.

G. The Executing Agency

1. Organization of DOP

61. The existing organization structure of DOP, as shown in Appendix 9, reflects its responsibility for a portion of the electric power assets of the Government. The DOP operates and maintains small power plants and the 66 kV, 33 kV, 11 kV and low-voltage systems under the direct guidance of MTI. Technical matters are handled by DOP, but all administrative and financial matters are supervised by Administrative and Finance Division of MTI. Overall planning for the sector is carried out by the National Planning Commission in consultation with MTI. Finalized plans are passed to DOP for execution. All budgetary allocations are channelled from the Ministry of Finance (MOF) through MTI to DOP. DOP collects revenue from the sale of electricity to domestic consumers and remits the entire amount to MOF. The major power plant at Chukka and the associated 220 kV transmission system are operated by CHPC, which is independent from DOP. Payments for purchase of electricity by DOP from India and CHPC are allocated to DOP through the national budgetary process.

62. Because DOP is a Government organization, it is governed by the Bhutan Civil Service Rules (1990) on recruitment, pay scales, incentives, promotions, and training.

63. For functional purposes, DOP has been divided into two wings, Operations and Maintenance (O&M), and Projects and Investigations (P&I). The O&M wing is responsible for maintaining the minihydro plants located in the different parts of the country and the associated distribution networks through ESUs and ESSUs. The O&M wing does not have responsibility for the microhydro plants, which are operated by the local districts, but is often called upon to maintain and repair them. The P&I wing is responsible for monitoring implementation of projects and assisting the Government in negotiations for projects.

¹ The Bank approved advance recruitment action on 17 May 1995.

64. In October 1993, the Government, in an effort to decentralize the provision of power supply and improve its effectiveness, transferred certain assets and staff of DOP to local government units. This resulted in the transfer of all microhydro assets to the districts (*dzongkhas*), which were made responsible for their O&M. In addition, the power distribution assets and the staff of DOP associated with the ESUs of Samdrup, Jongkhar, and Geylegphug in the eastern region, and Samchi in the western region, as well as the ESSU in Haa, were transferred to their respective districts. The districts are responsible for all billing and collection and all administrative matters associated with power distribution. They operate as separate distribution companies receiving supply from locally installed microhydros or from DOP through the national grid at a negotiated purchase price.

2. Financial Position

65. DOP is responsible only for domestic power sales and revenues because all exports of power and the associated revenue collection are carried out by CHPC. To assess DOP's financial position, accounting records of the Government were used to estimate revenues and expenditures for the last two fiscal years (see Table 4). The revenues include sales of energy, meter rentals, and meter security charges. The expenses include the purchase of power from CHPC and the operating and maintenance costs incurred by DOP.

Table 4: DOP's Estimated Annual Revenues and Expenses

	FY1993	FY1994
Energy Sold (GWh)	173.8	176.5
Revenues		
Sales (Nu million)	49.3	69.6
Unit Revenue (Nu/kWh)	0.28	0.39
Expenses		
O&M (Nu million)	39.5	40.0
Power Purchase (Nu million)	<u>20.3</u>	<u>20.9</u>
	59.8	60.9
Unit Cost (Nu/kWh)	0.34	0.35
Profit (Loss)		
Total Amount (Nu million)	(10.5)	8.7
Unit Amount (Nu/kWh)	(0.06)	0.05

66. The review indicates the financial position of DOP improved in FY1994. In terms of out-of-pocket expenses, which do not include depreciation or financial charges, it cost DOP Nu0.34 - 0.35 per kWh to generate and distribute electricity in Bhutan during the last two years. While the average revenue of Nu0.28 per kWh in FY 1993 was below the break-even point for out-of-pocket expenses, it rose to Nu0.39 per kWh in FY1994, sufficient to cover out-of-pocket expenses, but still inadequate to cover the depreciation and financing expenses of DOP. Unfortunately, the absence of any depreciation or financing charges makes it difficult to ascertain an accurate financial position or to calculate any meaningful financial ratios for the operations of DOP. Similarly, because the Government uses a cash accounting basis, it is impossible to

determine the accounts receivable position or collection efficiency. The Government is aware of these deficiencies and has agreed that the first phase of the power sector restructuring will address these issues through the development and implementation of an appropriate public utility accounting system to be installed in DOP. At the same time, DOP will be given more responsibility to manage its financial and planning functions.

H. Environmental and Social Measures

1. Environment

67. A detailed environmental impact assessment (EIA) was not considered mandatory because the Project has been classified in category "B". A summary initial environmental examination (SIEE), which was prepared by the consultants as part of the feasibility study, is attached as Appendix 10.

68. Electricity under the rural electrification program will be distributed by means of overhead power lines and substations. The lines will run along roads and require only minor clearing. The distribution substations will be mostly on poles. The impact of the lines and substations will not be significant except for the visual appearance and the hazards arising from the presence of live wires and equipment. DOP will undertake educational programs to alert citizens of the potential dangers.

2. Social Analysis

69. The Project has no particular negative social impact and requires no remedial action. There will be no resettlement of population. Small parcels of land will need to be acquired for substations in different locations and for maintenance cells. Cash compensation or alternative land sites will be provided to all owners of land needed for these sites.

70. A work force of 60 to 100, under the supervision of staff from DOP, will install the distribution lines and house connections throughout the areas covered by the Project. The provision of accommodation and services for the work force will not have a major impact because part of the work force will be recruited at the construction areas.

I. Technical Assistance

71. The Government has requested the Bank to provide an advisory TA to implement the first phase of the restructuring program for DOP (see the terms of reference in Appendix 11). The work will be divided into two parts. The first part includes the development and installation of accounting and management information systems. This will lead to the development of a computer-based billing and collection system, streamlined billing and collection procedures, a stores management and inventory control system, and a depreciation policy for DOP, including the determination of a revalued asset base. The second part will develop a revised tariff structure for DOP reflecting the cost of supplying electricity at different voltage levels. DOP will be the Executing Agency for the TA. About 12 person-months of international consulting services will be required. The consultants will be recruited in accordance with the Bank's *Guidelines on the Use of Consultants*. Computer hardware and software, office equipment and training

materials to be provided under the TA will be procured by the consultants under arrangements acceptable to the Bank. The total cost of the TA is estimated at \$440,000, of which \$400,000 is foreign exchange and \$40,000 is local currency cost. The detailed cost estimate is in Appendix 12.

V. PROJECT JUSTIFICATION

A. Financial and Economic Analysis

1. Demand Forecast

72. The demand forecast prepared by the consultants for the PSMP incorporated extensive data compiled during field surveys. The model developed by the consultants took into account, among others, customer consumption growth, population growth, changes in electrification ratios, and demand profile data including a daily load factor of 41 percent with two peak demand periods: from 4 to 6 in the morning and from 7 to 10 in the evening. The forecast in the PSMP for the seven districts considered under the Project is given in Appendix 13. It showed a total of almost 7,000 potential consumers in 1990 with an initial demand of about 12 GWh.

73. In formulating the Project, only accessible villages experiencing rapid development have been selected in the seven districts. Power demand has been estimated by consumer category (residential, commercial, and public services). Residential consumers are projected to account for 73 percent of the total demand, commercial establishments for 20 percent, and public services for 7 percent. A population growth rate of 3 percent per annum has been applied to residential consumers and their initial average monthly electricity consumption has been assumed to be 124 kWh per household and to grow at 6 percent per annum. The initial average monthly consumption of commercial establishments has been assumed to be 207 kWh and of public services to be 122 kWh, and to grow by 8 percent per annum. Based on these assumptions, about 3,100 consumers are expected to be connected under the Project, with electricity sales increasing from about 6 GWh in 1997 to about 12 GWh in 2001.

2. Ability and Willingness to Pay

74. Surveys indicate that the rural households in the selected villages are in a position to pay the current electricity tariff. This is supported by the relatively strong growth rate of over 10 percent per annum in the agricultural sector. People living in the areas covered by the Project cultivate several cash crops, such as mustard, fruit trees, and vegetables, and have access to cash from their market sales. The extensive use of kerosene lamps indicates cash availability and a demand for lighting. The initial capital investment of Nu1,000 (\$33) required for wiring the household is affordable as demonstrated by previous rural electrification schemes and by the existence of small agricultural machinery, cattle, poultry, and other assets in the villages in the areas covered by the Project. The surveys undertaken by consultants for DOP and UNDP have confirmed willingness to pay for electricity on the part of rural consumers with the major concern of the surveyed population being the provision of a reliable source of electric power rather than the price.

3. Least-Cost Alternative

75. The Project represents the least-cost solution for supplying electricity to the seven selected districts in a reliable manner to meet the forecast demand. The source of supply for all the schemes will be indigenously generated hydropower. The alternative option of diesel power generation is not viable in certain locations because of difficulties in transporting fuel in the mountainous terrain. Even where fuel can be delivered, the diesel option would be more costly and would need scarce foreign exchange. While the capital cost of installing small stand-alone diesel generators is the same order of magnitude as the cost of the proposed grid extensions, the O&M costs for the former are much higher.

4. Financial and Economic Analysis

76. The financial and economic viability of the proposed Project has been assessed on the basis of the economic internal rate of return (EIRR) and the financial internal rate of return (FIRR).

77. The FIRR and the EIRR have been calculated over a 25-year period based on incremental sales and the associated capital and O&M costs, using assumptions in Appendix 14. The FIRR for the Project is calculated at 1.1 percent, while the FIRRs for the individual schemes range from 0 percent to 3.4 percent. The average real weighted cost of capital for the Project is determined by the interest rate to be paid by the Government, 1 percent in nominal terms, the cost of equity, and the foreign exchange risk associated with the Bank loan. Calculated on this basis, the average real weighted cost of capital is estimated to be below 1 percent, indicating that the Project will not adversely affect the financial position of DOP or the Government. The EIRR, which is calculated by adjusting the benefit and cost flows so that they correspond more closely to the economic opportunities realized and foregone because of the Project, is estimated to be 11.9 percent, which is above the estimated 10 percent opportunity cost of capital for Bhutan. The EIRRs for the individual schemes range from 5.9 percent to 15.4 percent. Like the FIRR, the EIRR is most sensitive to changes in benefits (see Table 5). The risk associated with lower-than-anticipated benefits is considered small because the benefits have been estimated conservatively, with the diverted market set at 40 percent of total demand and the demand growth estimated at about 6 percent per annum. Also, no value has been attached to fuelwood that will be displaced as the result of the Project.

5. Project Risks

78. The Project is based entirely on proven technology and, consequently, there are no significant technical risks. The greatest risk involves the lack of implementation experience of DOP in undertaking projects funded by the Bank or other international lending agencies. The potential impact of this lack of experience could be (i) an increase in the cost of the Project; and (ii) delays in the completion of the Project. This risk will be mitigated by using appropriately qualified international consultants to assist in the implementation of the Project. The previous experience of DOP in constructing similar schemes ensures that the Project can be completed on schedule. In addition, the Project consists of a number of schemes, most of which will be commissioned independently of each other. Because each scheme will start generating benefits immediately upon completion, a significant overall delay in the completion of Project is unlikely.

Table 5. Sensitivity Analysis

Scenario		EIRR (%)	SI ^a	FIRR (%)	SI ^a
(i)	Base case	11.9		1.1	
(ii)	One-year delay	10.3	---	0.7	---
(iii)	10% reduction in sales	10.4	1.3	0.05	9.5
(iv)	20% reduction in sales	8.8	1.3	-0.9	9.1
(v)	10% increase in capital costs	10.5	1.2	0.4	6.4
(vi)	50% increase in maintenance cost	11.6	0.1	0.4	1.2
(vii)	Combination of (ii) & (v)	9.0	---	-0.1	---

^a The sensitivity indicator is the ratio of the percentage change in the FIRR and EIRR to the percentage change in given parameter.

B. Environment

79. The Government is committed to addressing environmental concerns and has passed a law requiring the preservation of a minimum 60 percent of the forest cover of the total land area. In view of the high reliance on fuelwood as a source of energy, the Government foresees benefits to accrue from the Project not only in terms of a balanced development throughout the country but also in a reduction rate of forest depletion. Working in tandem with the Bank's forestry sector strategy, the Project is expected to have a significant impact on the reduction of demand for fuelwood.

C. Social Dimensions

80. An analysis of the social dimensions of the Project has been difficult because of the unavailability of reliable data on population and income. Nevertheless, the Mission has attempted to assess the socioeconomic status of typical villages in the areas covered by the Project through surveys and interviews. It has been possible to distinguish the affluent from the less affluent in the rural villages by the structure of their house, the size of their farm plot, and the nature of their economic activities. The villages to be electrified under the Project have on average about 40 households of six people each. About 10 percent of the households can be classified as higher income, about 50 percent as middle income, and about 40 percent as poor. The higher income households have average incomes of about \$425 per annum, and live in large, traditionally built houses constructed of wood and concrete, with large wooden-frame windows. Such houses are adorned with Buddhist paintings and other artifacts. The homes have corrugated iron or tile roofing, and a large open area under the roof. These households permanently farm two or more hectares and have a dozen or more cattle, horses and mules. Their farm incomes are supplemented by buying and selling village produce and handicrafts or by making small loans to neighbors. The homes often have access to running water on or nearby the premises and an outside latrine. In villages already electrified, each household may have ten or more light bulbs and a radio.

81. The 50 percent of households classified as middle income have average incomes of about \$320 per annum. They occupy more modest houses, with mud rather than concrete walls. The wooden frames and windows of these homes are of rough hewn wood and are less decorative. Roofs are normally of galvanized iron sheets and floors are of rough wood. The households normally have several cattle, pigs, goats and horses or mules and cultivate about two hectares of land. When electrified, such houses have 3 to 8 electric light bulbs and sometimes a radio.

82. The bottom 40 percent of households in a typical village covered by the Project can be classified as poor. Such households have an average income of about \$180 per year, derived almost exclusively from subsistence farming. They supplement their incomes through the production of handicrafts, mainly traditional weaving. The houses are of very low quality, constructed mainly of woven siding and thatched roofs. Unless a smokeless stove has been installed, cooking inside the house fills the interior with smoke. There are typically one or two small rooms with earthen floors and no sanitation or water supply facilities are available on the premises. Water must be carried from a nearby stream or other source. The households cultivate less than one-half hectare and normally do not own any livestock.

83. The Government's policy is to guarantee access to basic services to all of the population. Consequently, once a village is electrified, all homes are provided access to electricity albeit a different level of services with only one or two light bulbs for the poorer homes. Such households are charged monthly Nu5.0 per bulb with no consumption charge. The supply of electricity to these lower income households is expected to enhance their income earning potential as weaving and other cottage industry activities can continue at night.

84. Interviews with local residents in the area covered by the Project indicate they are looking forward to having electricity. The positive social impacts of the proposed Project are considered to be significant: (i) the availability of a renewable and convenient form of energy for lighting, motive power, and heating will improve life in the rural areas; (ii) infrastructure such as water pumping and telecommunications will become available, (iii) jobs as the result of the availability of motive power for small industries will be created in the medium term; and (iv) substitution of electricity as source of energy for cooking and heating will reduce fuelwood consumption, smoke emission, and smoke inhalation¹.

¹ Bhutanese homes traditionally do not have proper ventilation. Household smoke inhalation has been identified as a major health hazard.

VI. ASSURANCES

85. The Government has given the following assurances, in addition to the standard assurances, which have been incorporated in the legal documents.

(i) Project Executing Agency

DOP will be the Executing Agency and will be responsible for implementation, monitoring and coordination of all activities under the Project.

(ii) Project Implementation Unit

DOP will establish a Project Implementation Unit (PIU) in its O&M wing to ensure timely implementation of the Project and to liaise with the Bank and the consultants during implementation of the Project. The PIU will be headed by a senior engineer or its equivalent. The O&M wing will be staffed with adequate technical and administrative personnel and will be provided with adequate support facilities.

(iii) Land Acquisition

The Government will acquire land, including rights in land, required for the Project on a timely basis. The Government will offer adequate cash compensation or suitable alternative land sites to land owners affected by the land acquisition.

(iv) Action Plan for Sector Restructuring

The Government will finalize an action plan to be agreed upon with the Bank for a two-phase restructuring of the power sector. The first phase will consist of the introduction of a commercial accounting system in DOP and the establishment of an appropriate tariff structure. The second phase will involve the corporatization of DOP.

(v) Domestic Electricity Tariff

The Government will carry out a tariff study to determine the appropriate tariff structure during the first phase of the restructuring of the power sector, and thereafter the Government will revise the domestic electricity tariff based on the findings of the study and on a time-bound plan agreed upon between the Government and the Bank.

(vi) Rural Electrification Construction and Installation of Distribution Lines

DOP will carry out the construction and the installation of distribution lines for rural electrification under the Project through its staff and by recruiting local contract workers.

(vii) Project Monitoring and Evaluation

DOP will monitor the Project with benchmark information agreed upon with the Bank. During the implementation period, DOP will furnish the Bank with annual performance reports on the monitoring of the Project. DOP will evaluate the benefits of the Project after its completion in accordance with a time schedule and terms of reference to be agreed upon with the Bank.

(viii) Budgetary Allocation

The Government will make adequate budgetary allocations for the Project for each related fiscal to ensure timely and effective implementation of the Project.

VII. RECOMMENDATION

86. I am satisfied that the proposed loan would comply with the Articles of Agreement of the Bank and recommend that the Board approve the loan in various currencies equivalent to Special Drawing Rights 4,809,000 to the Kingdom of Bhutan for the Rural Electrification Project, with a service charge at the rate of 1 percent per annum and with an amortization of 40 years, including a grace period of 10 years and such other terms and conditions as are substantially in accordance with those set forth in the draft Loan Agreement presented to the Board.

MITSUO SATO
President

23 August 1995

APPENDIXES

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EXISTING GENERATING PLANTS

A. Hydropower Plants

Station	District	Installed Capacity (No. x MW)	Generating Capacity (MW)	Year of Commissioning	Approx. Annual Output (GWh)
Chhuka	Chhuka	4 x 84	318.00 ^a	1986-1988	1554
Gyetsa(Chumey) ^b	Bumthang	3 x 0.5	1.50	1988	2
Gidakom ^c	Thimphu	5 x 0.25	0.50	1973	0.4
Chenari	Tashigang	3 x 0.25	0.75	1972	1.2
Khaling	Tashigang	3 x 0.2	0.60	1987	0.8
Khalanzi	Mongar	3 x 0.13	0.26	1976	0.8
Thimphu	Thimphu	4 x 0.09 (360 kW)	0.27	1967	0
Wangdi	Wangdiphodrang	3 x 0.1	0.20	1972	0.1
Rangjung	Tashigang	2 x 1.2	2.40	Under construction	n.a.
Total			324.48		

^a Second Tailrace tunnel is under construction to increase output.

^b To be restored to 750 kW firm capacity by 1997 with extra pondage.

^c To be recommissioned in March 1997.

B. Microhydro Plants (Rural Energy Division)

Station	District	Capacity (kW)	Year of Commissioning
Gangzur	Lhuntshi	20	1986
Thinleygang	Thimphu	30	1986-1987
Rukubli	Wangdiphodrang	40	1986-1987
Tangsibji	Tongsa	30	1986-1987
Tongsa	Tongsa	50	1986-1987
Bubia	Tongsa	30	1986-1987
Tamshing	Bumthang	30	1986-1987
Ura	Bumthang	50	1986-1987
Yadi	Mongar	30	1986-1987
Kekhar	Shemgang	20	1986-1987
Suray	Sarbang	70	1986-1987
Damphu	Chirang	200	1991
Tintibi	Shemgang	200	1992
Darachhu	Daga	200	1992
Total		1000	

C. Diesel Generating Sets

Location	Installed Capacity (MW)	Year of Commissioning
1. Division of Power		
Thimphu	3.20	1978-1985
Paro	0.09	1977
Phuntsholing	0.75	1966-1979
Damphu	0.18	1969-1991
Tongsa	0.50	1976
Geylegphug	0.69	1989-1991
Sarbang	0.25	1991
Kalikhola	0.05	1991
Shemgang	0.08	1983
Daga	0.04	1983
Tashigang	0.05	1991
Bumthang	0.06	-
Total	5.94	
2. Other Diesel Generating Sets		
Penden Cement Authority Limited	3.60	1981-1984
Bhutan Board Products Limited	0.25	n/a
Chukha Hydro Power Corporation	2.00	n/a
Bhutan Chemicals and Calcium Carbide Ltd.	0.22	1987
GWMC	0.84	n/a
Total	6.91	

A. HYDROPOWER PROJECTS UNDER STUDY

1. The Power System Master Plan (PSMP) selected 25 promising projects with a total capacity of 10,988 megawatts (MW), following an initial desk study. From this final list, the five most cost-effective projects were selected for construction. They include two projects each on the Wang and Sankosh rivers and a project on the Bumthang River. Their combined capacity would be 2,500 MW.
2. Prefeasibility studies for four sites (two on the Sankosh River, one on the Mangde River and another on the Kholong River) were conducted during Phase II of the PSMP. The four schemes were all run-of-river projects. Two projects on the Wang River, which were the most promising during the Phase I evaluation, were not included because the feasibility studies were already being conducted. Mangde Chu and Kholong were not among the five projects in the Phase I tentative selection. The main reason appears to have been the desire of the Royal Government of Bhutan (the Government) to have a major hydropower plant situated in each of the main river basins to achieve regionally balanced development.
3. **Chhuka II (Tala) and Chhuka III.** Proposals have been made by the Government of India for two more large hydropower projects downstream of the Chhuka project. One is Chhuka II (Tala) and the other is Chhuka III. A detailed feasibility study of Chhuka II (1,020 MW run-of-river project) has now been submitted to the Government by the Government of India. The estimated cost is Nu15,000 million (about US\$484 million equivalent). Chhuka III is a storage dam project near the border with India. The site for Chhuka III (262 MW) was studied under the PSMP and was ranked at the bottom of the 25 potential projects. The project has now been redesigned with a capacity of 900 MW. The report on the project will be completed by the end of 1995. In 1992, the cost of the project was estimated at US\$548 million. Design and construction of either project would take at least eight years.
4. **Mangde Chu.** The Government has decided to conduct a detailed feasibility study (under the PSMP Phase III) for this 265 MW run-of-river scheme to be located in the central part of the country.
5. **Bunakha Reservoir scheme.** This reservoir project upstream of the Chhuka plant would have 120 MW capacity. It is also designed to increase the output of Chhuka itself by controlling the Wang River flow during peak periods. A report on the project will be ready by the end of 1995.

B. HYDROPOWER PROJECTS UNDER IMPLEMENTATION

6. **Baso Chhu.** Baso Chhu is a run-of-river project situated in the Sankosh basin, 22 kilometers south of Wangdiphodrang. The total capacity of 61 MW will be commissioned in two stages. The total project cost is estimated at Nu1,515 million (\$49 million). The Government of Austria is financing 53 percent of the cost of the project through a grant and concessional loan. Eleven percent is being funded out of the Government budget, and the remaining 36 percent is still unfunded. A transmission line that will supply power to the project site is being installed. The construction of the project will begin following the monsoon season in 1995. Commissioning of the first stage (22.2 MW) is expected in 1998. The second stage (38.6 MW) is expected to be completed by the year 2001.

7. **Kurichu.** Kurichu is a reservoir-type hydropower project located in Mongar District in eastern Bhutan. The Government has been promoting this project since the 6th Five-Year Plan as a means for developing industrial activities in the eastern part of the country. The initial generation capacity will be 45 MW. The capacity could be increased at a later stage by 15 MW. The cost is estimated at about Nu2,560 million (\$83 million equivalent) and is fully financed by the Government of India through a grant (60 percent) and a loan (40 percent). The rate of interest of the loan is 10.75 percent.

8. While construction of Kurichu began in May 1994, the project is not expected to be commissioned until 1999. The reservoir will provide seasonal storage and will thus allow 45 MW of generation at peak and at least 25 MW at other times throughout the dry season. Upon completion, Kurichu will supply the proposed Dungsum cement project with 25 MW. Kurichu will also be connected to small hydropower networks through an eastern grid, which will almost eliminate the need for the eastern region of the country to import electricity from India.

9. **Chhuka tailrace.** Because of the insufficient capacity of the tailrace tunnel, the effective capacity of the Chhuka hydropower station has been 325 MW compared with the design capacity of the 336 MW. The construction of a tailrace tunnel will permit full capacity utilization. The cost of construction is estimated at Nu35 million. The project is expected to be completed by the mid-1995.

EXISTING TRANSMISSION, SUBTRANSMISSION AND DISTRIBUTION LINES (km)

A. Major Transmission Line

Name	220 kV (km)	55 kV (km)
Chhuka - Birpara	76 double circuit	-
Chhuka - Singhigaon	50 single circuit	-
Chhuka - Simtokha (II) not commissioned	59 single circuit	-
Chhuka - Gedu	-	21
Gedu - Phuntsholing	-	24
Chhuka - Confluence	-	44
Confluence - Simtokha (I)	-	15
Confluence - Ha	-	33
Confluence - Paro	-	24
Simtokha - Wangdiphodrang	-	26
Phuntsholing - Gomtu	-	27
Phuntsholing - Singhigaon	-	8
Phuntsholing - Birpara	-	30
Total	76 double circuit 109 single circuit	252

B. Subtransmission / Distribution Lines and Service Connections

1. Division of Power

Division	33 kV (km)	11 kV (OH/UG) (km)	LV (km)	Service Connection
ESSD Thimphu	55.7	119.6	173.3	6,684
ESSD Paro		73.6	107.7	1,929
ESSD Wangdiphodrang		59.6	45.0	1,193
ESSD Ha		41.4	45.0	308
ESD Bumthang		38.0	20.4	588
ESD Phuntsholing		131.7	167.0	3,764
ESD Tashigang		140.0	70.0	1,683
ESSD Mongar		72.5	35.1	712
ESD Samdrupjongkhar		10.1	25.0	804
ESD Geylegphung		53.9	81.3	1,444
Total	55.7	749.4	785.6	19,109

2. Supplied from Microhydros (Rural Energy Division)

Station	Dzongkhag	5.5 kv (km)	LV (km)	Service Connect- ions	No. of towns/ villages electrified
1. Gangzui	Lhuntshi	-	-	-	-
2. Thinleygang	Thimphu	6.4	4.9	44	3
3. Rukubli	Wangdiphodrang	6.1	1.8	49	3
4. Tangsibji	Tongsa	0.4	2.3	53	1
5. Tongsa	Tongsa	0.4	1.8	100	1
6. Bubia	Tongsa	2.0	3.2	43	2
7. Tamshing	Bumthang	0.05	3.1	63	4
8. Ura	Bumthang	3.8	3.7	95	4
9. Yadi	Mongar	3.4	1.0	65	1
10. Kekhar	Shemgang	1.7	1.2	47	2
11. Suray	Sarbang	3.3	4.0	53	5
12. Damphu	Chirang	6.6	3.8	45	2
13. Tintibi	Shemgang	16.2	1.9	110	4
14. Daracchu	Daga	31.9	3.5	25	2
Total		82.25	36.2	792	34

TIME-BOUND PLAN FOR DOMESTIC TARIFF INCREASES

	1995	1996	1997	1998	1999	2000
Nominal Tariff (Nu/kWh)	0.50	0.60	0.80	1.00	1.20	1.40
% Increase	25.0	20.0	33.3	25.0	20.0	16.7
Deflator*	1.000	1.060	1.124	1.191	1.262	1.338
Real Tariff (Nu/kWh)	0.500	0.566	0.712	0.840	0.951	1.046
Increase (%)	25.0	13.2	25.7	18.0	13.2	10.0
Real Tariff (US cents/kWh)	1.67	1.89	2.37	2.80	3.17	3.49

* 6 per cent inflation per annum.

33
DETAILED COST ESTIMATES
(\$ '000)

Appendix

Item	Foreign Exchange	Local Currency	Total
A. Base Cost			
33 kV Overhead Lines			
Feeders	1,896	486	2,382
Distributors/Spurs	424	66	490
Load Break Switches	80	10	90
Auto-Reclosers	93	13	106
Network Connections & Transformers	40	4	44
11 kV Overhead Lines			
Feeders	240	82	322
Distributors/Spurs	52	8	60
Load Break Switches	10	1	11
Auto Reclosers	12	2	14
Distributions/Substations (pole-mounted)			
33 kV/LV Transformers	445	121	566
11 kV/LV Transformers	55	15	70
Substations	33	9	42
Low-voltage Distribution			
Low-voltage Circuits	1,621	443	2,064
Customer Services			
Service Connections	153	17	170
Customer Meters	119	13	132
Support Facilities/Store Warehouse	470	20	490
DOP Administration and Overheads	0	200	200
Consulting Services	300	100	400
Subtotal A	6,048	1,610	7,653
B. Contingencies			
Physical Contingencies ^a	578	187	765
Price Contingencies ^b	479	366	845
Subtotal B	1,057	553	1,610
C. Financial Costs			
Service Charge on Bank Loan	200	0	200
Subtotal C	200	0	200
Total (A + B + C)	7,300	2,163	9,463
Percent	77	23	100

^a 10 percent

^b 2.5 per cent per annum for foreign costs; 5 per cent per annum for local costs.

IMPLEMENTATION SCHEDULE

[illegible]

TENTATIVE CONTRACT PACKAGES
(\$ million)

Package	Description	Estimated Contract Value	Procurement Mode ^a
1	Conductors: overhead, bundled and service conductors and accessories	1.3	ICB
2	Insulators: insulators and fittings	0.5	ICB
3	Support Poles: steel poles, crossarms, hardware fittings	2.0	ICB
4	Distribution Transformers and Equipment: distribution transformers and equipment, interconnection transformers, and substation equipment	1.0	ICB
5	Customer meters and Test Equipment: tariff meters, meter boards, fuses, LV ELCB, materials of Village Electrification Kit, and test equipment	0.2	IS
6	Construction Tools and Equipment: tools, equipment and safety equipment	0.2	IS
7	Transportation and Warehouse Equipment: trucks, 4WD vehicles, fork lifts	0.2	IS
8	Communications Equipment: UHF communications equipment, telefaxes	0.2	IS
9	Engineering Design Equipment: photocopiers, computer hardware and software, IEC standards	0.1	IS
Total ^b		5.7	

a ICB - International Competitive Bidding

IS - International Shopping

b The difference to the total cost of the Project of \$9.5 million allows for contingencies, financial, and local costs.

TERMS OF REFERENCE FOR CONSULTING SERVICES FOR PROJECT IMPLEMENTATION

Consulting services will be required for design, procurement, testing and installation of the Project, and training of the Division of Power (DOP) staff.

A. Procurement

1. The consultant will assist DOP in carrying out bid evaluation and answering post-tender queries to finalize contracts with equipment suppliers. The consultant will assist DOP with any problems related to shipping, delivery, inspection, insurance, unpacking, and demurrage in connection with international competitive bidding (ICB).

B. Detailed Design, Construction Supervision and Training of DOP staff

2. The consultant will review the proposed design technical specifications and bills of quantities included in the ICB documents that have already been prepared at an earlier stage. The consultant will also check and technically approve designs submitted by the contracted suppliers/equipment manufacturers.

3. The consultant will assist DOP in preparing detailed design of the 66/33 kV interconnecting system and will supervise and adequately train the DOP staff to erect, test, and commission this system and a small part of 400 V lines using for the first time in Bhutan the aerial bundled conductor (ABC). The consultant will also be responsible for:

- (i) the factory inspection and witnessing tests of equipment being supplied to the project;
- (ii) testing and commissioning of the 66/33 kV interconnecting system, 33 kV breakers and auto-reclosers and a few 33/0.4 kV substation with relay and control panels; and
- (iii) erection, testing, and commissioning of a few sections of 400 V low-voltage lines using the ABC.

4. The consultant will carry out training programs on the use of new equipment and techniques adopted for the first time in Bhutan.

C. Design Practices and Operational Procedures

5. The consultant will train DOP engineers in computer-aided design and drawing of network diagrams in accordance with modern power utility practices using computer software such as Autocad. Maps will be prepared in a way that they can be used for computerized circuit analysis and transformer load management.

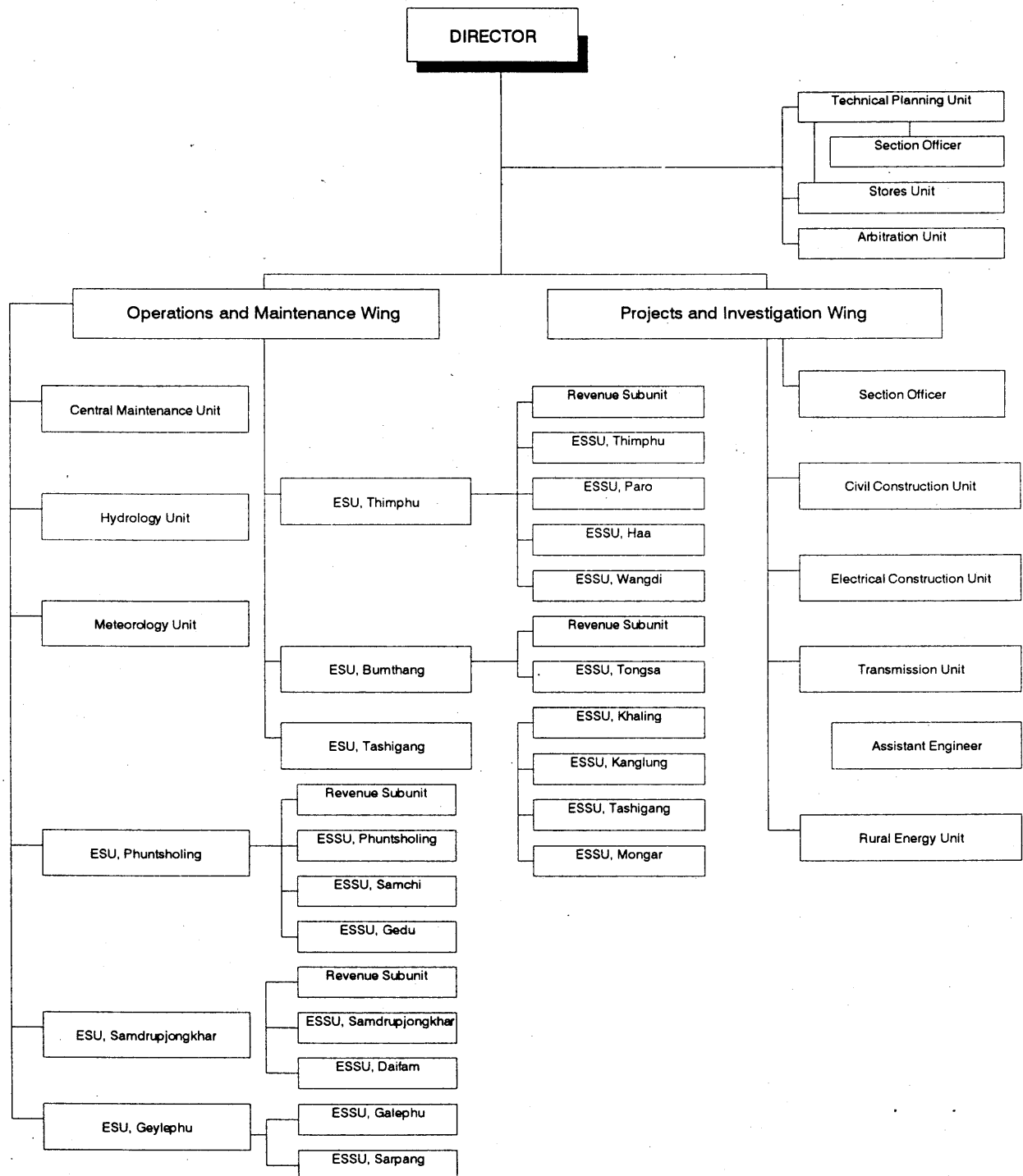
6. The consultant will also review existing design practices of DOP and train DOP engineers based on the latest design criteria being adopted for the Project in accordance with International Electrotechnical Commission (IEC) standards. Manuals will be prepared on the designs of the system.

7. The consultant will assist and train DOP staff in store management and materials despatch to site as per erection schedule.

D. Reporting

8. In addition to the reports on bid evaluations, factory inspections and testing, the consultant will report monthly to the Director of DOP and assist in preparing DOP's quarterly reports to the Bank on the progress being made. The consultant will present a final report on the Project to DOP and the Bank on completion of the services.

ORGANIZATION CHART DIVISION OF POWER



SUMMARY INITIAL ENVIRONMENTAL EXAMINATION

A. Introduction

1. This summary initial environmental examination (SIEE) for the proposed Rural Electrification Project is based on the investigations and findings of the consultants under TA No. 2043-BHU.
2. The SIEE incorporates information gathered and analysed by the staff of the Division of Power (DOP). The data gathering was based on extensive field surveys.
3. The SIEE follows the Bank's standard format for such reports and addresses potential environmental impacts resulting from the location, design, construction, operation, and maintenance of the Project.

B. Description of the Project

1. Type of Project

4. The Project is an integral part of the rural electrification program prepared by DOP under the Seventh Plan (1992-1997). The Project is consistent with the Royal Government of Bhutan's (the Government) development policies and the Bank's focus on the development of infrastructure in Bhutan.

2. Category of Project

5. The Project may have some adverse environmental impact, but of a minor nature. Therefore, it is classified under the Bank's Guidelines as Category "B".
6. The Government does not consider that a full environmental impact assessment (EIA) is necessary based on previous experience with rural electrification projects of this type.

3. Need for Project

7. More than 85 percent of Bhutanese people live in rural areas and most of them do not have access to electricity. Almost all the energy consumed in rural areas is fuelwood. This puts pressure on the forest resource. Fuelwood is mostly used for cooking purposes, except for a few more wealthy citizens living in district headquarters who use liquified petroleum gas (LPG). Most Government civil servants use kerosene cookers. Several smokeless stoves have been installed as a result of a Government program to reduce fuelwood consumption with assistance from the United Nations Development Programme (UNDP).

8. Kerosene lamps (wick type in rural areas and pressurized type in urban areas) are mostly used for lighting. People in remote areas who cannot afford or do not have access to kerosene, still use resin and coniferous wood sticks for lighting.

9. To improve the standard of living of the rural population and promote economic development, the Government's Seventh Plan provides for an expansion of rural electrification. The existing network is to be extended into rural areas wherever there is excess power available.

10. The Project provides for the extension of high-voltage (HV) distribution systems from the nearest power sources to distribution transformers in designated villages, together with the associated low-voltage (LV) networks and consumer service connections.

4. Location

11. The Project covers seven districts in Bhutan:

- (i) Chhuka
- (ii) Paro
- (iii) Punakha
- (iv) Tashigang
- (v) Tashiyangtse
- (vi) Thimphu
- (vii) Wangdiphodrang

5. Size of Operation

12. The Project is to provide the infrastructure to connect a total of about 3,100 new customers to electricity in those districts. In addition to the construction of the distribution networks, some limited financing has been included for tools, plant, vehicles and regional maintenance centers.

6. Description of Project

13. The Project will entail the construction of overhead electric lines at voltages of 33 kV, 11 kV and LV. The lines will be of pole type construction. Distribution transformers and associated equipment (distribution substations) will be mounted on the poles for supply of power into the LV lines, connecting from there to customer's houses and premises. Some small substations will be constructed on the ground for switching of the feeder lines and control of the power flows. Support facilities in the form of offices and depots of spare parts and maintenance vehicles and equipment will be constructed. Existing buildings and facilities may also be used for this purpose.

C. Description of the Environment

1. Physical Resources

a. Topography

14. Bhutan is located along the Himalayan Mountains and is very mountainous. The Project will span the country from east to west, therefore all topographical features ranging from valleys to mountain ridges will be encountered.

b. Climate

15. The climate in the area is alpine/tropical. Maximum temperatures reach approximately 40°C, but in the mountains temperatures can fall to -20°C during the winter months. Bhutan receives high seasonal rainfall particularly in the monsoon season.

2. Ecological Resources

16. Over 60 percent of Bhutan's area is covered by forest. In the area covered by the project, the forest is composed primarily of blue pines and other species of pine and fir. Many areas of forest remain untouched because of their remoteness and inaccessibility.

17. The natural areas that are not forested are commonly covered by temperate grasslands.

18. The Namgyel Wangchuck and Jigme Dorji wildlife sanctuaries in the southern part and northern part of Bhutan respectively were created to protect wildlife resources and endangered species. Districts that encroach on these wildlife sanctuaries will not be electrified.

3. Human and Economic Development

a. Population and Communities

19. Bhutan has the lowest population density of the Himalayan nations with approximately 28 people per square kilometer (km²). Generally, the areas to be electrified by the Project are some of the most populated in the country. These areas are characterised by widely scattered houses with small numbers of shops and some light industry. Certain villages in the area covered by the Project are administrative centers and have basic health units, hotels, or guest houses, Royal Bhutan Police centers and small local government offices. Primary and community schools are located throughout the area. Most of the roads in the area are sealed.

b. Industries / Infrastructure

20. The Chhukha District is the only area with major industrial activities comprising the five largest customers of DOP (Bhutan Ferro Alloys Ltd, Bhutan Chemical and Calcium Carbide Ltd, a plywood factory, and two cement companies).

21. There are no industrial manufacturing units, although there are timber sawmills running on diesel in some locations. In some cases, the timber is still sawn by hand. There are a few flour and husking mills running on diesel (where accessible) or water power. There are also some restaurants and small factories that make paper by hand. Most of the shops sell ready-made garments, food products, and village handicrafts.

22. There are only a few banking facilities in the larger villages.

23. The Government is encouraging small industrial development and providing training in business management. Banking institutions such as Bhutan Development Finance Corporation, are considering loans to viable small-scale industries in the major centers. Housing and trucking loans are also being considered by the agencies concerned. The Bank of Bhutan is considering expanding the scheme to provide loans for small-scale business artisans.

c. Agricultural and mineral development

24. The Seventh Plan includes plans to establish agricultural extension centers. It also includes proposals for soil conservation, plant protection, seeds and seedling supply, farm mechanization, soil fertility development, cash crop development programs, and livestock and animal health improvement programs. In the forestry sector, there are plans for plantation, reinforcement and development of community forestry, development of critical watersheds, forest roads, and range offices.

25. Some areas are irrigated.

4. Quality of Life Values

a. Socioeconomic values

26. Most people make their living by subsistence farming. They grow maize, rice, wheat, buckwheat, millet and other cash crops such as potatoes, oranges, apples, and mustard. Families living near the edge of the forest raise cattle. At higher altitudes, the yaks are also raised. Some families rear pigs (one or two), keep poultry for eggs and a horse or mule for transport. They use the produce of the land for their own subsistence and for making alcoholic drinks and seldom have a surplus to sell. Most food products such as rice, wheat, and barley flour, salt, edible oils, milk products, and dry fish are imported through the Food Corporation of Bhutan and sold at the shops in the area.

27. Exports from the areas covered by the Project mainly consist of cash crops, handicrafts and woven clothes, and dairy products such as yak cheese and butter.

b. Public health

28. Basic health units are located in some of the villages that will be electrified. The efficiency of the basic health units is restricted by the use of photovoltaic electricity, which provides limited energy for lighting and equipment.

c. Aesthetic values

29. As the LV and HV lines will follow main roads the reduction of aesthetic values in the area will be minimal compared with the largely unspoiled surroundings.

D. Screening of Potential Environmental Impacts and Mitigation Measures

1. Environmental Problems Related to Location

a. Resettlement Issues

30. Small parcels of land may be required for the Project for substations at various locations and for maintenance cells covering several villages. Most of the land required is presently privately owned and will need to be acquired from its owners. Some of the land is cultivated. The presently cultivated area required for permanent facilities, however, is expected to be minimal.

b. Ecological Impacts

31. The areas covered by the Project have already been greatly modified by human activity and field visits have indicated that there are not any populations of rare or endangered species living nearby that would be affected by the Project or associated construction activities.

2. Environmental Problems Related to Design

32. The electricity will be distributed throughout the area covered by the Project by overhead power lines and substations (the alternative of underground cables is not cost-effective in rural areas such as those covered by the Project). The lines will generally run along road sides and only minor clearing will be required for the lines and substations. Where possible HV and LV lines will follow existing roads and not require clearing the forest.

33. Careful route planning will ensure that cultural features in the area such as temples and monasteries will not be disturbed.

34. The impact of the lines and substations will not be significant other than in terms of visual appearance and the introduction of hazards arising from the presence of live wires and equipment.

3. Environmental Problems Associated with the Construction Stage

35. Some social impact will arise as a result of the presence of the installation workforce during erection of the lines and connection of houses to the network. This force will number around 60 to 100 throughout the area. Mostly, the installation workforce will be recruited from Bhutan, with some foreign nationals to assist in the initial phases of supervision of the Project. The provision of accommodation and services for the construction force will not have a major impact.

36. DOP will utilize local labor to carry out the civil works. Some skilled workers will be recruited from other parts of Bhutan.

37. The construction stage will not create any significant ecological impacts.

4. Environmental Problems Resulting from Project Operations

38. It is recommended that as areas become connected to the networks, DOP will undertake a public awareness campaign to reduce the possibility of health hazards such as the dangers of electricity.

39. A UNDP-financed study on rural energy development that will commence soon includes a component related to public safety and the proper management of electrical current and appliances. Its objective is to reduce the level of electricity-related accidents that usually follow the introduction of electricity to new users. DOP will monitor the effectiveness of this campaign and incorporate its recommendations in its orientation program for the rural electrification schemes covered by the Project.

40. The design and installation for the permanent administrative and maintenance offices (of which there will be up to 15) will follow local practices. There should be no significant impact.

41. The permanent labor force engaged on maintenance of the networks and collection of payments will number 50 to 60 (average of 8 per district). These staff will be Bhutanese and will be employed to maintain lines in their native district, thus having no impact on local social systems.

42. The operational phase will not generate any significant ecological impacts, and may bring about benefits where electricity substitutes for the use of fossil fuels or wood burning.

5. Potential Environmental Enhancement Measures

43. The main potential environmental enhancement measures are local social impacts which are considered to be significant and mostly positive. They will include:

- (i) Availability of a renewable and more convenient form of energy for light, motive power and heat, all essential elements for social and commercial life.
- (ii) Improved electricity-dependent infrastructure (such as water pumping, telecommunications)
- (iii) An improvement in the quality of life through:
 - (a) Availability of better lighting with consequential improvement in living conditions and educational opportunities

- (b) Improvement of infrastructure and social services for positive regional development arising through the availability of electricity.
- (c) The creation of jobs through the availability of motive power for small industries in the medium term.
- (iv) Substitution of electricity for fuelwood for cooking and heating will reduce fuelwood consumption and smoke production; although this benefit will be achieved only over time and may not match present expectations. Conversion from wood to electricity for fuel is also likely to reduce the rate of local deforestation.

6. Additional Considerations (Compensation)

44. A factor which should be considered is the compensation of landowners where poles will need to be located on their properties. Where private property is required for the Project, the owners of the land will be consulted by DOP in order to negotiate right of access. The existing DOP compensation rates for the area required and trees felled for the foundations of each tower are shown in Annex.

45. Consultation and compensation will be undertaken once the design of the Project has progressed to the next stage.

E. Institutional Requirement and Environmental Monitoring Program

46. Environmental monitoring will be conducted as a part of DOP's regular monitoring program. Particular note will be made of erosion problems, and timely remedial measures will be undertaken. Monitoring of forest resources and other ecological resources is the responsibility of the Bhutan Forestry Commission. Nonetheless, DOP's monitoring units will also note adverse changes to ecological resources, if any, during their regular inspection trips and notify the relevant authorities. The same will be done concerning socioeconomic conditions if required.

F. Findings and Recommendations

47. The main findings and recommendations are:

- (i) there will be significant social and quality of life benefits for people in areas connected under the Project;
- (ii) there will be minimal impact on the environment as LV and HV lines will follow established roads where possible;
- (iii) local residents should be consulted as to the planning of the works and compensation should be paid where productive land is lost; and

- (iv) an education program about the health hazards should be implemented as electrification proceeds.

G. Conclusions

48. From the results compiled from the socioeconomic evaluation, it is clear that the Project will have a positive impact on the people living in the areas concerned and their social environment.

49. Although the Government does not require preparation of an EIA for such projects, the screening process has been thorough. The proposed works will not affect any nationally or internationally endangered wildlife and flora. Therefore, a full EIA is not required.

Attachment : Annex - DOP Compensation Amounts

COMPENSATION AMOUNTS

A. Royalty Rates

1. Royalty for sand, stone, and boulders Nu40 per truckload
2. Royalty for felling trees (standing) varies from Nu6 to Nu4,000 per tree depending upon girth and species class.

B. Land Compensation Rates

1. Town Areas

- | | | |
|----|--------------|-------------------|
| a. | Class A town | Nu65,300 per acre |
| b. | Class B town | Nu43,500 per acre |
| c. | Class C town | Nu30,500 per acre |

2. Rural Areas

- | | | | |
|----|-----------------------------------|-----------|-------------------------------------|
| a. | Paddy field (wet) | Class I | Nu30,000 per acre |
| | same | Class II | Nu20,000 per acre |
| | same | Class III | Nu15,000 per acre |
| b. | Paddy field (dry) | Class I | Nu15,000 per acre |
| | same | Class II | Nu10,000 per acre |
| | same | Class III | Nu8,000 per acre |
| c. | Pangshi or Cheri (community land) | | up to a maximum of Nu3,000 per acre |
| d. | Grazing land | | Nu200 per acre |

3. Orchard

Nu15,000 per acre for land plus fruit trees compensation as follows:

a. Apple trees

- | | | |
|-------------------|--------|----------------|
| Non-fruit bearing | 1 year | Nu25 per tree |
| Non-fruit bearing | 2 year | Nu37 per tree |
| Non-fruit bearing | 3 year | Nu47 per tree |
| Non-fruit bearing | 4 year | Nu57 per tree |
| Fruit bearing | 5 year | Nu450 per tree |

b. Orange trees

- | | | |
|-------------------|--------|----------------|
| Non-fruit bearing | 1 year | Nu20 per tree |
| Non-fruit bearing | 2 year | Nu30 per tree |
| Non-fruit bearing | 3 year | Nu40 per tree |
| Non-fruit bearing | 4 year | Nu50 per tree |
| Non-fruit bearing | 5 year | Nu60 per tree |
| Non-fruit bearing | 6 year | Nu70 per tree |
| Fruit bearing | 7 year | Nu350 per tree |

c. Walnut trees		
Non-fruit bearing	1 year	Nu27 per tree
Non-fruit bearing	2 year	Nu37 per tree
Non-fruit bearing	3 year	Nu47 per tree
Non-fruit bearing	4 year	Nu57 per tree
Non-fruit bearing	5 year	Nu67 per tree
Non-fruit bearing	6 year	Nu77 per tree
Fruit bearing	7 year	Nu900 per tree
d. Arecanut trees		
Non-fruit bearing	1 year	Nu7.50 per tree
Non-fruit bearing	2 year	Nu8.75 per tree
Non-fruit bearing	3 year	Nu10.00 per tree
Non-fruit bearing	4 year	Nu11.25 per tree
Non-fruit bearing	5 year	Nu12.50 per tree
Non-fruit bearing	6 year	Nu13.75 per tree
Fruit bearing	7 year	Nu130 per tree
e. Peach, peas, plum and apricot, etc.		
Local		
	Non-fruit bearing	Nu35 per tree
	Fruit bearing	Nu100 per tree
Developed		
	Non-fruit bearing	Nu35 per tree
	Fruit bearing	Nu300 per tree
f. Cardamon		
Non-fruit bearing	1 year	Nu2,300 per acre
Non-fruit bearing	2 year	Nu3,300 per acre
Non-fruit bearing	3 year	Nu4,300 per acre
Fruit bearing	4 year	Nu15,000 per acre

**TECHNICAL ASSISTANCE FOR
INSTITUTIONAL AND FINANCIAL DEVELOPMENT OF DOP
Terms of Reference**

A. Background

1. The Division of Power (DOP) under the Ministry of Trade and Industry of the Kingdom of Bhutan is responsible for the power sector in Bhutan. As a first step in reorganizing the power sector, the Royal Government of Bhutan (the Government) has requested the Bank for a technical assistance (TA) grant to determine the financial reporting requirements of DOP, to assist them in implementing a utility accounting system to meet these requirements, and to develop a tariff structure adequate to support the needs of the sector.

2. The proposed TA will consist of two parts: Part A: Institutional and Financial Development of DOP and Part B: National Tariff Study. The Bank wishes to engage the services of two teams of consultants separately to carry out the two parts. However, the two teams are expected to coordinate their activities and consult each other for the efficient implementation of the TA.

B. Part A: Financial Development of the Division of Power

1. Scope of Work

3. The scope of work will include:
- (i) a brief diagnostic study to review the current systems and practices;
 - (ii) installation and efficient operation of basic, computerized accounting systems and procedures with particular emphasis on the modules of the overall system that are essential to account for: (a) generation and bulk purchase of electricity; (b) sales to consumers; (c) own use by DOP and their employees; (d) receivables due from consumers; and (e) transfer of cash between accounting units.
 - (iii) installation and efficient operation of appropriate internal control and financial planning, budgeting and monitoring systems for improved management and control; and
 - (iv) recommendations for training programs to be developed.

2. Terms of Reference

4. The consultant will review financial system needs of DOP and should initially concentrate on: (i) a consumer accounting system; (ii) cash collection; (iii) receipt and reconciliation of cash at regional bank account and transfers to the main account; (iv) system operational statistics to identify and account for losses in specific supply areas; and (v) inventory and stores management system. The overall review will cover work completed by the previous consultants, the system installed by Chhuka Hydropower Corporation, and as a minimum, cover the systems listed below:

- Billing, Receivables, and Consumer Accounting
- Cash, Petty Cash, and Bank Reconciliation
- System Operations Accounting System
- General Ledger and All Subsidiary Ledgers
- Accounts Payable
- Accounts Payable
- Payroll
- Rechargeable Works
- Purchasing
- Stock Control, Stores Movements, and Stores Accounting
- Time Recording and Costing
- Fixed Assets
- Depreciation
- Financial Planning and Budgetary Control Systems by Responsibility Centers
- Cash Management
- Fund Management
- Loan Administration and Accounting
- Project Accounting
- Verification and Performance Audit
- Preparation of Monthly, Quarterly, and Annual Accounts

5. The work of the consultant will include arrangements for the following: (i) source data; (ii) files; (iii) outputs; (iv) procedures; (v) verification and control processes; (vi) user training, timetables and supervision; and (vii) documentation of the system, including the use of appropriate flow charts and the need for the documentation to be in English. The consultant will identify causes where major system weaknesses could occur including: (i) inability of the system to produce the required level of detailed information; (ii) lack of staff knowledge and need for training; (iii) lack of system verification including balancing, checking, reviewing and inadequate system control and supervision; and (iv) inadequate documentation of procedures. After identifying the needs of DOP, the consultant will set up the consumer accounting system (from micro to macro level), the expected steps in setting up the system are as follows:

- (i) where applicable, set up the consumer accounting records on computer;
- (ii) prepare manuals for the operation and maintenance of the pilot system in English;
- (iii) train DOP staff in the operation and maintenance of the pilot system;
- (iv) operate the system, monitor the results and the crosschecks built into the system, and amend the system, if necessary;
- (v) finalize the accounting manuals in preparation for implementation during a later phase;
- (vi) prepare a report giving details of the installed system including: (a) level of staff required to operate the systems (including qualifications, experience and knowledge); (b) training required for system operators and users; (c) amendments, if necessary, to job descriptions or control/reporting/management structure; (d) review and control procedures (including verification and reconciliation); (e) implementation plan with order of priorities; (f) budget requirements; and (g) clearly defined supervisory responsibilities for operating and maintaining the systems.

3. Reporting Requirements

a. Inception Report

6. The consultant will submit an inception report for Bank approval within six weeks of commencement of the assignment. The report shall detail initial findings, proposed methodology and the timetable for the remaining work to be completed under the study. Four copies each of the inception report shall be submitted to the Bank, the Government and DOP.

b. Final Report

7. The final report will be submitted at the completion of the assignment. Ten copies of the final report will be submitted to the Government and DOP. Three copies will be submitted to the Bank.

C. Part B: National Tariff Study

1. Objectives

8. The current retail tariff for the public power supply in Bhutan requires adjustment to meet the financial and other objectives of the power sector. The main objectives of the study are to develop a tariff policy based on appropriate financial and social objectives and to formulate suitable tariff structures to meet sector objectives based on voltage levels and consumption patterns.

2. Terms of Reference

9. The terms of reference will include the following:

- (i) review the current pricing structure of the electricity sector. This will include a review of the long-run marginal cost of supply, both economic and financial, at different delivery points, as well as a review of the desirability and practicability of having a uniform tariff throughout the country;
- (ii) carry out a survey of residential consumers to determine their ability and willingness to pay;
- (iii) develop a tariff policy based upon appropriate financial and cost recovery objectives of the power sector and consumers' ability and willingness to pay (considering the introduction of lifeline tariffs for the poor), and the environmental objective of reducing consumption of fuelwood for cooking and heating (considering the introduction of special tariffs for such purposes);
- (iv) review the adequacy or otherwise of the existing tariff both in terms of level and structure based on the tariff policy developed in (iii) above and by drawing on, where appropriate, experience with tariff levels and structure of other power utilities of the region;

- (v) review the billing and collection capabilities of DOP and determine the extent to which these capabilities may affect the implementation of a revised tariff structure; recommend suitable improvements;
- (vi) formulate and recommend an appropriate tariff structure that is consistent with the tariff policy developed in (iii) above, and the billing and collection capabilities of the power companies, and that will enable the power sector to meet its operational budgets and to finance a reasonable proportion of its capital development program (the possibility of new capacity additions under build-operate-transfer-type of investments and their likely costs should be considered in formulating the bulk tariff).

3. Reporting Requirements

a. Inception Report

10. The consultant will submit an inception report for Bank approval within six weeks of the commencement of the assignment. The report will detail initial findings, proposed methodology, and the time table for the remainder of the study. Four copies of the inception report will be submitted to the Bank and four to the Government.

b. Draft Final Report

11. A draft final report will be submitted for approval of the Bank within six months of the commencement of the assignment. Four copies of this report will be submitted to the Bank, four to the Government, and four to the power companies.

c. Final Report

12. The final report will be submitted within one month of the receipt of comments. Three copies of the final report will be submitted to the Bank, ten to the Government and DOP.

D. Executing Agency Inputs

13. The Executing Agency, DOP, will provide free of charge all project information, office accommodation, secretarial services, interpreters, and local communications. The consultants are expected to make their own arrangements for word processing, computer facilities and local transport. For this purpose, personal computers and related software may be purchased under the TA, for subsequent transfer to DOP at the discretion of the Bank.

INSTITUTIONAL AND FINANCIAL DEVELOPMENT OF DOP

Estimated Cost of Technical Assistance (in US Dollars)

Item	Foreign Exchange	Local Currency	Total
A. Financed by the Bank			
1. Consultants			
a. Remuneration - Field	240,000		240,000
b. Per Diem	36,000		36,000
c. International Travel	14,500		14,500
Subtotal - Consultants	290,500		290,500
2. Equipment	28,500		28,500
3. Seminars, Training	3,000		3,000
4. Reports	5,000		5,000
5. Contract Negotiations	4,500		4,500
6. Miscellaneous (Communications) Supplies	9,000		8,500
7. Contingency	<u>60,000</u>		<u>60,000</u>
Subtotal A	400,000		400,000
B. Financed by the Government			
1. Counterpart Staff		15,000	15,000
2. Office Facilities		20,000	20,000
3. Contingencies		<u>5,000</u>	<u>5,000</u>
Subtotal (B)		40,000	40,000
TOTAL (A + B)	400,000	40,000	440,000

INITIAL POTENTIAL DEMAND FORECAST BY DISTRICT

DISTRICT	Consumers		Demand (MWh)	Market Share (%)
	Type	Number		
CHHUKA	Residential	537	466	78
	Commercial	19	88	15
	Public Service	41	47	8
	Total	597	601	100
PARO	Residential	123	178	35
	Commercial	2	283	55
	Public Service	35	51	10
	Total	160	512	100
PUNAKHA	Residential	469	699	54
	Commercial	5	351	27
	Public Service	111	248	19
	Total	585	1,298	100
TASHIGANG	Residential	2,736	4,366	72
	Commercial	27	1,497	25
	Public Service	197	227	4
	Total	2,960	6,090	100
TASHIYANGTSE	Residential	2,052	2,743	88
	Commercial	71	120	4
	Public Service	195	266	9
	Total	2,318	3,129	100
THIMPHU	Residential	85	60	28
	Commercial	3	129	59
	Public Service	16	28	13
	Total	104	217	100
WANGDIPHODRANG	Residential	183	257	100
	Commercial	0	0	0
	Public Service	18	0	0
	Total	201	257	100
TOTAL	Residential	6,185	8,769	72
	Commercial	127	2,468	20
	Public Service	613	867	7
	Total	6,925	12,104	100

FINANCIAL AND ECONOMIC EVALUATION

A. COST ASSUMPTIONS

1. The capital cost for the Project has been estimated in US dollars and expressed in 1995 price terms. The capital cost is net of interest during construction, provision for price escalation and taxes or duties. The life of the low-voltage (LV) transmission and distribution equipment is assumed to be 25 years.

2. The annual operation and maintenance costs are estimated to increase from 0.6 per cent of the capital cost to 1.25 percent over the life of each scheme. System losses are assumed to be 15 percent. For the FIRR calculation, the cost of power purchased by DOP from Chhuka is based on the 1995 selling price of Nu0.30 (\$0.0097/kWh). For the EIRR calculation, the power purchase price is based on the long-run marginal cost (LRMC) of generation of Nu0.50 (\$0.016/kWh), as derived in para. 40 of the main text.

B. BENEFIT ASSUMPTIONS

1. Financial Internal Rate of Return

3. The market consists of 3,147 prospective customers in seven districts. All of the villages in the selected districts have been classified as undergoing rapid development implying that 90 percent of the households, constituting 74 percent of the market, will be connected to the distribution system within the first five years. The load forecast is based on an average monthly consumption of 124 kWh per household, 122 kWh per public service, and 207 kWh per commercial establishment to be connected and takes into consideration consumption growth rates, population growth, electrification ratios, diversity factors, and daily load profiles.

4. Revenues are based on the projected LV real tariff rates shown in Appendix 4, rising to Nu1.05 or \$0.035 per kWh in the year 2000 and Nu1.55 (\$0.05/kWh) in the year 2004.

2. Economic Internal Rate of Return

5. For the economic analysis, the benefits have been valued on the basis of revenue cost savings (RCS) for the diverted market and consumers willingness to pay (WTP) for the generated market. WTP has been estimated at \$0.09/kWh. It is assumed that 75 percent of incremental sales, after year one, are from new consumers (diverted and generated) and 25 percent of incremental sales are from existing consumers whose consumer surplus is negligible. The lower bound of the WTP is the tariff value (\$0.035). The upper bound of the WTP is the financial cost of kerosene lighting for consumers. The consumer surplus for the generated market is estimated as equivalent to 40 percent of the difference between the consumers maximum WTP and the tariff rates. The load forecast assumes residential consumption to be 73 percent of the incremental sales, commercial consumption 20 percent, and public service 7 percent.

6. The financial price of kerosene is Nu3.9/liter (\$0.13/liter) and the economic price is Nu5.26/liter (\$0.17/liter). Consumption of 0.025 liters per hour is assumed equivalent to a 40 Watt (W) bulb. Kerosene prices were increased by 70 percent to reflect transport costs to the seven districts. The cost of owning and maintaining kerosene lighting is estimated to be approximately equivalent to the annual charges associated with the cost of the light bulbs and house wiring and therefore these costs have been exclusively from the analysis. The cost of fuelwood, a primary source of energy to be displaced, is not included, because it is available for consumers free of charge.

FINANCIAL INTERNAL RATE OF RETURN

Year	Total Purchases (MWh)	System Losses (%)	Total Sales (MWh)	Electricity Tariff (\$/kWh)	Gross Benefit (\$'000)	Capital Cost (\$'000)	O&M & Power Purchase Cost (\$'000)	Total Cost (\$'000)	Net Benefit Stream (\$'000)
1996				0.019	0.00	843		843	-843
1997	6,836	15	5,944	0.024	142	5,049		5,049	-4,908
1998	8,706	15	7,571	0.028	212	2,526		2,526	-2,314
1999	10,577	15	9,198	0.032	292		111	111	181
2000	12,448	15	10,824	0.035	378		129	129	248
2001	14,319	15	12,451	0.035	434		148	148	287
2002	14,319	15	12,451	0.035	434		173	173	261
2003	14,319	15	12,451	0.035	434		191	191	243
2004	14,319	15	12,451	0.050	623		191	191	431
2005	14,319	15	12,451	0.050	623		191	191	431
2006	14,319	15	12,451	0.050	623		199	199	424
2007	14,319	15	12,451	0.050	623		199	199	424
2008	14,319	15	12,451	0.050	623		199	199	424
2009	14,319	15	12,451	0.050	623		199	199	424
2010	14,319	15	12,451	0.050	623		206	206	416
2011	14,319	15	12,451	0.050	623		206	206	416
2012	14,319	15	12,451	0.050	623		206	206	416
2013	14,319	15	12,451	0.050	623		206	206	416
2014	14,319	15	12,451	0.050	623		214	214	409
2015	14,319	15	12,451	0.050	623		214	214	409
2016	14,319	15	12,451	0.050	623		214	214	409
2017	14,319	15	12,451	0.050	623		221	221	401
2018	14,319	15	12,451	0.050	623		221	221	401
2019	14,319	15	12,451	0.050	623		221	221	401
2020	14,319	15	12,451	0.050	623		221	221	401
2021	14,319	15	12,451	0.050	623		229	229	394
2022	14,319	15	12,451	0.050	623		232	229	390
2023	14,319	15	12,451	0.050	623		232	232	390

FIRR = 1.13%

ECONOMIC INTERNAL RATE OF RETURN

Fiscal Year	Total Purchases (MWh)	System Losses (%)	Total Sales (MWh)	Electricity Tariff (\$/kWh)	LRMC of Generation (\$/kWh)	Economic Price of Kerosene (\$/kWh)	Financial Price of Kerosene (\$/kWh)	Economic Benefit Replaced Cost Saving (\$/kWh)	Economic Benefit Diverted Market (\$/kWh)	Economic Benefit Induced Market (\$/kWh)	Incremental Economic Benefit (\$/kWh)	Total Economic Benefit (\$'000)	Capital Cost (\$'000)	O & M plus Purchase Cost (\$'000)	Total Cost (\$'000)	Net Economic Benefit (\$'000)
1996	0	15		0.019	0.016	0.186	0.138	0.000	0.013	0.007	0.038	0	843		843	-843
1997	6,836	15	5,944	0.024	0.016	0.186	0.138	0.031	0.013	0.009	0.093	551	5,049		5,049	-4,498
1998	8,706	15	7,571	0.028	0.016	0.186	0.138	0.031	0.012	0.011	0.096	723	2,526		2,526	-1,803
1999	10,577	15	9,198	0.032	0.016	0.186	0.138	0.031	0.012	0.012	0.098	902	154	154	154	748
2000	12,448	15	10,824	0.035	0.016	0.186	0.138	0.031	0.012	0.013	0.100	1,085	184	184	184	901
2001	14,319	15	12,451	0.035	0.016	0.186	0.138	0.031	0.012	0.013	0.100	1,248	214	214	214	1,034
2002	14,319	15	12,451	0.035	0.016	0.186	0.138	0.031	0.012	0.013	0.100	1,248	252	252	252	996
2003	14,319	15	12,451	0.035	0.016	0.186	0.138	0.031	0.012	0.013	0.100	1,248	282	282	282	967
2004	14,319	15	12,451	0.050	0.016	0.186	0.138	0.025	0.010	0.019	0.100	1,240	282	282	282	958
2005	14,319	15	12,451	0.050	0.016	0.186	0.138	0.031	0.010	0.019	0.111	1,378	282	282	282	1,096
2006	14,319	15	12,451	0.050	0.016	0.186	0.138	0.031	0.010	0.019	0.111	1,378	289	289	289	1,089
2007	14,319	15	12,451	0.050	0.016	0.186	0.138	0.031	0.010	0.019	0.111	1,378	289	289	289	1,089
2008	14,319	15	12,451	0.050	0.016	0.186	0.138	0.031	0.010	0.019	0.111	1,378	289	289	289	1,089
2009	14,319	15	12,451	0.050	0.016	0.186	0.138	0.031	0.010	0.019	0.111	1,378	289	289	289	1,089
2010	14,319	15	12,451	0.050	0.016	0.186	0.138	0.031	0.010	0.019	0.111	1,378	296	296	296	1,081
2011	14,319	15	12,451	0.050	0.016	0.186	0.138	0.031	0.010	0.019	0.111	1,378	296	296	296	1,081
2012	14,319	15	12,451	0.050	0.016	0.186	0.138	0.031	0.010	0.019	0.111	1,378	296	296	296	1,081
2013	14,319	15	12,451	0.050	0.016	0.186	0.138	0.031	0.010	0.019	0.111	1,378	296	296	296	1,081
2014	14,319	15	12,451	0.050	0.016	0.186	0.138	0.031	0.010	0.019	0.111	1,378	304	304	304	1,074
2015	14,319	15	12,451	0.050	0.016	0.186	0.138	0.031	0.010	0.019	0.111	1,378	304	304	304	1,074
2016	14,319	15	12,451	0.050	0.016	0.186	0.138	0.031	0.010	0.019	0.111	1,378	304	304	304	1,074
2017	14,319	15	12,451	0.050	0.016	0.186	0.138	0.031	0.010	0.019	0.111	1,378	304	304	304	1,074
2018	14,319	15	12,451	0.050	0.016	0.186	0.138	0.031	0.010	0.019	0.111	1,378	304	304	304	1,074
2019	14,319	15	12,451	0.050	0.016	0.186	0.138	0.031	0.010	0.019	0.111	1,378	311	311	311	1,066
2020	14,319	15	12,451	0.050	0.016	0.186	0.138	0.031	0.010	0.019	0.111	1,378	311	311	311	1,066
2021	14,319	15	12,451	0.050	0.016	0.186	0.138	0.031	0.010	0.019	0.111	1,378	311	311	311	1,066
2022	14,319	15	12,451	0.050	0.016	0.186	0.138	0.031	0.010	0.019	0.111	1,378	319	319	319	1,059
2023	14,319	15	12,451	0.050	0.016	0.186	0.138	0.031	0.010	0.019	0.111	1,378	323	323	323	1,055

EIRR = 11.9%