No.

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

DEPARTMENT OF POWER MINISTRY OF TRADE AND INDUSTRY
THE KINGDOM OF BHUTAN

FEASIBILITY STUDY ON THE DEVELOPMENT OF PUNATSANGCHHU HYDROPOWER PROJECT IN THE KINGDOM OF BHUTAN

FINAL REPORT

Vol. I

MAIN REPORT

FEBRUARY 2001

ELECTRIC POWER DEVELOPMENT CO.,LTD.

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PREFACE

In response to a request from the Royal Government of Bhutan , the Government of Japan decided to conduct the Feasibility Study on the Punatsangchhu Hydropower Project and entrusted the study to the Japan International Cooperation Agency (JICA) .

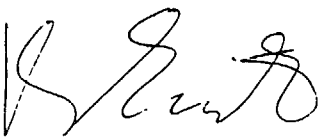
JICA sent a study team led by Mr.Susumu Tsunoda of Electric Power Development Co.,Ltd.(EPDC) to Bhutan seven times from November 1998 to February 2001.

The study team held discussions with the officials concerned of the Royal Government of Bhutan , and conducted related field surveys. The Study Team conducted further studies on the project in his home country , based on the field surveys , then came to the final phase to submit the report after compile.

I hope this report will contribute to the promotion of the plan and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Royal Government of Bhutan for their close cooperation throughout the study.

February 2001



Kunihiko Saito
President
Japan International Cooperation Agency

February 2001

Mr.Kunihiko Saito
President
Japan International Cooperation Agency
Tokyo , Japan

Letter of Transmittal

We are pleased to submit the feasibility study report on the Development of Punatsangchhu Hydropower Project in the Kingdom of Bhutan. The report contains advices and suggestions of the authorities concerned of the Government of Japan and your Agency as well as the formulation of the above mentioned project. Also included are comments made by the Ministry of Trade and Industry of the Royal Government of Bhutan during technical discussions on the draft report which were held in Thimphu.

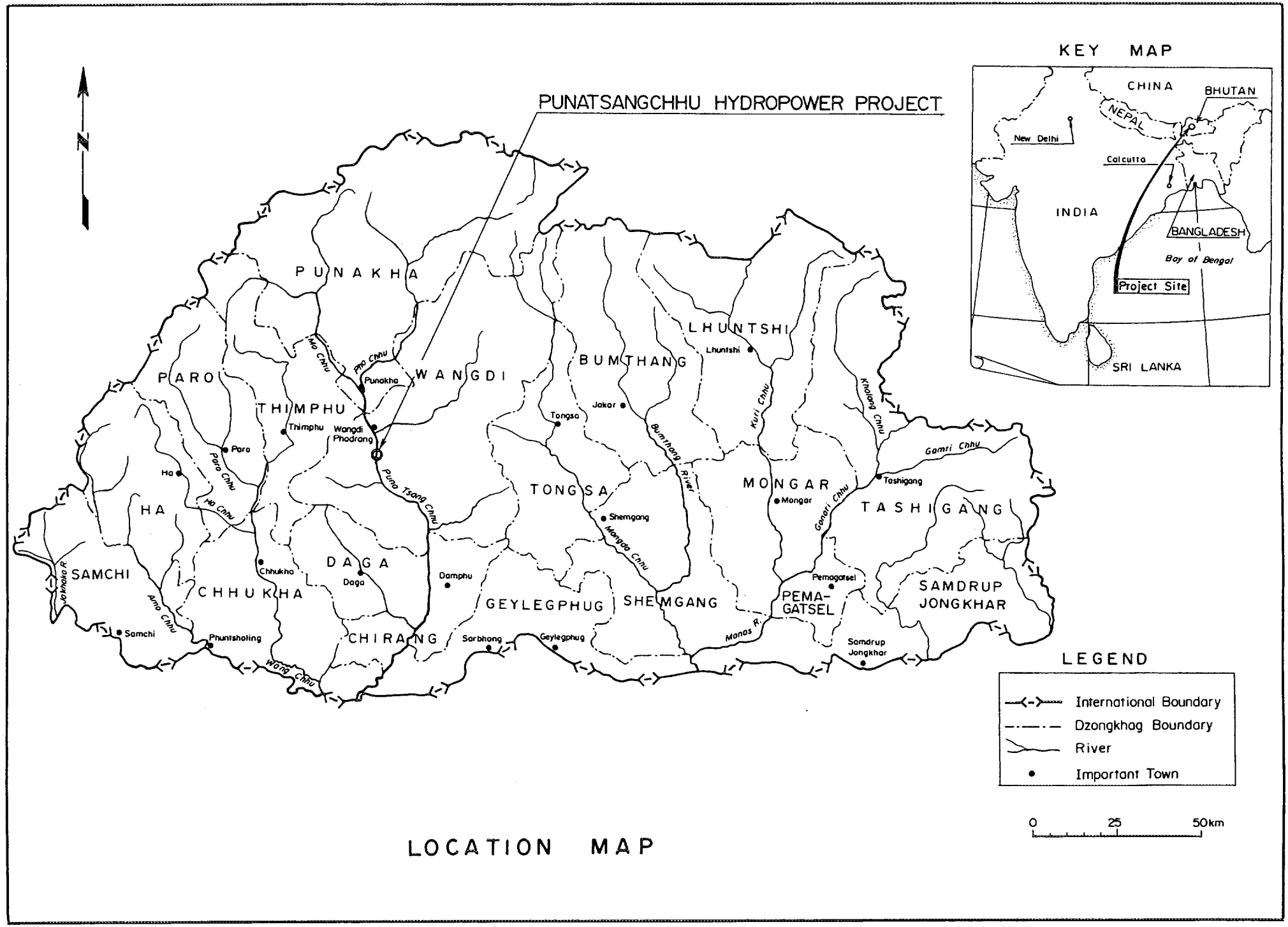
This report presents export-oriented development of a run-of-river type scheme with an installed capacity of 870MW for peak generation, providing annual energy production of 4,330MW. It should be pointed out that the Project has the least adverse effect on environment for its development scale.

In view of the effective use of natural resources as well as the importance of having much revenue from the project to strengthen financial structure of the country, we recommend that the Royal Government of Bhutan implement this Project as a top priority.

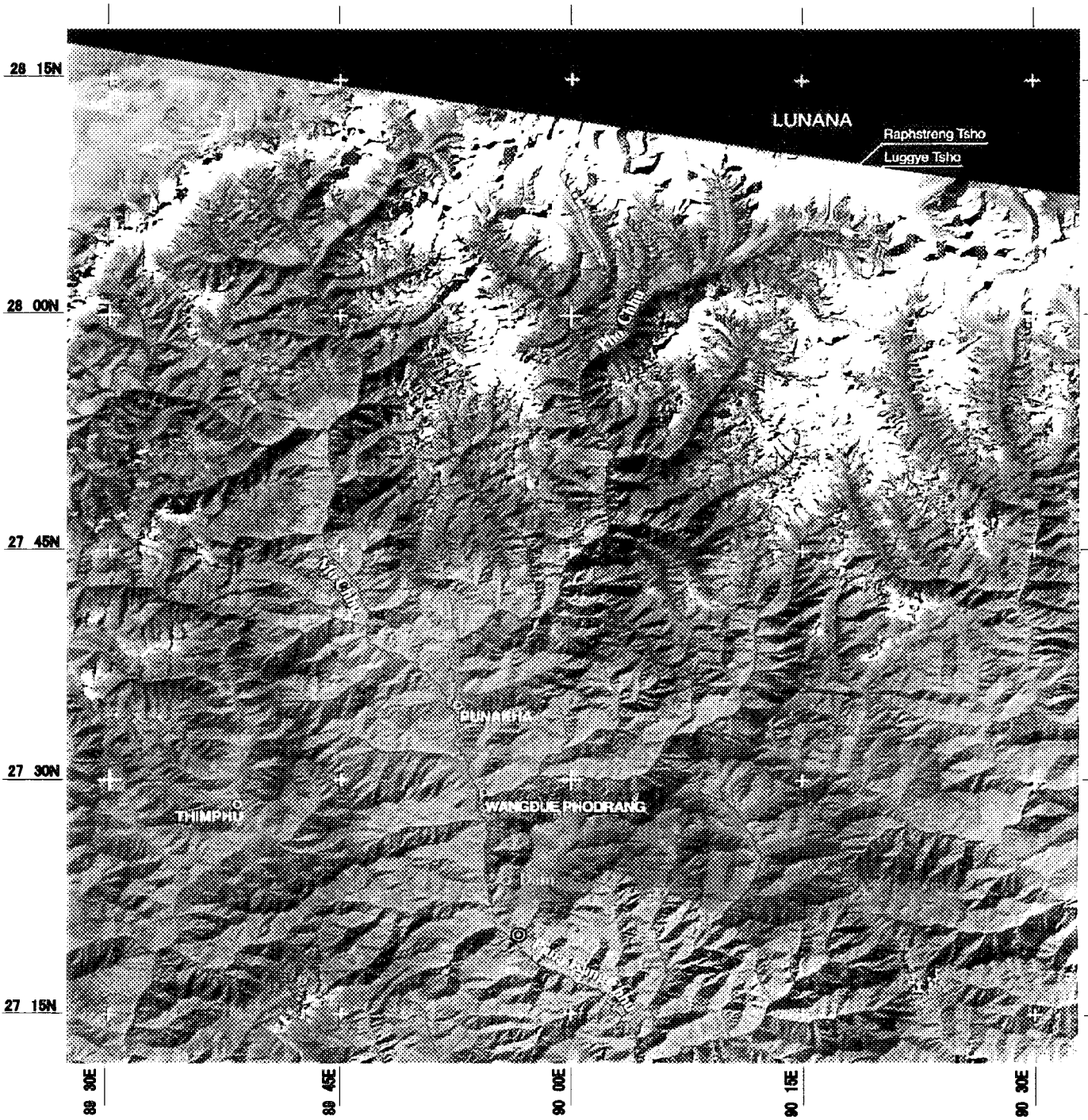
We wish to take this opportunity to express our sincere gratitude to your Agency, the Ministry of Foreign Affairs and the Ministry of Economy and Industry. We also wish to express our deep gratitude to the Ministry of Trade and Industry and other authorities concerned of the Royal Government of Bhutan for the close cooperation and assistance extended to us during our study.

Very truly yours,

Susumu Tsunoda
Team Leader
The study team on the Feasibility Study on the Development of The Punatsangchhu Hydropower Project in the Kingdom of Bhutan


PUNATSANGCHHU HYDROPOWER PROJECT
KEY MAP
CHINA
BHUTAN
NEPAL
New Delhi
Calcutta
INDIA
BANGLADESH
Bay of Bengal
Project Site
SRI LANKA
N
PUNAKHA
PARO
THIMPHU
WANGDI
BUMTHANG
LHUNTSHI
TONGSA
MONGAR
TASHIGANG
HA
SAMCHI
CHHUKHA
DAGA
GEYLEGPHUG
SHEMGANG
PEMA-GATSEL
SAMDRUP JONGKHAR
CHIRANG
Punakha
Thimphu
Wangdi Phodrang
Paro
Ha
Tongsa
Jakar
Lhuntshi
Shemgang
Mongar
Trashigang
Chhukha
Daga
Damphu
Pemagatsel
Samdrup Jongkhar
Samchi
Phuntsholing
Sarbhang
Geylegphug
Jo Khola R.
Amo Chhu
Wang Chhu
Paro Chhu
Ha Chhu
Puna Tsang Chhu
Mangde Chhu
Bumthang River
Kuri Chhu
Kholong Chhu
Gamri Chhu
Gamari Chhu
Manas R.
LEGEND
International Boundary
Dzongkhag Boundary
River
Important Town
0
25
50km
LOCATION MAP

LOCATION MAP OF THE PROJECT

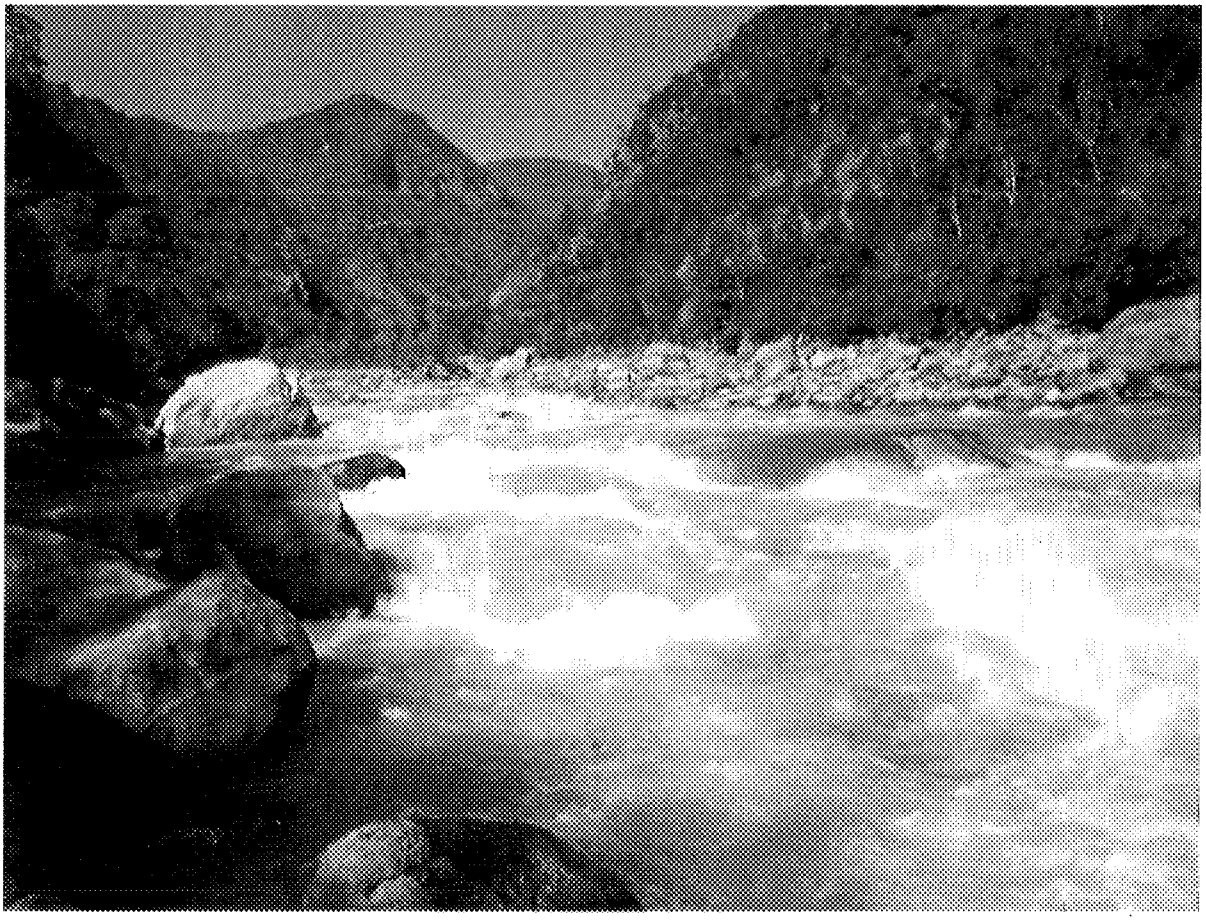


1988 Glacier Lake
1988 & 1998 Glacier Lake
1998 Glacier Lake

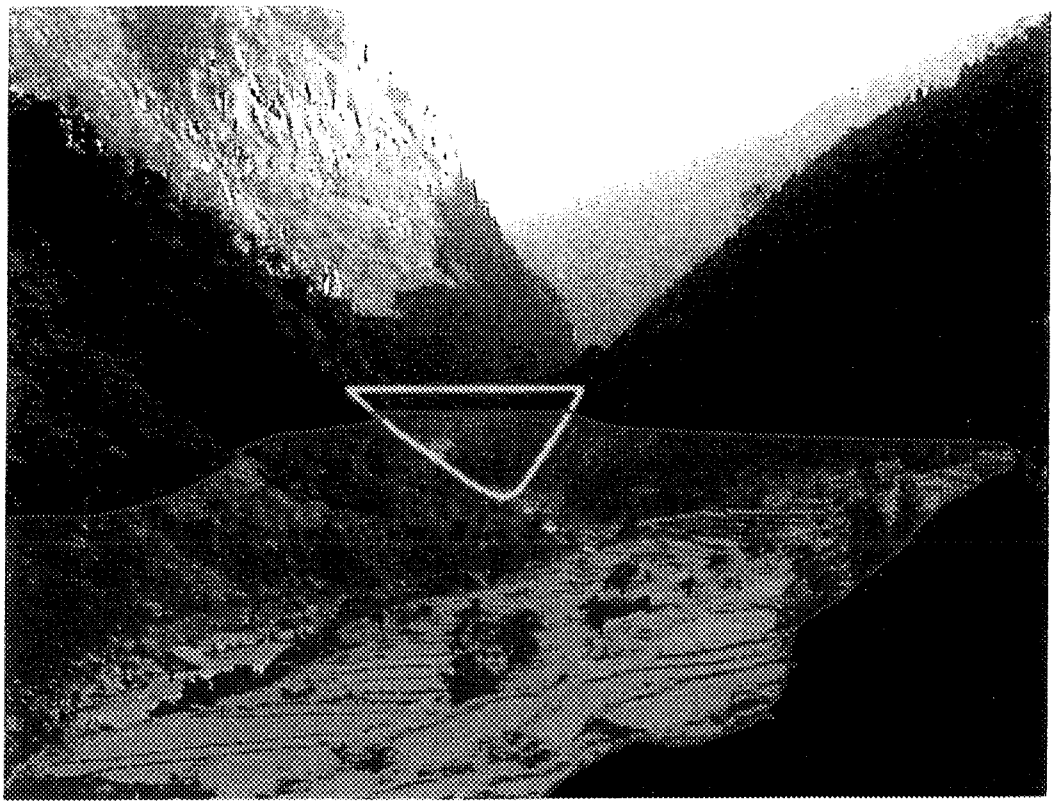
0 30km

1 : 652,000

JICA 1999.3



Upstream View from Dam Site (3.120)

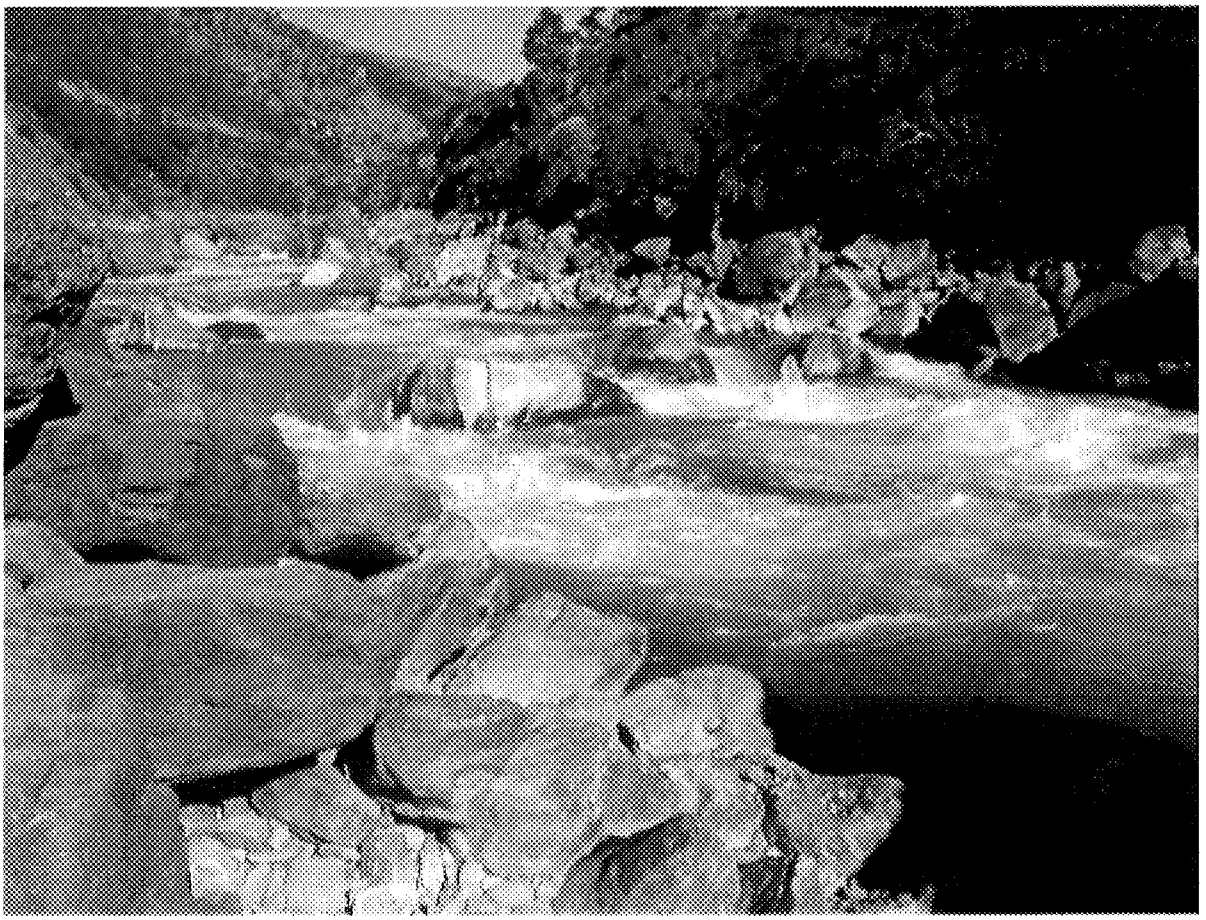


Dam Site (3.120), View from Upstream

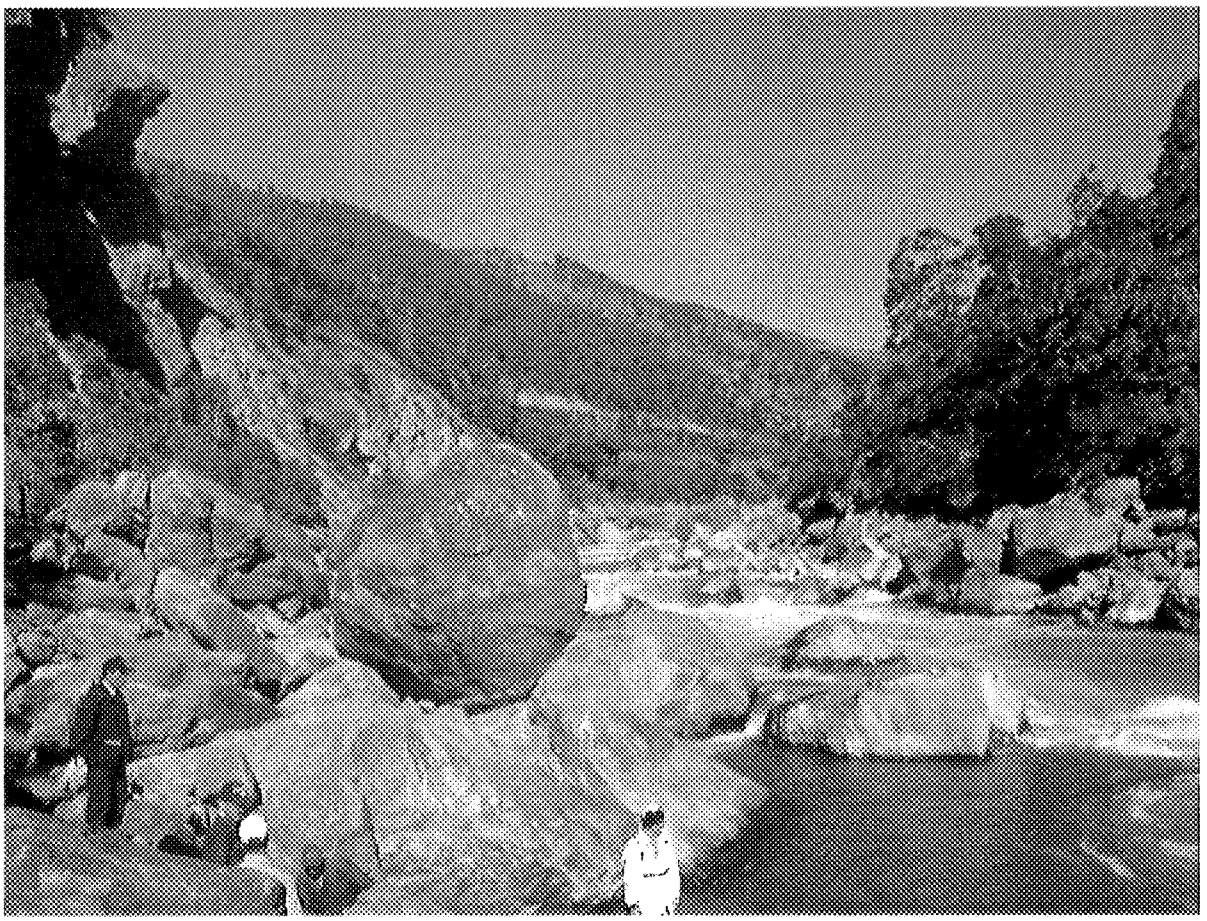
River Flow at Dam Site (3.120)

Upstream View from Dam Site (3.120)

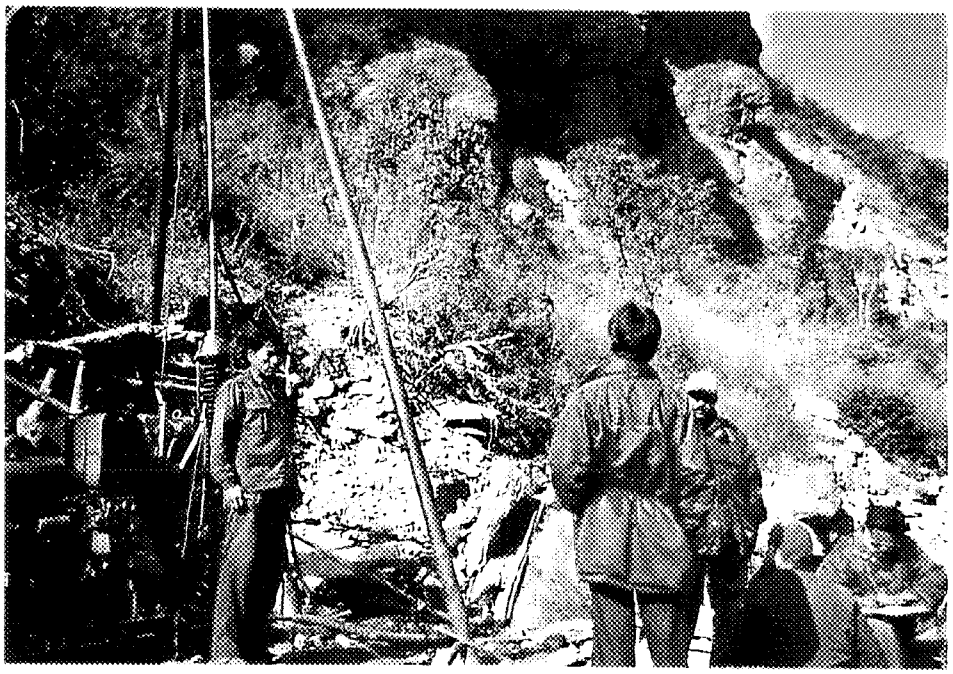
Upstream View from Dam Site (3.120)



Upstream View from Dam Site (3.120)



Upstream View from Dam Site (3.120)



Drilling at Dam Site

Seismic Prospecting

Road Condition at Dam Site

Road Condition (Thimphu – Phuentsoling)

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Conclusion and Recommendation

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ABBREVIATION

1. Country

Bhutan	The Kingdom of Bhutan

2. Domestic Organizations

RGB	The Royal Government of Bhutan
MoF	Ministry of Finance
NEC	National Environmental Commission
MTI	Ministry of Trade & Industry
DoP	Department of Power (ex-Division of Power)
GSB	Geological Survey of Bhutan
SoB	Survey of Bhutan
CHPC	Chhukha Hydro Power Corporation

3. International and Foreign Organizations

JICA	Japan International Cooperation Agency
JOCV	Japan Overseas Cooperation Volunteers
JBIC	Japan Bank for International Cooperation
IBRD	International Bank for Reconstruction and Development
ADB	Asian Development Bank
UNDP	United Nations Development Programme
NORAD	Norwegian Agency for Development Cooperation

4. Technical Terms

CA	Catchment area
PMF	Probable maximum flood
HWL	High water level
LWL	Low water level
IWL	Intake water level
TWL	Tailrace water level
EL	Elevation (m) above sea level
HPP	Hydropower plant (or project)
PS	Power station
GS	Gauging station
S/S	Sub station
T/G	Turbine and generator
T/L	Transmission line
D/L	Distribution line
AC	Alternating current
DC	Direct current

cct	Circuit
S/Y	Switchyard
GIS	Gas insulated switch gear
O&M	Operation and maintenance
Chhu	River
Tsho	Lake

5. **Measurement**

a) Length

mm	Millimeter
cm	Centimeter
m	Meter
km	Kilometer

b) Area

cm^2	Square centimeter
m^2	Square meter
ha	Hectare
km^2	Square kilometer

c) Volume

cm^3	Cubic centimeter
l	Liter
kl	Kiloliter
m^3	Cubic meter
MCM	Million cubic meter

d) Weight

g	Gram
kg	Kilogram
ton or t	Metric ton
tC	Carbon ton
gC	Carbon gram

e) Time

s	Second
min	Minute
h	Hour
d	Day
m	Month
yr	Year

f) Meteorology

C	Degree in centi-grade

K	Degree in Kelvin-grade
mb	Milibar

g) Electrical Measures

V	Volt
kV	Kilovolt
A	Ampere
Hz	Hertz (cycle)
W	Watt
kW	Kilowatt
MW	Megawatt
GW	Gigawatt
kWh	Kilowatt hour
MWh	Megawatt hour
GWh	Gigawatt hour
kVA	Kilovolt ampere

h) Others

Btu	British thermal unit
rpm	Revolutions per minute
%	Percentage
Lu	Lugeon

6. Economic Terms

GDP	Gross domestic product
B/C	Benefit cost ratio
B-C	Net benefit (Net present value)
EIRR	Economic internal rate of return
FIRR	Financial internal rate of return
DSCR	Debt service coverage ratio
LLRC	Loan life coverage ratio
FGC	Financial generation cost
IDC	Interest during construction
F/C	Foreign currency
L/C	Local currency
US$ or $	US dollar
M.US$	Million US dollar
USC or c	US cent
Rs.	Indian Rupee
Nu	Bhutanese Ngultrum
¥	Japanese Yen

PUNATSANGCHHU HYDROPOWER PROJECT

River		
	Name of River	Punatsangchhu
	Catchment Area	5,796 km^2
	Annual Inflow	9,398 × 10^6 m^3 (298 m^3/s)
Reservoir		
	High Water Level	1,161.50 m
	Low Water Level	1,147.00 m
	Available Drawdown	14.50 m
	Sedimentation Level	1,142.00 m
	Gross Storage Capacity	12.49 × 10^6 m^3
	Effective Storage Capacity	4.39 × 10^6 m^3
	Reservoir Area	0.53 km^2
Infrastructure		
	New road (highway)	400 m
	Bridge (permanent)	110 m
Dam		
	Type	Concrete Gravity Dam
	Elevation of Dam Crest	1,171.00 m
	Elevation of riverbed	1,090.00 m
	Height of Dam (from foundation)	141.00 m
	Length of Dam Crest	265 m
	Volume of Dam	830 × 10^3 m^3
Diversion Tunnel		
	Design Flood	1,470 m^3/s
	Type	Standard Horse Shoe, Pressure, Concrete Lining
	Number	Two
	Inner Diameter	7.80 m
	Length	822 m/932 m
Outlet Equipment		
	Type	Service: Jet Flow Gate
		Auxiliary: High Pressure Slide Gate

Spillway

Design Flood	13,900 m^3/s
Type	Shute with Gates
Elevation of Overflow Crest	1,142.00 m
Width of Overflow Crest	84.00 m (excluding pier width)
Energy Dissipator	Bucket Type
Type of Gate	Radial Gate
Number of Gate	Seven
Size of Gate	Width 12.00 m × Height 20.00 m

Emergency Spillway

Type	Flap Gate
Number	4
Size of Gate	Width 12.00 m × Height 5.00 m

Intake

Type	Horizontal
Number	Four
Elevation of Inlet Sill	1,144.00 m
Size	Width 10.50 m×Height 17.00 m
Type of Gate	Roller Gate
Number of Gate	Four
Size of Gate	Width 5.00 m×Height 5.00 m

Intake Tunnel

Type	Half Circle Half Rectangular, Concrete Lining
Number	Four Lines
Discharge Capacity	87.00 m^3/s per line × 4
Inner Diameter	5.00 m
Total Length	1,003 m

Settling Basin

Type	Underground, Concrete Lining
Number	Four
Size	Width 20.00 m × Height 37.00 ~ 41.00 m
Length	130.00 m

Headrace Tunnel

Type	Circular, Concrete Lining

	Number	Two Lines
	Max. Discharge	174.00 m^3/s per line × 2
	Inner Diameter	7.40 m
	Length	7,023 m/6,959 m
Surge Tank		
	Type	Orifice Type, Concrete Lining
	Number	Two
	Size	Diameter 15.00m×Height 63.00m
Penstock		
	Type	Steel Embedded
	Number	Four Lines
	Inner Diameter	7.40～3.20m
	Total length	1,037 m
Powerhouse		
	Type	Underground, Shotcrete· PS anchor
	Size	Width 20.00m×Height 38.00m×Length114.00 m
Access Tunnel		
	Type	Half Circle Half Rectangular, Concrete Lining
	Size	Width 6.00m×Height 6.00m×Length477m
Cable Tunnel		
	Type	Half Circle Half Rectangular, Concrete Lining
	Size	Width 4.00m×Height 4.00m×Length342m
Transformer House		
	Type	Underground, Shotcrete • PS anchor
	Size	Width 10.00m×Height 10.00m×Length 114.00m
Tailrace Tunnel		
	Type	Circular, Concrete Lining
	Number	Two Lines
	Max. Discharge	174.00 m^3/s per line × 2
	Inner Diameter	7.40 m
	Length	347 m/307 m
Development Plan		
	Normal Intake Water Level	1,154.30 m
	Normal Tail Water Level	845.00 m

	Gross Head	309.30 m
	Effective Head	286.30 m
	Maximum Discharge	348.00 m^3/s for 6 units
	Number of Unit	Six
	Installed Capacity	870 MW
	Firm Peak Power	859 MW
Turbine		
	Type	Vertical Shaft, Francis Turbine
	Number	Six
	Max. Discharge	58.00 m^3/s per unit
	Turbine Output	148,500 kW
	Revolving Speed	300 rpm
Generator		
	Type	Three phases
		Alternating Current
		Synchronous
	Number	Six
	Rated Output	161,700 kVA
	Revolving Speed	300 rpm
	Frequency	50 Hz
	Voltage	15 kV
	Power Factor	0.9 lag
Main Transformer		
	Type	Indoor special three phases, Forced-oil-forced-air
		Cooled type
	Number	Six(6)
	Capacity	161,700 kVA
	Voltage	(Primary) 15 kV
		(Secondary) 400 kV
Switchyard	Bus System	Double Buses with Bus Tie
	Bus Conductor Type	ACSR
	Number of Lines Connected	2 cct Transmission Line

	Voltage	400 kV	
	Conductor Type	ACSR	
Transmission Line	Length	140 km (80 km in Bhutan, 60 km in India)	
	Type of Transmission Tower	Steel lattice tower	
	Number of Circuit	Two(2), (Vertical configuration)	
	Voltage	400kV	
	Conductor Type	1,351.5 MCM ACSR (Martin)	
Annual Energy Production	Average Energy	4,330 GWh	
	Firm Energy	1,268 GWh	
Construction Period		6 years	
Project Cost		36.3×10^9 Nu (813×10^6 US$)	
Unit Construction Cost	Per kW	41,754 Nu/kW (934 US$/kW)	
Economic/Financial Evaluation	Financial Generation Cost	2.76 US cent/kWh	
	Economic/Financial Evaluation	Power Sale	Alternative thermal
	Benefit-Cost Ratio (Financial)	1.35	1.98
	EIRR	13.1%	29.8%
	FIRR	13.1%	---

CONCLUSION AND RECCOMENDATION

CONCLUSION AND RECOMMENDATION

Conclusion

The conclusions described hereunder are based on all results of the Feasibility Study on the Punatsangchhu Hydropower Project, carried out from 1998 to 2001.

The Project is considered to be technically, economically, environmentally and financially feasible.

The Project is a power export-oriented development scheme to India utilizing the maximum potential of the mainstream of the Punatsangchhu to strengthen the financial foundation of the country by revenue of power export.

The Project could constantly supply qualified power with peaking capacity for the tightened power demand in the Eastern Region of India, represented by West Bengal State.

(Features of the Project)

The Project is a run-of-river type scheme with an installed capacity of 870MW for peak generation, providing annual energy production of 4,330 GWh by concrete gravity diversion dam 141m in height from rock foundation with a reservoir of about 4.4 million m^3 in active capacity, as well as twin tunnels of about 7 km in length and 7.40 m in diameter and an underground powerhouse.

Dimensions for major structures for the Project are shown in the Table (Punatsangchhu Hydropower Project).

(Project site)

The Project is located mid basin between the Punatsangchhu, one of the major rivers flowing in the western region of the country, and the hydropower project identified as Project 3.120, then further studied at pre-feasibility level in the Power System Master Plan in Bhutan (PSMP), carried out with aid of a grant by UNDP and NORAD during the period 1990 to 1993.

The Project is a dam and waterway type scheme, with selected dam site at 10 km downstream from Wangdue Phodrang, one of major towns in the western region of the country, and selected powerhouse site at a further 8 km downstream from the dam site.

The Punatsangchhu has a steep river profile in mid basin where the Project is located, and suitable topographical conditions for a so called dam and waterway type scheme, which obtains its available head primarily by waterway.

(Demand Forecast)

Demand forecast was studied for the power market of India, especially that of the Eastern Region of India, as well as for Bhutan, since the Project is a power export-oriented development scheme. The maximum power demand in Bhutan was 72 MW in 1996, whereas it is estimated to be 418 MW in 2020.

The maximum power and energy demand in the Eastern Region of India was 3,240 MW and 16,975 GWh, respectively, in 1996, whereas it is estimated to be 10,391 MW and 54,616 GWh, respectively, in 2020.

The power market of the Eastern Region may expect power supply from the Tala hydropower plant (1,020 MW) which is being constructed now and expects its commissioning within the next five years, and the Punatsangchhu hydropower plant (870 MW), as a part of required power sources.

(The Optimum Power Generation Plan)

Studies on the optimum power generation plan were carried out with various powerhouse sites, Cases 1 to 5 for the downstream site, Cases 6 to 10 for the mid stream site and Cases 11 to 15 for the upstream site, with altered maximum discharge for each case, as well as common site and height for the dam and a 4-hour peaking duration.

As a result, Case –2, providing 870 MW of installed capacity, was selected as the optimum power generation plan for the Project, aiming to utilize the maximum potential available at mid basin of the river.

(Glacier Lake Outburst Flood, GLOF)

Glacier lake outburst flood, (GLOF), is a distinctive hydraulic phenomenon where glaciers and glacier lake are in the upper reach of the basin.

Based on satellite image analyses and hydraulic simulation computations with a presumption that two Glico lakes, Luggye Thso and Raphstreng Thso burst almost simultaneously, it is presumed to be 4,600 m^3/s peak discharge at the dam site.

This peak discharge of flood is some 1/3 of the design flood at the dam site. Therefore it could be released downstream safely without damage to the dam.

As a countermeasure to GLOF, it is essential that the water level of the reservoir be lowered by gate operation prior to the arrival of GLOF to the dam site, indicated by observation of river water level and/or installation of a detective sensor in the upper basin.

(Construction Schedule and Project Cost)

It takes seven years in total, one year for preparatory works and six years for main civil works, electro-mechanical equipment and so on, from the beginning of preparatory works to commissioning the first unit.

The required project cost will be US$813 Million (2000 basis), including direct costs such as preparatory works, main civil works, electro-mechanical equipment and so on, and indirect costs such engineering and administrative costs for the project, cost of land acquisition, physical contingency and so on.

The project cost covers construction of the A route transmission line (powerhouse site - Sarpang - Bongaigaon) which runs to the primary substation in India beyond the Bhutanese - Indian border.

(Environmental Impact Assessment)

Since the Project is a run-of-river type development with a relatively small-scaled reservoir and located in a less populated area, submerged cultivated land and number of families to be resettled are limited. However, it is necessary that landowners and families to be resettled be properly compensated.

It is felt that major issues will not take place related to the natural environment, since the project area is located outside protected areas. It is required, however, that the mitigation plan, a proper monitoring system and management in the project area be implemented.

The required amount of water should be released in order to maintain the natural river condition between the dam and the powerhouse site where the natural river water decreases due to diversion of water for power generation.

The A route transmission line (powerhouse - Sarpang - Bongaigaon) of the Project crosses biological corridors linking protected areas on the way to the Bhutanese Indian border. However, it is felt that the environmental impact of transmission lines can be minimized by laying the route along existing infrastructures such as roads etc.

(Economic and Financial Evaluation)

Financial generating cost (FGC) of the Project is 2.59 cent/kWh, when all financing is provided by equity with a discount rate of 10%. This FDC is competitive compared to average sale price in the power market of the Project i.e. the eastern states of India.

As regards economic evaluation of the Project, economic internal rate of return (EIRR) based on the revenue of power sale and value of alternative thermal power is 13.1% and 29.8%, respectively. This shows that the project is feasible from an economic point of view.

(Financing and Development Scenario)

Case studies on fund procurement for the Project were carried out with presumed schemes and conditions. Hence, three scenarios are as listed below:

-Existing finance scheme from India (scenario A)
-Financing under BOT scheme (scenario B)
-Region-oriented or regional ODA (scenario C)

According to the study results, every financing scenario would be possible, since DSCR is more than 1.5, which is the recommended level by international financial institutions.

Recommendation

The Punatsangchhu Hydropower Project is technically, economically and environmentally feasible, and should be implemented as a run-of-river type with a peak generating capacity to be value added, power export-oriented scheme.

Commissioning would be possible around 2010 or later, with necessary time scheduled for detailed design, financial procurement, construction and so on after taking the Feasibility Study into consideration. According to the demand forecast of 2010, circumstances of the power market in India, especially in the Eastern Region, would be anticipated to be tightened. Therefore, the Project should be promoted to be a next candidate hydro- power project, subsequent to those now on going.

Layout and project cost of facilities shown in the report indicate a best alternative based on the Feasibility Study grade design. Detailed design should be carried out and accuracy of the plan should be heightened further in order to implement the project without risk.

In this regard, appropriate additional geological investigations should be carried out as soon as possible at riverbed, slope of right abutment of the dam site, along the tunnel route and at the powerhouse site to make conditions there clearer.

Also, as regards the transmission line of the Project, the A route was selected based on the results of a comparative study between A route (powerhouse-Sarpang -Bongaigaon) and B route (powerhouse-Kerabari-Coah Bihar) in terms of their construction cost, environmental impact and so on. A route was selected, but final decision on this should be made based on a detailed study, which will be carried out from now on.

The mitigation measures plan (MMP) of GLOFs is now being studied so that it becomes one of the basin control plans. The power generation plan is being studied, taking the study results made by the Study Team, as well as the results of MMP, into consideration. If mitigation measure are implemented, the Project would become more secure.

Anticipated negative environmental effects during construction were studied by carrying out EIA as a grade of the feasibility study, i.e. muck transportation and disposal, drainage, turbidity, dust, noise, sewage water and so on during construction. These were confirmed settled, however countermeasures should be made clearer by formulating a detailed construction plan during the detailed design stage.

Bhutan should consolidate investment circumstances by reforming its organization in the power sector, as well as putting in order that sector's related laws, rules and codes, to guide loans of international financial institutions and capital of investors.

In this way, Bhutan should select a scenario by which the country can implement a power export-oriented project with the most independence possible.

CHAPTER 1

INTRODUCTION

CONTENTS

1. INTRODUCTION

1.1 Background

This feasibility study on the Punatsangchhu Hydropower Project (the Project) was carried out under Scope of Work and Minutes of Meeting made between JICA and Department of Power (hereinafter referred to as "DoP") on 15th July 1998, having the Ministry of Finance of Bhutan as a Responsible Agency, and Ministry of Trade and Industry (hereinafter referred to as "MTI") as an Implementing Agency.

This study is to carry out the Feasibility Study (hereinafter referred to as "Feasibility Study") for the Project to comply with international norm with a level acceptable to international financial organizations. Then, the study is to support the activities of Bhutanese Government to materialize the Project, by carrying out case studies for financing and repayment and also by transferring related technology and training engineers.

The study was carried out during November 1998 to January 2001, in the project site and in Japan.

1.2 Purpose and Contents

The study has been executed focusing on the project area for Project 3.120 and Project 3.320B, and their surrounding on the Punatsangchhu basin which have been identified in the "Bhutan Power System Master Plan (1993)". Furthermore, since the Project is power export-oriented scheme, power sector and power market in India are also studied as potential power importer.

The schedule of study and contents are shown in Fig. 1.1.

This report is submitted as the Final Report on the Project based on the results of the preliminary study, the detail investigation and feasibility design.

1.3 Preliminary Stage Study

1.3.1 The First Site Study Work

The first site study work was carried out during November 25 to December 30, 1998.

The study team carried out explanation and discussion on inception report, site reconnaissance, hydrological study, data collection on glacier lake outburst flood (GLOF), basic study on construction costs, initial environmental examination (IEE), power sector survey, and data collection in the various fields related to the above listed in the period of the first site study.

The study team made general reconnaissance for extensive areas including the project site by engineers in charge such as civil, hydrological, electrical, environmental engineers, survey specialist and project economist in order to grasp over-all conditions of the project area and neighboring areas.

Data collection were carried out during the first site study work, related to previous study reports such as Master Plan report, Pre-feasibility report, information on maps and geology, hydrological data, power demand and consumption in Bhutan, and environmental data.

1.3.2 The First Study Work in Japan

Based on the results of the first site study work, the study team carried out review on previous study reports, analyses on geological and hydrological data, alternative plans of development as a part of the first study work in Japan.

Regarding geological study, basic studies were carried out to understand regional geology and conditions of the project site and the neighbor area. A basic plan of site investigation works for fiscal year 1999 was planned.

Hydrological studies on recorded run-off and flood discharge were carried out as a basis of optimization of power generation plan based on collected data previous reports and information on other projects in Bhutan. As regards GLOFs in the upper reaches of the project area, satellite image analyses were carried out to extract several basic parameters for hydraulic simulation computation of floods.

As regards environmental study, draft manual of environmental impact assessment (EIA) was provided based on discussion and exchange of opinions with concerned organizations, as a part of the initial environmental examination (IEE).

1.3.3 The Second Site Survey Work

The study team carried out 2nd Site Survey Work during March 4 to 19, 1999 to explain the study results compiled in the Progress Report (1) to the Counterpart and to exchange opinions.

A seminar of technology transfer was held in this occasion, as well as explanation on detailed investigation program and its procedure to be carried out in the fiscal year 1999.

1.4 The Detailed Investigation Stage Study

1.4.1 Third Site Survey Work

The study team carried out 3rd site survey work during May 26 to June 23, 1999, in order to contract with Bhutanese and Indian sub-consultants to carry out various site investigation works as sub-contract basis. Following items for site investigation works were carried out as sub-contractual basis.

- Drilling work at dam site, powerhouse site and quarry site.
- Seismic prospecting at dam site, portal of adit tunnel and powerhouse site.
- Material investigation and testing of river deposit and drilled core.
- Aerial photography for 1/5,000 mapping of project area.
- 1/1,000 topographical survey, mapping and river profile/cross section survey
- Environmental Impact Assessment. (EIA)

1.4.2 The Fourth Site Survey Work

The Study Team made the 4th site survey work from late September 1999 when sub-contractors started their main activities and right after finishing preparatory works on the site such as mobilization and so on, till late January 2000.

The Study Team visited the project site periodically as schedule during about 4 months till February 2000, to control and supervise detailed investigation works carried out by sub-contractors, as well as carrying out data collection, ground preparatory work for aerial photography by JICA study team. The Study Team also carried out interim brief explanation on the results of drilling investigation, seismic prospecting work, probable maximum floods (PMF), as well as additional data collection for environmental study to the Counterpart.

1.4.3 The Second Study Work in Japan

The Study Team carried out the second study in Japan for optimization of power development plan and EIA by summarizing all the site investigations made by Study Team and sub-contractors.

Studies on the optimization of Power Development Plan and layout were carried out based on 1/5000 maps provided in this period, results on geological investigations such as drilling works, seismic prospecting and material investigation, as well as results of hydrological study.

The Study Team also evaluated and summarized the Indian power market survey conducted in the previous fiscal year as sub-contract basis.

Regarding the EIA, the Study Team summarized study results made by the sub-contractor of EIA for submission to the Counterpart in July 2000 along with the Interim Report.
All results above-mentioned were compiled as Progress Report (2).

1.5 Feasibility Study Grade Design Stage

1.5.1 The Fifth Site Survey Work

As Fifth Site Survey Work, the Study Team made explanation on the Progress Report (2) and exchanging opinions from March 4 to 15, 2000, as well as seminar for technology transfer. The Study Team confirmed the intention of the Counterpart regarding the development plan and scale.

The Study Team also started the work for case study on fund procurement and financing plan of the Project from February 2000.

1.5.2 The Third Study Work in Japan

The Study Team carried out all feasibility design work for civil facilities, hydro-mechanical equipment, electro-mechanic equipment, transmission line and so on, based on the selected development plan, i.e. Case-2 during the Third Study Work in Japan.

The work also included construction planning and estimation of project cost, as well as economic and financial evaluation, study on financial planning. The Study Team compiled all study results as the Interim Report.

1.5.3 The Sixth Site Survey Work

The Study Team carried out the Sixth Site Survey Work to explain, discuss on the Interim Report, as well as EIA report, during June 29 to 30, 2000.

In this period, the Study Team also conducted data collection for the latest information related to optimization study of financial plan and fund procurement, based on contents described in the Interim Report. In addition to this, the study results of Indian power sector having conducted previously was updated on a sub-contract basis.

The Counterpart explained the project features to people living in the project area through the occasion of Public Consultation held on July 20 and 21,2000.

1.5.4 The Fourth Study Work in Japan

The Study Team carried out study on economic and financial evaluation, working out on financing plan, strategic scenario on development of the Project, then compiled all results into the Draft Final Report.

1.5.5 The Seventh Site Survey Work

The Study Team explained the Draft Final Report on the Punatsangchhu Hydropower Project to the Counterpart during November 18 to 29, 2000, and discussed all results of the Feasibility Study contained in the report. In the same period, seminar of technology transfer was held.

1.6 Personnel related to the Study

(1) Ministry of Finance

H.E. Lyonpo Yeshey Zimba	Honorable Minister

(2) Ministry of Trade & Industry

H.E. Lyonpo Khandhu Wangchuk	Honorable Minister

(3) Department of Power, Ministry of Trade & Industry

1) Department of Power

Dasho Karma Dorjee	Joint Secretary
Mr. Sonam Tshering	Director
Mr. Bharat Tamang	SE (Electrical Engineer)
Mr. K.B. Wakhley	SE (Project and Investigation Wing)

2) Hydrology Unit

Mr. Dorji Namgay	Executive Engineer
Mr. N.P. Sharma	Electrical Engineer
Mr. Pashupati Sharma	Sediment Laboratory
Mr. Dhuendup Tshering	Civil Engineer
Mr. J.N. Sharma	Hydrologist
Mr. Penjore	Civil Engineer
Mr. Karma Dupchu	Hydrologist
Ms. Phub Wangmo	Civil Engineer
Mr. J.B. Basneth	Surveyor

3) Electrical Unit

Mr. Nepal	Transmission Engineer

4) Meteorology Unit

Mr. Kinzang Sonam	Technical Officer

(4) Geological Survey of Bhutan

Mr. Dorji Wangda	Head
Mr. Nawang Norbu	Unit Head, Drilling
Dr. Mutsumi Motegi	JICA Expert

(5) Ministry of Home Affairs Survey of Bhutan

Mr. Choeki Khorlo	Head
Mr. Ugen Takchhu	Chief Manager

(6) National Environment Commission EIA Division

Mr. Karma C. Nyedrup	Head

(7) Planning Commission

Ms. Monird Tshewang

(8) Ministry of Communications, Division of Civil Aviation

Mr. Rin Gyeltshen	Director

(9) Wangdue Phodrang Dzongkhag Administration

Mr. Pem L. Dorji	Commissioner

(10) Royal Bhutanese Embassy

Mr. Dago Tshering	Ambassador
Ms. Nima Ome	Counselor
Mr. Thinley Penjor	Counselor
Mr. Tshewang Dorfi	Secreary

(11) Central Electricity Authority (India)

Mr. V.K. Sood	Member (Power System)

(12) West Bengal State Electricity Board (WBSEB)

Mr. B. Das	Member (Hydro)

(13) Embassy of Japan (New Delhi, INDIA)

H.E. Hiroshi HIRABAYASHI	Ambassador
Mr. Kenichi KOMANO	Counselor and Head Economic Department
Mr. Mitsuaki KINOSHITA	Firsts Secretary
Mr. Junichi TANIUCHI	First Secretary
Mr. Seiji TAKAGI	First Secretary

(14) JICA India Office

Mr. Tadashi SATO	Resident Representative
Mr. Toru TAKE	Deputy Resident Representative
Mr. Jitsuo TAKASUGI	Ex-Resident Representative
Mr. Toshiaki TANAKA	Ex-Deputy Resident Representative

(15) JBIC (Representative Office in New Delhi)

Mr. Jun YOTSU	Senior Representative
Mr. Hiroshi OITA	Ex-Chief Representative
Mr. Naruhiko TAKESADA	Representative

(16) JICA/JOCV Bhutan Office

Mr. Yasuyuki MORI	Resident Representative
Mr. Seiji KOMATSU	Ex-Resident Representative
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Mr. Toshio KITAMURA	Coordinator
Mr. Hideki SATO	Coordinator
Mr. Kinley Dorji	Programme Officer
Ms. Tae KIKUCHI	Coordinator

(17) JICA Study Team

Mr. Susumu TSUNODA	Team Leader	EPDC
Mr. Nobuo HASHIMOTO	Civil Design Engineer	EPDC
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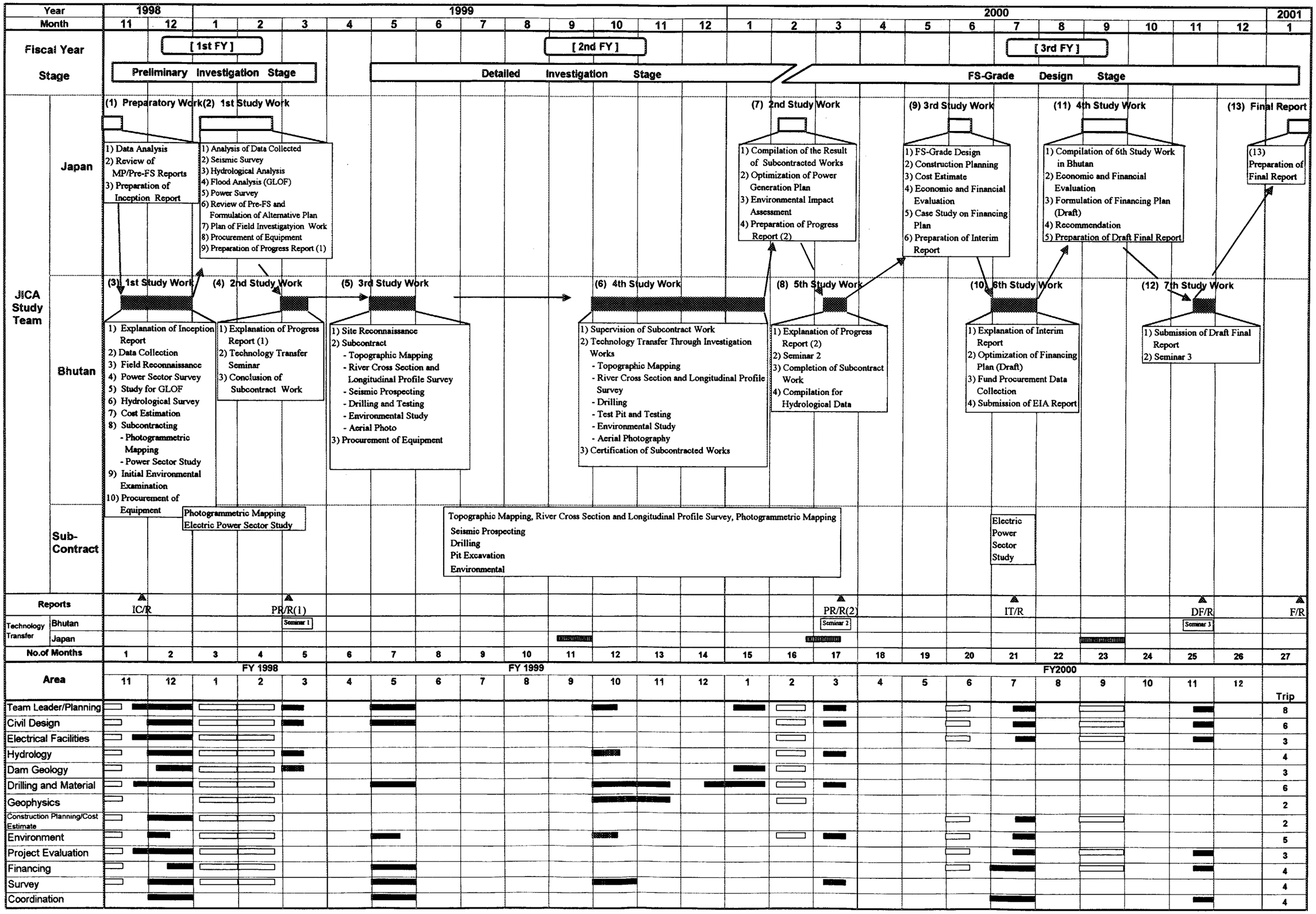
Mr. Hiroyasu AKAIKE	Hydrologist	EPDC
Mr. Yozo FUKUTAKE	Dam Geologist	EPDC
Mr. Seiji HONGO	Drilling & Material Geologist	EPDC
Mr. Tsukasa YOSHIMURA	Geophysicist	EPDC
Mr. Minaichi TAKEOKA	Construction Planning & Cost Estimate Engineer	KDC
Mr. Ryozo OHNO	Environmental Engineer	JANUS
Mr. Tetsuya HIRAHARA	Project Economist	EPDC
Mr. Takuya TAKAOKA	Financial Specialist	EPDC
Mr. Mitsuo SAITO	Survey Expert	PASCO
Mr. Katsuma HASEGAWA	Coordinator	EPDC

Note:

EPDC : Electric Power Development Co., Ltd., Tokyo
KDC : Kaihatsu Design Consulting Engineers, Tokyo
PASCO : PASCO International Inc., Tokyo
JANUS : Japan NUS Company Ltd., Tokyo

Fig. 1.1 Flow Chart of Study Work for Punatsangchhu Hydropower Project



CHAPTER 2

GENERAL SITUATION

IN THE KINGDOM OF BHUTAN

CONTENTS

2. GENERAL SITUATION IN THE KINGDOM OF BHUTAN

2.1 Geography

The Bhutan is located in Bhutan-Himalayas (Longitude 88.7°E, Latitude 26.7~28.4°N) in the eastern part of the Himalayas, having an area of 46,620 km^2 which is almost similar to Switzerland. The country is surrounded by the Tibet Autonomous Region of China on the north and by State of Arunachal Pradesh, Assam, and West Bengal of India along on the northeast to the south and the west, and stretches for 330 km in east-west direction and 180 km in north-south direction.

Geographically, the country is divided into a number of regions by ravines created by several major rivers such as Amochhu, Wangchhu, Punatsangchhu, Mangdechhu and Manaschhu that flow approximately towards the south. Their sources are the glacier and glacier lakes existing in the upstream regions of basin higher than 4,000 m above sea level.

They travel for approximately 150 km along north-south direction, until they join to the Brahmaputra river in the Assam State of India where altitude is below 200 m above sea level beyond the Bhutanese-Indian border.

Although the country is divided into 20 administrative districts or Dzongkhas in Bhutanese, from the geographical and cultural point of view, it is more common to group them into three districts of West, Central, and East.

The region westerner than Pele La (mountain pass) is called West district and major towns in this district are Paro, Thimphu, Punakha, Wangdue Phodrang. Central district is the region between Pele La and Thrumsing La, and Tongsa and Bumthang are the major towns.

Region easterner than Thrumsing La is called East district and Mongal and Tashgang are the major towns.

Also the two major cities, Phuentsholing on southwest end and Sandrup Jongkhar on southeast end of the country are where trading with West Bengal and Assam of India is carried out.

2.2 Climate

2.2.1 Temperature

The climate of the country is categorized into three types of namely, Alpine, Mid-montane, and Subtropical. Alpine is for the higher region above 3,500 m above sea level, Mid-montane is for the

region between 1,800 m and 3,500 m above sea level, and Subtropical is for the region below 1,800 m which is from the foothills of the Himalayas to mid- mountainous region.

The temperature distribution seems to be affected by the altitude between north high Himalayas and sub-Himalayas rather than the fact that the country situates in low latitude.

In the capital, Thimphu located 2,400 m above sea level, the temperature ranges from 15.2℃ to 24.4℃ in July, and from –2.6℃ to 12.3℃ in January. In Wangdue Phodrang where the altitude is somewhat 1,000 m lower than the capital, temperature in July ranges from 29.1℃ to 20.1℃, and from 4.3℃ to 17℃ in January and it is generally 5℃ higher than those in Thimphu.

On the other hand, in Phuentsholing on the south-eastern border with India, the climate is classified as sub-tropical and the annual average temperature is 24℃, whereas the maximum in summer season rises up to near 40℃.

The temperature of Punakha and Wangdue Phodrang, in the mid-basin of the Punatsangchhu ,of which the project area is closes to, it rises up over 30℃ in August and goes down to 0℃ in January.

2.2.2 Precipitation

The rainfall in the Himalayas is mainly caused by the monsoon that develops in Bay of Bengal. The rain front due to the monsoon usually onsets towards north-western direction during the end of May to the beginning of June and withdraws towards south-eastern direction during September to October. Hence four months of June to September, is wet season in the Eastern Himalayas where the country situated.

According to the precipitation data published by Survey of Bhutan, the annual average precipitation is about 400 to 600 mm in North High Himalayas region, 700 to 900 mm in Midland where Thimphu, Punakha, and Wangdue Phodrang are situated. Although this midland region is called 'dry-valley' from relatively less precipitation caused by geographical reason, the precipitation could exceed 2,000 mm at the transitional region from mid to upper stream of basin where a steep slope forms. On the other hand Sub-Himalayas, near the border with India, is a pluvial region with annual average precipitation is 3.000 to 5,000 mm.

2.3 Population

According to the Statistical Yearbook (43rd issue), the population of Bhutan was reported to be 1,034,774, as of November 1969,

According to the 7th Five-Year Plan (1992-1997) compiled by Planning Committee, it is estimated as 765,000 head and this figure is thought to be rather close to the actual number. From this, the

population density can be worked out as 16 per km^2, and this can be compared with that in neighboring countries: 144 in Nepal, 834 in Bangladesh, and 285 in India.

People of Bhutan are classified generally into three groups. More than 60% of the population consist of Tibetan Bhutanese living in mid to high mountain region, then Nepalese Bhutanese living in the region of low altitude is the second group. Table 2.1 shows the movement of the population in 1998.

2.4 Economy

According to the 43rd issue of Statistical Yearbook published by the United Nations, GDP of Bhutan in 1996 was US$ 320 Million, thus GDP per capita is US$176. On the other hand, GDP in 1999 basis is US$ 420 Million based on the latest data using an exchange rate of Nu.42.6/US$, therefore GDP per capita based on population of 656,000 described in the same data exceeds US$500.

The sector-wise share ratio of GDP is 38.0% for agricultural sector, 10.8% for construction sector, 10.9% for community service sector, respectively, therefore this indicates that national economy fundamentally relies on agriculture.

Major products from agriculture and forestry are Cereals of 112,000 mts, Cattle and other livestock of 673,000, Lumber of 1,400,000 m^3 and so on. A traditional style in agriculture with less consumption of chemical fertilizer is a fairly common in the country, i.e. somewhat 100 mts per annum.

Remarkable trends in the country's economy is incredible increase in the share of electricity industry sector from 0.4% to 8.3 %, boosted by commissioning Chhukha Hydropower Station and power export to India since 1986/87.

2.5 Energy Resource

The primary energy production of the country is 150,000 oil equivalent metric tons (OMT) in 1996, of which electric power occupies 99.3% or 149,000 OMT, according to the 43rd issue of Statistical Year Book published by the United Nations. An 86.0% of the primary energy production, thus equivalent of 129,000 OMT is exported. The balanced 0.7%, equivalent of 1,000 OMT consists of coal.

Hence it is essential for Bhutan to promote the development of hydropower resource and export electricity so as to strengthen foundation of national economy. Consequently, power stations such as Chhukha Hydro Power (336 MW) under operation since 1987 owned by CHPC and Tala Hydro Power (1,020 MW) under construction by THPA, to be commissioned by July 2006, have been developed for the purpose of exporting electricity. Also middle capacity hydro power development, such as Basochhu hydro power (60.8 MW), Kurichhu hydro power (60 MW) which is expected to be commissioned in 2001/02 have been under construction as well, for the purpose of regional or

domestic consumption. Table 2.2 shows the hydropower developments currently under construction or under planning.

2.6 Transportation and Communication

The current main arterial roads run across from west to east and connect the major cities of Ha Paro, Thimphu, Wangdue Phodrang, Trongsa, Jakar, Mongar and Transhigang on the most east end. Furthermore from Transhigang to Samdrup Jongkhar, from Trongsa and Wangdue Phodrang to Sarpang, there are routs going up to north and down to south, respectively.

These arterial roads extend for about 700 km in west-east direction and for about 1,000 km in north-south direction, hence 1,700 km in total and 3,400 km including roads other than arterial roads.

These arterial roads have been improved year by year by widening and curvature improvement, pavement and so on, however, sizes of these works are so limited.

Out of 20 administrative districts (Dzongkhag Administration), 19 districts are facilitated with telephone communication service provided under grant aid scheme of Japan.

2.7 Access (Aviation and Overland)

Aviation

The only international airport of Bhutan, Paro airport, is situated at approximately 20km west of Thimphu. Paro is connected with Bangkok, Delhi, Calcutta, Katmandu, Dhaka, and Yangon via aviation service own by the Royal Government of Bhutan. The navigation distance and number of passengers on scheduled services in 1996 are 1,000,000 km and 35,000 heads respectively.

Overland

Although there are several ways to enter the country from India, the route from Phuentsholing is most general. There are about 800 km from Calcutta to Phuentsholing. From Phuentsholing, it is about 180 km to Thimphu via Chhukha and Simtokha.

Table 2.1 Country Performance Indicators for Bhutan

Population Indicators	Latest year
Total population (thousands)	638 (1998)
Annual Population Growth Rate (% change)	3.1%
Age composition(%)	42.1%
0-14	44.0%
15-49	6.7%
50-59	7.2%
60+	13.7
Population density	19.4 yrs
Median age	65.9 yrs
Life expectancy (1999) Male	66.1 yrs
Life expectancy (1999) Female	
Crude Birth Rate (per '000 population)	39.9
Crude Death Rate (per '000 population)	9.0
Social Indicators	
Total Fertility Rate (births per woman)	5.6 (1994)
Maternal mortality rate (per thousand live births)	380.0
Infant Mortality Rate (below 1 year, per thousand live births)	70.7
Adult Literacy	54% (1996)
Female Literacy	28%
Primary School Enrolment (% of school age population)	72%
Female	60%
Child Malnutrition (% children< 5 yrs)	39.1%
Population with safe access to water	58%
Population with safe access to sanitation	90%
Hospitals	28
Indigenous Units	12
Training Institutes	3
Basic Health Units	145
Malaria Centers	19
Outreach Clinics	454
Universal child immunization	90%
Rural Water Supply Schemes	1768
High Schools	18
Junior High Schools	44
Primary Schools incl. Community Schools	243
Private Schools	7
Degree College	1
Other institutes	9

Source: Compiled and Verified by Central Statistical Office, Bhutan 1999

Table 2.2 Power Development Plan of DOP

Status	Project Name	District	Description	Scheme type
Under Construction	Basochhu	Wangdue Phodrang	Installed Capacity: 61 MW Firm Capacity: 12 MW Energy: 291 GWh Completion: 2000/01	Run of River (ROR)
	Kurichhu	Mongar	Installed Capacity: 60 MW Firm Capacity: 24 MW Energy: 322/400 GWh Completion: 2002	ROR
	Tala	Chhukha	Installed Capacity: 1,020 MW Firm Capacity: 168 MW Energy: 3,962 GWh Completion: 2006/07	ROR
Planned and Studied	Bunakha Reservoir	Chhukha	Installed Capacity: 180 MW Firm Capacity: - MW Energy: 688 GWh	Storage
	Mangdechhu	Trongsa	Installed Capacity: 425 MW Firm Capacity: - MW Energy: 1,800 GWh	ROR
	Punatsangchhu	Wangdue Phodrang	Installed Capacity: 760 MW Firm Capacity: 125 MW Energy: 3,305 GWh	ROR

Source: Division of Power, 1998

CHAPTER 3

OUTLINE OF PROJECT SITE AND SURROUNDINGS

CONTENTS

3. OUTLINE OF PROJECT SITE AND SURROUNDINGS

3.1 The Surroundings

3.1.1 General

Punatsangchhu, also called Sankosh River in India, is a river consisting of the two major rivers, Mochhu and Phochhu at its upper basin having their source in the north-eastern part of the Himalayas and merging each other at Punakha where altitude is about 1,200 m. It runs for 320 km with a total basin area of 12,061 km^2 and finally flows into Brahmaputra River in the Assam State of India.

The watershed at left bank of the basin is divided from the Mangdechhu's basin by Pele La (mountain pass) and Black Mountain area for instance, and its right bank is divided from the basin of Wangchhu which consists of the Parochhu and the Hachhu by Western Ridge including Dochu La (mountain pass).

The altitude of those watersheds are, 3,500~4,500 m above sea level in the mid-stream of the Punatsangchhu's basin where Punakha and Wangdue Phodrang locate, and this undulation forms a fairly severe topographical features rising more than 2,000 m form the river bed .

The climate of the project area is categorized into monsoon climate which consists of wet season during June to September, and dry season during October to May in general. Annual precipitation varies from 400 to 600 mm in the upstream region, 700 to 900 mm for mid-stream region where Punakha and Wangdue Phodrang locate, and exceptionally more than 2,000 mm for steeply inclined topography in mid to down stream areas of the basin. The climate in downstream region near the border of India is also categorized to be subtropical with annual precipitation of 3,000 to 5,000 mm.

3.1.2 Water Resource Development and the Current Situation

Power System Master Plan (PSMP) for the whole country was set up during 1990~1993 with funds from UNDP and NORAD. The PSMP reporting on 25 development projects in the country indicated seven projects with a total potential generating capacity of 1,894 MW in the Punatsangchhu basin, and Pre-Feasibility Study carried out as a part of PSMP indicated two projects, i.e. Project 3.120 (Punatsangchhu, 760 MW) and Project 3.230B (650 MW).

The dam site for Project 3.120 (Punatsangchhu) locates about 10km down stream of Wangduc Phodrang, and the powerhouse locates further 8km downstream from the dam site. For Project 3.230B, the dam site locates further down stream, so that two projects are planned to be cascade development on the main stream by dam and waterway type.

Basochhu Hydropower Project (61 MW) is being constructed as of November 2000, on the right flank near the project area in the same basin. The electricity produced there is planned to put in to the new 220kV transmission line connecting the power station to Simtokha substation. There are small hydropower stations named Wangdue Phodrang (300kW, 1972) and Punakha (30kW, 1986/87) as well. The former is being repaired and the latter is out of operation.

3.2 Project Site

3.2.1 Topography and Nature

(1) Topography

Since Bhutan is located between the Himalayas of high altitude on the north and Assam and West Bengal plain on the south. Therefore its topography inclines steeply from the northern end towards the southern end, dropping from high mountains exceeding 5,000 meters to few hundred meters in altitude within only approximately 150 km.

The dam site for the project is located about 10 km downstream of Wangdue Phodrang situated in mid-stream region of Punatsangchhu basin (Sankosh River). The altitude of the riverbed is about 1,090 m at the proposed dame site, whereas about 840 m at the proposed outlet portal of tailrace tunnel.

The inclination along river bed of the Punatsangchhu is quite steep in the mid stream where the project locates, i.e.1/20~1/30 as average one. Therefore the project area and its the surrounding have a topographically severe features.

(2) Nature

Geology

The Himalayas is said to be the youngest *organic* mountain around the world. Out of the 4 sections, Sub-Himalayas, Lower-Himalayas, Higher-Himalayas, and Tibetan or Teethes Himalayas, of the Bhutan-Himalayas, the project area is located in Lower-Himalayas. The geological structure of the Himalayas is complicated that a number of thrusts and faults intersect

each other in all direction. Around the dam site, a number of landslide vestiges can be observed and big boulders scattering along river bed. Outcrops can be observed on both flanks of the proposed dam site, and can be seen piled river deposit at the down stream area of the dam site which thickness is estimated to be 50 to 60 m.

Proposed underground powerhouse site is located further 8 km downstream area where it is covered with hard and folded metamorphic rock and weathered at its surface.

Earthquake

The project area is classified as Zone-V according to Indian Standard, IS: 1893 (1894), Bureau of Indian Standards.

Climate

The climate of the project area is classified as tropical-monsoon and this is identified by two distinctive seasons, wet season from June to September and dry season from October to May. The temperature in Wangdue Phodrang exceeds 30℃ in summer season, and drops down to 0℃ in January. Annual precipitation is around 700 to 900 mm with quite high annual precipitation in steep topography in mid to downstream areas of the basin. Run-off is quite abundant, such as somewhat 290 m^3/s for average one, somewhat 60m^3/s for the one of lean season and 1200 m^3/s can be expected during wet season according to recorded run-off data at Wangdue Rapids gauging station in the period of 1992 to 1999.

3.2.2 Natural and Social Environment

(1) Natural Environment

Landscape

According to the land utilisation map for Thimphu-Wangdue Phodrang Dzongkhags provided by the Department of land utilization planning, Ministry of Agriculture, Thimphu-Wangdue Phodrang Dzongkhags , 92% of the region including the project area, equivalent to 63,206 ha, is covered with forest consisting of Fir, mixed conifer and blue pine etc.

Flora

The flora in the country is integrated and tangled within the small area because her climate consists of quite distinctive 3 type such as high Himalayas, cram monsoon and subtropical one. Vegetation found in the country ranges from banana and citrus fruits field up to the 1,300 m above sea level, after that rice and crop fields up to 2,400 m above sea level or higher, and forests of deciduous trees and alpine plants for high land upwards.

Broad-leafed trees can be observed along both sides of the river banks near river bed around the project area. Chirpine or *pinus roxburghii* dominates in the mountain flanks above half way to mountain back.

Fauna

According to the report by the Department of Forest of Bhutan, 15 kinds of the mammalia, 3 kinds of reptilia and 31 kinds of birds are known to inhabit in the country. Out of these the protected fauna by Forest and Nature Conservation Act (1995) are Barking deer as endangered species, and Serow, Himalayan Black Bear, Leopard cat, Leopard under careful protection. However this list was produced many years ago, so that it is possible that the list is not reflecting the current situation such as the effect due to new arterial roads constructed after such investigation.

Water quality

The sewage water from the residents dwelling is being disposed to Punatsangchhu from Punakha and Wangdue Phodrang without treatment. However the run-off in Punatsangchhu is quite sufficient that the river's self purification system can be relied and hence sewage has no harm. Also the population around the project site is fairly few and no industries that are likely to cause water pollution are recognized so far. The water quality of the river can be thought of a good quality.

(2) Socioeconomic Environment

Population

The total population of Wangdue Phodrang in 1998 was approximately 28,800 and total number of households of 2,800 with average number of people in each household of around 10.

Public facilities

One hospital, 9 Basic Health Units (BHU), and 20 outreach clinics are facilitated in Wangdue Phodrang. There are only limited number of medical facilities in the area and for most residents, it is few hours walk to nearby BHS. Only 1,746 households, 63% of the total, are supplied with water system.

As for education facilities, there is one senior high school, 3 junior high schools, 9 primary schools, and 4 community schools. Also approximately 9km away from Wangdue Phodrang, there is Natural Resource Training Institute.

Transportation

Roads are constructed in a way that they cross the Punatsangchhu basin longitudinally.

Wangdue Phodrang is an important intersection that connects Punakha in the northern region, Thimphu in western region, Trongsa and Mongar in eastern region and southern region. Those roads running across in north-south direction and west-east direction allow transition of large vehicles although the section between Punakha and Thasithang in northern region is in bad condition. The dam site locates about 10 km down from Wangdue Phodrang to the south by the arterial road and the powerhouse site locates further 8 km down stream on the same arterial road.

Industry

About 90% of the residents rely their living on agriculture where they grow rice, flour, corn, buckwheat, barley, millets, potatoes, apples, oranges and mustards. There are 30 people holding some kind of industrial license, and 180 people holding trading license in Wangdue Phodrang. There are 10 construction businesses going on, and also plants for such as woodworking or paper production exist as well.

Cultural preservation, recreation

It is not known that any cultural preservation nor recreation facilities exist within the land required for the project that may stop the project.

CHAPTER 4

POWER SECTOR SURVEY

CONTENTS

4. POWER SECTOR SURVEY

4.1 Introduction

The objective of power sector study is to grasp of the situation of power demand and supply of both Bhutan and India in order to reveal the appropriateness and project position.

The first point, project position, needs to be studied from view points of financial planning, socio-economy, capability of executing agency and operation management system, law and policy of electric utility. The second point, appropriateness, needs to be studied to grasp power demand and supply of Bhutan as well as India.

India is the most suitable country for selling the power from the Project in view of its location and the past experience of hydropower station (Chhukha power station 336 MW, 1986/88 completed and 90% of generation power export to Indian power grid).

Under such circumstances, the study team has conducted the power sector survey in Bhutan and India. The team has collected and reviewed data and information from Bhutan authorities, and the power sector of India, which was surveyed by the sub-contract of Indian Consultant.

4.2 Power Sector Survey in Bhutan

4.2.1 Summary

The study team has conducted the site survey and to collect the power sector data and information in Bhutan. Within a single decade between 1988 and 1998, real GDP increased approximately 1.7 times from 1,993.6 millions Nu. to 3,541.3 millions Nu. (in current price: 3,850.9 millions to 15,660.7 millions Nu. increased approximately 4 times) (exchange rate : Bhutan 1 Nu.= 3.1 Yen as of October 1998). Increasing this GDP, together with electric energy consumption was also increased from 275.95 GWh in 1994/95 to396.57 GWh in 1998/99 (total installed capacity was 356.67 MW), and the energy power sector contributed approx. 25% of the Governmental income in the middle of 7th 5-year-plan.

Peak demand of Bhutan was rapid increased approx. 3.6 times from 22 MW in 1990 to 80 MW in 1999.

Bhutan is important energy power sector which export the hydro power energy to India since completion of large scale power station in Chhukha in 1986/88.

The number of electrification villages and towns became approx. 2 times and consumers were 15,629 in 1990 to 33,710 in 1999. It is expected to increase the power consumption that the energy source will be electricity, wooden or charcoal in the country, because Bhutan does not product the fossil fuel such as oil, gas and coal and they are difficult to transport into the mountain and isolated area in the country.

Under developing country of Bhutan, the export of hydropower to India is very important to obtain the only way of the foreign currency (Indian Rupees) and a role of the Governmental income.

It is also expected to develop that Tala (1,020 MW) and Punatsangchhu (870 MW) of large scale hydro power plants are to be helpful the best mix with thermal and hydro energy of India power system.

4.2.2 Overview of Electric Power Sector

In these circumstances, the study team carried out data collection and analysis of the power sector in Bhutan and those are compiled and used updated data in 1998/99, but a part of data and information were used before published in 1998.

(1) Review of Development and Energy in Bhutan

1) Gross domestic product (GDP)

a) GDP in the country

The Seventh Five Year Plan (1992-1997) led the country from success to success ended in 1996. These twenty-five years have seen unparalleled progress in all sectors and brought rapid improvement to the quality of life of Bhutanese people and The Eighth Five Year Plan (1997-2002) is contributing new ideas (such as new development business and privatization business) toward the completion of the work.

Within a single decade between 1985 and 1995, life expectancy rose from 48.0 to 66.1 years, real GDP increased approximately 1.7 times from Nu. 1,993.6 millions Nu. to 3,541.3 millions Nu.(in current price : 3,850.9 millions to 15,660.7 millions Nu. increased approximately 4 times) (exchange rate : Bhutan 1 Nu.= 3.1 yen as of October 1998).

By the end of 1985, Bhutan has completed 24 years of planned development. Nonetheless the Bhutanese economy was still dominated by agriculture and vast majority of Bhutanese depended on agriculture for their livelihood. In 1985, agriculture contributed 54.9% of GDP and 38% in 1995 as shown in Table 4.1. Next to major contributor to GDP was community, social and personal services (government) sector with 10.9%, and the most increasing sector was Power sector

contributed to GDP from 0.4 to 10.3%, after commissioning of Chhukha power station in 1986/88.

The average annual growth rate of GDP during the period 1987 to 1997 was 5.2%, but the growth of GDP in the Seventh Five Year Plan (7FYP : 1992-97) was around 6.5% as shown in Tables 4.1 to 4.4.

b) GDP forecast in the country

GDP for the 8FYP(1996/97 – 2001/02) is projected to grow at an average of about 6.4% per annum.

The preparation of detailed forecasts for the 9th,10th and 11th FYPs, is more difficult because of the unpredictable behavior of the financial variable over the long period. The method used to forecast GDP is based on the assumption that the economy will have an underlying average growth rate of about 5% per annum until year 2005/06, an about 4.5% thereafter. The underlying growth rate is then boosted upwards by larger projects coming on stream, especially in the power sector.

(2) Industrial Development

Industrial development is the key issue in the region from the economic point of view and for estimating future power demand. During the 7FYP, development of the industrial sector continued at a steady pace. Considerable investment was made in new industrial ventures as well as in the expansion of existing enterprises.

The Industrial Division under the overall guidance of the Ministry of Trade and Industry (MTI) is responsible for all industrial activities in the Bhutan.

The Division has the following activities at Thimphu, Phuentsholing, Gelephu and Sandrup Jongkhar.

- Project Development Section
- Entrepreneur ship Promotion Center
- Industrial Licensing & Monitoring Section
- Industrial Estate Development Section
- Essential Oils Development Unit
- Regional Trade & Industry Offices

Development of industry is planned and started in the 8FYP as the following program.

Small Industries Development

- The MTI will continue to promote private sector entrepreneur ship through the Small Industries Development Program. The program will assist in starting new project, conducting training courses for existing entrepreneurs to improve their business management skills.

Industrial Development Program

- Feasibility study of Medium & Large Projects to assist the private sector in identification and promotion of viable industrial projects.
- Study of Waste Recycling to promote an environmentally friendly industrial development.
- Preparation of Industrial Master Plan to asset the project development plan.

Industrial Monitoring Program

- Bhutan Standards Institute will be established to monitor quality standards of Bhutanese industrial products and to prevent the export and import of sub-standard goods.
- Occupational Safety and Health Network Center will help in achieving the adoption of safety and health measures.

Industrial Estate Development

- Development of Industrial Estate and Service Centers is aimed at enhancing income and employment through a regionally balanced development and by grouping of industries.

Development of Essential Oil Industry

- This project is a continuation of the 7FYP, and 8FYP will focus on diversification, establishment of a processing units and also look into the possibilities of expanding the project area.

(3) Energy Demand and Supply

The development of energy sector is of crucial importance to the country, and in recent years high priority is placed on this sector. A major source of energy in Bhutan has traditionally been firewood which is available in abundant quantities from the country's extensive forests. Kerosene and LPG are still widely used for domestic purposes, followed by diesel and petrol, predominantly for transport.

Recently, electricity generation was based on micro hydropower and small diesel generating providing limited supply of electricity which was supplemented by imports from India through the power transmission lines.

With the commissioning of large-scale hydropower project, Chhukha power station in 1986/87, Bhutan substantially increased its electricity generation and become a significant exporter of electricity to India.

Now, hydropower is assuming the leading role in the consumption pattern of energy in the capital and large towns.

Hydroelectric Power

- The country is endowed with large hydropower generation potential, the total capacity estimated at about 30,000 MW. The Master Plan Study conducted during 1990-93, identified 91 hydropower potential sites above 10 MW capacity.

  Update of the techno-economically exploitable hydropower potential is about 16,280 MW in 1995.

During the 7FYP, the power sector accounted for some 25 % of government revenue by the middle of 1995 and the annual domestic consumption of electricity was 275.95 GWh, 1994/95. The total installed capacity is 360.534 MW in 1999.

Solar Energy

- Bhutan has country area of good sunshine hours available, the solar power system was launched to provide electric light to institution in the remote areas.

  By the end of 7FYP, there were 1,316 photovoltaic panels throughout the country distributed to schools, monasteries, basic health units and some remote animal husbandry farms.

Fuel Wood

- Fuel-wood continues to be the main source of energy for lighting, heating and cooking in the rural areas.

  Total consumption energy of fuel-wood is more than 75% at the national level. In order to minimize wood consumption, extensive rural electrification was launched in consecutive five year plans.

Fossil Fuel (Petroleum products)

- Due to rapidly expand the development of communications and transport facilities, the consumption of imported petrol and diesel oil increased and kerosene also consumed in the rural areas for cooking and lighting. LPG is now in general use for cooking in the urban areas.

The import of petroleum products and electricity consumption during the period 7FYP is listed below.

Import of Petroleum Products and Electricity

Year	1990/91	1991/92	1992/93	1993/94	1994/95
Fuel Imported					
LPG(ton)	—	720	1,800	1,741	1,675
Kerosene(KL)	6,253	7,122	8,078	6,691	7,961
Diesel(KL)	16,173	16,778	16,461	17,647	20,035
Petrol(KL)	3,574	3,506	3,469	3,530	3,690
Electricity(GWh)	144.665	159.713	173.823	176.509	275.951
Domestic	18.327	18.293	21.500	17.037	16.790
Commercial & GOV	10.713	9.871	12.896	17.912	23.600
Industries	110.628	123.928	31.675	136.281	228.200
Bulk Supply	4.914	7.397	107.309	4.861	7.021
Public Lighting	0.083	0.224	0.443	0.418	0.340

Source: Statistical Year Book of Bhutan,1995

(2) Energy Policy for the Country

1) Development of Energy

In accordance with the Royal Government of Bhutan (RGOB) energy policy to reduce the dependency on oil, RGOB gives priority to hydropower resource as electric energy sources, where available.

Another policy objective is the further diversification of energy sources into non-exhaustive alternatives such as hydropower, biomass, solar and wind, but the contribution of these renewable energy sources is minor at present. Studies are being made for a more positive utilization of these sources. The improvement of energy efficiency is also a pressing policy objective.

After 1994, the Government's policy is encourage to the private sector and privatization, the volume of private investment is also steadily increasing.

Rural electrification is also an important subject to be considered in accordance with the country's policy, because substantial improvement of the standard of living throughout the country, even if social tasks as the provision of electricity to rural and remote areas, at not-profitable rates. The population is expected to reach 931,711 in 2016/17 from 600,000 in 1996 and energy consumption will be increased.

Mostly due to the booming demand from the industrial sector, the electric energy supply hardly catches up with the demand. This situation is also the consequence of the difficulties for RGOB to meet the high magnitude of capital required for power development and rural electrification.

4.2.3 Electric Power Survey in Bhutan

(1) Existing Electric Power Facilities and Utilities

At present, the Bhutan power system are divided into 3 regions of Western, Central and Eastern to cover those cities/towns and their 3 power systems are not interconnected yet because there are crossing the high mountains and no living zones among 3 regions.

Division of Power (DoP) under the Ministry of Trade and Industry (MTI) is responsible for supply and development for electrical energy activities in Bhutan power system.

On the other hand, 5 private industries are operating power station with diesel generation units and to supply the power neighboring consumers as an isolated power system.

According to the future expansion plan prepared by MTI, the System will be expanded or interconnected with 220 kV and 66 kV transmission lines and distribution lines to cover most of cities/towns for urban and rural electrification by the end of 8FYP(year 2002). But MTI has difficulties, from an economic point of view, being involved in the System since it is too far from the area covered by the System and its power requirement is still too small.

1) Organization

Organization of Division of Power (DoP) is shown in Fig. 4.1, and Punatsangchhu Project formation is shown in Fig. 4.2, respectively.

DoP is operating by approximately 544 technical personnel headed Joint Secretary including miscellaneous job workers.

The Hydrology Unit of DoP manages Punatsangchhu Project, and National Project Manager handles these project activities.

2) Power plants in Bhutan

a) Existing Power Plants

The generating capacities of the existing plants in Bhutan System are summarized in the Tables 4.5 to 4.6.

The total installed capacity is 356.67 MW in 1995, and generating capacities of about 94 % (336 MW) account for Chhukha hydropower station. DoP has about 14.15 MW with micro-hydro and diesel generation, and private industries have total about 6.52 MW of diesel stations.

The power supply of limited areas are based on micro-hydro and diesel generating stations which is supplemented by imports from India to the part of Central and Eastern Regions in Bhutan.

b) Chhukha Power Station

The Chhukha hydropower project was completed with 336 MW (84 MW x 4 units) in 1986/88 to connect with Eastern Grid of India through 220 kV transmission lines.

The project was a joint venture of the Royal Government of Bhutan and the Government of India for the socio-economic development of Bhutan.

The CHPC generated 1,732.92 GWh in 1998/99, and the export of power to Power Grid Corporation of India Ltd. (PGCI) during 1998/99 was 1,302.2 GWh as shown in Fig. 4.3. The domestic supply of 398.17GWh was made to the DoP.

The Chhukha power station is well operating with total operation hours of 28,489 for 4 units per annum, availability factor of 81.3% and overall load factor of 60.3% in 1997.

The CHPC maintained uninterrupted power supply to industries such as BCCL, Penden Cement Factory and others as well as the domestic consumers.

3) Existing Transmission/Distribution Lines and Substations

a) Existing Transmission/Distribution Lines

At present, the Bhutan power system are divided into 3 regions of Western, Central and Eastern to cover those cities/towns surrounding with 220 kV and 66 kV transmission lines and 33 kV, 11 kV, 6.6 kV and 400 V distribution lines. Their 3 power systems are not interconnected yet.

The existing transmission and distribution lines in Bhutan Power System are summarized in the Table 4.7 and Fig. 4.4.

The total installed lengths of main transmission lines (EHV) are 220 kV of 71 km (double circuit), 86.8km (single circuit), 132 kV of 0.3 km and 66kV of 234.8 km in 1998/99.

Length of sub-transmission lines for high tension (HV) are installed 33 kV of 174.86 km, 11 kV of 952.85 km (including under cables of 14.2 km). Low tension lines (LV), 6.6 kV of 89.4 km and 400/230 V of 64 km distribution lines for micro-hydro were constructed by the Japanese grant aid.

Low tension distribution lines to consumers are total length of 928.7 km (including under cables of 40.9 km) which specified 400 V of 3 phases with 4-wires and 230 V single phase.

Voltage allowable tolerance in variation in EHV, HV and LT class is ±5% and Frequency is 50 hertz (Hz) and allowable tolerance in variation of frequency is ± 3 %.

Western Region

This region have big consumed areas such as cities Phuentsholing, Thimphu and Phunaka connecting with 220 kV and 66 kV transmission lines and 33 kV, 11 kV, 400 V distribution lines. After commissioning Chhukha power station in 1986/88, power grid system is well maintained and operating for power supply to the customers and export energy to India from Chhukha through 220 kV transmission lines. Solar energy system for school, basic health and official residents area are installed at Gasa area.

Central Region

This region covers central power system of Bhutan, and all power system is not connected with transmission/distribution lines because Gaylegphug is near borderline of India and Tongsa, Jakar and Shemgang are located in mountain and isolated areas and their power are supplied with micro-hydro or import from India (ASEB).

Eastern Region

The eastern region covers towns of Tashigang, Mongar, Samdrup Jonkharto, their power are supply with micro-hydro for north area (Tashigang, Mongar) and south area (Samdrup Jonkhar to Deothang) are connected 33 kV lines with India.

b) Existing Substations

The existing substation capacities are summarized below.

Substations	Voltage(kV/kV)	Capacity(MVA)
1. Substations		
220kV	220/66	150
	220/11	420
132kV	132/66	50
66kV	66/33/11	25
	66/22	28.5
	66/11	134
	66/6.6	10
Total		817.5
2 Step up/down Substations (total capacity)	-	484.3
3. Distribution Substations (total capacity)	-	116.1

Source: Division of Power, 1998/99

4) Power Demand and Supply

a) Energy generation

According to the actual production of energy in 1998/99 as shown in Table 4.5, total energy generation of Bhutan was 1,746.08 GWh and Chhukha hydropower station (CHPC) shares of the total energy produced was about 99.2% (1,732.9 GWh) and therefore plays a very important role in the System. On the other hand, other hydro stations, micro-hydro stations and scattered diesel stations, their total energy produced were 13.18 GWh.

Energy Generation and Sharing

	Produced Energy in 1995	
Plants	GWh	Share %
Chhukha	1732.9	99.2
Micro-Hydro	13.1	0.75
Diesel	0.08	0.05
Total	1,746.08	100.0

Source : Statistical Year Book of Bhutan, 1998/99

b) Peak Load

Total peak load of Bhutan power system was 80 MW in 1998/99 and increasing year by year, this means that consumption of electricity per household increase with electrical equipment such as electric cooker, heater, etc. and also rural and urban electrification.

Year	Peak Load (MW)	Number of Consumers	Villages/Towns Electrified
1990	22.0	15,629	221/28
1991	22.8	18,806	254/30
1992	22.0	19,626	270/36
1993	23.0	19,501	277/37
1994	33.0	19,901	282/37
1995	70.416	21,797	297/38
1996	70.416	21,990	331/39
1997	72	30,321	363/39
1998	77	31,639	370/39
1998/99	80	33,710	443/40

Source: DoP Power data, 1998/99

5) Energy Losses

Energy losses in the system are about 12.2% in 1995/96 including own use and transmission and distribution lines loss. DoP is expecting the loss to be 10% lower during 8FYP. It seems difficult to realize a loss factor of less 10%, and then DoP reached the system losses was 6.5% in 1998/99 by mean of expansion of distribution network. Several countermeasures are taken as mentioned below need to be improving the present situation:

a) Own use

Hydropower plants require less power for their own use than diesel power plants. It is recommendable to promote the development of hydropower plants.

b) Transmission lines

Higher voltage leads to lower losses, so the expansion of the 220 kV and 66 kV lines meets this purpose.

c) Distribution lines

To install as many substations as possible in load centers.

The table below is shown the energy losses year by year in the System.

Energy Losses in the System

Year	Losses(%)	Peak Demand (MW)	Total Energy Sales(GWh)
1991	10.5	22.8	1549.9
1992	14.5	22	1563.88
1993	11	23	1683.89
1994	11.1	33	1685.81
1995	7.5	72	1629.98
1996	12.2	72	1972.18
1997	4.5	72	1828.06
1998	4.0	77	1801.02
1998/99	6.5	80	1746.13

Source :DoP, Power Data, 1998/99

(Reference data)

System losses of the electric power system of ASEAN countries and others in 1995 are referred as follows.(source : Wold bank 1998)

Thailand	8%	Philippines	16%
Malaysia	10%	Japan	4%
Indonesia	12%	India	18%

6) Electricity Tariff

There are two category applying electric rates of urban area in town/city (for public, industry and commercial) and local area (agricultural citizen). Electricity tariff is given the following table in 2000, since tariff was changed several times from 0.7 Nu/kWh in 1988 which was completed Chhukha power station to 0.4 Nu/kWh and so on.

Items	Category	Tariff (Nu/kWh)
Domestic use	Urban area in town/city (for public, industry and commercial)	0.7
Domestic use	Local area (agricultural citizen).	0.5
Export	Export to India	1.5

Source: DoP, 2000

Users are consisted of large and medium

Users are consisted of large and medium consumers, industries, public and corporation with different basic charge of the above table due to the contracted power capacity (kVA) and purpose of use. Other hand, local area is applied flat charge without metering system. Marginal utility tariff may be 1.8 Nu/kWh, then a difference is subsidized by the Government.

Rapidly increased power consumption of Bhutan, which was 90kWh/capita in 1888 to 609.8 kWh/capita in 1997/98, but it was still 10 % of Japanese consumer (6,273 kWh/capita, 1997), and they are not contributed to the Government income.

The export tariff was contracted with 0.37 Nu/kWh in 1995, but after 3 times revision of tariff, becomes 1.5 Nu/kWh. Under developing country of Bhutan, the export of hydro power to India is very important to obtain the only way of the foreign currency (Indian Rupees) and a role of the Governmental income.

(2) Plan of Power Development

The plans of development program for hydropower projects are summarized below:

Status	Project Name	District	Description	Scheme type
Under Construction	Basochhu	Wangdue Phodrang	Installed Capacity: 61 MW Firm Capacity: 12 MW Energy:291 GWh Completion: July, 2001	Run of River (ROR)
	Kurichhu	Mongar	Installed Capacity: 60 MW Firm Capacity: 24 MW Energy 322/400 GWh Completion: 2002	ROR
	Tala	Chhukha	Installed Capacity: 1,020 MW Firm Capacity: 168 MW Energy: 3,962 GWh Completion: 2006/07	ROR

Planned and Studied	Bunakha Reservoir	Chhukha	Installed Capacity: 180 MW Firm Capacity: - MW Energy:688 GWh	Storage
	Mangdechhu	Trongsa	Installed Capacity: 425 MW Firm Capacity: - MW Energy:1,800 GWh	ROR
	Punatsangchhu	Wangdue Phodrang	Installed Capacity: 760 MW Firm Capacity: 125 MW Energy:3,305 GWh	ROR

Source: Division of Power, 1998/99

a) Basochhu Project

This project is financed grant loan basis under Austrian Government.

Designed to feed the Western transmission grid currently served by Chhukha, and the project is located in the Rurichu River converted by the diversion tunnel of about 3km from the Basochuu Tributary. The project will be commissioned during 8FYP.

b) Kurichhu Project

This project is financed 60% of grant and 40% loan basis under Indian's Government and National Hydro Electric power Cor. of Government of India is managing the project turn-key basis. (first stage 45MW)

Energy will consume targeted to the 5 Eastern districts and the Dungsum Cement Project at Nanglam. Option to upgrade to further 15 MW will be added in second stage.

c) Tala Project

This project is financed 60% of grant and 40% loan basis under Government of India.

Power purchase and implementation agreement signed with India was conducted in 1996.

The project will be commissioned during 9FYP.

d) Bunakha Reservoir Project

This project is located upstream from the existing Chhukha power station.

Detailed design is undertaken, and designed to augment Chhukha's peaking power generation capacity (by 101GWh) as well as other schemes down stream.

e) Trongsa Project

Feasibility study is underway. Energy export to other country is oriented and options for private sector investment is to be considered.

(3) Expansion Plan for Transmission Lines and Substations

An expansion plan of 220 kV transmission lines from Basochhu to Semotokha and a 66kV line from Basochhu to Tsirang and diversion to Dagana will be constructed during 8FYP.

For evacuation of Kurichhu hydropower, 132 kV transmission lines from Gyeloposhing to Nanglam and from Gyeloposhing to Thtashigang via Mongar and Pemagatsel to Deothang will be constructed during 8FYP.

Substation 66/33 kV, 5 MVA of Samtse is proposed to install for supplying power surrounding villages.

Existing Gedu 66/33 kV substation is proposed to be upgraded from 6 to 20 MVA for consumption of industries and Tala project headquarter.

Existing Singyegaon 66/11 kV substation(under Phuentsholing Electricity Supply Unit) is proposed to be upgraded from 6 to 10 MVA for consumption of mushrooming industries at Pasakha and villages electrified in Bhalujora Gewog.

4.3 Power Sector Survey in India

4.3.1 General

The objective of power sector survey is to grasp the situation of power demand and supply of both countries: Bhutan which exports power, and India which imports power, in order to reveal appropriateness and project position.

The objective states in this survey are West Bengal and Assam, because, they are the nearest States in India to consume the imported power from Bhutan. Moreover, it is available to evacuate the power to whole Indian power system thanks to the connected trunk lines between both states and/or each area which were completed in the end of 1999.

Results of the survey revealed that Eastern region including West Bengal state is more advantageous than North-eastern region including Assam in the following points. It is concluded that 1) maximum consumption of Assam state is only 10% as compared with West Bengal state in spite of the highest growth rate of demand forecast in the 11th plan than other regions, 2) future plan for energy best mix: hydro and thermal power of the Eastern region including West Bengal state, 3) advanced energy policy

of import power in West Bengal state. Considering the above mentioned points, the hydro power energy of Bhutan is exported to Eastern region including West Bengal state in order to reveal appropriateness and project position. Therefore, the load forecast and system analysis are carried out for West Bengal state.

JICA study team made a sub-contract with an Indian consultant for "Indian Power Sector" and "Power Purchase Business" at the 1st field survey in 1998. And then the JICA study team carried out information/data collection and/or update at the 6th field survey (from June to July 2000).

(1) Activity of Power Sector Survey of India

JICA study team for Punatsangchhu Hydropower project sub-contracted WAPCOS (Water and Power Consultancy Services (India) Ltd.) the work pertaining to data collection in respect of power sector for West Bengal and Assam States and micro economy for whole India as follows:

1) Period

1. First survey: From 9th February 2000 to 19th March 2000

2. Second survey: From 23rd June 2000 to 31st March 2000

2) Scope of Work

1. Macro Economy Survey in India

2. Power Sector Survey in India (West Bengal and Assam States)

3. Power Purchase Business in India

3) Acquisitive Agencies of Data

WAPCOS has collected the above information/data from various Central and State Government agencies as follows:

1.	CEA	Central Electric Authority, Govt. of India
2.	WBSEB	West Bengal State Electricity Board, Govt. of West Bengal
3.	ASEB	Assam State Electricity Board, Govt. of Assam
4.	MOP	Ministry of Power, Govt. of India
5.	CSODS	Central Statistical Organization Department of Statistics
6.	MOP&PI	Ministry of Planning & Program Implementation, Govt. of India
7.	NEEPCO	North Eastern Electric Power Corporation
8.	CPU	Council of Power Utilities

9. CBI&P Central Board of Irrigation and Power

4) Collected Data

List of collected data for power sector survey in India is shown in Appendix.

4.3.2 Power Sector in India

The most recent Electric Power Survey in India, conducted by the 15th Electric Power Survey Committee, constituted by the Government of India in March 1994, was published in 1995. It reviewed the electricity demand projections in detail during the 9th plan period i.e., up to 2001-02 and projected the perspective demand up to 2011-12 of the 11th plan. Based on the collected data and information, JICA study team carried out the review of Indian Power Sector and analyzed the forecast of power demand.

(1) Summary of Indian Power Sector

The power sector has registered significant progress since the process of planned development of the economy began in 1950. Hydro power and based thermal power of coal have been the main sources of generating electricity. Nuclear power development is at slower pace which was introduced in late sixties. The concept of operating power systems on a regional basis crossing the political boundaries of State was introduced in early sixties. In spite of the overall development that has taken place, the power supply industry has been under constant pressure to bridge the gap between supply and demand.

- All Indian Power System

There are five (5) regions in the power system i.e. Northern, Western, Southern, Eastern and North-Eastern Regions. NPTC (National Power Transmission Company) was established in 1989 under the MOP (Ministry of Power), and named POWERGRID in 1991. POWERGRID is managed operation & maintenance for all power system. Each region is operating independently without Eastern and North-Eastern Regions. Advanced development regions are Northern, Western, Southern and Eastern and their electricity power generation in 1998 of March were approx. 116,914 GWh, 132,163 GWh, 101,711 GWh and 44,591 GWh respectively. North-Eastern Regions was 3,157 GWh, peak demand of all India was 65,435 MW (increasing 72,669 MW in 1999/2000). Regions to regions are interconnected/on going with area transmission lines and/or HVDC, and to be planned the expansion more than 10,000 km in the 9th development plan. Northern and Western is interconnected with HVDC. Southern is independent power system, but connected area to area in Western region. Eastern has surplus of supply power and interconnected to North-Eastern and Western regions, etc. with AC and/or

HVDC transmission lines. Power flow between regions to regions is controlled by five (5) Regional Electricity Boards (REB).

Power demand and consumption of all India in 1998 to 2000/March are shown in Fig. 4.5 and 4.6.

- Shortage and Expansion of Power Supply

The country suffers from an overall energy shortage of 10~12% (which rise to above 15~20% during peak hours). The existing installed capacity is around 110.8 GW in 2000/March (83.1GW for thermal and 23.8 GW for hydro, 2.7 GW for nuclear and 1.2GW for wind), but it is clearly inadequate to meet the current demand because of maximum power consumption is 480,340 GWh compared with supplied power of 450,594 GWh.. A low (63%) PLF and high transmission & distribution lines losses further aggravate the situation. At the present estimated rate of growth of the economy and taking into account the previous energy backlog, it feels that the country would need a new addition of 8 to 10 GW annually for the next ten years. Power Ministry itself has set an aim of adding 80 GW by the year 2010, with matching investment in transmission & distribution lines. In this, private power would have a significant role to pay.

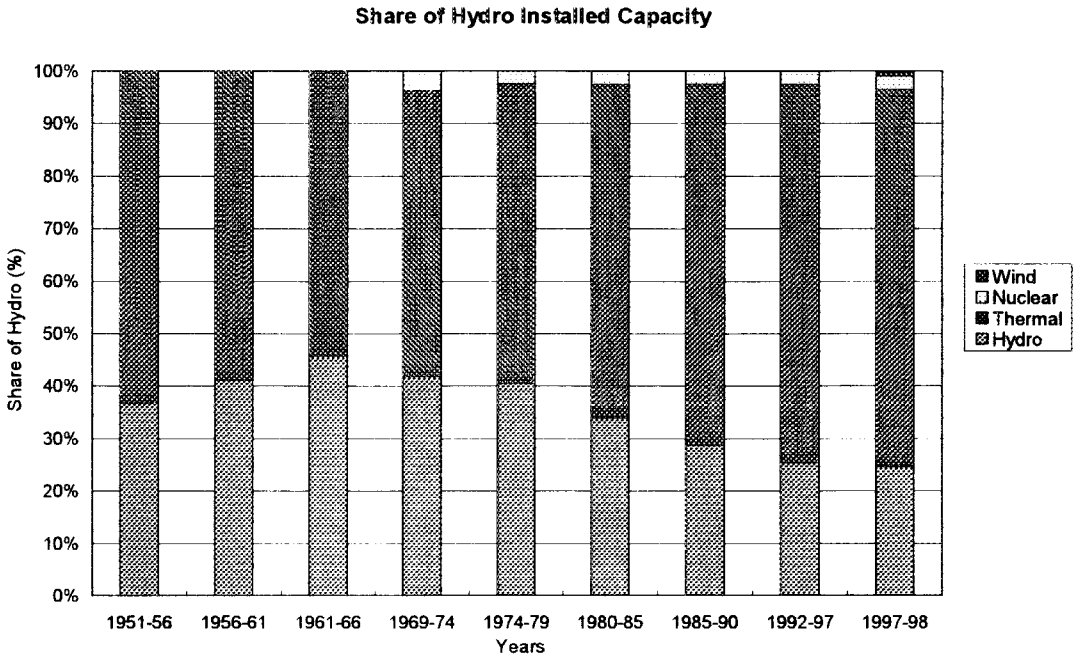
The proposed capacity addition of 57.7 GW during 9th plan (1997-2002) comprises benefits of new development 28.2 GW from private sector, 17.6 GW in state sector and 11.8 GW in central sector. But, in the initial years of power privatization, not many project proposals from IPPs fell in the "mega project" category (1,000 MW and above, the power should be allocated to power system of the states), and those that did also ran into difficulties. (Of the eight "fast-track" projects, four were "mega power", till the end of financial year 1997-98, only 12 IPP projects (2,277 MW) had been commissioned, another 5 projects (748 MW) partly commissioned, and 14 projects (3,352 MW) had received CEA's final approval and were awaiting financial closure.)

- A Policy of Hydropower Development

Presently, it is mare 24% and even an enhancement by 5% (aimed by Ministry of Power; for efficient operation of power system, ideal hydro-thermal mix is considered to be 40:60) would required a further addition of 10,000 MW of new hydro capacity. (refer to figure as follows:)

An imbalance in the hydro thermal mix, especially in the Eastern and Western regions, many thermal power stations are required to reduce the power during off peak hours, because of low ratio of hydro power stations in the power system.

On the other hand, almost 40% of even the existing capacity requires urgent renovation and up-rating, task being undertaken by SEBs at low speed.



Private power sector from 1991 onwards has had little impact on hydropower development in the country. Only two IPP (both Indian) projects had obtained CEA's final clearance, aggregating a mere 700 MW.

Hydropower is a renewable economic, non polluting and environmentally benign source of energy. Hydropower stations have inherent ability for instantaneous starting, stopping, load variations, etc. and help in improving reliability of power system. Hydro power stations are the best choice for meeting the peak demand. Hydropower projects have long useful life extending over 50 years and help in conserving fossil fuels. They also help in operating of avenues for development of remote and backward areas.

It is explained concretely that the tasks and its countermeasure of the Indian power sector during power sector survey are as follows.

1) The tasks of the Indian power sector

- New policy option for long term strategies have to be tried to accelerate the pace of growth (Growth rates in electricity consumption all India period 1955 to 1995-96 is 9.19 % of average).

- Reform process have to be given renewed and dynamism and remove all the bottle necks step-by-step.
- Restructuring of power supply industry, would have to be speeded up to make it commercially viable.
- Some short term strategies viz. reduction of gestation period of projects.
- Reduction of Transmission & distribution losses (the losses of T&D in 1997-98 was 20.7%).
- Maximizing generation from existing facilities, demand side management, energy conservation and promotion of inter and intra-Regional exchange of power.
- Encourage private sector participation in all the three areas (generation, transmission and distribution lines), setting up joint sector mega-projects, are to be adopted.
- In the long term perspective, acceleration of hydro and nuclear power development.
- Adopting an optimistic and nationalistic approach, projecting India as a reliable markets for investment from national and international investors for power sector.

2) Countermeasure

- Immediate refurbishment/ up rating and modernization of old and ailing power stations

  The cost of refurbishment per MW varies between 25% - 50% of that for setting up a new power station, as it is cheaper and a faster way.

- Priority for development of hydro power stations

  All hydropower projects already approved or taken up or even at the drawing up stage should be given top priority and executed in the shortest possible time.

- National power grid

  Setting up of national power grid with HVDC links in the shortest possible time.

- Demand side management and a new look at subsidies

  A total abolition of un-metered supplies and setting up the tariff to pay flat rates. The difference between the maximum demand in a power system and the minimum is very substantial (the "peak" and the "trough" of the daily curve), suitably designed "off-peak tariff" to be considered.

- Efficiencies of electrical appliances

  Equipment/appliances should be specified according to Bureau of Indian Standards, system for ISI Certification, etc.

  Compulsory use of capacitors for power factor correction for fluorescent lamps, motors, etc. must also be introduced.

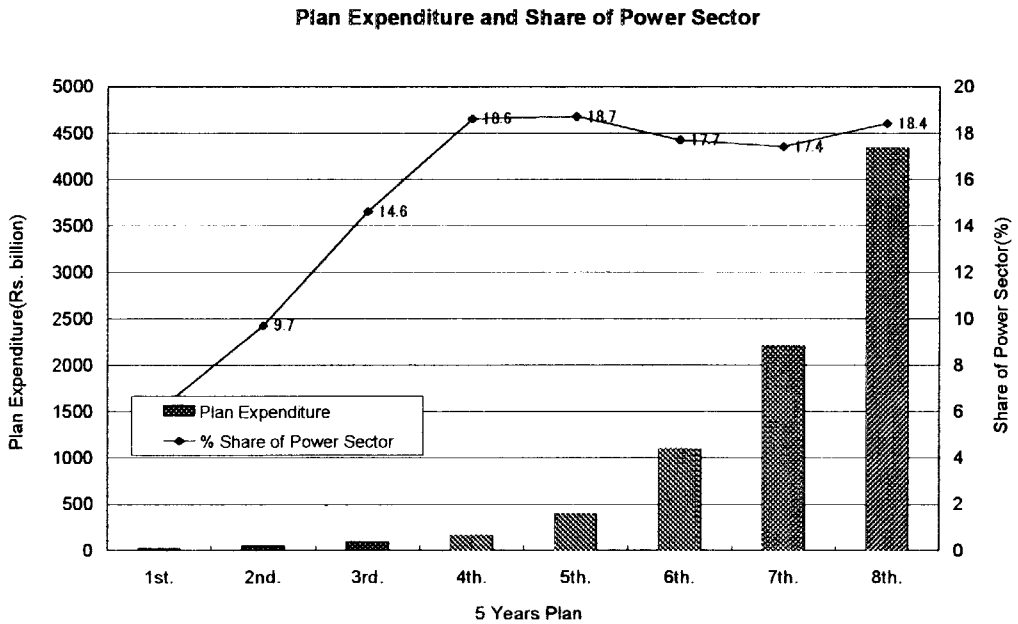
- Energy audit and consumer education

  Government, NGOs and others should educate the consumers about energy efficient lamps and other devices and the benefits thereof, specially through the electronic media.

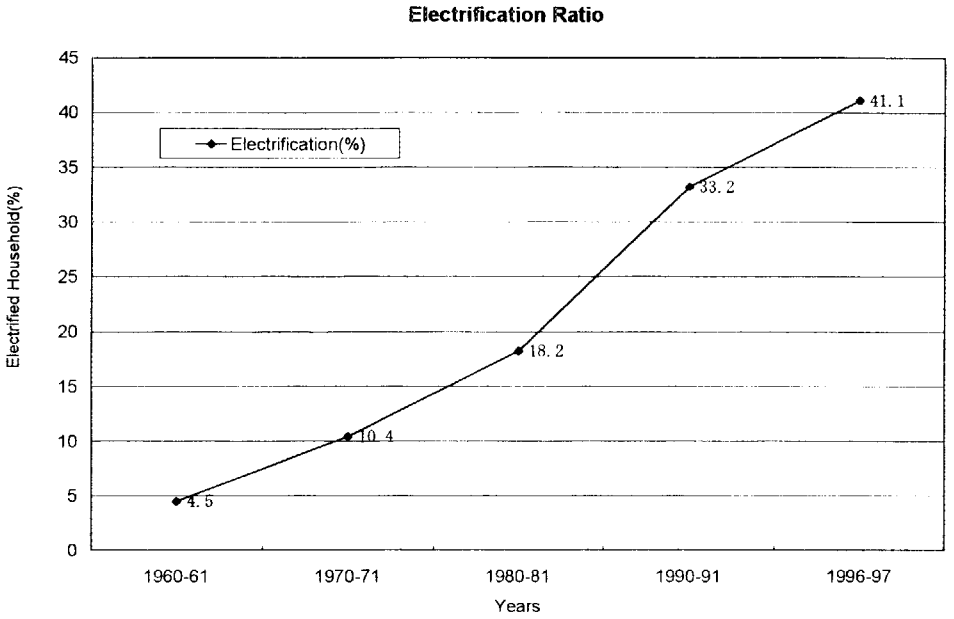
(2) Power Sector Overview

Power development has been receiving adequate priority ever since the process of planned development of the economy began in 1950. Remarkable growth and progress have led to extensive use of electricity in the successive Five Year Plans. In the last 48 years, the table below indicate gross electricity generation (utilities) in India has increased by well over 82 times from 5,107 GWh in 1950 to more than 421,747 GWh by the end of March 1998.

The investment in the power sector was Rs. 19.6 billion in the first plan (1951-56) and has increased to Rs. 4,341 billion in the 8th plan (1992-97). This corresponds to an increase in the share of power sector investment in the total public sector from 6.1% to 18.4%.



The number of domestic consumers increased from 150 million in 1950 to over 9,100 million at the end of March 1996. As against 3,061 villages electrified by the end of 1950-51, about 50 million villages (86% of the total villages) have been electrified in the country till 1995-96, this is about 163 times. Similarly the number of pump-sets energized increased from a meager 21,000 to about 11 million.



(3) Power Facilities and Operations

1) Installed Capacity

The growth of installed capacity in India has been phenomenal from a meager 2,300 MW in 1950, it has risen to 102,000 MW in both utility and non utility (utility was 89,167 MW) at the end of March 1998, this was about 44 times. The trends in the share of installed capacity was 24.6 % for hydro, 71.9% for thermal, 2.5% for nuclear and 1.0 for wind as shown table below. (In 2000/March, installed capacity is 97,836.9 MW and the share of installed capacity was 24.3% for hydro, 71.7 % for thermal, 2.8% for nuclear and 1.2 for wind. The breakdown of installed capacity by Region-wise as on 31 March, 2000 is given in Table 4.10.

Share of Installed Capacity in 1998, March

Source	Central Power (MW)	State Power (MW)	Private Power (MW)	Total (MW)	% share of Total
Thermal total	22,645.5 (35.3%)	36,439.7 (56.8%)	5,065.6 (7.9%)	64,150.8 (100%)	71.9
Coal	19,057.5	33,860.6	3,051.4	55,969.5	62.8
Gas	3,588	2,203.5	2,013.9	7,805.4	8.7
Liquid	0	375.6	0.3	375.9	0.4
Hydro	2,509 (11.5%)	18,921.1* (86.5%)	456 (2%)	21,891.1 (100%)	24.6
Nuclear	2,225 (100%)	0	0	2,225 (100%)	2.5
Wind	0	49.9 (5%)	850.1 (95%)	900 (100%)	1.0
Total	27,379.5	55,415.7	6,371.7	89,166.9	100
Share(%)	30.7	62.1	7.2	100	

* Including 2,704.5 MW of BBMB in joint sector

The peaking shortages are consistently high and showing an increasing trend from 14.4% at the end of 6th plan to 16.7% of the 7th plan and 18% of the 8th plan. In this situation of the gap between demand and supply, it is problem that the delay of development program will not sustain the quality and supply of the power to the peaking demand. Many pumped storage power stations which is capable power supply at the peaking hours are being constructed due to thermal share of the total generation capacity in Indian power system reached 70%.

End of Plan	6th (1880-85)	7th (19985-90)	8th (1992-97)
Peak Demand (MW)	25,730	40,385	63,853
Dependable Capacity (MW)	22,016	33,658	52,376
Shortages (%)	14.4	16.7	18

2) Electricity Generation

With the progressive increase in the installed generating capacity, power generation in India has also been increasing at about the same rate of growth as that of installed capacity. The generation of power has accordingly increased from 6,600 GWh (5,100 GWh in

utilities) in 1950 to 465,824 GWh (out of which 421,747 GWh in utilities) in 1997/98. The trends in the share of generation of electricity is 17.7% for hydro, 79.7% for thermal, 2.4% for nuclear and 0.1% for wind. The electricity generation in the various regions during the year 1997-98 is indicated in Table 4.11.

3) Transmission and Distribution System

The length of transmission lines is 5.5 million ctk-km at the end of March, 1998 as compared to 29,271 ckt-km in the year 1950.

The present basic transmission and distribution configuration, a 400 kV network (over 36,497 ckt-km, upto March 1998) is a main and bulk transmission system. And each region are connected with 220 kV(83,390 km), 132 kV and 110 kV network(103,902 km) as main and support systems. In each state, 66 kV, 33 kV and 22 kV as sub-transmission systems are also connected with 11 kV network as primary distribution and 400/230 volts as local distribution system. The circuit km of different voltage level is indicated in Table 4.12.

Connection lines between each region are listed below as a "Back to Back" DC system.

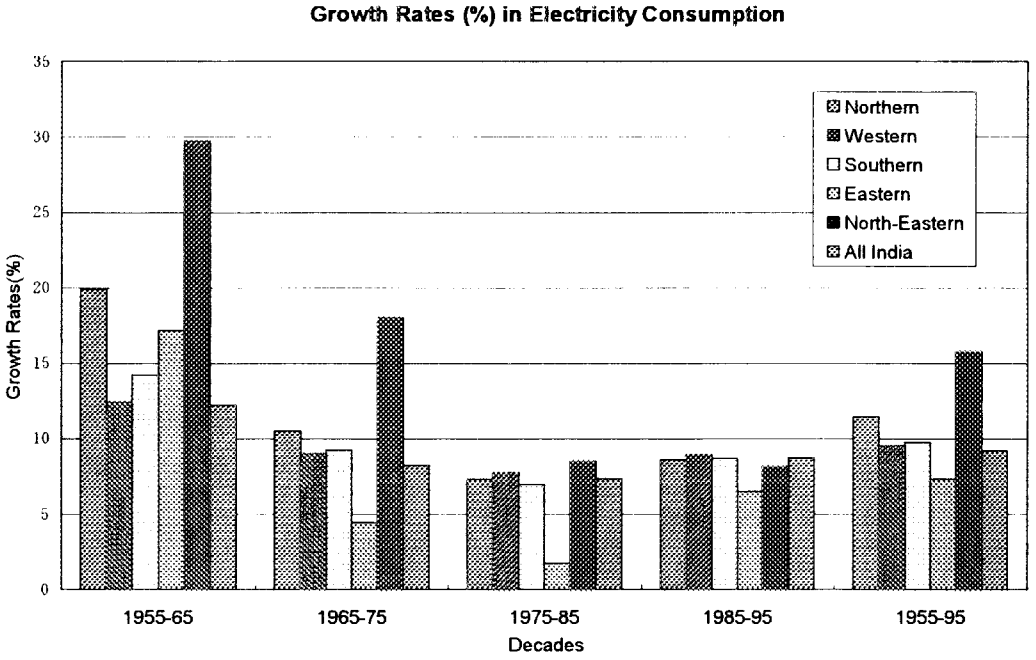
Northern – Western Region	HVDC (500 MW)
Western – Southern Region	HVDC (1,000 MW)
Southern – Eastern Region	HVDC (500 MW)
Northern - Eastern Region	HVDC (500 MW) under construction
Eastern – North-Eastern Region	AC 220 kV, 132 kV and 400 kV

It is not enough controlling the system voltage, then big fluctuation occurs, because reactive power supply is poor in the upper voltage system. Controlled voltage in the system is ±5%, but in the actual voltage is 80 to 105%, therefore, the losses increase. The other reason of voltage down in the system, is agricultural load (pump-sets, etc.) which is consumed reactive power due to low power factor, and distribution lines are over loaded.

4) Power Market

It could be observed that the electricity consumption recorded an average growth rate of 12.23 % during the decade 1955 to 1965/66, came down to 8.25% decade 1965 to 1975/76, and 1985/86 downed 7.35%, and it increased to 8.71% during the decade 1985 to 1995/96. Further, the Northern region recorded higher growth rates than other regions. In the Western, Southern and North-Eastern regions (Assam state, etc) the growth rate had

been steady and sustained, while Eastern region (West Bengal state, etc.) recorded lower growth rate.



There are four main categories of consumers in Power Utilities viz. domestic (18.9%), commercial (6.1%), industry (44.8%), agricultural (28.6%) and other in 1997/98. The industrial category comprises low tension and high-tension consumers. Other less power consuming categories (1.6%) are Public lighting, Public water supply and drainage, railway traction etc. The intensity of consumption in each category is different in five regions of the country due to climatic differences, status of industrial development and requirements of agricultural, etc.

The region-wise electricity consumption during 1997/98 for different categories of consumer is given in Table 4.13.

5) System Loss

The transmission & distribution (T&D) losses in India were very high: 20.7% in 1997/98 as compared to other country.

Out of those the transmission losses component is 6~7% and the distribution losses are of the order of 14~15%. The factors which have contributed to these high losses are (i) extension of network to far flung rural area (ii) low load densities and long lines (iii) un-metered supply to agricultural pump-sets (iv) large scale theft and unauthorized use of energy. The first two could be classified as "technical losses" which would have to be

brought down by strengthening of the system; technical improvement of line length and voltage grad up or installation of shunt capacitor, etc.

6) Electricity Tariff

There are two category applying electric rates; HT (high voltage) and LT (low voltage) users. HT users are consisted of large and medium industries, public and corporation, power distribution licenser and railway. Other hand, LT users are domestic, commercial, agricultural and small industries.

Electricity tariff of HT table is defined based on the two perts rate system (basic charge plus energy charge system), which are applied to maximum load (kW) and energy consumption (kWh). But, LT table is only paid flat rate system, which is applied to energy consumption (kWh). As a result of heavy subsidies to agricultural consumers (many of whom are not metered and pay flat rates) abnormally high tariff have been imposed on industrial consumers.

Electricity tariff (Average) (unit: paise/kWh)

Electric Charge	Domestic/ House	Commercial	Agriculture	Industrial Power		
				Low Volt	Middle Volt	High Volt
All India in 1992/93 (Average)	66.8	161.7	42.6	121.2	130.8	153.8
Actual in 1992/93 (Average)	75.57	158.12	16.61	166.14		
Actual in 1996/97 (Average)	112.3	284.89	46.44	224.93		
Private Power in 1992/93 (major company)	55 ~ 106	118.7 ~ 275	N.A	98.8 ~ 278	119.8 ~ 346.2	100.6 ~ 212.1

Note: 1 Rupee = 100 paise
Source: JEPIC, 1995 and 1998

(4) Load Forecast

According to collected data (at the first site survey of JICA Team in 1998) from CEA, the long term forecast for 2006-07 (end of 10th plan) and 2011-12 (end of 11th plan) has been worked out by extrapolating the energy requirement (at power station bus-bars) obtained on the basis of the detailed forecast up to 2001-02. The growth rates for projection have been determined after studying the growth rates anticipated during the period 1993-94 to 2001-02 and keeping in view the enlarging base and liberalized economic policy.

According to the 15th EPS (Electric Power Survey), the estimated energy requirement at power station bus-bars by the end of 10th (2006-07) and 11th (2011-12) Plans would be 781,863 GWh and

1,058,440 GWh respectively. The corresponding peak load would be 130,944 MW and 176,647 MW respectively.

The region-wise estimation of CEA is shown blow

(unit : MW)

Region	Energy Consumption			Peak Demand		
	2002-02	2006-07	2011-12	2001-02	2006-07	2011-12
	9th Plan	10th Plan	11th Plan	9th Plan	10th Plan	11th Plan
Northern	181,649	254,161	350,185	31,735	44,009	60,077
Western	176,732	239,731	320,956	28,430	38,538	51,562
Southern	134,671	178,690	234,164	21,975	29,070	37,996
Eastern	68,243	96,884	135,049	12,438	16,722	23,228
North Eastern	8,148	12,062	17,553	1,808	2,652	3,844
A&N Islands	180	295	475	41	67	108
Lakshadweep	27	40	58	8	11	15
All India	569,650	681,863	1,058,440	95,759	130,944	176,647

Source: CEA (Central Electricity Authority), 1998

(5) Development Plan

There is a slippage of 46% in capacity addition against the target. The slippage in hydro capacity is as high as 74% of the target. The 8th plan capacity additions represents an average of 3,285 MW per annum compared to the target of 6,108 MW per annum.

Planning commission has considered feasible addition to the generating capacity as 40,245 MW, keeping in view, the status of on-going, sanctioned and new projects, the detailed are given below.

All the Constituent State of Northern region would be facing peaking and energy shortage except Himachal Pradesh. The position in Western region would be comparatively better, though heavy peaking shortage are excepted to continue in Gujarat and Madhya Pradesh. In the other three regions, the position would be comfortable and any shortages could be met from unallocated power from Central sector.

9th Five Year Plan(1997-2002) Unit : MW

Source	On-going/sanctioned schemes	CEA Cleared/new schemes	Total
Hydro	9,126.7	693	98,198
Thermal	12,047	16,898.5	29,545.5
Nuclear	880	-	880
Total	22,654	17,591	40,245.

CEA: Central Electric Authority

Out of the above capacity during 10th plan, schemes totaling to 7,330 MW have been sanctioned and 10,556 MW cleared by CEA so far. Beside the above schemes, new schemes of 39,812 MW have to be considered to meet the demand. In addition of 11th plan, 9,086 MW have been cleared by CEA so far. Beside the above schemes, new schemes of 48,961 MW have to be considered to met the demand.

Especially, energy of hydro power imported from other countries have been planned, definitely, that

(i) Eastern Region From Bhutan

Punatsangchhu Power Station : 874 MW

Tala Power Station : 1,020 MW

(ii) Northern Region from Nepal

Pancheswar Power Station : 6,480 MW

The 10th and 11th Plans of new development are listed below.

10th Five Year Plan(2002-07) (Unit: MW)

Region	Hydro	Thermal	Nuclear	Total
Northern	2,086	10,745	1,000	13,831
Western	2,250	17,744	1,000	20,994
Southern	1,711	6,321	2,880	10,912
Eastern	2,261	8,230	0	10,491
North Eastern	710	760	0	1,470
All India	9,018	43,800	4,880	57,698

CEA: Central Electric Authority

11th Five Year Plan(2007-12) Unit: MW

Region	Hydro	Thermal	Nuclear	Total
Northern	13,322*	3,300	1,000	17,332
Western	3,836	5,441	-	9,277
Southern	4,204	11,111	-	15,315
Eastern	5,852**	8,690	-	14,542
North Eastern	1,381	-	-	1,381
All India	28,505	28,542	1,000	58,047

* Including 6,480 MW imports from Nepal.

** Including 1,785 MW imports from Bhutan.

In this regard, JICA Team made power demand forecast up to 2020 for Bhutan (supplier) and West Bengal (consumer) based on the collected data and social-economic index of both countries.

The detail of study is described in Chapter 5 "Power Demand and Supply Forecast" hereinafter.

(6) Energy Resources

The energy resources for generation of electricity in the country are coal and lignite, oil and natural gas, nuclear power and hydropower. Some other non-conventional sources of energy such as wind, solar energy, biogas, and geo thermal energy are also available but the development of these sources is in the initial stage.

1) Hydro Power

The systematic survey for hydropower potential of the country was carried out during early 50s. This survey was based on specific schemes of power development on the various river basins, which were considered economically viable and technically feasible at that time. This survey estimated the firm economically exploitable hydro electric power potential as equivalent to 600 TWh of annual energy generation, A systematic re-assessment of hydro electric potential was undertaken by the CEA subsequently and completed by March 1987. As per the re-assessment, the total hydro electric power potential is estimated as 84,044 MW at 60% load factor from a total of 7,845 number of identified major, medium and a few small hydro electric schemes. Of this, 15.07% of the total potential at 60% load factor has been developed as on 31 March, 1997 and the scheme under development will account for another 5,881 MW (7.23%) at 60% load factor. The regionwise potentials assessed, developed and under development are indicted in Tables 4.2.6 and 4.2.7. From these tables it may be observed that about 77.7% of the hydro potential is yet to be developed.

2) Coal

The coal reserves in the country down to depth of 1,200 meters stood at 201.95 billion tonnes according to the assessment carried out in January 1996. About 85% of the coal reserves are in the non-coking coal category. The reserves of coking coal are quite small. The coal reserves are unevenly distributed in the country. The bulk of the coal reserves, about 73%, are in the Eastern States of Bihar, Orissa and West Bengal, Madhya Pradesh too has sizable coal reserves at 17.5% of the total. The distribution of coal reserves in the various States is given in Table 4.2.8.

3) Lignite

Lignite reserves in the country are estimated to be about 24.40 billion tonnes. About 80% of the lignite reserves are located in the South Arcot in Tamil Nadu. The details of the geographical disposition of lignite reserves in the country are given at Table 4.2.9.

At present only a small percentage of the total reserves of lignite have been exploited. Considerable scope remains for the exploitation of the lignite reserves and use of lignite in thermal power stations. The technology for the use of lignite in power station boilers has been well developed and modern boiler designs cater to the high moisture content and low calorific value of lignite.

4) Oil and Natural Gas

India is rather short of crude petroleum oil and natural gas and has to depend on bulk imports of crude petroleum oil. Two major organisations are associated with oil exploration, drilling and production, namely the Oil and Natural Gas Corporation (ONGC) Limited and the Oil India Ltd. (OIL). Their latest assessment shows that the balance recoverable reserves of crude oil are about 728 million tonnes and that of Natural Gas about 680 billion cubic meters. The details of this are given in Table 4.2.10.

5) Nuclear Power

Nuclear power generation was started in India in 1969 with the commissioning of the Tarapur Atomic Power station with assistance from USA, which has the capacity of 2×210 MW based on Boiling Water Reactor (BWR) technology. This power station continues to operate and supply power to the Western Regional grid. All subsequent projects in India were based on the Pressurised Heavy Water Reactor (PHWR) technology. The first such power project was set up in Rajasthan with external assistance from Canada and subsequently these reactors have been fully indigenes and further developed. At present Pressurised Heavy Water Reactors are also in operation at Kalpakkam near

Madras, at Narora in Uttar Pradesh and at Kakarpara in Gujarat and are based entirely on indigenous efforts.

6) Co-Generation

Co-generation of power is particularly attractive in industries in which process heat and electricity are both required. A task Force on co-generation in various industries has in its final report produced in January 1996 reported that a co-generation potential of 6,500 to 8,000 MW exits in various generic industries that were studied by the Task Force. The details of these industries and their potential are indicated in Table 4.2.11.

(7) Organizational Structure of the Power Supply Industry

Electricity is a concurrent subject as per Indian constitution. The Central Government formulates power/energy policy decisions, takes and administers policy decisions, frames Act/Rules to govern power supply, monitors progress of project implementation works, makes investment decisions etc. It has also organizations to generate and transmit power and to conduct research on power and in general carry out works of common interest. The organizations involved in the power development in the central sector are

1. Ministry of Power
2. Central Electricity Authority (CEA) constituted under the Electricity supply Act 1948
3. Bhakra Beas Management Board (BBMB)
4. National Hydro Power Corporation (NHPC)
5. North Eastern Electric Power Corporation (NEEPCO)
6. Tehri Hydro Development Corporation (THDC)
7. Natpha Jhakri Power Corporation (NJPC)
8. National Thermal Power Corporation (NTPC)
9. Damodar Valley Corporation (DVC)
10. Neyveli Lignite Corporation (NLC)
11. Rural Electrification Corporation (REC)
12. Central Power Research Institute (CPRI)
13. Power Engineers Training Society (PETS)
14. Energy Management Centre (EMC)
15. Power Finance Corporation (PFC)
16. Power Grid Corporation of India Limited (PGCIL)
17. Central Board of Irrigation and Power (CBI & P)
18. Nuclear Power Corporation
19. Council of Power Utilities

Power Development works in the state are carried out by different Electricity Boards/Government undertakings, private generating companies and Electricity departments.

4.3.3 Power Sector Survey of West Bengal State

(1) Summery of Power Sector in West Bengal

Dependable capacity of West Bengal was 3,792 MW as of 1997/98 (increased 4,580 MW in 2000/March) and almost of them are thermal power stations, only 4% was hydro power stations. On the other hand, there was surplus of power capacity because peak demand was only 2,800 MW (increased 3,217MW in 2000/March) in the power system. Energy available in the state of 19,166.29GWh as of 1997/98, consisted of 13,192.4GWh by state owned power stations and 5,974GWh by power purchase from other states or country (including 1,357GWh from Bhutan).

Peak demand and energy consumption of West Bengal are shown in Fig. 4.7 to 4.9.

On the other hand, energy sold was 15,266.08 GWh, consumption within state was 14,467.2 GWh and power exchange to other states was 798.88 GWh from West Bengal including export of 4.5 GWh to Bhutan. The rest 3,900 GWh was losses of transmission and distribution lines (20.35 % of loss ratio). The power exchange is active between state and state in this regions.

Five REBs (Regional Electricity Board) manage and operate the power exchange in the level of regional as a power pool system. Therefore, West Bengal purchases about 30% of power from others despite having enough dependable capacity of the own power stations, because imported power from Bhutan or other states of India are cheaper than own generation power. And also, it is an important issue to increase the load factor performance of thermal power stations taking into consideration of technical and financial aspect because of low efficiency or stoppage of power plants without maintenance (average P.L.F was 52% in thermal power stations of the state). POWERGRID is developing the interconnection line between Eastern and Northern regions as a first priority project. And it is greatly expected that a best mix of energy in the power system will be proceeded within both regions, especially surplus power at off peak of Eastern region including West Bengal will be supplied to the Northern region. In the view point of whole power system, it is enough to reveal propriety of imported hydro power from Bhutan because of the advantage of system load variation and a quick response of start/stop for the power stations, furthermore, effect of CO2 reduction.

The detail of power sector of West Bengal is described below.

(2) Power Facilities and Operation

1) Installed Capacity

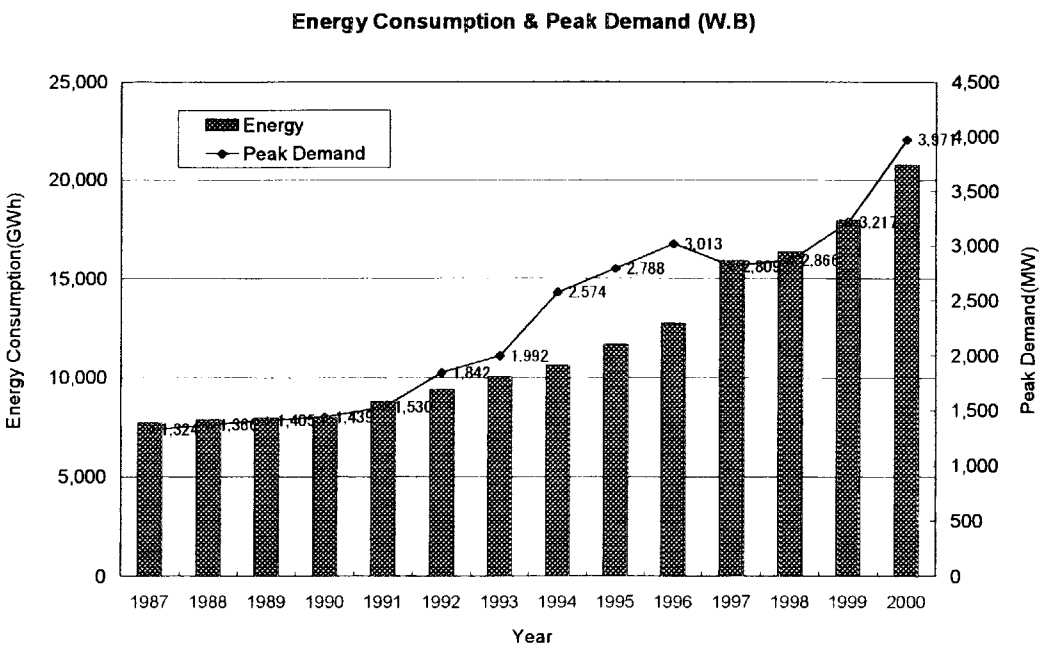
Organized power sector for West Bengal State is West Bengal State Electricity Board (WBSEB). The installed generating capacity of WBSEB has increased from 2,694.4 MW in 1986-87 to 4,856 MW at the end of March 2000, this is about 1.8 times. The share of 96.6% was almost thermal generation and hydro was only 3.4 %.

The breakdown of installed generating capacity at the end of March 2000 is given in the table below.

Source	Installed Capacity(MW)	Dependable Capacity (MW)	Share of Total (%)
Hydro	163.5	163	3.4
- Steam	4570	4460	
- Gas Turbine	100	100	
- Diesel	22.5	19.7	
Thermal total	4692.5	4579.7	96.6
Total Capacity	4856	4742.7	100

2) Electricity Generation

Sold energy in 1986/87 was 8,079 GWh, and 6,953 GWh of them was domestic generation and the power purchase was 2,747 GWh, the losses factor was 16.7 %. The sold energy in 1997/98 has recorded sharp increase during this decade, reached to 15,266.08 GWh. This was about 1.88 times increase. A 13,192 GWh of them were domestic generation and 3,770 GWh were imported, and loss factor was 20.35%. Especially increase rate of residential: 2.5 times, commercial: 2.3 times and agriculture: 8.5 times were outstanding.



3) Transmission and Distribution System

The lengths of transmission lines in West Bengal State were 1,228 ckt-km of 400 kV, 2,337 ckt-km of 220 kV and 2,697 ckt-km of 132 kV at the end of March 1997. The present basic transmission and distribution configuration, a 400 kV network is a main and bulk transmission system. And each region is connected with 220 kV, 132 kV and 110 kV network as main and support systems. In each state, 66 kV, 33 kV and 22 kV as sub-transmission systems are also connected with 11 kV network as primary distribution and 400/230 volts as local distribution system.

Expansion plan of transmission lines during 9th plan (1997-2002) is shown in the table below, and actually making a slow progress behind the schedule. The power system network of Eastern Region is shown in Figure 4.10.

Voltage Level	Line length (km)	No. of Circuits
400 kV	60	Double Circuits(D/C)
	10	Single Circuit(S/C)
220 kV	432	D/C
	181	S/C
132 kV	692	D/C
	260	S/C

4) Substations

Capacities of main substations by each voltage classes are as given below.

Transformer Voltage (kV/kV)	Total Capacity(MVA) as of 1988/3	Total Capacity (MVA) as of 1999/3
400/220	630	1,050
220/132	800	1,890
132/66		
132/25		
132/33		
Total	1,395	2,957.5
132/66		
132/25		
132/33		
Total	1,395	2,957.5
66/33/100		
66/33		
66/11		
66/6.6		
total	248.3	295.1
33/66		
33/11		
Total	95	241.3

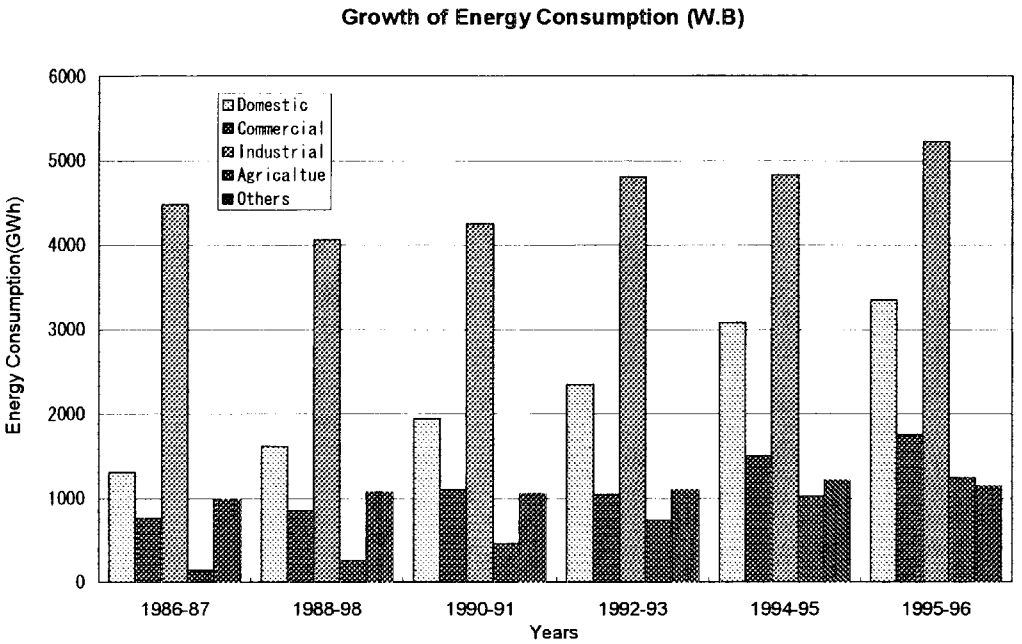
5) Power Market

The electricity consumption of 1987/88 was 7,668 GWh and increased to 14,340 GWh in 1997/98. The growth rate of this decade was not so sharp as 1.87 times.

There are four main categories of consumers as domestic, commercial, industry and agricultural, etc. Other less power consuming categories are public lighting, public water supply and drainage, railway traction etc. Electricity consumption of each category in 1997/98 was domestic: 27%, commercial: 12%, industry:40%, agricultural 10.3% and the others 10.7%. The intensity of consumption in each category was different in each region

of the country due to climatic differences, status of industrial development and requirements of irrigation etc.

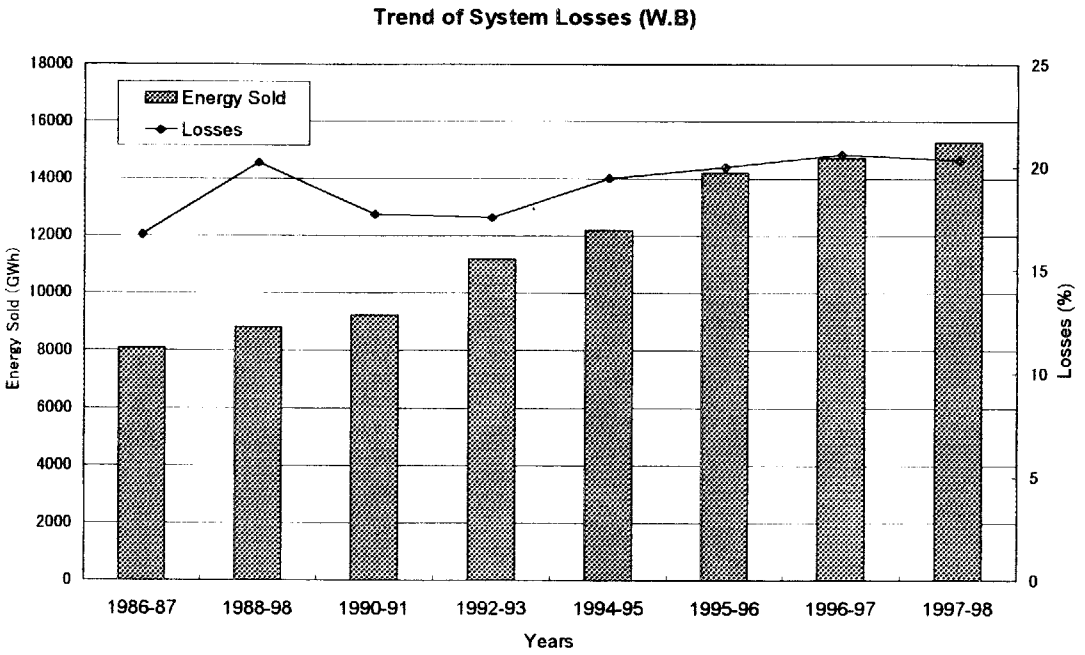
Growth of electricity consumption for different categories of consumer is given in the Figure below.



6) System Loss

The transmission & distribution (T&D) losses in West Bengal State were almost same as other states in India, 20.35% in 1997/98. Non-technical losses such as un-metered supply to agricultural pump-sets and large-scale theft and unauthorized use of energy occupy large part of the losses.

Tendency of the system losses is given in the Figure below.



7) Electricity Tariff

There are two category applying electric rates; HT (high voltage) and LT (low voltage) users. HT users are consisted of large and medium industries, public and corporation, power distribution licenser and railway. Other hand, LT users are domestic, commercial, agricultural and small industries. Typical electricity tariffs for urban area by each category at November 1996 are given in the table below.

(unit: paise/kWh)

Electric Charge	Domestic/ House	Commercial	Agriculture	Industrial Power		
				Low Volt	Middle Volt	High Volt
All India in 1992/93 (Average)	66.8	161.7	42.6	121.2	130.8	153.8
West Bengal in 1996/97 (For Example)	75.65 1kW 30kWh/M	260.04 5kW 200kWh/M	41.67 5HP 15%LF 408kWh/M	191.94 5HP 15%LF 681kWh/M	312.14 5HP 40%LF 14.6GWh/M	286.79 5000kW 70%LF 2555MWh/M

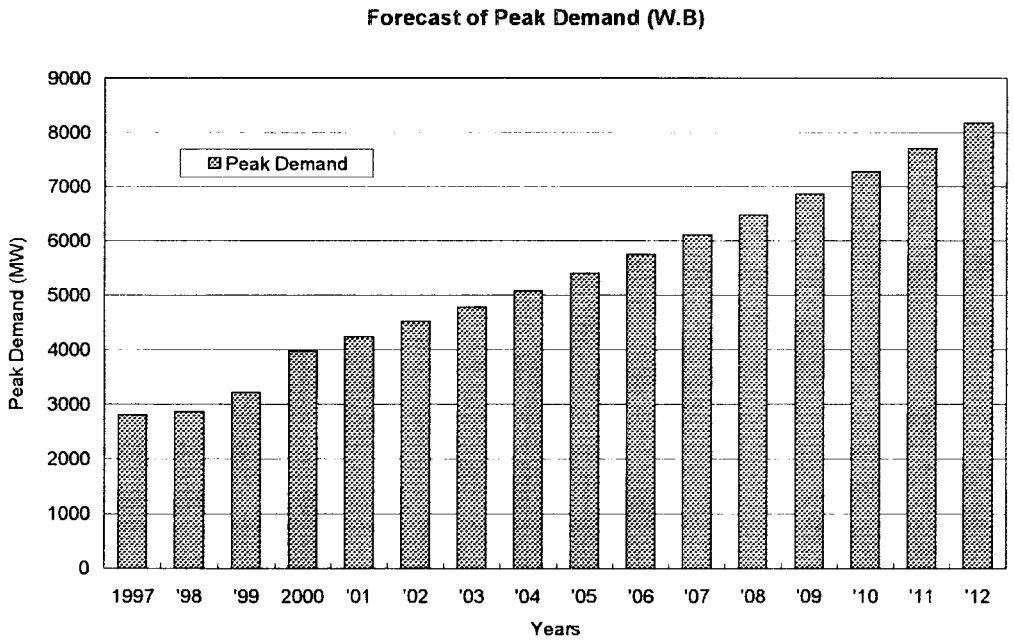
Note: 1 Rupee = 100 paise
Source: JICA Survey Team, 1999 and JEPIC, 1995

(3) Load Forecast

According to collected data (at the first site survey of JICA Team in 1998) from CEA, the long term forecast for 2006-07 (end of 10th plan) and 2011-12 (end of 11th plan) has been worked out by extrapolating the energy requirement (at power station bus-bars) obtained on the basis of the detailed forecast up to 2001-02. The growth rates for projection have been determined after studying the growth rates anticipated during the period 1993-94 to 2001-02 and keeping in view the enlarging base and liberalized economic policy.

According to the 15th EPS (Electric Power Survey), the estimated energy requirement at power station bus-bars in West Bengal State by the end of 10th (2006-07) and 11th (2011-12) Plans would be 32,100 GWh and 42,957 GWh respectively. The corresponding peak load would be 6,107 MW and 8,173 MW respectively.

The estimation of CEA up to 2006-07 (end of 11th plan) is shown blow:



(4) Development Plan

Total capacity of development plan after 9th plan in West Bengal State is 5,660 MW, hydro generation is 2,110 MW (37%) and thermal generation is 3,550 MW (63%). 1,800 MW development plan of two pumped-storage plants, occupying about 85% hydro generation plan means necessity of countermeasures against peak demand of the network and past excessive priority to thermal generation development. Developments plan after 9th plan is shown below.

Power Development Plan (Planned / on going projects)

Unit : MW

Name of Projects	Hydro	Thermal
Farakka barrage	125	
Purulia (pump)	900	
Rammam st-1	36	
Teesta Canal	46	
Jal Dhaka (extension)	13	
Rammam st-3	90	
Togra (pump)	900	
Bakreshwar 1-5		1,050
Balagarh		500
Sagardighi –1		1,000
Sagardighi –2		1,000
Total	2,110	3,550

CEA: Central Electric Authority, 1998

4.3.4 Power Sector Survey of Assam State

(1) Summery of Power Sector in Assam

Dependable capacity of Assam was 1,217 MW as of March/2000, it was consisted of 20 % of hydro power stations and remaining thermal power stations. On the other hand, peak demand was approx.565 MW and balanced with the capacity in the power system. Energy available in the State was 2,582.6 GWh as of 1997/98, consisted of 936 GWh by state owned power stations and 1,464.3 GWh of power purchase from other states. Energy sold was 1,877 GWh and 705 GWh (27.3% of total) was losses of transmission and distribution lines. Further, 5.38 GWh was exported from Assam to other states, including export of 2.7 GWh to Bhutan. The power exchange is active between state and state in the regions.

Five REBs (Regional Electricity Board) manage and operate the power exchange in the level of regional as a power pool system using POWERGRID interconnection line. Therefore, Assam purchases about 50% of power from others despite of enough dependable capacity of the own power stations. It was because that purchased power from other states was cheaper than own generation power. As for financial aspect, the development program of new projects have been established, but behind schedule compared to the growth of demand.

Since technical losses were high due to transferring power through long distance transmission lines as well as commercial losses by un-metering and imperfect levy of electric charge, etc.

And also, it is an important issue to increase the load factor performance of thermal power stations taking into consideration of technical and financial aspect because of low efficiency or stoppage of power plants without maintenance (average P.L.F was 40.6% in thermal power stations of the state).

By the results of survey, Eastern region including West Bengal state is advantage than North-eastern region including Assam state, because 1) maximum consumption of Assam state is only 10% compared with West Bengal state in spite of the highest growth rate of demand forecast in the 11th plan than other regions, 2) future plan for energy best mix : hydro and thermal power of the Eastern region policy, 3) advanced energy policy of import power in West Bengal state. Considering the above mentioned, it is said that the hydro power energy of Bhutan is exported to Eastern region including West Bengal state in order to reveal propriety.

The detail of power sector of Assam is described below.

(2) Power Facilities and Operation

1) Installed Capacity

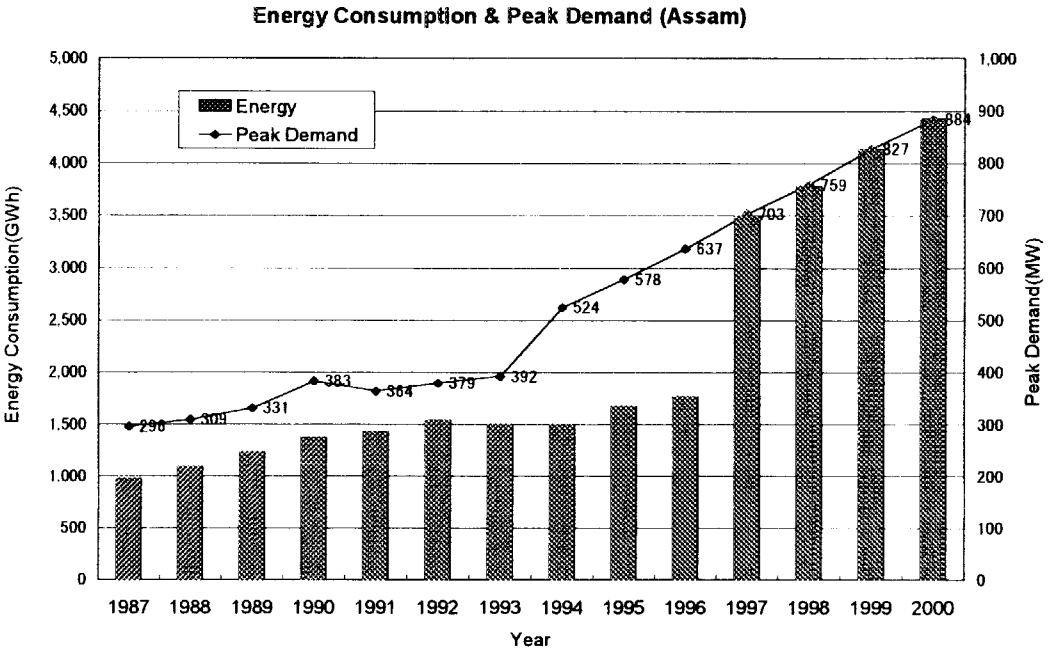
Organized power sector for Assam State is Assam State Electricity Board (ASEB). The installed generating capacity of ASEB has increased from 432.2 MW in 1986/87 to 1,220.9MW at the end of March 2000, this is about 2.8 times. The share of 83.5 % was almost thermal generation and hydro was 16.5 % at the end of March 2000. The breakdown of installed generating capacity at the end of March 2000 is given in the table below.

Source	Installed Capacity (MW)	Dependable Capacity (MW)	Share of Total (%)
Hydro	202.0	202.0	16.5
- Steam	570	570	
- Gas Turbine	445.5	443.4	
- Diesel	3.42	1.9	
Thermal total	1018.92	1015.3	83.5
Total Capacity	1220.92	1217.3	100

2) Electricity Generation

Sold energy of fiscal year 1987 was 1,051GWh, 936 GWh of them was domestic generation and the rest 513 GWh was imported, and loss factor was 27.44%. The sold

energy has recorded sharp increase during this decade, reached to 1,877 GWh at the end of March 1998. This was about 1.8 times increase. 936 GWh of them were domestic generation and 1,646 GWh are imported, and loss factor was 27.3%. Especially increase rate of residential: 3.1 times, commercial: 1.7 times and agriculture: 2.8 times were outstanding. The fact that the increase rate of imported energy is greater than that of domestic generation means delay of new plant development program.



3) Transmission and Distribution System

The lengths of transmission lines in Assam State were 2,142 ckt-km of 400 kV, 2,818 ckt-km of 220 kV and 1,179 ckt-km of 132 kV at the end of March 1997. The present basic transmission and distribution configuration, a 400 kV network is a main and bulk transmission system. And each regions are connected with 220 kV, 132 kV and 110 kV network as main and support systems. In each state, 66 kV, 33 kV and 22 kV as sub-transmission systems are also connected with 11 kV network as primary distribution and 400/230 volts as local distribution system.

Expansion plan of transmission lines during 9th plan (1997-2002), a 400 kV bulk transmission line of 1,200 km - 2 circuits completed at the end of 1999, and now ready to import energy from Bhutan. The bulk transmission line is from Kathalguri thermal power station in Assam State, via Misa substation, Bongaigaon substation (proposing lead-in substation of Punatsangchhu Project) and up to Molda substation in West Bengal State. The power system network of Eastern Region is shown in Fig. 4.11.

4) Substations

Capacities of main substations by each voltage classes in 1997/98 are as given below:

Capacity of Major Substations

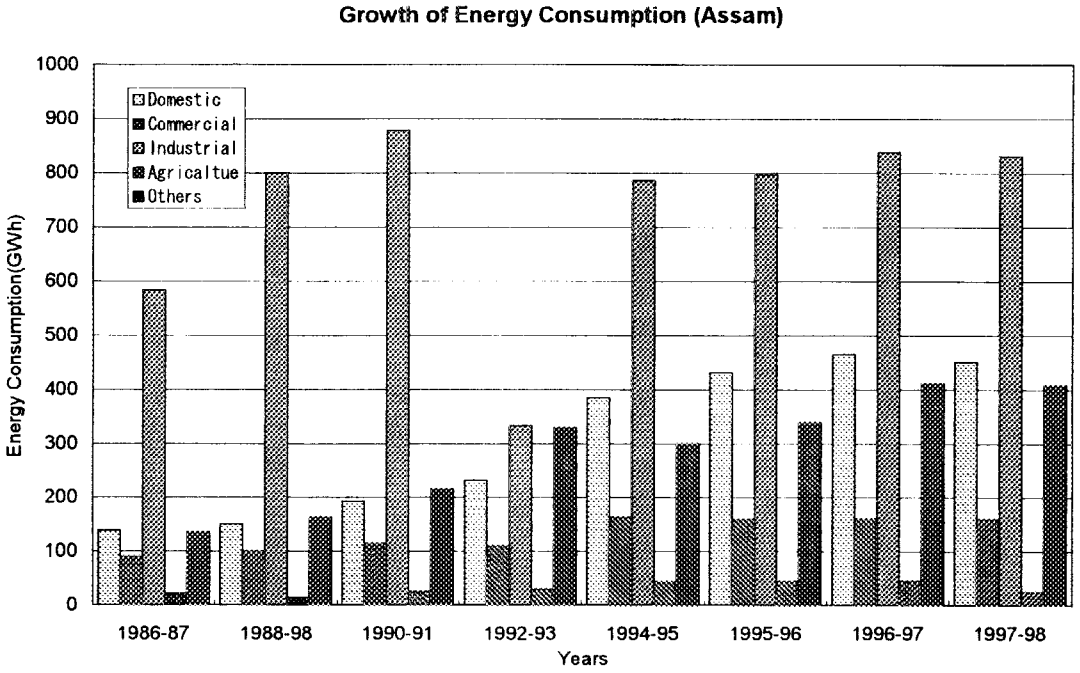
Transformer Voltage (kV/kV)	Transformer Capacity (MVA)	No. of units	Total Capacity (MVA)
400/220	105	3	345
	315	1	315
Sub-total			660
220/132	326	1	326
	160	1	160
	150	3	450
	100	1	100
	80	2	160
	50	1	50
Sub-total			1,246
132/66	111	1	111
	100	1	100
	72	1	72
	60	2	120
	40	1	40
	20	2	40
	18	1	18
Sub-total			501
132/11	150	1	150
	80	1	80
Sub-total			230

5) Power Market

The electricity consumption of 1987/88 was 7,668 GWh and increased to 1,877 GWh in 1997/98. The growth rate of this decade was not so sharp as 1.9 times.

There are four main categories of consumers as domestic, commercial, industry and irrigation. Other less power consuming categories were public lighting, public water supply and drainage, railway traction etc. Electricity consumption of each category in 1998 was domestic: 24%, commercial: 9%, industry: 45%, agricultural 1% and the others 21%. The intensity of consumption in each category was different in each region of the country due to climatic differences, status of industrial development and requirements of irrigation etc.

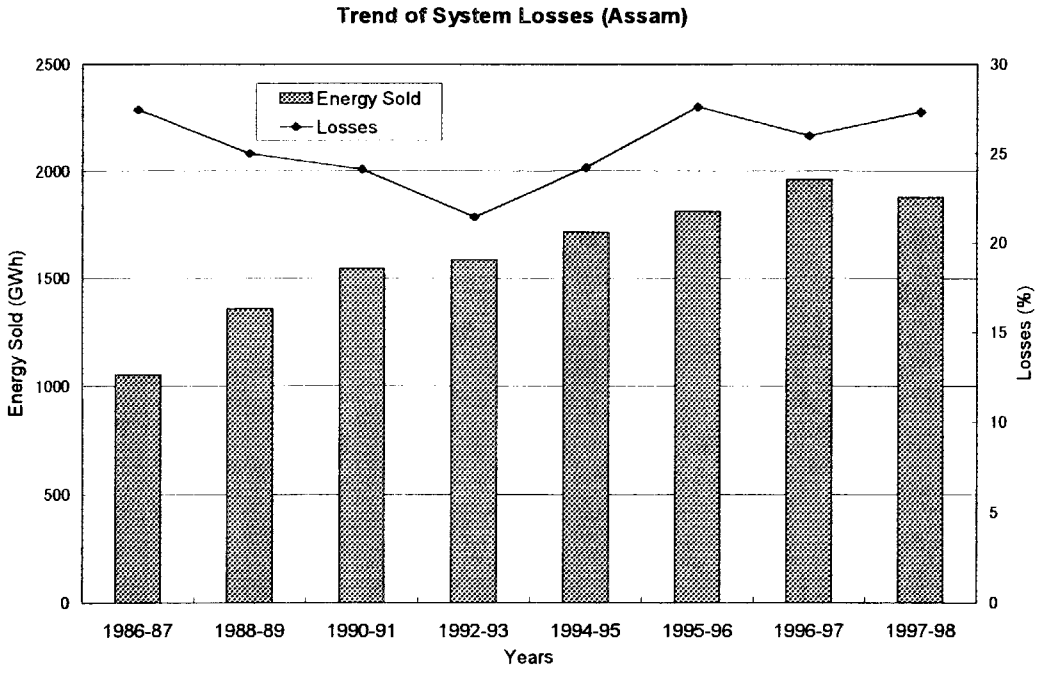
Growth of electricity consumption by each category of consumer is given in the Figure below.



6) System Loss

The transmission & distribution (T&D) losses in Assam State were outstanding comparing other states in India. The rate was not decreased during this decade, and was 27.3% in 1997/98. Superannuated and insufficient facilities and large electricity purchase from other states were main reason of them. Non-technical losses such as un-metered supply to agricultural pump-sets and large-scale theft and unauthorized use of energy were same as other states.

Tendency of the system losses is given in the Figure below.



7) Electricity Tariff

There are two category applying electric rates; HT (high voltage) and LT (low voltage) users. HT users are consisted of large and medium industries, public and corporation, power distribution licenser and railway. Other hand, LT users are domestic, commercial, agricultural and small industries. Typical electricity tariffs for urban area by each category at November 1996 are given in the Table below.

(unit: paise/kWh)

Electric Charge	Domestic/ House	Commercial	Agriculture	Industrial Power		
				Low Volt	Middle Volt	High Volt
All India in 1992/93 (Average)	66.8	161.7	42.6	121.2	130.8	153.8
Assam in 1996/97 (For Example)	105 1kW 30kWh/M	315.4 5kW 200kWh/M	90 3HP 10%LF 163kWh/M	N.A 5HP 25%LF 681kWh/M	227.1 5HP 40%LF 14.6MWh/M	224.71 250kW 50%LF 91.3MWh/M

Note:1 Rupee = 100 paise
Source: JICA Study Team,1999 and JEPIC,1995

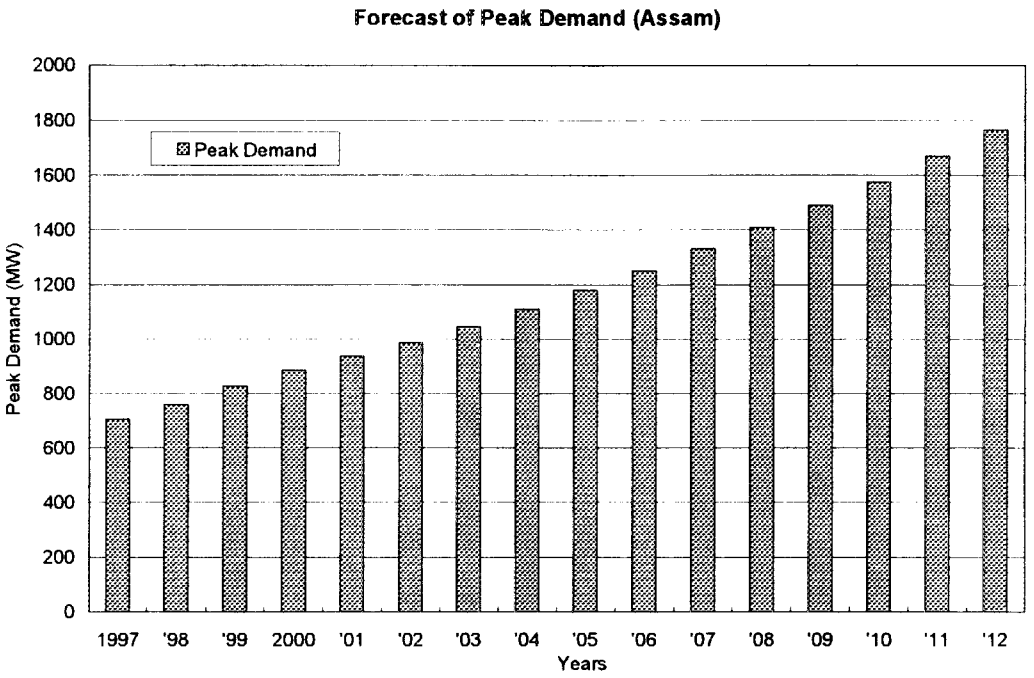
(3) Load Forecast

According to collected data (at the first site survey of JICA Team in 1998) from CEA, the long term forecast for 2006-07 (end of 10th plan) and 2011-12 (end of 11th plan) has been worked out by

extrapolating the energy requirement (at power station bus-bars) obtained on the basis of the detailed forecast up to 2001-02. The growth rates for projection have been determined after studying the growth rates anticipated during the period 1993-94 to 2001-02 and keeping in view the enlarging base and liberalized economic policy.

According to the 15th EPS (Electric Power Survey), the estimated energy requirement at power station bus-bars in Assam State by the end of 10th (2006-07) and 11th (2011-12) Plans would be 6,818 GWh and 9,124 GWh respectively. The corresponding peak load would be 1,333 MW and 1,765 MW respectively.

The estimation of CEA up to 2006-07 (end of 11th plan) is shown blow.



(4) Development Plan

Total capacity of development plan after 9th plan in Assam State is 468 MW, hydro generation is 240 MW (51 %) and thermal generation is 228 MW (49 %). Development plan of two middle-size hydro generation plant (100 MW and 120 MW) means necessity of countermeasures against peak demand of the network and past excessive priority to thermal generation development. Developments plan after 9th plan is shown below.

Power Development Plan (Planned / on going projects)

Unit : MW

Name of Projects	Hydro	Thermal
Dhansiri	20	
Lower Borpani	120	
Lower Kopili	100	
Kathalguri		60
Lakwa		48
Namrup		120
Total	240	228

CEA: Central Electric Authority, 1998

The following data and information was collected at site survey of WAPCOS.

The JICA mission team has collected data for power sector in West Bengal and Assam States as follows.

[Collected Data/Information for Power Sector Survey]

1) Actual Peak Demand 1985/86 to 1997/98

2) Actual Energy Consumption 1986/87 to 1997/98

3) Forecast of Peak Demand and Energy Requirement (up to 2011/12)

4) Information of Existing Power Stations (hydro, coal and gas based thermal Power stations)

5) Information of Existing Transmission Lines

6) Information of Existing Substations (400 kV, 220 kV and 132 kV)

7) Information of Power Demand and Supply 1986/87 to 1997/98

8) Information of Average Electric Rates and Duties

9) Information of Price of Fuel and Construction Cost

10) Information of Power Development Plan for Power Projects (hydro, coal and gas based thermal Power stations)

11) Information of Power Development Plan for Transmission Lines (400 kV, 220 kV and 132 kV)

12) Performance of Hydro Power Stations

13) Performance of Thermal Power Stations

14) Organization Chart and Board of Members

15) Power System map

4.4 Macro-Economy of India

(1) General Information

India is the seventh largest and second most populous country in the world. It has an area of 3,288 million square kilometers with a land frontier of 15,170 kilometers and a coast line of 5,690 kilometers.

Capital	New Delhi	
Land Area	3,288 million sq. km	
Population (1998 estimated)	971.832 million	
Rural population (1998 estimated)	West Bengal	77.25 million
	Assam	25.646 million
Population decennial growth (1985-95 average)	1.9%	
Population density	275 persons per sq. km	
Birth rate per '000 population	27.2 (1997)	
Death rate per '999 population	8.9 (1997)	
Per capita electric consumption	348 kWh (1996)	

Source: Statistical Year Book of India, 1998 and IDE-JETRO, 1999

(2) Economic-Overview

In recent times, world trade growth decelerated sharply, commodity prices fell and deflation affected much of the world economy. India was not wholly immune to these unfavorable developments. The recent 1993-94 based GDP series released by the Government shows that GDP growth decelerated from 7.8 percent in 1996-97 to 5.0 percent in 1997-98. The slowdown in GDP growth in 1997-98 was largely the result of the volatility in agricultural growth. The deceleration in the growth of India's export continued for the third year in succession and growth was negative for the first nine months of the year 1997-98. Foodgrain production estimated at 192.4 million tons in 1997-98 was quite a letdown from the preceding years record output of 199.4 million tons. Industrial growth remained almost unchanged in 1997-98 as this was compensated by an increase in other sub-sectors. Electricity growth improved from 6 percent in 1997 to 6.6 percent in 1998. Growth rate of GNP and GDP is shown in Table 4.20.

The Government initiated several reforms for producing stimulus to Industrial growth. In Infrastructure sector, the Indian Electricity Act 1910 and Electricity (Supply) Act 1948 were amended to provide for private investment in power transmission.

The fiscal deficit is the key parameter of macro-economic policy, which has profound implications policy for inflation, interest rates, investment and growth, the financial system, balance of payments and last, but not the least, over all credibility of Governments macroeconomic policy. Quite clearly, fiscal consolidation is absolutely necessary for containing inflation, reducing interest rates, promoting investment and growth and fostering reasonable stability in the financial system and the foreign exchange market.

(3) Economic and Social Index Survey

The data under the following heads have been compiled in respect India, State of West Bengal and North-Eastern states including Assam.

- Population
- Health
- Education
- Human Resources
- Industries
- Transportation and Communication
- Energy
- Tourism
- Prices
- Macro Economy

1) Population:

Available data on area and population of the Indian Union based on the decadal census of population has been furnished in tables given below:

State	Land Area (million sq km)	Population (million)	
		1991	1998 (Estimated)
All India	3,288	846.3	971.832
West Bengal	89	68.1	77.25
Assam	79	22.4	25.646

Table 4.21: This table contains data on area, total population and its classification according to sex as per 1991 census. This table also shows mid-year population projecting for the year 1992 to 1998. The estimates have been made by the expert committee on population projections.

Table 4.22: This table presents data on birth rate, death rate and infant mortality rate as revealed by Sample Registration System.

Figure 4.12: This figure indicates growth of population by census.

2) Health:

Available information relating to public health statistics in India, is furnished in the tables given below:

(Unit: per 1,000)

State	Birth rate	Death rate	Infant Mortality rate
All India	27.5	9	72
West Bengal	22.8	7.8	55
Assam	27.7	9.5	75

Table 4.23: This table shows the number of hospitals dispensaries and beds available.

Table 4.24: This table gives the number of medical practitioners registered with the "Medical Council's" and number of nursing personnel (different categories) registered with "Nursing Councils of Boards".

3) Education:

Table 4.25: This table provides the following:

- Number of recognized educational institutions of various types.
- Enrolment n institutions/colleges and schools.
- Number of Teachers engaged in institutions/colleges and schools.

Data of monthly stipend for boarders in different educational institutions is not available.

4) Human Resources:

The information relating to percentage of population according to economic activities by Sex and employment in Government Sector have been summarized in the Tables 4.26 & 4.27.

Regarding ratio of workers for males, cultivators was about 54% of Main workers in all India and West Bengal was 88% and Assam was more than 93% respectively, but Non-workers was 48% of human resources of all India.

(Unit per 1,000)

State	Cultivators		Agricultural		Household Industries		Other Workers	
	M	F	M	F	M	F	M	F
All India	88,480	22,221	14,164	28,433	4,555	2,249	82,457	11,371
West Bengal	5,424	4,205	4,074	982	510	294	7,981	896
Assam	28,706	689	683	162	32	39	2,055	472

M: Males F: Females

Table 4.26: This table presents classification of the population according to economic activities.

Table 4.27: This table gives estimated employment in all establishments under Central Government, State Government, Quasi-Government Organizations and Local bodies. This information is based on the data collected by the Employment Exchanges as part of their program for collection of Employment market information.

5) Industries:

In this section, number of Mining and Manufacturing Industries and employment in these industries are to be included. The same has been compiled and furnished in Tables 4.28 and 4.29.

Table 4.28: This table contains data on number of mines in India by the categories such as fuels, metallic and non-metallic mines and employment in mines.

Table 4.29: This table presents data based upon regarding Annual Survey of Industries (ASI). The information in respect of following items (for the year 1994-95) has been covered in the table.

- Number of Manufacturing industries
- Total persons engaged: All persons engaged by the factory whether for wages or not, in work connected directly or indirectly with the manufacturing process and includes all administrative, technical, clerical staff as also labor engaged in production of capital assets for factory's own use.

  The number of workers or employees is an average number, obtained by dividing man-days worked by the number of days of factory had worked during the year.
- Man-days: represents the total number of man-days worked during the year.

6) Transportation and Communication:

Roads in India are constructed and maintained by different government bodies at national, state and local levels. National highways are the prime arterial routes which cater above 40% of the total transport demand. The government has taken initiates to attract private sector investment in the road sector. The provisions relating to foreign investment have been further liberalized. Automatic approval will be accorded for foreign equity in any such project does not exceed Rs.1500 crore. A model concession agreement for Build-Operate-Transfer (BOT) projects is being finalized.

India operates one of the largest telecommunication networks in Asia comprising over 23,527 exchange with a capacity 226.4 lakh (2,264 million) lines and 191.3 lakh (1,913 million) working connection as on Nov. 1998. The annual growth of providing new connection has been increasing steadily.

Table 4.30: This table consists length of highways constructed and maintained by different authorities.

Table 4.31: The table presents the number of motor vehicles registered in India as on 31st March, 1996.

Table 4.32: This table shows summary statistics regarding telephone lines, telephone offices and total number of registered telephones.

7) Energy:

The information is covered under Clause 4.3.2 "Power Sector Survey of India"

8) Tourism:

Number of foreign tourism to India was 2367 million in 1998. Most of 35% was coming from Western Europe and follow South Asia. North America and South East Asia.

Table 4.33: The table presents data on foreign tourists coming to India by their Nationality from the year 1991 onwards.

9) Prices:

This section presents statistics of prices indexes such as Index number of wholesale prices, Index number of consumer prices for different categories of workers etc.

Table 4.34: This table provides the consumer price index for industrial workers on base 1982 = 100 from 1991 to 1995. The weightage to various items of consumption for the compilation of Consumer Price Index Numbers are based on the average consumption expenditure of the working class family.

Table 4.35: This table presents Consumer Price Index Number for Urban Non-Manual Employees based on the family budget survey of non-manual employee populations. A non-manual employee family for purpose of this survey was defined as one "which derived 50 percent or more of its income during the reference month from the earnings of its members who are gainfully occupied as employees in non-manual work in non-agricultural sectors".

Table 4.36: This table presents Consumer Price Index Number for Agricultural laborers on base.

Table 4.37: This table provides data in respect of the current series of Index Numbers of wholesale prices in India with base 1981-82 = 100. All the important items transacted in the economy have been included to the extent feasible.

10) Macro Economy:

The information is furnished as under.

a) GDP

Table 4.38: National Product at factor cost (at current prices)
Table 4.39: National Product at factor cost (at 1980-81 prices)
Table 4.40: Net Domestic Product at factor cost (at current prices)
Table 4.41: Net Domestic Product at factor cost (at 1980-81 prices)
Table 4.42: Performance of public sector (at current prices)
Table 4.43: Performance of public sector (at 1980-81 prices)

b) Five Year Plans

Table 4.44: Plan outlay/Expenditure for public sector by heads of development
Table 4.45: Plan outlay/Expenditure for public sector by heads of development For the state (Outlay for Eight plan)
Table 4.46: Plan outlay/Expenditure for public sector by heads of development For the state (Outlay for 1995-96 & 1996-97)
Table 4.47: Plan expenditure for public sector by heads of development (Actual expenditure for Annual plan 1994-95)

c) National Finance

Table 4.48: Budgetary position of the Government of India
Table 4.49: General statement of the revenue receipt and revenue expenditure account of State Governments.

d) Foreign Trade

Table 4.50 Presents value of foreign trade of India by all modes (i.e. Sea, air and land). All foreign trade transactions in gold, currency notes and coins

are included under treasure. Balance of trade in treasure refer to gold. Trade in silver is included under merchandise.

e) International balance and foreign investment

Table 4.51: India's overall balancing payments statistics has been presented in the standard format

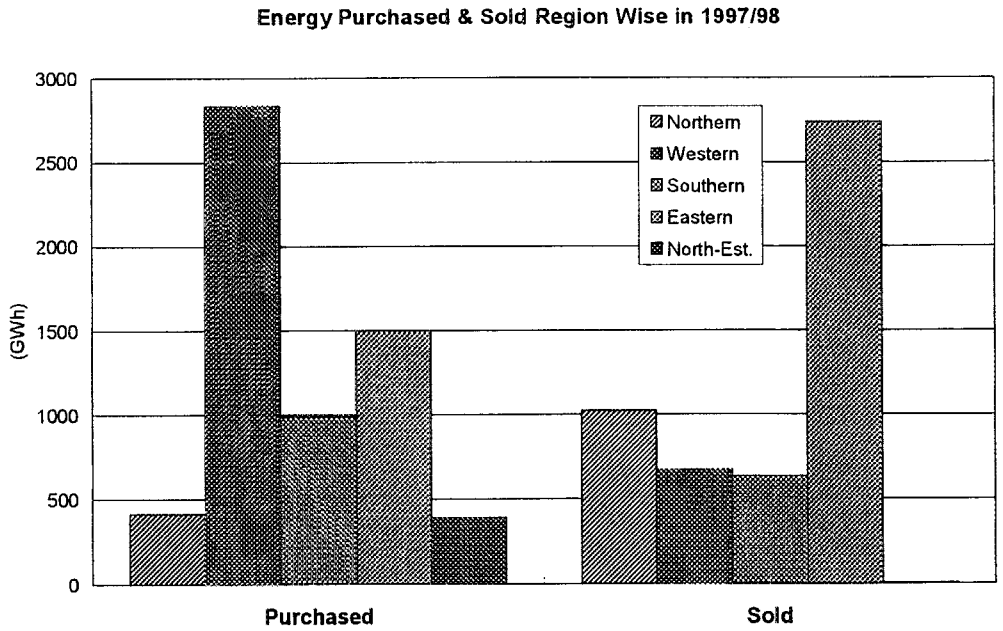
4.5 Power Purchase Business in India

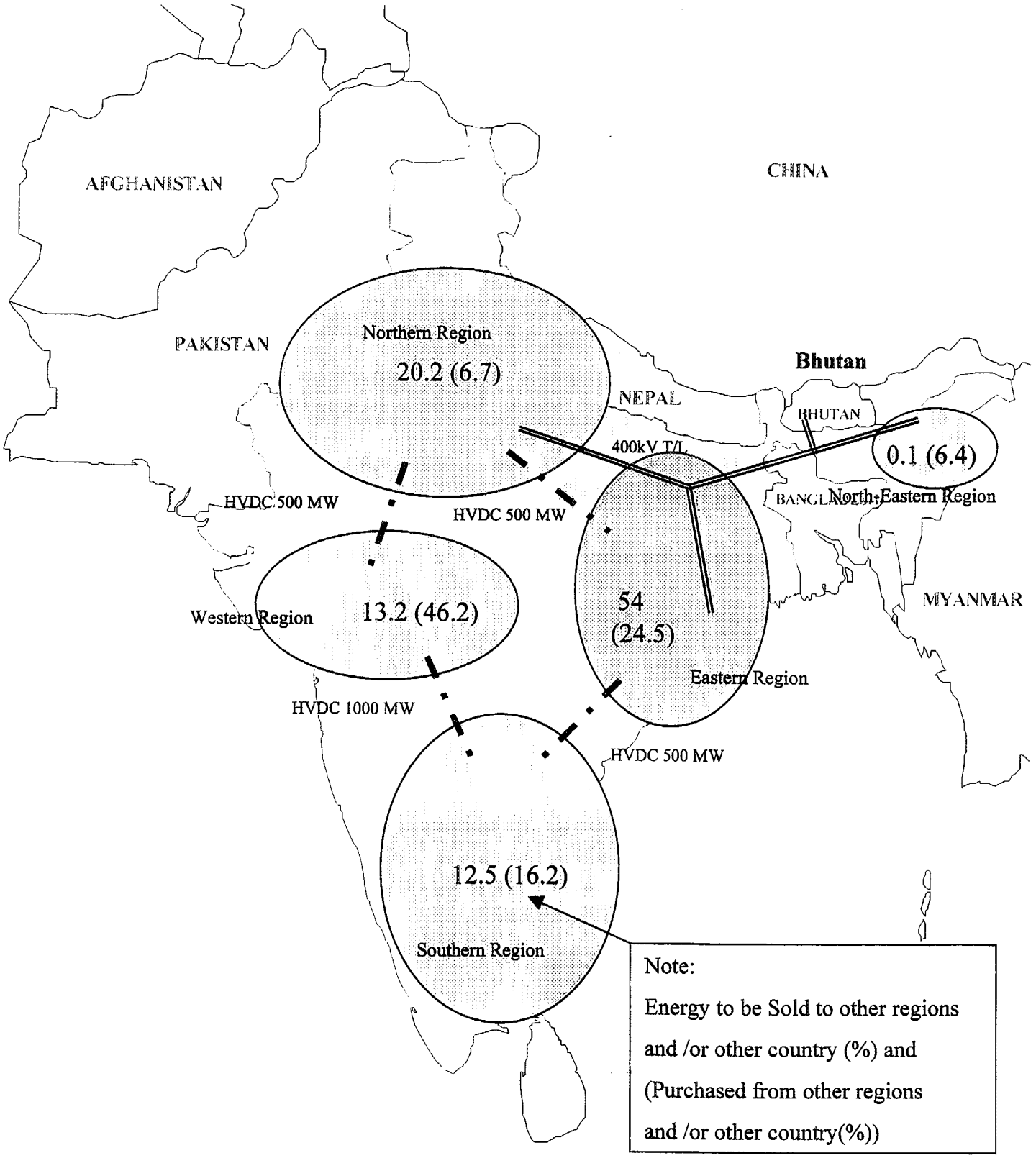
(1) Situation of Power Purchase of India

Gross energy generation in utilities of year 1997/98 in India was 421,747.28GWh, and 394,989.25GWh was available supply energy of all India excepting 30,684.2GWh (7.28 %) for power station services use, composing 391,063.08GWh(92.72 %) was a net energy generation at bus-bar, 2,541.51GWh (0.74 %) was purchased from non-utilities and 1,384.66GWh(0.42 %) was imported from Bhutan. On the other hand, total energy sold was 296,748.92GWh (75.13 %) and remaining 321.43GWh (0.08 %) was sold to other countries (Bhutan and Nepal) and 97,918.9GWh (24.79 %) for commercial and technical losses in the power system. Detailed is shown in Tables 4.52 to 4.54.

Imported energy of the region wise was only Eastern region (West Bengal state) and 1,384.66GWh(0.42 %) was imported from Bhutan.

Power exchange of each regions from other states is shown below, and its percentage is shown in figure next page.





Percentage of Power Sold and Purchased

in Region Wise, India in 1997/98

(2) Plan of Energy Import in India

The 11th development plan has been cleared by CEA so far. Especially, energy of hydro power imported from other countries have been planned, definitely, that

1) Eastern Region From Bhutan

Punatsangchhu Power Station : 870 MW

Tala Power Station : 1,020 MW

2) Northern Region from Nepal

Pancheswar Power Station : 6,480 MW

(3) Background of Purchase Business in India

In India, the power generation was by and large concentrated in public sector. Recognizing the financial constraints, the Govt. of India encouraged greater private sector participation in electricity generation, supply and distribution in 1991. To add more clarity to the policy, the tariff notification has been amended from time to time. Detailed guidelines have also been issued for adopting competitive bidding.

The following incentives have been offered to investors so as to make the policies more attractive.

- Assured return on equity upto 16% with plant performance of 68.5% PLF in case of thermal projects and with normative level generation in case of hydro projects.
- Liberalised norms of depreciation.
- The protection of return upto 16% from foreign exchange fluctuation.
- Reduced ecise duties for import of power equipment.
- 100 percent tax holiday in the first 5 years. Capitalization of interest during construction (IDC).
- Two part tariff structure.
- Upto 100% foreign equity participation.
- Additional incentives on account of better performance beyond 68.5% PLF in case of thermal projects and availability of capacity and energy higher than normative level in case of hydro projects.
- To boost investment in hydro projects, concept of deemed generation had been recently introduced which would assure return on investment in case generation falls short of normative level for reasons solely attributable to hydrology.

For transacting the business relating power generation with Independent Power Producers and Public/Govt. Sector Utilities, Govt. of India has issued a series of Notifications and resolutions which sets out guidelines for private participation in power sector. The important Notifications and resolutions are (i) Notification dated 15th Oct. 1991 dealing with amendment in Electricity Laws, (ii) Resolution dated 22nd Oct. 1991 dealing with Financial and Administrative Environment and amendments to India Electricity Supply Act 1910 and Electricity Supply Act 1948, (iii) Notification dated 31st March,, 1992 dealing with tariff for sale of Electricity, (iv) Notification dated 29th March, 1994 dealing with depreciation and (v) Notification dated 13th January, 1995 dealing with tariff for hydro stations.

(4) Electricity Tariff for Power Purchase in India

Imported power of Indian power system is only from Chhukha hydropower station in Bhutan completed in 1986/88.

The imported electricity tariff was contracted with 0.37 Nu/kWh in 1995, but after 3 times revision of tariff, becomes 1.5 Nu/kWh from 1.0 Nu/kWh in 1998.

Under developing country of Bhutan, the export of hydro power to India is very important to obtain the only way of the foreign currency (Indian Rupees) and a role of the Governmental income. India expects to purchase the electricity for best mix in Indian power system composing the thermal and hydro power which will be developed large scale of hydropower station such as Tala(1020MW) and Punatsangchhu (870MW) in Bhutan near future.

TABLE 4.1 GROSS DOMESTIC PRODUCT AT FACTOR COST IN CURRENT PRICES BY KIND OF ACTIVITY, 1985 TO 1998, Bhutan

(millions Nu.)

Activity	1985	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998*
Agriculture, livestock, forestry and fishing	1,236.2	1,924.3	2,094.9	2,305.1	2,460.2	2,801.9	3,427.1	3,897.6	4,538.0	5,276.0	5,975.9
Agriculture	580.6	937.7	1,057.6	1,180.8	1,363.0	1,526.6	1,814.6	2,043.2	2,253.7	2,485.8	2,808.9
Livestock	276.0	441.2	474.8	528. 6	487.4	545.9	703.5	805.5	910.2	1,237.5	1,398.4
Forestry & logging	379.6	545.4	562.5	595.7	610.1	729.4	909.0	1,048.9	1,374.1	1,552.7	1,768.6
Fishing	-	-	-	-	-	-	-	-	-	-	-
Mining and quarrying	20.2	41.8	44.8	90.0	98.8	102.3	172.4	193.1	467.3	308.7	385.9
Manufacturing	128.3	302.5	396.7	499.5	647.4	752.3	875.2	1,088.8	1,393.4	1,588.5	1,810.9
Electricy and gas	6.8	391.0	384.7	384.4	445.3	560.9	574.2	1,058.7	1,101.6	1,729.5	1,784.9
Construction	290.5	365.4	398.7	359.7	595.1	616.8	787.2	930.7	1,040.0	1,466.4	1,730.4
Wholesale, retail trade, hotels and restaurants	203.0	282.3	321.6	382.9	479.7	551.2	647.2	730.7	903.5	1,014.4	1,146.2
Transport, storage and communications	104.1	235.6	346.7	398.5	471.2	587.4	638.0	687.6	855.8	1,022.6	1,216.9
Finance, insurance and real estate	149.3	306.9	378.0	409.4	438.8	457.7	468.2	503.0	441.9	729.2	838.6
Community, social services (government)	262.2	525.1	540.5	564.4	608.9	645.0	709.2	751.4	1,013.7	1,362.7	1,398.2
Less: Imputed bank service charges	-51.0	-67.0	-58.4	-51.8	-68.1	-68.0	-148.2	-231.0	-350.0	-526.9	-627.9
Gross domestic product	2,349.6	4,307.9	4,848.2	5,342.1	6,177.9	7,007.4	8,150.5	9,610.7	11,405.2	13,971.1	15,660.7
Annual growth rate (%)		11.9	12.5	10.2	15.6	13.4	16.3	17.9	18.7	23.0	12.1

Note: * Provisional

Source; CSO, Planning Commission, Thimphu.

TABLE 4.2 GROSS DOMESTIC PRODUCT AT FACTOR COST IN 1980 PRICES BY KIND OF ACTIVITY, 1985 TO 1998, Bhutan

(millions Nu.)

Activity	1985	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998*	Share of %
Agriculture, livestock, forestry and fishing	833.9	962.9	992.8	1,024.6	1,004.0	1,040.2	1,081.2	1,108.2	1,196.2	1,233.3	1,275.6	36.2
Agriculture	411.6	51.4.7	530.9	544.8	555.6	563.9	578.7	585.1	599;7	619.5	644.3	
Livestock	168.6	201.7	212.2	221.43	201.6	226.1	227.6	234.4	256.0	259.7	263.0	
Forestry & logging	253.7	246.5	249.7	258.5	246.8	250.2	274.9	288.7	340.5	354.1	368.3	
Fishing	-	-	-	-	-	-	-	-	-	-	-	
Mining & quarrying	12.6	21.7	19.3	27.4	23.5	26.2	32.7	34.8	46.2	43.7	48.9	1.4
Manufacturing	75.4	129.2	158.1	186.7	208.8	218.9	233.0	269.7	314.0	325.3	367.6	10.5
Electricity and gas	6.0	222.3	204.1	200.4	210.0	232.0	258.8	365.6	342.6	353.6	361.3	10.3
Construction	169.0	136.2	136.8	116.2	168.5	178.0	221.5	243.0	243.1	259.2	276.0	7.9
Wholesale, retail trade, hotels & restaurants	132.4	133.6	134.7	145.1	160.7	163.8	170.2	178.0	203.1	218.2	226.9	6.5
Transport, storage & communications	79.4	142.4	172.1	182.0	192.3	234.6	241.5	242.6	274.5	313.0	349.6	9.9
Finance, insurance & real estate	110.1	162.9	212.2	208.8	215.4	238.1	245.4	263.2	256.2	319.9	348.7	9.9
Community, social services (government)	126.0	217.0	223.3	233.2	251.6	266.5	293.0	310.5	334.5	360.5	385.7	10.9
Less: Imputed bank service charges	-25.0	-41.1	-28.8	-21.0	-28.1	-45.0	-61.2	-95.4	-115.8	-106.0	-126.2	-3.5
Gross domestic product	1,519.8	2,087.1	2,224.6	2,303.4	2,406.6	2,553.3	2,716.1	2,290.1	3,094.6	3,320.7	3,514.3	100
Annual growth rate (%)	3.7	4.7	6.6	3.5	4.5	6.1	6.4	7.5	6.1	7.3	5.8	

Note: * Provisional

Source; CSO, Planning Commission, Thimphu.

TABLE 4.3 COMPOUND GROWTH RATE OF GROSS DOMESTIC PRODUCT DURING FIFTH TO EIGHTH PLAN BY KIND OF ACTIVITY, Bhutan

(percent)

Activities	Growth Rate in Current Price				Growth Rate in 1980 Prices			
	Vth Plan (1980-87)	VIth Plan (1987-91)	VIIth Plan (1992-97)	VIII Plan* (1997-2002)	Vth Plan (1980-87)	VIth Plan (1987-91)	VIIth Plan (1992-97)	VIIIth Plan (1997-2002)
Agriculture, livestock & forestry and fishing	17.6	9.2	16.5	11.8	6.7	2.6	4.5	1.4
Agriculture proper	15.8	13.4	13.4	13.6	6.9	4.4	1.9	3.1
Livestock production	18.3	9.2	16.9	13.0	4.2	5.6	6.2	3.4
Forestry and logging	20.2	2.7	22.5	7.5	8.3	-0.3	8.4	-3.4
Fishing	-	-	-	-	-	-	-	-
Mining and quarrying	40.6	24.9	28.5	30.3	20.1	6.1	18.4	28.7
Manufacturing	30.8	25.0	21.1	22.6	3.7	15.5	10.7	13.5
Electricity and gas	107.7	0.5	25.4	11.9	86.2	-3.3	13.0	-0.4
Construction	24.8	0.7	15.0	13.0	1.6	-6.5	9.6	16.8
Wholesale, ratail trade, hotels and restaurants	14.0	11.4	17.1	12.1	0.4	0.5	6.0	0.5
Transport, storage & communications	19.0	33.4	16.1	19.0	8.9	18.8	9.3	6.4
Finance, insurance & real estate	19.4	18.4	0.2	19.8	9.5	11.4	4.4	11.5
Community, social & personal services	23.8	7.9	13.6	7.7	6.8	3.9	7.4	5.6
Gross domestic product	20.3	10.9	16.4	15.0	6.8	3.9	6.5	6.4

Note: *8th Five Year Plan (FYP) projected @ contains 6 years.
Source: CSO, Planning Commission, Thimphu.

TABLE 4.4 PERCENTAGE COMPOSITION OF GROSS DOMESTIC PRODUCT BY VARIOUS ACTIVITIES, 1989 TO 1998, Bhutan

Activities	1989	1991	1992	1993	1994	1995	1996	1997	1998*
Agriculture Sector	42.7	42.7	39.4	39.6	41.3	39.6	38.6	36.4	36.7
Agriculture proper	21.6	21.9	21.8	21.6	21.9	20.8	19.2	17.1	17.2
Livestock production	9.7	9.8	7.8	7.7	8.5	8.2	7.7	8.5	8.6
Forestry and logging	11.5	11.0	9.8	10.3	11.0	10.7	11.7	10.7	10.9
Fishing	-	-	-	-	-	-	-	-	-
.Mining and quarrying	0.9	1.7	1.6	1.4	2.1	2.0	4.0	2.1	2.4
Manufacturing	8.1	9.3	10.4	10.6	10.5	11.1	11.9	11.0	11.1
Electricity and gas	7.8	7.1	7.1	7.9	6.9	10.8	9.4	11.9	11.0
Construction	8.1	6.7	9.5	8.7	9.5	9.5	8.8	10.1	10.6
Wholesale, retail trade, hotels ' restaurants	6.6	7.1	7.7	7.8	7.8	7.4	7.7	7.0	7.0
Transport, storage & communications	7.1	7.4	7.5	8.3	7.7	7.0	7.3	7.1	7.5
Finance, insurance and real estate	7.7	7.6	7.0	6.5	5.6	5.1	3.8	5.0	5.1
Community, social and personal services	11.0	10.4	9.7	9.1	8.5	7.6	8.6	9.4	8.6
Gross domestic product	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Note: Provisional
Source: CSO, Planning Commission, Thimphu.

TABLE 4.5 ELECTRICITY GENERATING STATIONS AND THEIR CAPACITIES, FY 1996/97, Bhutan

Power Stations		Installed capacity (No. x MW)	Generating capacity (MW)	Peak Genertaion (MW)	Energy Generated (GWh)
Hydro stations (a)					
Chhukha		4 x 84.00	336.000	363.000	1,828.062
Chumey	(Bumthang)	3 x 00.50	2.000	0.435	2.368
Gidakom	(Thimphu)	5 x 00.25	0.500	0.000	0.000
Jushina	(Thimphu)	4 x 00.09	0.090	0.000	0.000
Rangjung	(Trashigang)	2 x 01.10	2.200	0.790	3.832
Chenari	(Trashigang)	3 x 00.25	0.250	0.000	0.000
Khaling	(Trashigang)	3 x 00.20	0.400	0.215	1.523
Khalangzi	(Mongar)	3 x 00.13	0.260	0.256	0.040
Wangduephodrang		3 x 00.10	0.200	0.115	0.263
Micro hydels		..	..	..	..
Lhuntse	(Lhuntse)	1 x 0.020	..	..	..
Thinleygang	(Thimphu)	1 x 0.030	..	..	..
Rukubji	(Wangduephodrang)	1 x 0.040	..	..	..
Tangsibi	(Trongsa)	1 x 0.030	..	..	.
Trongsa	(Trongsa)	1 x 0.050	..	..	..
Bubja	(Trongsa)	1 x 0.030	..	..	..
Tamshing	(Bjakar)	1 x 0.050	..	..	..
Ura	(Bjakar)	1 x 0.030	..	..	..
Yadi	(Mongar)	1 x 0.020	..	..	..
Kekhar	(Zhemgang)	1 x 0.070	..	..	..
Surey	(Sarpang)	2 x 0.010	..	..	..
Damphu	(Tsirang)	2 x 0.010	0.200	..	..
Tingtibi	(Zhemgang)	2 x 0.010	0.200	..	..
Dagana	(Dagana)	2 x 0.010	0.200	..	..
Diesel generation stations		..	..	..	..
Thimphu		9	..	..	..
Paro		1	..	..	..
Phuentsholing		4	..	..	..
Damphu		2	..	..	..
Trongsa		1	..	..	..
Gelephu		2	..	..	..
Sarpang		1	..	..	..
Kalikhola		1	..	..	..
Zhemgang		1	..	..	..
Dagana		1	..	..	..
Trashigang		1	..	..	..
Bjakar		1	..	..	..
Other diesel stations					
Penden Cememt Authority Lt		4	..	..	..
Bhutan Board Products Ltd.		2	..	..	..
Chhukha Hydro Power Corp.		5	..	..	..
Bhutan Chemical & Carbide		2	..	..	..
Bhutan Ferro Alloys Ltd.		1	..	..	..

Note: The energy generated by micro hydels is the cumulated generation till date

Source: Division of Power, Thimphu.

TABLE 4.6 TOTAL ELECTRICITY GENERATION AND SUPPLY, 1989/90 TO 1997/98, Bhutan

Details	1989/90	1990/91	991/92	1992/93	1993/94	1994/95	1995/96	1996/97	1997/98
Installed capacity	348.85	347.01	347.56	347.57	347.94	347.94	350.14	350.14	350.17
Chhukha hydro power	336.00	336.00	336.00	336.00	336.00	336.00	336.00	336.00	336.00
Other hydro power	5.56	5.56	6.06	6.06	6.15	6.15	8.35	8.35	8.35
All diesel generators	5.13	5.45	5.50	5.51	5.79	5.79	5.79	5.79	5.82
Electricity generation	1,556.90	1,549.90	1,563.88	1,683.89	1,685.81	1,629.98	1,972.18	1,838.38	1,801.02
Chhukha hydro power	1,554.30	1,542.41	1,554.37	1,677.81	1,679.24	1,623.91	1,964.63	1,828.06	1,789.98
Other hydropower	2.58	7.45	8.20	5.05	5.49	5.89	7.50	10.25	10.97
All diesel generators	0.02	0.04	1.31	1.04	1.09	0.18	0.06	0.07	0.06
Exports (MU)	1,395.59	1,374.62	1,336.87	1,464.96	1,456.34	1,311.84	1,564.04	1,430.29	1,357.20
Imports (MU)	3.31	4.44	4.98	5.10	4.62	5.34	7.24	7.03	7.54
Total energy requirement	142.30	161.62	186.70	195.26	198.50	298.16	390.43	378.02	389.90
Total energy sales	127.57	144.67	159.71	173.82	176.51	275.95	342.79	361.04	375.24
Energy losses	14.77	16.95	26.99	21.43	21.99	22.21	47.64	16.98	14.66
Percentage losses	10.38	10.49	10.45	10.98	11.08	7.45	12.20	4.49	3.76
Peak system demand	22.00	22.80	19.22	23.00	33.00	70.42	70.42	72.00	77.00
Length of HT lines									
Overhead lines	624.58	751.04	765.14	764.78	820.14	841.22	872.26	923.82	954.41
Underground lines	8.60	8.60	8.60	8.60	8.60	9.01	9.01	9.01	12.27
Length of LT lines									
Overhead lines	560.66	730.31	732.44	733.87	736.89	736.89	809.70	863.11	885.74
Underground lines	28.00	28.00	28.00	28.00	28.00	29.05	29.05	29.05	37.63

Note: Diesel generators excludes those owned by private organization. HT = High tension, LT = Low tension
Source: Division of Power, Thimphu.

TABLE 4.7 MAJOR TRANSMISSION LINES FOR EVACUATING CHUUKHA POWER PLANT, 1998/99, Bhutan

(Line lengths in km)

No.	Particulars	220 kV	132 kV	66 kV
1	CHPC-BIRPARA	71.000 (D/C)	-	-
2	CHPC – SINGHIGAON	33.320	-	-
3	CHPC – SIMTOKHA (II)	54.367	-	-
4	INDIAN BORDER – GELEPHUG	-	0.300	-
5	CHPC – GEDU	-	-	20.100
6	GEDU-PHUENTSHOLING	-	-	17.700
7	CHPC – CONFLUENCE	-	-	36.700
8	CONFLUENCE-SIMTOKHA (I)	-	-	18.300
9	CONFLUENCE-HA	-	-	33.522
10	CONFLUENCE-PARO	-	-	24.022
11	SIMTOKHA-WANGDUEPHODRANG	-	-	26.023
12	PHUENTSHOLING-GOMTU	-	-	27.002
13	PHUENTSHOLING-SINGHIGAON	-	-	8.380
14	LOBEYSA-BASOCHHU	-	-	23.023
	TOTAL	71(D/C)::87.69(S/C)	0.300	234.772

*: 5&6 are one continuous line.

TABLE 4.8 HIGH VOLTAGE TRANSFORMATION CAPACITY OF SUBSTATIONS, 1998/99, Bhutan

No.	Station	Voltage Ratio (kV)	Transformers No.& Capacity (No.x MVA)	Total Capacity (MVA)
1	CHHUKHA HYDEL PROJECT	11/220	12 × 35	420
2	CHHUKHA HYDEL PROJECT	220/66	2 × 20	40
		66/11	2 × 3	6
3	SINGHIGAON	220/66	2 × 35	70
		66/11	2 × 3	6
4.	PASAKHA (BCCL)	66/11	2 × 20	40
5	PASAKHA (BFAL)	66/22	1 × 28.5	28.5
6	PENDEN	66/11	2 × 5	10
7	PENDEN (PCAL)	66/6.6	2 × 5	10
8	PHUENTSHOLING	66/11	2 × 3	6
9	GEDU	66/11	2 × 3	6
10	SIMTOKHA (I)	66/33/11	2 × 2.5/2.5	10
11	SIMTOKHA (II)	220/66	6 × 6.67	40
		66/11	2 × 10	20
12	PARO	66/33/11	2 × 2.5/2.5	10
13	HA	66/11	2 × 5	10
14	LOBEYSA	66/11	2 × 5	10
		66/33	1 × 5	5
15	GELEPHUG	132/66	2 × 25	50
		66/11	2 × 10	20
	TOTAL			817.5

Table 4.9 GROWTH OF POWER SECTOR IN THE COUNTRY, All India

No.	Items	Unit	Position In 1950	Position in In 1997	Increase No. of Times
1.	INSTALLED CAPACITY (UTILITIES)	MW	1713	89100	52
2.	INSTALLED CAPACITY (NON UTILITIES)	MW	588	12900	22
3.	ENERGY GENERATION (UTILITIES)	MU	5107	420600	82
4.	ENERGY GENERATION (NON UTILITIES))	GWh	1468	43800	30
5.	ELECTRICITY SALES (UTILITIES)	GWh	4157	277028	67
6.	NO. OF CONSUMERS	Million	1.5	91	60
7.	TRANSMISSION AND DISTRIBUTION LINES	Ckt Km	29271	5089696	162
8.	VILLAGES ELECTRIFIED	Nos.	3061	579132	164
9.	PUMPSETS ENERGISED	Nos.	21008	11104090	528
10.	T&D LOSSES	%	15.33	20.27	

Table 4.10 INSTALLED GENERATING CAPACITY, All India

As on 31st March '2000

Region	Installed Capacity (MW)			
	Hydro	Thermal	Nuclear	Total
Northern Region	7699.23	17452.99	1130.00	26284.22
Western Region	4265.18	25140.98	860.00	30535.05
Southern Region	9103.19	13358.32	690.00	24034.23
Eastern Region	2147.72	13084.88	0.00	15333.70
North-Eastern Region	600.69	1113.74	0.00	1628.95
Islands				
i) A & N Islands	0.00	28.33	0.00	28.33
ii) Lakshdweep	0.00	6.92	0.00	6.92
All India (Utilities)	23816.01	70186.16	2680.00	97851.40
All India (Non-Utilities)	20.75	12917.43	0.00	13003.92
All India (Total)	23936.76	83103.59	2680.00	110855.32

Table 4.11 GROSS POWER GENERATION DURING 1997-98 in India

REGION	HYDRO	THERMAL	NUCLEAR	WIND	TOTAL
1. Northern Region	30688.43	89399.53	3917.05	0.00	124005.01
2. Western Region	8508.97	126397.87	4273.55	143.00	139323.39
3. Southern Region	28696.87	75545.34	1892.00	845.43	106979.64
4. Eastern Region	4623.01	42705.1	0.00	0.00	47328.11
5. North-Eastern Region	2064.43	2046.7	0.00	0.00	4111.13
All India (Utilities)	74581.71	336094.54	10082.60	988.43	421747.28
All India (Non-Utilities)	78.84	36461.36		7537.39	44077.59
All India (Total)	74660.55	372555.9	10082.60	8525.82	465824.87

Table 4.12 LENGTH OF THE TRANSMISSION LINES

As on 31st March '1998

Voltage	Length of Lines (Cut kms)
HVDC	1667
400 kV	36497
230/220 kV	83390
132/110/90 kV	103902
33/22 kV	39028
15/11 kV	256160
6.6/3.3/2.2 kV	1593105
Distribution lines upto 500 volts	3405788
Total	5519537

Table 4.13 REGION WISE ELECTRICITY CONSUMPTION DURING 1997-98

Region	Domestic	Commercial	Industrial	Agricultural	Others	Total
Northern Region	19,714.75	6,548.11	49,972.73	24,841.08	1,876.90	102,953.57
Western Region	16,979.38	5,328.51	45,053.35	36,433.80	409.85	104,204.89
Southern Region	16,091.87	4,643.83	28,633.33	26,687.28	1,708.91	77,765.22
Eastern Region	6,489.99	2,569.16	18,146.23	3,184.03	639.10	31,028.51
North-Eastern Region	1,070.22	277.90	1,181.42	95.32	531.84	3,156.70
All India (Total)	60,346.21	19,367.51	142,987.06	91,241.51	5,166.60	319,108.89

Table 4.14 BASIN-WISE DISTRIBUTION OFHYDROELECTRIC POTENTIAL OF RIVER

As on 31st March '1997

S.No.	Name of River	No. of basins studied (MW)	Firm Potential	Potential at 60% LF	
				Economic (MW)	Theoretical (MW)
1.	Great Indus	6	11992.8	19988.0	50172
2.	Great Brahmpurta	9	23951.9	34919.8	146170
3.	Ganga	10	6428.8	10714.8	52938
4.	West flowing rivers of South India	7	6428.8	1071.8	52938
5.	East flowing rivers of South India	9	5719.0	9531.3	26972
6.	Central India	8	1644.2	2740.3	14888
	TOTAL	49	50426.1	84043.6	301117

Table 4.15 REGION-WISE DISTRIBUTION OF HYDROELECTRIC POTENTIAL

As on 31st March '1997

Region	Energy (TWh)	Potential 60% Load Factor (MW)	% developed	% under developed
Northern	225.0	21155	14.30	8.03
Western	31.4	5679	31.94	26.97
Southern	61.8	10763	49.21	10.27
Eastern	42.5	5590	16.41	12.73
North-Eastern	239.3	31857	1.02	0.96
ALL INDIA	**600.0**	**84044**	**15.07**	**7.23**

Table 4.16 DISTRIBUTION OF COAL RESERVES

S.No.	State	Million Tonnes
1.	Andhra Pradesh	13021
2.	Arunachal Pradesh	90
3.	Assam	320
4.	Bihar	65205
5.	Madhya Pradesh	41060
6.	Maharashtra	6636
7.	Meghalaya	459
8.	Nagaland	20
9.	Orissa	46722
10.	Uttar Pradesh	1062
11.	West Bengal	27358
	TOTAL	201953

Table 4.17 LIGNITE RESERVES

(Million Tonnes)

S.No.	State Location	Estimated Reserves
1.	Tamil nadu and Pondicherry	
	Neyveli	3300
	Bahur	575
	Jayamkondacholapuram	1150
	Mannargudi	15500
	East of Veeranam	1164
	Kadikadu	117
2.	Gujarat	932
3.	Rajasthan	1430
4.	Jammu & Kashmir	127
5.	Kerala	108
	TOTAL	24403

Table 4.18 OIL AND GAS RESERVES

Agency/Region		Crude Oil (MT)	Natural Gas (BCM)
ONGC			
(A)	On-Shore		
	Western Region	155.86	92.06
	Rajasthan	-	1.04
	Eastern Region	81.61	34.54
	Southern Region	1.79	16.36
	TOTAL ON-SHORE	239.26	144.52
(B)	Off-Shore		
	West Coast	418.80	446.40
	East Coast	13.33	10.95
	TOTAL OFF-SHORE	432.13	457.35
	TOTAL ONGC	671.39	601.87
OIL INDIA LIMITED		56.80	84.57
	TOTAL	728.19	686.44

Table 4.19 CO-GENERATION POTENTIAL IN THE INDUSTRY

S.No.	Industry	Potential (Surplus) (in MW)
1.	Sugar	3200
2.	Petrochemical	1500
3.	Steel Industry	800
4.	Fertilizer	600
5.	Cement	250
6.	Paper	180
	Total	6530

Table 4.20 Growth rates of GNP and GDP for industrial

Key Indicators								
	1995-96	1996-97	1997-98	1998-99	1995-96	1996-97	1997-98	1998-99
	Absolute Values				Per cent changes over previous period			
Gross national product (Rs. Thousand crore)								
At current prices	1089.8	1272.2P	1413.2Q	NA	17.1	16.7P	11.1Q	NA
At 1993-94 prices	913.8	983.3P	1038.7Q	1099.7A	7.8	8.1P	5.1Q	5.9A
Gross domestic product (Rs. Thousand crore)								
At current prices	1103.2	1285.3P	1426.7Q	NA	16.9	16.5P	11.0Q	NA
At 1993-94 prices	926.4	999.0P	1049.2Q	1110.0A	7.6	7.8P	5.0Q	5.8A
Agricultural production(1)	160.7	175.4	164.9	171.3P	-2.7	9.1	-6.0	3.9P
Foodgrains production (million tonnes)	180.4	199.4	192.4	195.3P	-5.8	10.5	-3.5	1.5P
Industrial production(2)	122.3	129.1	137.6	139.2 #	12.8	5.6	6.6	3.5 #
Electricity generated (Billion, KWH)	379.9	394.5	420.6	392.4 #	8.4	3.8	6.6	6.6 #
Wholesale price Index(3)	299.5	320.1	337.1	353.9 *	4.4	6.9	5.3	4.6 #
Consumer price index for Industrial workers(4)	319.0	351.0	380.0	429.0 @	8.9	10.0	8.3	15.3 @
Money supply (M3) (Rs. Thousand crore)	604.0	701.8	825.4	934.7 (5)	13.7	16.2	17.6	13.2 @
Imports at current prices								
(Rs. crore)	122678	138920	151553	132447 #	36.4	13.2	9.0	23.2 #
(US$ million)	36678	39133	40779	31583 #	28.0	6.7	4.2	7.1 #
Exports at current prices								
(Rs. crore)	106353	118817	126286	101850 #	28.6	11.7	6.3	11.7 #
(US$ million)	31797	33470	33980	24287 #	20.7	5.3	1.5	-2.9 #
Foreign currency assets(7)								
(Rs. crore)	58446	80368	102507	116515 (8)	-11.5	37.5	27.5	13.7 (8)
(US$ million)	17044	22367	25975	27429 (8)	-18.1	31.2	16.1	5.6 (8)
Exchange rate (Rs/US$)(10)	33.45	35.50	37.16	41.99 (9)	-6.1	-5.8	-4.5	-11.5 (9)

Note: Gross national product and Gross domestic product figures are at factor cost (new series with base 1993-94).
Q-Quick estimates; A-advance estimates; P-Provisional ; NA- Not available
1. Index of agricultural production (of 46 crops including plantations) with base triennium ending 1981-82=100
2. Index of industrial Production 1993-94=100
3. Index with base 1981-82=100, at the end of fiscal year
4. Index with base 1982=100, at the end of fiscal year
5. Outstanding as on January 15, 1999 for 1998-99 and end of financial year for previous years.
6. April 1, 1998 to January 15, 1999
7. Outstanding at the end of fiscal year
8. At the end of January ,1999.
9. April-January, 1998-99
10. Per cent change indicates the rate of appreciation/depreciation (-) of the Rupee vis-à-vis the US dollar.
* As on 30.1.1999(Provisional). @Dec.1998 #April-December, 1998

Source : Economy Survey, 1998-99, Ministry of Finance, Government of India

Table 4.21 POPULATION BY SEX AND ESTIMATED MID YEAR POPULATION PROJECTION

(No in Thousand)

S.No	State	Area in Sq. Km.	Population(1991 census)			Projection (as on 21st July)						
			Males	Females	Persons	1992	1993	1994	1995	1996	1997	1998
1	**India**	3,287,263	439,230	407,072	846,302	867,818	883,910	899,953	915,964	939,540	955,219	971,832
2	**State:**											
2.1	West Bengal	88,752	35,511	32,567	68,078	69,662	70,871	72,082	73,271	74,988	76,141	77,250
3	**Northestern States**											
3.1	Arunachal Pradesh	83,743	465	399	864	893	915	938	961	1,047	1,087	1,128
3.2	Assam	78,438	11,658	10,756	22,414	23,084	23,593	24,105	24,616	24,866	25,275	25,646
3.3	Manipur	22,327	938	899	1,837	1,895	1,939	1,984	2,031	2,217	2,301	2,385
3.4	Maghalaya	22,429	908	867	1,774	1,830	1,872	1,916	1,960	2,143	2,224	2,305
3.5	Mizoram	21,081	359	331	690	719	742	765	789	836	868	901
3.6	Nagaland	16,579	641	568	1,209	1,261	1,302	1,343	1,386	1,474	1,532	1,591
3.7	Tripura	10,486	1,418	1,339	2,757	2,843	2,909	2,976	3,045	3,229	3,455	3,582

Source: Statistical abstract India 1998, Central Statistical Organisation, Department of Statistics, Government of India

Table 4.22 Summary of Demographic Indicators (1997)

(Per Thousand)

S.No	State	Birth Rate			Death Rate			Infant Mortality Rate		
		Total	Rural	Urban	Total	Rural	Urban	Total	Rural	Urban
1	**India**	27.2	28.9	21.5	8.9	9.6	6.5	71	77	45
2	**State:**									
2.1	West Bengal	22.4	24.8	15.9	7.7	7.9	7.2	55	58	43
3	**Northestern States**									
3.1	Arunachal Pradesh	21.4	22.3	12.2	5.8	6.1	2.0	47	49	17
3.2	Assam	28.2	29.0	20.7	9.9	10.3	5.9	76	79	37
3.3	Manipur	19.7	20.5	17.6	5.9	5.8	6.2	30	21	28
3.4	Maghalaya	30.2	32.9	16.6	8.8	9.7	4.4	54	56	52
3.5	Tripura	18.3	18.9	15.5	6.8	6.9	5.8	51	53	39

Source: Statistical abstract India 1998, Central Statistical Organisation, Department of Statistics, Government of India

Table 4.23 Summary of Health Facilities (1995)

S.No	State	Number of Hospitals	Number of Dispensaries	Number of Beds
1	**India**	15,097	28,225	870
2	**State:**			
2.1	West Bengal	399	551	68
3	**Northestern States**			
3.1	Arunachal Pradesh	262	11	2
3.2	Assam	268	325	16
3.3	Manipur	32	42	2
3.4	Maghalaya	9	21	3
3.5	Mizoram	17	18	2
3.6	Nagaland	31	16	2
3.7	Tripura	26	474	2

Source: Statistical abstract India 1998, Central Statiatical Organisation, Department of Statistics, Government of India

Table 4.24 Health Personnel

S.No	State	Number of Registered Medical Practioners 1998	Number of Registered Nursing Personnel 1997		
			Nurses	Health Visitors	Auxiliary Nurses/Midwives
1	**India**	503,947	565,696	26,578	283,195
2	**State:**				
2.1	West Bengal	46,941	34,701	2,983	36,094
2.2	Assam	13,293	2,270	46	2,054

Table 4.25 Number of Institutes, Teachers & Enrollment

S.No	State	Number of Institutions		Number of Institutions		Number of Institutions	
		Colleges(1993-94)	Schools(91-92)	Colleges(1993-94)	Schools(91-92)	Colleges(1993-94)	Schools(91-92)
1	**India**	9,003	1,016,313	291,048	4,079,713	5,817,247	164,907,524
2	**State:**						
2.1	West Bengal	403	90,318	53,442	316,284	344,167	17,211,704
3	**Northestern States**						
3.1	Arunachal Paradesh	5	2,486	851	6,601	3,204	199,623
3.2	Assam	229	49,255	19,489	153,205	144,113	5,225,131
3.3	Manipur	51	6,787	4,240	27,345	29,710	555,102
3.4	Maghalaya	27	7,190	3,302	14,633	20,526	453,405
3.5	Mizoram	12	2,196	2,452	8,543		179,874
3.6	Nagaland	14	2,540	716	13,742		320,660
3.7	Tripura	21	8,139	2,703	26,275		769,909

Source: Statistical abstract India 1998, Central Statistical Organisation, Department of Statistics, Government of India

Table 4.26 Population according to economic activities(1/2)
(1991 Census)

S.No	State	Main Workes							
		Cultivators		Agricultural Labourers		Household Industries		Other Workers	
		Males	Females	Males	Females	Males	Females	Males	Females
1	2	3	4	5	6	7	8	9	10
1	**India**	88,480,942	22,221,404	14,164,747	28,432,997	4,555,016	2,249,005	82,457,879	11,370,503
2	**State:**								
2.1	West Bengal	5,424,497	420,496	4,073,895	981,583	510,048	293,635	7,981,065	895,829
3	**Northestern States**								
3.1	Arunachal Pradesh	116,931	119,056	12,780	7,274	531	211	118,634	15,559
3.2	Assam	2,870,583	688,534	682,573	162,391	32,134	39,321	2,054,897	471,623
3.3	Manipur	243,267	194,232	19,151	28,199	6,024	35,065	146,370	35,975
3.4	Maghalaya	228,196	167,608	52,177	37,315	1,634	1,251	167,618	59,788
3.5	Mizoram	94,878	83,223	6,181	3,346	1,997	961	74,955	24,776
3.6	Nagaland	178,974	192,623	5,109	2,124	896	1,095	114,458	16,218
3.7	Tripura	254,550	50,973	146,092	41,456	7,933	3,451	257,722	39,896

Source: Statistical abstract India 1998, Central Statistical Organisation, Department of Statistics, Government of India

Table 4.26 Population according to economic activities(2/2)
(1991 Census)

S.No	State	Total Main Workers			Marginal Workers			Non Workers		
		Males	Females	Persons	Males	Females	Persons	Males	Females	Persons
1	**India**	221,658,584	64,273,909	285,932,493	2,705,223	25,493,654	28,198,877	210,844,351	313,592,215	524,436,566
2	**State:**									
2.1	West Bengal	17,989,505	2,591,543	20,581,048	262,414	1,071,312	1,333,726	17,258,714	28,904,477	46,163,191
3	**Northestern States**									
3.1	Arunachal Pradesh	248,876	142,100	390,976	1,117	7,689	8,806	215,011	249,765	464,776
3.2	Assam	5,640,187	1,351,869	6,992,056	124,213	972,666	1,096,879	5,893,589	8,431,798	14,325,387
3.3	Manipur	414,812	293,471	708,283	9,958	56,663	66,621	513,589	548,656	1,062,245
3.4	Maghalaya	449,625	265,962	715,587	4,844	36,891	41,735	453,218	564,238	1,017,456
3.5	Mizoram	178,011	112,306	290,317	15,370	31,658	47,028	165,597	186,814	352,411
3.6	Nagaland	299,437	212,060	511,497	1,078	3,662	4,740	340,767	352,542	693,309
3.7	Tripura	666,287	135,776	802,063	7,897	48,557	56,454	743,746	1,154,942	1,898,688

Source: Statistical abstract India 1998, Central Statistical Organisation, Department of Statistics, Government of India

Table 4.27 ESTIMATED EMPLOYMENT IN THE PUBLIC AND PRIVATE SECTORS
(As on 31st March,1995-96)

State	Public Sector				Private Sector			
	Central Govt. establish-ments	State Govt. establish-ments	Quasi Govt. establishments		Local Bodies	Large establish-ments	Small establish-ments	Grand Total
			Central	State				
India	3,365.9	7,413.8	3,538.0	2,920.0	2,191.6	7,550.3	961.3	27,940.9
State:								
Assam	83.2	301.6	78.7	59.7	13.1	562.8	9.2	1,108.2
Manipur	4.6	61.4	3.8	3.6	3.4	1.3	0.5	78.6
Meghalaya	13.5	35.2	5.9	7.8	2.3	5.4	1.9	72.0
Mizoram	0.8	33.7	1.2	1.4	1.8	1.7	-	40.6
Nagaland	5.6	60.3	2.0	2.3	0.3	1.2	1.4	73.1
Tripura	4.0	80.1	4.4	3.1	3.0	15.0	0.7	110.3
West Bengal	417.1	307.2	507.0	169.9	149.6	776.1	35.4	2,362.2

Source: Statistical abstract India 1998, Central Statistical Organisation, Department of Statistics, Government of India

Table 4.28 Number of Mines (1997-98)

S.No	State	Total	Fuels	Metallic Minerals	Non-Metallic Minerarls	Employment in Mines (1995) (*)
1	**India**	3,195	578	558	2,059	716,183
2	**State:**					
2.1	West Bengal	127	111	-	16	99,767
3	**Northestern States**					
3.1	Arunachal Pradesh	-	-	-	-	505
3.2	Assam	9	6	-	3	18,271
3.3	Manipur	1	-	1	-	-
3.4	Maghalaya	2	-	-	2	174

Source: Statistical abstract India 1998, Central Statistical Organisation, Department of Statistics, Government of Indi

(*) Average daily number of workers employed

( ) Other mines

Table 4.29 Number of Manufacturing Industries (Factory Sector) (1994-95)

S.No	State	No. of Factories	Persons engaged		Man days Employees (lakh)
			Total('000)	Workers('000)	
1	**India**	123,010	9,227	6,970	28,548
2	**State:**				
2.1	West Bengal	5,593	751	581	2,354
3	**Northestern States**				
3.1	Assam	1,514	125	101	373
3.2	Manipur	74	2	1	4
3.3	Maghalaya	30	1	1	3
3.4	Nagaland	85	5	3	12
3.5	Tripura	157	8	7	20

Source: Statistical abstract India 1998, Central Statistical Organisation, Department of Statistics, Government of India

Table 4.30 Road Network-length of Highway By Authorities (as on 31st March, 1996)

(in Kilometer)

S.No	State	National Highway	State Highway	Other PWD Roads	Zilla Parishad Roads	Village Panchayat Road	CD/Panchayat Samiti Road	Rural Road	Total Highway
1	**India**	34,508	135,187	763,959	435,716	406,575	179,516	916,010	2,871,471
2	**State:**								
2.1	West Bengal	1,651	3,388	17,366	29,383	28,524	-		51,808
3	**Northestern States**								
3.1	Arunachal Pradesh	3,686	-	6,151	-	-	-		9,150
3.2	Assam	2,254	1,811	26,416	-	2,631	27,371		57,582
3.3	Manipur	438	1,437	6,342	-	-	1,991		10,208
3.4	Maghalaya	464	988	5,094	-	-	572		7,218
3.5	Mizoram	566	240	3,682	-	1,664	1,664		6,152
3.6	Nagaland	131	390	6,273	-	-	6,273		13,057
3.7	Tripura	198	136	5,569	-	7,183	7,183		13,086

Source: Statistical abstract India 1998, Central StatisticalOrganisation, Department of Statistics, Government of India

Table 4.31 Number of Registered Vehicles (1996-97)

S.No	State	Two Wheelers	Autorickshaws	Jeeps	Cars	Trains	Buses	Goods Vehicles	Miscellaneous	Total No of Vehicles
1	**India**	23,111,385	1,008,974	667,894	3,139,444	382,029	448,970	2,028,840	2,769,990	33,557,526
2	**State:**									
2.1	West Bengal	663,801	14,789		282,526	41,298	25,575	140,645	30,090	1,198,733
3	**Northestern States**									
3.1	Arunachal Pradesh	7,352	209	1,615	1,168	207	1,493	2,256	521	14,821
3.2	Assam	195,110	9,875	10,019	38,943	6,164	10,033	57,717	30,803	358,664
3.3	Manipur	43,616	1,889	4,500	3,271	302	1,663	4,939	1,331	61,511
3.4	Maghalaya	12,581	246	7,142	7,513	2,671	1,884	9,874	2,804	44,715
3.5	Mizoram	6,825		4,965	1,414	1,328	604	2,770	332	18,238
3.6	Nagaland	20,427	6,367	21,098	20,533	1,904	3,213	23,329	4,250	101,121
3.7	Tripura	17,809	2,071	3,190	3,587	509	1,230	4,813	1,474	34,683

Source: Statistical abstract India 1998, Central StatisticalOrganisation, Department of Statistics, Government of India

Table 4.32 Communication Network in India

S.No	Particular	1992-93	1993-94	1994-95	1995-96	1996-97
1	Kilometers of Lines	718,000	761,000	782,000	NA	NA
2	Kilometers of Cables	526,000	538,000	528,000	NA	NA
3	Number of Exchange	17,455	18,956	20,169	21,160	22,199
4	Total Telephones	7,712,628	8,877,347	10,588,430	12,892,495	15,394,411

Source: Statistical abstract India 1998, Central StatisticalOrganisation, Department of Statistics, Government of India

Table 4.33 Number of Foreign Tourists to India

S.No	Nationality	1991	1992	1993	1994	1995	1996	1997	1998
1	North America	153,502	195,872	206,077	232,938	267,188	302,894	322,864	324,920
2	Central and South America	11,819	12,339	13,450	11,805	16,672	19,346	17,011	23,701
3	Africa	62,127	71,020	61,975	64,134	87,238	89,148	102,361	110,708
4	Australia	30,535	35,685	39,020	43,865	49,941	63,063	65,387	80,212
5	Western Europe	514,541	606,739	624,628	664,820	754,182	821,222	831,324	853,411
6	Eastern Europe	46,073	48,974	56,709	66,060	53,275	55,673	45,102	482,243
7	West Asia	118,530	135,874	118,223	114,096	114,748	114,262	112,607	98,589
8	South Asia	590,621	578,368	465,655	480,142	540,209	543,967	583,706	558,772
9	South East Asia	78,966	93,328	98,935	113,535	129,491	132,808	146,205	133,524
10	East Asia	67,793	85,940	77,058	93,844	109,916	144,266	146,880	129,366
11	Stateless	3,001	3,512	3,100	1,194	823	1,211	647	183
Grand Total		1,677,508	1,867,651	1,764,830	1,886,433	2,123,683	2,287,860	2,374,094	2,795,629

Source: Statistical abstract India 1998, Central StatisticalOrganisation, Department of Statistics, Government of India

Table 4.34 Consumer Price Index Number for Industrial Workers
(Base: 1982=100)

S.No	State	Weightage	1991	1992	1993	1994	1995	1996	1997	1998
1	**All India**									
	Food	57.00	222	251	265	296	331	359	380	437
	Clothing, bedding, footwear	8.54	164	182	197	219	247	267	281	293
	General	100.00	212	237	252	278	306	334	358	405
2	**West Bengal**									
	Calcutta									
	Food	2.62	227	248	269	292	330	359	373	451
	Clothing, bedding, footwear	0.22	160	174	145	217	252	268	278	290
	General	4.24	218	238	257	280	312	340	359	416
3	**Assam**									
	Guwahati									
	Food	0.38	219	251	270	297	331	363	379	429
	Clothing, bedding, footwear	0.06	179	202	225	254	299	327	326	342
	General	0.66	208	235	252	280	312	341	357	405

Source: Statistical abstract India 1998, Central StatisticalOrganisation, Department of Statistics, Government of India

Table 4.35 Consumer Price Index Number for Urban Non-Manual Employees
General Index
(Base: 1984-85=100)

S.No	State/Centre	Weight	1991	1992	1993	1994	1995	1996	1997	1998
1	**All India**	100	177	199	212	231	254	276	297	329
2	**West Bengal**									
	Calcutta	6.92	176	195	209	224	246	264	281	311
3	**Assam**									
	Guwahati	0.95	168	192	204	219	243	274	290	320

Source: Statistical abstract India 1998, Central StatisticalOrganisation, Department of Statistics, Government of India

Table 4.36 Consumer Price Index Number for Agricultural /Rural Labourers (Base: Agrl. 1986-87=100)

S.No	State/Centre	Weight	1995-96	1996-97	1997-98
1	**All India**				
	Food Index	69.15	242	264	269
	General Index	100	238	260	269
2	**West Bengal**				
	Food Index	6.96	242	264	270
	General Index	9.17	232	248	260
3	**Assam**				
	Food Index	1.42	243	258	278
	General Index	1.9	244	259	273

Source: Statistical abstract India 1998, Central StatisticalOrganisation, Department of Statistics, Government of India

Table 4.37 Index Numbers of Wholesale Prices in India By Major Groups and Grops (Base: 1981-82=100)

Major Gropu/Group	Commodity Weight	Financial Year Averages									
		1982-83	1985-86	1988-89	1989-90	1990-91	1991-92	1992-93	1993-94	1994-95	1995-96
All Commodities	100.00	104.90	125.40	154.20	165.70	182.70	207.80	228.70	247.80	274.70	295.80
I.Primary Articles	32.30	106.70	125.70	160.10	163.60	184.90	218.30	234.60	250.90	283.20	304.10
A.Food Articles	17.39	111.10	134.10	177.10	179.30	200.60	241.10	271.00	284.40	312.70	335.70
B.Non-Food Articles	10.08	100.80	120.40	160.20	166.00	194.20	229.20	228.70	249.10	299.00	321.70
C.Minerals	4.83	103.30	106.50	98.50	102.20	109.90	113.50	116.10	133.90	143.60	135.00
II.Fuel,Power ,Light and Lubricants	10.66	106.50	129.80	151.20	156.60	175.80	199.00	227.10	262.40	280.40	285.40
III.Manufactured Products	57.04	103.50	124.50	151.50	168.60	182.80	203.40	225.60	243.20	268.80	293.10
A.Food Products	10.14	97.40	117.20	147.80	165.30	181.70	206.30	223.80	246.70	270.50	278.80
B.Beverages, Tabacco and Tabaco Products	2.15	100.20	123.20	180.70	207.70	242.10	265.70	293.70	306.60	342.10	373.90
C.Textiles	11.55	104.80	119.50	139.60	158.20	171.20	188.30	200.70	219.90	256.80	294.60
D.Wood and Wood Products	1.20	113.40	146.00	156.60	157.70	159.10	161.60	318.20	380.90	421.00	442.00
E.Paper and Paper Products	1.99	108.50	144.10	180.90	208.40	222.40	261.50	311.40	328.20	330.20	374.00
F.Leather and Leather Products	1.02	110.40	128.10	168.40	185.70	224.30	233.90	228.20	245.20	261.80	276.80
G.Rubber and Plastic Products	1.59	108.40	125.60	155.30	159.40	164.90	170.60	186.20	189.90	200.60	235.40
H.Chemicals and Chemical Products	7.36	103.50	118.30	135.80	140.00	147.90	168.40	192.60	207.80	232.60	249.90
I.Non-Metallic Mineral Products	2.48	114.50	141.10	152.40	167.00	185.60	215.70	232.80	255.10	275.70	315.80
J.Basic Metals, Alloys & Metal Products	7.63	104.50	139.60	176.40	205.60	219.90	234.80	256.60	276.60	300.50	329.00
K.Machinery & Machine Tools (incl. Electric Machinery)	6.27	102.80	121.40	150.80	166.20	180.20	208.30	230.60	237.90	262.80	282.80
L.Transport Equipment & Parts	2.71	103.60	123.00	148.90	166.20	181.30	202.50	218.10	223.80	238.50	254.50
M.Other Miscellaneous Manufacturing Industries	0.97	101.80	99.30	113.10	117.20	119.00	128.30	138.80	148.20	165.90	169.90

Source: Statistical abstract India 1998, Central StatisticalOrganisation, Department of Statistics, Government of India

Table 4.38 National Product At Factor Cost (at current prices)

Item	1993-94	1994-95	1995-96	1996-97	1997-98
1	2	3	4	5	6
Gross National Product (GNP)(Rs. Crore)	786,997	930,325	1,089,754	1,272,177	1,413,231
Net National Product (NNP)(Rs. Crore)	704,038	833,325	975,645	1,140,895	1,265,167
Estimate Population (crore)	89	91	93	94	96
Per Capita Net National Product (Rupee)	7,902	9,178	10,525	12,099	13,193
Index Number (1980-81=100)					
GNP	100	118.2	138.5	161.6	179.6
NNP	100	118.4	138.6	162.1	179.7
Per Capita NNP	100	116.1	133.2	153.1	167.0

Source: Statistical abstract India 1998, Central StatisticalOrganisation, Department of Statistics, Government of India

Table 4.39 National Product At Factor Cost (at 1980-81 prices)

Item	1993-94	1994-95	1995-96	1996-97	1997-98
1	2	3	4	5	6
Gross National Product (GNP)(Rs. Crore)	786,997	847,849	913,810	988,255	1,038,692
Net National Product (NNP)(Rs. Crore)	704,038	758,781	817,489	884,237	926,420
Estimate Population (crore)	89	91	93	94	96
Per Capita Net National Product (Rupee)	7,902	8,357	8,819	9,377	9,660
Index Number (1980-81=100)					
GNP	100	107.7	116.1	125.6	132.0
NNP	100	107.8	116.1	125.6	131.6
Per Capita NNP	100	105.8	111.6	118.7	122.2

Source: Statistical abstract India 1998, Central StatisticalOrganisation, Department of Statistics, Government of India

Table 4.40 Net Domestic Product at Factor Cost By Industry of Origin
(at current prices)

(Rs. crore)

Item	1993-94	1994-95	1995-96	1996-97	1997-98
1	6	7	8	9	
1. Agriculture, forestry and fishing	229,908	269,779	296,473	357,593	371,603
1.1 Agriculture	211,841	248,444	273,119	330,946	341,225
1.2 Forestry & logging	9,928	11,373	11,979	13,087	13,961
1.3 Fishing	8,139	9,962	11,375	13,560	16,417
2. Mining & quarrying	14,546	16,004	17,326	19,265	21,000
3. Manufacturing	105,214	129,320	160,385	177,049	194,676
3.1 Registered	67,009	84,072	103,725	114,364	125,757
3.2 Unregistered	38,205	45,248	56,660	62,685	68,919
4. Electricity, gas and water supply	8,618	11,742	13,862	14,160	18,349
5. Construction	38,531	44,218	52,960	60,057	64,505
6. Trade, hotels and restaurants	108,305	132,455	161,162	192,861	217,110
6.1 Trade	103,737	126,942	152,834	182,529	205,437
6.2 Hotels & restaurants	4,568	5,513	8,328	10,332	11,673
7. Transport, storage and communication	44,426	53,032	59,790	71,944	85,173
7.1 Railways	6,808	8,077	9,135	9,464	10,735
7.2 Transport by other means	29,619	34,898	38,680	48,088	57,493
7.3 Storage	558	682	781	859	921
7.4 Communication	7,441	9,375	11,194	13,533	16,024
8. Financing, insurance, real estate and business services	80,107	91,637	110,288	124,521	139,172
8.1 Banking & insurance	40,128	47,921	62,891	73,371	83,704
8.2 Real estate, ownership of dwellings & business services	39,979	43,716	47,397	51,150	55,468
9. Community, social & personal services	86,463	98,221	116,883	136,527	167,018
9.1 Public administration and defence	39,173	43,498	51,378	58,719	76,630
9.2 Other services	47,290	54,723	65,505	77,808	90,388
10. Net domestic product at factor cost	716,118	846,408	989,129	1,153,977	1,278,606

Source: Statistical abstract India 1998, Central StatisticalOrganisation, Department of Statistics, Government of India

Table 4.41 Net Domestic Product at Factor Cost By Industry of Origin
(at 1980-81 prices)

(Rs. crore)

Item	1993-94	1994-95	1995-96	1996-97	1997-98
1	2	3	4	5	6
1. Agriculture, forestry and fishing	229,908	252,566	242,549	266,046	262,703
1.1 Agriculture	211,841	223,418	222,711	244,870	241,075
1.2 Forestry & logging	9,928	10,355	10,499	10,863	11,242
1.3 Fishing	8,139	8,793	9,339	10,313	10,386
2. Mining & quarrying	14,546	15,633	16,925	17,124	17,765
3. Manufacturing	105,214	116,496	134,232	142,594	149,759
3.1 Registered	67,009	75,988	87,524	92,652	97,873
3.2 Unregistered	38,205	40,508	46,708	49,942	51,886
4. Electricity, gas and water supply	8,618	9,770	10,583	11,292	12,241
5. Construction	38,531	40,592	43,931	45,074	46,824
6. Trade, hotels and restaurants	108,305	124,639	140,729	152,561	160,679
6.1 Trade	103,737	119,599	133,998	145,061	152,713
6.2 Hotels & restaurants	4,568	5,040	6,731	7,500	7,966
7. Transport, storage and communication	44,426	48,569	53,157	58,162	61,869
7.1 Railways	6,808	6,926	7,647	8,048	8,310
7.2 Transport by other means	29,619	32,387	34,470	37,078	38,522
7.3 Storage	558	570	599	592	599
7.4 Communication	7,441	8,686	10,441	12,444	14,438
8. Financing, insurance, real estate and business services	80,107	84,462	91,558	99,108	107,761
8.1 Banking & insurance	40,128	43,184	48,788	55,134	62,452
8.2 Real estate, ownership of dwellings & business services	39,979	41,278	42,770	43,974	45,309
9. Community, social & personal services	86,463	89,269	96,427	102,999	117,318
9.1 Public administration and defence	39,173	39,515	42,349	44,296	54,018
9.2 Other services	47,290	49,754	54,078	58,703	63,300
10. Net domestic product at factor cost	716,118	771,996	830,091	894,960	963,919

Source: Statistical abstract India 1998, Central StatisticalOrganisation, Department of Statistics, Government of India

Table 4.42 Performance of Public Sector
(at current prices)

(Rs. Crore)

Item	1985-86	1990-91	1991-92	1992-93	1993-94	1994-95	1995-96	1996-97
1	2	3	4	5	6	7	8	9
1. Gross domestic product	233,799	477,814	552,768	630,772	732,874	868,019	1,006,286	1,149,215
1.1 Public	58,326	125,690	150,581	172,055	200,501	231,764	263,957	294,050
1.2 Private	175,473	352,124	402,187	458,717	532,373	636,255	742,329	855,165
2. Gross domestic saving	51,933	129,999	141,251	155,225	183,710	247,087	283,003	333,816
2.1 Public	8,457	5,436	11,888	10,765	4,557	17,491	25,195	24,728
2.2 Private	43,476	124,563	129,363	144,460	179,153	229,596	257,808	309,088
3. Gross domestic capital formation unadjusted	63,442	135,156	140,068	169,656	172,532	241,379	304,980	291,848
3.1 Public	29,417	52,151	56,537	62,763	69,523	86,749	88,477	64,215
3.2 Private	34,025	83,005	83,531	106,893	103,009	154,630	216,503	227,633
4. Final consumption expenditure	206,932	394,143	454,609	513,913	588,853	675,833	765,051	867,032
4.1 Public	29,174	61,779	69,459	78,596	89,926	100,498	115,957	132,166
4.2 Private	177,758	332,364	385,150	435,317	498,927	575,335	649,094	734,866
Percentage Share of Public Sector								
1. Gross domestic product	24.9	26.3	27.2	27.3	27.4	26.7	26.2	25.6
2. Gross domestic saving	16.3	4.2	8.4	6.9	2.5	7.1	8.9	7.4
3. Gross domestic capital formation unadjusted	46.4	38.6	40.4	37.0	40.3	35.9	29.0	29.3
4. Final consumption expenditure	14.1	15.7	15.3	15.3	15.3	14.9	15.2	15.2

Source: Statistical abstract India 1998, Central StatisticalOrganisation, Department of Statistics, Government of India

Table 4.43 Performance of Public Sector
(at 1980-81 prices)

(Rs. Crore)

Item	1985-86	1990-91	1991-92	1992-93	1993-94	1994-95	1995-96	1996-97
1	2	3	4	5	6	7	8	9
1. Gross domestic product	1,256,566	212,253	213,983	225,240	239,145	257,700	276,132	296,845
1.1 Public	34,842	50,334	53,743	55,593	59,783	62,435	66,059	69,238
1.2 Private	1,221,724	161,919	160,240	169,647	179,362	195,265	210,073	227,607
2. Gross domestic capital formation unadjusted	39,847	56,885	50,633	56,894	54,353	72,446	84,912	84,418
2.1 Public	18,504	21,592	20,047	20,583	21,546	24,945	22,937	22,992
2.2 Private	21,343	35,293	30,586	36,311	32,807	47,501	61,975	61,426
3. Final consumption expenditure	142,978	181,513	184,091	191,364	200,817	211,419	222,414	235,171
3.1 Public	18,924	26,059	25,912	26,779	28,495	29,034	30,441	31,997
3.2 Private	124,054	155,454	158,179	164,585	172,322	182,385	191,973	203,174
Percentage Share of Public Sector								
1. Gross domestic product	22.3	23.7	25.1	24.7	25.0	24.2	23.9	23.3
2. Gross domestic capital formation unadjusted	46.4	38.0	39.6	36.2	39.6	34.4	27.0	27.2
3. Final consumption expenditure	13.2	14.4	14.1	14.0	14.2	13.7	13.7	13.6

Source: Statistical abstract India 1998, Central StatisticalOrganisation, Department of Statistics, Government of India

Table 4.44 Plan Outlay / Expenditure for Public Sector By Heads of Development(1/2)

(Rs. Crore)

Head of Development	Annual Plan 1991-92		Eight Plan Outlay (1992-97)	Annual Plan 1992-93	
	Plan Outlay	Actual Expenditure		Plan Outlay	Actual Expenditure
Central Government:	42,969	37,846	247,865	48,407	43,694
1. Agriculture and allied activities	1,858	1,592	11,118	1,879	1,923
2. Rural Development	2,702	2,355	24,170	2,610	3,110
3. Special area programmes					
4. Irrigation and flood control	267	230	1,500	231	189
5. Energy	13,514	12,060	66,795	14,998	12,587
6. Industry and minerals	7,117	5,312	37,539	8,198	6,090
7. Transport	7,537	7,120	40,977	9,129	8,172
8. Communications, information and broadcasting	3,383	3,611	25,097	4,890	5,149
9. Science, technology and environment	961	819	5,139	935	890
10. Social services	4,956	4,325	34,445	5,128	4,519
11. Others	673	422	1,085	409	1,065
States and Union Territories:	29,348	26,905	186,235	32,365	29,159
1. Agriculture and allied activities	2,615	2,258	11,349	2,831	2,293
2. Rural Development	1,740	1,786	10,255	1,926	1,982
3. Special area programmes	1,143	1,067	6,750	1,180	1,284
4. Irrigation and flood control	4,432	4,002	31,025	4,704	4,516
5. Energy	7,788	7,674	48,766	8,576	7,703
6. Industry and minerals	1,500	1,252	9,383	1,686	1,354
7. Transport	2,380	2,194	14,948	2,627	2,491
8. Communications, information and broadcasting	2	2	13		2
9. Science, technology and environment	57	42	3,903	57	40
10. Social services	6,834	5,794	44,567	7,719	6,803
11. Others	857	652	5,275	1,059	691
Grand Total	72,317	64,751	434,100	80,772	72,852

Source: Statistical abstract India 1998, Central StatisticalOrganisation, Department of Statistics, Government of India

Table 4.44 Plan Outlay / Expenditure for Public Sector By Heads of Development(2/2)

(Rs. Crore)

Head of Development	Annual Plan 1993-94		Annual Plan 1994-95		Plan Outlay (1995-96) Expenditure	Approved Outlay (1996-97)
	Plan	Actual Outlay	Plan	Actual Outlay		
Central Government:	63,936	55,216	70,141	59,054	78,849	74,595
1. Agriculture and allied activities	2,436	1,764	2,637	2,504	3,022	2,708
2. Rural Development	4,229	4,660	6,036	5,702	6,540	6,095
3. Special area programmes						
4. Irrigation and flood control	275	256	261	221	288	250
5. Energy	21,911	18,701	22,857	17,880	23,795	20,268
6. Industry and minerals	9,634	6,897	10,394	7,019	11,598	10,817
7. Transport	10,893	9,010	11,343	8,703	14,088	11,963
8. Communications, information and broadcasting	6,245	6,199	7,191	7,271	8,318	9,776
9. Science, technology and environment	1,251	1,105	1,362	1,353	1,616	1,534
10. Social services	6,459	6,168	7,381	7,848	8,839	10,432
11. Others	603	466	678	553	745	752
States and Union Territories:	36,184	31,838	40,974	38,012	43,973	51,671
1. Agriculture and allied activities	2,973	2,499	3,208	2,846	3,386	3,706
2. Rural Development	1,959	2,374	2,591	3,015	3,380	4,869
3. Special area programmes	1,406	337	466	326	392	426
4. Irrigation and flood control	5,579	5,115	6,234	5,883	6,297	7,743
5. Energy	9,009	8,208	10,059	9,602	9,799	10,014
6. Industry and minerals	1,729	1,584	2,172	2,069	2,045	2,136
7. Transport	3,054	2,967	3,565	3,394	3,958	4,512
8. Communications, information and broadcasting	3	3	3	3	3	3
9. Science, technology and environment	66	48	73	55	98	98
10. Social services	8,971	7,859	10,668	9,561	12,806	16,080
11. Others	1,436	846	1,936	1,257	1,808	2,085
Grand Total	100,120	87,054	111,115	97,066	122,822	126,266

Source: Statistical abstract India 1998, Central StatisticalOrganisation, Department of Statistics, Government of India

Table 4.45 PLAN OUTLAY FOR PUBLIC SECTOR BY HEADS OF DEVELOPMENT
State and Union Territories
Outlay for Eight plan (1992-97)

(Rs. Crore at 1991-92 prices)

State	Agriculture & Allied Activities and Irrigation & Flood Control	Rural Development	Speacial Area Programmes	Energy (Incl.IREP)	Industry and Minerals	Transport	Science and Technolgy	Ecology and Technology	Social Services	Others	Total
1	2	3	4	5	6	7	8	9	10	11	12
Arunachal Pradesh	181	36		152	24	344		47	322	48	1,155
Assam	777	187	12	1,197	323	295	5	117	1,642	109	4,662
Manipur	245	14		187	40	161	4	24	256	47	976
Meghalaya	149	38	11	172	43	207	2	62	275	71	1,029
Mizoram	83	130		104	44	103	2	31	212	53	763
Nagaland	109	96	10	61	49	162	1	29	226	100	844
Tripura	279	74	90	121	65	105	2	27	350	16	1,130
West Bengal	1,522	683	144	3,025	1,075	575	18	143	2,372	203	9,760

Source:Statistical abstract India 19988, Central Statistical Organisation, Department of Statistics, Government of India

Table 4.46 PLAN OUTLAY FOR PUBLIC SECTOR BY HEADS OF DEVELOPMENT
State and Union Territories(1/4)
Outlay for (1995-96)

(Rs. lakh)

State	Agriculture & Allied Activities	Rural Development	Speacial Area Programmes (Backward Areas)	Irrigation and Flood Control	Energy	Industry and Minerals
1	2	3	4	5	6	7
Arunachal Pradesh	4,940	1,890		2,013	10,760	682
Assam	13,993	8,992	310	9,667	15,407	5,590
Manipur	2,556	1,217		4,889	4,348	1,105
Meghalaya		2,173	279	1,000	1,499	1,249
Mizoram	2,260	3,760		247	2,935	1,043
Nagaland	1,618	2,918	178	355	2,100	693
Tripura	3,680	3,013	2,134	1,201	3,521	1,191
West Bengal	10,223	15,029	2,175	16,500	74,362	19,500

Source:Statistical abstract India 1998, Central Statistical Organisation, Department of Statistics, Government of India

Table 4.46 PLAN OUTLAY FOR PUBLIC SECTOR BY HEADS OF DEVELOPMENT
State and Union Territories(2/4)
Outlay for (1995-96)

(Rs. lakh)

State	Transport and Communi-cations	Science, Technology and Envoirment	General Economics Services	Social Services	General Services	Total
1	8	9	10	11	12	13
Arunachal Pradesh	10,267	26	994	11,325	1,023	43,930
Assam	10,662	273	3,991	50,167	1,148	120,200
Manipur	4,078	112	439	9,552	746	29,042
Meghalaya	6,325	112	785	7,793	709	25,567
Mizoram	4,480	50	1,535	6,516	574	23,400
Nagaland	1,506	19	3,320	5,612	1,181	19,500
Tripura	3,153	71	198	11,398	309	29,839
West Bengal	15,500	219	2,066	48,468	4,158	208,200

Source:Statistical abstract India 1998., Central Statistical Organisation, Department of Statistics, Government of India

Table 4.46 PLAN OUTLAY FOR PUBLIC SECTOR BY HEADS OF DEVELOPMENT
State and Union Territories(3/4)
Outlay for (1996-97)

(Rs. lakh)

State	Agriculture & Allied Activities	Rural Development	Speacial Area Programmes (Backward Areas)	Irrigation and Flood Control	Energy	Industry and Minerals
1	2	3	4	5	6	7
Arunachal Paradesh	4,461	1,755		1,947	7,455	736
Assam	12,950	11,452	230	10,772	12,252	5,200
Manipur	2,531	1,246		4,739	4,460	1,164
Meghalaya	3,137	2,240	178	888	1,560	1,034
Mizoram	2,430	3,615	10	278	4,563	1,037
Nagaland	1,614	3,179	427	252	2,061	750
Tripura	3,650	3,272	2,134	1,643	3,371	1,191
West Bengal	8,480	17,700	1,930	17,375	103,508	13,070

Source:Statistical abstract India 1998, Central Statistical Organisation, Department of Statistics, Government of India

Table 4.46 PLAN OUTLAY FOR PUBLIC SECTOR BY HEADS OF DEVELOPMENT
State and Union Territories(4/4)
Outlay for (1996-97)

(Rs. lakh)

State	Transport and Communi-cations	Science, Technology and Envoirment	General Economics Services	Social Services	General Services	Total
1	8	9	10	11	12	13
Arunachal Pradesh	12,229	26	1,548	14,499	1,061	45,717
Assam	9,234	160	3,383	53,369	2,623	121,625
Manipur	8,037	113	630	11,741	883	35,544
Meghalaya	6,650	100	790	9,899	664	27,140
Mizoram	3,953	57	1,783	9,194	682	27,602
Nagaland	2,394	24	3,737	8,939	746	24,123
Tripura	3,681	71	208	15,101	369	34,691
West Bengal	18,225	355	1,093	46,534	1,730	230,000

Source:Statistical abstract India 1998, Central Statistical Organisation, Department of Statistics, Government of India

Table 4.47 PLAN EXPENDITURE FOR PUBLIC SECTOR BY HEADS OF DEVELOPMENT(1/2)
State and Union Territories
Actual Expenditure For Annual Plan 1994-95

(Rs. lakh)

State	Agriculture & Allied Activities	Rural Development	Speacial Area Programmes (Backward Areas)	Irrigation and Flood Control	Energy	Industry and Minerals
1	2	3	4	5	6	7
Arunachal Paradesh	4,172	1,250		1,778	18,291	580
Assam	11,530	8,820	299	8,876	18,284	5,414
Manipur	2,055	444		4,230	4,098	1,000
Meghalaya	2,343	819	115	528	720	826
Mizoram	2,065	3,428		245	2,742	890
Nagaland	618	141	167	226	1,016	474
Tripura	3,329	2,008	1,980	1,028	3,319	1,021
West Bengal	6,985	17,948	3,662	15,917	57,307	21,634

Source:Statistical abstract India 1998, Central Statistical Organisation, Department of Statistics, Government of India

Table 4.47 PLAN EXPENDITURE FOR PUBLIC SECTOR BY HEADS OF DEVELOPMENT(2/2)

State and Union Territories

Actual Expenditure For Annual Plan 1994-95

(Rs. lakh)

State	Transport and Communi-cations	Science, Technology and Envoirment	General Economics Services	Social Services	General Services	Total
1	2	3	4	5	6	7
Arunachal Pradesh	8,917	19	584	9,068	677	25,759
Assam	8,176	212	2,427	39,415	829	180,461
Manipur	3,417	106	361	5,731	626	12,883
Meghalaya	5,910	82	570	5,600	380	109,159
Mizoram	3,490	37	1,302	5,590	426	106,610
Nagaland	451	10	3,135	2,113	234	159,971
Tripura	2,556	71	158	9,981	292	13,058
West Bengal	12,129	134	5,299	27,660	1,526	46,748

Source:Statistical abstract India 1998, Central Statistical Organisation, Department of Statistics, Government of India

Table 4.48 BUDGETARY POSITION OF THE GOVERNMENT OF INDIA

(Rs.crore)

Item	1985-86	1989-90	1990-91	1991-92	1992-93	1993-94	1994-95	1995-96	1996-97	1997-98
1	2	3	4	5	6	7	8	9	10	11
1.Revenue Account										
A. Revenue	29,178	54,614	57,650	69,100	77,573	79,650	95,549	115,679	131,686	145,773
B. Expenditure	35,066	66,528	76,212	85,361	96,147	112,366	126,578	149,010	164,340	189,459
C. Surplus(+)/Deficit(-)	-5,888	-11,914	-18,562	-162,261	-18,574	-32,716	-31,029	-33,331	-32,654	-43,686
2.Capital Account										
A.Receipts	19,315	30,020	38,997	38,528	36,178	55,440	68,695	65,213	61,544	96,731
B.Disbursements	18,742	28,698	31,782	29,122	29,916	33,684	38,627	39,482	42,074	53,045
C. Surplus(+)/Deficit(-)	573	1,322	7,215	9,406	6,262	21,756	30,068	25,731	19,470	43,686
3.Overall Surplus(+)/Deficit(-)	-5,315	-10,592	-11,347	-6,855	-12,312	-10,960	-961	-7,600	13,184	2,324
4.Financing Of Surplus(+)/Deficit(-)										
A.Increase(-)/Decrease(-)in Treasury Bill	-6,562	-10,911	-11,769	-6,887	-11,773	-11,982	268	-6,477	12,729	-
B.Decrease(-)/Increase(+) in cash balance	-381	319	422	32	-539	1,022	-1,229	-1,123	455	2,324
(i) Opening Balance	488	1,146	1,465	1,887	1,919	1,380	2,402	1,173	2,829	2,374
(ii) Closing Balance	107	1,465	1,887	1,919	1,380	2,402	1,173	50	2,374	50

Source:Statistical abstract India 1998, Central Statistical Organisation, Department of Statistics, Government of India

Table 4.49 GENERAL STATEMENT OF THE REVENUE RECEIPTS AND REVENUE EXPENDITURE ACCOUNT OF STATE GOVERNMENTS

State	Item	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87
1		2	3	4	5	6	7
West Bengal	Revenue	1,223.8	1,379.3	1,533.1	1,778.6	2,343.2	2,510.2
	Expenditure	1,311.6	1,621.7	1,739.3	2,150.5	2,260.3	2,697.5
	Surplus(+)/Deficit(-)	-87.8	-22.4	-206.2	-371.9	+82.9	-187.3
Assam	Revenue	367.1	439.0	550.6	697.3	957.1	1,233.7
	Expenditure	404.5	482.9	689.6	837.1	958.1	1,160.4
	Surplus(+)/Deficit(-)	-37.4	-43.9	-139.0	-139.8	-1.0	+73.3
Manipur	Revenue	95.1	116.6	129.7	171.4	226.3	248.3
	Expenditure	85.1	92.6	106.0	133.8	155.8	198.1
	Surplus(+)/Deficit(-)	10.0	+24.0	+23.7	+37.6	+70.5	+50.2
Meghalaya	Revenue	82.0	96.8	125.0	148.0	182.9	214.9
	Expenditure	74.3	85.0	99.7	116.9	135.8	155.3
	Surplus(+)/Deficit(-)	7.7	+11.8	+25.2	+31.0	+47.1	+59.6
Nagaland	Revenue	108.4	133.8	161.9	209.5	297.4	300.7
	Expenditure	100.6	128.2	165.2	209.5	297.4	268.7
	Surplus(+)/Deficit(-)	+7.8	+5.6	-3.3	+16.2	69.3	+32.0
Tripura	Revenue	96.7	123.7	145.0	182.7	231.3	274.9
	Expenditure	90.8	108.5	141.2	146.2	187.4	229.5
	Surplus(+)/Deficit(-)	+5.9	+15.2	+3.8	+36.5	+43.9	+45.4

Source: Statistical abstract India 1998, Central Statistical Organisation, Department of Statistics, Government of India

Table 4.50 FOREIGN TRADE: OVERALL TRADE IN MERCHANDISE AND TREASURE

(Rs.lakh)

Item	1990-91	1991-92	1992-93	1993-94	1994-95	1995-96	1996-97
Merchandise							
Imports (Foreign merchandise)	4,319,286	4,785,084	6,337,451	7,310,101	8,997,066	12,267,814	13,891,968
Exports (Indian merchandise)	3,240,565	4,397,591	5,360,539	6,965,583	8,260,872	10,619,013	11,858,824
Re-Exports (Foreign merchandise)	14,769	6,590	8,286	9,556	6,539	16,321	22,884
Total exports	3,255,334	4,404,181	5,368,825	6,975,139	8,267,411	10,635,334	11,881,708
Balance of Trade	-1,063,952	-380,903	-968,626	-334,962	-729,655	-1,632,480	-2,010,260
Treasure							
Imports							
Gold	447	11,159	3,367	1,254	35	663	262
Currency notes(1)	148		1,372,203	4,510	17	42	930
Total	595	11,159	140,570	5,764	52	705	1,192
Exports (2)							
Gold	-	-	-	-	-	-	-
Currency notes(1)	-	-	-	-	-	-	-
Total	-	-	-	-	-	-	-
Balance of Trade(3)	-447	-11,159	-3,367	-1,254	-35	-663	-262
Visible balance of trade	-1,064,399	-392,062	-1,109,196	-340,726	-729,690	-1,633,143	-2,010,260

(1) Include GOI coins; (2) Includes re-exports; (3)with respect of gold only;

Source: Statistical abstract India 1998, Central Statistical Organisation, Department of Statistics, Government of India

Table 4.51 OVERALL BALANCE OF PAYMENTS(1/2)

(Rs.crore)

Item	1990-91			1992-93		
	Credit	Debit	Net	Credit	Debit	Net
1	2	3	4	5	6	7
A. Current Account						
I Merchandise	33,152.6	50,086.2	-16,933.6	54,762.0	68,862.9	-14,100.9
II Invisibles (a+b+c)	13,393.6	13,828.5	-434.9	23,901.0	22,563.6	1,337.4
a) Services	8,167.1	6,408.1	1,759.0	13,718.1	11,019.6	2,698.5
i) Travel	2,612.5	702.5	1,910.0	6,090.3	1,176.9	4,883.4
ii) Transportation	1,764.6	1,961.0	-196.4	2,850.4	4,547.0	-1,696.6
iii) Insurance	198.4	158.4	40.0	459.4	448.9	10.5
iv) Government not included elsewhere	27.3	311.2	-283.9	219.6	305.2	-85.6
v) miscellaneous	3,564.3	3,275.0	289.3	4,128.4	4,541.6	-413.2
b)Transfer	4,566.0	27.5	4,538.5	9,179.0	37.3	9,141.7
vi) Official	829.3	1.8	827.5	1,055.0	2.3	1,052.7
vii) Private	3,736.7	25.7	3,711.0	8,124.0	35.0	8,089.0
c) Investment income	660.5	7,392.9	-6,732.4	1,003.9	11,506.7	-10,502.8
Total Current Account [I+II]	46,546.2	63,914.7	-17,368.5	78,663.0	91,426.5	-12,763.5
B. Capital Account						
1. Foreign Investment (a+b)	201.8	18.3	183.5	1,798.5	98.6	1,699.9
a) In India	201.8	18.3	183.5	1,798.5	98.6	1,699.9
i) Direct	191.7	18.1	173.6	1,051.1	92.4	958.7
ii) Portfolio	10.1	0.2	9.9	747.4	6.2	741.2
b) Abroad						
2. Loans [a+b+c]	16,922.4	6,994.7	9,927.7	26,639.3	25,193.9	1,445.4
a) External Assistance	6,094.5	2,140.1	3,954.4	10,172.7	4,433.5	5,739.2
i) By India		10.5	-10.5		10.5	-10.5
ii) To India	6,094.5	2,129.6	3,964.9	10,172.7	4,423.0	5,749.7
b) Commercial Borrowing (MT & LT)	7,683.8	3,639.2	4,044.6	3,620.3	4,739.6	-1,119.3
i) By India	54.1	43.9	10.2	37.6	62.2	-24.6
ii) To India	7,629.7	3,595.3	4,034.4	3,582.7	4,677.4	-1,094.7
c) Short Term to India	3,144.1	1,215.4	1,928.7	12,846.3	16,020.8	-3,174.5
3. Banking Capital [a+b]	18,133.4	16,908.6	1,224.8	34,255.4	22,098.6	12,156.8
a) Commercial Banks	14,282.0	12,659.8	1,622.2	29,682.7	20,726.8	8,955.9
i) Assets	764.2	1,415.8	-651.6	3,782.7	484.9	3,297.8
ii) Liabilities	334.5	817.1	-482.6	709.3	1,148.4	-439.1
iii) Non-Resident Deposits	13,183.3	10,426.9	2,756.4	25,190.7	19,093.5	6,097.2
b) Others	3,851.4	4,248.8	-397.4	4,572.7	1,371.8	3,200.9
4. Rupee Debt Service		2,139.8	-2,139.8		2,334.6	-2,334.6
5. Other Capital	5,593.3	2,128.7	3,464.6	3,432.9	4,191.5	-758.6
Total Capital Account [1 to 5]	40,850.0	28,190.1	12,660.8	66,126.1	53,917.2	12,208.9
C. Errors & Ommissions	236.8		236.8		245.6	-245.6
D. Overall Balance [A+B+C]	87,633.9	92,104.8	-4,470.9	144,789.1	145,589.3	-800.2
E. Monetary Movements[i+ii+iii]	5,626.8	1,155.9	4,470.9	4,231.0	3,430.8	800.2
i) I.M.F	3,333.7	1,155.9	2,177.8	4,231.0	867.6	3,363.4
ii) SDR Allocation						
iii) Foreign Exchange Reserves (Increase-/Decrease+)	2,293.1		2,293.1		2,563.2	-2,563.2

Source: Statistical Abstract of India 1998, Central Statistical Organisation, Department of Statistics, Government of India

Table 4.51 OVERALL BALANCE OF PAYMENTS(2/2)

(Rs.crore)

Item	1993-94			1994-95		
	Credit	Debit	Net	Credit	Debit	Net
1	8	9	10	11	12	13
A. Current Account						
I Merchandise	71,146.0	78,630.3	-7,484.3	84,328.5	106,155.2	-21,826.7
II Invisibles (a+b+c)	30,262.2	26,413.7	3,848.5	42,245.1	31,001.0	11,244.1
a) Services	16,510.6	14,833.9	1,676.7	19,258.8	17,375.0	1,883.8
i) Travel	6,970.3	1,558.5	5,411.8	7,423.8	2,569.5	4,854.3
ii) Transportation	4,494.9	5,536.5	-1,041.6	5,328.1	5,851.8	-523.7
iii) Insurance	388.1	611.8	-223.7	475.7	566.6	-90.9
iv) Government not included elsewhere	94.5	480.6	-386.1	28.3	518.4	-490.1
v) miscellaneous	4,562.8	6,646.5	-2,083.7	6,002.9	7,868.7	-1,865.8
b)Transfer	12,514.0	83.4	12,430.6	20,203.8	71.5	20,132.3
vi) Official	1,170.3	15.0	1,155.3	1,322.9	1,390.0	1,309.0
vii) Private	11,343.7	68.4	11,275.3	18,880.9	57.6	18,823.3
c) Investment income	1,237.6	11,496.4	-10,258.8	2,782.5	13,554.5	-10,772.0
Total Current Account [I+II]	101,408.2	105,044.0	-3,635.8	126,573.6	137,156.2	-10,582.6
B. Capital Account						
1. Foreign Investment (a+b)	14,461.4	1,179.9	13,281.5	18,085.5	2,998.4	15,087.1
a) In India	14,461.4	1,178.8	13,282.6	18,058.0	2,608.6	15,449.4
i) Direct	2,041.6	203.8	1,837.8	4,241.0	25.0	4,216.0
ii) Portfolio	12,419.8	975.0	11,444.8	13,817.0	2,583.6	11,233.4
b) Abroad		1.1	-1.1	27.5	389.8	-362.3
2. Loans [a+b+c]	31,275.8	25,590.1	5,685.7	34,328.9	24,786.5	9,542.4
a) External Assistance	10,903.5	4,954.7	5,948.8	10,029.7	5,256.5	4,773.2
i) By India		15.1	-15.1	4.3	29.4	-25.1
ii) To India	10,903.5	4,939.6	5,963.9	10,025.4	5,227.1	4,798.3
b) Commercial Borrowing (MT & LT)	9,457.1	7,307.7	2,149.4	13,346.7	9,813.4	3,533.3
i) By India	320.1	75.6	244.5	306.2	10.7	295.5
ii) To India	9,137.0	7,232.1	1,904.9	13,040.5	9,802.7	3,237.8
c) Short Term to India	10,915.2	13,327.7	-2,412.5	10,952.5	9,716.6	1,235.9
3. Banking Capital [a+b]	36,069.8	28,971.3	7,098.5	22,033.5	23,091.6	-1,058.1
a) Commercial Banks	33,289.3	28,091.0	5,198.3	20,243.9	22,215.7	-1,971.8
i) Assets	864.4	3,513.0	-2,648.6	755.8	3,779.7	-3,023.9
ii) Liabilities	4,665.8	598.8	4,067.0	1,263.9	751.0	512.9
iii) Non-Resident Deposits	27,759.1	23,979.2	3,779.9	18,224.2	17,685.0	539.2
b) Others	2,780.5	880.3	1,900.2	1,789.6	875.9	913.7
4. Rupee Debt Service		3,301.6	-3,301.6		3,089.6	-3,089.6
5. Other Capital	9,450.5	3,872.7	5,577.8	7,901.9	700.7	7,201.2
Total Capital Account [1 to 5]	91,257.5	62,915.6	28,341.9	82,439.8	54,666.8	27,683.0
C. Errors & Ommissions	2,510.1		2,510.1	2,049.1		2,049.1
D. Overall Balance [A+B+C]	195,175.8	167,959.6	27,216.2	210,972.5	191,823.0	19,149.5
E. Monetary Movements[i+ii+iii]	1,006.9	28,233.1	-27,216.2		19,149.5	-19,149.5
i) I.M.F	1,006.9	419.7	587.2		3,585.0	-3,585.0
ii) SDR Allocation						
iii) Foreign Exchange Reserves (Increase-/Decrease+)		27,803.4	-27,803.4		15,564.5	-15,564.5

Source: Statistical Abstract of India 1997, Central Statistical Organisation, Department of Statistics, Government of India

Table 4.52 ELECTRICITY GENERATED, PURCHASED, SOLD AND ENERGY LOSSES (ALL INDIA UTILITIES) DURING 1997-98

Data No: IND -1

S.No	Item	Energy (GWh)	% age of Item 1
1	Energy generated (gross) (Utilities)	421747.28	100.00
2	Energy used in power station auxiliaries	30684.2	7.28
3	Energy generated (Net) at bus-bar i.e. (1) - (2)	391063.08	92.72 % of item 6
4	Energy purchased from Non-Utilities	2541.51	0.74
5	Energy imported from other countries (Nepal & Bhutan)	1384.66	0.42
6	Energy available for supply i.e. (3) + (4) + (5)	394989.25	100.00
7	Energy sold to ultimate consumers	296743.6	75.13
8	Energy sold to other countries (Nepal & Bhutan)	326.73	0.08
9	Total energy sold i.e (7) + (8)	297070.33	75.21
10	Energy lost in transformation, transmmision and distribution and unaccounted for i.e. (6) - (9)	97918.92	24.79

Table 4.53 ELECTRICITY GENERATED, PURCHASED, SOLD AND ENERGY LOSSES, REGION WISE DURING 1997-98

Energy in GWh

Data No: IND-2

		Northern Region	Western Region	Southern Region	Eastern Region	North Eastern Region
I	**Energy Generated (Net)**	116302.02	128426.09	100126.14	42248.49	3960.34
II	**Energy Purcased**					
a)	From Non-Utilities	196.83	904.12	594.85	842.03	3.68
b)	From Other Regions	415.33	2833.06	990.33	116.15	391.40
c)	From Other Countries	0.00	0.00	0.00	1384.66	0.00
	Sub-Totsl	612.16	3737.18	1585.18	2342.84	395.08
III	**Total Energy available (I+II)**	116914.18	132163.27	101711.32	44591.33	4355.42
IV	**Energy Sales**					
a)	To Ultimate consumers	80593.57	104204.89	77765.22	31028.54	3151.40
b)	To Other Regions	1001.68	672.26	634.53	2437.80	2.60
c)	To Other Countries	20.00	0.00	0.00	301.43	2.70
	Sub-Total IV	81615.25	104877.15	78399.75	33767.77	3156.70
V	**Energy Loss in Transmission & Distribution & Unaccounted for**	35298.93	27286.12	23311.57	10823.56	1198.72
VI	**Percentage Energy Loss** (V/III)	30.19	20.65	22.92	24.27	27.52

Table 4.54 ENERGY GENERATION (NET), INTER SYSTEM TRANSFER OF ENERGY,UTILISATION OF ENERGY AND SYSTEM LOSSES STATE WISE DURING 1997-98

Energy in GWh
Data No: IND -3

Region	State/U.Ts	Net generation in own power Houses (Other than jointly owned projects & Central Govt. Projects)	Energy Received From			Energy Available in the States (3+4+5+6)	Energy sent out to /Sold to			Transmission, Transformation, Distribution losses & Energy unaccounted for	
			Jointly owned & Central Govt. projects except BBMB & DVC	Self Generating Industries	From Other States including BBMB & DVC including from outside the Country		Other States including outside the Country	Ultimate consumers within the State	Total (8+9)	Quantum (7-10)	% of Column 7
1	2	3	4	5	6	7	8	9	10	11	12
Northern Region	Haryana	3316.51	6405.89	92.83	3075.60	12890.83	32.55	8470.46	8503.01	4387.82	34.04
	Himachal Pradesh	1302.64	1117.47	0.00	942.63	3362.74	721.46	1961.44	2682.90	679.84	20.22
	Jammu & Kashmir	948.18	4131.81	0.00	143.52	5223.51	21.29	2520.40	2541.69	2681.82	51.34
	Punjab	12161.34	6464.64	0.00	4589.55	23215.53	954.00	17899.45	18853.45	4362.08	18.79
	Rajasthan	6124.81	11610.53	0.00	2957.64	20692.98	458.29	14766.60	15224.89	5468.09	26.42
	Uttar Pradesh	21893.09	14820.10	104.00	213.24	37030.43	545.63	26681.30	27226.93	9803.50	26.47
	Chandigarh	0.00	319.18	0.00	531.69	850.87	0.00	660.44	660.44	190.43	22.38
	Delhi	1423.21	13624.58	0.00	48.23	15096.02	140.07	7633.48	7773.55	7322.47	48.51
	B.B.M.B	10474.08	0.00	0.00	0.00	10474.08	10072.20	0.00	10072.20	401.88	3.84
Western Region	Gujrat	27672.17	9218.75	510.05	336.09	37737.06	0.00	2852.05	28525.05	9212.01	24.41
	Madhya Pradesh	15601.47	14290.76	364.18	511.67	30768.08	118.06	24207.16	24325.22	6442.86	20.94
	Maharashtra	49994.47	11203.10	29.89	35.83	61263.29	597.79	49612.87	50210.66	11052.63	18.04
	Goa	0.00	1416.50	0.00	0.10	1416.60	0.00	977.15	977.15	439.45	31.02
	Daman & Diu	0.00	414.60	0.00	0.00	414.60	0.00	353.69	353.69	60.91	14.69
	D. N. Haveli	0.00	607.33	0.00	0.00	607.33	0.00	528.97	528.97	78.36	12.90

Table 4.54 ENERGY GENERATION (NET), INTER SYSTEM TRANSFER OF ENERGY,UTILISATION OF ENERGY AND SYSTEM LOSSES STATE WISE DURING 1997-98

Energy in GWh
Data No: IND -3

Region	State/U.Ts	Net generation in own power Houses (Other than jointly owned projects & Central Govt. Projects)	Energy Received From			Energy Available in the States (3+4+5+6)	Energy sent out to /Sold to			Transmission, Transformation, Distribution losses & Energy unaccounted for	
			Jointly owned & Central Govt. projects except BBMB & DVC	Self Generating Industries	From Other States including BBMB & DVC including from outside the Country		Other States including outside the Country	Ultimate consumers within the State	Total (8+9)	Quantum (7-10)	% of Column 7
1	2	3	4	5	6	7	8	9	10	11	12
Southern Region	Andhra Pradesh	26068.68	9131.46	369.48	68.46	35638.08	62.62	24070.31	24132.93	11505.15	32.28
	Karnataka	16456.75	5087.62	1.04	216.64	21762.05	4.22	17609.30	17613.52	4148.53	19.06
	Kerela	5152.68	4373.61	0.00	0.20	9526.49	20.61	7684.28	7704.89	1821.60	19.12
	Tamil Nadu	22218.73	10880.94	224.33	8.58	33332.58	198.06	27448.19	27646.25	5686.33	17.06
	Pondicherry	0.00	838.73	0.00	246.28	1085.01	0.00	937.89	937.89	147.12	13.56
	Lakshyadweep	18.09	0.00	0.00	0.00	18.09	0.00	15.25	15.25	2.84	15.70
Eastern Region	Bihar	3162.32	4000.10	0.00	5826.25	12988.67	403.58	11155.08	11558.66	1430.01	11.01
	Orissa	5362.11	4183.92	842.03	335.40	10723.46	144.35	5240.24	5384.59	5338.87	49.79
	West Bengal	13192.40	2203.90	0.00	3769.99	19166.29	798.88	14467.20	15266.08	3900.21	20.35
	D.V.C	6250.12	1690.28	0.00	964.08	8904.48	8796.56	0.00	8796.56	107.92	1.21
	A. & N. Islands	92.62	0.00	0.00	0.00	92.62	0.00	73.55	73.55	19.07	20.59
	Sikkim	62.35	45.20	0.00	12.60	120.15	0.20	92.47	92.67	27.48	22.87
North Eastern Region	Assam	936.32	1423.03	3.68	219.61	2582.64	5.38	1871.60	1876.98	705.66	27.32
	Manipur	0.67	403.56	0.00	4.04	408.27	0.00	322.18	322.18	86.09	21.09
	Maeghalaya	593.08	46.57	0.00	0.00	639.65	240.71	321.38	562.09	77.56	12.13
	Nagaland	2.14	173.69	0.00	12.13	187.96	0.07	131.89	131.96	56.00	29.79
	Tripura	295.90	155.75	0.00	5.01	456.66	0.00	314.61	314.61	142.05	31.11
	Arunachal Pradesh	82.48	86.43	0.00	0.00	168.91	0.00	111.32	111.32	57.59	34.10
	Mizoram	17.66	134.46	0.00	5.37	157.49	0.00	83.72	83.72	73.77	46.84

Table 4.55 ENERGY SALES (GWh) TO ULTIMATE CONSUMERS STATE WISE DURING 1997-98

Data No: IND -4

Region	State/U.Ts	Total Energy Sold	Domestic	Commercial	Industrial Power (Low & Medium Voltage)	Industrial Power (High Voltage)	Public Lighting	Traction	Agriculture	Public Water Works & Sewage Pumping	Miscellaneous
1	2	3	4	5	6	7	8	9	10	11	12
Northern Region	Haryana	8470.46	1821.30	316.57	589.69	1344.29	31.39	0.00	3842.84	210.65	313.73
	Himachal Pradesh	1955.06	481.40	134.91	1020.72	(A)	6.21	0.00	10.53	162.81	138.48
	Jammu & Kashmir	2098.45	507.77	304.07	242.33	174.36	38.72	0.00	341.44	259.35	230.41
	Punjab	17899.45	3336.56	675.59	1617.64	5430.92	51.19	0.00	6049.31	167.46	570.78
	Rajasthan	14765.94	2438.31	868.75	1371.01	3824.78	98.98	206.51	4980.35	630.95	346.30
	Uttar Pradesh	26714.53	7360.73	1926.00	1599.00	4560.00	385.80	858.00	9455.00	564.00	16.00
	Chandigarh	660.44	212.32	150.85	67.58	112.14	15.93	0.00	3.00	(A)	87.81
	Delhi	7633.48	3427.48	2087.00	993.00	433.00	200.00	65.00	55.00	255.00	118.00
	Sub-Total	**80197.81**	**19585.87**	**6463.74**	**7500.97**	**15879.49**	**828.22**	**1129.51**	**24737.47**	**2250.22**	**1821.51**
Western Region	Gujrat	28524.29	3444.65	1174.78	3985.95	8110.69	135.67	349.00	10774.84	460.61	88.10
	Madhya Pradesh	24202.87	4203.88	707.63	880.30	6537.03	140.20	1256.20	10004.66	455.97	17.00
	Maharashtra	49612.87	9053.15	3364.57	2784.03	15200.43	449.06	1450.53	15630.45	1380.20	300.45
	Goa	1027.96	243.89	71.89	37.31	573.71	14.13	0.00	11.22	75.81	0.00
	Daman & Diu	353.69	20.10	11.38	45.76	270.77	3.41	0.00	1.27	1.00	0.00
	D. N. Haveli	528.97	11.17	4.13	17.83	494.66	0.54	0.00	0.43	0.21	0.00
	Sub-Total	**104250.65**	**16976.84**	**5334.38**	**7751.18**	**31187.29**	**743.01**	**3055.73**	**36422.87**	**2373.80**	**405.55**

Table 4.55 ENERGY SALES (GWh) TO ULTIMATE CONSUMERS STATE WISE DURING 1997-98

Region	State/U.Ts	Total Energy Sold	Domestic	Commercial	Industrial Power (Low & Medium Voltage)	Industrial Power (High Voltage)	Public Lighting	Traction	Agriculture	Public Water Works & Sewage Pumping	Miscellaneous
1	2	3	4	5	6	7	8	9	10	11	12
Southern Region	Andhra Pradesh	24153.65	4665.52	937.95	1413.52	5321.00	291.70	850.00	9798.78	(A)	875.12
	Karnataka	17609.30	3181.82	511.93	1099.06	3233.17	160.38	26.44	9171.53	200.56	24.41
	Kerela	7684.28	3798.69	670.31	534.18	2003.44	117.95	8.50	340.81	173.26	37.14
	Tamil Nadu	27448.19	4288.78	2472.26	2249.89	9459.58	245.81	360.00	7281.02	318.61	772.24
	Pondicherry	937.89	144.53	48.21	52.78	573.33	9.86	0.00	95.14	14.04	0.00
	Lakshyadweep	15.25	10.62	3.17	0.44	0.00	1.02	0.00	0.00	0.00	0.00
	Sub-Total	**77848.56**	**16089.96**	**4643.83**	**5349.87**	**20590.52**	**826.72**	**1244.94**	**26687.28**	**706.47**	**1708.91**
Eastern Region	Bihar	11295.72	900.79	433.17	408.55	7121.62	35.89	668.24	1507.14	183.94	36.38
	Orissa	7812.04	3125.85	401.80	560.19	2892.60	15.40	169.70	343.82	176.58	126.10
	West Bengal	14340.14	3867.53	1738.87	1031.86	4709.50	108.80	677.87	1482.94	324.70	398.07
	A. & N. Islands	73.55	31.83	19.14	5.58	0.00	5.66	0.00	0.00	0.61	10.73
	Sikkim	92.47	48.85	13.98	13.99	0.00	15.65	0.00	0.00	0.00	0.00
	Sub-Total	**33613.92**	**7974.85**	**2606.96**	**2020.17**	**14723.72**	**181.40**	**1515.81**	**3333.90**	**685.83**	**571.28**
North Eastern Region	Assam	1871.60	449.57	159.49	203.82	626.04	6.00	0.00	25.32	34.76	366.60
	Manipur	322.18	157.87	20.94	27.38	24.16	11.28	0.00	8.06	16.11	56.38
	Maeghalaya	320.63	129.09	37.11	14.96	34.10	3.47	0.00	0.70	24.92	76.28
	Nagaland	131.89	75.40	9.07	20.65	0.00	3.70	0.00	0.00	3.05	20.02
	Tripura	314.61	112.43	36.31	38.77	0.00	6.05	0.00	60.52	51.44	9.09
	Arunachal Pradesh	111.32	81.36	7.97	10.00	0.00	10.50	0.00	0.00	1.49	0.00
	Mizoram	83.72	64.47	7.01	0.89	0.00	4.38	0.00	0.00	3.50	3.47
	Sub-Total	**3155.95**	**1070.19**	**277.90**	**316.47**	**684.30**	**45.38**	**0.00**	**94.60**	**135.27**	**531.84**
	Total (All India)	**299066.89**	**61697.71**	**19326.81**	**22938.66**	**83065.32**	**2624.73**	**6945.99**	**91276.12**	**6151.59**	**5039.09**

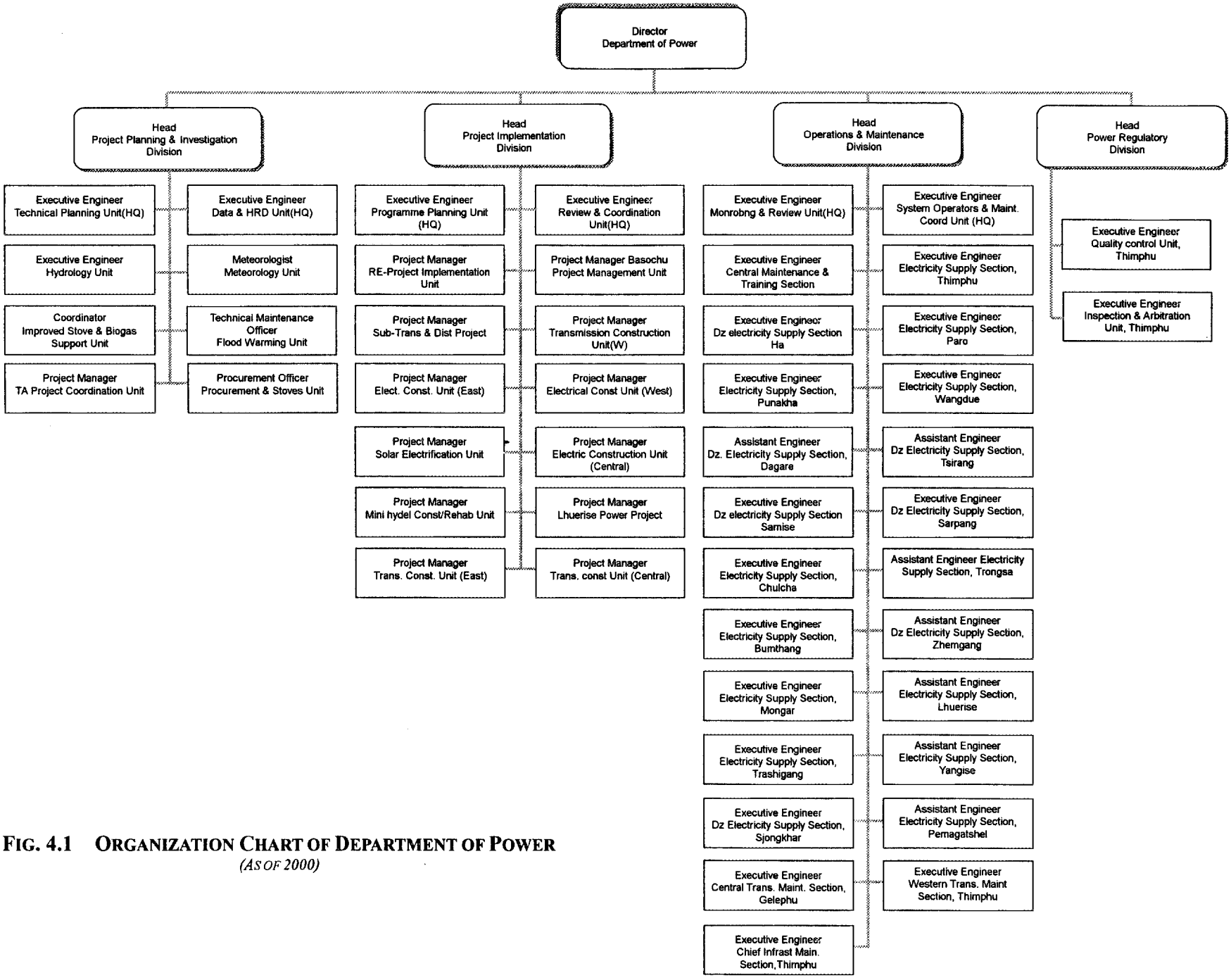


FIG. 4.1 ORGANIZATION CHART OF DEPARTMENT OF POWER

(AS OF 2000)

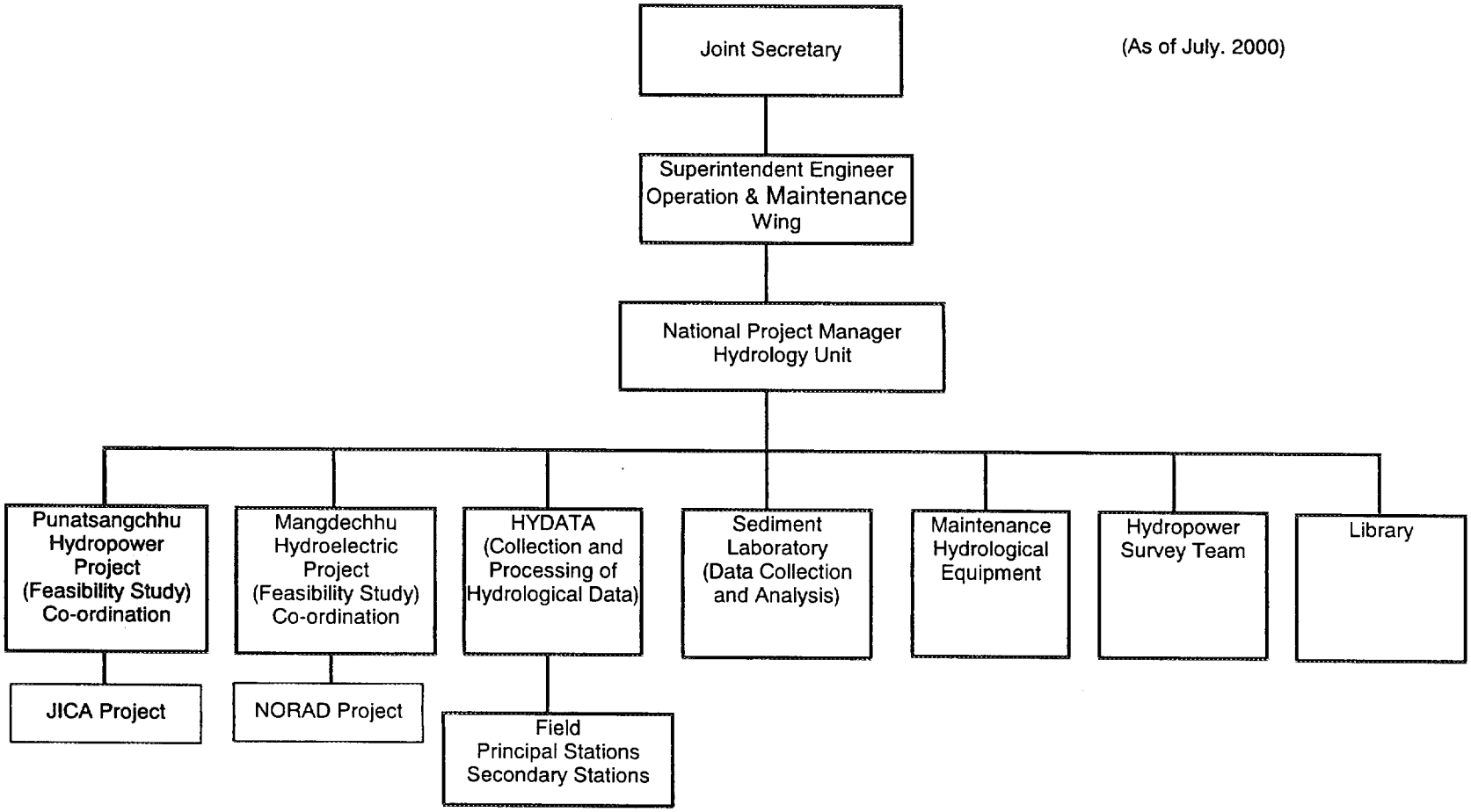


Fig. 4.2 Organization Chart of Punatsangchhu Hydropower Project

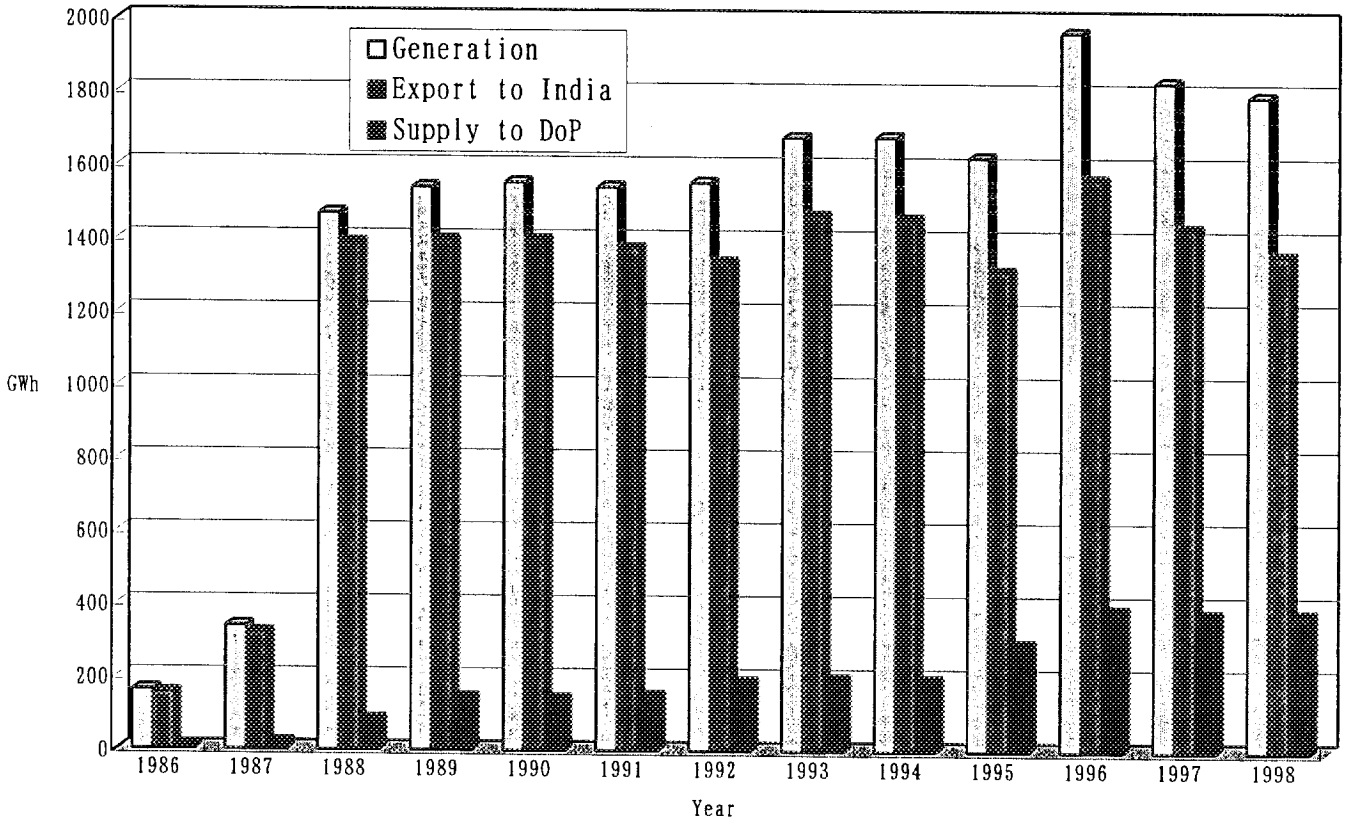


Fig. 4.3 Energy Generation of CHPC

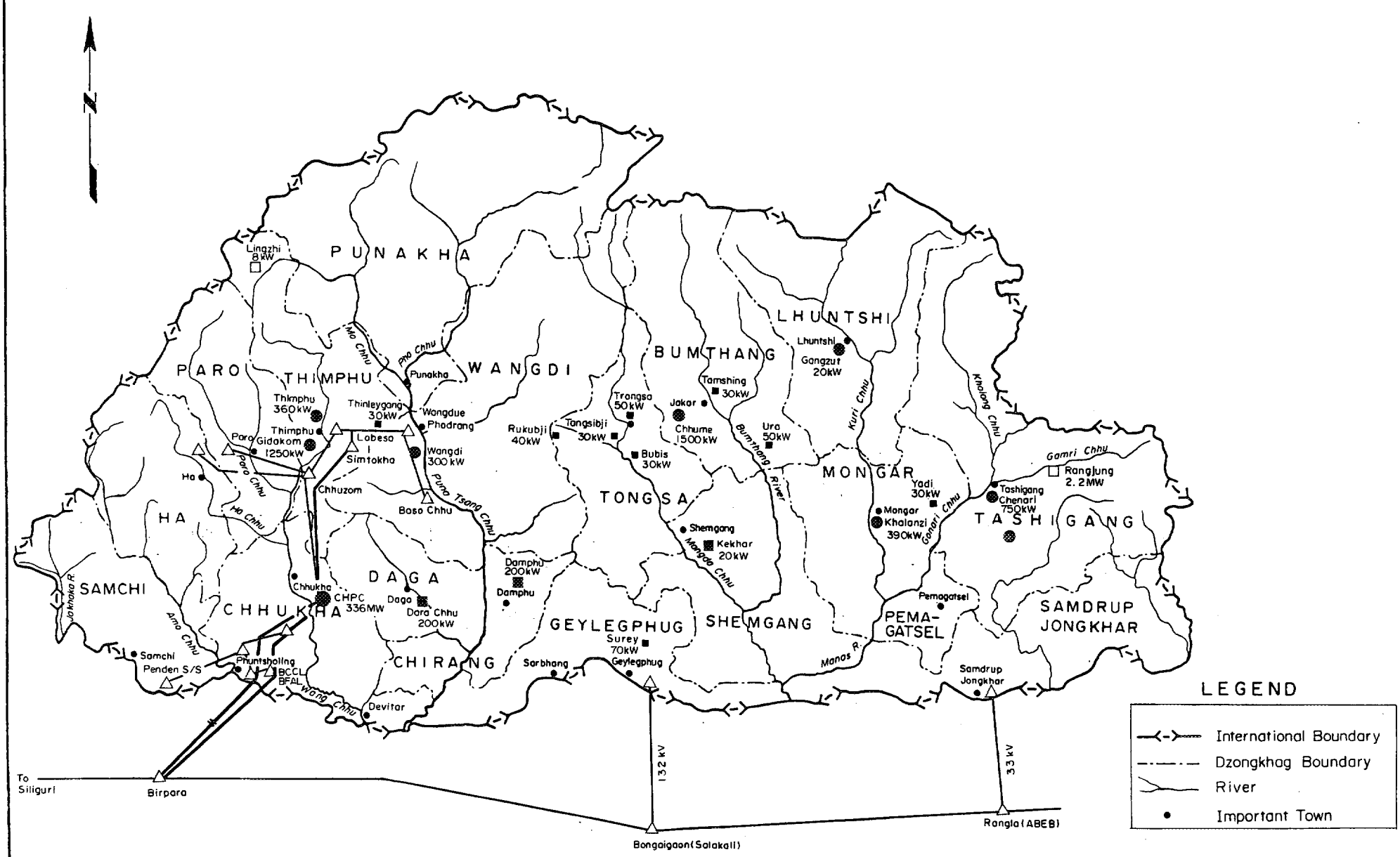


Fig. 4.4 Hydro Power Plants and Transmission Lines in 2000, Bhutan

Fig. 4.5 Peak Demand and Power Supply Position from 1997-98 to 1999-2000 ALL INDIA UTILITIES

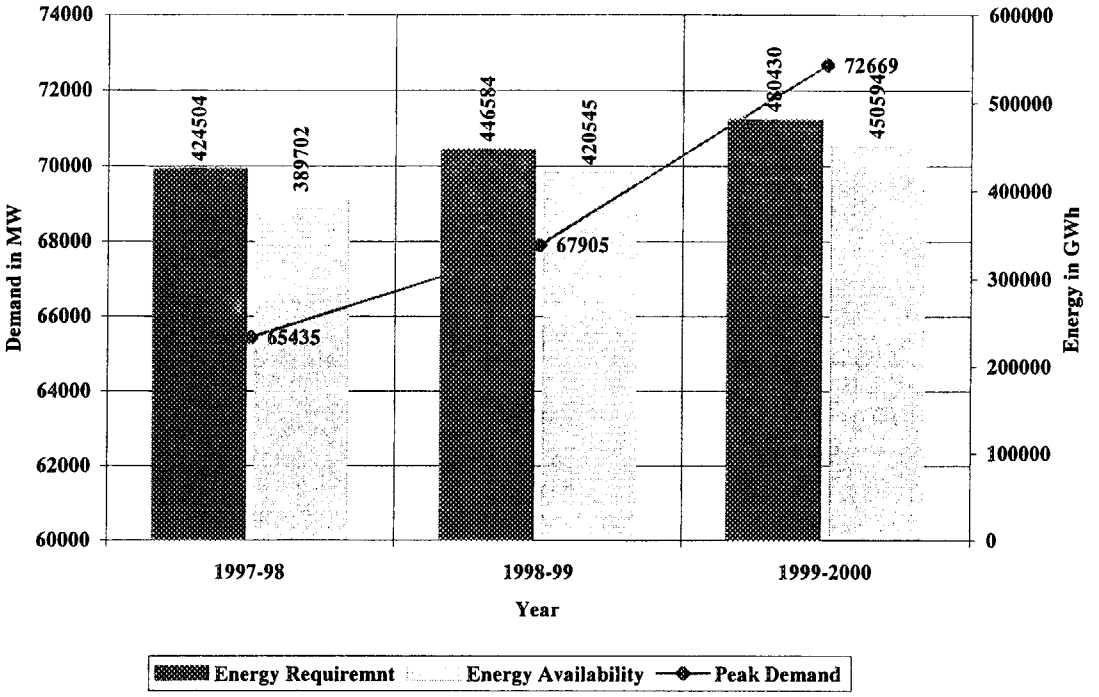


Fig. 4.6 Monthly Peak Load for the Year 1999-2000 ALL INDIA UTILITIES

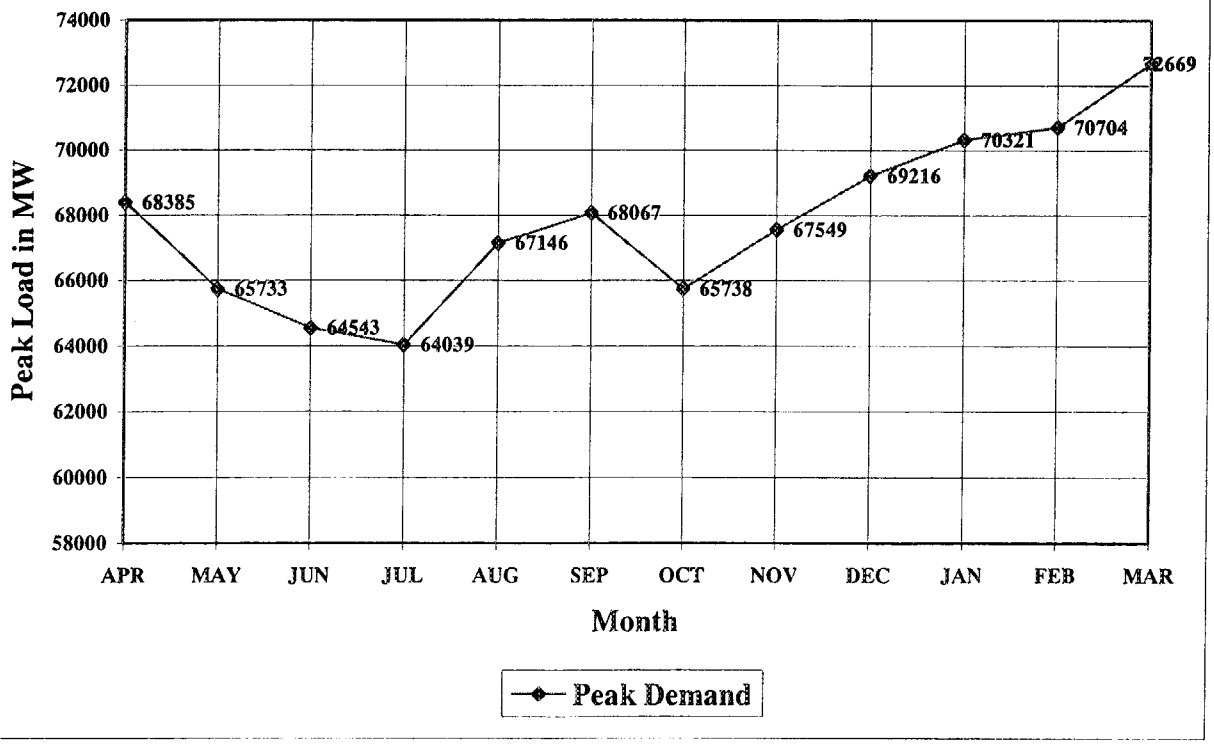


Fig. 4.7 Peak Demand and Power Supply Position from 1997-98 to 1999-2000, WEST BENGAL STATE

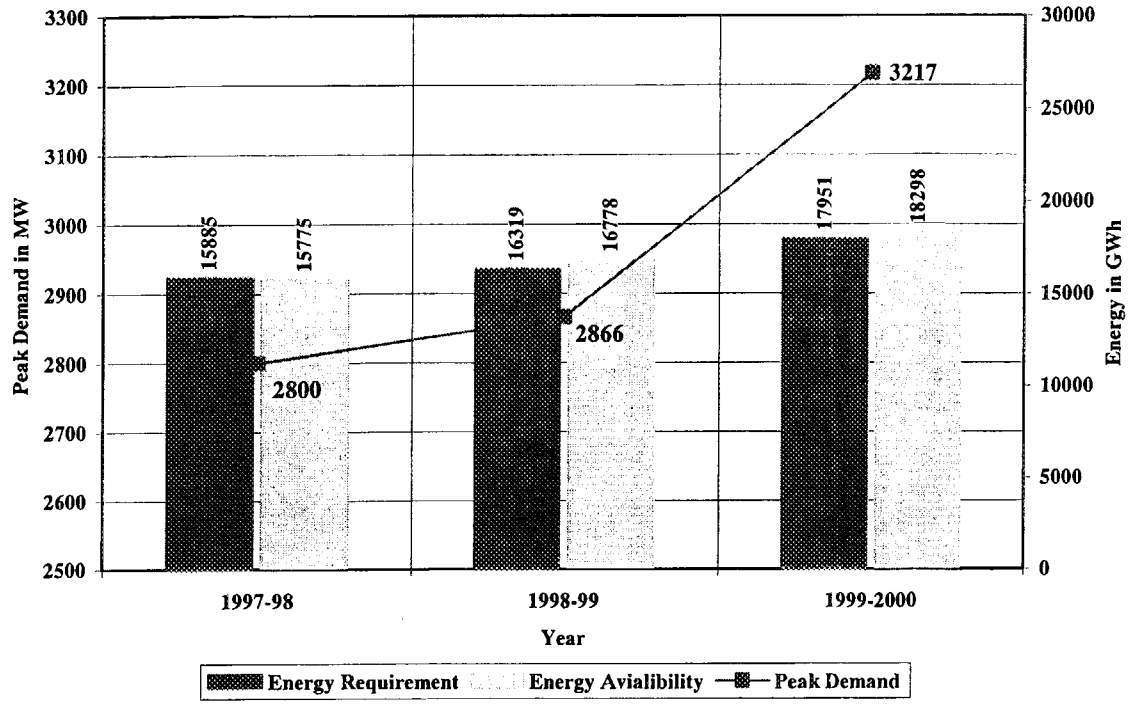
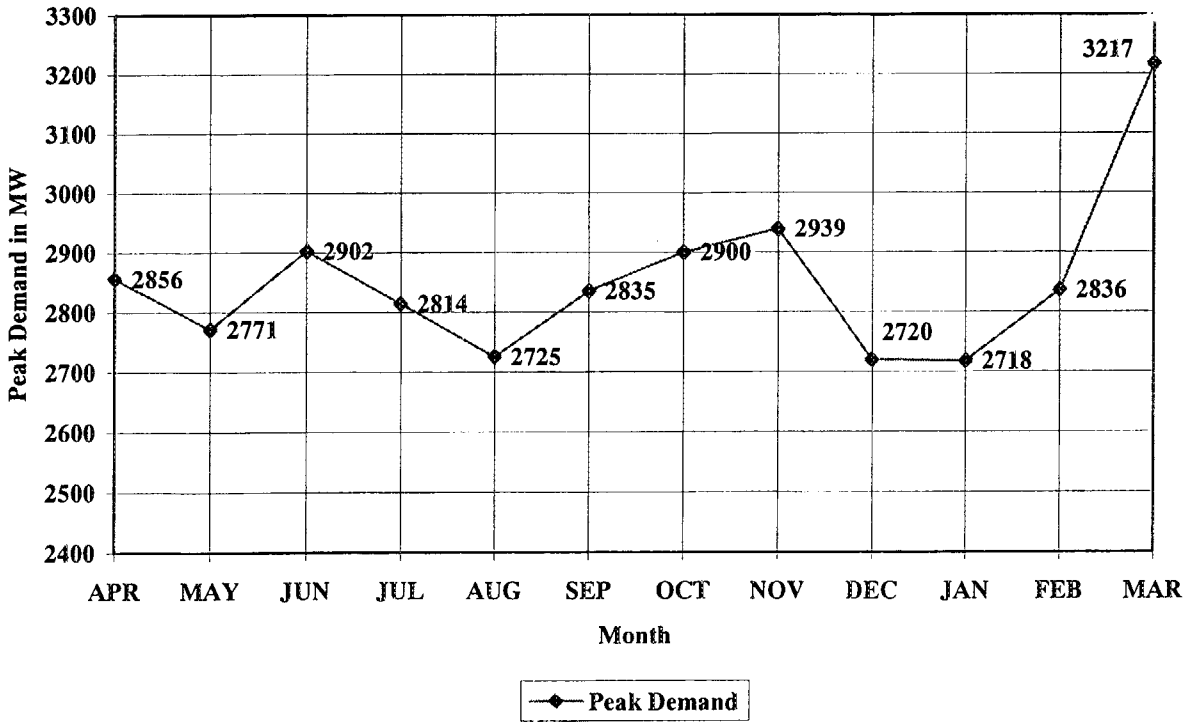
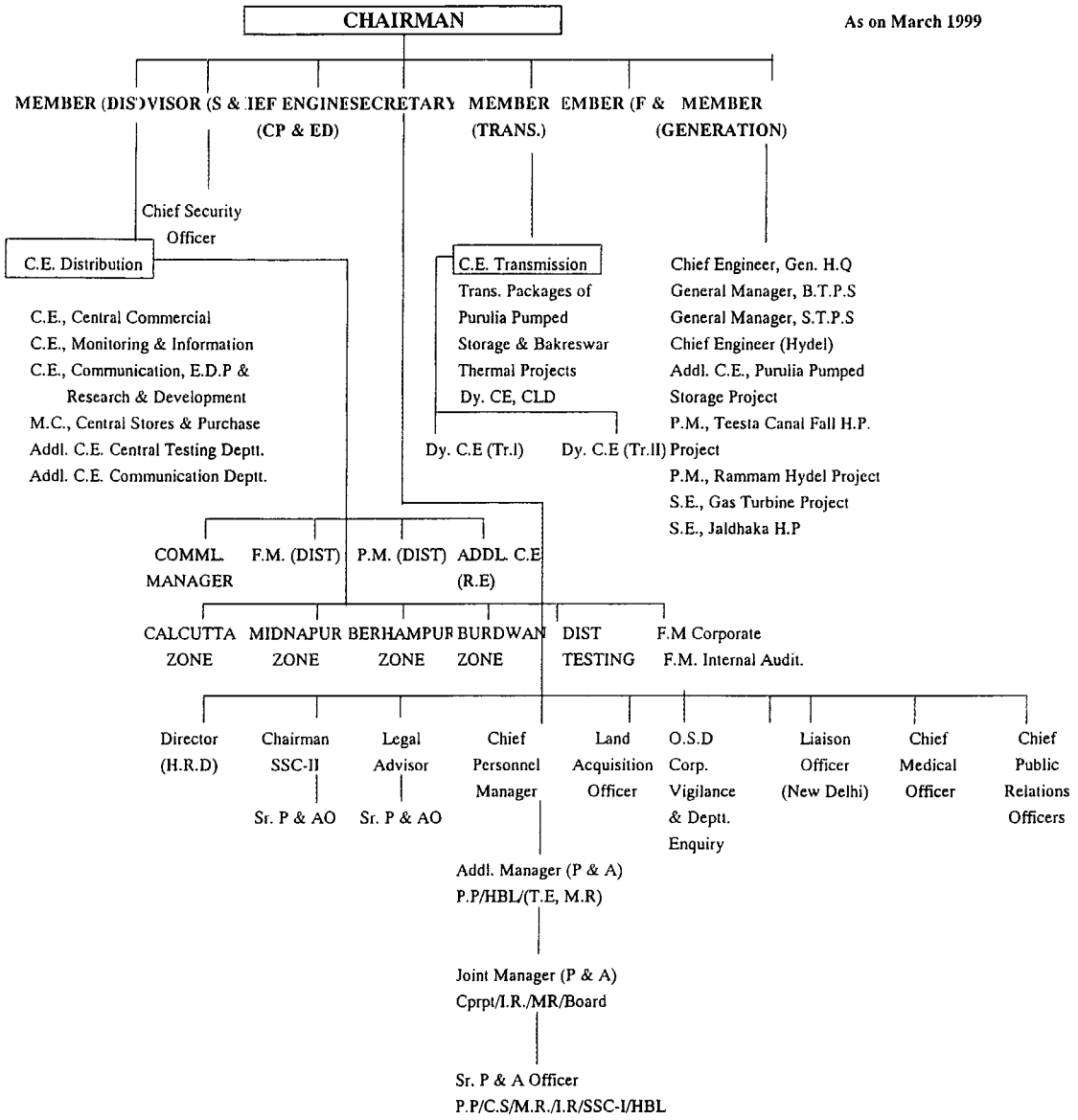


Fig. 4.8 Monthly Peak Demand for the Year 1999-2000 WEST BENGAL STATE





Shri S.R. Sikdar	Chairman
Shri. S.K. Ghosh	Member (Distribution)
Shri T.K. Das, IAS	Member (Finance & Accounts)
Shri. A.K. Bose	Member (Generation)
Shri. B.R. Biswas	Member (Transmission)
Shri. S.B. Barma, IAS	Secretary, Deptt. of Power, Govt. of West Bengal & Ex-Officio Member.
Shri A.K. Gupta, IAS	Principal Secretary, Deptt. of Finance, Govt. of West Bengal & Ex-Officio Member.
Shri D.Som, IAS	Secretary to the Board.

Fig. 4.9 ORGANISATION CHART OF WEST BENGAL STATE ELECTRICITY BOARD

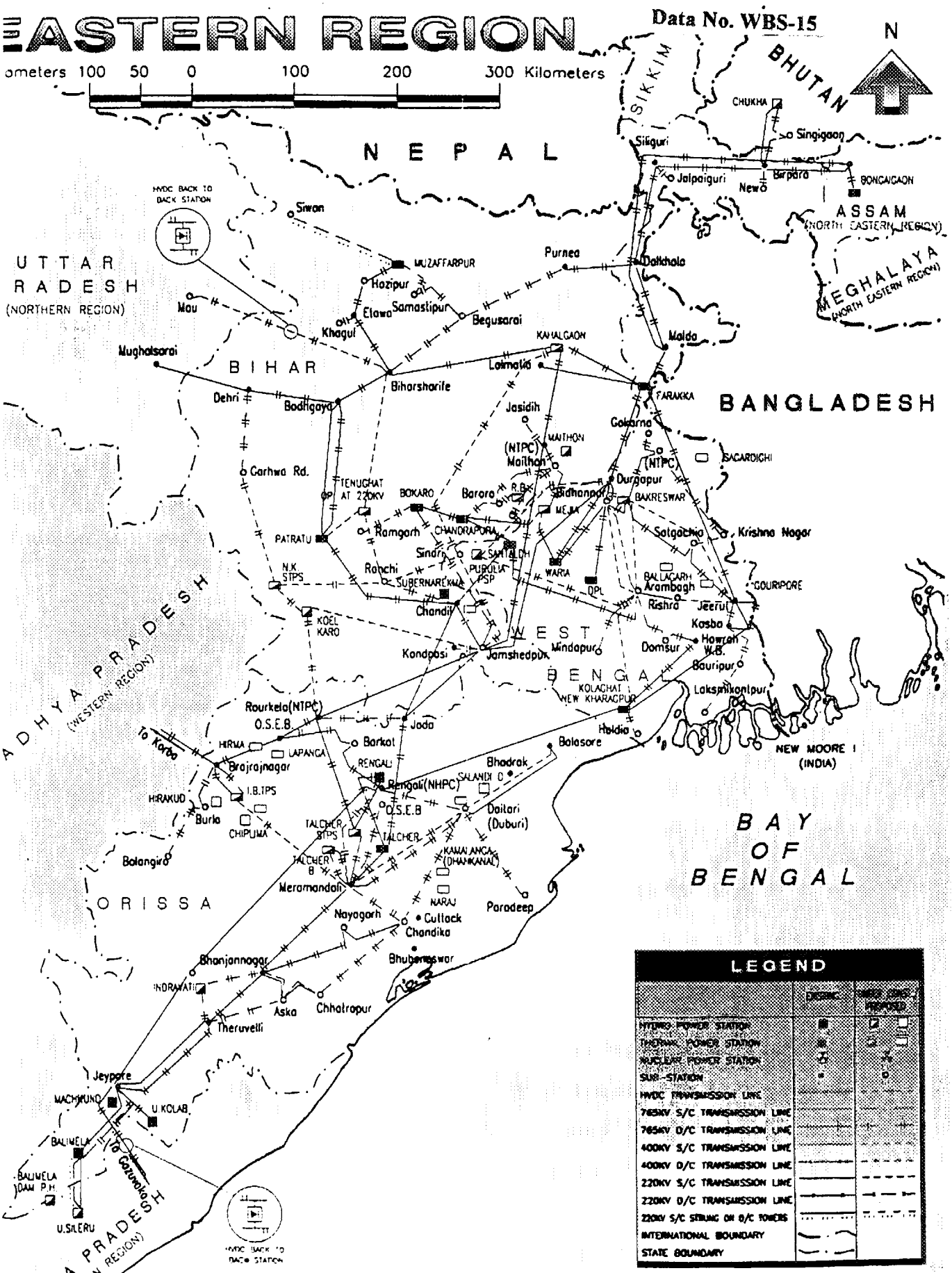


Fig.4.10 Power System Map of Eastern Region

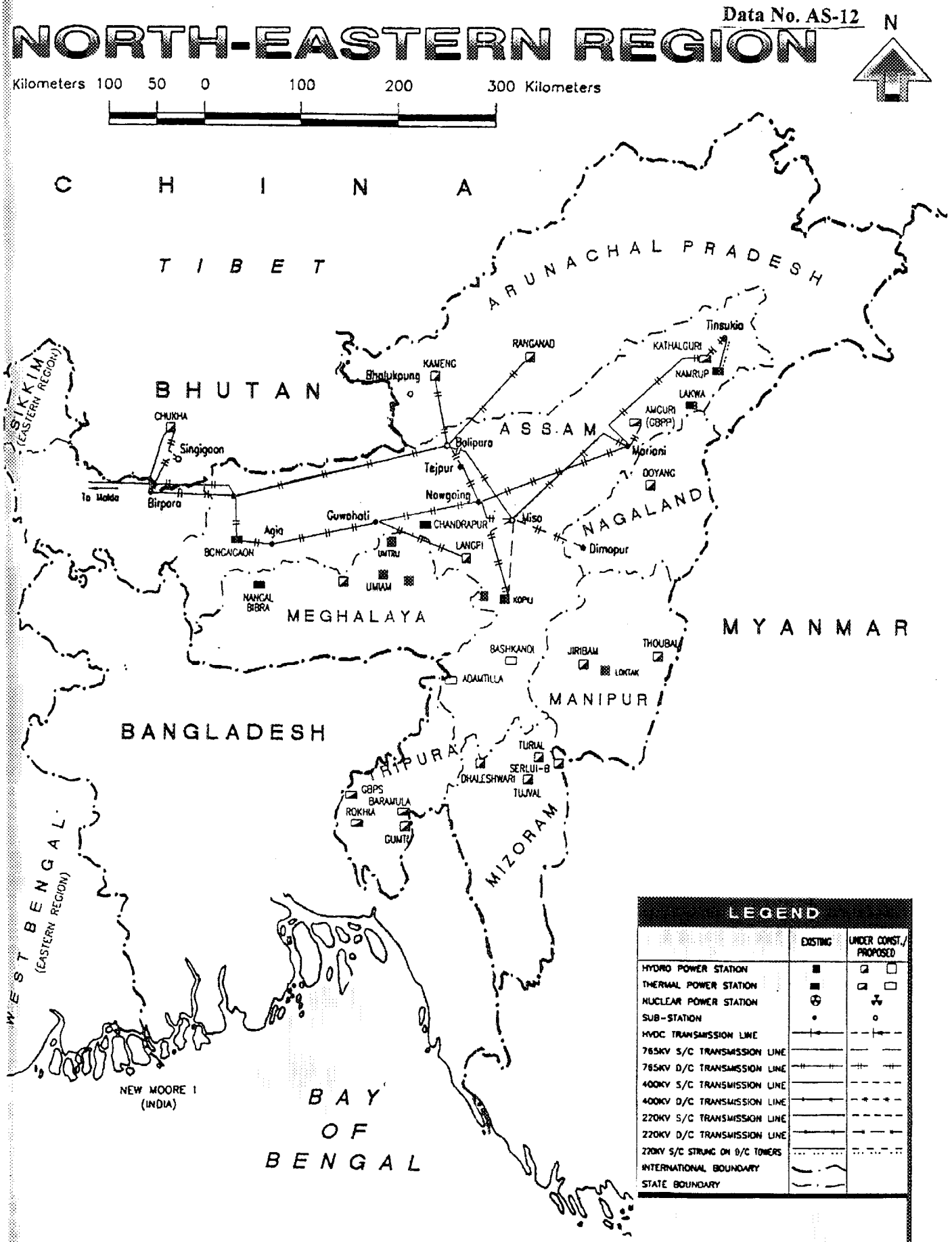


Fig.4.11 Power System Map of North-Eastern Region

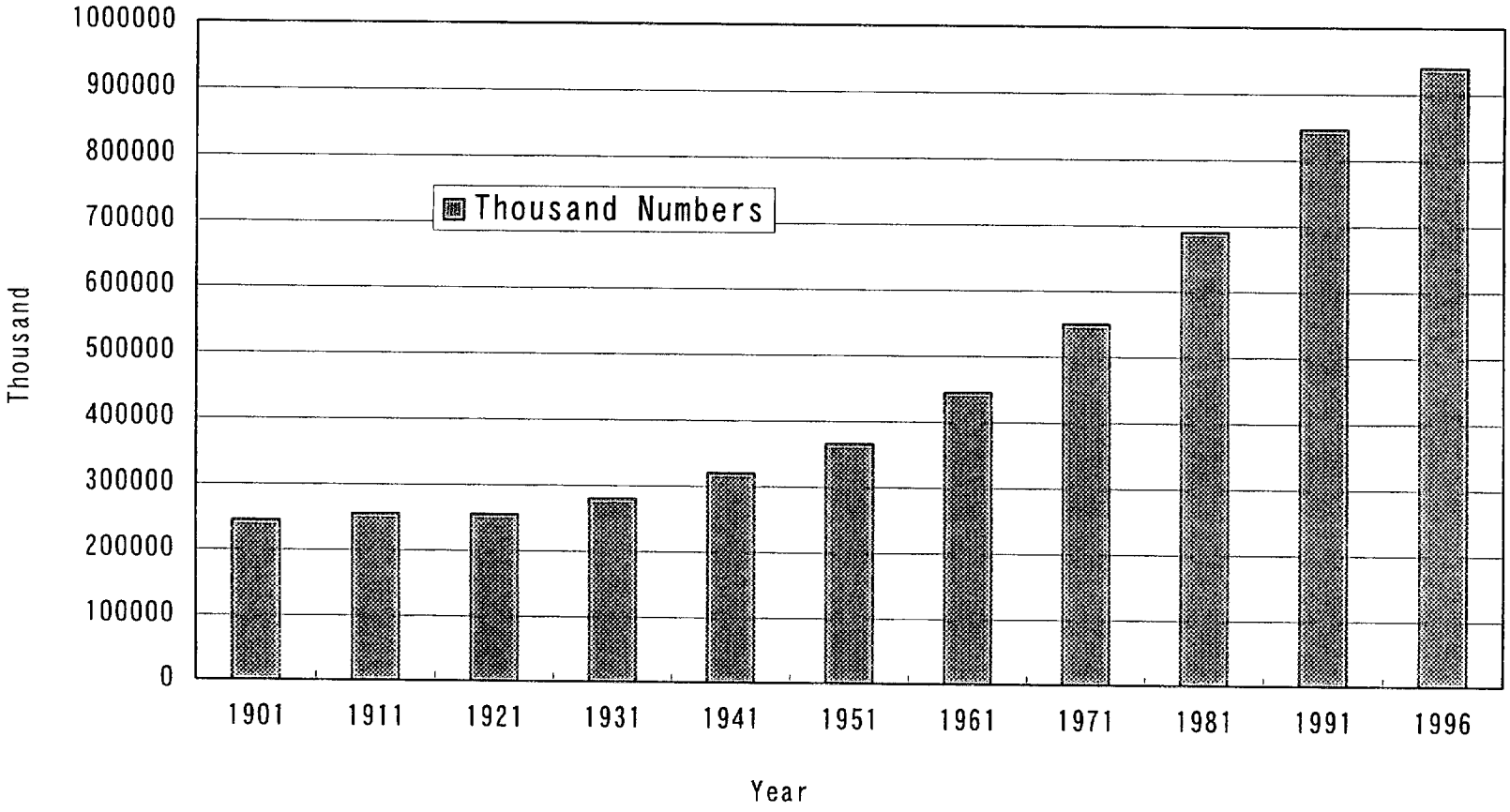


Fig. 4.12 Growth of Population by Census

CHAPTER 5

POWER DEMAND FORECAST AND SUPPLY

CONTENTS

5. POWER DEMAND FORECAST AND SUPPLY

5.1 Summary of Power Demand and Supply

Results of the survey revealed that Eastern region including West Bengal state is more advantageous than North-eastern region including Assam in the following points. It is concluded that 1) maximum consumption of Assam state is only 10% as compared with West Bengal state in spite of the highest growth rate of demand forecast in the 11th plan than other regions, 2) future plan for energy best mix: hydro and thermal power of the Eastern region including West Bengal state, 3) advanced energy policy of import power in West Bengal state. Considering the above mentioned points, the hydro power energy of Bhutan is exported to Eastern region including West Bengal state in order to reveal appropriateness and project position. Therefore, the load forecast and system analysis are carried out for West Bengal state. Scope of the power demand forecast covers all over the nation of Bhutan and West Bengal State of India. Study of power demand and supply balances in both regions up to 2020 are done and a capacity and commissioning year of the Punatsangchhu Project with the aim of exporting its generated energy to West Bengal State are discussed.

(1) Power Demand

Power demand forecast up to 2020 revealed that the peak power of 72 MW in 1996 will increase to 418 MW (515MW at high scenario) in 2020 and annual energy consumption also from 412G Wh to 2342 GWh. An annual average growth rate over the 24-years is 6.4 ~ 6.5%. On the other hand, in West Bengal State the peak power of 3,240 MW in 1996 will increase to 10,391 MW in 2020 and annual energy consumption also from 16,975 GWh to 54,616 GWh. An annual average growth rate over the 24-years is around 5.0%.

(2) Power Supply

It is possible to fill an increasing power demand in Bhutan between 2000 and 2020 by drawing gradually the generated energy of Chhukha (336 MW) exporting to West Bengal State and of the planned Basochhu (61 MW) and Kurichhu (60 MW) plants. On the other hand West Bengal State has to develop the new thermal power plants of 5,250 MW in capacity and 27,590 GWh in generating energy with the plant factor of 60%, under the condition to import the surplus energy of Chhukha (CHP), Basochhu and Kurichhu plants from Bhutan.

If Tala (1,020 MW) and Bunakha (180 MW) projects, which is planned in Bhutan for taking the place of a new power plant in West Bengal State, will be commissioned by 2009(10^{th} FYP), Punatsangchhu project (870 MW) will be needed to be commissioned in around 2010~11 for West Bengal State.

5.2 Method of Power Demand Forecast and Conditions

(1) Method of Forecast

To estimate the power demand, a macroscopic forecast method is used with regard to the comprehensive nationwide power demand. In this method, a certain fixed rule or tendency is derived from the past actual demand trend and then used to estimate the long-term nationwide power demand.

To this effect, the following three approximate equations are used in order to find out the correlation between the power consumption and economic potential.

1) The simple regression equation that is to be used when a linear correlation is found between the power demand and GDP.

2) The multi-regression equation that is to be used when a linear correlation is found among the power demand, population and GDP.

3) The parabolic regression equation that is to be used when a quadratic correlation is found between the power demand and GDP.

Out of the above regression equations, the most suitable one for the power demand pattern in the target country is to be selected.

(2) Conditions for Estimation

1) Bhutan

a) Time series data of GDP and energy consumption

Over the 12-years data between 1988 and 1999 are used (Ref. to Table 5.1).

1988~96: Records

1997~99: Expected data in the 8th-5year plan

b) Estimation of increased demand of new electrification households

Number of new electrification households is 1,000 per annum, which is based on a electrification rate of the records in the 7FYP and the electrification scheme in the 8FYP. The maximum power demand of a household is assumed to be 500W and its load factor is 40% and distribution losses factor is 11%.

c) Population data is not available and not used

d) Peak power

The peak power in the system is calculated based on the forecasted energy demand and the estimated load factor around 64~65% is used.

e) Estimation of GDP growth rate and sensibility analysis

The GDP growth rates estimated on the long-term development outlook by the Government of Bhutan are as follows.

8th-5 year Plan (1997~2002) : 6.8%

9th-5 year Plan (2002~2007) : 5.0%

10th-5 year Plan (2008~2012) : 4.5%

11th-5 year Plan (2013~2017) : 4.5%

The above growth rates are applied for as base case (i.e. middle scenario) and ±1.0% of which for a high scenario and a low scenario respectively for a sensitive analysis. After the year 2018 a growth rate of 3.5% is applied for the middle scenario. But 6.8% are applied for all scenarios by 2000.

2) West Bengal

a) Time series data of GDP, energy consumption and population

Over the 12-years data between 1985 and 1996 are used (Ref. to Table 5.1)

b) Peak power

The peak power is calculated based on the forecasted energy demand and the load factor of 60% that WAPCOS estimated in the long-term power demand forecast.

c) Estimation of GDP growth rate and sensitivity analysis

The GDP growth rates estimated in the long term Five-Year-Plan by the Government of India are as follows.

9th-5year Plan (1997~2001) : 4.29%

10th-5year Plan (2002~2007) : 4.75%

11th-5year Plan (2008~2012) : 5.31%

The above growth rates after the year 2001 are simplified to be 5.0 ~ 6.0% and applied for the middle scenario and ±1.0% of which are considered in a high scenario and a low scenario respectively as sensitivity analysis. After the year

2018 the growth rate of 3.5% is applied for the base scenario. But by 2000 same growth rate as 6.8% are used for all scenarios.

3) Period of demand forecast

The period of demand forecast in Bhutan and West Bengal State is over the 21-years from 2000 to 2020.

4) Regression equation

As a result of the above study, the simple regression equation shows the highest correlation coefficient and a linear correlation with GDP. The regression equations for Bhutan and West Bengal State are as follows:

Bhutan: $Y = -462.9233 + 0.28283 \times X1$ (R=0.987)

West Bengal $Y = 424.7220 + 0.05661 \times X1$ (R=0.994)

Where,

Y: Energy consumption (GWh)

X1: GDP (million Nu. in Bhutan and Rs. Core in India)

R: Correlation coefficient

5.3 Result of Power Demand Forecast

(1) Bhutan

Table 5.2 shows the results of power demand forecast of Bhutan by the scenario. Under the Middle scenario the peak power demand will grow from 72 MW in 1996 to 418 MW in 2020, and annual energy consumption from 412 GWh to 2,342 GWh. Expected average growth rate of power demand over the 24-years is 6.4% to 6.5% per annum. Fig. 5.1 illustrates the trend of energy consumption by the High, Middle and Low scenarios and Fig. 5.2 is the peak power demand trends.

In the case of the Middle scenario the energy consumption/GDP elasticity shows a gradual decrease from 1.56 in 2001 to 1.21 in 2020 (Table 5.2). As a general trend in developing countries, the energy consumption/GDP elasticity shows around 1.5 in early stage and maintains around 1.1 to 1.2 depending on the spread of electrification and industrialization around ten to twenty years later. Discussion about a suitable level of the energy consumption/GDP elasticity is not appropriate because a level of which is changeable and maintains its level at a certain range with the effect of the industrial structure and the national economic policy. In Bhutan it is expected that a high level of the elasticity with promoting the electrification under a suitable economic growth.

Fig. 5.3 shows the forecasted energy consumption/GDP elasticity trend of Bhutan, which also has the trend of West Bengal State. Large fluctuation of the elasticity trend is caused by unsettled or a short of energy supply, not by GDP trend. Power demands of the waiting consumers are restricted by the lack of energy supply. Energy market implies that increasing energy supplies, a power demand will grow and then the elasticity will rise. Similarly, decreasing energy supplies, the elasticity will drop. It is not reasonable to evaluate the level of the energy consumption/GDP elasticity only for a few years.

(2) West Bengal

Table 5.3 shows the results of power demand forecast of West Bengal State by the scenario. Under the Middle scenario the peak power demand will grow from 3,240 MW in 1996 to 10,391 MW in 2020, and annual energy consumption from 16,975 GWh to 54,616 GWh. Expected average growth rate of power demand over the 24-years is 5.04% per annum. Fig. 5.4 illustrates the trend of energy consumption by the High, Middle and Low scenarios and Fig. 5.5 illustrates the peak demand trends.

In the case of the Middle scenario the energy consumption/GDP elasticity shows almost constant level, 0.98 to 0.99, after 1998 (Table 5.3 and Fig.5.3). The energy consumption/GDP elasticity of West Bengal State between 1980 and 1990 showed below 1.0 for a few years. Which is function of the chronic energy shortage, not by the industrial structure. The characteristics of regression equations have the past trend and the expected elasticity after 2000 also shows the same trend as below 1.0 (0.98 to 0.99). Supplying enough energy to meet a demand, it is expected that the elasticity will maintain the normal level of 1.0 to 1.2.

5.4 Plan of Power Supply

(1) Hydropower Project in Bhutan

Hydropower projects currently planned in Bhutan are listed in Table 5.4. These projects are with the aim of exporting their generated energy to India in respect of their big capacities. Study of power demand and supply balance for a long term is done on the condition that all projects will be commissioned according to the schedule.

(2) Demand and Supply in Bhutan

Study of power demand and supply balance in Bhutan is done based on the following assumptions.

1) The existing power plants of DoP shall be able to maintain their output as of 1996 from now on.

2) Chhukha(CHP) and the new power plants listed in Table 5.4 have priority to consume their generated energy in Bhutan and surplus of which shall be exported to West Bengal State.

3) Commissioning month of the new power plants is the middle of year (i.e. in July) except Basochuu (in January) and Kurichhu (in February).

4) Mini-hydro power plants of a several hundred kW to 1.0 MW sizes are excluded from the power supply source.

5) Energy importing from India for Boarder area in Bhutan, which is equivalent to 1.85% of total energy consumption of Bhutan in 1996, is not counted in the energy balance of India, but the Boarder area shall be supplied from Bhutan's own source.

As a result, the peak power balance is shown in Table 5.5 and the energy balance in Table 5.6. CHP (336 MW), Basochhu (61 MW) and Kurichhu (60 MW) will be able to supply electricity to meet the peak power demand of 418 MW and the energy consumption of 2,342 GWh in 2020. The big projects as Tala, Bunakha and Punatsangchhu, which is scheduled to commission around 2010, are for exporting all their generated energy to West Bengal State. Specific commissioning years of these three projects have to be studied with considering the demand and supply balance in West Bengal State.

(3) Demand and supply in West Bengal State

Study of the power demand and supply balance in West Bengal State is done based on the following assumptions.

1) The existing power plants of West Bengal State shall be able to maintain their output as of 1997 from now on.

2) West Bengal State shall be allowed to import continuously the same energy as the amount of import in 1995 from Bhutan and count them in its energy balance. But energy consumption in Bhutan shall be excluded.

3) CHP and the new power plants listed in Table 5.4 shall have priority to supply their generated energy for Bhutan and surplus of which shall be imported to West Bengal State.

4) A year when the electric energy will be shortage in West Bengal, a new thermal power plant shall be set in West Bengal State, the function of which shall be 210 MW/unit and 1,105 GWh/annum under the operation with plant factor of 60%.

5) Commissioning month of the new power plants shall be January in the said year.

6) The energy balance is studied but the peak power balance is not done because it is difficult to fix the exact output of power plants in West Bengal State.

As a result, the energy balance is shown in Table 5.7. Increased energy consumption from 19,602 GWh in 1999 to 54,616 GWh in 2020 is about 35,000 GWh. 7,900 GWh of which will be able to import from Bhutan and the balance of 27,100 GWh have to be supplied from new thermal power plants in West Bengal State. A required capacity of the new power plants to meet the said energy supplies is about 5,250 MW. The new thermal power plants to commission between 2000 to 2005 is 1,260 MW (210 MW × 6 units), considering that Tala, Bunak and Punatsangchhu projects are scheduled to commission after 2006. After 2012 as three big projects in Bhutan will be over, the new thermal power plants will be required and capacity of which is about 3,990 MW (210 MW × 19 units). In Table 5.7, item "Wh-balance" shows the sign of "minus", but amount of which is 0.05 to 1.7% of annual energy consumption and it will be the range of narrow demand fluctuation and implying a tight balance of energy.

(4) Commissioning Year of the Big Projects in Bhutan

The big projects, Tala, Bunakha and Punatsangchhu, should be commissioned in steps to meet the energy demand and supply balance in West Bengal State. The latest DOP plan shows that Tala is scheduled to commission in 2006 and Bunakha is under the 10FYP (2008 to 2012). After the both projects are developed in steps, Punatsangchhu have to be commissioned in two-steps for the balance of energy. That is to commission the 3-units (145 W × 3 = 435 MW) in 2010 as the first step and the other 3-units (145 MW × 3 units = 435 MW) in 2011 as the second step. In case of that West Bengal State will develop new power plants or be able to expect to purchase the required energy from other states, it will be allowed to delay the commissioning years of these projects in view of the demand and supply balance.

Mangdechhu project (600 MW) is listed in implementation program of the DoP plan in the future, but it is not counted in this demand and supply balance study due to unknown the commissioning year and probably to develop after Punatsangchhu project. Growth of power demand implies that this project will be able to develop after 2012 in view of the energy balance, but the implementation schedule will be limited due to many big projects will concentrated in near 2010.

Table 5.1 **Input Data for Power Demand Forecast**

No. of data	Year	Bhutan			West Bemgal		
					W.Bengal	Whole India	Whole India
		Energy.req. (GWh)	GDP (mil.Nu)	Population	Energy.req. (GWh)	GDP (mil.Nu)	Population (1,000)
1	1985	n.a	n.a	n.a	9,425	156,566	756,500
2	1986	n.a	n.a	n.a	9,700	166,391	770,780
3	1987	n.a	n.a	n.a	10,560	176,832	785,320
4	1988	143.000	1,993.6	n.a	11,026	187,928	800,140
5	1989	142.341	2,087.1	n.a	11,494	199,720	815,240
6	1990	161.619	2,224.6	n.a	11,982	212,253	830,630
7	1991	186.699	2,303.4	n.a	12,491	213,983	846,302
8	1992	195.256	2,406.6	n.a	13,352	225,240	867,818
9	1993	198.496	2,553.3	n.a	14,625	239,145	883,910
10	1994	298.161	2,716.1	n.a	15,126	257,700	899,953
11	1995	390.433	2,920.1	n.a	16,025	276,132	915,964
12	1996	411.640	3,109.0	600,000	16,975	296,845	939,540
13	1997	462.182	3,286.2	n.a	-	-	-
14	1998	524.766	3,453.6	n.a	-	-	-
15	1999	595.867	3,705.5	n.a	-	-	-

Table 5.2 **Power Demand Forecast of Bhutan**

Year	Low		Middle		Hight		Elasticity of Energy to GDP
	Energy (GWh)	Peak (MW)	Energy (GWh)	Peak (MW)	Energy (GWh)	Peak (MW)	
1991	187	22	187	22	187	22	4.38
1992	195	23	195	23	195	23	1.02
1993	198	33	198	33	198	33	0.27
1994	298	70	298	70	298	70	7.87
1995	390	70	390	70	390	70	4.12
1996	**412**	**72**	**412**	**72**	**412**	**72**	**0.84**
1997	462	81	462	81	462	81	2.15
1998	525	92	525	92	525	92	2.66
1999	596	105	596	105	596	105	1.86
2000	678	119	678	119	678	119	1.79
2001	739	130	750	132	761	134	1.56
2002	803	141	827	145	851	149	1.51
2003	854	150	891	157	930	163	1.56
2004	906	159	959	168	1,013	178	1.52
2005	961	169	1,030	181	1,102	194	1.48
2006	1,011	177	1,097	193	1,188	209	1.45
2007	1,062	187	1,167	205	1,278	225	1.42
2008	1,115	196	1,240	218	1,374	241	1.39
2009	1,171	206	1,317	231	1,475	259	1.37
2010	1,228	216	1,397	245	1,582	278	1.35
2011	1,287	226	1,481	260	1,694	297	1.33
2012	1,348	237	1,568	275	1,812	318	1.31
2013	1,411	248	1,659	291	1,937	340	1.29
2014	1,477	259	1,755	308	2,069	363	1.28
2015	1,545	271	1,854	326	2,209	388	1.26
2016	1,615	284	1,959	344	2,355	414	1.25
2017	1,687	296	2,067	363	2,510	441	1.24
2018	1,741	306	2,156	379	2,644	464	1.22
2019	1,796	315	2,248	395	2,784	489	1.21
2020	**1,853**	**325**	**2,342**	**418**	**2,930**	**515**	**1.21**

Table 5.3 **Power Demand Forecast of West Bengal**

Year	Low		Middle		Hight		Elasticity of Energy to GDP
	Energy (GWh)	Peak (MW)	Energy (GWh)	Peak (MW)	Energy (GWh)	Peak (MW)	
1991	12,491	1,842	12,491	1,842	12,491	1,842	5.21
1992	13,352	1,992	13,352	1,992	13,352	1,992	1.31
1993	14,625	2,574	14,625	2,574	14,625	2,574	1.54
1994	15,126	2,788	15,126	2,788	15,126	2,788	0.44
1995	16,025	3,016	16,025	3,016	16,025	3,016	0.83
1996	**16,975**	**3,240**	**16,975**	**3,240**	**16,975**	**3,240**	**0.79**
1997	17,986	3,422	17,986	3,422	17,986	3,422	1.32
1998	18,776	3,572	18,776	3,572	18,776	3,572	0.98
1999	19,602	3,729	19,602	3,729	19,602	3,729	0.98
2000	20,465	3,894	20,465	3,894	20,465	3,894	0.98
2001	21,166	4,027	21,367	4,065	21,567	4,103	0.98
2002	21,996	4,185	22,414	4,264	22,835	4,345	0.98
2003	22,859	4,349	23,513	4,474	24,180	4,600	0.98
2004	23,756	4,520	24,667	4,693	25,605	4,872	0.98
2005	24,689	4,697	25,880	4,924	27,116	5,159	0.98
2006	25,660	4,882	27,152	5,166	28,718	5,464	0.98
2007	26,669	5,074	28,489	5,420	30,415	5,787	0.98
2008	27,850	5,299	30,032	5,714	32,365	6,158	0.99
2009	29,084	5,534	31,661	6,024	34,441	6,553	0.99
2010	30,374	5,779	33,379	6,351	36,652	6,973	0.99
2011	31,722	6,035	35,191	6,695	39,007	7,421	0.99
2012	33,130	6,303	37,103	7,059	41,514	7,898	0.99
2013	34,438	6,552	38,937	7,408	43,980	8,368	0.99
2014	35,799	6,811	40,863	7,775	46,593	8,865	0.99
2015	37,214	7,080	42,885	8,159	49,363	9,392	0.99
2016	38,685	7,360	45,008	8,563	52,300	9,950	0.99
2017	40,216	7,651	47,237	8,987	55,412	10,543	0.99
2018	41,807	7,954	49,577	9,433	58,711	11,170	0.99
2019	43,463	8,269	52,035	9,900	62,208	11,836	0.99
2020	**45,184**	**8,597**	**54,616**	**10,391**	**65,916**	**12,541**	**0.99**

Table 5.4 Hydro Power Project of Bhutan

Year	Name of Project	Out Put (MW)	Unit cap. (MW)	Unit	Generation (GWh)	Accumulate (MW)	Accumulate (GWh)
2000							
2001	Basochu	61	61	1	291	61	291
2002	Kurichu	60	60	1	322	121	613
2003						121	613
2004						121	613
2005						121	613
2006	Tala (1,2)	340	170	2	1,320	461	1,933
2007	Tala (3,4)	340	170	2	1,320	801	3,253
2008	Tala (5,6)	340	170	2	1,320	1,141	4,573
2009	Bunakha	180	180	1	688	1,321	5,261
2010	Punatsang (1,2,3)	435	145	3	2,165	1,756	7,426
2011	Punatsang (4,5,6)	435	145	3	2,165	2,191	9,591
2012							
Total	-	2,191	-	-	9,591	-	-

Table 5.5 Peak Power Demand and Supply Balance of Bhutan

(MW)

Year	Demand & Supply Balance in DOP network					Supply from CHP & New Plants				Surplus for W.Beng.	New Plants (Big size) for W.Bengal				Total surplus (New plants +Surplus)
	Peak Demand (Middle)	Supply			Balance	CHP (336)	Baso. (61)	Kuric. (45)	Total		Tala (1,020)	Bunakha (180)	Mangdech. (425)	Punatsa. (760)	Total	
		Hydro	Diesel	Total												
	①			②	③=②-①				④	⑤=③+④					⑥	⑦=⑤+⑥
1995	70	8	12	21	-50	336			336	286						286
1996	72	8	12	21	-51	336			336	285						285
1997	81	8	12	21	-61	336			336	275						275
1998	92	8	12	21	-72	336			336	264						264
1999	105	8	12	21	-84	336			336	252						252
2000	119	8	12	21	-98	336			336	238						238
2001	132	8	12	21	-111	336	61	60	457	346						346
2002	145	8	12	21	-125	336	61	60	457	332						332
2003	157	8	12	21	-136	336	61	60	457	321						321
2004	168	8	12	21	-148	336	61	60	457	309						309
2005	181	8	12	21	-160	336	61	60	457	297						297
2006	193	8	12	21	-172	336	61	60	457	285	340				340	625
2007	205	8	12	21	-184	336	61	60	457	273	680				680	953
2008	218	8	12	21	-197	336	61	60	457	260	1,020				1,020	1,280
2009	231	8	12	21	-211	336	61	60	457	246	1,020	180			1,200	1,446
2010	245	8	12	21	-225	336	61	60	457	232	1,020	180		435	1,635	1,867
2011	260	8	12	21	-239	336	61	60	457	218	1,020	180		870	2,070	2,288
2012	275	8	12	21	-255	336	61	60	457	202	1,020	180		870	2,070	2,272
2013	291	8	12	21	-271	336	61	60	457	186	1,020	180		870	2,070	2,256
2014	308	8	12	21	-288	336	61	60	457	169	1,020	180		870	2,070	2,239
2015	326	8	12	21	-305	336	61	60	457	152	1,020	180		870	2,070	2,222
2016	344	8	12	21	-323	336	61	60	457	134	1,020	180		870	2,070	2,204
2017	363	8	12	21	-342	336	61	60	457	115	1,020	180		870	2,070	2,185
2018	379	8	12	21	-358	336	61	60	457	99	1,020	180		870	2,070	2,169
2019	395	8	12	21	-374	336	61	60	457	83	1,020	180		870	2,070	2,153
2020	418	8	12	21	-397	336	61	60	457	60	1,020	180		870	2,070	2,130

Note:
( ): Installation capacity(MW)

Table 5.6 Energy Demand and Supply Balance of Bhutan

(GWh)

Year	Balance in DOP network					CHP & New Plants					Surplus in Bhu. to W.Beng.	New Plants (Big size)					Total surplus (New plants +Surplus)
	Energy Demand (Middle)	Supply			Balance	Supply											
		Hydro	Diesel	Total		CHP (1,660)	Adjusting	Baso. (291)	Kuric. (322)	Total		Tala (3,962)	Bunakha (688)	Mangdech. (1,800)	Punatsa. (4,395)	Total	
	①			②	③=②-①					④	⑤=③+④					⑥	⑦=⑤+⑥
1995	390	7.50	0.06	7.56	-383	1,965	-18			1,947	1,564						1,564
1996	412	10.25	0.07	10.32	-401	1,828	3			1,831	1,430						1,430
1997	462	10.25	0.07	10.32	-452	1,828				1,828	1,376						1,376
1998	525	10.25	0.07	10.32	-514	1,828				1,828	1,314						1,314
1999	596	10.25	0.07	10.32	-586	1,828				1,828	1,242						1,242
2000	678	10.25	0.07	10.32	-668	1,828				1,828	1,160						1,160
2001	750	10.25	0.07	10.32	-740	1,828		291		2,119	1,379						1,379
2002	827	10.25	0.07	10.32	-817	1,828		291	295	2,414	1,598						1,598
2003	891	10.25	0.07	10.32	-881	1,828		291	322	2,441	1,560						1,560
2004	959	10.25	0.07	10.32	-949	1,828		291	322	2,441	1,492						1,492
2005	1,030	10.25	0.07	10.32	-1,020	1,828		291	322	2,441	1,421						1,421
2006	1,097	10.25	0.07	10.32	-1,087	1,828		291	322	2,441	1,354	660				660	2,014
2007	1,167	10.25	0.07	10.32	-1,157	1,828		291	322	2,441	1,284	1,980				1,980	3,264
2008	1,240	10.25	0.07	10.32	-1,230	1,828		291	322	2,441	1,211	3,300				3,300	4,511
2009	1,317	10.25	0.07	10.32	-1,307	1,828		291	322	2,441	1,134	3,960	344			4,304	5,438
2010	1,397	10.25	0.07	10.32	-1,387	1,828		291	322	2,441	1,054	3,960	688		1,083	5,731	6,785
2011	1,481	10.25	0.07	10.32	-1,470	1,828		291	322	2,441	971	3,960	688		3,248	7,896	8,866
2012	1,568	10.25	0.07	10.32	-1,558	1,828		291	322	2,441	883	3,960	688		4,330	8,978	9,861
2013	1,659	10.25	0.07	10.32	-1,649	1,828		291	322	2,441	792	3,960	688		4,330	8,978	9,770
2014	1,755	10.25	0.07	10.32	-1,744	1,828		291	322	2,441	697	3,960	688		4,330	8,978	9,675
2015	1,854	10.25	0.07	10.32	-1,844	1,828		291	322	2,441	597	3,960	688		4,330	8,978	9,575
2016	1,959	10.25	0.07	10.32	-1,948	1,828		291	322	2,441	493	3,960	688		4,330	8,978	9,471
2017	2,067	10.25	0.07	10.32	-2,057	1,828		291	322	2,441	384	3,960	688		4,330	8,978	9,362
2018	2,156	10.25	0.07	10.32	-2,146	1,828		291	322	2,441	295	3,960	688		4,330	8,978	9,273
2019	2,248	10.25	0.07	10.32	-2,237	1,828		291	322	2,441	204	3,960	688		4,330	8,978	9,182
2020	2,342	10.25	0.07	10.32	-2,332	1,828		291	322	2,441	109	3,960	688		4,330	8,978	9,087

Table 5.7 Energy Demand and Supply Balance of West Bengal

(GWh)

Year	Balance in West Bengal							Increase of Balance	Requirement of new power plants equivalent to thermal p.plant 210MW/unit Utility factor= 0.60				
	Energy Demand (Middle)	Supply				Total Available	Balance		Capacity (MW)	Accumulate of MW	Gneration (GWh)	Accumulate of GWh	Wh Balance (GWh)
		Gen.	Purchese										
			India	Bhutan	Total								
	①	②			③	④=②+③	⑤=④-①					⑥	⑦=⑤+⑥
1995	16,025	12,798	3,393	1,564	4,957	17,755	1,731						
1996	16,975	13,898	3,393	1,430	4,823	18,721	1,746						
1997	17,986	15,000	3,393	1,376	4,769	19,769	1,783						
1998	18,776	15,000	3,393	1,314	4,707	19,707	931						
1999	**19,602**	**15,000**	**3,393**	1,242	**4,635**	**19,635**	**34**						
2000	20,465	15,000	3,393	1,160	4,553	19,553	-912	945	210	210	1,104	1,104	192
2001	21,367	15,000	3,393	1,379	4,772	19,772	-1,594	683	210	420	1,104	2,208	613
2002	22,414	15,000	3,393	1,598	4,991	19,991	-2,423	829	210	630	1,104	3,311	888
2003	23,513	15,000	3,393	1,560	4,953	19,953	-3,560	1,137	210	840	1,104	4,415	855
2004	24,667	15,000	3,393	1,492	4,885	19,885	-4,782	1,222	210	1,050	1,104	5,519	737
2005	25,880	15,000	3,393	1,421	4,814	19,814	-6,065	1,283	210	1,260	1,104	6,623	557
2006	27,152	15,000	3,393	2,014	5,407	20,407	-6,745	680		1,260		6,623	-123
2007	28,489	15,000	3,393	3,264	6,657	21,657	-6,832	86		1,260		6,623	-209
2008	30,032	15,000	3,393	4,511	7,904	22,904	-7,128	297		1,260		6,623	-506
2009	31,661	15,000	3,393	5,438	8,831	23,831	-7,829	701	210	1,470	1,104	7,726	-103
2010	33,379	15,000	3,393	6,785	10,178	25,178	-8,201	371		1,470		7,726	-475
2011	35,191	15,000	3,393	8,866	12,259	27,259	-7,932	-269		1,470		7,726	-206
2012	37,103	15,000	3,393	9,861	13,254	28,254	-8,849	917	210	1,680	1,104	8,830	-19
2013	38,937	15,000	3,393	9,770	13,163	28,163	-10,774	1,925	420	2,100	2,208	11,038	263
2014	40,863	15,000	3,393	9,675	13,068	28,068	-12,795	2,021	420	2,520	2,208	13,245	450
2015	42,885	15,000	3,393	9,575	12,968	27,968	-14,917	2,122	420	2,940	2,208	15,453	536
2016	45,008	15,000	3,393	9,471	12,864	27,864	-17,144	2,227	420	3,360	2,208	17,660	516
2017	47,237	15,000	3,393	9,362	12,755	27,755	-19,482	2,338	420	3,780	2,208	19,868	386
2018	49,577	15,000	3,393	9,273	12,666	27,666	-21,911	2,429	420	4,200	2,208	22,075	164
2019	52,035	15,000	3,393	9,182	12,575	27,575	-24,460	2,549	420	4,620	2,208	24,283	-178
2020	**54,616**	**15,000**	**3,393**	9,087	**12,480**	**27,480**	**-27,136**	2,675	630	5,250	3,311	27,594	458
Increase ('99~2020)	**35,014**	-	-	**7,844**	-	-	-	**27,169**	-	**5,250**	-	**27,594**	-

Fig. 5.1 **Energy Demand Forecast of Bhutan**

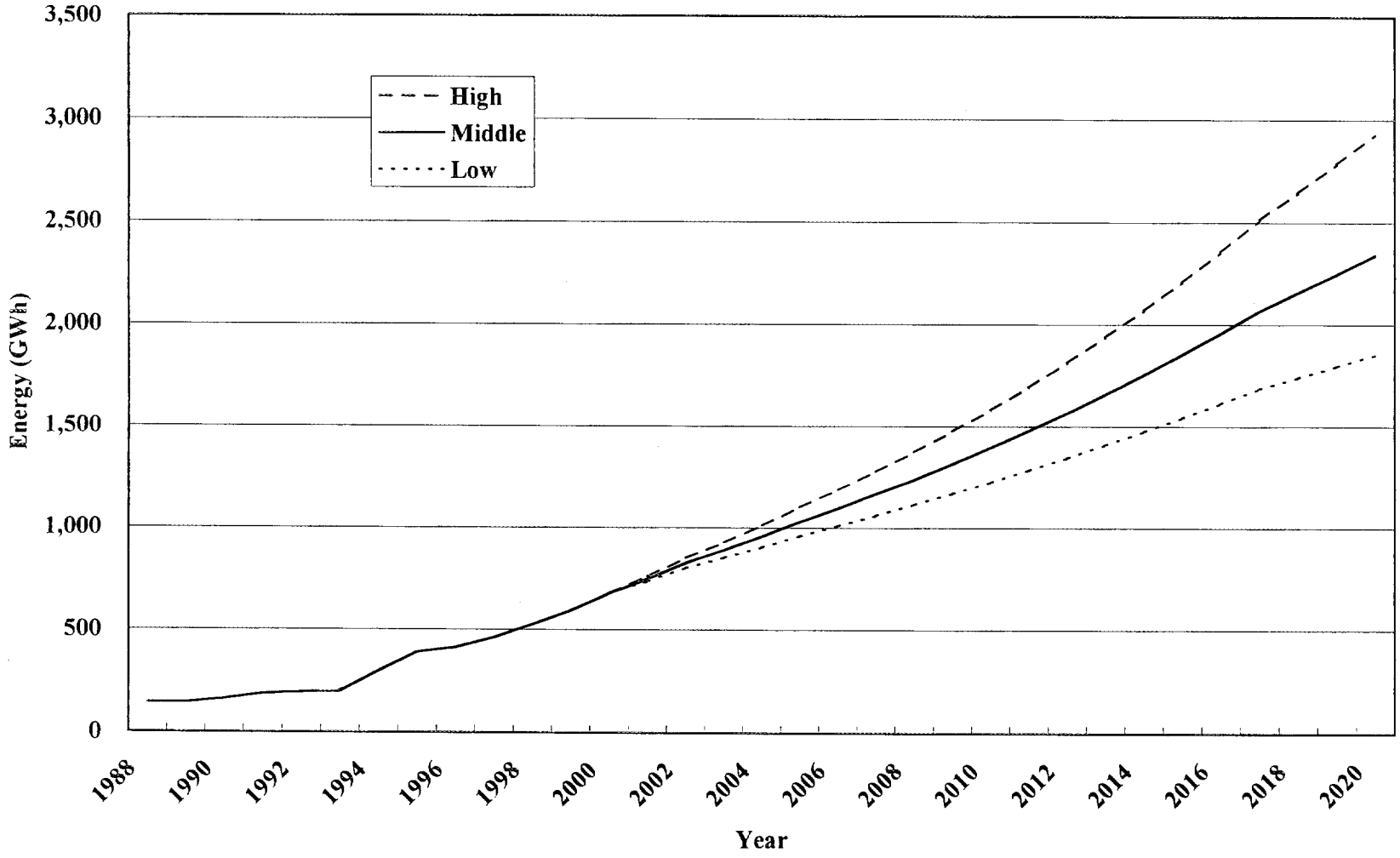


Fig. 5.2 **Peak Power Demand Forecast of Bhutan**

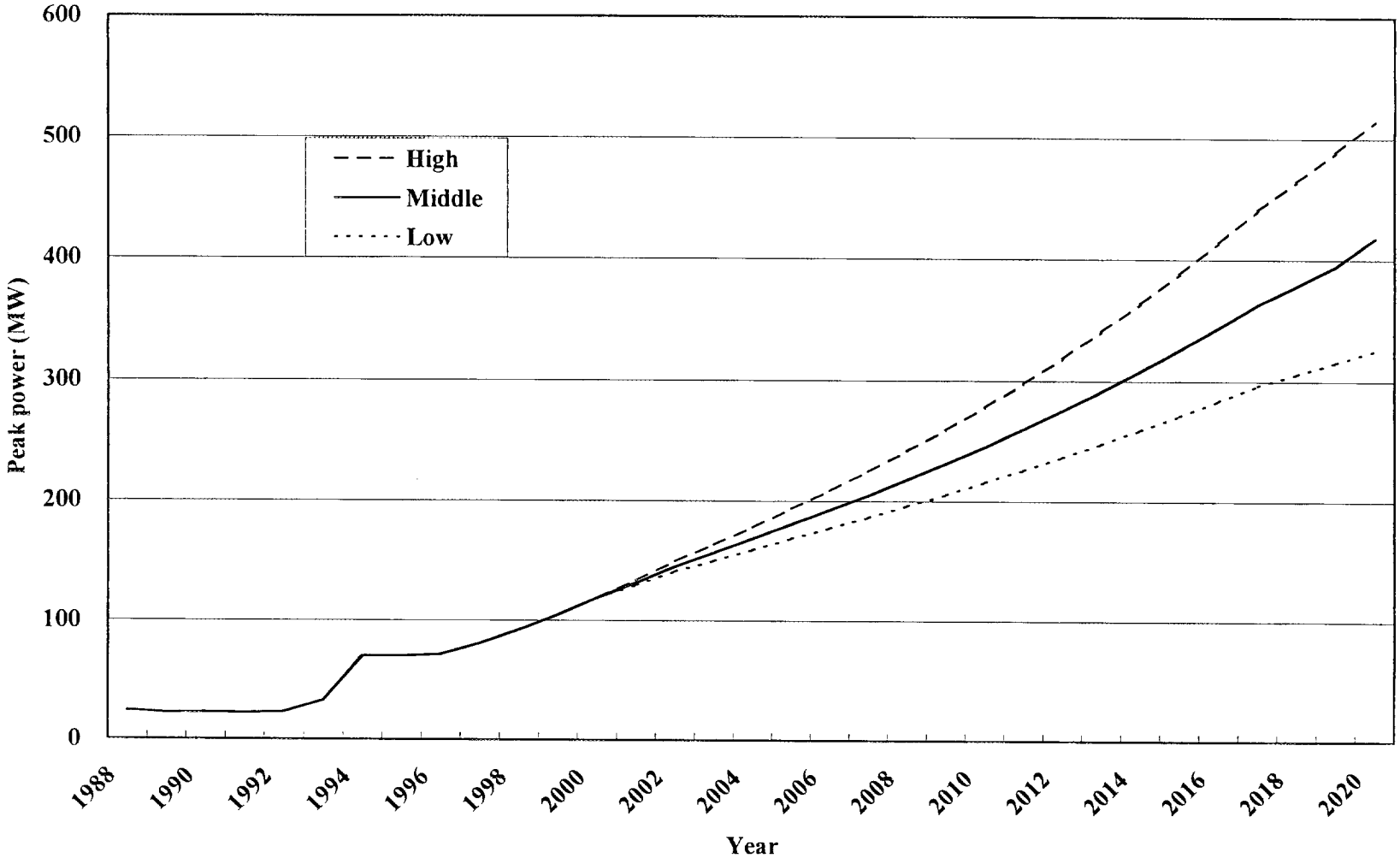


Fig. 5.3 **Elasticity of Energy to GDP (Bhutan & W.Bengal)**

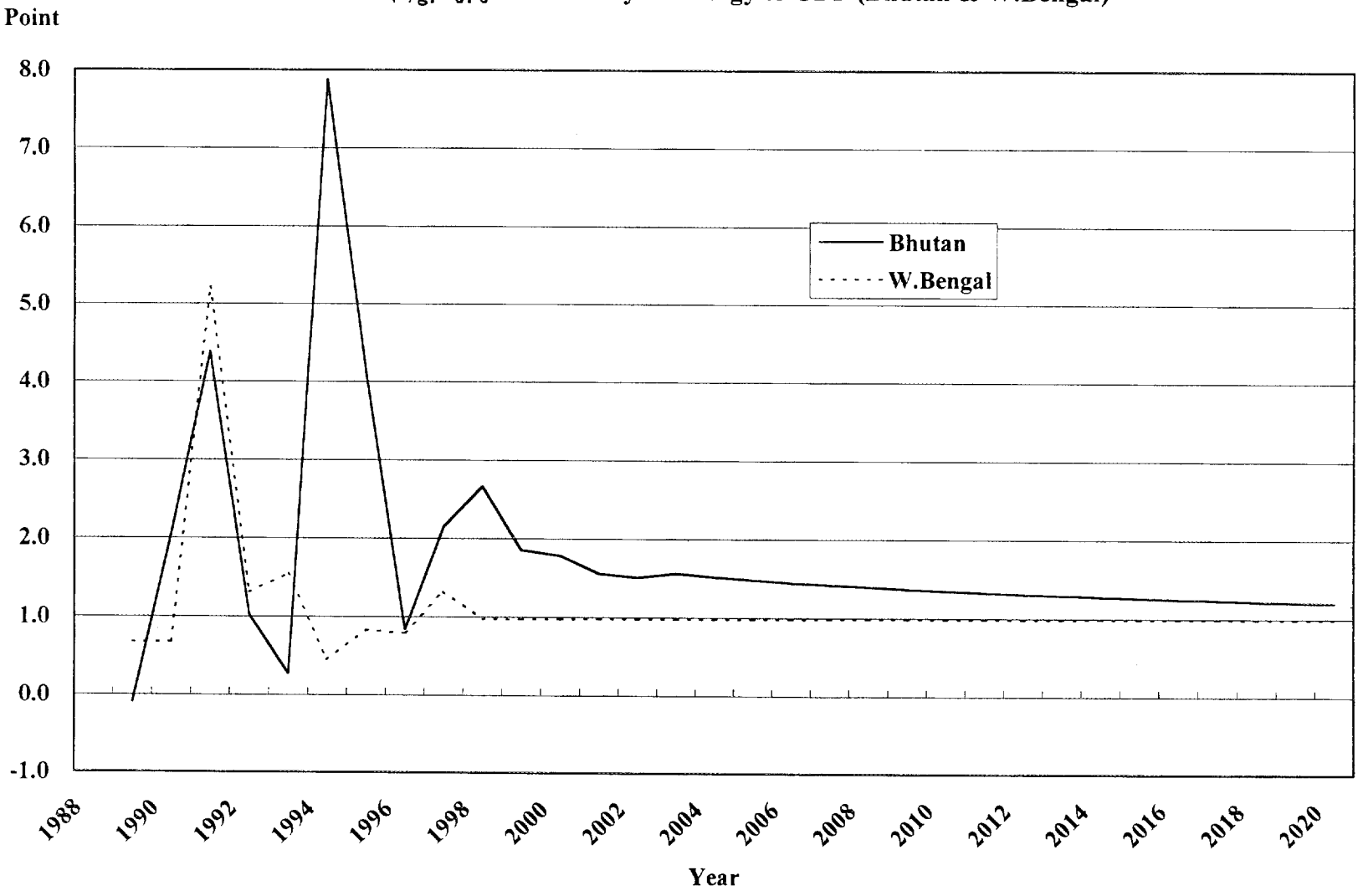


Fig. 5.4 **Energy Demand Forecast of West Bengal**

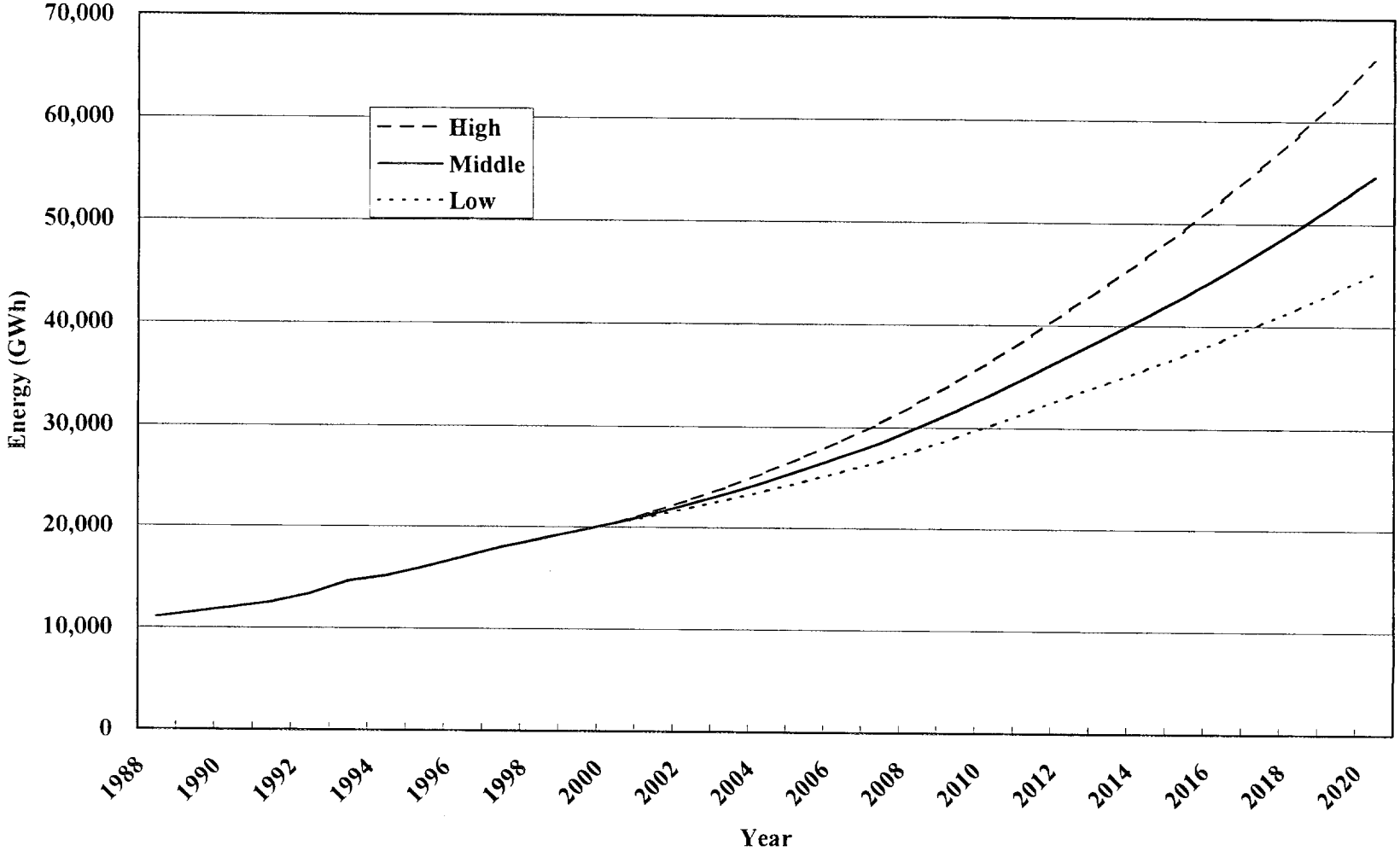


Fig. 5.5 Peak Power Demand of West Bengal